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物理专业科技英语

SCIENCE AND TECHNOLOGY ENGLISH IN PHYSICS

主编 李 锦 谢康宁

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前　言

随着物理学科的不断发展和新技术的广泛应用，以及物理学及其相关领域的国际教育与研究合作交流更加频繁，科技英语早已经是国际上专业交流的主要语言。对物理学专业学生来说，学习物理专业科技英语是必不可少的，也是吸取国外先进知识，进行国内外学术交流的基础。然而，很多高校的物理学专业英语课程并没有得到应有的重视，也没有形成系统的课程体系，在本科生一、二年级上完大学外语以后，即使开设了专业英语，很多专业英语课程的学习方式也仅仅停留在复印一些英文材料进行阅读、解释和翻译的阶段。学生学习后只是提高了一些专业词汇量和阅读翻译水平，而在使用专业英语进行写作和口头交流时，仍力不从心。基于此，作者认为，系统的专业英语的教学，对学生素质的影响举足轻重，不可忽视。

基于这样的想法，作者从自身近几年从事物理学专业科技英语教学、专业课程双语教学以及从事科学研究、国际学术交流的经验出发，编写了这本面向物理学专业的《物理学专业科技英语基础及应用》。

本书是一本针对高等学校物理学及其相关专业的专业英语教材，主要按照两大模块、七章内容、七个部分对物理学专业英语知识进行全方位的阐述。各部分内容既构成统一的整体，同时又自成体系，具体包括：物理学专业英语基础和物理学专业英语应用两大模块；力学、热学、光学、电学、近代物理学、科技英语写作以及科技英语交流七章内容；课文、生词表、课文注释、扩展阅读、常用用法、同义词辨析以及练习题七个部分。其中课文是从西尔斯大学物理英文原版教材中所选取的经典内容，然后通过生词表解释课文中部分难度较大的词汇。课文注释对课文中的语法、词汇表达等内容进行了详尽的解释。扩展阅读选用物理学相应领域的一些前沿和热点话题，用来拓宽学生的知识面。常用用法对物理学专业中用到的一些工具、仪器、设备、数学符号、物理量及其英语表达等做了列举，可供学生有针对性地查阅和掌握。在每节课的最后配备了一些形式多样的练习题，供学生课外练习使用。

全书分为物理学专业英语基础和物理学专业英语应用两个部分，第一、三、七章由谢康宁编写；第二、四、五、六章由李锦编写。雷涛、刘大钊、李瑜、徐文敏、赵筱等都参与查找资料、校对工作之中，在此深表感谢。在本书的编写过程中，屈世显、刘渊声等人为我们提出了宝贵的意见，给予了很大的帮助，在此谨表示衷心的感谢。

书中所有课文和部分扩展阅读的内容都选自《西尔斯物理学》（英文版·原书第10版），在此，向该书的所有作者表示感谢。我们还参考了国内外出版物（见某些章节后面以及本书后面的“参考文献”）中的部分观点和内容，在此谨向这些编著者致以真诚的谢意，并对未能够事先征得同意表示歉意。此外，我们还选用了互联网上的部分资料，由于这些资料涉及面广，选用时做了大量修改，在此不便一一注明，谨向有关人士深表感谢。

本书可以作为物理学及其相关专业本科生、硕士生的教材使用，也适合物理学及其相关领域的科技工作者在使用专业英语进行学习和交流时翻阅参考。

由于水平有限，并且是第一次进行物理学专业科技英语教材的编写，错误和不足是难免的，请读者和同行多指教，以利于再版时修正和改进。

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李　锦

2013年7月

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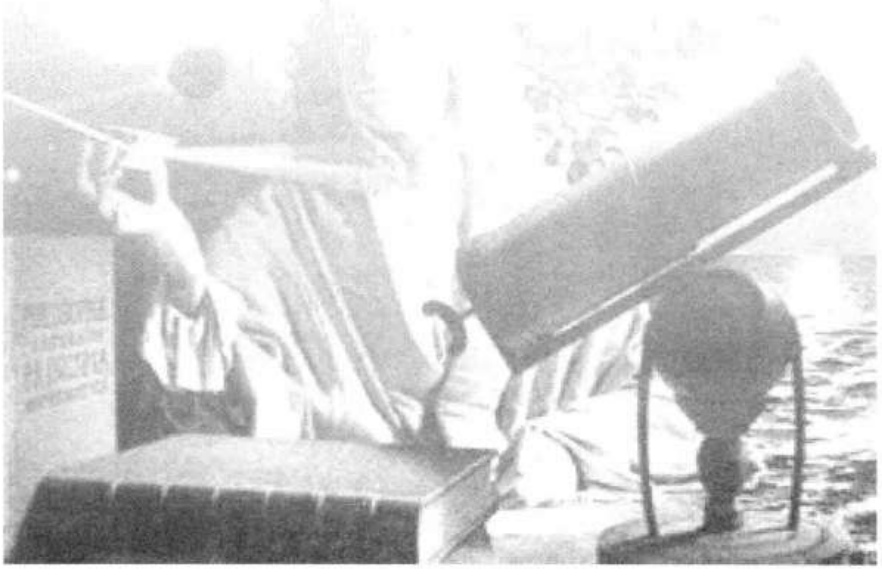
Part One

物理学专业英语基础



第一章 力 学

Lesson 1

内容 1.1 牛顿第一定律 Newton's First Law
1.2 生词表 New Words
1.3 课文注释 Text Annotation
1.4 扩展阅读 Extended Reading: Newton's Second Law
1.5 常用用法 Usages and Expressions
Ⅰ. 数学表达式 Mathematical Expressions
Ⅱ. 力学常用实验仪器 Usual Experimental Mechanics Instruments
1.6 同义词辨析 Synonyms
1.7 练习题 Exercise

1.1 牛顿第一定律 Newton's First Law

[1]**To begin with, let's consider what happens when the net force on a body is zero.** You would almost certainly agree that[2] **if a body is at rest, and if no net force acts on it (that is, no net push or pull), that body will remain at rest.** [3]**But what if there is zero net force acting on a body in motion?**

Suppose you slide a hockey puck along a horizontal table top, applying a horizontal force to it with your hand (Fig. 1 – 1a). After you stop pushing, the puck does not continue to move indefinitely; it slows down and stops. To keep it moving, you have to keep pushing (that is, applying a force). You might come to the "common sense" conclusions that bodies in motion naturally come to rest and that a force is required to sustain motion.

But now imagine pushing the puck across a smooth surface of ice (Fig. 1 – 1b). After you quit pushing, the puck will slide a lot farther before it stops. Put it on an air-hockey table, where it floats on a thin cushion of air, and it moves still farther (Fig. 1 – 1c). In each case, what slows the puck down is friction, an interaction between the lower surface of the puck and the surface on which it slides. Each surface exerts a frictional force on the puck that resists the puck's motion; the difference in the three cases is the magnitude of the frictional force.

The tendency of a body to keep moving once it is set in motion results from a property called inertia. You use inertia when you try to get ketchup out of a bottle by shaking it. First you start the bottle (and the ketchup inside) moving forward; [4] **when you jerk the bottle back, the ketchup tends to keep moving forward and, you hope, ends up on your burger.** The tendency of a body at rest to remain at rest is also due to inertia. You may have seen a tablecloth yanked out from under the china without breaking anything. The force on the china isn't great enough to make it move appreciably during the short time it takes to pull the tablecloth away.

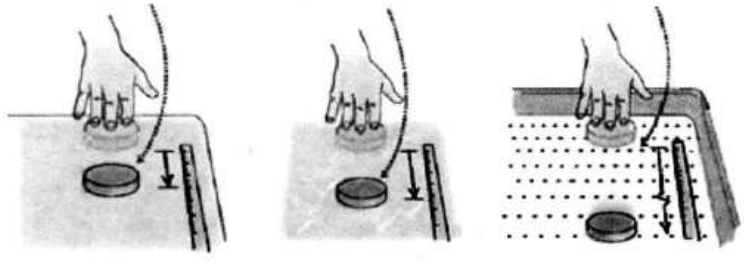


Fig. 1 – 1 (a) Table: puck stops short. (b) Ice: puck slides further. (c) Air-hockey table: puck slides even further.

When no net force acts on a body, the body either remains at rest or moves with constant velocity in a straight line. Once a body has been set in motion, no net force is needed to keep it moving. We now call this observation Newton's first law of motion.

Newton's first law of motion: A body acted on by no net force moves with constant velocity (which may be zero) and zero acceleration.

It's important to note that the net force is what matters in Newton's first law. For example, a physics book at rest on a horizontal table top has two forces acting on it: an upward supporting force, or normal force, exerted by the table top and the downward force of the earth's gravitational attraction (a long-range force that acts even if the table top is elevated above the ground). The upward push of the surface is just as great as the downward pull of gravity, so the net force acting on the book (that is, the vector sum of the two forces) is zero. In agreement with Newton's first law, if the book is at rest on the table top, it remains at rest. The same principle applies to a hockey puck sliding on a horizontal, frictionless surface: The vector sum of the upward push of the surface and the downward pull of gravity is zero. Once the puck is in motion, it continues to move with constant velocity because the net force acting on it is zero.

Inertial Frames of Reference

The concept of frame of reference is central to Newton's laws of motion. Suppose you are in a bus that is traveling on a straight road and speeding up. If you could stand in the aisle on roller skates, you would start moving backward relative to the bus as the bus gains speed. If instead the bus was slowing to a stop, you would start moving forward down the aisle. In either case, it looks as though Newton's first law is not obeyed; there is no net force acting on you, yet your velocity changes. What's wrong?

The point is that the bus is accelerating with respect to the earth and is not a suitable frame of reference for Newton's first law. This law is valid in some frames of reference and is not valid in others. A frame of reference in which Newton's first law is valid is called an inertial frame of reference. The earth is at least approximately an inertial frame of reference, but the bus is not. (The earth is not a completely inertial frame, owing to the acceleration associated with its rotation and its motion around the sun. These effects are quite small, however.) Because Newton's first law is used to define what we mean by an inertial frame of reference, it is sometimes called the law of inertia.

There is no single inertial frame of reference that is preferred over all others for formulating Newton's laws. If one frame is inertial, then every other frame moving relative to it with constant velocity is also inertial. [5] **Viewed in this light, the state of rest and the state of motion with constant velocity are not very different**; both occur when the vector sum of forces acting on the body is zero.

1.2 生词表 New Words

hockey puck 冰球
friction *n.* 摩擦力
inertia *n.* 惯性
ketchup *n.* 番茄酱
jerk *v.* 猛拉
yank *v.* 猛拉
velocity *n.* 速度
acceleration *n.* 加速度
exert *v.* 施以影响
gravitational *adj.* 重力的,引力的
elevate *v.* 提升;举起
gravity *n.* 重力
vector *n.* 向量
frame of reference 参照系
aisle *n.* 过道
roller skate 轮式溜冰鞋
obey *v.* 遵守
owing to 由于

1.3 课文注释 Text Annotation

【1】To begin with, let's consider what happens when the net force on a body is zero.

首先,让我们考虑当作用在物体上的合力为零时,会发生什么。

net 这个单词有两个语源,一是"网",可以作名词或动词;二是"净(neat)",一般作形容词,表示去掉外围剩下的核心部分,与此相对的是 gross,表总数。

►1. "网"

e. g. :a fishing net 捕鱼网(名词)

If the ball touches the net during a service in a game of tennis, you have to serve again.

在网球比赛中如果发球触网,必须重新发球。(名词)

How many fish did you net this afternoon?

今天下午你网了多少鱼?(动词)

▶2. “净(neat)”

e. g. : I earn £ 5,000 gross, but my net income (= income that is left after tax has been paid) is about £ 2,000.

我总收入 5 000 英镑,但我的净收入(税后收入)大约是 2 000 英镑。

【2】if a body is at rest, and if no net force acts on it (that is, no net push or pull), that body will remain at rest.

如果一个物体处于静止状态,并且没有合力作用于其上(即没有推力或拉力)时,该物体将会保持静止。

at rest 静止;休息;安眠。这里的意思是“静止”。

◆1. 静止,不运动

e. g. : My heartbeat is only 50 at rest.

我安静时的心跳只有 50 次/分钟。

◆2. 对死亡的敬语

e. g. : Tom was a very troubled man, but he's at rest now.

汤姆是个多灾多难的人,但现在他安息了。

◆3. set/put sb. 's mind at rest/ease 令某人不再担心

e. g. : Mary phoned to say she had gone home safely, and that really put her mother's mind at rest.

玛丽打电话说她已经安全回家了,她的妈妈不再担心了。

【3】But what if there is zero net force acting on a body in motion?

但是如果作用于运动中的物体的合外力为零的话,结果会是怎样?

zero 是“零”,复数形式为 zeros 或 zeroes,可以是可数名词或不可数名词。zero 也可以作形容词,意思为“没有”。在英国还经常用 nought 表示“零”。

◆1. 作名词

e. g. : The number one thousand is written with a one and 3 zeros/noughts.

数字 1 000 写为 1 个 1 和 3 个 0。

◆2. 作形容词

e. g. : My chances of getting the job were zero (= I had no chance).

我得到那个工作的机会是零。

【4】when you jerk the bottle back, the ketchup tends to keep moving forward and, you hope, ends up on your burger.

当你迅速拉回瓶子时,番茄酱趋向于继续向前运动,并且,你希望它最终会落在你的汉堡包上。

end up 是动词短语,意为“最终处于某个位置或情况”,通常带有偶然和意外的意味。

e. g. : She fled with her children, moving from neighbour to neighbour and ending up in a friend's basement.

她和她的孩子们逃走了,从一家邻居转到另一家,最终来到一个朋友家的地下室。

If you don't know what you want, you might end up getting something you don't want.

如果你不知道自己想要什么,你可能会到头来得到自己不想要的东西。

【5】Viewed in this light, the state of rest and the state of motion with constant velocity are not very different.

从这个观点考虑,处于静止状态和匀速直线运动状态是相同的。

in this light 短语,意为"就这个方面(情况、观点)而言"。light 的意思很多,最基本的意思是名词"光"和形容词"轻的",在此处的意思是 a particular perspective or aspect of a situation。

▶1. 情况;观点

e. g. : Although he saw it in a different light, he still did not understand.

虽然他换了一种角度看这个(事物),但是他仍然无法理解。

▶2. the light of your life

e. g. : the person you love most 你最爱的那个人

▶3. come to light 显示

e. g. : Fresh evidence has recently come to light which suggests that he didn't in fact commit the murder.

最新的证据表明,他实际上并没有参与谋杀。

▶4. cast/shed/throw light on sth. 解释

e. g. : As an economist, he was able to shed some light on the problem.

作为一名经济学家,他能对这个问题做出解释。

▶5. show someone in a bad light 使某人看起来像个坏人

注意区别另一个类似的短语 in (the) light of,该短语意思为 because of。

▶6. in(the) light of = because of

e. g. : In the light of recent incidents, we are asking our customers to take particular care of their personal belongings.

由于近来的事件,我们正督促用户特别注意个人物品安全。

1.4 扩展阅读 Extended Reading

Newton's Second Law

Newton's first law tells us that when a body is acted on by zero net force, it moves with constant velocity and zero acceleration. Suppose a hockey puck is sliding to the right on wet ice. There is negligible friction, so there are no horizontal forces acting on the puck; the downward force of gravity and the upward normal force exerted by the ice surface sum to zero. So the net force acting on the puck is zero, the puck has zero acceleration, and its velocity is constant.

But what happens when the net force is not zero? We apply a constant horizontal force to a sliding puck in the same direction that the puck is moving. Then net force is constant and in the same horizontal direction as velocity. We find that during the time the force is acting, the velocity of the puck changes at a constant rate; that is, the puck moves with constant acceleration. The speed of the

puck increases, so the acceleration is in the same direction as velocity and net force.

Newton's second law of motion: If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. The mass of the body times the acceleration of the body equals the net force vector.

In symbols,

$$\sum \vec{F} = m\vec{a} \tag{1-1}$$

The above equation has many practical applications. You've actually been using it all your life to measure your body's acceleration. In your inner ear, microscopic hair cells sense the magnitude and direction of the force that they must exert to cause small membranes to accelerate along with the rest of your body. By Newton's second law, the acceleration of the membranes—and hence that of your body as a whole—is proportional to this force and has the same direction. In this way, you can sense the magnitude and direction of your acceleration even with your eyes closed!

Using Newton's Second Law

First, the equation is a vector equation. Usually we will use it in component form, with a separate equation for each component of force and the corresponding acceleration:

$$\sum F_x = ma_x, \quad \sum F_y = ma_y, \quad \sum F_z = ma_z \tag{1-2}$$

This set of component equations is equivalent to the single vector equation. Each component of the net force equals the mass times the corresponding component of acceleration.

Second, the statement of Newton's second law refers to external forces. By this we mean forces exerted on the body by other bodies in its environment. It's impossible for a body to affect its own motion by exerting a force on itself; if it were possible, you could lift yourself to the ceiling by pulling up on your belt!

Third, Eqs. (1-1) *and* (1-2) *are valid only when the mass m is constant. It's easy to think of systems whose masses change, such as a leaking tank truck, a rocket ship, or a moving railroad car being loaded with coal. But such systems are better handled by using the concept of momentum.*

Finally, Newton's second law is valid only in inertial frames of reference, just like the first law. Thus it is not valid in the reference frame of any accelerating vehicles; relative to any of these frames, the passenger accelerates even though the net force on the passenger is zero. We will usually assume that the earth is an adequate approximation to an inertial frame, although because of its rotation and orbital motion it is not precisely inertial.

"Force of Acceleration" Does Not Exist

You must keep in mind that even though the vector $m\vec{a}$ *is equal to the vector sum* $\sum \vec{F}$ *of all the forces acting on the body, the vector is not a force. Acceleration is a result of a nonzero net force; it is not a force itself. It's "common sense" to think that there is a "force of acceleration" that pushes you back into your seat when your car accelerates forward from rest. But there is no such force; instead, your inertia causes you to tend to stay at rest relative to the earth, and the car accelerates*

around you. The "common sense" confusion arises from trying to apply Newton's second law where it isn't valid, in the non-inertial reference frame of an accelerating car. We will always examine motion relative to inertial frames of reference only.

Mass and Weight

One of the most familiar forces is the weight of a body, which is the gravitational force that the earth exerts on the body. (If you are on another planet, your weight is the gravitational force that planet exerts on you.) Unfortunately, the terms mass and weight are often misused and interchanged in everyday conversation. It is absolutely essential for you to understand clearly the distinctions between these two physical quantities. Mass characterizes the inertial properties of a body. Mass is what keeps the china on the table when you yank the tablecloth out from under it. The greater the mass, the greater the force needed to cause a given acceleration; this is reflected in Newton's second law.

Weight, on the other hand, is a force exerted on a body by the pull of the earth. Mass and weight are related: Bodies having large mass also have large weight. A large stone is hard to throw because of its large mass, and hard to lift off the ground because of its large weight.

To understand the relationship between mass and weight, note that a freely falling body has an acceleration of magnitude g. Newton's second law tells us that a force must act to produce this acceleration. If a 1kg *body falls with an acceleration of* 9.8 m/s^2, *the required force has magnitude*

$$F = ma = (1\ \text{kg})(9.8\ \text{m/s}^2) = 9.8\ \text{kg} \cdot \text{m/s}^2 = 9.8\ \text{N}.$$

We will use $g = 9.80\ \text{m/s}^2$ *for problems on the earth (or, if the other data in the problem are given to only two significant figures,* $g = 9.8\ \text{m/s}^2$). *In fact, the value of g varies somewhat from point to point on the earth's surface, from about* 9.78 *to* 9.82 m/s^2, *because the earth is not perfectly spherical and because of effects due to its rotation and orbital motion. At a point where* $g = 9.80\ \text{m/s}^2$, *the weight of a standard kilogram is* $G = 9.80$ N. *At a different point, where* $g = 9.78\ \text{m/s}^2$, *the weight is* $G = 9.78$ N *but the mass is still* 1 kg. *The weight of a body varies from one location to another; the mass does not.*

The concept of mass plays two rather different roles in mechanics. The weight of a body (the gravitational force acting on it) is proportional to its mass; we call the property related to gravitational interactions gravitational mass. On the other hand, we call the inertial property that appears in Newton's second law the inertial mass. If these two quantities were different, the acceleration due to gravity might well be different for different bodies. However, extraordinarily precise experiments have established that in fact the two are the same to a precision of better than one part in 10^{12}.

1.5 常用用法 Usages and Expressions

Ⅰ. 数学表达式 Mathematical Expressions

表达式	发 音
$a+b$	a plus b
$a-b$	a minus b

Cont. 续表

表达式	发　音
$a \cdot b$	a times b, or a is multiplied by b
a/b, $a \div b$	a over b, or a is divided by b
‰	per mille
%	percent
$x \leqslant a$	x is less than or equal to a
$y \geqslant b$	y is greater than or equal to b
$1/3 \approx 0.33$	one divided by three is approximately equal to zero point three three
$x \equiv a$	x is identical to a, or x is equivalent to a
$\lvert a \rvert$	the absolute value of a
a^2	a squared
a^3	a cubed
a^n	a to the nth power
$n!$	factorial n
$\sqrt{x}$	square root of x
$\sqrt[3]{x}$	cube root of x
$\sqrt[n]{x}$	the nth root of, n is called index, $\sqrt{\ }$ is called the radical sign or radix and x is called the radicand
$\frac{1}{3}\{a[2-(b+c)]\}$	one-third open brace, a open bracket b minus open parenthesis b plus c close parenthesis close bracket close brace
$\sum_{n=1}^{10} X_n$	capital sigma X_n from n equals one to n equals ten
$\prod_{n=-\infty}^{\infty} Y_n$	product of all Y_n from n equals minus infinity to infinity
$\lim_{n\to\infty} X_n$	the limit of X_n as n gets infinite
$f(x)=ax^2+bx+c, a\neq 0$	the function of x equals a times the square of x plus b times x plus c, where a is not equal to zero

Ⅱ. 力学常用实验仪器 Usual Experimental Mechanics Instruments

metric ruler 米尺　　micrometer screw gauge 螺旋测微计

vernier caliper 游标卡尺　　balance 天平

stopwatch 秒表

1.6 同义词辨析 Synonyms

look, glance, appear, watch, notice, guard, see, perceive, meet, encounter, visit, witness, view, consider, check, observe, inspect, regard

These words all mean to turn your eyes in a particular direction.

以上各词均含“看,观看”之义。

◆ look to turn your eyes in a particular direction 在某一方向上集中注意力看,瞧

e. g. : We sneaked out while Jessie's mom wasn't looking.
我们趁杰茜的妈妈没有看到,偷偷地溜了出去。
The men all turned to look at her as she entered the room.
她走进房间的时候,所有男人都转过头来看她。

【习惯用法】

look into 观察;过问;调查
look at 看望;注视
look back 回顾;回头看
look for 寻找;寻求

◆ glance to look quickly at sth./sb. 匆匆一看;扫视

e. g. : The man glanced nervously at his watch.
那人紧张地看了一下手表。
Emily glanced over her shoulder.
埃米莉回头看了一眼。

【习惯用法】

at a glance 一眼
glance at 朝……看一眼

◆ appear (not used in the progressive tenses 不用于进行时) to give the impression of being or doing sth. 显得;看来;似乎

e. g. : Police say there appears to be signs of a break-in.
警方称似乎有破门而入的迹象。
It may be less useful than it appears at first.
它可能没有一开始显得那么有用。

◆ watch to look at sb./sth. for a time, paying attention to what happens 看,注视,观看,观察

e. g. : We sat and watched the sunset.
我们坐着看日落。
He watched helplessly as Paula fell into the icy water.
他无助地看着葆拉落入冰冷的水中。

【习惯用法】

watch out 当心,注意;监视
watch one's step 留心脚下; 小心摔倒

◆ notice the fact of sb. paying attention to sb./sth. or knowing about sth. 注意或察觉某事,注意;理会;察觉

e. g. : I waved but they took no notice.
我挥了挥手,可是他们没有注意到。

◆ guard to prevent prisoners from escaping 防止犯人逃跑,看守;监视

e. g. : The sergeant told Swift to guard the entrance.
中士叫斯威夫特守着入口。
There is no one to guard these isolated farms against attack.
这几处孤立的农场门户大开,无人守卫。

◆ see to watch a game, television programme, performance, etc. 观看(比赛、电视节目、演出等)

e. g. : Did you see that programme on monkeys last night?
你昨晚看了那个讲猴子的节目了吗?
We're going to see "Romeo and Juliet" tonight.
今晚我们要去看《罗密欧与朱丽叶》。

【习惯用法】

keep guard　　守望
guard against　　留心

◆ perceive to notice or become aware of sth. 注意到;意识到;察觉到

e. g. : That morning, he perceived a change in Franco's mood.
那天早上,他注意到佛朗哥情绪的变化。
He perceived that there was no other way out of the crisis.
他意识到没有其他办法可以摆脱危机。

◆ meet to be in the same place as sb. by chance and talk to him 相遇;相逢;遇见

e. g. : Why don't we meet for lunch on Friday?
我们星期五一起吃午饭吧。
We arranged to meet outside the theatre.
我们说好在剧院外面碰头。

◆ encounter to meet sb., or discover or experience sth. 遇见;发现;偶然碰到

e. g. : They encountered serious problems when two members of the expedition were injured.
两名远征队员受伤,他们遇到了严重的问题。
The doctor had encountered several similar cases in the past.
那位医生过去曾碰到过好几个类似的病例。

◆ visit to make an official visit to sb. 视察;巡视

e. g. : The building inspector is visiting the new housing project.
建筑检查员正在视察这个新的住房项目。
The President's first trip abroad will be to visit troops in Bosnia.
总统第一次出国之行将视察驻扎在波斯尼亚的军队。

◆ witness to see sth. happen (typically a crime or an accident) 当场看到某事(尤指罪行或事故);目击

e. g. : Police have appealed for witnesses to come forward.

警方呼吁目击者站出来。

One witness to the accident said the driver appeared to be drunk.

事故的一名目击者说司机似乎喝醉了。

◆ view (formal) to look at sth., especially when you look carefully; to watch television, a film / movie, etc. 仔细观察,观看;看(电视、电影等)

e. g. : an opportunity to view the film before it goes on general release

在影片公映之前的一个观看机会

◆ consider to look carefully at sb./sth. 仔细看某人,端详;注视

e. g. : Ben considered the statue with an expert eye.

本以专家的眼光仔细地审视这座雕像。

◆ check to find out if sth. is correct or true or if sth. is how you think it is 判断某事是否正确;查明;查看;核实

e. g. : Conduct regular checks on your water quality.

要经常检查水质。

Have a check in your bag first and see if it's there.

先检查一下你的袋子,看是否在那儿。

【习惯用法】

check in 住进,登记

check out 检查;调查

check on 核对

◆ observe (formal) to watch sb./sth. carefully, especially to learn more about it 观察;注视;监视

e. g. : One student performs the experiment, while his partner observes it.

一名学生做实验,他的搭档则进行观察。

Observe how the people in the group interact.

注意观察这个小组内的人是如何相互交流的。

◆ inspect to officially visit a school, factory, etc., in order to check that rules are being obeyed and that standards are acceptable. (官方正式的)访问;参观(目的是了解和视察规章制度和标准是否合理)

e. g. : The building is regularly inspected by the fire-safety officer.

消防安全官定期巡视这座大楼。

General Allenby arrived to inspect the troop.

艾伦比将军来此检阅部队。

◆ regard to look at sb./sth., especially in a particular way 注视;凝视

e. g. : She stood back and regarded him coldly.

她退后站着,冷冷地看着他。

【习惯用法】

at regards	关于,至于
in this regard	在这方面,关于这件事
regard as	视为,当做

1.7 练习题 Exercise

(1-1) 完形填空,然后把短文译成汉语。

The aim of this review paper is to report on the current state of the ____[1]____ in creating in silico humans able to simulate the biomechanics of the human body at all scales of interest. The focus is ____[2]____ the musculoskeletal apparatus, although much of what is written is valid also for the biomechanical modeling of other organs. The state of the ____[3]____ of computational biomechanics at body, organ, tissue, and cell levels is briefly described and the most recent achievements in the area of multiscale models ____[4]____ discussed. In ____[5]____, the challenges to be faced to realize a true living human model are summarized. It is evident that the demands associated with some of these challenges greatly exceed the potential currently possessed by the computational biomechanics research community. ____[6]____, to tackle them it will be necessary not only to coordinate all efforts in a coherent way, but also to mobilize much greater financial and human resources that are currently available.

[1] A. science	B. technology	C. art	D. history
[2] A. on	B. in	C. for	D. to
[3] A. science	B. technology	C. art	D. history
[4] A. is	B. be	C. were	D. are
[5] A. beginning	B. end	C. up	D. conclusion
[6] A. However	B. Thus	C. Moreover	D. In addition

(1-2) 用单词的适当形式填空。

A cochlear implant is a surgically implanted electronic device that can help provide a sense of sound to a person who is profoundly deaf or severely hard of hearing. The cochlear implant is often (1) _____(refer) to as a bionic ear. Unlike other kinds of hearing aids, the cochlear implant doesn't amplify sound, but (2) _____(work) by directly stimulating any functioning auditory nerves inside the cochlea with electrical impulses. External components of the cochlear implant (3) _____(include) a microphone, speech processor and transmitter.

An implant does not restore or create normal hearing. Instead, under the appropriate conditions, it can give a deaf person a useful auditory understanding of the environment and help them to understand speech although post-implantation therapy may be required. According to (4) _____(research) at the University of Michigan, approximately 100,000 people worldwide have received cochlear implants; roughly half (5) _____(be) children and half adults. The vast majority are in developed countries due to the prohibitive cost of the device, surgery and post-implantation therapy. Mexico had performed only 55 cochlear implant operations by the year 2000.

(1-3) 填空。

The International System of Units, abbreviated as (1)_____, is the modern form of the metric system. It is the world's most widely used (2)_____ of units, both in everyday commerce and in science. The older metric system included several groupings of units. The SI was developed in 1960 from the metre-kilogram-second (mks) system, rather than the centimetre-(3)_____-second (cgs) system which, in turn, had many variants. The SI introduced several newly named units. The SI is not static; it is a living set of standards where units are created and definitions are modified with international agreement as measurement technology progresses.

With few exceptions, the system is used in every country in the world, and many countries do not maintain official definitions of other (4)_____. In the United States, industrial use of SI is increasing, but popular use is still limited. In the United Kingdom, conversion to metric units is official policy but not yet complete. Those countries that still recognize non-SI units ((5)_____ the U.S. and UK) have redefined their traditional non-SI units in terms of SI units.

(1-4) 阅读并用自己的话复述短文,可以借助黑板、多媒体等工具,培养科技英语阅读和口头表达能力。

There is a popular story that Newton was sitting under an apple tree, an apple fell on his head, and he suddenly thought of the Universal Law of Gravitation. As in all such legends, this is almost certainly not true in its details, but the story contains elements of what actually happened.

Probably the more correct version of the story is that Newton, upon observing an apple fall from a tree, began to think along the following lines: The apple is accelerated, since its velocity changes from zero as it is hanging on the tree and moves toward the ground. Thus, by Newton's 2nd law there must be a force that acts on the apple to cause this acceleration. Let's call this force "gravity", and the associated acceleration the "acceleration due to gravity." Then imagine the apple tree is twice as high. Again, we expect the apple to be accelerated toward the ground, so this suggests that this force that we call gravity reaches to the top of the tallest apple tree.

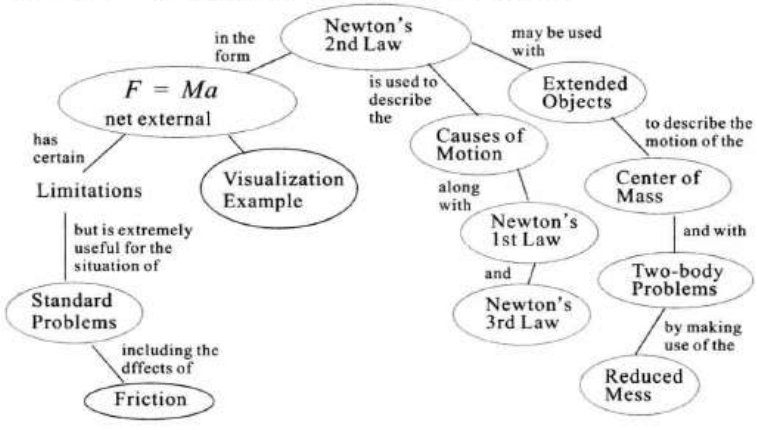
Now came Newton's truly brilliant insight: If the force of gravity reaches to the top of the highest tree, might it not reach even further; in particular, might it not reach all the way to the orbit of the Moon! Then, the orbit of the Moon around the Earth could be a consequence of the gravitational force, because the acceleration due to gravity could change the velocity of the Moon in just such a way that it followed an orbit around the earth.

This can be illustrated with the thought experiment shown in the following figure. Suppose we fire a cannon horizontally from a high mountain; the projectile will eventually fall to earth, as indicated by the shortest trajectory in the figure, because of the gravitational force directed toward the center of the Earth and the associated acceleration. (Remember that an acceleration is a change in velocity and that velocity is a vector, so it has both a magnitude and a direction. Thus, an acceleration occurs if either or both the magnitude and the direction of the velocity change.)

But as we increase the muzzle velocity for our imaginary cannon, the projectile will travel further and further before returning to the Earth. Finally, Newton reasoned that if the cannon projected the cannon ball with exactly the right velocity, the projectile would travel completely around

the Earth, always falling in the gravitational field but never reaching the Earth, which is curving away at the same rate that the projectile falls. That is, the cannon ball would have been put into orbit around the Earth. Newton concluded that the orbit of the Moon was of exactly the same nature: The Moon continuously "fell" in its path around the Earth because of the acceleration due to gravity, thus producing its orbit.

(1-5) 根据下图写一段话,将图中的逻辑关系表达清楚。



(1-6) 翻译。

Newton's first law tells us that when a body is acted on by zero net force, it moves with constant velocity and zero acceleration. Suppose a hockey puck is sliding to the right on wet ice. There is negligible friction, so there are no horizontal forces acting on the puck; the downward force of gravity and the upward normal force exerted by the ice surface sum to zero. So the net force acting on the puck is zero, the puck has zero acceleration, and its velocity is constant.

But what happens when the net force is not zero? We apply a constant horizontal force to a sliding puck in the same direction that the puck is moving. Then net force is constant and in the same horizontal direction as velocity. We find that during the time the force is acting, the velocity of the puck changes at a constant rate; that is, the puck moves with constant acceleration. The speed of the puck increases, so the acceleration is in the same direction as velocity and net force.

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Lesson 2

内容 2.1 功和能 Work and Energy
2.2 生词表 New Words
2.3 课文注释 Text Annotation
2.4 扩展阅读 Extended Reading: Fossil Fuel
2.5 常用用法 Usages and Expressions
集合 Sets
2.6 同义词辨析 Synonyms
2.7 练习题 Exercise

2.1 功和能 Work and Energy

Suppose you try to find the speed of an arrow that has been shot from a bow. You apply Newton's laws and all the problem-solving techniques that we've learned, but you run across a major stumbling block: After the archer releases the arrow, the bow string exerts a varying force that depends on the arrow's position. As a result, the simple methods that we've learned aren't enough to calculate the speed. Never fear; we aren't by any means finished with mechanics, and there are other methods for dealing with such problems.

The new method that we're about to introduce uses the ideas of work and energy. [1]**The importance of the energy idea stems from the principle of conservation of energy**: Energy is a quantity that can be converted from one form to another but cannot be created or destroyed. In an automobile engine, chemical energy stored in the [2]**fuel** is converted partially to the energy of the automobile's motion and partially to thermal energy. In a microwave oven, electromagnetic energy obtained from your power company is converted to thermal energy of the food being cooked. In these and all other processes, the total energy—the sum of all energy present in all different forms—remains the same. No exception has ever been found.

We'll learn about one important form of energy called kinetic energy, or energy of motion, and how it relates to the concept of work. We'll also consider power, which is the time rate of doing work.

You'd probably agree that it's hard work to pull a heavy sofa across the room, to lift a stack of

encyclopedias from the floor to a high shelf, or to push a stalled car off the road. Indeed, all of these examples agree with the everyday meaning of work—any activity that requires muscular or mental effort.

In physics, work has a much more precise definition. By making use of this definition we'll find that in any motion, no matter how complicated, the total work done on a particle by all forces that act on it equals the change in its kinetic energy—a quantity that's related to the particle's speed. This relationship holds even when the forces acting on the particle aren't constant, a situation that can be difficult or impossible to handle. The ideas of work and kinetic energy enable us to solve problems in mechanics that we could not have attempted before.

The physicists' definition of work is based on these observations. Consider a body that undergoes a displacement of magnitude along a straight line. (For now, we'll assume that any body we discuss can be treated as a particle so that we can ignore any rotation or changes in shape of the body.) While the body moves, a constant force $\vec{F}$ acts on it in the same direction as the displacement. We define the work done by this constant force under these circumstances as the product of the force magnitude and the displacement magnitude:

$$W = Fs \text{ (constant force in direction of straight-line displacement)}. \qquad (2-1)$$

The [3]**SI** unit of work is the joule (abbreviated J, pronounced "jewel," and named in honor of the 19th century English physicist [4]**James Prescott Joule**). From Eq. (2-1) we see that in any system of units, the unit of work is the unit of force multiplied by the unit of distance. In SI units the unit of force is the newton and the unit of distance is the meter, so 1 joule is equivalent to 1 newton-meter (N·m):

$$1 \text{ joule} = (1 \text{ newton})(1 \text{ meter}) \text{ or } 1\ \mathrm{J} = 1\ \mathrm{N \cdot m}.$$

The total work done on a body by external forces is related to the body's displacement—that is, to changes in its position. But the total work is also related to changes in the speed of the body. To see this, consider Fig. 2-1, which shows three examples of a block sliding on a frictionless table. The forces acting on the block are its weight $\vec{G}$, the normal force $\vec{N}$, and the force $\vec{F}$ exerted on it by the hand.

In Fig. 2-1(a) the net force on the block is in the direction of its motion. From Newton's second law, this means that the block speeds up; from Eq. (2-1), this also means that the total work W_{tot} done on the block is positive. The total work is negative in Fig. 2-1(b) because the net force opposes the displacement; in this case the block slows down. The net force is zero in Fig. 2-1(c), so the speed of the block stays the same and the total work done on the block is zero. We can conclude that when a particle undergoes a displacement, it speeds up if $W_{tot} > 0$, slows down if $W_{tot} < 0$, and maintains the same speed if $W_{tot} = 0$.

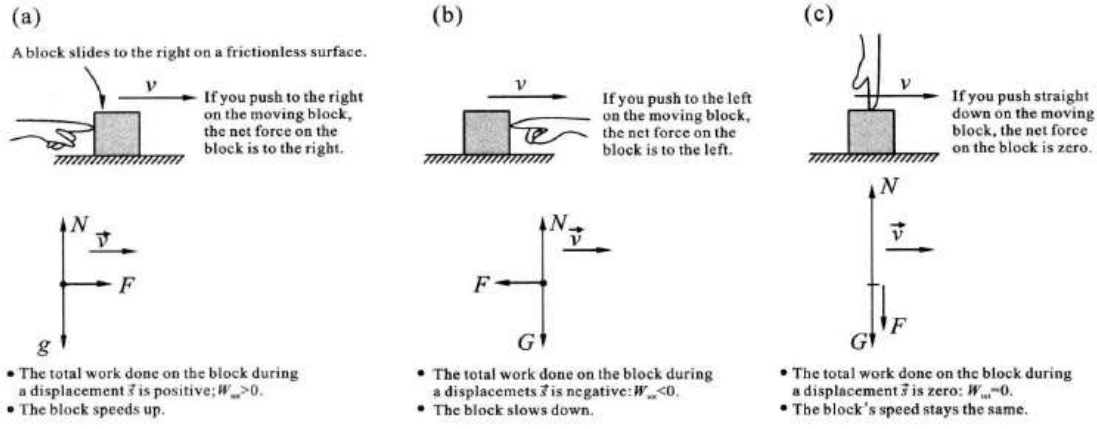


Fig. 2 – 1 The relationship between the total work done on a body and how the body's speed changes.

Let's make these observations more quantitative. Consider a particle with mass m moving along the x-axis under the action of a constant net force with magnitude F directed along the positive x – axis (Fig. 2 – 2). The particle's acceleration is constant and given by Newton's second law, $F = ma_x$. Suppose the speed changes from v_1 to v_2 while the particle undergoes a displacement $s = x_2 - x_1$ from point x_1 to x_2. Using a constant-acceleration equation, we have

$$v_2^2 = v_1^2 + 2a_x s,$$

$$a_x = \frac{v_2^2 - v_1^2}{2s.}$$

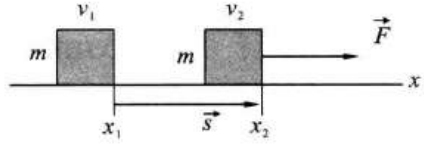


Fig. 2 – 2 A constant net force does work on a moving body.

When we multiply this equation by m and equate ma_x to the net force F, we find

$$F = ma_x = m\frac{v_2^2 - v_1^2}{2s}$$

and

$$Fs = \frac{1}{2}mv_2^2 - \frac{1}{2}v_1^2. \tag{2-2}$$

The product Fs is the work done by the net force F and thus is equal to the total work W_{tot} done by all the forces acting on the particle. The quantity $\frac{1}{2}mv^2$ is called the kinetic energy K of the particle:

$$K = \frac{1}{2}mv^2 \text{ (definition of kinetic energy)}. \tag{2-3}$$

Like work, the kinetic energy of a particle is a scalar quantity; it depends on only the particle's mass and speed, not its direction of motion. A car (viewed as a particle) has the same

kinetic energy when going north at 6 m/s as when going east at 6 m/s. Kinetic energy can never be negative, and it is zero only when the particle is at rest.

We can now interpret Eq. (2 – 2) in terms of work and kinetic energy. The first term on the right side of Eq. (2 – 2) is $K_2 = \frac{1}{2}mv_2^2$, the final kinetic energy of the particle (that is, after the displacement). The second term is the initial kinetic energy, $K_1 = \frac{1}{2}mv_1^2$, and the difference between these terms is the change in kinetic energy. So Eq. (2 – 2) says: The work done by the net force on a particle equals the change in the particle's kinetic energy:

$$W_{tot} = K_2 - K_1 = \Delta K(\text{work-energy theorem}). \qquad (2-4)$$

This result is the work-energy theorem.

2.2 生词表 New Words

stumbling *adj.* (令人)摇摇晃晃的
archer *n.* 弓箭手
mechanics *n.* 力学
fuel *n.* 燃料
kinetic energy 动能
encyclopedia *n.* 百科全书
stall *v.* (发动机)停止运转
displacement *n.* 位移
joule *n.* 焦耳
quantitative *adj.* 定量的
scalar *n.* 标量
in terms of 在……方面

2.3 课文注释 Text Annotation

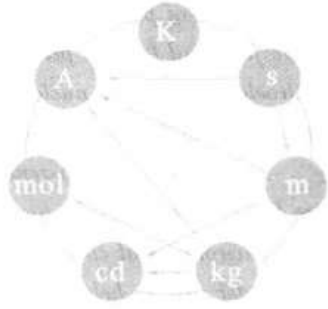
【1】The importance of the energy idea stems from the principle of conservation of energy.
能量概念的重要性来自于能量守恒定律。
stem from sth. 动词短语,意为"来源于"。
e. g. :This project stems from last week's lecture.
这一设计源自于上周的讲座。

【2】fuel 燃料
e. g. : fuel cell 燃料电池
diesel fuel 柴油燃料 (注意柴油的发音/ˈdiːz(əl)/)
fossil fuel 是煤炭、石油、天然气等埋藏在地下和海洋下的不能再生的化石燃料。右图为煤。



【3】SI
The International System of Units (abbreviated SI from French: Le Système international d'unités) is the modern form of the metric system. It comprises a coherent system of units of measurement built around seven base units, 22 named and an indeterminate number of unnamed coherent derived units, and a set of prefixes that act as decimal-based multipliers. The standards, published in 1960, are based on the metre-kilogram-second

system, rather than the centimetre-gram-second system, which, in turn, had several variants. The SI has been declared to be an evolving system; thus prefixes and units are created and unit definitions are modified through international agreement as the technology of measurement progresses, and as the precision of measurements improves. SI is the world's most widely used system of measurement, used in both everyday commerce and science.



Right: The seven SI base units and the interdependency of their definitions. Clockwise from top: kelvin (temperature), second (time), metre (length), kilogram (mass), candela (luminous intensity), mole (amount of substance) and ampere (electric current).

(from: wikipedia)

【4】James Prescott Joule

英国皇家学会会员(Royal Society Fellow,可以作为头衔),物理学家和酿酒师(brewer)。出生于英国的兰开夏郡索尔福德(Salford, Lancashire)。英国皇家学会是英国资助科学发展的组织,成立于 1660 年,并于 1662 年、1663 年、1669 年领到皇家的各种特许证。英女皇是学会的保护人。全称"伦敦皇家自然知识促进学会",学会宗旨是促进自然科学的发展,是世界上历史最长而又从未中断过的科学学会。它在英国起着全国科学院的作用。



英国皇家学会

2.4 扩展阅读 Extended Reading

Fossil Fuel

Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms. The age of the organisms and their resulting fossil fuels is typically millions of years, and sometimes exceeds 650 *million years. Fossil fuels contain high percentages of carbon and include coal, petroleum, and natural gas. They range from volatile materials with low carbon: hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like*

anthracite coal. Methane can be found in hydrocarbon fields, alone, associated with oil, or in the form of methane clathrates. Fossil fuels formed from the fossilized remains of dead plants by exposure to heat and pressure in the Earth's crust over millions of years. This biogenic theory was first introduced by Georg Agricola in 1556 *and later by Mikhail Lomonosov in the* 18*th century.*

It was estimated by the Energy Information Administration that in 2007 *primary sources of energy consisted of petroleum* 36.0%, *coal* 27.4%, *natural gas* 23.0%, *amounting to an* 86.4% *share for fossil fuels in primary energy consumption in the world. Non-fossil sources in* 2006 *included hydroelectric* 6.3%, *nuclear* 8.5%, *and others (geothermal, solar, tidal, wind, wood, waste) amounting to* 0.9%. *World energy consumption was growing about* 2.3% *per year.*

Fossil fuels are non-renewable resources because they take millions of years to form, and reserves are being depleted much faster than new ones are being made. The production and use of fossil fuels raise environmental concerns. A global movement toward the generation of renewable energy is therefore under way to help meet increased energy needs.

The burning of fossil fuels produces around 21.3 *billion tonnes (*21.3 *gigatonnes) of carbon dioxide (CO_2) per year, but it is estimated that natural processes can only absorb about half of that amount, so there is a net increase of* 10.65 *billion tonnes of atmospheric carbon dioxide per year (one tonne of atmospheric carbon is equivalent to* 44/12 *or* 3.7 *tonnes of carbon dioxide). Carbon dioxide is one of the greenhouse gases that enhances radiative forcing and contributes to global warming, causing the average surface temperature of the Earth to rise in response, which the vast majority of climate scientists agree will cause major adverse effects.*

Petroleum and natural gas are formed by the anaerobic decomposition of remains of organisms including phytoplankton and zooplankton that settled to the sea (or lake) bottom in large quantities under anoxic conditions, millions of years ago. Over geological time, this organic matter, mixed with mud, got buried under heavy layers of sediment. The resulting high levels of heat and pressure caused the organic matter to chemically alter, first into a waxy material known as kerogen which is found in oil shales, and then with more heat into liquid and gaseous hydrocarbons in a process known as catagenesis.

There is a wide range of organic, or hydrocarbon, compounds in any given fuel mixture. The specific mixture of hydrocarbons gives a fuel its characteristic properties, such as boiling point, melting point, density, viscosity, etc. Some fuels like natural gas, for instance, contain only very low boiling, gaseous components. Others such as gasoline or diesel contain much higher boiling components.

Terrestrial plants, on the other hand, tend to form coal and methane. Many of the coal fields date to the Carboniferous period of Earth's history. Terrestrial plants also form type Ⅲ *kerogen(油母岩质), a source of natural gas.*

Fossil fuels are of great importance because they can be burned (oxidized to carbon dioxide and water), producing significant amounts of energy per unit weight. The use of coal as a fuel predates recorded history. Coal was used to run furnaces for the melting of metal ore. Semi-solid hydrocarbons from seeps were also burned in ancient times, but these materials were mostly used for water-

proofing and embalming.

Commercial exploitation of petroleum, largely as a replacement for oils from animal sources (notably whale oil), for use in oil lamps began in the 19th century. Natural gas, once flared-off as an unneeded byproduct of petroleum production, is now considered a very valuable resource.

Heavy crude oil, which is much more viscous than conventional crude oil, and tar sands, where bitumen is found mixed with sand and clay, are becoming more important as sources of fossil fuel. Oil shale and similar materials are sedimentary rocks containing kerogen, a complex mixture of high-molecular weight organic compounds, which yield synthetic crude oil when heated. These materials have yet to be exploited commercially. These fuels can be employed in internal combustion engines, fossil fuel power stations and other uses.

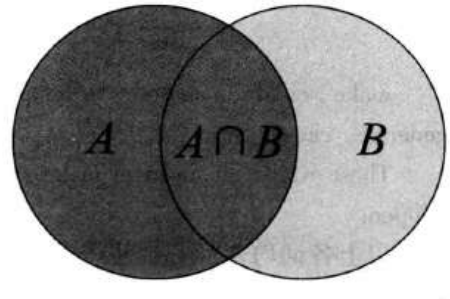
Prior to the latter half of the 18th century, windmills and watermills provided the energy needed for industry such as milling flour, sawing wood or pumping water, and burning wood or peat provided domestic heat. The wide scale use of fossil fuels, coal at first and petroleum later, to fire steam engines enabled the Industrial Revolution. At the same time, gas lights using natural gas or coal gas were coming into wide use. The invention of the internal combustion engine and its use in automobiles and trucks greatly increased the demand for gasoline and diesel oil, both made from fossil fuels. Other forms of transportation, railways and aircraft, also required fossil fuels. The other major use for fossil fuels is in generating electricity and as feedstock for the petrochemical industry. Tar, a leftover of petroleum extraction, is used in construction of roads.

The U. S. holds less than 5% of the world's population, but due to large houses and private cars, uses more than a quarter of the world's supply of fossil fuels. In the United States, more than 90% of greenhouse gas emissions come from the combustion of fossil fuels. Combustion of fossil fuels also produces other air pollutants, such as nitrogen oxides, sulfur dioxide, volatile organic compounds and heavy metals.

2.5 常用用法 Usages and Expressions

集合 Sets

In mathematics, a set is a collection of distinct objects, considered as an object in its own right. Sets are one of the most fundamental concepts in mathematics. Developed at the end of the 19th century, set theory is now a ubiquitous part of mathematics, and can be used as a foundation from which nearly all of mathematics can be derived.



The key relation between sets is *membership*—when

one set is an element of another. If a is a member of B, this is denoted a $\in B$, while if c is not a member of B then $c \notin B$.

If every member of set A is also a member of set B, then A is said to be a subset of B, written $A \subseteq B$ (also pronounced A is contained in B). Equivalently, we can write $B \supseteq A$, read as B is a superset of A, B includes A, or B contains A. The relationship between sets established by $\subseteq$ is called inclusion or containment.

Two sets can be "added" together. The union of A and B, denoted by $A \cup B$, is the set of all things that are members of either A or B.

A new set can also be constructed by determining which members two sets have "in common." The intersection of A and B, denoted by $A \cap B$, is the set of all things that are members of both A and B. If $A \cap B = \varnothing$, then A and B are said to be disjoint.

Two sets can also be "subtracted." The relative complement of B in A (also called the set-theoretic difference of A and B), denoted by $A \setminus B$ (or $A - B$), is the set of all elements that are members of A but not members of B. Note that it is valid to "subtract" members of a set that are not in the set, such as removing the element green from the set $\{1, 2, 3\}$; doing so has no effect.

A new set can be constructed by associating every element of one set with every element of another set. The Cartesian product of two sets A and B, denoted by $A \times B$ is the set of all ordered pairs (a, b) such that a is a member of A and b is a member of B.

Expressions	Pronunciation
$N = \{1,2,3,4\}$	N equals the set whose members (elements) are one, two, three, four
$2 \in N$	Two is a member of N
$X \subseteq Y$	X is a subset of set Y or X is a part of Y
$X \cap Y = Y \cap X$	The set consisting of all elements common to X and Y equals the set consisting of all elements common to Y and X
If $X \cup Y = X \cap Y$, then $X = Y$	if the set consisting of all elements of X or Y or both equals the set consisting of all elements of X and Y, then set X equals set Y

2.6 同义词辨析 Synonyms

make, create, compose, develop, evolve, invent, produce, manufacture, construct, build, generate, cause, form

These words all mean to make sth., to form parts or materials, or to cause sth. to exist or happen.

以上各词均含"制造;使产生"之义。

◆ make to create or prepare sth. by combining materials or putting parts together; to cause sth.

to exist or happen 制造;做;组装;使产生

e. g. : I am going to show you how to make a box for your tools.

我来教你怎么做一个箱子放你的工具。

The company has been making quality furniture for over 200 years.

这家公司制作优质家具有 200 多年的历史了。

【习惯用法】

be made up of	由……组成,含有
make a difference	起作用,产生影响
make a face	做鬼脸
make a fool of	愚弄,欺骗
make a living	谋生
make a mistake	做错,犯错误
make an appointment	约定,约会
make an effort	努力
make for	走向;促进;有助于,有利于
make out	辨认;区分;理解,了解;开列;书写
make up	构成,组成;拼凑;弥补;赔偿;编造
make up for	补偿,弥补
make up one's mind	下决心,决定

◆ create to make sth. exist or happen, especially sth. new that did not exist before 制造;创作;创建

e. g. : Some people believe the universe was created by a big explosion.

有些人认为宇宙是通过一次大爆炸创造出来的。

This dish was created by our chef Jean Richard.

这道菜是我们的厨师琼·理查德烹调的。

MAKE OR CREATE? 用 make 还是 create?

"Make" is a more general word and is more often used for physical things: You would usually make a table/dress/cake but create jobs/wealth. You can use "create" for sth. physical in order to emphasize how original or usually the object is.

make 是一个普通词汇,常用于指物质,如做桌子、做衣服、做蛋糕通常用 make,但创造就业机会和财富用 create。要强调某物品或实体物质是原创的或不同寻常,也可用 create。

e. g. :Try this new dish created by our head chef.

品尝一下这道新菜吧,是我们厨师长首创的。

◆ compose to write music 作曲;创作(音乐)

e. g. : Barrington has composed the music for a new production of "A Midsummer Night's Dream."

巴林顿为新版的《仲夏夜之梦》谱写了曲子。

◆ develop (used especially in business contents) to think of and produce a new product(尤用于

商务语境)开发,研制(产品)

e. g. : Scientists are developing new drugs to treat arthritis.

科学家们正在研制治疗关节炎的新药。

Researchers are developing technology for the US military.

研究人员在为美国军方开发技术。

【习惯用法】

developed countries	发达国家
developing countries	发展中国家
undeveloped countries	不发达国家

◆ evolve to develop over time, often many generations, into forms that are better adapted to survive changes in their environment 进化;进化形成

e. g. : Fish evolved from prehistoric sea creatures.

鱼是由史前的海洋生物进化而来的。

Animals have evolved camouflage to protect themselves from predators.

动物进化形成了伪装,以保护它们不受食肉动物的捕食。

◆ invent to produce or design sth. that has not existed before 发明;创造

e. g. : Alexander Graham Bell invented the telephone in 1876.

亚历山大·格雷厄姆·贝尔于1876年发明了电话。

◆ produce to make things sold; to create sth. using skill 生产,制造(产品);(运用技巧)制作,造出

e. g. :a factory that produces microchips 微芯片制造厂

◆ manufacture to make goods in large quantities, using machinery (用机器)大量生产,成批制造

e. g. : the company that manufactured the drug 生产这种药的公司

Cost will determine the methods of manufacture.

成本决定生产方法。

◆ construct to build or make sth. such as a road, building or machine 建筑;修建;建造

e. g. : There are plans to construct a new road bridge across the river.

有计划要建造一条跨河公路。

◆ build to make sth. ,especially a building parts together 建筑;建造

e. g. : The purpose is to build new houses for local people.

目的是为当地居民建造新的住宅。

The road took many years to build.

这一条路修了好多年。

【习惯用法】

build up 扩大,增进

He has built up a good business.
他已建立了良好的业务。

◆ generate to produce or create sth., especially power, money or ideas 制造;产生(电、财富或主意等)

e. g.: The program would generate a lot of new jobs.
这个项目将创造许多新的就业岗位。
Tourism generates income for local communities.
旅游业为当地的社区创造了收益。

◆ cause to make sth. happen, especially sth. bad or unpleasant (不好的或不愉快的事情)发生;造成;引起;导致

e. g.: Heavy traffic is causing delay on the freeway.
拥堵的交通造成高速公路上长时间的延误。
The oil spill is causing problems for coastal fisheries.
石油泄漏给沿海捕鱼业带来了问题。

◆ form [often passive] to make sth. form sth. else; to make sth. into sth. else 制造;组成;制成

e. g.: Rearrange the letters to form a new word.
重新排列字母,组成另一单词。
The winning part will form the government.
获胜的党派将组建政府。
In English the past tense of a verb is usually formed by adding "ed."
在英语中,动词的过去式通常通过加 ed 构成。

【习惯用法】

in the form of 以……的形式
in form 形式上

2.7 练习题 Exercise

(2-1) 完形填空,给出理由并举 1—2 例说明类似的用法。

The development of low-carbon energy is progressing too slowly to limit climate change, the International Energy Agency in Paris said on Wednesday. With power generation still dominated by coal and governments failing to increase investment in clean energy, the target of keeping the global temperature rise to less than 2 degrees centigrade (3.6 degrees F) this century is slipping out of ____[1]____, the agency said in a report released on Wednesday. "The drive to clean ____[2]____ the world's energy system has stalled," IEA Executive Director Maria van der Hoeven told the Clean Energy Ministerial, which brings together ministers representing countries responsible ____[3]____ four-fifths of global greenhouse-gas emissions. "Despite much talk by world leaders,

and despite a boom in renewable energy over the last decade, the average unit of energy produced today is basically as dirty as it was 20 years ago," she said. Progress remains alarmingly slow for technologies such as ____[4]____ photovoltaic and wind power that could save energy and reduce carbon dioxide emissions consistent with international climate goals, the IEA report said. "As world temperatures creep higher due to ever-increasing emissions of greenhouse gases like carbon dioxide—two-thirds of which come from the energy sector—the overall lack of progress should serve as a wake-____[5]____ call," said Van der Hoeven.

[1] A. mind	B. date	C. reach	D. box
[2] A. up	B. out	C. down	D. in
[3] A. to	B. for	C. with	D. out
[4] A. sun	B. moon	C. sunshine	D. solar
[5] A. in	B. up	C. over	D. out

(2-2) 完形填空。

Sound received by the microphone must next be processed to determine how the electrodes should be activated. The simplest way of processing would be to divide the ____[1]____ signal by the number of electrodes in the device and apply the resulting voltage to the appropriate electrode. More sophisticated processing algorithms are used in practice because applying voltage to each of the electrodes ____[2]____ could cause non-charge-balanced currents to flow between the electrodes. This could stimulate the nerves in undesirable ways and lead to both tissue and electrode damage.

Fourier strategies use bandpass filters to divide the signal into different frequency bands. The algorithm chooses a number of the strongest outputs from the ____[3]____, the exact number depending on the number of implanted electrodes and other factors. These strategies emphasize transmission of the temporal aspects of speech.

Feature extraction strategies use ____[4]____ which are common to all vowels. Each vowel has a fundamental frequency (the lowest frequency peak) and formants (peaks with higher frequencies). The pattern of the fundamental and formant frequencies is specific for different vowel sounds. These algorithms try to recognize the ____[5]____ and then emphasize its features. These strategies emphasize the transmission of spectral aspects of speech. Feature extraction strategies are no longer widely used.

[1] A. light	B. acoustic	C. electrical	D. sound
[2] A. simultaneously	B. instantaneously	C. substantially	D. significantly
[3] A. system	B. circle	C. filters	D. wave
[4] A. extraction	B. feat	C. feature	D. features
[5] A. vowel	B. sound	C. consonant	D. acoustic

(2-3) 将下面的句子重新组合,形成符合逻辑关系的段落。

a. You apply Newton's laws and all the problem-solving techniques that we've learned, but you run across a major stumbling block: After the archer releases the arrow, the bow string exerts a varying force that depends on the arrow's position.

b. Suppose you try to find the speed of an arrow that has been shot from a bow.

c. Never fear; we aren't by any means finished with mechanics, and there are other methods for dealing with such problems.

d. As a result, the simple methods that we've learned aren't enough to calculate the speed.

e. The importance of the energy idea stems from the principle of conservation of energy: Energy is a quantity that can be converted from one form to another but cannot be created or destroyed.

f. The new method that we're about to introduce uses the ideas of work and energy.

(2-4) 将下面的句子重新组合,形成符合逻辑关系的段落。

a. They range from volatile materials with low carbon: hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal.

b. Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms.

c. The age of the organisms and their resulting fossil fuels is typically millions of years, and sometimes exceeds 650 million years.

d. Fossil fuels contain high percentages of carbon and include coal, petroleum, and natural gas.

e. This biogenic theory was first introduced by Georg Agricola in 1556 and later by Mikhail Lomonosov in the 18th century.

f. Methane can be found in hydrocarbon fields, alone, associated with oil, or in the form of methane clathrates.

g. Fossil fuels formed from the fossilized remains of dead plants by exposure to heat and pressure in the Earth's crust over millions of years.

(2-5) 翻译下面的段落,注意黑体部分的用法。

[1] It was estimated by the Energy Information Administration that in 2007 primary sources of energy consisted of petroleum 36.0%, coal 27.4%, natural gas 23.0%, **amounting** to an 86.4% share for fossil fuels in primary energy consumption in the world. Non-fossil sources in 2006 included hydroelectric 6.3%, nuclear 8.5%, and others (geothermal, solar, tidal, wind, wood, waste) amounting to 0.9%. World energy consumption was growing about 2.3% per year.

[2] Fossil fuels are **non-renewable** resources because they take millions of years to form, and reserves are being **depleted** much faster than new ones are being made. The production and use of fossil fuels raise environmental concerns. A global movement toward the generation of **renewable energy** is therefore under way to help meet increased energy needs.

[3] The burning of fossil fuels produces around 21.3 billion **tonnes** (21.3 gigatonnes) of **carbon dioxide** (CO_2) per year, but it is estimated that natural processes can only absorb about half of that amount, so there is a **net** increase of 10.65 billion tonnes of atmospheric carbon dioxide per year (one tonne of atmospheric carbon is equivalent to 44/12 or 3.7 tonnes of carbon dioxide). Carbon dioxide is one of the greenhouse gases that enhances radiative forcing and contributes to global warming, causing the average surface temperature of the Earth to rise in response,

which the vast majority of climate scientists agree will cause major adverse effects.

[4] There is a wide range of **organic**, or **hydrocarbon**, compounds in any given fuel mixture. The specific mixture of hydrocarbons gives a fuel its characteristic properties, such as **boiling point**, melting point, density, **viscosity**, etc. Some fuels like natural gas, for instance, contain only very low boiling, gaseous components. Others such as gasoline or diesel contain much higher boiling components.

[5] **Terrestrial plants**, on the other hand, tend to form coal and **methane**(沼气). Many of the coal fields date to the Carboniferous period of Earth's history. Terrestrial plants also form type III **kerogen**(油母岩质), a source of natural gas.

[6] Fossil fuels are **of great importance** because they can be burned (oxidized to carbon dioxide and water), producing significant amounts of energy per unit weight. The use of coal as a fuel predates recorded history. Coal was used to run furnaces for the melting of metal ore. Semi-solid hydrocarbons from seeps were also burned in ancient times, but these materials were mostly used for waterproofing and embalming.

参考文献

Wikipedia: Set (mathematics), Fossil fuel, sound.

Lesson 3

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3.1 动量与冲量 Momentum and Impulse

There are many questions involving forces that cannot be answered by directly applying Newton's second law, $\sum \vec{F} = m\vec{a}$. For example, [1]**In playing pool, how do you decide how to aim the cue ball in order to knock the eight ball into the pocket?** [2]**And when a meteorite collides with the earth, how much of the meteorite's kinetic energy is released in the impact?**

A common theme of all these questions is that they involve forces about which we know very little: The forces between the two pool balls, or between the meteorite and the earth. [3] **Remarkably, we will find that we don't have to know anything about these forces to answer questions of this kind!**

Our approach uses two new concepts, momentum and impulse, and a new conservation law, conservation of momentum. [4]**This conservation law is every bit as important as that of conservation of energy.** The law of conservation of momentum is valid even in situations in which Newton's laws are inadequate, such as bodies moving at very high speeds (near the speed of light) or objects on a very small scale (such as the constituents of atoms). Within the domain of Newtonian mechanics, conservation of momentum enables us to analyze many situations that would be very difficult if we tried to use Newton's laws directly. Among these are collision problems, in which two bodies collide and can exert very large forces on each other for a short time.

Newton's Second Law in Terms of Momentum

Consider a particle of constant mass m. (Later we'll see how to deal with situations in which the mass of a body changes.) Because $\vec{a} = d\vec{v}/dt$, we can write Newton's second law for this particle as

$$\sum \vec{F} = m\frac{d\vec{v}}{dt} = \frac{d}{dt}(m\vec{v}). \tag{3-1}$$

We can take the mass m inside the derivative because it is constant. Thus Newton's second law says that the net force $\sum \vec{F}$ acting on a particle equals the time rate of change of the combination $m\vec{v}$, the product of the particle's mass and velocity. We'll call this combination the momentum, or linear momentum, of the particle. Using the symbol $\vec{p}$ for momentum, we have

$$\vec{p} = m\vec{v} \quad \text{(definition of momentum)}. \tag{3-2}$$

The greater the mass m and speed $\vec{v}$ of a particle, the greater its magnitude of momentum $m\vec{v}$. Keep in mind, however, that momentum is a vector quantity with the same direction as the particle's velocity (Fig. 3-1). Hence a car driving north at 20 m/s and an identical car driving east at 20 m/s have the same magnitude of momentum (mv) but different momentum vectors ($m\vec{v}$) because their directions are different.

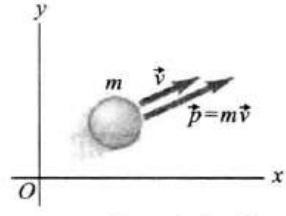


Fig. 3-1 The velocity and momentum vectors of a particle. Momentum $\vec{p}$ is a vector quantity; a particle's momentum has the same direction as its velocity $\vec{v}$.

We often express the momentum of a particle in terms of its components. If the particle has velocity components v_x, v_y, and v_z, then its momentum components p_x, p_y and p_z (which we also call the x-momentum, y-momentum, and z-momentum) are given by

$$p_x = mv_x, \quad p_y = mv_y, \quad p_z = mv_z. \tag{3-3}$$

These three component equations are equivalent to Eq. (3-2).

The units of the magnitude of momentum are units of mass times speed; the SI units of momentum are kg · m/s. The plural of momentum is "momenta."

If we now substitute the definition of momentum, Eq. (3-2) into Eq. (3-1), we get

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \quad \text{(Newton's second law in terms of momentum)}. \tag{3-4}$$

The net force (vector sum of all forces) acting on a particle equals the time rate of change of momentum of the particle. This, not $\sum \vec{F} = m\vec{a}$, is the form in which Newton originally stated his second law (although he called momentum the "quantity of motion"). This law is valid only in inertial frames of reference.

According to Eq. (3-4), a rapid change in momentum requires a large net force, while a gradual change in momentum requires less net force. This principle is used in the design of automobile safety devices such as air bags.

3.2 生词表 New Words

pool *n.* 台球
cue ball *n.* 母球
momentum *n.* 动量
impulse *n.* 冲量
conservation of momentum 动量守恒定律
valid *adj.* 有效的
Newtonian mechanics 牛顿力学
derivative *n.* 导数
component *n.* 分量
plural *n.* 复数形式
gradual *adj.* 逐渐的;平缓的
air bag *n.* 气囊

3.3 课文注释 Text Annotation

【1】In playing pool, how do you decide how to aim the cue ball in order to knock the eight ball into the pocket?

打台球时,你怎么决定怎样去瞄准母球将八号球击打进洞?

pool game,台球,是一项非常受欢迎的体育项目,也经常被称为 pocket billiards. 其中包含了一个黑色的八号球。因此,课文中 eight ball 不是指八个球,ball 不用复数形式。

【2】And when a meteorite collides with the earth, how much of the meteorite's kinetic energy is released in the impact?

当陨石与地球相撞时,陨石动能中有多少被释放出来?

impact,作为名词主要有两层意思,一是"撞击",二是"影响"。本文是"撞击"的意思。

►1. 撞击,冲击

impact test 冲击试验
impact pressure 碰撞压力
impact area 攻击区
impact stress 冲击应力

►2. 影响

impact factor 影响因子

The impact factor (IF) of an academic journal is a measure reflecting the average number of citations to recent articles published in the journal. It is frequently used as a proxy for the relative importance of a journal within its field, with journals with higher impact factors deemed to be more important than those with lower ones. The impact factor was devised by Eugene Garfield, the founder of the Institute for Scientific Information. Impact factors are calculated yearly for those journals that are indexed in the Journal Citation Reports.

【3】Remarkably, we will find that we don't have to know anything about these forces to answer questions of this kind!

令人吃惊的是,我们将发现回答此类问题并不需要对力有任何知识。

在字典中 remarkably 一般翻译成"引人注目地;明显地;非常地"。但这样解释是有一定的误导性的,其实 remarkably 的本意是"不同寻常,令人吃惊从而值得一提"。

【4】This conservation law is every bit as important as that of conservation of energy.

这个守恒定律与能量守恒定律同等重要。

every bit as = equally as, 习惯用法,意为"全部,完全一样"。

3.4 扩展阅读 Extended Reading

Ⅰ. 动量守恒 Conservation of Momentum

The concept of momentum is particularly important in situations in which we have two or more interacting bodies. To see why, let's consider first an idealized system consisting of two bodies that interact with each other but not with anything else—for example, two astronauts who touch each other as they float freely in the zero-gravity environment of outer space. Think of the astronauts as particles. Each particle exerts a force on the other; according to Newton's third law, the two forces are always equal in magnitude and opposite in direction. Hence, the impulses that act on the two particles are equal and opposite, and the changes in momentum of the two particles are equal and opposite.

Let's go over that again with some new terminology. For any system, the forces that the particles of the system exert on each other are called internal forces. Forces exerted on any part of the system by some object outside it are called external forces. The vector sum of the external forces on a system is zero; the total momentum of the system is constant.

This is the simplest form of the principle of conservation of momentum. This principle is a direct consequence of Newton's third law. What makes this principle useful is that it doesn't depend on the detailed nature of the internal forces that act between members of the system. This means that we can apply conservation of momentum even if (as is often the case) we know very little about the internal forces. We have used Newton's second law to derive this principle, so we have to be careful to use it only in inertial frames of reference.

In some ways the principle of conservation of momentum is more general than the principle of conservation of mechanical energy. For example, mechanical energy is conserved only when the internal forces are conservative—that is, when the forces allow two-way conversion between kinetic and potential energy—but conservation of momentum is valid even when the internal forces are not conservative.

To most people the term collision is likely to mean some sort of automotive disaster. We'll use it in that sense, but we'll also broaden the meaning to include any strong interaction between bodies that lasts a relatively short time. So we include not only car accidents but also balls colliding on a billiard table, neutrons hitting atomic nuclei in a nuclear reactor, the impact of a meteor on the Arizona desert, and a close encounter of a spacecraft with the planet Saturn(土星). If the forces be-



tween the bodies are much larger than any external forces, as is the case in most collisions, we can neglect the external forces entirely and treat the bodies as an isolated system. Then momentum is conserved and the total momentum of the system has the same value before and after the collision. Two cars colliding at an icy intersection provide a good example. Even two cars colliding on dry pavement can be treated as an isolated system during the collision if the forces between the cars are much larger than the friction forces of pavement against tires.

An elastic collision is one in which no kinetic energy is lost. Perfectly elastic "collisions" can occur when the objects do not touch each other, as for example in atomic or nuclear scattering where electric repulsion keeps them apart. A slingshot maneuver of a satellite around a planet can also be viewed as a perfectly elastic collision from a distance. A collision between two pool balls is a good example of an almost totally elastic collision, due to their high rigidity; but when bodies come in contact there is always some dissipation.

A head-on elastic collision between two bodies can be represented by velocities in one dimension, along a line passing through the bodies. If the velocities are u_1 and u_2 before the collision and v_1 and v_2 after, the equations expressing conservation of momentum and kinetic energy are:

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

In an inelastic collision, some of the kinetic energy of the colliding bodies is converted into other forms of energy such as heat or sound. Examples include traffic collisions, in which the effect of lost kinetic energy can be seen in the damage to the vehicles; electrons losing some of their energy to atoms (as in the Franck-Hertz experiment), and particle accelerators in which the kinetic energy is converted into mass in the form of new particles.

Ⅱ. 蒙大纳州立大学物理学家爱因斯坦赢得 50 万美元奖金 MSU Physicist Einstein Expert Wins $500,000 Award

A Montana State University physicist who recently led Bozeman in celebrating Einstein has now won a five-year $500,000 Young Investigator CAREER Award from the National Science Foundation.

Nico Yunes, 32, learned about his award the same day he was notified that he and Angela Des Jardins, director of the Montana Space Grant Consortium (MSGC), were named Fellows in Engagement in MSU's College of Letters and Science. The designation recognizes their significant contributions in communicating science to the public. The CAREER Award is the NSF's most prestigious award that supports the early career development of teacher-scholars and honors outstanding scientists who haven't yet received tenure.

"That was a great day, a very good day," Yunes said.

Richard Smith, professor and head of the MSU Department of Physics, said, "When one of our faculty wins a CAREER award, we are very pleased because it reflects well on the very high level of research programs at MSU, the top notch caliber of the faculty we are able to attract, and the respect that peer scientists around the country have for the talent and potential they see in new faculty at MSU.

"Nico's proposed work, along with that of the gravity group at MSU (with Neil Cornish and Ron Hellings) is helping the community of gravitational wave astronomers to put in place a theoretical framework to help them identify gravity waves, the ripples in the fabric of Einstein's space-time, when they are (hopefully) first detected later in this decade," Smith said.

Yunes, a former Einstein Fellow at the Massachusetts Institute of Technology (MIT) and research associate at Princeton University, said he will use part of his CAREER grant to continue researching Einstein's Theory of General Relativity and gravitation. To help in that effort, he will hire an additional graduate student and postdoctoral researcher for his research.

MSU held "Celebrating Einstein" two years before the 2015 centennial of Einstein's Theory of General Relativity and the impending detection of its final prediction, gravitational waves, to build public awareness and excitement, Yunes said. He added that his CAREER grant will allow him to take the Einstein celebration beyond Bozeman and onto a national stage.

He wants, first of all, to make Einstein materials available to other universities that plan to hold their own celebrations. Princeton, MIT, Dartmouth College and the University of Wisconsin-Madison are among those that have already expressed interest, Yunes said.

He also wants to have "Celebrating Einstein" materials translated into Spanish so schools, especially those across the southern tier of the United States, can hold Einstein celebrations, too. Joey Shapiro Key, for one, said she could use such materials in her new position as director of education and outreach in the Center for Gravitational Wave Astronomy at the University of Texas at Brownsville. Key is currently the education specialist at the MSGC and one of the co-organizers for "Celebrating Einstein."

In addition, Yunes said he will use his grant to work with MSU's Museum of the Rockies and develop a 20-to-30-minute planetarium show that incorporates the "Celebrating Einstein" materials from MSU. The show will be available for free to 1,000 small planetariums across the United States.

He will also use his grant locally to continue the Science Bowl that began with "Celebrating Einstein" and builds community among MSU physicists, Yunes said. Similar to the television game show, "Jeopardy," the bowl involves four-person teams that include one undergraduate, two gradu-

ate students and one postdoctoral researcher in physics. They compete by answering general physics questions such as "How old is the universe?" (13.8 billion years old) and "How long does it take for light from the sun to reach us?" (about eight minutes). They also answer questions that require simple computations.

Regarding his research, Yunes said he will use his CAREER grant to help him calculate gravitational wave solutions that could then be used as software filters. These filters are critical to detect gravitational waves and to test Einstein's theory.

The idea is similar to someone looking for a rock in a haystack or a miner panning for gold, he said. First, the seeker has to know what the rock or gold looks like. Is the gold in the form of a brick or sphere, for example? How big is the rock? Knowing that allows physicists to design a filter that captures the rock or gold (the gravitational wave) while letting the hay, water or mud (the noise) flow through the filter.

Gravitational waves are produced by violent astrophysical events, such as when stars explode or two black holes collide, Yunes said. Physicists believe they may be able to detect them for the first time in the history of humankind by the end of this decade. They say this feat will test the accuracy of Einstein's final theory and lead to revolutionary discoveries about regions of the universe that are currently inaccessible with traditional electromagnetic astronomy.

"To make a simple analogy, these waves are like the soundtrack to the universe, and their detection will be like transitioning from mute pictures to modern cinema," Yunes said.

3.5 常用用法 Usages and Expressions

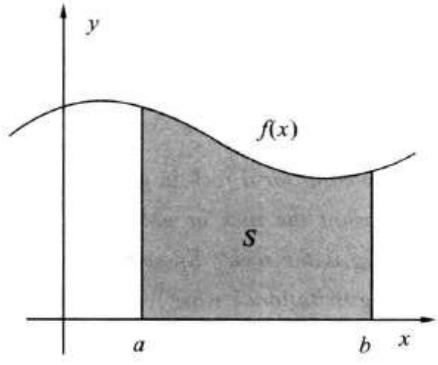
微积分 Calculus

Calculus is the mathematical study of change, is the study of operations and their application to solving equations. It has two major branches, differential calculus (concerning rates of change and slopes of curves), and integral calculus (concerning accumulation of quantities and the areas under curves); these two branches are related to each other by the fundamental theorem of calculus. Both branches make use of the fundamental notions of convergence of infinite sequences and infinite series to a well-defined limit. Calculus has widespread uses in science, economics, and engineering and can solve many problems that algebra alone cannot.

Differential calculus is the study of the definition, properties, and applications of the derivative of a function. The process of finding the derivative is called differentiation. Given a function and a point in the domain, the derivative at that point is a way of encoding the small-scale behavior of the function near that point. By finding the derivative of a function at every point in its domain, it is possible to produce a new function, called the derivative function or just the derivative of the original function. In mathematical jargon, the derivative is a linear operator which inputs a function and outputs a second function.

Integral calculus is the study of the definitions, properties, and applications of two related

concepts, the indefinite integral and the definite integral. The process of finding the value of an integral is called integration. In technical language, integral calculus studies two related linear operators.



Integration can be thought of as measuring the area under a curve, defined by $f(x)$, between two points (here a and b).

表 达	发 音
$\frac{\partial g}{\partial x}$	the first partial derivative of g with respect to x
$\frac{\partial^2 g}{\partial x^2}$	the second partial derivative of g with respect to x
$dz(x,y)=\frac{\partial z}{\partial x}dx+\frac{\partial z}{\partial y}dy$	the differential of z with respect to x and y equals the partial derivative of z with respect to x times the differential of x plus the partial derivative of z with respect to y times the differential of y
$g^n(x)$	the n th derivative of g with respect to x
$\int f(x)dx$	the indefinite integral of the function f with respect to x
$\int f(x)dx$	the definite integral of the function f of x with limits a and b (from a to b) with respect to x
$\iint f(x,y)$	the double integral of f of x, y(with respect to x and y)
$\iiint f(x,y,z)dxdydz$	the triple integral of f of x, y, z with respect to x, y and z over the region
$\int_c (xdy-ydx)$	the closed linear integral of x times the differential of y minus y times the differential of x around the boundary curve of c
$\int \frac{a}{x-a}dx=a\log\lvert x-a\rvert$	the indefinite integral of the quantity a over x minus a with respect to x equals a times the quantity log of the absolute value of x minus a plus C

3.6 同义词辨析 Synonyms

mention, reference, talk, discuss, speak, communicate, relate, hint, refer, cite, instance, charge, quote, allude

These words all mean writing or speaking about sb./sth., often in order to give an example or prove sth.

以上各词均含“写到;说到;谈及;举例;说明”之义。

◆ mention to write or speak about sth./sb., especially without giving much information 提到;写到;说到

e. g.: Was my name mentioned at all?

我的名字被提到过吗?

I mentioned the idea to Joan, and she seemed to like it.

我向琼提起过这个想法,她似乎很喜欢。

【习惯用法】

Don't mention it.	(客气用语)不用谢,不用客气。
not to mention	此外,更不用说……
mention	后可接动名词,不接动词不定式

◆ reference a thing you say or write that mentions sb./sth. else; the act of mentioning sb./sth. 说到(或写到)的事;提到;谈及;涉及

e. g.: There is no direct reference to her own childhood in the novel.

小说里没有直接提及她的童年。

The governor made only a passing reference to the program of unemployment.

州长对失业问题只是一语带过。

【习惯用法】

in/with reference to	关于
without reference to	与……无关,不管

◆ talk to say words in a language (用某种语言)讲,说

e. g.: She spent a long time talking to him.

她和他谈了很长时间。

I could hear Sarah and Andy talking in the next room.

我听到萨拉和安迪在隔壁讲话。

【习惯用法】

talk to/with sb. about/of sth.	与某人谈论某事
talk back (to sb.)	(对某人)反唇相讥,回嘴
talk sb. into/out of doing sth.	说服某人做/不做
talk over	讨论,商量

◆ discuss to talk about sth. with sb., especially in order to decide sth. (为了决定某事)与某人展开讨论;谈论;商量

e. g. : Littman refused to discuss the case publicly.
利特曼拒绝公开讨论此案。
If you would like to discuss the matter further, please call me.
如果你想进一步谈论此事,请给我打电话。

◆ speak to mention, describe sth./sb. 提起;讲述

e. g. : He emphasized that he was speaking as a private citizen, not in any official capacity.
他强调,他是以公民的身份,不是任何官方的身份在说话。
The results speak for themselves.
结果不辩自明。

【习惯用法】

speak to /with sb. about sth.	同某人谈论某事
speak for sb.	为某人发言,陈述某人的观点
speak of	谈论,谈到(指内容)
speak highly/ill of sb.	说某人的好话/坏话

◆ communicate (with sb.) to exchange information, news, ideas, etc. with sb. (与某人)交流(信息或消息、意见等);沟通

e. g. : We communicated mostly by E-mail.
我们主要用电子邮件沟通。
People use more than words when they communicate with each other.
人们相互交流时不仅仅使用语言。

◆ relate (formal) to give a spoken or written report of sth.; to tell a story 叙述;讲述;讲(故事)

e. g. : He later related the whole story to me.
他后来给我讲了整件事情的来龙去脉。

【习惯用法】

relate to	与……有关,涉及
be related to	与……有亲属关系,与……相关
relate...to/with	把(某事)与(某事)关联

◆ hint something that suggests what will happen in the future 征兆;迹象

e. g. : There has been hints that he may take up coaching.
有迹象表明他可能出任教练。
I made it clear I wasn't interested in him, but he didn't take the hint.
我清楚地表明我对他不感兴趣,但他不明白我的意思。

◆ refer to sb./sth. (rather formal) to mention or speak about sb./sth. 提到;谈及;说起

e. g. : We agreed never to refer to the matter again.
我们同意永远不再提这件事。
The hospital now refers to patients by name, not case number.
医院现在叫病人的名字,不叫号码了。

【习惯用法】

refer to	查阅,涉及;提到
refer to...as	把……称作,把……当做
refer sb. to	使某人求助于
refer sth. to	认为……是;把……归类于;把……提交给

◆ cite (formal) to mention sth. as a reason or an example, or in order to support what you are saying 提及(原因);(举出示例)证明

e. g. : Several factors have been cited as a cause of the unrest.
好几个原因被引证为这次动乱的原因。

◆ instance (formal) to give sth. as an example 举……为例

e. g. : We need to rethink the way we consume energy. Take, for instance, our approach to transport.
我们需要重新考虑我们使用能源的方式,例如我们的运输方式。
She instanced the first chapter as proof of his skill in constructing scenes.
她以第一章为例证明他构思情节的技巧。

【习惯用法】

for instance	例如,举例说

◆ charge ~ sb. (with sth./with doing sth.) to formally of a crime so that there can be a trial in court 控告;起诉

e. g. : Demonstrators have charged that the police used excessive force against them.
示威者指责说警方对他们使用了暴力。
Gibbons has been charged with murder.
吉本斯被指控谋杀。

【习惯用法】

in charge of	主持,负……责任
charge sb. with sth. = accuse sb. of sth.	控诉
take charge for	担任,负责

◆ quote to mention an example of sth. to support what you are saying 举例说明

e. g. : Mr. Jackson quoted the case of an elderly man who had been evicted from his home.
杰克逊先生举了一个例子,说有一位老人被赶出了家门。
He quoted the example of France as a country with good rail service.
他举法国为例,说法国是铁路服务很完善的国家。

CITE OR QUOTE? 用 cite 还是 quote?

You can cite reasons or examples, but you can only quote examples. cite 可指提及原因或举出示例,但 quote 只用于举例。

Cite is a more formal word than quote and is often used in more formal situations, for example in descriptions of legal cases. cite 较 quote 正式,常用于较正式的场合中,如说明法律案件时。

◆ allude to sb./sth. (formal) to mention sth. in an indirect way 间接提到;暗指;影射

e. g.: Rick didn't want to discuss his past, but he alluded darkly to "some bad things that happened."

里克不想谈论自己的过去,不过他含含糊糊地说起"发生过一些不幸的事"。

3.7 练习题 Exercise

(3-1) 完形填空,给出理由并举 1—2 例说明类似的用法。

A leading candidate for dark matter, which scientists believe makes up about 27 percent of the universe but they have never directly observed, are the delightfully named WIMPs, or weakly interacting massive particles. These are theoretical, and they are just what they're called: They almost never interact with normal matter, and they're large because they make up a lot of the universe. But "almost never" interacting with normal matter doesn't mean ____[1]____. And scientists believed with the right kind of detector they could observe WIMPs.

Between 2006 and 2008 about four dozen physicists buried 19 Germanium-based detectors and 11 silicon-based detectors deep in a mine in Minnesota. They believed the Germanium detectors might be just ____[2]____ to capture the rare, but theoretically possible collision between a WIMP and an atomic nucleus. The silicon detectors were just there to confirm the result—____[3]____ if a Germanium detector recorded such a collision and a silicon detector did not, that would be good evidence for a WIMP.

Why? Because theoretical physicists guessed that WIMPs would be about 50 times the size of a proton. Because mass and energy are equivalent ____[4]____ to Einstein's $E = mc^2$, particle physicists measure mass in energy units. A proton has a ____[5]____ of 1 billion electron volts, or 1 GeV. Physicists thought WIMPs might have a mass of about 50 GeV.

[1] A. ever	B. never	C. always	D. sometime
[2] A. right	B. good	C. well	D. nice
[3] A. e. g.	B. et ac.	C. i. e.	D. i. g.
[4] A. thanks	B. given	C. asks	D. assumes
[5] A. mass	B. temperature	C. height	D. energy

(3-2) 完形填空。

A Comparative Climatology Symposium held at NASA Headquarters on May 7 focused on new approaches to climate research by highlighting the similarities and contrasts between the environments of the rocky worlds Venus, Earth, Mars and Saturn's smoggy moon Titan. The symposium also included discussions about exoplanets(外星行星), the sun and past, ____[1]____ and fu-

ture space missions. John Grunsfeld, Associate Administrator for NASA's Science Mission Directorate, said that the upcoming James Webb Space Telescope will be able to make important observations of the atmospheres of exoplanets. He said JWST won't be able to locate the ____[2]____, only study them, but the recently selected TESS mission could act as a planet scout for JWST targets. It is estimated that TESS will discover around 300 "super-Earth" alien planets, many of them in the habitable zone. But the number one challenge, Grunsfeld noted, is figuring out the climate of our own planet. Jim Green, ____[3]____'s Planetary Science Division Director, said that one goal is to examine a variety of planetary bodies as a system, to see if there are trends or similarities. He also pointed out that from a planetary scientist's ____[4]____, climate change on our planet is not a new thing. "Earth's climate has done nothing but change," Green said. Green said that three Earth-observing satellites will be launched this year, and they will help us better understand how the climate is currently changing and the implications that have for our planet's environment. David Grinspoon, holder of the first Baruch S. Blumberg NASA/Library of Congress ____[5]____ in Astrobiology, talked about Mars' "ferocious and interesting" meteorology, and how Martian global dust storms may help unravel what happened on our planet during the K-T extinction 65 million years ago, when an asteroid hitting the Yucatan Peninsula is thought to have eradicated 75 percent of animals and plants on Earth, including the dinosaurs.

[1] A. now	B. present	C. today	D. this moment
[2] A. earth	B. planets	C. exoplanets	D. sun
[3] A. SATA	B. GABA	C. OMEGA	D. NASA
[4] A. perspective	B. case	C. thing	D. think
[5] A. bench	B. desk	C. chair	D. rostrum

(3-3) 完形填空。

As for Venus, Grinspoon said scientists believe current-day volcanism on Venus is thought to be necessary to sustain the planet's thick clouds. He added that the active surface has eradicated most ancient rocks, preventing us from easily understanding ____[1]____ early history. Grinspoon also discussed the unique climate of Titan, noting that the methane cycle on this moon of Saturn is "like Earth's hydrological cycle on steroids." Studying the climates of Mars, Venus, Titan and even exoplanets could help us refine our climate models of the Earth. However, Grinspoon said that "clouds are the biggest uncertainty in understanding the past of Venus and predicting the future of Earth." Tying climatology to astrobiology, Grinspoon said that our expectations of the other planets, in the ____[2]____ of data, were that they'd be much more Earth-like than they actually are. We still haven't found a planet quite like our own, although astronomers are zeroing in on exoplanets that should have habitable conditions. But, Grinspoon said, "it may be that conditions for life's ____[3]____ aren't rare, but the hard part is the persistence of habitable conditions."

Venus was a popular topic during the symposium. Roald Sagdeev, University of Maryland professor and former director of the Space Research Institute of the USSR Academy of Sciences, said during an overview of the Russian missions to Venus that "from the point of ____[4]____ of

habitability, Venus is like having a dead body to study, which is of course very useful for learning anatomy." David Crisp, Senior Research Scientist at the Jet Propulsion Laboratory/California Institute of Technology, said that sending weather balloons to Venus taught us a lot about ____[5]____ physics. And Roger Bonnet, Executive Director of the International Space Science Institute, said there was no chance for a big "flagship" mission to Venus, since the viewpoint among many amounts to "Who cares about clouds and wind on Venus, when we have so much of that on Earth? We want to see little green men!" One participant noted the presence of "the Venus mafia" at the symposium, inferring that the focus on Earth's "twin planet" had muscled out discussion of other places of interest.

[1] A. Venus'	B. Earth's	C. Mar's	D. Jupiter's
[2] A. presence	B. absence	C. vanity	D. time
[3] A. miracle	B. feature	C. origin	D. meaning
[4] A. listening	B. theory	C. thought	D. view
[5] A. atmospheric	B. temperature	C. biological	D. energy

(3-4) 任选两个段落翻译成汉语。

[1] The concept of momentum is particularly important in situations in which we have two or more interacting bodies. To see why, let's consider first an idealized system consisting of two bodies that interact with each other but not with anything else—for example, two astronauts who touch each other as they float freely in the zero-gravity environment of outer space.

[2] Think of the astronauts as particles. Each particle exerts a force on the other; according to Newton's third law, the two forces are always equal in magnitude and opposite in direction. Hence, the impulses that act on the two particles are equal and opposite, and the changes in momentum of the two particles are equal and opposite.

[3] A Montana State University physicist who recently led Bozeman in celebrating Einstein has now won a five-year $500,000 Young Investigator CAREER Award from the National Science Foundation.

[4] Nico Yunes, 32, learned about his award the same day he was notified that he and Angela Des Jardins, director of the Montana Space Grant Consortium (MSGC), were named Fellows in Engagement in MSU's College of Letters and Science. The designation recognizes their significant contributions in communicating science to the public. The CAREER Award is the NSF's most prestigious award that supports the early career development of teacher-scholars and honors outstanding scientists who haven't yet received tenure.

[5] Richard Smith, professor and head of the MSU Department of Physics, said, "When one of our faculty wins a CAREER award, we are very pleased because it reflects well on the very high level of research programs at MSU, the top notch caliber of the faculty we are able to attract, and the respect that peer scientists around the country have for the talent and potential they see in new faculty at MSU."

[6] In addition, Yunes said he will use his grant to work with MSU's Museum of the Rockies and develop a 20-to-30-minute planetarium show that incorporates the "Celebrating Einstein" ma-

terials from MSU. The show will be available for free to 1,000 small planetariums across the United States.

[7] He will also use his grant locally to continue the Science Bowl that began with "Celebrating Einstein" and builds community among MSU physicists, Yunes said. Similar to the television game show, "Jeopardy," the bowl involves four-person teams that include one undergraduate, two graduate students and one postdoctoral researcher in physics. They compete by answering general physics questions such as "How old is the universe?" (13.8 billion years old) and "How long does it take for light from the sun to reach us?" (about eight minutes). They also answer questions that require simple computations.

[8] Regarding his research, Yunes said he will use his CAREER grant to help him calculate gravitational wave solutions that could then be used as software filters. These filters are critical to detect gravitational waves and to test Einstein's theory.

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第二章 热 学

Lesson 4

内容 4.1 温度和热平衡 Temperature and Thermal Equilibrium
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4.6 同义词辨析 Synonyms
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4.1 温度和热平衡 Temperature and Thermal Equilibrium

Whether it's a sweltering summer day or a frozen midwinter night, your body needs to be kept at a constant temperature. It has effective temperature-control mechanisms, but sometimes it needs help. On a hot day you wear less clothing to improve heat transfer from your body to the air and for better cooling by evaporation of perspiration. You probably drink cold beverages, possibly with ice in them, and sit near a fan or in an air-conditioned room. On a cold day you wear more clothes or stay indoors where it's warm. When you're outside, you keep active and drink hot liquids to stay warm. The concept of temperature will help you understand the basic physics of keeping warm or cool.

The concept of **temperature** is rooted in qualitative ideas of "hot" and "cold" based on our sense of touch. [1]**A body that feels hot usually has a higher temperature than a similar body that feels cold.** That's pretty vague, and the senses can be deceived. But many properties of matter that we can measure depend on temperature. The length of a metal rod, steam pressure in a boiler, the ability of a wire to conduct an electric current, and the color of a very hot glowing object—all these depend on temperature.

Temperature is also related to the kinetic energies of the molecules of a material. In general this relationship is fairly complex. The temperature and heat are inherently macroscopic concepts.

They can and must be defined independently of any detailed molecular picture.

[2] **To use temperature as a measure of hotness or coldness, we need to construct a temperature scale.** To do this, we can use any measurable property of a system that varies with its "hotness" or "coldness." Figure 4 – 1(a) shows a familiar system that is used to measure temperature. When the system becomes hotter, the colored liquid (usually mercury or ethanol) expands and rises in the tube, and the value of L increases. Another simple system is a quantity of gas in a constant-volume container (Fig. 4 – 1(b)). The pressure p, measured by the gauge, increases or decreases as the gas becomes hotter or colder. A third example is the electrical resistance R of a conducting wire, which also varies when the wire becomes hotter or colder. Each of these properties gives us a number (L, p or R) that varies with hotness and coldness, so each property can be used to make a thermometer.

To measure the temperature of a body, you place the thermometer in contact with the body. If you want to know the temperature of a cup of hot coffee, you stick the thermometer in the coffee; as the two interact, the thermometer becomes hotter and the coffee cools off a little. After the thermometer settles down to a steady value, you read the temperature. [3] **The system has reached an equilibrium condition, in which the interaction between the thermometer and the coffee causes no further change in the system.** We call this a state of thermal equilibrium.

[4] **If two systems are separated by an insulating material or insulator such as wood, plastic foam, or fiberglass, they influence each other more slowly.** [5] **Camping coolers are made with insulating materials to delay the ice and cold food inside from warming up and attaining thermal equilibrium with the hot summer air outside.** An ideal insulator is a material that permits no interaction at all between the two systems. It prevents the system from attaining thermal equilibrium if they aren't in thermal equilibrium at the start. An ideal insulator is just that, an idealization; real insulators, like those in camping coolers, aren't ideal, so the contents of the cooler will warm up eventually.

We can discover an important property of thermal equilibrium by considering three systems, A, B and C, that initially are not in thermal equilibrium (Fig. 4 – 2). We surround them with an ideal insulating box so that they cannot interact with anything except each other. We separate systems A and B with an ideal wall (the deep colour slab in Fig. 4 – 2a), but we let system C interact with both systems A and B. This interaction is shown in the figure by the light colour slab representing a thermal conductor, a material that permits thermal interactions through it. We wait until thermal equilibrium is attained; then A and B are each in thermal equilibrium with C. But are they in thermal equilibrium with each other?

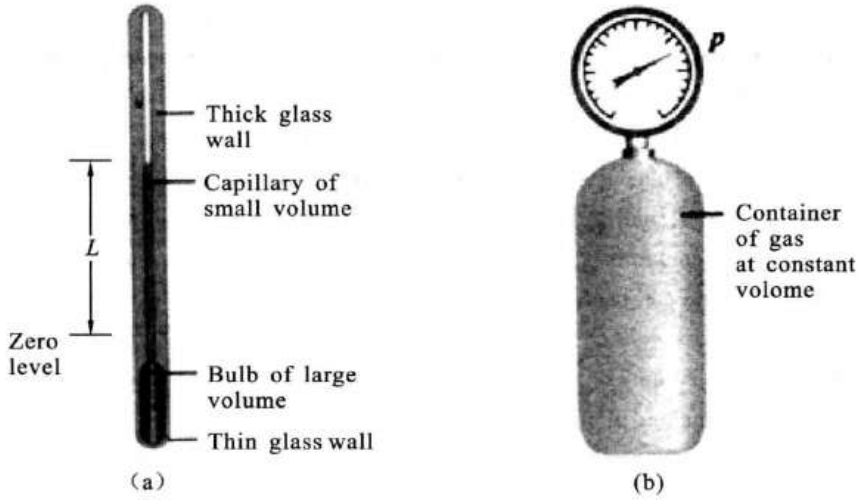


Fig. 4 – 1 (a) A system whose temperature is specified by the value of L. (b) A system whose temperature is value of the pressure p.

To find out, we separate system C from system A and B with an ideal insulating wall (Fig. 4 – 2b), and then we place the insulating wall between A and B with a conducting wall that let A and B interact. What happens? Experiment shows that nothing happens; there are no additional changes to A or B. We conclude that if C is initially in thermal equilibrium with both A and B, then A and B are also thermal equilibrium with each other. This result is called the zeroth law of thermodynamics. It may seem trivial and obvious, but even so it needs to be verified by experiment.

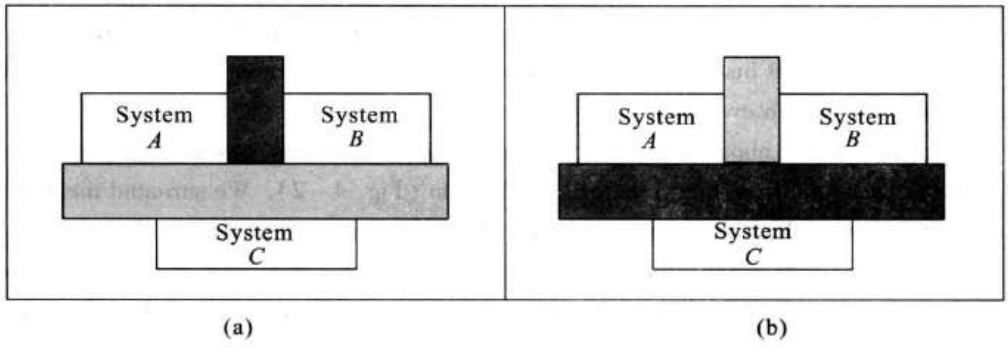


Fig. 4 – 2 The zeroth law of thermodynamics.

(a) If system A and B are each in thermal equilibrium with system C, deep colour Blue slabs represent insulating walls; light colour slabs represent conducting walls. (b) A and B are in thermal equilibrium with each other.

Now suppose system C is a thermometer, such as the tube-and-liquid system. The thermometer C is in contact with both A and B. In thermal equilibrium, when the thermometer reading reaches a stable value, the thermometer measures the temperature of both A and B; hence A and B both have the same temperature. Experiment shows that thermal equilibrium isn't affected by

adding or removing insulators, so the reading of thermometer *C* wouldn't change if it were in contact only with *A* or only with *B*. We conclude that two systems are in thermal equilibrium if and only if they have the same temperature. This is what makes a thermometer useful; a thermometer actually measures its own temperatures, but when a thermometer is in thermal equilibrium with another body, the temperatures must be equal. When the temperatures of two systems are different, they cannot be in thermal equilibrium.

4.2 生词表 New Words

thermal equilibrium 热平衡
mechanism *n.* 方法;机制
evaporation *n.* 蒸发;挥发
perspiration *n.* 汗;排汗,出汗
beverage *n.* 饮料
deceive *v.* 欺诈,误导
property *n.* 性质,特性
gauge *n.* 测量仪,计量器
macroscopic *adj.* 宏观的
thermometer *n.* 温度计,体温表
in contact with 与……在接触中
stick *v.* 插入,放置
cool off 冷却下来
settle down 安定
steady *adj.* 稳定的,不变的
insulator *n.* 绝缘、隔热或隔音等的物质或装置
surround *v.* 包围,围绕
initially *adv.* 开始,最初
interact *v.* 相互作用;互相影响
affect *v.* 影响
trivial *adj.* 平常的,平凡的;不重要的
obvious *adj.* 明显的,平淡无奇的
measure *v.* 测量,估量
kinetic *adj.* 动力(学)的,运动的
conductor *n.* 导体

4.3 课文注释 Text Annotation

【1】A body that feels hot usually has a higher temperature than a similar body that feels cold.
感觉到热的物体通常比凉的物体具有比较高的温度。

这句话包含两个知识点:定语从句作后置定语和专业英语中的比较。that feels hot 和 that feels cold 分别是两个定语从句作后置定语。大量地使用后置定语是科技英语的特点之一。

1. 后置定语常见的结构:

(1)介词短语

e. g. : The forces due to friction are called frictional forces.

由于摩擦而产生的力称为摩擦力。

A call for papers is now being issued.

征集论文的通知现正陆续发出。

(2)形容词及形容词短语

e. g. : All radiant energy has wavelike characteristics, analogous to those of waves that move through water.

所有的辐射都具有波的特征，与水中移动的波的特征相似。

In this factory the only fuel available is coal.

该厂唯一可用的燃料是煤。

Non-mobile robots, capable of learning to perform an industrial task and then of being left to perform it tirelessly, are even now in use in industrial plants all over the world.

非移动机器人，因其有能力完成一定的工业任务，而且可以不知疲倦地工作，因此早已在世界各地的工厂中得到应用。

(3)副词

e. g. : The air outside pressed the side in.

外面的空气将桶壁压得凹进去了。

The force upward equals the force downward so that the balloon stays at the level.

向上的力与向下的力相等，所以气球就保持在这一高度。

(4)单个分词，但仍保持较强的动词意义

e. g. : The results obtained must be checked.

获得的结果必须加以校核。

The heat produced is equal to the electrical energy wasted.

产生的热量等于浪费了的电能。

(5)定语从句

e. g. : During construction, problems often arise which require design changes.

在施工过程中，常会出现需要改变设计的问题。

The molecules exert forces upon each other, which depend upon the distance between them.

分子相互间都存在着力的作用，力的大小取决于它们之间的距离。

Very wonderful changes in matter take place before our eyes every day to which we pay little attention.

我们几乎没有注意到很奇异的物质变化每天都在眼前发生。

定语从句 to which we pay little attention 修饰的是 changes，这是一种分隔定语从句。

To make an atomic bomb we have to use uranium 235, in which all the atoms are available for fission.

制造原子弹，我们必须用铀 235，因为铀的所有原子都会裂变。

2. 专业英语中的比较

1. 同级比较句型：

as...as (和……一样)

e. g. : I am as high as you.

我和你一样高。

be identical with, be the same as, be equal to (和……相同)

The TV set uses the same capacitor as that one does.

这台电视机用的电容器和那台的一样。

no more...than... (和……一样不……)

Wood is no more conductor than glass.

木头和玻璃都不是导体。

2. 比较级句型：

...than...（比……更……一些）

e. g. : This computer works better than that one.

这台计算机的性能比那台好。

...not as/so...as（和……不一样）

This desk is not as big as that one.

这张桌子没有那张桌子大。

be superior to / be inferior to（优于……/劣于……）

The power of the new engine is superior to that of the old one.

这台新发电机的功率优于那台旧发电机。

3. 最高级句型：the +最高级+ of /in...（在……之中）最……

e. g. : Hydrogen is the lightest of all elements.

氢是所有元素中最轻的。

This is the largest workshop in our factory.

这是我们厂里最大的车间。

【2】To use temperature as a measure of hotness or coldness, we need to construct a temperature scale.

要使用温度计来测量冷和热，就需要设定温度的测量尺度。

to use temperature as a measure of hotness or coldness 是目的状语从句。目的状语从句常用的引导词有：so that, in order to, to 等。

e. g. : In order to improve the quality of teaching, the teachers revised syllabus.

为了提高教学质量，老师们重新修订了教学大纲。

【3】The system has reached an equilibrium condition, in which the interaction between the thermometer and the coffee causes no further change in the system.

该系统已达到一个平衡状态，温度计和咖啡之间没有进一步的变化。

in which the interaction between the thermometer and the coffee causes no further change in the system 是非限定性定语从句修饰先行词 the system。非限定性定语从句既可修饰先行词，也可修饰整个主句，起补充说明作用，与主句之间有逗号隔开，若省去，原句意思不受影响。不可用 that 引导非限定性定语从句，关系词也不可省略。

非限定性定语从句的结构：先行词 + 逗号 + 引导词，常用的引导词有 which, as。

e. g. : He was late again, as/which we had expected.

正如我们所料，他又迟到了。

This cable is like a snake, as/ which everybody can see. = As everybody can see, this cable is like a snake.

任何人都看得出来，这条电线像条蛇。

在形式上 as 引导的非限定性定语从句可以位于主句的后面，也可位于主句的前面；而 which 引导的非限定性定语从句只能位于主句的后面，不能位于主句的前面。

【4】If two systems are separated by an insulating material or insulator such as wood, plastic foam,

or fiberglass, they influence each other more slowly.

如果两个系统是由绝热材料或绝缘物,如木材、塑料泡沫、或玻璃纤维分隔开,那么它们之间的相互影响更会非常慢。

该句中 if 引导条件状语从句。条件状语从句常用的引导词有:if, unless 等。

e. g. :If it rains, the event will be cancelled this afternoon.

如果天下雨,今天下午的活动取消。

Unless there is motion, however, there is no work.

除非有运动,否则不会有做功存在。

【5】Camping coolers are made with insulating materials to delay the ice and cold food inside from warming up and attaining thermal equilibrium with the hot summer air outside.

用绝缘材料制造的野营冷却器延迟冰冷的食物变暖,阻止内部食物与炎热的夏季空气实现热平衡。

该句应用了被动语态。根据英国利兹大学 John Swales 的统计,科技英语中的谓语至少三分之一是被动语态。这是因为:①科技文章侧重叙事推理,强调客观准确。第一、二人称使用过多,会造成主观臆断的印象。因此尽量使用第三人称叙述,采用被动语态,例如:Attention must be paid to the working temperature of the machine. 应当注意机器的工作温度。而很少说:You must pay attention to the working temperature of the machine . 你们必须注意机器的工作温度。②科技文章将主要信息前置,放在主语部分。这也是广泛使用被动语态的另一个主要原因。

被动语态的构成:主语(动作的承受着) + 谓语 + by + 动作的发出者

e. g. :Machines are run by electricity.

机器是由电来驱动的。

That satellite was launched last year.

那颗卫星是去年发射的。

A new kind of computer is being designed by this research institude.

这个研究所正在研究一种新的计算机。

4.4 扩展阅读 Extended Reading

Molecular Speeds

As we know, the molecules in a gas don't all have the same speed. Fig. 4 – 3 shows one experimental scheme for measuring the distribution of molecular speeds. A substance is vaporized in a hot oven; molecules of the vapor escape through an aperture in the oven wall and into a vacuum chamber. A series of slits block all molecules except those in a narrow beam, which is aimed at a pair of rotating disks. A molecule passing through the slit in the first disk is blocked by the second disk unless it arrives just as the slit in the second that passes only molecules within a certain narrow speed range. This range can be varied by changing the disk rotation speed, and we can measure how many molecules lie within each of various speed ranges.

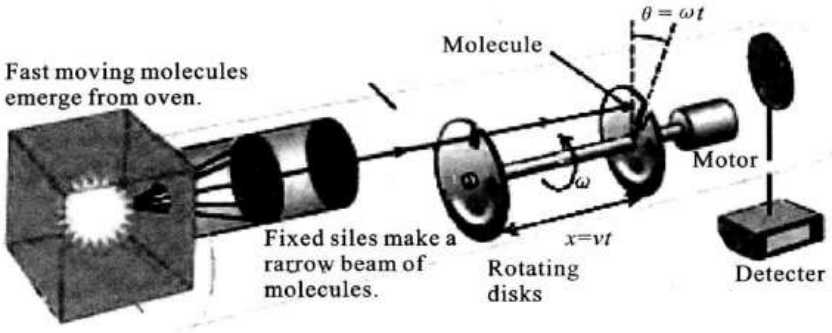


Fig. 4 – 3 A molecule with a speed v is passing through the first slit
When it reaches the second slit, the slits have rotated through the offset angle θ.
If $v = \omega x/\theta$, the molecule passes through the second slit and reaches the detector.

To describe the results of such measurements, we define a function $f(v)$ called a distribution function. If we observe a total of N molecules, the number $\mathrm{d}N$ *having speeds in the range between v and $v + \mathrm{d}v$ is given by*

$$\mathrm{d}N = Nf(v)\,\mathrm{d}v. \tag{4-1}$$

We can also say that the probability that a randomly chosen molecule will have a speed in the interval v to $v + dv$ is $f(v)\,dv$. Hence is the probability per unit speed interval; it is not equal to the probability that a molecule has speed exactly equal to v. Since a probability is a pure number, $f(v)$ has units of reciprocal speed (s/m).

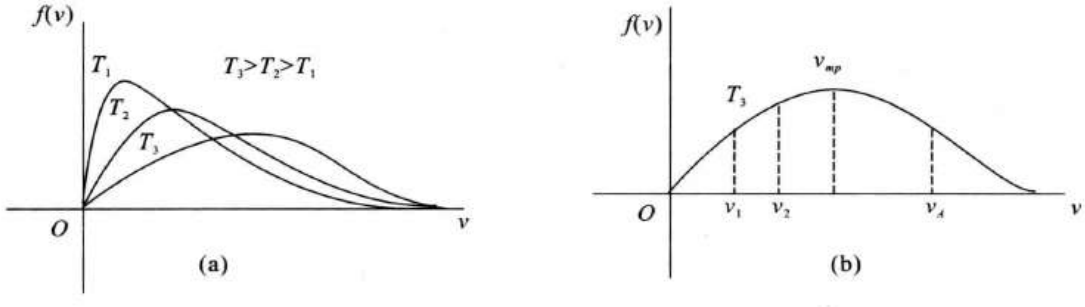


Fig. 4 – 4(a) Curves of the Maxwell-Boltzmann distribution function $f(v)$ for various temperatures.
As the temperature increases, the curve becomes flatter, and its maximum shifts to higher speeds.
(b) At temperature T_3 the fraction of molecules having speeds in the range v_1 to v_2 is shown by the shaded area under the T_3 curve. The fraction with speeds greater than v_A is shown by the area from v_A to infinity.

Fig. 4 – 4(*a*) *shows distribution functions for several different temperatures. At each temperature the height of the curve for any value of v is proportional to the number of molecules with speeds near v. The peak of the curve represents the most probable speed v_{mp} for the corresponding temperature. As the temperature increases, the average molecular kinetic energy increases, and so the peak of $f(v)$ shifts to higher and higher speeds.* Fig. 4 – 4(*b*) *shows that the area under curve between any two values of v represents the fraction of all the molecules having speeds in that range. Every molecule must have some value of v, so the integral of $f(v)$ over all v must be unity for any T.*

If we know, we can calculate the most probable speed v_{mp}, the average speed v_{av}, and the rms speed v_{rms}. To find v_{mp}, we simply find the point where $df/dv = 0$; this gives the value of the speed where the curve has its peak. To find v_{av}, we take the number $nf(v)/dv$ having speeds in each interval dv, multiply each number by the corresponding speed v, add all these products (by integrating over all v from zero to infinity), and finally divide by N. This is,

$$v_{av} = \int_0^\infty vf(v)\,dv. \tag{4-2}$$

The rms speed is obtained similarly; the average of v^2 is given by

$$(v^2)_{av} = \int_0^\infty v^2 f(v)\,dv, \tag{4-3}$$

and v_{rms} is the square root of this.

The function $f(v)$ describing the actual distribution of molecular speeds is called the Maxwell-Boltzmann distribution. It can be derived from statistical-mechanics considerations, but that derivation is beyond our scope. Here is the result:

$$f(v) = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} v^2 e^{-mv^2/2kT} \quad (\textit{Maxwell-Boltzman distribution}). \tag{4-4}$$

We can also express this function in terms of the translational kinetic energy of a molecule, which we denote by ε. That is, $\varepsilon = mv^2/2$. We invite you to verify that when this is substituted into Eq. (4-4), *the result is*

$$f(v) = \frac{8\pi}{m}\left(\frac{m}{2\pi kT}\right)^{3/2} \varepsilon e^{-\varepsilon/kT}. \tag{4-5}$$

This form shows that the exponent in the Maxwell-Boltzmann distribution function is $-\varepsilon/kT$ and that the shape of the curve is determined by the relative magnitude of ε and kT at any point. We leave it as an exercise to prove that the peak of each curve occurs where $\varepsilon = kT$, corresponding to a most probable speed v_{mp} given by

$$v_{mp} = \sqrt{\frac{2kT}{m}}. \tag{4-6}$$

To find the average speed, we substitute Eq. (4-4) *into* Eq. (4-2) *and carry out the integration, making a change of variable $v^2 = x$ and then integrating by parts. We leave the details as an exercise; the result is*

$$v_{av} = \sqrt{\frac{8kT}{\pi m}}. \tag{4-7}$$

Finally, to find the rms speed, we substitute Eq. (4-4) *into* Eq. (4-3). *Evaluating the resulting integral takes some mathematical acrobatics, but we can find it in a table of integrals. The result is*

$$v_{rms} = \sqrt{\frac{3kT}{m}}. \tag{4-8}$$

It must agree if the Maxwell-Boltzmann distribution is to be consistent with the equipartition theorem and our other kinetic-theory calculations.

Table 4-1 *shows the fraction of all the molecules in an ideal gas that have speeds less than va-*

rious multiples of v_{rms}. These numbers were obtained by numerical integration; they are the same for all ideal gases.

Table 4 – 1. *Fractions of molecules in an ideal gas with speeds less than various multiples of v/v_{rms}.*

v/v_{rms}	*fraction*
0.20	0.011
0.40	0.077
0.60	0.218
0.80	0.411
1.00	0.608
1.20	0.771
1.40	0.882
1.60	0.947
1.80	0.979
2.00	0.993

The distribution of molecular speeds in liquids is similar, although not identical, to that for gases. We can understand the vapor pressure of a liquid and the phenomenon of boiling on this basis. Suppose a molecule must have a speed at least as great as v_A in Fig. 4 – 4*b to escape from the surface of a liquid into the adjacent vapor. The number of such molecules, represented by the area under the "tail" of each curve (to the right of v_A), increases rapidly with temperature. Thus the rate at which molecules can escape is strongly temperature-dependent. This process is balanced by another one in which molecules in the vapor phase collide inelastically with the surface and are trapped back into the liquid phase. The number of molecules suffering this fate per unit time is proportional to the pressure in the vapor phase. Phase equilibrium between liquid and vapor occurs when these two competing processes at exactly the same rate. So if the molecular speed distributions are known for various temperatures, we can make a theoretical prediction of vapor pressure as a function of temperatures. When liquid evaporates, it's the high-speed molecules that escape from the surface. The ones that are left have less energy on average; this gives us a molecular view of evaporative cooling.*

Rates of chemical reactions are often strongly temperature-dependent, and the reason is contained in the Maxwell-Boltzmann distribution. When two reacting molecules collide, the reaction can occur only when the molecules are close enough for the electric-charge distributions of their electrons to interact strongly. This requires a minimum energy, called the activation energy, and thus a certain minimum molecular speed. Fig. 4 – 4*a shows that the number of molecules in the high-speed tail of the curve increases rapidly with temperature. Thus we expect the rate of any reaction that depends on an activation energy to increase rapidly with temperature. Similarly, many plant growth processes have strongly temperature-dependent rates, as can be seen by the rapid and diverse growth in tropical rain forests.*

4.5 常用用法 Usages and Expressions

Ⅰ. 几种常用的温度计 Several Usual Thermometers

温度计(thermometer)	测温属性(Measurement attributes)
定容气体温度计(Constant volume gas thermometer) 定压气体温度计 (Constant pressure gas thermometer) 铂电阻温度计 (Platinum resistance thermometer) 铂 - 铂铑热电偶温度计 (Platinum platinum-rhodium thermocouple thermometer) 液体温度计 (Liquid filled thermometer)	压强 (pressure) 体积 (volume) 电阻 (resistance) 热电动势 (thermal electromotive force) 液柱长度(liquid column length)

Ⅱ. 热学常用实验仪器 Usual Thermal Experiment Instruments

refrigerator 电冰箱
digital thermometer 数字温度计
heater 加热器
thermotics experiment facility
热学实验仪
heat converter 热交换器
thermostat 恒温箱
calorimeter 热量计
heat exchanger 热交换器
barometer 气压计
specific heat capacity converter
比热容转换器
varying-temperature viscosity
coefficient tester
变温黏滞系数实验仪
interconversion of mechanical
energy and heat energy demonstrator
机械能和热能互变演示器
metal linear expansion demonstrator
金属线膨胀演示器
refrigerated centrifuge
冷冻离心分离机
experimental device for gas law
气体定律实验器
heat conduction demonstrator
热传导演示器
thermoelectric couple 热电偶
heat flux density converter
热流密度转换器
thermistor thermometer
热敏温度计/热敏电阻温度计
quick freezing refrigeration device
速冻制冷装置
liquid specific heat detector
液体比热测定仪
vacuum thermopile
真空热电堆/真空温差电堆
refrigeration compressor
制冷压缩机/冷冻机
thermal coefficient meters
导热系数测定仪
meter of metal specific heat capacity
金属比热容测定仪

4.6 同义词辨析 Synonyms

thing, object, article, item, commodity, provision, stuff, substance, property, possessions, junk, entity, belongings, goods, stock, merchandise, valuables

These are all words for objects or items.

以上各词均指东西、物品。

◆ thing (rather informal) objects, clothing or tools that you own or that are used for a particular purpose(个人拥有或作特定用途的)物品;衣服;用具

e. g. : The shed is where we keep our tools and things.

这棚子是我们放工具的地方。

I want to sell some of my things, but they aren't worth much.

我想卖掉一些东西,但它们值不了几个钱。

【习惯用法】

be seeing things	胡思乱想;产生幻想
for one thing	首先;一则
have a thing	偏爱或厌恶

◆ object a thing that can be seen and touched, but is not alive(能够看得见、摸得着的,没有生命的)物品

e. g. : an everybody object such as a spoon

调羹之类的日常用品

a small metal object

一个小的金属物件

◆ article (formal) a particular item or separate thing, especially one of a set(特定的、属于一套或一系列的)物品

e. g. : household articles

家居用品

She only took a few articles of clothing with her.

她随身只带了几件衣服。

◆ item a single article or object 单一的东西或物品

e. g. : He opened the cardboard box and took out each item.

他打开纸板箱把里面的物品一一拿出来。

The store is having a sale on furniture and household items.

这家商店正在减价出售家具和家居用品。

◆ commodity a thing that is useful or has a useful quality 有用的东西;有使用价值的事物

e. g. : Time is a precious commodity.

时间是宝贵的财富。

◆ provision supplies of food and drink, especially for a long journey 饮食供应(尤指旅途中的粮食)

e. g. : We had enough provisions for two weeks.
我们的粮食足够应付两星期。

◆ stuff used to refer to a group of objects when you do not know their names, when the names are not important or when it is obvious what you are talking about(名称不详、名称无关紧要的)东西,物品,玩意儿

e. g. : How do you think you're going to fit all that stuff into the car?
你认为怎样才能把那些东西装进车里呢?
Where's all the camping stuff?
野营用的东西都在哪儿?

【习惯用法】

know one's stuff 精通本行

e. g. : As a teacher you should know your stuff well.
作为一名教师是应该精通教学本行的。

◆ substance a type of solid, liquid or gas that has particular qualities 物质,物品,东西

e. g. : The leaves were covered with a strange sticky substance.
树叶上覆盖着一层奇怪的黏糊糊的东西。
Police found an illegal substance in his car.
警察在他的车里发现了违禁品。

◆ property a thing or things owned by sb. ; a possession or possessions 所有物;财产;财物

e. g. : The hotel is not responsible for any loss or damage to guests' personal property.
旅馆对客人财物的丢失和损坏概不负责。
Some of the stolen property was found in Mason's house.
在梅森的房间里找到了部分被盗财物。

◆ possessions things that you own, especially sth. that can be moved 个人财产,私人物品(尤指动产)

e. g. : He had sold all his possessions and left the country.
他变卖了所有财产,离开了那个国家。
Prisoners were allowed no personal possessions.
犯人们不得随身携带私人物品。

◆ junk things that are considered useless or of little value 无用的东西,无价值的东西

e. g. : This cupboard's full of junk.
这个壁橱里塞满了杂物。

◆ entity (formal) something that exists separately from other things and has its own identity 具有独特特征的独立物体

e. g. : The mind exists as a separate entity.
心灵作为一个独立的实体存在。
Good design brings a house and a garden together as a single entity.
优秀的设计能把房子和花园组成一个统一的实体。

◆ belongings possessions that can be moved, especially ones that you have with you at a particular time 动产(尤指随身物品)

e. g. : an insurance policy that covers your personal belongings
一张承包个人财产的保单

◆ goods (rather formal or technical) possessions that can be moved 动产;(可搬运的)私人财产

e. g. : They were charged with handing stolen goods.
他们因为买卖赃物被起诉。
We collected up our goods and left.
我们收拾好东西就走了。

【习惯用法】

by goods	用货车装运
catch sb. with the goods	人赃俱获

◆ stock ~ (of sth.) a supply of sth. that is available for use(可以使用的)储备;供给

e. g. : He keeps a stock of medicines in the cupboard.
他在柜子里有一些备用药品。
The country has been building up its stock of weapons.
这个国家一直在增加武器装备。

◆ merchandise (formal) goods that are bought or sold; goods that are for sale in a shop /store (商店、仓库中用来出售的)储备物;商品

e. g. : A range of official Disney merchandise was on sale.
一系列正版的迪士尼商品在售。
They inspected the merchandise carefully.
他们仔细检查了商品。

◆ valuables things that are worth a lot of money, especially small personal things such as jewellery or cameras 私人的贵重物品(如首饰、相机等)

e. g. : Guests should leave their valuables in the hotel safe.
客人应该把贵重东西存放在酒店保险柜中。

4.7 练习题 Exercise

(4-1) 用括号内所给词的适当形式填空,然后把短文译成汉语。

[1] The use of solar and wind power is now increasing rapidly, raising hope that such alternative energy technologies can significantly _____(reduce) greenhouse gas emissions and generate new jobs.

[2] The globe wind power industry, for example, has become a $ 2-billion-a-year business, expanding at a rate of 25% per year. India, China, and a dozen European nations _____(install) thousands of wind turbines that generate electricity at a cost comparable to new coal-fired power plants. In the 1990s, Germany _____(create) 10,000 new jobs in its wind industry. Wind power now provides less than 1% of the world's total electricity, but that figure could climb to 20% or more within 50 years, according to Worldwatch Institute researchers.

[3] Solar power is the second fastest _____(grow) energy source today. The cost of buying a kilowatt worth of solar photovoltaic cells _____(drop) from $ 70,000 in the 1970s to $ 4,000 in 1997, and in 10 years it could go as low as $ 1,000. Approximately 400,000 homes — many in remote areas not connected by power lines — already use solar power. Worldwatch studies _____(suggest) that _____(cover) the rooftops of existing buildings with solar cells could meet more than half of the electricity needs each year.

[4] "During the past few years a host of promising new technologies _____(move) quietly but decisively from experimental curiosity to commercial reality," write Woldwatch Institute energy analysts Christopher Flavin and Seth Dunn in their report, *Rising Sun, Gathering Winds: Policies to Stabilize the Climate and Strengthen Economics.* Advances in electronics, biotechnology, and the use of synthetic materials could soon _____(lead to) cleaner and more efficient ways to generate energy.

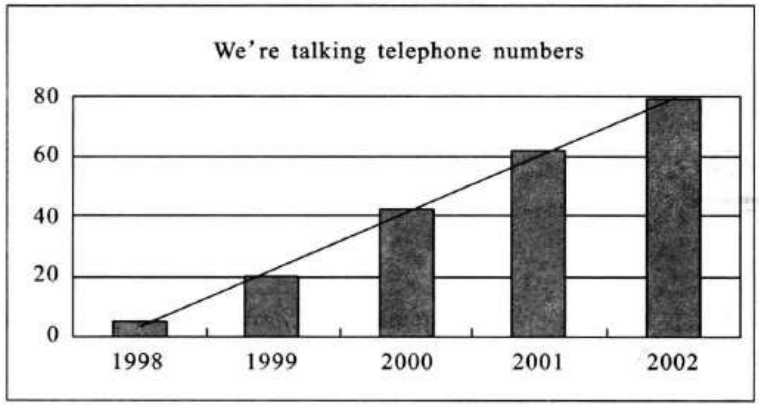
[5] A new generation of lightweight hybrid electric vehicles could exceed 100 miles per gallon by _____(utilize) a combination of fuel cells, and small piston engines, turbine generators, and highly efficient electric motors. Similar technologies using micro-turbines and fuel cells could _____(generate) electricity and heat for commercial buildings and private homes while producing just 10% to 20% of the emissions from today's power plants. Micro-power plants located in buildings are extremely efficient; 90% of the fuel they use can be turned into electricity, usable space heat, and heat for warming water.

(4-2) 写作。

线性图和柱形图通常用来显示变化趋势。尽管趋势本身变化多端,但是首先着眼看总体趋势是非常重要的。

INCREASING OR DECREASING TRENDS 上升/下降趋势

◆ Look at this bar chart. The information it presents shows a consistent overall trend.



◆ First ask yourself these questions:

What is the chart about?

What does the horizontal axis show?

What does the vertical axis show?

What overall trend(s) does the graph show?

◆ Look at the chart carefully, then complete these two descriptions of the overall trend.

1. Between ... and ... the global number of the text messages sent rose steadily.
2. There was ... in the global number of text messages sent.
3. The number of text messages sent worldwide rose from...in...to...in....

Lesson 5

内容 5.1 内能和热力学第一定律 Internal Energy and the First Law of Thermodynamics
5.2 生词表 New Words
5.3 课文注释 Text Annotation
5.4 扩展阅读 Extended Reading
Ⅰ. 理想气体的内能 Internal Energy of an Ideal Gas
Ⅱ. 理想气体的热容量 Heat Capacities of an Ideal Gas
5.5 常用用法 Usages and Expressions
Ⅰ. 面积的表示法 The Representation of the Area
Ⅱ. 体积与容量的表示法 The Representation of Volume
5.6 同义词辨析 Synonyms
5.7 练习题 Exercise

5.1 内能和热力学第一定律 Internal Energy and the First Law of Thermodynamics

Internal energy is one of the most important concepts in thermodynamics.[1] **When we discussed energy changes for a body sliding with friction, we stated that warming a body increased its internal energy and that cooling the body decreased its internal energy.** But what is internal energy? We can look at it in various ways; let's start with one based on the ideas of mechanics. Matter consists of atoms and molecules, and these are made up of particles having kinetic and potential energies. We tentatively define the internal energy of a system as the sum of the kinetic energies of all of its constituent particles, plus the sum of all the potential energies of interaction among these particles.

Note that internal energy does not include potential energy arising from the interaction between the system and its surroundings. If the system is a glass of water, placing it on a high shelf increases the gravitational potential energy arising from the interaction between the glass and the earth. But this has no effect on the interaction between the molecules of the water, and so the internal energy of the water does not change.

We use the symbol U for internal energy. (We used this same symbol in our study of mechanics to represent potential energy. You may have to remind yourself occasionally that U has a

different meaning in thermodynamics.) During a change of state of the system the internal energy may change from an initial value U_1 to a final value U_2. We denote the change in internal energy as $\Delta U = U_2 - U_1$.

We know that heat transfer is energy transfer. When we add a quantity of heat Q to a system and it does not work during the process, the internal energy increases by an amount equal to Q; that is, $\Delta U = Q$. When a system does work by expanding against its surroundings that no heat is added during the process, energy leaves the system and the internal energy decreases. That is, when W is positive, ΔU is negative, and conversely. So $\Delta U = -W$. When both heat transfer and work occur, the total change in internal energy is

$$U_2 - U_1 = \Delta U = Q - W \text{ (first law of thermodynamics)}. \tag{5-1}$$

We can rearrange this to the form

$$Q = \Delta U + W. \tag{5-2}$$

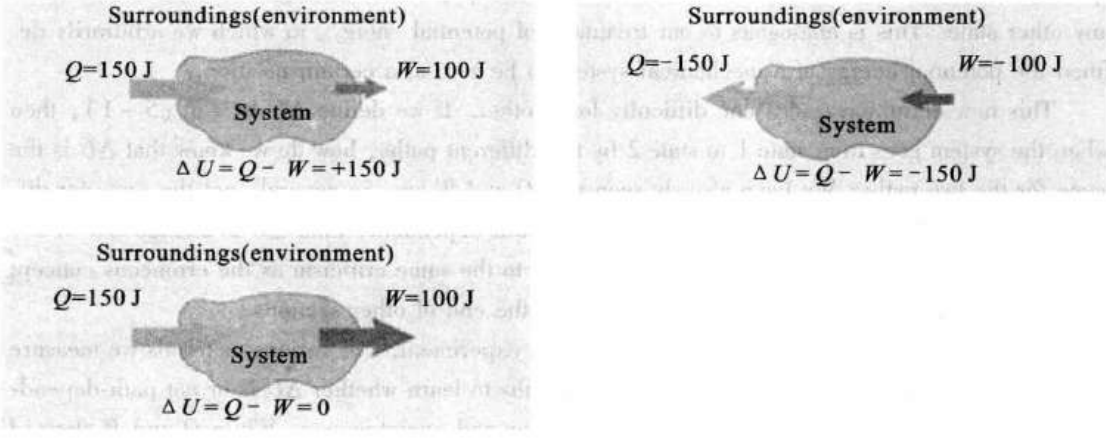


Fig. 5-1 In a thermodynamic process, the internal energy of a system may increase, decrease, or stay the same. (a) If more heat is added to the system than the system does work, ΔU is positive and the internal energy increases. (b) If more heat flows out of the system than work is done on the system, ΔU is negative and internal energy decreases. (c) If the heat added to the system equals the work done by the system, $\Delta U = 0$ and the internal energy is unchanged.

The message of Eq. (5-2) is that in general when heat Q is added to a system, some of this added energy remains within the system, changing its energy by an amount ΔU; the remainder leaves the system again as the system does work W against its surroundings. Because W and Q may be positive, negative, or zero, ΔU can be positive, negative, or zero for different processes (Fig. 5-1).

Eq. (5-1) or (5-2) is the first law of thermodynamics. [2] **It is a generalization of the principle of conservation of energy to include energy transfer through heat as well as mechanical work.** As you will see this principle can be extended to ever broader classes of phenomena by identifying additional forms of energy and energy transfer. [3] **In every situation in which it seems that the total energy in all known forms is not conserved, it has been possible to**

identify a new form of energy such that the total energy, including the new form, is conserved. There is energy associated with electric fields, with magnetic fields, and, according to the theory of relativity, even with mass itself.

At the beginning of this discussion we tentatively defined internal energy in terms of microscopic kinetic and potential energies. This has drawbacks, however. Actually calculating internal energy in this way for any real system would be hopelessly complicated. Furthermore, this definition isn't an operational one because it doesn't describe how to determine internal energy from physical quantities that we can measure directly.

So let's look at internal energy in another way. Starting over, we define the change in internal energy ΔU during any change of a system as the quantity given by Eq. (5 – 1), $\Delta U = Q - W$. This is an operational definition, because we can measure Q and W. It does not define U itself, only ΔU. This is not a shortcoming, because we can define the internal energy of a system to have a specified value in some reference state, and then use Eq. (5 – 1) to define the internal energy in any other state. This is analogous to our treatment of potential energy, in which we arbitrarily defined the potential energy of a mechanical system to be zero at a certain position.

This new definition trades one difficulty for another. If we define ΔU by Eq. (5 – 1), then when the system goes from state 1 to state 2 by two different paths, how do we know that ΔU is the same for the two paths? We have already seen that Q and W are, in general, not the same for different paths. If ΔU, which equals $Q - W$, is also path-dependent, then ΔU is ambiguous. If so, the concept of internal energy of a system is subject to the same criticism as the erroneous concept of quantity of heat in a system, as we discussed at the end of other sections.

The only way to answer this question is through experiment. For various materials we measure Q and W for various changes of state and various paths to learn whether ΔU is or not path-dependent. The results of many such investigations are clear and unambiguous: While Q and W depend on the path, $\Delta U = Q - W$ is independent of path. The change in internal energy of a system during any thermodynamic process depends only on the initial and final states, not on the path leading from one to the other.

Experiment, then, is the ultimate justification for believing that a thermodynamic system in a specific state has a unique internal energy that depends only on that state. An equivalent statement is that the internal energy U of a system is a function of the state coordinates p, V and T (actually, any two of these, since the three variables are related by the equation of state).

To say that the first law of thermodynamics, given by Eq. (5 – 1) or (5 – 2), represents conservation of energy for thermodynamic processes is correct, as far as it goes. But an important additional aspect of the first law is the fact that internal energy depends only on the state of a system. In changes of state, the change in internal energy is path-independent.

All this may seem a little abstract if you are satisfied to think of internal energy as microscopic mechanical energy. There's nothing wrong with that view, and we will make use of it at various times during our discussion. But in the interest of precise operational definitions, internal energy, like heat, can and must be defined in a way that is independent of the detailed microscopic struc-

ture of the material.

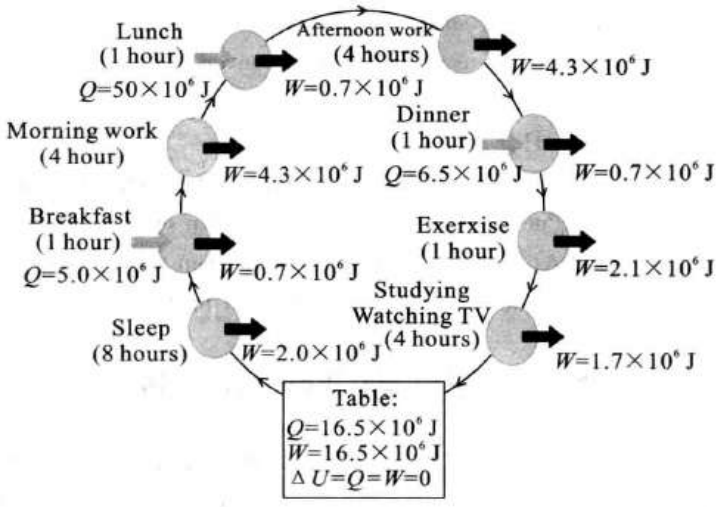


Fig. 5 – 2 Every day, your body(a thermodynamic system) goes through a cyclic thermodynamic process like this one. Heat Q is added by metabolizing food and your body does work W in breathing walking, and other activities. If you return to the same state at the end of the day, $Q = W$ and the net change in your internal energy is zero.

Two special cases of the first law of thermodynamics are worth mentioning. A process that eventually returns a system to its initial state is called a cyclic process. For such a process, the final state is the same as the initial state, and so the total internal energy change must be zero. Then

$$U_2 = U_1 \text{ and } Q = W.$$

If a net quantity of work W is done by the system during this process, an equal amount of energy must have flowed into the system as heat Q. But there is no reason why either Q or W individually has to be zero (Fig. 5 – 2).

Another special case occurs in an isolated system, one that does no work on its surroundings and has no heat flow to or from its surroundings. For any process taking place in an isolated system,

$$W = Q = 0,$$

and therefore

$$U_2 - U_1 = \Delta U = 0.$$

In other words, the internal energy of an isolated system is constant.

Problem-Solving Strategy

1. [4] **The internal energy change in any thermodynamic process or series of processes is independent of the path, whether the substance is an ideal gas or not.** This is of the utmost importance in the problems in this chapter. Sometimes you will be given enough information about one path between given initial and final states to calculate ΔU for that path. Since ΔU is the same for every other path between the same two states, you can then relate the various energy quantities for other paths. For a cyclic process, $\Delta U = 0$.

2. As usual, consistent units are essential. If p is in Pa and V in m^3, then W is in joules.

Otherwise, you may want to convert the pressure and volume units into Pa and m^3. If a heat capacity is given in terms of calories, the simplest procedure is usually to convert it to joules. Be especially careful with moles. When you use $n = m_{tot}/M$ to convert between total mass and number of moles, remember that if m_{tot} is in kilograms, M must be in kilograms per mole. The usual units for M are grams per mole; be careful!

3. When a process consists of several distinct steps, it often helps to make a chart showing Q, W, and ΔU for each step. Put these quantities for each step on a different line, and arrange them so that the Q's, W's, and ΔU's form columns. Then you can apply the first law to each line; in addition, you can add each column and apply the first law to the sums.

5.2 生词表 New Words

energy *n.* 能量
slid *v.* 滑动,滑行
friction *n.* 摩擦
mechanics *n.* 力学
atom *n.* 原子
molecule *n.* 分子
potential energy 势能
tentatively *adv.* 试验性地;暂时地
shelf *n.* 架子,搁板
gravitational potential energy 重力势能
represent *v.* 表现;象征;代表;代理
transfer *n.* 转移
positive *adj.* 正的
negative *adj.* 负的
conversely *adv.* 相反地,颠倒地;倒地;反之;反过来
generalization *n.* 一般化;普通化;归纳
conservation *n.* 保存
situation *n.* 情况;局面,形势
associated with 与……有关,由于
magnetic *adj.* 磁性的
drawback *n.* 缺点
operational *adj.* 可使用的;(用于)操作的
shortcoming *n.* 短处,缺点
analogous *adj.* 相似的,可比拟的
unambiguous *adj.* 不含糊的;清楚的;明白的
ultimate *adj.* 最后的
unique *adj.* 唯一的,仅有的;独一无二的,独特的
precise *adj.* 清晰的;精确的
individually *adv.* 分别地;各个地;各自地
utmost *adj.* 极度的,最大的
quantity *n.* 量;数目

5.3 课文注释 Text Annotation

【1】When we discussed energy changes for a body sliding with friction, we stated that warming a body increased its internal energy and that cooling the body decreased its internal energy.
当我们讨论滑动摩擦的物体的能量变化时,我们说,变热的物体其内部能量增加,变冷的物体其内部能量降低。
这个句子中包括了两个知识点:时间状语从句和分词作后置定语。

◆ when we discussed energy changes for a body sliding with friction,作整个句子的时间状语从句。

时间状语从句常用引导词有:when, as, while, as soon as, before, after, since, till, until, once 等。时间状语从句一般放在句首或句尾。特别需要注意的是,在时间状语从句中一般不使用将来时,而是用现在时表示将来时。

e. g. :The body possesses a definite store of potential energy while it is in the elevated position.

把物体举高时,它具有一定的势能。

Until 1982 he was a senior lecturer in botany at Durham University.

1982 年以前他一直是达勒姆大学生物系的高级讲师。

Once the overall system concept is defined, our choice becomes increasingly limited as we proceed from general concepts to actual design details.

一旦全系统概念定义后,当我们从一般概念进入到设计细节时,我们的选择变得越来越有限了。

◆ ...a body sliding with friction...中, sliding with friction 是分词短语作 a body 的后置定语。

▶分词或分词短语作定语常见的结构:

(1) 分词作定语:单独的分词作定语时,通常放在所修饰的词之前,与所修饰的词之间存在主谓关系。若是现在分词,其表示主动和进行,若是过去分词,则要看它是及物动词还是不及物动词,及物动词时表示被动和完成,不及物动词时表示主动和完成。

e. g. : It's difficult to stop the vehicle moving fast.

让那辆快速移动的车停下来不容易。

Polluted air or water is harmful to our health.

被污染的空气和水对我们的健康有害。

注:分词作定语时,通常都有介词引导,当一个名词后有两个过去分词时,第一分词是作定语,第二个分词则是句子的谓语。

e. g. :All steel obtained contained varing amounts of carbon,silicon,sulfur and other impurities.

获得的各种钢含有数量不等的碳、硅、硫和其他杂质。

(2) 分词短语作定语:现在分词短语和过去分词短语作定语时,前者表示主动和进行,后者表示被动和完成,两者均放在所修饰的词之后。分词短语作定语,其作用相当于定语从句。

e. g. : The man standing by the door is my English teacher.

站在门口的那个人是我的英语老师。

Is there anything planned for this evening?

今晚有什么计划吗?

(3) 非谓语动词作定语的总结:

	与中心词的位置关系	与中心词的逻辑关系	时间概念
不定式	总是位于其后	多有动宾关系	多表将来(将发生)
动名词	多位于其前	表示其性能作用	无时间性(常发生)
现在分词	或前或后	多有主谓关系	表示进行(已发生)
过去分词	或前或后	有动宾关系	多表完成(已发生)

【2】It is a generalization of the principle of conservation of energy to include energy transfer through heat as well as mechanical work.

这是一个包括通过热以及机械做功进行能量转移的能量守恒原理的概括。

The only way to answer this question is through experiment.

回答这个问题的唯一方法是通过实验。

这两个句子都采用了不定式作后置定语。不定式作定语时位于所修饰的词的后面，与所修饰的词之间通常存在动宾关系（不及物动词要带相应的介词）或主谓关系（相当于定语从句），有时用来说明所修饰词的内容。

e. g. :I have a few questions to ask.

我想问几个问题。

She is a very nice person to work with.

她是一个很好共事的人。

We have a plan to finish the work.

我们有一个计划来完成这项工作。

【3】In every situation in which it seems that the total energy in all known forms is not conserved, it has been possible to identify a new form of energy such that the total energy, including the new form, is conserved.

在每一种情况下，似乎在所有已知类型的能量中，总能量是不守恒的，也有可能存在一个新的能量形式，使得所有的总能量是守恒的。

"In every situation in which it seems that the total energy in all known forms is not conserved"中，"in which + 从句"作 every situation 的限制性定语从句。

引导定语从句的关系代词有 who, whom, whose, that ,which, as 等。who, whom, whose 用于指人，whose 有时也可指物，相当于 of which; which 指物；that 既可以指人也可以指物，但只用于限制性定语从句中。在介词提前到关系代词之前形成"介词 + 关系代词"结构来修饰表示事物的先行词时关系代词只能用 which。

e. g. :He is the man whom/ that I saw yesterday.

他是我昨天看到的人。

One who doesn't work hard will never succeed in his work.

不努力工作的人，永远不会成功。

Such people as you describe are rare nowadays.

你描述的这种人现在很少见。

She was pleased with the way in which he had accepted her criticism.

她很满意他接受她的批评的方式。

【4】The internal energy change in any thermodynamic process or series of processes is independent of the path, whether the substance is an ideal gas or not.

在任何热力学过程或一系列过程内部能量的变化是独立的，无论该物质是不是理想气体。

whether the substance is an ideal gas or not 是由 whether 引导的让步状语从句。

让步状语从句：引导让步状语从句的常用引导词有：though, although, even if, even

though，特殊引导词有：as（用在让步状语从句中必须要倒装），while（一般用在句首），no matter + 疑问词，in spite of the fact that，whatever，whoever，wherever，however，whether... or... 等。

e. g. ：Cleveland has always had a reputation for being a dirty，ugly，boring city，though now they say it is much better.

克利夫兰一直因其环境脏乱、市容丑陋、沉闷无趣而恶名在外，尽管据说现在好多了。

Even if many difficulties remain，we can overcome them.

即便是再多的困难，我们也能克服。

No matter what happens，don't look back.

不管发生了什么事，都不要回头看。

However much it hurt，he could do it.

无论有多痛，他都能做到。

5.4 扩展阅读 Extended Reading

Ⅰ. 理想气体的内能 Internal Energy of an Ideal Gas

We will now show that for an ideal gas，the internal energy U depends only on temperature，not on pressure or volume. Let's think again about the free-expansion experiment. A thermally insulated container with rigid walls is divided into two compartments by a partition (Fig. 5 - 3). *One compartment has a quantity of an ideal gas，and the other is evacuated.*

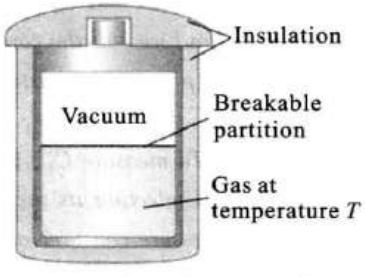


Fig. 5 - 3 *The partition is broken (or removed) to start the free expansion of gas into the vacuum region.*

When the partition is removed or broken，the gas expands to fill both parts of the container，the gas does no work on its surroundings because the walls of the container don't move，and there is no heat flow through the insulation. So both Q and W are zero，and the internal energy U is constant. This is true of any substance，whether it is an ideal gas or not.

Does the temperature change during a free expansion? Suppose it does change，while the internal energy stays the same. In that case we have to conclude that the internal energy depends on both the temperature and the volume or on both the temperature and the pressure，but certainly not on the

temperature alone. But if T is constant during a free expansion, for which we know that U is constant even though both p and V change, then we have to conclude that U depends only on T, not on p or V.

Many experiments have shown that when a low-density gas undergoes a free expansion, its temperature does not change. Such a gas is essentially an ideal gas. The conclusion is: The internal energy of an ideal gas depends only on its temperature, not on its pressure or volume. This property, in addition to the ideal-gas equation of state, is part of the ideal-gas model. Make sure that you understand that U depends only on T for an ideal gas, for we will make frequent use of this fact.

For non-ideal gases, some temperature change occurs during free expansions, even though the internal energy is constant. This shows that the internal energy cannot depend only on temperature; it must depend on pressure as well. From the microscopic viewpoint, in which internal energy U is the sum of the kinetic and potential energies for all the particles that make up the system, this is not surprising. Non-ideal gases usually have attractive intermolecular forces, and when molecules move farther apart, the associated potential energies increase. If the total internal energy is constant, the kinetic energies must decrease. Temperature is directly related to molecular kinetic energy, and for such a gas a free expansion is usually accompanied by a drop in temperature.

Ⅱ. 理想气体的热容量 Heat Capacities of an Ideal Gas

We defined specific heat capacity and molar heat capacity before. We also remarked that the specific or molar heat capacity of a substance depends on the conditions under which the heat is added. It is usually the easiest to measure the heat capacity of a gas in a closed container under constant-volume conditions. The corresponding heat capacity is the molar heat capacity at constant volume, denoted by C_V. Heat capacity measurements for solids and liquids are usually carried out in the atmosphere under constant atmospheric pressure, and we call the corresponding heat capacity the molar heat capacity at constant pressure C_p. If neither p nor V is constant, we have an infinite number of possible heat capacities.

Let's consider C_V and C_p for an ideal gas. To measure C_V, we raise the temperature of an ideal gas in a rigid container with constant volume (neglecting its thermal expansion). To measure C_p, we let the gas expand just enough to keep the pressure constant as the temperature rises.

Why should these two molar heat capacities be different? The answer lies in the first law of thermodynamics. In a constant-volume temperature increase, the system does no work, and the change in internal energy ΔU equals the heat added Q. In a constant-pressure temperature increase, on the other hand, the volume must increase; otherwise, the pressure (given by ideal-gas equation of state $p = nRT/V$) could not remain constant. As the material expands, it does an amount of work W. According to the first law,

$$Q = \Delta U + W. \tag{5-3}$$

For a given temperature increase, the internal energy change ΔU of an ideal gas has the same value no matter what the process (remember that the internal energy of an ideal gas depends only on temperature, not pressure or volume). Eq. (5-3) then shows that the heat input for a constant-

pressure process must be greater than that for a constant-volume process because additional energy must be supplied to account for the work W done during the expansion. So C_p is greater than C_V for an ideal gas. The pV-diagram in Fig. 5 – 4 *shows this relationship. For air, C_p is 40% greater than C_V. For a very few substances (one of which is water between 0℃ and 4℃) the volume decreases during heating. In this case, W is negative, the heat input is less than in the constant-volume case, and C_p is less than C_V.*

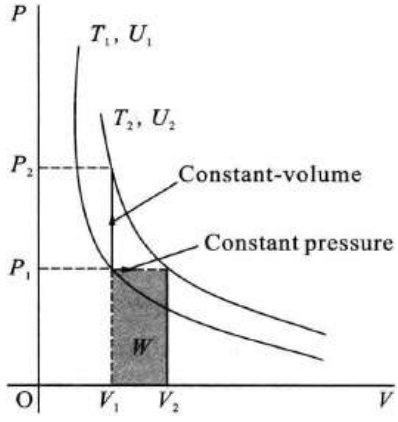


Fig. 5 – 4 Raising the temperature of an ideal gas from T_1 to T_2, by a constant-volume or a constant-pressure process. For an ideal gas depends only on T, ΔU is the same for both processes. In the constant-volume process, no work is done, so $Q = \Delta U$. But for the constant-pressure process, more heat Q must be added to both increase U and do work W. Hence $C_p > C_v$.

We can derive a simple relation between C_p and C_V for an ideal gas. First consider the constant-volume process. We place n moles of an ideal gas at temperature T in a constant-volume container. We place it in thermal contact with a hotter body; an infinitesimal quantity of heat dQ flows into the gas, and its temperature increases by an infinitesimal amount dT. By the definition of C_v, the molar heat capacity at constant volume,

$$dQ = nC_V dT. \tag{5-4}$$

The pressure increases during this process, but the gas does no work ($dW = 0$) because the volume is constant. The first law in differential form is $dQ = dU + dW$. Since $dW = 0$, $dQ = dU$ and Eq. (5 – 4) can also be written as

$$dU = nC_V dT. \tag{5-5}$$

Now consider a constant-pressure process with the same temperature change. We place the same gas in a cylinder with a piston that we can allow to move just enough to maintain constant pressure. Again we bring the system into contact with a hotter body. As heat flows into the gas, it expands at constant pressure, the amount of heat dQ entering the gas is

$$dQ = nC_p dT. \tag{5-6}$$

The work dW done by the gas in this constant-pressure process is

$$dW = pdV.$$

We can also express dW *in terms of the temperature change* dT *by using the ideal-gas equation of state,* $pV = nRT$. *Because p is constant, the change in V is proportional to the change in T:*

$$dW = pdV = nRdT. \tag{5-7}$$

Now we substitute Eqs. (5-6) *and* (5-7) *into the first law,* $dQ = dU + dW$. *We obtain*

$$nC_p dT = dU + nRdT. \tag{5-8}$$

Now here comes the crux of the calculation. The internal energy change dU for the constant-pressure process is again given by Eq. (5-5), $dU = nC_V dT$, *even though now the volume is not constant. Why is this so? Recall the discussion; one of the special properties of an ideal gas is that its internal energy depends only on temperature. Thus the change in internal energy during any process must be determined only by the temperature change. If* Eq. (5-5) *is valid for an ideal gas for one particular kind of process, it must be valid for an ideal gas for every kind of process with the same* dT. *So we may replace* dU *in* Eq. (5-8) *by* $nC_V dT$:

$$nC_p dT = nC_V dT + nRdT.$$

When we divide each term by the common factor n dT, *we get*

$$C_p = C_V + R \quad (\textit{molar heat capacities of an ideal gas}). \tag{5-9}$$

As we predicted, the molar heat capacity of an ideal gas at constant pressure is greater than the molar heat capacity at constant volume; the difference is the gas constant R. (Of course, R must be expressed in the same units as C_p *and* C_V, *such as* J/mol · K.)

We have used the ideal-gas model to derive Eq. (5-9), *but it turns out to be obeyed to within a few percent by many real gases at moderate pressures. Measured values of* C_p *and* C_V *are given in* Table 5-1 *for several real gases at low pressures; the difference in most cases is approximately* $R = 8.315$J/mol · K.

The table also shows that the molar hear capacity of a gas is related to its molecular structure.

Table 5-1. Molar heat capacities of gases at low pressure

Type of Gas	*Gas*	C_V(J/mol · K)	C_p(J/mol · K)	$C_p - C_V$(J/mol · K)	$\gamma = C_p/C_V$
Monatonmic	He	12.47	20.78	8.31	1.67
	Ar	12.47	20.78	8.31	1.67
	H_2	20.42	28.74	8.32	1.41
Diatomic	N_2	20.76	29.07	8.31	1.40
	O_2	20.85	29.17	8.31	1.40
	CO	20.85	29.16	8.31	1.40
Polyatomic	co_2	28.46	35.94	8.48	1.30
	SO_2	31.39	40.37	8.98	1.29
	H_2S	25.95	34.60	8.65	1.33

The last column of Table 5-1 *lists the values of the dimensionless ratio of heat capacities,* C_p/C_V, *denoted by the Greek letter* γ ("*gamma*"):

$$\gamma = \frac{C_p}{C_V} \quad (\textit{ratio of heat capacities}). \tag{5-10}$$

(This is sometimes called the "ratio of specific heats.") For gases, C_p is always greater than C_V and γ is always greater than unity. This quantity plays an important role in adiabatic processes for an ideal gas.

We can use our kinetic-theory discussion of the molar heat capacity of an ideal gas to predict values of γ. As an example, an ideal monatomic gas has $C_V = \frac{3}{2}R$. From Eq. (5 – 9),

$$C_p = C_V + R = \frac{3}{2}R + R = \frac{5}{2}R,$$

so

$$\gamma = \frac{C_P}{C_V} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} = 1.67.$$

As Table 5 – 1 *shows, this agrees well with values of computed from measured heat capacities. For most diatomic gases near room temperature, $C_V = \frac{5}{2}R$, $C_p = C_V + R = \frac{7}{2}R$, and*

$$\gamma = \frac{C_p}{C_V} = \frac{\frac{7}{2}R}{\frac{5}{2}R} = \frac{7}{5} = 1.40,$$

also in good agreement with measured values.

Here's a final reminder: For an ideal gas the internal energy change in any process is given by $\Delta U = nC_V\Delta T$, whether the volume is constant or not. This relation, which comes in handy in the following example, holds for other substances only when the volume is constant.

5.5 常用用法 Usages and Expressions

Ⅰ. 面积的表示法 The Representation of the Area

- 1. 通常用 by,表示乘、除及度量关系

  e. g.: The room is 3 meters by four.

  这个房间长 3 m,宽 4 m。

- 2. 用 area 表示面积,其结构常见的有:has an area of...; the area is...;...is...in area;...covers an area....

  e. g.: The room has an area of ten square meters.

  The area of the room is ten square meters.

  The room is ten square meters in area.

  The room covers an area of ten square meters.

  这个房间的面积为 10 m^2。

- 3. 面积单位缩写

平方米 sq. m.	公顷 ha.
公亩 a.	平方千米 sq. km.

Ⅱ. 体积与容量的表示法 The Representation of Volume

• 1. 常用"基数词 + 长度名词 + by + 基数词 + 宽度名词 + by + 基数词 + 高度名词"表示,若长、宽、高的单位一致,则通常省略后两个单位名词。

e. g. : The box is seven inches by eight by five.

这个盒子长、宽、高分别为 7in、8in 和 5in。

• 2. 用 capacity, volume 以及 cube (立方), cubed (自乘二次的), to the third power (……的三次方), liter, cubic meter, cubic centimeter 等。其结构有: The volume/capacity is...; has a capacity of...; be with a capacity of...; 等等。

e. g. : The interconnection, commissioned in 1981, currently has a capacity of 720 MW.

联网系统于 1981 年启用,现时的输电量为 720 MW。

Rectifier units with a capacity of 20 to 25 amperes for each charging circuit are acceptable.

每条充电线路可容纳容量为 20 ~ 25 A 的整流装置。

We have an emergency-standby electric generator with a capacity of 300 kilowatts.

我们有一台 30 kW 的事故备用发电机。

First, the volume is proportional to the number of moles.

第一,体积和摩尔数成正比。

The first question is to raise 4 to the third power.

第一道题是使 4 自乘到 3 次幂。

Three to the third power is three times three times three, which equals 27.

3 的 3 次幂相当于 3 乘 3 乘 3,等于 27。

• 3. 容积的单位缩写

微升 μl.	分升 dl.	百升 hl.
毫升 ml.	升 l.	千升 kl.
厘升 cl.	十升 dal.	

5.6 同义词辨析 Synonyms

mistake, error, fault, misunderstand, confuse, err, misconceive, difference, inaccuracy, slip, trip, howler, misprint, typo

These are all words for a word, figure or fact that is not said written down or typed correctly.

以上各词均指用词、数字、事实等的错误、口误、笔误。

◆ mistake a word or figure that is not said or written down correctly (用词或数字上的)错误;口误;笔误

e. g. : The article was littered with spelling mistakes.

这篇文章尽是拼写错误。

The most common mistake is to plant them too deep.

最常见的错误就是把它们种得太深了。

【习惯用法】

mistake...for... 误认,误以为

e. g. : I mistake her for his wife.

我误以为她是他的妻子。

by mistake 弄错,误写

and no mistake 毫无疑问

make a mistake 犯错误

◆ error (rather formal) a word, figure, etc. that is not said or written down correctly(用词、数字等的)错误;口误;笔误

NOTE: error is a more formal way of saying mistake. * error 为 mistake 的较正式用语。

e. g. : The bill was sent to the wrong person because of a computer error.

账单因计算机出错而寄错了人。

There must be an error in our calculations.

我们的计算肯定有错。

◆ fault (for doing sth.) the responsibility for sth. wrong that has happened or been done 责任;过错;过失

e. g. : I'm really sorry—it's all my fault.

我真的很抱歉——都是我的错。

It's my fault not making your new job clearer.

没有把你的新工作解释清楚是我的责任。

◆ misunderstand to fail to understand sb./sth. correctly 误解;误会

e. g. : Rachel, you must have misunderstood her! Ellie would never say something like that.

雷切尔,你一定是误会她了! 艾莉绝不会说那样的话。

Don't misunderstand me. She's a very nice person when you get to know her.

不要误解我的意思,你了解她后就知道她是个很好的人。

◆ confuse to make sb. unable to think clearly or understand sth. 使糊涂;使迷惑

e. g. : I understand the text but the diagrams are confusing me.

我理解文本,那些图表把我弄糊涂了。

I always confuse you with your sister—you look so alike.

我总是把你和你妹妹搞错,你俩太像了。

◆ err to make a mistake 犯错误;做错事;出差错

e. g. : It's always best to err on the side of caution.

宁愿总是过于谨慎也不要冒风险。

◆ misconceive to understand sth. in the wrong way 误解;误会

e. g. : His arguments are totally misconceived.

他的论点完全错误。

◆ difference the way in which two people or things are not like each other; the way in which sb. / sth. has changed 差别;差异;不同(之处);变化(之处)

e. g. : There's not much difference in price.

价格上没有什么差别。

See if you can spot the difference between these two pictures.

你看看能否找出这两张照片中的不同之处。

【习惯用法】

make a difference　　有影响,很重要

make no difference　　没有差别

◆ inaccuracy (rather formal) a piece of information that is not exactly correct 不准确; 误差

e. g. : As a journalist you simply cannot tolerate inaccuracy.

作为记者,绝不能容忍报道失实。

◆ slip a small mistake, usually made by being careless or not paying attention(因粗心或未予以重视而造成的)差错;疏漏;纰漏

e. g. : He let his slip that they were planning to get married.

他说漏了嘴,说他们打算要结婚了。

The company apologized for slipping up so badly.

这家公司为这么严重的疏忽表示歉意。

◆ trip the experience that sb. has if they take a powerful drug that affects the mind and makes them imagine things (服用毒品后所产生的)幻觉,迷幻感受

e. g. : a bad trip

一阵不舒服的迷幻感受

◆ howler (informal, especially BrE) a stupid mistake, especially in what sb. says or writes(言谈或行为中的)愚蠢;错误

NOTE: Howler is usually an embarrassing mistake which shows that the person who made it does not know sth. that they really should know. * howler 通常指令人难堪的错误,表明犯错误者不知道应该知道的东西。

e. g. : The report is full of howlers.

这份报告错误百出。

◆ misprint a small mistake in a printed text(印刷文本上的)错误

e. g. : There is a misprint in your paper.

你的论文里有一个打印错误。

◆ typo (informal) a small mistake in a typed or printed text(打印或排版文稿中的)小错误

NOTE: Typo is mostly used by people whose work involves checking printed material before it is made into a book, magazine, etc. * typo 多为校对人员校勘图书杂志等印刷

品错误时使用。

e. g. : How could I miss that typo?

我怎么把那个错误给遗漏了呢?

For example, if he snarls when you arrive just five minutes late to work or make one typo on a memo, avoid these slipups no matter how trivial they seem.

比如,他为了你上班仅迟到5分钟或在备忘录中打错了一个字便大发雷霆,那么你就要尽量避免这类疏忽,不论它们看起来多么微不足道。

5.7 练习题 Exercise

(5-1)完形填空。

"FINAGLE" is not a word that most people associate with science. One reason is that the image of the scientist is of one who always collects date in an impartial ___1___ for truth. In any debate—over intelligence, schooling, energy—the ___2___ "science says" usually disarms opposition.

But scientists have long acknowledged the existence of a "finagle factor" —a tendency by many scientists to give a helpful change to the date to ___3___ desired results. The latest of the finagle factor in action comes from Stephen Jay Gould, a Harvard biologist, ___4___ has examined the important 19th century work of Dr. Samuel Morton. Morton was famous in his time ___5___ analyzing the brain size of the skulls as a measure of intelligence. He concluded that whites had the ___6___ brains, that the brains of Indians and Blacks were smaller, and therefore, that whites constitute a superior race.

Gould went back to Morton's original date and concluded that the ___7___ were an example of the finagle at work. He found that Morton's "discovery" was made by leaving out embarrassing date, using incorrect procedures, making simple arithmetical ___8___ (always in his favor) and changing his criteria—again, always in his favor of his argument. Morton has been thoroughly discredited by now and scientists do not believe that brain size reflects ___9___.

But Gould went on to say Morton's story is only an example of a common problem in ___10___ work. Some of the leading figures in science are believed to have ___11___ the finagle factor. Gould says that Isaac Newton fudged out to support at least three central statements that he could not prove. And so ___12___ Claudius Ptolemy ,the Greek astronomer, whose master work, *Almagest*, summed up the cases for a solar system that had the earth as its centre. Recent studies indicate that Ptolemy ___13___ faked some key date or resorted heavily to the finagle factor.

All this is ___14___ because the finagle factor is still at work. For example, in the artificial sweetener controversy, for example, it is said that all the studies sponsored by the sugar industry find that the artificial sweetener is unsafe, while all the studies sponsored by the diet food industry find nothing ___15___ with it.

1. A. search B. leaning C. teaching D. dialogue

2. A. clause B. slang C. idiom D. phrase

3. A. convey	B. acquire	C. modify	D. prove
4. A. whose	B. she	C. he	D. who
5. A. in	B. about	C. for	D. on
6. A. more	B. largest	C. large	D. larger
7. A. results	B. experiments	C. publications	D. suggestions
8. A. mistakes	B. misunderstanding	C. calculation	D. problems
9. A. creativity	B. ability	C. intelligence	D. ingenuity
10. A. inventive	B. mental	C. scientific	D. manual
11. A. used	B. rejected	C. misused	D. sought
12. A. was	B. had	C. could	D. did
13. A. either	B. both	C. could	D. never
14. A. necessary	B. important	C. available	D. changeable
15. A. helpful	B. serious	C. happy	D. wrong

(5-2)解释词汇。

[1]finagle	[4]discredit	[7]impartial	[10]sweetener
[2]fudge	[5]disarm	[8]astronomer	
[3]fake	[6]embarrassing	[9]procedure	

(5-3) 翻译下列带有状语从句的句子。

1. 如果一个假设经受了无数实验的考验仍然不动摇,这个假设就变成了定律。

2. 即使我们的测量值表明在不同区间速度相同,但我们也许只能说,这个运动只是在该测量准确度范围内是匀速的。

3. 目前天文观察表明,宇宙将继续永远膨胀下去,而不像科学家们曾经以为的那样,膨胀到最大体积然后开始收缩。

4. 风明显增大,导致蒸发明显增强。(with the result that)

5. 无论资料的数量如何惊人,现在计算机都能容易地(readily)加以处理。(however)

6. 除非能找到一种比这种高强度的铝合金还要轻的金属,否则我们不可能造出这种飞机。(unless)

7. 当晶体管截断时,交流负载线是水平的。(while)

Lesson 6

内容 6.1 热力学第二定律 The Second Law of Thermodynamics
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Ⅱ. 熵 Entropy
Ⅲ. 熵的微观解释 Microscopic Interpretation of Entropy
6.5 常用用法 Usages and Expressions
常用几何部分词汇 Usual Vocabularies for Geometry
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6.1 热力学第二定律 The Second Law of Thermodynamics

[1] **Experimental evidence suggests strongly that it is impossible to build a heat engine that converts heat completely to work, that is, an engine with 100% thermal efficiency.** This impossibility is the basis of one statement of the second law of thermodynamics, as follows:[2] **It is impossible for any system to undergo a process in which it absorbs heat from a reservoir at a single temperature and converts the heat completely into mechanical work, with the system ending in the same state in which it began.**

[3] **We will call this the "engine" statement of the second law.**

The basis of the second law of thermodynamics lies in the difference between the nature of internal energy and that of macroscopic mechanical energy.[4] **In a moving body the molecules have random motion, but superimposed on this is a coordinated motion of every molecule in the direction of the body's velocity.** The kinetic energy associated with this coordinated macroscopic motion is what we call the kinetic energy of the moving body. The kinetic and potential energies associated with the random motion constitute the internal energy.

When a body sliding on a surface comes to rest as a result of friction, the organized motion of the body is converted to random motion of molecules in the body and in the surface. Since we cannot control the motions of individual molecules, we cannot convert this random motion completely

back to organized motion. We can convert part of it, and this is what a heat engine does.

If the second law were not true, we could power an automobile or run a power plant by cooling the surrounding air. Neither of these impossibilities violates the first law of thermodynamics. The second law, therefore, is not a deduction from the first but stands by itself as a separate law of nature. The first law denies the possibility of creating or destroying energy; the second law limits the availability of energy and the ways in which it can be used and converted.

Our analysis of refrigerators forms the basis for an alternative statement of the second law of thermodynamics. Heat flows spontaneously from hotter to colder bodies, never the reverse. A refrigerator does take heat from a colder to a hotter body, but its operation requires an input of mechanical energy or work. Generalizing this observation, we state: It is impossible for any process to have as its sole result the transfer of heat from a cooler to a hotter body.

We will call this the "refrigerator" statement of the second law. It may not seem to be very closely related to the "engine" statement. In fact, though, the two statements are completely equivalent.[5] **For example, if we could build a workless refrigerator, violating the second or "refrigerator" statement of the second law, we could use it in conjunction with a heat engine, pumping the heat rejected by the engine back to the hot reservoir to be reused.** This composite machine(Fig. 6 – 1a) would violate the "engine" statement of the second law because its net effect would be to take a net quantity of heat $Q_H - |Q_C|$ from the hot reservoir and convert it completely to work W.

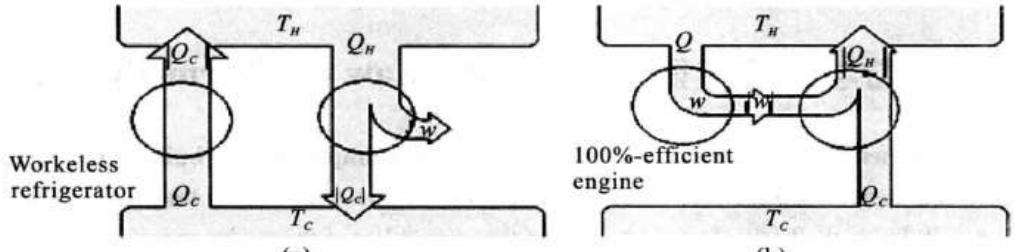


Fig. 6 – 1 Energy-flow diagrams for equivalent forms of the second law. (a) A workless refrigerator (left), if it existed, could be used in combination with an ordinary heat engine (right) to form a composite device that functions as an engine with 100% efficiency, converting heat $Q_H - |Q_C|$ completely to work. (b) An engine with 100% efficiency (left), if it existed, would be used in combination with an ordinary refrigerator (right) to form a workless refrigerator, transferring heat Q_C from the cold reservoir to the hot with no net input of work. Since either of these is impossible, the other must be also.

Alternatively, if we could make an engine with 100% thermal efficiency, in violation of the first statement, we could run it using heat from the hot reservoir and use the work output to drive a refrigerator that pumps heat from the cold reservoir to the hot (Fig. 6 – 1b). This composite device would violate the "refrigerator" statement because its net effect would be to take heat Q_C from the cold reservoir and deliver it to the hot reservoir without requiring any input of work. Thus any device that violates one form of the second law can be used to make a device that violates the other form. If violations of the first form are impossible, so are violations of the second!

The conversion of work to heat, as in friction or viscous fluid flow, and heat flow from hot to cold across a finite temperature gradient, are irreversible processes. The "engine" and "refrigerator" statements of the second law state that these processes can be only partially reversed. We could cite other examples. Gases always seep spontaneously through an opening from a region of high pressure to a region of low pressure; gases and miscible liquids left by themselves always tend to mix, not to unmix. The second law of thermodynamics is an expression of the inherent one-way aspect of these and many other irreversible processes. Energy conversion is an essential aspect of all plant and animal life and of human technology, so the second law of thermodynamics is of the utmost fundamental importance in the world we live in.

6.2 生词表 New Words

convert *v.* 转变
undergo *v.* 经历
absorb *v.* 吸收
reservoir *n.* 蓄水池;储液器
lie in 在于,位于
superimpose *v.* 添加;附加
coordinated *adj.* 协调的
velocity *n.* 速度
violate *v.* 违反
deduction *n.* 推演,推理,演绎
spontaneously *adv.* 自然地,自发地
sole *adj.* 单独的,唯一的
equivalent *adj.* 相等的,等效的,等价的
in conjunction with 连同; 与……一起
pump *v.* 用泵抽
reject *v.* 排斥,拒绝
viscous fluid flow 黏性流动,稳流,层流
gradient *n.* 梯度
irreversible *adj.* 不可逆的,不可翻转的
cite *v.* 引用
fundamental *adj.* 基础的,根本的

6.3 课文注释 Text Annotation

【1】Experimental evidence suggests strongly that it is impossible to build a heat engine that converts heat completely to work, that is, an engine with 100% thermal efficiency.

实验证据有力地表明,建立一个热机将热量完全转换用来做功是不可能,即 100% 热效率的热机是不存在的。

该句描述了一个客观的实验结果,采用的时态是一般现在时。

英语动词有十六个时态,其中最常用的有五个。它们是一般现在时、现在进行时、一般过去时、一般将来时和现在完成时,在科技文章中一般现在时、一般过去时和现在完成时要比另外两种更常用些。此外,科技文章中的时态的用法也不如普通英语那样丰富多样。

▶1. 一般现在时:一般现在时是科技文章中最常见的时态,主要有三种用法:

(1)一般叙述过程

e. g. : A scientist observes carefully, applies logical thought to his observations and tries to find relationships in data, etc.

科学家仔细观察,利用逻辑思维,试图在数据之间发现联系。

(2)叙述客观事实或科学定理

e. g. : Sound travels through the air in waves.

声音以波的形式通过空气传播。

A complete rotation of the Earth in relation to the pole star takes four minutes short of twenty-four hours.

与北极星有关的地球进行一个完整的自转需要 24 小时差 4 分钟。

Work is equal to the product of force and the distance through which the force moves.

功等于力和力的方向上移动的距离的乘积。

(3)通常或习惯发生的行为

e. g. : Alternating current is usually supplied to people's houses at 50 cycles per second.

交流电流通常是 50 Hz 的频率供人们使用。

►2. 一般过去时:用于叙述过去某一时刻(时段)的发现、某一研究过程(实验、观察、调查、医疗等过程)。

e. g. : This result was calculated directly from Coulomb's law.

这是直接从库仑定律计算的结果。

►3. 现在完成时:表示到现在为止发生的行为或者已经发生并对现在有影响的行为。

e. g. : During the past few years, several countries have pooled their resources in order to carry out certain types of scientific investigation efficiently.

在过去的几年里,好几个国家已经投入了大量资源,以便有效地开展各种科学研究。

【2】It is impossible for any system to undergo a process in which it absorbs heat from a reservoir at a single temperature and converts the heat completely into mechanical work, with the system ending in the same state in which it began.

任何系统经历这样一个过程都是不可能的,即在一定的温度中它从一个储器中吸收热量,然后将热量全部转化成机械做工,而系统又回到初始时的状态。

在这个句子中,句首的 it 作形式主语,真正的句子的主语是 to undergo a process。

引导词 it 的用法:

►1. 作形式主语:代替由不定式(或不定式复合结构)、动名词或从句所表示的真正主语。

e. g. : It was wrong for you not to help her.

你当时不帮助她是错误的。(it 代替不定式短语)

It will be useless learning a theory without practice.

学习理论而没有实践是无用的。(it 代替动名词短语)

It's not yet known where she has gone.

她去哪里了还不知道。(it 代替主语从句)

►2. 作形式宾语:代替由不定式、动名词或从句所表示的真正宾语。

e. g. : We consider it necessary to master two foreign languages.

我们认为掌握两门外语是有必要的。(it 作动词不定式的先行词)

We found it useless talking to her.

我们认为跟她谈是无用的。(it 作动名词的先行词)

I must make it clear that I'll always support you.

我必须申明我将永远支持你。(it 作 that 引导的宾语从句的先行词)

▶3. 用在强调结构中:为了强调句子的某一成分(通常是主语、宾语或状语),常用"It is (was) + 被强调成分 + that(或 who)..."结构。

e. g.: I met Tom in the street yesterday.

我昨天在街上遇见了汤姆。

It was I who met Tom in the street yesterday.

是我昨天在街上遇见汤姆的。

It was Tom that I met in the street yesterday.

昨天我在街上遇见的是汤姆。

It was in the street that I met Tom yesterday.

我昨天是在街上遇见汤姆的。

It was yesterday that I met Tom in the street.

我是昨天在街上遇见汤姆的。

【3】We will call this the "engine" statement of the second law.

我们将这种现象称为第二定律的发动机状态。

这个句子采用"we will call this..."来进行下定义。

下定义是为了对某一科学概念或事物的本质和特征有清晰的介绍而采用的一种描述方法。常用 be, be called, be known as, be defined as, be referred to as 等结构。

e. g.: A force is an effect of attraction or repulsion between two bodies or particles.

力是物体或粒子之间的吸引或排斥效应。

The set of specifications may be called a standard.

这一整套的规范可称之为标准。

This design came to be known as the oriental style.

这种设计后来被称为东方风格。

Transport channel can be defined as the underlying transport mechanism for web services invocation.

传输通道可以定义为 web 服务调用的底层传输机制。

This solute will be referred to as a tracer.

这种溶质称为示踪剂。

【4】In a moving body the molecules have random motion, but superimposed on this is a coordinated motion of every molecule in the direction of the body's velocity.

在运动的物体内部,分子随机运动,但是每一个分子都是在物体的速度方向上做协调运动。

the molecules have random motion 作后置定语修饰 a moving body。

【5】For example, if we could build a workless refrigerator, violating the second or "refrigerator" statement of the second law, we could use it in conjunction with a heat engine, pumping the heat rejected by the engine back to the hot reservoir to be reused.

例如,如果我们违反第二定律能够建造一个不工作的制冷机,我们用它协同热机,抽取

被热机排出送回到热储能重复使用的热能。

该句应用了举例这种常见的表达方式。举例是作者为了更形象、更生动地揭示所表达的内容而采取的一种表达方法，起到进一步解释说明的作用。举例可以使抽象的内容更加具体、形象、生动，便于理解、记忆和运用。

举例常用到如下的短语：for example...，e. g. ，for instance 等等。

e. g. : For example, a person who has difficulty reading may have dyslexia.

譬如，一个有着阅读障碍的人可能患有诵读困难。

For example, high cholesterol can lead to xanthoma.

举例来说，高胆固醇可导致黄瘤。

It's for pretty obvious reasons actually, on most of the maps where you will use one at the start (e. g ta), it will be to gain an economic advantage over your opponent by accessing blue tib.

原因显而易见，在许多地图上你会在开始时使用一个(比如 ta)，通过获取蓝矿来在经济上取得超过敌人的优势。

Device providing one value from a set of alternatives, e. g. a function keyboard.

一种从一组可选值中选择一个值的输入设备，例如功能键盘。

6.4 扩展阅读 Extended Reading

Ⅰ. 绝对温度 The Kelvin Temperature Scale

We expressed the need for a temperature scale that doesn't depend on the properties of any particular material. We can now use the Carnot cycle to define such a scale. The thermal efficiency of a Carnot engine operating between two heat reservoirs at temperatures T_H *and* T_C *is independent of the nature of the working substance and depends only on the temperatures. This thermal efficiency is*

$$e = \frac{Q_H + Q_C}{Q_C} = 1 + \frac{Q_C}{Q_H}.$$

Therefore the ratio Q_C/Q_H *is the same for all Carnot engines operating between two given temperatures* T_H *and* T_C.

Kelvin proposed that we define the ratio of the temperatures, T_C/T_H, *to be equal to the magnitude of the radio* Q_C/Q_H *of the quantities of heat absorbed and rejected:*

$$\frac{T_C}{T_H} = \frac{|Q_C|}{|Q_H|} = -\frac{Q_C}{Q_H} \quad (\textit{definition of Kelvin temperature}). \tag{6-1}$$

Eq. (6 - 1) *defines a temperature scale based on the Carnot cycle and the second law of thermodynamics and independent of the behavior of any particular substance. Thus the Kelvin temperature scale is truly absolute. To complete the definition of the Kelvin scale, we assign the arbitrary value of* 273. 16K *to the temperature of the triple point of water. When a substance is taken around a Carnot cycle, the ratio of the heats absorbed and rejected,* $|Q_H|/|Q_C|$, *is equal to the ratio of the temperatures of the reservoirs as expressed on the gas-thermometer scale. Since the triple point of*

water is chosen to be 273. 16K *in both scales, it follows that the Kelvin and ideal-gas scales are identical.*

The zero point on the Kelvin scale is called absolute zero. Absolute zero can be interpreted on a molecular level; at absolute zero the system has its minimum possible total internal energy (kinetic plus potential). Because of quantum effects, however, it is not true that at $T=0$, *all molecular motion ceases. There are theoretical reasons for believing that absolute zero cannot be attained experimentally, although temperatures below* 10^{-7}K *have been achieved. The more closely we approach absolute zero, the more difficult it is to get closer. One statement of the third law of thermodynamics is that it is impossible to reach absolute zero in a finite number of thermodynamic steps.*

Ⅱ. 熵 Entropy

The second law of thermodynamics, as we have stated it, is rather different in form from many familiar physical laws. It is not an equation or a quantitative relationship but rather a statement of impossibility. However, the second law can be stated as a quantitative relation with the concept of entropy, the subject of this section.

We have talked about several processes that proceed naturally in the direction of increasing disorder. Irreversible heat flow increases disorder because the molecules are initially sorted into hotter and cooler regions; this sorting is lost when the system comes to thermal equilibrium. Adding heat to a body increases its disorder because it increases average molecular speeds and therefore the randomness of molecular motion. Free expansion of a gas increases its disorder because the molecules have greater randomness of position after the expansion than before.

Entropy provides a quantitative measure of disorder. To introduce this concept, let's consider an infinitesimal isothermal expansion of an ideal gas. We add heat $\mathrm{d}Q$ *and let the gas expand just enough to keep the temperature constant. Because the internal energy of an ideal gas depends only on its temperature, the internal energy is also constant; thus from the first law, the work* $\mathrm{d}W$ *done by the gas is equal to the heat* $\mathrm{d}Q$ *added. That is,*

$$\mathrm{d}Q=\mathrm{d}W=p\mathrm{d}v=\frac{nRT}{V}\mathrm{d}V,\quad so\quad \frac{\mathrm{d}V}{V}=\frac{\mathrm{d}Q}{nRT}.$$

The gas is in a more disordered state after the expansion than before because the molecules are moving in a larger volume and have more randomness of position. Thus the fractional volume change $\mathrm{d}V/V$ *is a measure of the increase in disorder, and the above equation shows that it is proportional to the quantity* $\mathrm{d}Q/V$. *We introduce the symbol* S *for the entropy of the system, and we define the infinitesimal entropy change* $\mathrm{d}S$ *during an infinitesimal reversible process at absolute temperature* T *as*

$$\mathrm{d}S=\frac{\mathrm{d}Q}{T}\quad (infinitesimal\ reversible\ process). \tag{6-2}$$

If a total amount of heat Q *is added during a reversible isothermal process at absolute temperature* T, *the total entropy change* $\Delta S=S_2-S_1$ *is given by*

$$\Delta S=S_2-S_1=\frac{Q}{T}\quad (reversible\ isothermal\ process). \tag{6-3}$$

Entropy has units of energy divided by temperature; the SI unit of entropy is 1 J/K.

We can see how the quotient Q/T is related to the increase in disorder. Higher temperature means greater randomness of motion. If the substance is initially cold, with little molecular motion, adding heat Q causes a substantial fractional increase in molecular motion and randomness. But if the substance is already hot, the same quantity of heat adds relatively little to the greater molecular motion already present. So the quotient Q/T is an appropriate characterization of the increase in randomness or disorder when heat flows into a system.

Ⅲ. 熵的微观解释 Microscopic Interpretation of Entropy

We described how the internal energy of a system could be calculated, at least in principle, by adding up all the kinetic energies of its constituent particles and all the potential energies of interaction among the particles. This is called a microscopic calculation of the internal energy. We can also make a microscopic calculation of the entropy S of a system. Unlike energy, however, entropy is not something that belongs to each individual particle or pair of particles in the system. Rather, entropy is a measure of the disorder of the system as a whole. To see how to calculate entropy microscopically, we first have to introduce the idea of macroscopic and microscopic states.

Suppose you toss N identical coins on the floor, and half of them show heads and half show tails. This is a description of the large-scale or macroscopic state of the system of N coins. A description of the macroscopic state of the system includes information about each individual coin: Coin 1 *was heads, coin* 2 *was tails, coin* 3 *was tails, and so on. There can be many microscopic states that correspond to the same macroscopic description. For instance, with* $N = 4$ *coins there are six possible states in which half are heads and half are tails* (Fig. 6 – 2). *The number of microscopic states grows rapidly with increasing N; for* $N = 100$ *there are* $2^{100} = 1.27 \times 10^{30}$ *microscopic states, of which* 1.01×10^{29} *are half heads and half tails.*

The least probable outcomes of the coin toss are the states that are either all heads or all tails. It is certainly possible that you could throw 100 *heads in a row, but don't bet on it; the probability of doing this is only* 1 *in* 1.27×10^{30}. *The most probable outcome of tossing N coins is that half are heads and half are tails. The reason is that this macroscopic state has the greatest number of corresponding microscopic states, as shown in* Fig. 6 – 2.

To make the connection to the concept of entropy, note that N coins that are all heads constitutes a completely ordered macroscopic state; the description "all heads" completely specifies the state of each one of the N coins. The same is true if the coins are all tails. But the macroscopic description "half heads, half tails" by itself tells you very little about the state (heads or tails) of each individual coin. We say that the system is disordered because we know so little about its microscopic state. Compared to the state "all heads" or "all tails," the state "half heads, half tails" has a much greater number of possible microscopic states, much greater disorder, and hence much greater entropy (which is a quantitative measure of disorder).

Now instead of N coins, consider a mole of an ideal gas containing Avogadro's number of molecules. The macroscopic state of this gas is given by its pressure p, volume V, and temperature T; a

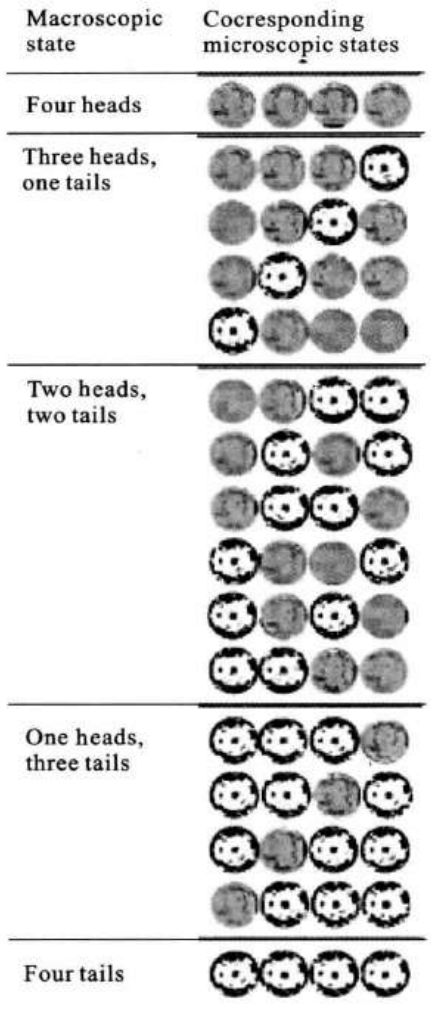


Fig. 6 – 2 All possible microscopic states of four coins. There can be several possible microscopic states for each macroscopic state.

description of the microscopic state involves stating the position and velocity for each molecule in the gas. At a given pressure, volume, and temperature the gas may be in any one of an astronomically large number of microscopic states, depending on the positions and velocities of its 6.02×10^{23} *molecules. If the gas undergoes a free expansion into a greater volume, the range of possible positions increases, as does the number of possible microscopic states. The system becomes more disordered, and the entropy increases.*

We can draw the following general conclusion: For any system the most probable macroscopic state is the one with the greatest number of corresponding microscopic states, which is also the macroscopic state with the greatest disorder and the greatest entropy.

Let w represent the number of possible microscopic states for a given macroscopic state. (For the four coins shown in Fig. 6 – 2 *the state of four heads has* $w = 1$, *the state of three heads and one tails*

has $w=4$, and so on.) Then the entropy S of a macroscopic state can be shown to be given by

$$S = k \ln w \quad (\textit{microscopic expression for entropy}), \tag{6-4}$$

Where $k = R/N_A$ is the Boltzmann constant (gas constant per molecule). As Eq. (6-4) shows, increasing the number of possible microscopic states w increases the entropys.

What matters in a thermodynamic process is not the absolute entropy S but the difference in entropy between the initial and final states. Hence an equally valid and useful definition would be $s = k\ln w + C$, where C is a constant, since C cancels in any calculation of an entropy difference between two states. But it's convenient to set this constant equal to zero and use Eq. (6-4). *With this choice, since the smallest possible value of w is unity, the smallest possible value of S for any system is $k\ln 1 = 0$. Entropy can never be negative.*

In practice, calculating w is a difficult task, so Eq. (6-4) *is typically used only to calculate the absolute entropy S of certain special systems. But we can use this relation to calculate differences in entropy between one state and another.*

Consider a system that undergoes a thermodynamic process that takes it from macroscopic state 1, for which there are w_1 possible microscopic state, to macroscopic state 2, with w_2 associated microscopic states. The change in entropy in this process is

$$\Delta S = S_2 - S_1 = k \ln w_2 - k \ln w_1 = k \ln \frac{w_2}{w_1}. \tag{6-5}$$

The difference in entropy between the two macroscopic states depends on the ratio of the numbers of possible microscopic states.

6.5 常用用法 Usages and Expressions

常用几何部分词汇 Usual Vocabularies for Geometry

【1】所有的角

alternate angle 内错角
corresponding angle 同位角
vertical angle 对顶角
central angle 圆心角
interior angle 内角
exterior angle 外角
supplementary angles 补角
acute angle 锐角
obtuse angle 钝角
complementary angle 余角
right angle 直角
round angle 周角
straight angle 平角
included angle 夹角

【2】所有的三角形

equilateral triangle 等边三角形
scalene triangle 不等边三角形
isosceles triangle 等腰三角形
oblique 斜三角形
inscribed triangle 内接三角形
right triangle 直角三角形

【3】有关收敛的平面图形(除三角形外)

semicircle 半圆
concentric circles 同心圆
quadrilateral 四边形
pentagon 五边形
hexagon 六边形
heptagon 七边形
octagon 八边形
nonagon 九边形
decagon 十边形
polygon 多边形
parallelogram 平行四边形
equilateral 等边形
plane 平面
square 正方形,平方
rectangle 长方形
regular polygon 正多边形
rhombus 菱形
trapezoid 梯形

【4】其他平面图形

arc 弧
line/ straight line 直线
line segment 线段
parallel lines 平行线
segment of a circle 弧形

【5】有关立体图形

cube 立方体,立方数
rectangular solid 长方体
regular solid/regular polyhedron 正多面体
circular cylinder 圆柱体
cone 圆锥
sphere 球体
solid 立方体

【6】有关图形上的附属物

altitude 高
depth 深度
side 边长
circumference perimeter 周长
radian 弧度
surface area 表面积
volume 体积
arm 直角三角形的股
cross section 横截面
center of a circle 圆心
chord 弦
radius 半径
angle bisector 角平分线
diagonal 对角线
diameter 直径
edge 棱
face of a solid 立体的面
hypotenuse 斜边
included side 夹边
leg 三角形的直角边
opposite 直角三角形中的对边
midpoint 中点
endpoint 端点
vertex 顶点
tangent 切线的
transversal 截线
intercept 截距

【7】有关坐标

coordinate system 坐标系
rectangular coordinate 直角坐标系
origin 原点
abscissa 横坐标
ordinate 纵坐标
number line 数轴

quadrant 象限
slope 斜率
complex plane 复平面

【8】其他

plane geometry 平面几何
trigonometry 三角学
bisect 平分
circumscribe 外切
inscribe 内切
intersect 相交
perpendicular 垂线
pythagorean theorem 勾股定理
congruent 全等的
multilateral 多边的

6.6 同义词辨析 Synonyms

notice, see, spot, behold, note, detect, discover, find, observe, watch, examine, spy, survey, inspect, regard, witness, perceive

These words all mean to see sth ,especially when you pay carefully attention to it.

以上各词均含“看到;注意到”之义。

◆ notice to see, hear or become aware of sb./sth. ; to pay attention to sb./sth. 看(听)到,注意到,意识到;注意,留意

e. g. : He noticed a woman in a black dress sitting across from him.

他看到有位黑衣女子坐在他的对面。

I didn't notice any smoke.

我没注意到有烟。

◆ see to become aware of sb./sth. by using your eyes 看见,见到,看出

e. g. : The moment we saw the house, we knew we wanted to buy it.

看到房子的那一刻,我们就知道我们想把它买下来。

Can I see your ticket, please?

我能看看你的票么?

【习惯用法】

see sb. off	送行
see through	看穿,识破
see to	注意,留心;照料
see to it that	设法使,务必
see about	办理(某事),处理

◆ spot to see or notice a person or thing, especially suddenly or when it is not easy to do so (突然)看见;看出;注意到;发现

e. g. : I spotted a police car behind us.

我发现有辆警车在我们后面。

It can be hard for even a trained doctor to spot the symptoms of lung cancer.

即使是训练有素的医生也很难看出肺癌的症状。

◆ behold to look at or see sb./sth. 看,看见

e. g. : The beauty of the garden was a pleasure to behold.
花园美景赏心悦目。

◆ note (rather formal) to notice or pay careful attention to sth. 注意,留意

e. g. : He carefully noted the time when they left the building.
他们离开大楼的时候,他特地留意了一下时间。

◆ detect to discover or notice sth., especially sth. that is not easy to see, hear, etc. 发现;查明;侦查出

e. g. : Many forms of cancer can be cured if detected early.
如果发现得早,许多癌症都可以治愈。
Dan detected a change in her mood.
丹发现她的情绪有变化。

【习惯用法】

detect sb. in (doing) a dishonest act 察觉某人在做不正当的事

◆ discover to find sb./sth. that was hidden or that you did not expect to find (出乎意料地)发现;找到;发觉

e. g. : The body was discovered in a field.
尸体是在田野里找到的。
Forest Service crew often discover campfires that have not been put out completely.
林务局员工常常发现未完全熄灭的篝火。

◆ find to discover sb./sth. unexpectedly or by chance (意外或偶然地) 发现;碰到

e. g. : Hold on while I find a pen.
别挂电话,我找支笔。
I can't find the car keys.
我找不到汽车的钥匙。

◆ observe (formal) to see sth. happen 看到;注意到;观察到

e. g. : Scientists have observed a drop in ozone levels over the Antarctic.
科学家已经观察到南极洲上方的臭氧浓度下降了。

【习惯用法】

observe sb. do sth./observe sb. doing sth. 观察某人做某事

◆ watch to look at sb./sth. for a time, paying attention to what happens (全神贯注地)看;注视;观看;观察

e. g. : Dou you mind if I watch?
你介意我看着吗?
We sat and watched the sunset.

我们坐着看日落。

【习惯用法】

watch out (for sth.)　　当心;注意;监视

watch one's step　　留心脚下,小心摔倒

◆ examine to look at sth./sb. closely to see if there is anything wrong or to find the cause of a problem(仔细地)检查,检验

e. g. : A team of divers was sent down to examine the wreck.

一组潜水员被送到水下检查船只。

Hegel's philosophy will be examined in detail in Chapter 4.

黑格尔的哲学将在第四章作详细探讨。

◆ spy to suddenly see or notice sb./sth. (突然看见)发现

e. g. : He was walking down the street when he spied an old friend.

他正沿街走着,突然看见了一位老朋友。

【习惯用法】

spy into/on/upon sth., spy sth. out　　侦查;窥探

◆ survey to look carefully at the whole to sth., especially in order to get a general impression of it (为了得到一般的总印象而仔细地)查看;审视;审察

e. g. : She turned to survey her daughter's pale face.

她转过头审视女儿苍白的面孔。

They got out of the car to survey the damage.

他们下车查看受损的情况。

【习惯用法】

make a survey of　　对……做全面调查

◆ inspect to look closely at sth./sb., especially to check that everything is as it should be 仔细检查;查看;审视

e. g. : I got out of the car to inspect the damage.

我下车查看损坏情况。

Police inspected the scene and interviewed all the staff.

警察仔细检查了现场,向所有员工问话。

◆ regard to look at sb./sth., especially in a particular way (以某种方式)注视,凝视

e. g. : She has no regard for other people's feelings.

她无视别人的感受。

【习惯用法】

as regards　　关于,至于

in this regard　　在这方面,关于这件事

with/in regard to　　关于,至于

regard as　　视为,当作

◆ witness (rather formal) to see sth. happen(当场)看到,目击

e. g. : Priests have witnessed an increase in religious intolerance.
牧师们亲身感受到宗教不宽容现象日益加重。

◆ perceive (formal) to notice or become aware of sth. ,especially sth. that is not obvious 注意到;意识到;察觉到

e. g. : That morning, he perceived a change in Franco's mood.
那天早上,他注意到弗朗哥情绪的变化。

6.7 练习题 Exercise

(6-1) 用所给动词的正确形式填空。

[1] Lightning _____(cause) awe and wonder since old times. Although Benjamin Franklin demonstrated lightning as an enormous electrical discharge, more than 200 years many puzzles still surround this powerful phenomenon.

[2] Lightning is generated when electrical charges separate in rain clouds, though processes are still not fully understood. Typically, positive charges build at the cloud top, while the bottom becomes negatively _____(charge). In most instances of cloud-to-ground lightning, the negatively charged lower portion of the cloud repels negatively charged particles on the ground's surfaces, making it become positively charged. The positive charge on the ground gathers at elevated points.

[3] A flow of electrons begins between the cloud and earth when the voltage charge _____ (become) large enough, it breaks through the insulating barrier of air, and electrons zigzag earthward. We see the discharge as lightning.

[4] Lightning can occur within a cloud, between clouds, or between clouds and the ground. The first variety, intra-cloud lightning, is the most frequent but is often _____(hide) from our view. Cloud-to-ground lightning, making up about 20 percent of lightning discharges is what we usually see. Lightning comes in several forms, including sheet, ribbon, and intra-cloud lightning can illuminate a cloud so it looks like a white sheet, hence its name when cloud-to-ground lightning occurs during strong winds, they can shift the lightning channel sideways, so it _____ (look) like a ribbon. The average lightning strike is more than 3 miles long and can travel at a tenth of the speed of light. Ball lightning, the rarest and mysterious form, derives its name from the small luminous ball that appears near the impact point, moves horizontally, and lasts for several seconds.

[5] Thunder _____(generate) by the tremendous heat released in a lightning discharge. Temperatures near the discharge can reach as high as 500,008 F within thousandths of a second. This sudden _____(heat) acts as an explosion, generating shock waves we hear as thunder.

[6] About 2,000 thunderstorms are occurring in the world at any time, _____(generate) about 100 lightning strikes every second, or 8 million daily. Within the United States, lightning

strikes _____ (estimate) at 20 million a year, or about 22,000 per day. You have a 1-in-600,000 chance of being struck by lightning during your lifetime. Lightning can strike twice or more in the same spot. The Empire State Building in New York is struck by lightning about two dozen times annually.

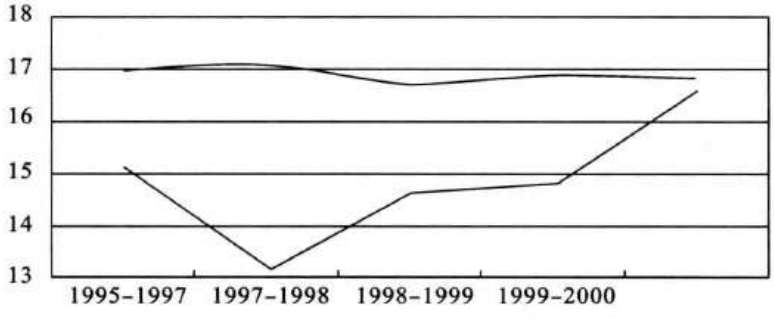
[7] You can measure how far you are from a lightning strike by counting the seconds between viewing the flash and hearing the bang, and then _____ (divide) by five. This approximates the mileage.

(6-2) 解释下列词语。

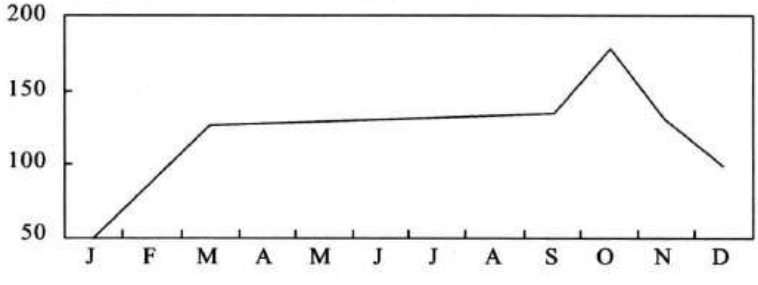
[1] phenomenon
[2] typically
[3] point
[4] lightning
[5] make up
[6] derive
[7] second
[8] thunder
[9] chance
[10] struck

(6-3) 有些图表中的走势并不随时间变化而变化，或者变化极小，我们称之为稳定。

• Look at the examples of "stability" shown in graphs (a) and (b).



(a)



(b)

Write two sentences which describe the overall trends shown in graph (a).

Write two or more sentences to form a short paragraph which describes graph (b).

第三章 光 学

Lesson 7

内容
7.1 光的本质 Nature of Light
7.2 生词表 New Words
7.3 课文注释 Text Annotation
7.4 扩展阅读 Extended Reading: Hologram
7.5 常用用法 Usages and Expressions
常用的函数表达 Usual Function Expressions
7.6 同义词辨析 Synonyms
7.7 练习题 Exercise

7.1 光的本质 Nature of Light

Blue lakes, ochre deserts, green forests, and multicolored rainbows can be enjoyed by anyone who has eyes with which to see them. But by studying the branch of physics called optics, which deals with the behavior of light and other electromagnetic waves, [1] **we can reach a deeper appreciation of the visible world.** A knowledge of the properties of light allows us to understand the blue color of the sky and the design of optical devices such as telescopes, microscopes, cameras, eyeglasses, and the human eye. The same basic principles of optics also lie at the heart of modern developments such as the laser, optical fibers, holograms, optical computers, and new techniques in medical imaging.

Until the time of Isaac Newton (1642 – 1727), most scientists thought that light consisted of streams of particles (called corpuscles) emitted by light sources. Galileo and others tried (unsuccessfully) to measure the speed of light. Around 1665, evidence of wave properties of light began to be discovered. By the early 19th century, evidence that light is a wave had grown very persuasive. In 1873, James Clerk Maxwell predicted the existence of electromagnetic waves and calculated their speed of propagation. This development, along with the experimental work of Heinrich Hertz starting in 1887, showed conclusively that light is indeed an electromagnetic wave.

The wave picture of light is not the whole story, however. Several effects associated with

emission and absorption of light reveal a particle aspect, in that the energy carried by light waves is packaged in discrete bundles called photon or quanta. These apparently contradictory wave and particle properties have been reconciled since 1930 with the development of quantum electrodynamics, a comprehensive theory that includes both wave and particle properties. The propagation of light is best described by a wave model, but understanding emission and absorption requires a particle approach. The fundamental sources of all electromagnetic radiation are electric charges in accelerated motion. All bodies emit electromagnetic radiation as a result of thermal motion of their molecules; this radiation, called thermal radiation, is a mixture of different wavelengths. At sufficiently high temperatures, all matter emits enough visible light to be self-luminous; a very hot body appears "red hot" (Fig. 7 – 1) or "white hot." Thus hot matter in any form is a light source. Familiar examples are a candle flame, hot coals in a campfire, the coils in an electric room heater, and an incandescent lamp filament (which usually operates at a temperature of about 3,000℃).



Fig. 7 – 1 An electric heating element emits primarily infrared radiation. But if its temperature is high enough, it also emits a discernible amount of visible light.

Light is also produced during electrical discharges through ionized gases. The bluish light of mercury-arc lamps, the orange-yellow of sodium-vapor lamps, and the various colors of "neon" signs are familiar. A variation of the mercury-arc lamp is the fluorescent lamp. This light source uses a material called a phosphor to convert the ultraviolet radiation from a mercury arc into visible light. This conversion makes fluorescent lamps more efficient than incandescent lamps in transforming electrical energy into light.

A light source that has attained prominence in the last forty years is the laser. In most light sources, light is emitted independently by different atoms within the source; in a laser, by contrast, atoms are induced to emit light in a cooperative, coherent fashion. The result is a very narrow beam of radiation that can be enormously intense and that is much more nearly monochromatic, or single-frequency, than light from any other source. Lasers are used by physicians for microsurgery, in CD players and computers to scan the information encoded on a compact disc or CD-ROM, in industry to cut through steel and to fuse high-melting-point materials, and in many other applications.

No matter what its source, electromagnetic radiation travels in vacuum at the same speed. The speed of light in vacuum is defined to be $c = 2.99792458 \times 10^8$ m/s or to three significant figures. The duration of one second is defined by the cesium clock, so one meter is defined to be the distance that light travels in 1/299,792,458 s.

We often use the concept of a wave front to describe wave propagation. We introduced this concept to describe the leading edge of a wave. More generally, we define a wave front as the locus of all adjacent points at which the phase of vibration of a physical quantity associated with the wave is the same. That is, at any instant, all points on a wave front are at the same part of the cycle of their variation.

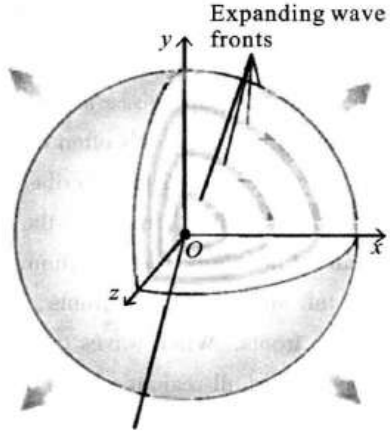


Fig. 7 – 2 Spherical wave fronts of sound spread out uniformly in all directions from a point source in a motionless medium. Such as still air, that has the same properties in all regions and in all directions. Electromagnetic waves in vacuum also spread out as shown here. Point sound source producing spherical sound waves (alternating compressions and rarefactions of air).

[2] **When we drop a pebble into a calm pool, the expanding circles formed by the wave crests, as well as the circles formed by the wave troughs between them, are wave fronts.** Similarly, when sound waves spread out in still air from a point-like source, or when electromagnetic radiation spreads out from a point like emitter, any spherical surface that is concentric with the source is a wave front, as shown in Fig. 7 – 2. In diagrams of wave motion we usually draw only parts of a few wave fronts, often choosing consecutive wave fronts that have the same phase and thus are one wavelength apart, such as crests of water waves. Similarly, a diagram for sound waves might show only the "pressure crests," the surfaces over which the pressure is maximum, and a diagram for electromagnetic waves might show only the "crests" on which the electric or magnetic field is maximum.

We will often use diagrams that show the shapes of the wave fronts or their cross sections in some reference plane. For example, when electromagnetic waves are radiated by a small light source, we can represent the wave fronts as spherical surfaces concentric with the source or, as in Fig. 7 – 3(a), by the circular intersections of these surfaces with the plane of the diagram. Far

away from the source, where the radii of the spheres have become very large, a section of a spherical surface can be considered as a plane as is shown in Fig. 7 – 3(b).

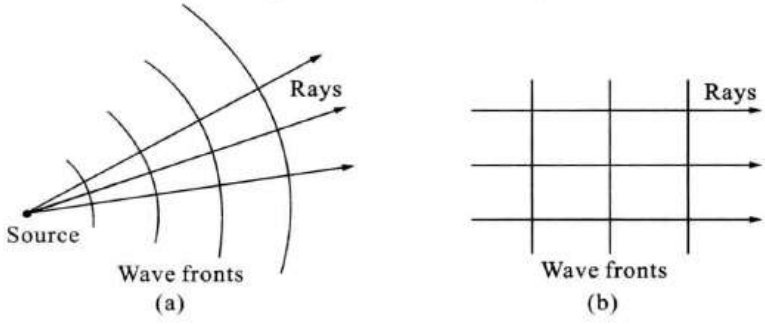


Fig. 7 – 3 Wave fronts and rays. (a) When wave fronts are spherical, the rays radiate from the spheres. (b) When wave fronts are planes, the rays are perpendicular to the wave fronts and parallel to each other.

To describe the directions in which light propagates, it's often convenient to represent a light wave by rays rather than by wave fronts. Rays were used to describe light long before its wave nature was firmly established. In a particle theory of light, rays are the paths of the particles. From the wave viewpoint a ray is an imaginary line along the direction of travel of the wave. In Fig. 7 – 3 (a) the rays are the radii of the spherical wave fronts, and in Fig. 7 – 3 (b) they are straight lines perpendicular to the wave fronts. When waves travel in a homogeneous isotropic material (a material with the same properties in all regions and in all directions),[3] **the rays are always straight lines normal to the wave fronts.** At a boundary surface between two materials, such as the surface of a glass plate in air, the wave speed and the direction of a ray may change, but the ray segments in the air and in the glass are straight lines.

7.2 生词表 New Words

ochre *adj.* 赭色的
optics *n.* 光学
hologram *n.* 全息图;全息摄影
corpuscle *n.* 微粒
in that = because 体现在
reconcile *v.* 使和解
incandescent lamp filament 白炽灯丝
discernible *adj.* 可辨别的;可识别的
ionized *adj.* 电离的
bluish *adj.* 带蓝色的;有点蓝的
sodium *n.* 钠
fluorescent lamp 荧光灯
phosphor *n.* 磷光剂
ultraviolet *n./adj.* 紫外线(的)
monochromatic *adj.* 单色的
cesium 铯(55 号元素,符号 Cs)
wave front 波前
locus *n.* 轨迹
trough *n.* 波谷
pebble *n.* 卵石
crest *v.* 形成浪峰
rarefaction *n.* 稀疏
spherical *adj.* 球形的
radii *n.* radius 的复数形式
concentric *adj.* 同心的
normal *adj.* 法向的,正交的

7.3 课文注释 Text Annotation

【1】..., we can reach a deeper appreciation of the visible world.

……,我们能够达到对可见世界更深层次的理解。

appreciation 第一个意思是基于对重要的有价值的东西的认识和理解而产生的欣赏、鉴别或感谢,另一个意思是"增值"。联系上下文,直接翻译成"理解"更为直接。

►1. 感谢(基于对对方重要性的认识而产生的)

e. g. :These flowers are a token of my appreciation of/for all your help.

►2. 欣赏(基于对事物重要性的认识而产生的)

e. g. :John has no appreciation of the finer things in life.

约翰不会欣赏生活中美好的事物。

►3. 增值

e. g. :There has been little appreciation (= increase) in the value of property recently.

近来房地产价格几乎没有增值。注意:在经济领域 property 通常指房地产(或单独的房产、地产)。

【2】When we drop a pebble into a calm pool, the expanding circles formed by the wave crests, as well as the circles formed by the wave troughs between them, are wave fronts.

当我们将一粒卵石扔进平静的水池,由波峰和波谷形成的圆圈向外延伸,即为波前。

crest 有"高"的意思,衍生为:①最高点;②头上的毛、冠;③头上装饰。这里是"波峰"的意思。注意与 crust 的区别,crust 是地壳。

►1. 山峰,波峰

the crest of a hill/wave

►2. 冠

The rooster bristled his crest.

公鸡竖起了鸡冠。

►3. 饰章

On the wall is the family crest.

墙上挂着那个家族的饰章。

【3】...,the rays are always straight lines normal to the wave fronts.

射线总是正交于波前的直线。

normal:

►1. 正常的

►2. 正态的(统计学)

►3. 师范的

Beijing Normal University 北京师范大学

►4. 法向的

normal line

法线

7.4 扩展阅读 Extended Reading

Hologram

Holography is a technique which enables three-dimensional images to be made. It involves the use of a laser, interference, diffraction, light intensity recording and suitable illumination of the recording. The image changes as the position and orientation of the viewing system changes in exactly the same way as if the object were still present, thus making the image appear three-dimensional.

Holography is a technique that enables a light field, which is generally the product of a light source scattered off objects, to be recorded and later reconstructed when the original light field is no longer present, due to the absence of the original objects. Holography can be thought of as somewhat similar to sound recording, whereby a sound field created by vibrating matter like musical instruments or vocal cords, is encoded in such a way that it can be reproduced later, without the presence of the original vibrating matter.

Holograms are recorded using a flash of light that illuminates a scene and then imprints on a recording medium, much in the way a photograph is recorded. In addition, however, part of the light beam must be shone directly onto the recording medium—this second light beam is known as the reference beam. A hologram requires a laser as the sole light source. Lasers can be precisely controlled and have a fixed wavelength, unlike sunlight or light from conventional sources, which contain many different wavelengths. To prevent external light from interfering, holograms are usually taken in darkness, or in low level light of a different color from the laser light used in making the hologram. Holography requires a specific exposure time (just like photography), which can be controlled using a shutter, or by electronically timing the laser.

When the two laser beams reach the recording medium, their light waves intersect and interfere with each other. It is this interference pattern that is imprinted on the recording medium. The pattern itself is seemingly random, as it represents the way in which the scene's light interfered with the original light source — but not the original light source itself. The interference pattern can be considered an encoded version of the scene, requiring a particular key — the original light source — in order to view its contents.

This missing key is provided later by shining a laser, identical to the one used to record the hologram, onto the developed film. When this beam illuminates the hologram, it is diffracted by the hologram's surface pattern. This produces a light field identical to the one originally produced by the scene and scattered onto the hologram. The image this effect produces in a person's retina is known as a virtual image.

For a better understanding of the process, it is necessary to understand interference and diffraction. Interference occurs when one or more wave fronts are superimposed. Diffraction occurs whenever a wave front encounters an object. The process of producing a holographic reconstruction is explained below purely in terms of interference and diffraction. It is somewhat simplified but is accurate enough

to provide an understanding of how the holographic process works.

7.5 常用用法 Usages and Expressions

常用的函数表达 Usual Function Expressions

表 达	发 音
$f(x)=c^x$	the function f of x is an exponential function with base c
$\ln(x)=\log e^x$	注意:ln 的发音没有统一的标准,可以分别读出两个字母 ell en, natural log of x equals the logarithm to the base e of x
$\sin x=1$	the sine of x equals 1
$\tan(\pi/2)=1$	the tangent of pi over 2 equals 1
$\cot x=1$	the cotangent of x equals 1
$\arcsin x=\pi/6$	the arcsine of x equals pi over 6
$\mathrm{sh}\ x=\frac{e^x-e^{-x}}{2}$	the hyperbolic sine of x equals the quantity e to the xth power minus e to the minus xth power over two
$\mathrm{sh}^{-1}x=\ln(x\pm\sqrt{x^3+2})$	the arc-hyperbolic sine of x equals natural log of the quantity x plus or minus the square root of x squared plus 2

7.6 同义词辨析 Synonyms

sign, password, mark, hint, gesture, indication, suggestion, implication, symptom, symbol, label, indicator, signal

These are all words for an event, action or fact that shows that sth. exists, is happening or may happen in the future.

以上各词均指迹象、征兆、预兆。

◆ sign an event, action or fact that shows that sth. exists, is happening or may happen in the future 迹象,征兆,预兆

e. g.: Headaches may be a sign of stress.

头痛可能是紧张的迹象。

The tests can detect early signs of disease.

这些检查可以发现疾病的早期征兆。

【习惯用法】

sign sb.'s praise 衷心赞美某人,歌颂某人

◆ password a secret word or phrase that you need to know in order to be allowed into a place(进入某一地方需要的)暗语,暗号,口令

e. g.: Enter your password, then click on the "proceed" icon.

输入您的密码,然后点击"继续"图标。

◆ mark a sign that a quality or feeling exists (品质或情感的)标志;迹象;表示

e. g. :When you're done, put your sheet in the envelope marked with your name.
当你完成的时候,把你的表在信封上注明你的名字。

【习惯用法】

mark out 画线分开

◆ hint something that suggests what will happen in the future(某事将会在未来发生的)征兆,迹象

e. g. : He hinted strongly that he might be prepared to send troops in.
他强烈暗示,他可能会准备派遣军队。

◆ gesture a movement that you make with your hands, your head or your face to show a particular meaning 做手势;用手势表达;用动作示意

e. g. :He gestured for her to take a seat.
他示意让她坐下。

【习惯用法】

make an anger gesture 做一个愤怒的手势
make a bold gesture 做一个无礼的手势
make a friendly gesture 做一个友好的手势

◆ indication (rather formal) a remark or sign that shows that sth. is happening or what sb. is thinking or feeling 标示;象征

e. g. : Could you give me some indication as to when I am likely to receive a reply?
当我可能得到一个答复时你能否给我一些指示?
They gave no indication as to how the work should be done.
他们根本没说明这项工作该怎样做。

SIGN OR INDICATION? 用 sign 还是 indication?

An indication often comes in the form of sth. that sb. says, while a sign is usually sth. that happens or sth. that sb. does. * indication 常通过某人的说话表明,而 sign 通常为发生的事或某人所做的事。

◆ suggestion a slight amount or sign of sth. 微量;些微;迹象

e. g. :The government has denied any involvement in her death.
关于她的死亡政府否认有任何迹象。

【习惯用法】

a whispered suggestion of something significant about to happen
即将发生重大事情的私下暗示
with the mere suggestion of a smile
脸上勉强露出一丝笑意

◆ implication something that is suggested or indirectly stated (= sth. that is implied)(非直接说出的)含义,暗指

e. g. :This election has profound implications for the future of U. S. democracy.

这次选举对美国民主的未来有深远意义。

◆ symptom a change in your body or mind that shows that you are not healthy; a sign that sth. exists, especially sth. bad 症状;征候;征兆

e. g. :Symptoms include a sore throat. 症状包括嗓子疼。

The rise in inflation was just one symptom of the poor state of the economy.

通胀上升不过是经济不景气的一个征候。

Common symptoms of diabetes are weight loss and fatigue.

糖尿病的常见症状是消瘦和疲劳。

【习惯用法】

have(或 show)symptom of 有……的症状

◆ symbol a person, object or event that represents a more general quality or situation 象征

e. g. :The dove is a universal symbol of peace.

鸽子是和平的象征。

Fe is the chemical symbol for iron.

Fe 是铁的化学元素符号。

【习惯用法】

作"象征"讲时,常接介词 of。

◆ label a piece of paper, etc. that is attached to sth. and that gives information about it (贴到某物质上标记其信息的)标签;签条;标记

e. g. : Each bag of seeds is labeled with the grower's name.

每一袋种子都贴上了种殖者的名字。

【习惯用法】

label...as... 把……称为……

◆ indicator (rather formal) a sign that shows you what sth. is like or how a situation is changing 指示信号;标志;迹象

e. g. :the economic indicators 经济指标

All the main economic indicators suggest that trade is improving.

所有的主要经济指标显示,贸易正在改善。

◆ signal an event, action or fact that shows that sth. exists, is happening or may happen in the future 标志;预示;信号

e. g. :Chest pains can be a warning signal of heart problems.

胸部疼痛可能是心脏病的报警信号。

【习惯用法】

signal 是发出警报的"信号",是可数名词。

signal 还可作"是……的标志,标志着"解。

SIGN OR SIGNAL? 用 sign 还是 signal?

"Signal" is often used to talk about an event, action or fact that suggests to sb. that they should do sth. "Sign" is not usually used in this way. * signal 常用于指应该采取行动的暗号、信号;sign 通常不用于此义。

7.7 练习题 Exercise

(7-1)完形填空,然后把短文译成汉语。

Google Inc. will pay $ 1 for a municipal fiber-optic system that cost $ 39 million to build, according to terms of the Internet company's agreement with Provo. The deal is widely expected to be approved Tuesday by the City Council, making Provo ____[1]____ third city selected by Google for high-speed Internet and television service. Google is already operating a fiber-optic system in Kansas City, Mo., and earlier this month it selected Austin, Texas, as a second candidate. In Provo, a city of 115,000 about 45 miles south of Salt Lake ____[2]____, Google is making its first plans to take over an existing fiber system and will start operating it long before it can build the service for Austin. Even as Google takes ownership of the municipal network, Provo will have to pay ____[3]____ loans for its construction for another dozen years, according to agreements released Thursday by city officials. For nearly as many years, households have been paying $ 5.35 a month on their utility bills for a system that provides Internet, television and phone service — whether they use it ____[4]____ not. But Provo officials say Google's deal is a good one for the city and its residents because the system hasn't been able to support itself. Google Fiber will offer residents something in return for the utility fee — basic Internet service at no charge if they pay a $ 30 hookup fee. That's far less than the current $ 700 activation ____[5]____.

[1] A. a	B. the	C. some	D. any
[2] A. Province	B. County	C. City	D. State
[3] A. on	B. up	C. down	D. off
[4] A. or	B. and	C. both	D. useless
[5] A. money	B. tip	C. receipt	D. fee

(7-2)用下面方框内单词的适当形式填空。

absorb	electromagnetic	medium	opaque
prism	rainbow	reflects	refraction
shadows	translucent	transparent	white

Light is a visible form of _____ radiation. The sun produces _____ light, which is a combination of all the colors of light. However, these colors can be separated using a device called a _____. A prism uses the property of _____, which is the bending of light as it passes from one _____ to another. A _____ is formed when the sun's light is refracted through droplets of water in the atmosphere.

We see objects when light _____ off of them. Different objects appear to be different colors because of the way light reflects off of the objects. Blue objects _____ every color except

blue, which is reflected. Light can also pass through objects. Objects that allow light to pass through them are _____. Objects that blur light as it passes through are called _____. Objects that block light completely are _____. Opaque objects form _____ under them when light shines on them.

(7-3) 用下面方框内单词的适当形式填空。

process	surface	transferred	higher
heating	frequencies	warm	absorbed
reducing	radiation		

The greenhouse effect is a _____ by which thermal radiation from a planetary _____ is absorbed by atmospheric greenhouse gases, and is reradiated in all directions. Since part of this reradiation is back towards the surface, energy is _____ to the surface and the lower atmosphere. As a result, the temperature there is _____ than it would be if direct _____ by solar radiation were the only warming mechanism. Solar radiation at the high _____ of visible light passes through the atmosphere to _____ the planetary surface, which then emits this energy at the lower frequencies of infrared thermal radiation. Infrared radiation is _____ by greenhouse gases, which in turn reradiate much of the energy to the surface and lower atmosphere. The mechanism is named after the effect of solar _____ passing through glass and warming a greenhouse, but the way it retains heat is fundamentally different as a greenhouse works by _____ airflow, isolating the warm air inside the structure so that heat is not lost by convection.

(7-4) 用下面方框内单词的适当形式填空。

few	wavelengths	nanometers	solid	continuous
lines	visible light	line or atomic	frequency	electromagnetic

The _____ spectrum covers the range of wavelengths from 10^{-16} to 10^{8} m, which corresponds to the _____ range from 10^{24} to 10 cycles per second. _____ is only a small portion of the electromagnetic spectrum, _____ with ranging from 4×10^{-7} to 7×10^{-7} m, that is from 400 to 700 _____ sunlight and the light generated by hot _____ objects have a _____ spectrum. Gases subjected to electrical discharge give a _____ spectrum composed of several narrow _____. Only a _____ wavelengths are represented in such spectra.

(7-5) 回答以下问题。

[1] Light is a form of e _____.

[2] In what form does light energy travel from the sun?

[3] (a) Does light need a medium for travelling?

(b) Thus, can light travel in a vacuum?

[4] Light travels in s _____ lines.

[5] The path along which light travels is called a r _____.

[6] A _____ are drawn on light rays to show the direction in which light travels.

[7] A _____ of light consists of a bundle of light rays.

[8] Reflection is the _____ of light off a surface.

[9] _____ ray is the ray of light striking a surface.

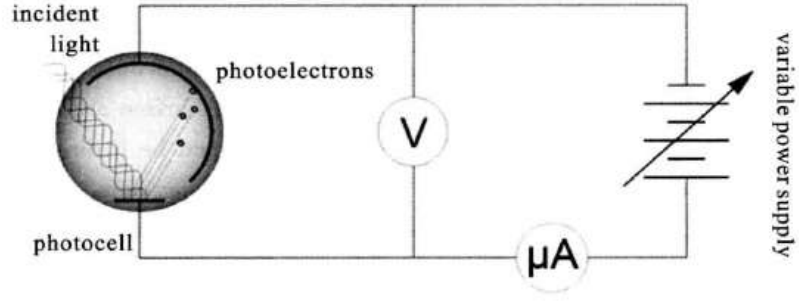
[10] _____ ray is the ray of light reflected from a surface.

[11] _____ is an imaginary line perpendicular to the surface where the reflection occurs.

[12] Angle of incidence is the angle between _____ and the _____.

[13] Angle of reflection is the angle between _____ and the _____.

(7-6)根据下图写一段话,将图中的逻辑关系表达清楚(photoelectric effect)。



(7-7)阅读并用自己的话复述短文,可以借助黑板、多媒体等工具,培养科技英语阅读和口头表达能力。

Many are well aware of the various non-medical problems associated with light pollution, such as energy waste, sky glow, and environmental impact.

But not many people know about the burgeoning growth of research that demonstrates direct human-health issues related to excess light. Though we certainly need to be mindful of wasting energy, health effects might ultimately be the most important reason to control light pollution. The energy wasted by excessive lighting is produced primarily by burning fossil fuels, leading directly to air pollution that causes higher asthma rates and increased respiratory problems for people with lung disease and other medical issues.

Glare is the most common health safety problem resulting from poorly designed outdoor lighting. You have probably noticed poor vision stemming from glare on a dirty windshield. Over time, calcifications build up in the lenses of our eyes, which eventually develops into a cataract. These calcifications and other lens and eye imperfections scatter light in a similar fashion to a dirty windshield. This effect grows more severe with age, and is the primary reason why the elderly have a difficult time driving at night near poorly designed street lights. Most people with this problem are not even aware that it's the glare that's the main cause of their poor night vision, and that they would be able to drive more safely if street lights were properly designed with full shielding. Recognizing that our streets could be safer places at night, the American Medical Association (AMA) adopted a resolution in 2009 urging full shielding for all public street lighting.

A very active new area of research is the effect of night light on circadian-rhythm disruption. Numerous papers over the past 20 years have led medical researchers to conclude that light at night

increases the incidence of certain cancers, most notably breast cancer. In fact, researchers now estimate that up to 30% of breast cancers are secondary to light at night suppressing circadian rhythm. The research basis for this conclusion has become so compelling that the International Agency for Research on Cancer (IARC) recently declared circadian-rhythm disruption as a class 2A carcinogen — placing it on the same level of severity as the effects of tobacco smoke on lung cancer. Light-at-night and circadian disruptions have been suggested to play a role in other cancers including endometrial, ovarian, prostate, colorectal, and non-Hodgkins lymphoma but evidence comparable to that obtained for breast cancer has not yet been developed.

The biochemical mechanism for this has been thoroughly researched and is thought to result from the suppression of melatonin production by the pineal gland in the center of our brain. This gland produces the hormone melatonin while we sleep. Repeated exposure to lights for night-shift workers or in our bedrooms markedly suppresses melatonin production. Previous research has shown that this hormone helps the immune system suppress the development of several types of cancers.

The modern world has an epidemic of obesity and diabetes that may be influenced by lack of sleep, lack of dark, and/or circadian disruption. Non-day shift workers have a higher incidence of diabetes and obesity. Epidemiological studies also show associations of reported sleep duration and risk of obesity and diabetes. Circadian disruption may be a common mechanism for these outcomes and potential links between the circadian rhythm and metabolism.

As an elected member of the AMA's Council of Science and Public Health, I have asked the world's five foremost researchers on this subject to help me draft a review monograph to summarize these important studies. After a year of work, this report has been approved by the Council of Science and Public health of the American Medical Association, and is on the docket for a full vote of the AMA House of delegates in June to be adopted as official policy of the AMA. It is my hope that this report will prod governments and municipalities adopt sensible and rational lighting policies.

(7-8) 翻译。

When walking out of a dark room into the sunshine, light can be blinding. As our eyes become accustomed to the light, we can see more clearly and enjoy the scenery that surrounds us. Likewise, when we look into the light of the scriptures, the brightness of truth can sometimes hurt. However, as our spiritual eyesight becomes adjusted, we can enjoy "walking in the light."

参考文献

[1] Mario E Motta, GAM 2012 Dark Skies Awareness.

[2] http://technology. topnewstoday. org.

Lesson 8

内容 8.1 几何光学 Geometric Optics
8.2 生词表 New Words
8.3 课文注释 Text Annotation
8.4 扩展阅读 Extended Reading: "Nanosuits" Made with Electron Microscope Protect Creatures from Vacuum
8.5 常用用法 Usages and Expressions
光学常用实验仪器 Laboratory Apparatus in Optics
8.6 同义词辨析 Synonyms
8.7 练习题 Exercise

8.1 几何光学 Geometric Optics

Your reflection in the bathroom mirror, the view of the moon through a telescope, the patterns seen in a kaleidoscope; all of these are examples of images. In each case the object that you're looking at appears to be in a different place than its actual position: Your reflection is on the other side of the mirror, the moon appears to be much closer when seen through a telescope, and objects seen in a kaleidoscope seem to be in many places at the same time. In each case, light rays that come from a point on an object are deflected by reflection or refraction (or a combination of the two), so they converge toward or appear to diverge from a point called an image point. Our goal is to see how this is done and to explore the different kinds of images that can be made with simple optical devices.

Before discussing what is meant by an image, we first need the concept of object as it is used in optics. By an object we mean anything from which light rays radiate. This light could be emitted by the object itself if it is self-luminous, like the glowing filament of a light bulb. Alternatively, the light could be emitted by another source (such as a lamp or the sun) and then reflected from the object; an example is the light you see coming from the pages of this book. Fig. 8 – 1 shows light rays radiating in all directions from an object at a point P. For an observer to see this object directly, there must be no obstruction between the object and the observer's eyes. [1] **Note that light rays from the object reach the observer's left and right eyes at different angles; these differences are processed by the observer's brain to infer the distance from the observer to the object.**

The object in Fig. 8 – 1 is a point object that has no physical extent. Real objects with length, width, and height are called extended objects. To start with, we'll consider only an idealized point object, since we can always think of an extended object as being made up of a very large number of point objects.

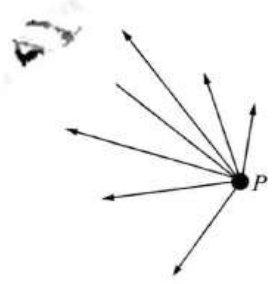


Fig. 8 – 1 Light rays radiate from a point object P in all directions.

[2] **Suppose some of the rays from the object strike a smooth, plane reflecting surface** (Fig. 8 – 2). This could be the surface of a material with a different index of refraction, which reflects part of the incident light, or a polished metal surface that reflects almost 100% of the light that strikes it. We will always draw the reflecting surface as a black line with a shaded area behind it, as in Fig. 8 – 2. Bathroom mirrors have a thin sheet of glass that lies in front of and protects the reflecting surface; we'll ignore the effects of this thin sheet.

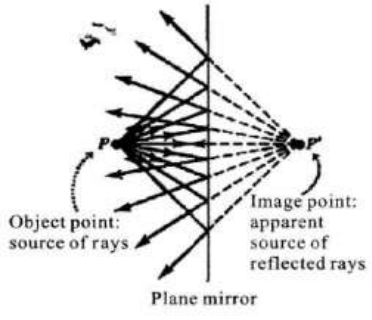


Fig. 8 – 2 Light rays from the object at point P are reflected from a plane mirror. The reflected rays entering the eye look as though they had come from image point P'.

According to the law of reflection, all rays striking the surface are reflected at an angle from the normal equal to the angle of incidence. Since the surface is plane, the normal is in the same direction at all points on the surface, and we have specular reflection. After the rays are reflected, their directions are the same as though they had come from point P'. We call point P an object point and point P' the corresponding image point, and we say that the reflecting surface forms an image of point P. An observer who can see only the rays reflected from the surface, and who doesn't know that he's seeing a reflection, thinks that the rays originate from the image point P'. The image point is therefore a convenient way to describe the directions of the various reflected rays, just as the object point P describes the directions of the rays arriving at the surface before re-

flection.

If the surface in Fig. 8 – 2 were not smooth, the reflection would be diffuse, and rays reflected from different parts of the surface would go in uncorrelated directions. In this case there would not be a definite image point P' from which all reflected rays seem to emanate. You can't see your reflection in the surface of a tarnished piece of metal because its surface is rough; polishing the metal smoothes the surface so that specular reflection occurs and a reflected image becomes visible.

An image is also formed by a plane refracting surface, as shown in Fig. 8 – 3. Rays coming from point P are refracted at the interface between two optical materials. When the angles of incidence are small, the final directions of the rays after refraction are the same as though they had come from point P', as shown, and again we call P' an image point.

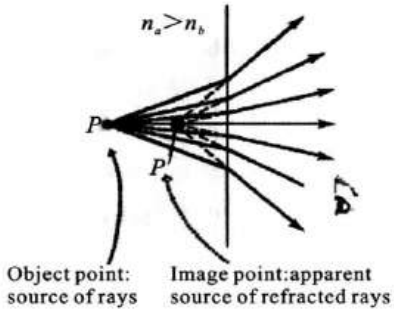


Fig. 8 – 3 Light rays from the object at point P are refracted at the plane interface. The refracted rays entering the eye look as though they bad come from image point P'. When $n_a > n_b$ 'P' is closer to the surface than P; for $n_a < m_b$' the reverse is true.

In both Fig. 8 – 2 and Fig. 8 – 3 the rays do not actually pass through the image point P'. Indeed, if the mirror in Fig. 8 – 2 is opaque, there is no light at all on its right side. [3] **If the outgoing rays don't actually pass through the image point, we call the image a virtual image.** Later we will see cases in which the outgoing rays really do pass through an image point, and we will call the resulting image a real image. The images that are formed on a projection screen, on the photographic film in a camera, and on the retina of your eye are real images.

Let's concentrate for now on images produced by reflection. To find the precise location of the virtual image P' that a plane mirror forms of an object at P, we use the construction shown in Fig. 8 – 4. The figure shows two rays diverging from an object point P at a distance s to the left of a plane mirror. We call s the object distance. The ray PV is incident normally on the mirror (that is, it is perpendicular to the mirror surface), and it returns along its original path.

The ray PB makes an angle θ with PV. It strikes the mirror at an angle of incidence θ and is reflected at an equal angle with the normal. When we extend the two reflected rays backward, they intersect at point P', at a distance s' behind the mirror. We call s' the image distance. The line between P and P' is perpendicular to the mirror. The two triangles PVB and $P'VB$ are congruent,

so P and P' are at equal distances from the mirror, and s and s' have equal magnitudes. The image point P' is located exactly opposite the object point P as far behind the mirror as the object point is from the front of the mirror.

We can repeat the construction of Fig. 8 – 4 for each ray diverging from P. The directions of all the outgoing reflected rays are the same as though they had originated at point P', confirming that P' is the image of P. No matter where the observer is located, she will always see the image at the point P'.

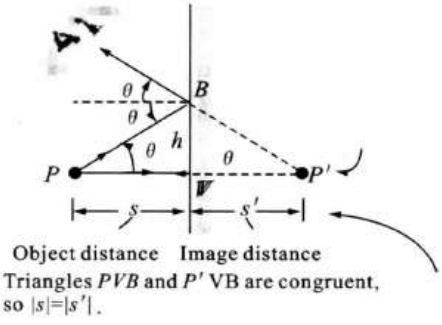


Fig. 8 – 4 Construction for determining the location of the image formed by a plane mirror. After reflection, all rays originating at P diverge from P'. Because the rays do not actually pass through P', the image is virtual. The image point P' is as far behind the mirror as the object point P is in front of it.

8.2 生词表 New Words

kaleidoscope *n.* 万花筒
alternatively *adv.* 或者
note that 注意
incident light 入射光
angle of incidence 入射角
specular reflection 镜面反射
diffuse *adj.* 弥散的,漫反射的
emanate *v.* 发射
tarnished *adj.* 生锈的
opaque *adj.* 不透明的
congruent *adj.* 全等的

8.3 课文注释 Text Annotation

【1】Note that light rays from the object reach the observer's left and right eyes at different angles; these differences are processed by the observer's brain to infer the distance from the observer to the object.

请注意,从物体发出的光线以不同的角度到达观察者的左眼和右眼;观察者的大脑会处理这种不同并据此推断出物体和观察者之间的距离。

双眼视差(binocular disparity)指由于正常的瞳孔距离和注视角度不同,造成左右眼视网

膜上的物像存在一定程度的水平差异。在观察立体视标的时候，两只眼由于相距约60mm，所以会从不同角度观察，左眼看到视标的左侧部分多一些，右眼看到右侧的部分多一些。据此，大脑能够计算出物体离观察者的距离，即depth perception。

1. binocular vision

[生理] 双眼视觉；双目镜观察

2. stereoscopy

[测] 体视学；体视术；体视法；立体观视；实体镜学

3. orthoptics

视轴矫正法；双眼斜视校正术

【2】Suppose some of the rays from the object strike a smooth, plane reflecting surface.

设想物体发出的一些光线照射到光滑的平面。

strike 有"击打；罢工；去除；发现"等意思。

▶1. 击打

Her car went out of control and struck an oncoming vehicle.

她的汽车失去控制，碰到了驶近的车辆。

▶2. 罢工

hunger strike

绝食抗议

▶3. 去除

Please strike my name from your mailing list immediately.

请马上将我的名字从邮件列表中去除

▶4. 发现(油、天然气或金属矿等)

The first person to strike oil in the US was Edwin Laurentine Drake.

第一个发现石油的美国人是爱德温·劳伦庭·德瑞克。

【3】If the outgoing rays don't actually pass through the image point, we call the image a virtual image.

如果外向射线并没有实际穿过像点，我们称此像为虚像。

outgoing 有"离开的；卸任的；外向的"等含义。

▶1. 离开的

outgoing flights 出境航班

▶2. 卸任的

He is the outgoing head of a company.

他是一家公司即将离职的负责人。

▶3. 外向的

She is an outgoing girl.

她是一位外向的女孩。

virtual 这个词如果单看英汉翻译，可能会难以理解。例如，某词典给出的释义是"*adj.* 实质上的，事实上的；(计算机)虚拟的；〈物〉有效的，虚像的"。那么，到底是虚拟还是事实，为什么这两个截然相反的解释会同时出现在一个单词的身上？这个问题这样理解可能比较

好:虚拟的目的是为了真实。

▶1. virtual reality 虚拟现实(虚拟的目的是为了模拟真实)

▶2. This reply is a virtual acceptance of our offer.

这一回答实质上是接受了我们的建议(但仍然以一种虚拟迂回的方式表达)。不能翻译成这一回答虚拟地接受了我们的建议,也不能理解为不接受。

8.4 扩展阅读 Extended Reading

"Nanosuits" Made with Electron Microscope Protect Creatures from Vacuum

***Nature* news** 2013

Researchers have found that the beam of a scanning electron microscope can turn a thin coating that occurs naturally on the larvae of some insects into a sort of miniature spacesuit that can keep the animals alive in a vacuum for up to an hour.

Imaging specimens with electron microscopy imposes conditions that are typically deadly for living things, such as a high vacuum. But the electrons used to create the images might actually have a protective effect. Researchers have found that the beam of a scanning electron microscope can turn a thin coating that occurs naturally on the larvae of some insects into a sort of miniature spacesuit that can keep the animals alive in a vacuum for up to an hour.

Takahiko Hariyama, a biologist at the Hamamatsu University School of Medicine in Japan, and his collaborators describe the results in the proceedings of the National Academy of Sciences.

The discovery builds on previous findings that some organisms, including beetle larvae and ticks, can survive short stints in the extremely low-pressure environment of scanning electron microscopes.



The researchers made their discovery while testing how long various animals could survive in a high vacuum while being imaged inside a scanning electron microscope. Most organisms lose water rapidly in these conditions, leading to death by dehydration and physical distortion, but the larvae of the fruitfly Drosophila survived for 60 minutes and went on to develop normally after being returned to normal pressure.

The cuticles of fruitfly larvae are naturally coated in a substance made of biological molecules such as proteins, and the researchers suspected that exposure to the electron beam caused molecules in the substance to lock together in long chains, or polymers. That would create a flexible, protective layer just 50 ~ 100 nm *thick. Other organisms that have similar coatings, such as Japanese honeybees (Apis cerana japonica) and larvae of blue-bottle flies (Protophormia terraenovae), survived in*

the high vacuum after being irradiated with plasma beams, which can generate a polymerization effect similar to that of an electron beam. Plasma beams are already used for that purpose in some industrial applications.

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Takahiko Hariyama, a biologist at the Hamamatsu University School of Medicine in Japan, and his collaborators describe the results in the proceedings of the National Academy of Sciences. The discovery builds on previous findings that some organisms, including beetle larvae and ticks, can survive short stints in the extremely low-pressure environment of scanning electron microscopes — and even, in the case of dormant tardigrades, or 'water bears,' in outer space.

To further test their hypothesis, the team tried applying an artificial version of the coating — a detergent solution made from a surfactant — on organisms that did not have one, including a flatworm (Dugesia japonica) and the larvae of the Asian tiger mosquito (Aedes albopictus). Under plasma irradiation, the coating formed a similarly effective nanosuit.

The researchers also found that many structural details of the surviving larvae were "completely different from that of untreated specimens and traditionally prepared specimens," suggesting that the nanosuit was preserving the 'real-life appearance' of the specimens.

However, materials scientist Robert Sinclair of Stanford University in California notes that the process might introduce additional changes — and that the magnifications used in the study are relatively low for electron microscopes.

If it proves sound, however, the technique "could change the way in which some living organisms could be studied using present-day electron microscopes," says Harry Horner, a developmental biologist at Iowa State University in Ames. "Not only with organisms that exist on Earth, but with organisms sent into space or retrieved from space explorations."

Hariyama already has an eye on the skies: He and his team hope to send small animals wearing nanosuits to space, and he says that they have already had some success in nanosuiting small fish.

8.5 常用用法 Usages and Expressions

光学常用实验仪器 Laboratory Apparatus in Optics

分光仪 spectrometer	激光器 laser
干涉仪 interferometer	分束镜 beam splitter
偏振片 polaroid	扩束镜 beam expander
光 栅 grating	凸透镜 convex lens
棱 镜 prism	凹透镜 concave lens

8.6 同义词辨析 Synonyms

sure, fixed, definite, confident, convinced, certain, absolute, inevitable, positive, clear, firm, assured

These words all describe sb. who knows without doubt that sth. is true or will happen.

以上各词均指"确信,肯定,有把握"。

◆ sure [not before noun] without any doubt that you are right, that sth. is true, that you will get sth. or that sth. will happen 确信,肯定,有把握,必定

e. g. : I'm sure there's a logical explanation for all this.

我确信这一切是有合理解释的。

That's Sarah's cousin. Are you sure?

那是萨拉的表妹。你能肯定吗?

NOTE: Sure is often used in negative statements and questions, because there is some doubt or anxiety over the matter. If there is no doubt, people often say "quite sure."

* sure 常用于否定句和疑问句,表示有所怀疑或担忧。毫无疑问时常用 quite sure。

e. g. : —That's the man I saw in the building last night. 那就是我昨晚在大楼里看见的那个男人。

—Are you quite sure about that? 你能完全肯定吗?

【习惯用法】

be/feel sure about sth. 有把握,确信

be/feel sure of sth./that 相信,确信

be sure to do 一定会,务必

make sure of sth./that 确信,确定无疑;查明,使确定

◆ fixed (often disapproving) (of ideas and wishes) to be help very firmly; not easily changed(思想和期望)不易改变的;执着的

e. g. : He has very fixed ideas about how a wife should behave.

他对应当如何为人之妻很有定见。

◆ definite ~ (that...) sure or certain; unlikely to change 肯定的;确定的;不会改变的

e. g. : Fix a definite daie for the delivery of your computer.

请为你的计算机定个确定的交货日期。

◆ confident completely sure that sth. will happen in the way that you want or expect 肯定,确信,有把握

e. g. : We are confident next year's profits will be higher.

我们确信明年的利润会增加。

The company is confident of success.

这家公司对成功很有把握。

NOTE: Confident is a stronger and more definite word than sure and is more often used in positive statements, when you feel no anxiety.

* confident 较 sure 语气强，而且更肯定的情况下较常用于肯定句中，表达从容淡定的思想状态。

◆ convinced [not before noun] completely sure that sth. is true or right, especially when the evidence seems to prove it or sb. else has persuaded you to believe it 坚信，深信，确信（尤指有证据证明或经说服）

e. g. : Herschel was firmly convinced of the possibility of life on other planets.

赫歇尔坚信在其他星球上可能存在生命。

I was convinced that we were doing the right thing.

我确信我们做的事情是正确的。

◆ certain [not usually before noun] sure that you are right or that sth. is true 确信，肯定，无疑

e. g. : I'm absolutely certain that I left the keys in the kitchen.

我绝对肯定我把钥匙落在厨房里了。

I felt certain that I'd passed the test.

我感觉自己肯定通过这次测验了。

【习惯用法】

for certain　　确定

make certain of = make sure of　　弄清楚

SURE OR CERTAIN? 用 sure 还是 certain?

Like sure, certain is often used in negative statements and questions. It is slightly more formal than sure; sure is more frequent, especially in spoken English. * certain 与 sure 一样，常用于否定句和疑问句中，但比 sure 稍正式些。sure 较常用，尤其是在英语口语中。

◆ absolute definite and without any doubt or confusion 语气比较坚决的，肯定的；无疑的；明确的

e. g. : We need absolute proof that he took the money.

我们需要确凿的证据，证明他拿了钱。

◆ inevitable noun[sing.] something that is certain to happen 必然发生的；不可避免的

e. g. : A further escalation of the crisis now seems inevitable.

危机的进一步升级现在看来已不可避免。

It's inevitable that doctors will make the occasional mistake.

医生偶尔犯错是不可避免的。

◆ positive [not before noun] (rather informal) completely sure that sth. is true 有绝对把握的，确信的，肯定的

e. g. : Are you absolutely positive you locked the door?

你肯定你锁了门吗？

—Are you sure about that? 那件事你能肯定吗?

—Positive. 能。

◆ clear ~ (to sb.) (that)/ what, how, whether, etc. obvious and leaving no doubt at all 明显的;显然的;明确的

e. g. :They won by a clear majority.

他们以明显的多数获胜。

a clear case of sexual discrimination

性别歧视的一个很明显的例子

◆ firm not likely to change 坚定的;确定的;坚决的

e. g. : Our client hasn't reached a firm decision on the matter yet.

我们的客户在这件事上还未作出最后决定。

Corey was always a firm believer in prayer.

科里一直对祷告的力量坚信不疑。

【习惯用法】

be firm with sb. 对某人严格

◆ assured confident in yourself and your abilities (在个人的能力方面)自信的,有把握的

e. g. :He was infinitely more assured than in his more recent parliamentary appearances.

比起最近几次在国会中的露面,他表现得自信多了。

【习惯用法】

an assured manner 自信的态度

8.7 练习题 Exercise

(8-1) 完形填空,然后把短文译成汉语。

The provincial health department is urging doctors in Nova Scotia to be on the lookout for a new form of bird flu. Health officials are saying it's unlikely the new strain of influenza will show up here in the province, but they're not taking any chances. Dr. Robert Strang, the province's chief public health officer, issued a memo on April 12, advising Nova Scotia physicians to look for anyone with ____[1]____ -like symptoms who has recently travelled to China or anyone with severe respiratory symptoms. The H7N9 avian influenza virus has infected 87 people in several regions of China and caused 17 ____[2]____. Though the World Health Organization said Friday there's no evidence a new bird flu strain is spreading easily among people in China, even though there may be sporadic cases of the virus spreading to people who have close contacts with infected patients. The source of the virus remains unclear because only a handful of birds — out of tens of thousands that have been tested — have been found to carry the H7N9 virus. Also, many of the patients have no reported ____[3]____ of contact with birds. Still, Chinese health and agricultural authorities have closed live poultry markets and slaughtered birds as preventive measures based

on suspicion that sick people had contact with infected fowl. Dr. Todd Hatchette, the service chief of microbiology at Halifax's Victoria General Hospital, said there is a limited chance the virus will show up here in Nova Scotia. However, he said that medical officials are busy ____[4]____ protocols are ____[5]____ place, just in case a strange flu appears.

[1] A. sickness	B. illness	C. flu	D. bacterium
[2] A. dead	B. death	C. deaths	D. deadness
[3] A. future	B. past	C. reason	D. history
[4] A. ensuring	B. to ensure	C. ensured	D. being ensuring
[5] A. on	B. of	C. in	D. with

(8-2) 翻译,注意黑体部分的含义和用法。

[1] Chemistry is the science of matter at the atomic to molecular scale, dealing primarily with collections of atoms, such as molecules, crystals, and metals.

[2] Chemistry deals with the composition and statistical properties of such structures, **as well as** their transformations and interactions to become materials encountered in everyday life.

[3] Chemistry also **deals with** understanding the properties and interactions of individual atoms with the purpose of applying that knowledge at the macroscopic level.

[4] According to modern chemistry, the physical properties of materials are generally **determined** by their structure at the atomic **scale** which is determined by the properties and energies of the interactions.

[5] An **element** is a class of atoms which have the same number of protons in the nucleus.

[6] This number is known as the **atomic number** of the element. For example, all atoms with 6 **protons** in their **nuclei** are atoms of the chemical element carbon, and all atoms with 92 protons in their nuclei are atoms of the element **uranium.**

[7] The most convenient presentation of the chemical elements is in the **periodic table** of the chemical elements, which groups elements by atomic number.

[8] Due to its ingenious arrangement, groups, or columns, and periods, or rows, of elements in the table either share several chemical properties, or follow a certain trend in characteristics such as atomic radius, **electronegativity**, electron **affinity**, and etc.

[9] Lists of the elements by name, by symbol, and by atomic number are also available. In addition, several **isotopes** of an element may exist.

(8-3) 回答描述中涉及的概念。

[1] In mathematics, a _____ can mean either an element of the set {1, 2, 3, ...} (i.e. the positive integers) or an element of the set {0, 1, 2, 3, ...} (i.e. the non-negative integers). The former is generally used in number theory, while the latter is preferred in set theory and computer science.

[2] Natural numbers have two main purposes: They can be used for counting ("there are 3 apples on the table"), and they can be used for ordering ("this is the 3rd largest city in the country").

[3] The _____ consist of the positive natural numbers {1, 2, 3, ...}, their negatives

$\{-1, -2, -3, \ldots\}$ and the number zero. A formal way of stating this: The integers are the only integral domain whose positive elements are well-ordered, which has order preserved under addition. Like the natural numbers, the integers form a countable infinite set.

[4] In mathematics, a _____ (commonly called a fraction) is a ratio or quotient of two integers, usually written as the vulgar fraction a/b, where b is not zero.

[5] In mathematics, an _____ is any real number that is not a rational number, i. e., that cannot be expressed by a quotient of two integers, i. e., it cannot be written as a fraction in which the numerator and denominator are integers.

(8-4) 用下面方框内单词的适当形式填空。

chemical	conservation	electrical	energy	food
mechanical	plants	radiant	thermal	transform

Energy transformation is changing ____[1]____ from one form to another. Energy has to ____[2]____ to make things happen. Riding a bicycle shows many types of energy transformations. If you are going to ride a bike, your body needs energy that it will get from eating ____[3]____. The fruits and vegetables that we eat come from ____[4]____. Plants use ____[5]____ energy to photosynthesize to produce food that contains ____[6]____ energy. When you eat the food, you convert the chemical energy into ____[7]____ energy as your muscles contract for movement. Your body also changes some of the chemical energy into ____[8]____ energy which causes your body temperature to rise.

(8-5) 阅读并用自己的话复述短文，可以借助黑板、多媒体等工具，培养科技英语阅读和口头表达能力。

The night is not what it was. Once, the Earth was cast perpetually half in shadow. Man and beast slept beneath inky skies, dotted with glittering stars. Then came fire, the candle, and the light bulb, gradually drawing back the curtain of darkness and giving us unprecedented control over our lives.

But a brighter world, which is becoming increasingly clear, has its drawbacks. A study released last month finding that breast cancer is nearly twice as common in brightly lit communities as in dark ones only added to a growing body of evidence that artificial light threatens not just stargazing but also public health, wildlife, and possibly even safety.

Those findings are all the more troubling considering that an estimated 30 percent of outdoor lighting—plus even some indoor lighting—is wasted. Ill-conceived, ineffective, and inefficient lighting costs the nation about $ 10.4 billion a year, according to Bob Gent of the International Dark-Sky Association, a nonprofit that aims to curtail light pollution, and it generates 38 million tons of carbon dioxide a year.

Motivated by such trends, more than two dozen cities worldwide will go dim on March 29 in an hourlong demonstration. At 8 p. m. local time, Atlanta's and Chicago's tallest towers, the Phoenix Suns' arena, and San Francisco's Golden Gate Bridge will join many other sites in turning off their lights. According to the World Wildlife Fund, which is organizing the event, an estimated

2.2 million Australians switched off their lights or took other action during "Earth Hour" last year in Sydney, briefly reducing that city's energy use by more than 10 percent.

A number of groups are trying to measure light pollution and assess its detrimental effects on the environment in the hope that people will reduce their own contribution to the problem. Last week, as part of an annual program called Globe at Night, thousands of students and amateur scientists stared up at the constellation Orion from locations across the country and reported how many of its stars they could see. No data are yet available, but in dark, rural areas, says Gent, about 2,000 stars are typically visible at night, compared with "maybe five" in a bright city square—and about 5,000 in centuries past. "One of the goals," says Steve Pompea of the National Optical Astronomy Observatory in Tucson, Ariz., "is to identify urban oases—places in our cities that are dark enough to see the sky."

People who are working while others are stargazing may face the greatest risks. Hormonal disturbances triggered by nighttime exposure to white or bluish light can disrupt circadian rhythms and fuel the growth of tumors, experiments show. Two decades of research indicate that women who work night shifts have unusually high rates of breast cancer, and some data suggest a parallel effect on male workers' prostate cancer rates. Last December, a unit of the World Health Organization deemed shift work a probable human carcinogen.

Yet light and cancer may be even more fundamentally linked. In last month's study, a team that included Richard Stevens, the University of Connecticut Health Center epidemiologist who first proposed the connection, compared satellite images of Israel at night with maps showing where cancers are most common. Its analysis suggests that 73 percent more breast cancers occur in the country's brightest communities than in its darkest.

参考文献

[1] *Nature* news 2013.

[2] Ben Harder, Light Pollution: Night Skies, Dark No More, US News.

Lesson 9

内容 9.1 物理光学 Physical Optics
9.2 生词表 New Words
9.3 课文注释 Text Annotation
9.4 扩展阅读 Extended Reading: Contact Lens
9.5 常用用法 Usages and Expressions
希腊字母 Greek Alphabet
9.6 同义词辨析 Synonyms
9.7 练习题 Exercise

9.1 物理光学 Physical Optics

Soapy water is colorless, but when blown into bubbles it shows vibrant colors. How does the thickness of the bubble walls determine the particular colors that appear?

[1] **An ugly black oil spot on the pavement can become a thing of beauty after a rain, when the oil reflects a rainbow of colors.** Multicolored reflections can also be seen from the surfaces of soap bubbles and compact discs. These familiar sights give us a hint that there are aspects of light that we haven't yet explored.

In our discussion of lenses, mirrors, and optical instruments we used the model of geometric optics, in which we represent light as rays, straight lines that are bent at a reflecting or refracting surface. But many aspects of the behavior of light can't be understood on the basis of rays. [2] **We have already learned that light is fundamentally a wave, and in some situations we have to consider its wave properties explicitly.** If two or more light waves of the same frequency overlap at a point, the total effect depends on the phases of the waves as well as their amplitudes. The resulting patterns of light are a result of the wave nature of light and cannot be understood on the basis of rays. Optical effects that depend on the wave nature of light are grouped under the heading physical optics.

We'll look at interference phenomena that occur when two waves combine. The colors seen in oil films and soap bubbles are a result of interference between light reflected from the front and back surfaces of a thin film of oil or soap solution.

The principle of superposition states: When two or more waves overlap, the resultant dis-

placement at any point and at any instant is found by adding the instantaneous displacements that would be produced at the point by the individual waves if each were present alone. (In some special physical situations, such as electromagnetic waves propagating in a crystal, this principle may not apply. A discussion of these is beyond our scope.) We use the term "displacement" in a general sense. With waves on the surface of a liquid, we mean the actual displacement of the surface above or below its normal level. With sound waves, the term refers to the excess or deficiency of pressure. For electromagnetic waves, we usually mean a specific component of electric or magnetic field.

Interference effects are most easily seen when we combine sinusoidal waves with a single frequency f and wavelength λ. Fig. 9 – 1 shows a "snapshot" or "freeze-frame" of a single source S_1 of sinusoidal waves and some of the wave fronts produced by this source. The figure shows only the wave fronts corresponding to wave crests, so the spacing between successive wave fronts is one wavelength. The material surrounding S_1 is uniform, so the wave speed is the same in all directions, and there is no refraction (and hence no bending of the wave fronts). If the waves are two-dimensional, like waves on the surface of a liquid, the circles in Fig. 9 – 1 represent circular wave fronts; if the waves propagate in three dimensions, the circles represent spherical wave fronts spreading away from S_1.



Fig. 9 – 1 A "snapshot" of sinusoidal waves of frequency f and wavelength λ spreading out from source S_1 in all directions. Wave fronts: crests of the wave (frequency f) separated by one wavelength λ, the ware speed $v = f\lambda$.

In optics, sinusoidal waves are characteristic of monochromatic light (light of a single color). While it's fairly easy to make water waves or sound waves of a single frequency, common sources of light do not emit monochromatic (single frequency) light. For example, incandescent light bulbs and flames emit a continuous distribution of wavelengths. However, there are several ways to produce approximately monochromatic light. For example, some filters block all but a very narrow range of wavelengths. By far the most nearly monochromatic source that is available at present is the laser. An example is the helium-neon laser, which emits red light at 632.8 nm with a wavelength range of the order of ±0.000001 nm.

Two identical sources of monochromatic waves, S_1, and S_2, are shown in Fig. 9 – 2(a). The two sources produce waves of the same amplitude and the same wavelength λ. In addition, the two sources are permanently in phase; they vibrate in unison. They might be two synchronized agita-

tors in a ripple tank, two loudspeakers driven by the same amplifier, two radio antennas powered by the same transmitter, or two small holes or slits in an opaque screen, illuminated by the same monochromatic light source. We will see that if there were not a constant phase relationship between the two sources, the phenomena we are about to discuss would not occur. Two monochromatic sources of the same frequency and with any definite, constant phase relationship ([3] **not necessarily** in phase) are said to be coherent. We also use the term coherent waves (or, for light waves, coherent light) to refer to the waves emitted by two such sources.

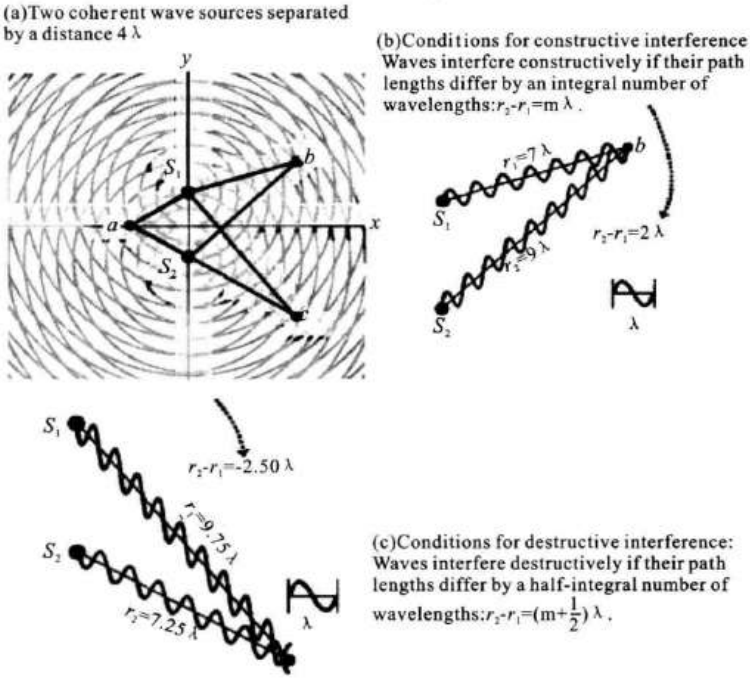

Fig. 9 – 2 (a) A "snapshot" of sinusoidal waves spreading out from two coherent sources S_1, and S_2. Constructive interference occurs at point a (equidistant from the two sources) and (b) at point b. (c) Destructive interference occurs at point c.

If the waves emitted by the two coherent sources are transverse, like electromagnetic waves, then we will also assume that the wave disturbances produced by both sources have the same polarization (that is, they lie along the same line). For example, the sources S_1, and S_2 in could be two radio antennas in the form of long rods oriented parallel to the z-axis (perpendicular to the plane of the figure); at any point in the xy-plane the waves produced by both antennas have $\vec{E}$ fields with only a z-component. Then we need only a single scalar function to describe each wave; this makes the analysis much easier.

We position the two sources of equal amplitude, equal wavelength, and (if the waves are transverse) the same polarization along the y-axis in Fig. 9 – 2(a), equidistant from the origin. Consider a point a on the x-axis. From symmetry the two distances from S_1 to a and from S_2 to a are equal; waves from the two sources thus require equal time to travel to a. Hence waves that leave S_1, and S_2 in phase arrive at a in phase. The two waves add, and the total amplitude at a is

twice the amplitude of each individual wave. This is true for any point on the x-axis.

Similarly, the distance from S_2 to point b is exactly two wavelengths greater than the distance from S_1 to b. A wave crest from S_1, arrives at b exactly two cycles earlier than a crest emitted at the same time from S_2, and again the two waves arrive in phase. As at point a, the total amplitude is the sum of the amplitudes of the waves from S_1, and S_2.

In general, when waves from two or more sources arrive at a point in phase, the amplitude of the resultant wave is the sum of the amplitudes of the individual waves; the individual waves reinforce each other. This is called constructive interference (Fig. 9 – 2(b)). Let the distance from S_1, to any point P be r_1 and let the distance from S_2 to P be r_2. For constructive interference to occur at P, the path difference $r_2 - r_1$ for the two sources must be an integral multiple of the wavelength λ:

$$r_2 - r_1 = m\lambda\,(m = 0, \pm 1, \pm 2, \pm 3, \ldots)\,(\text{constructive interference, sources in phase}) \quad (9-1)$$

In Fig. 9 – 2(a), points a and b satisfy Eq. (9 – 1) with $m = 0$ and $m = +2$, respectively.

Something different occurs at point c in Fig. 9 – 2(a). At this point, the path difference $r_2 - r_1 = -2.50\,\lambda$, which is a half-integral number of wavelengths. Waves from the two sources arrive at point c exactly a half-cycle out of phase. A crest of one wave arrives at the same time as a crest in the opposite direction (a "trough") of the other wave (Fig. 9 – 2(c)). The resultant amplitude is the difference between the two individual amplitudes. If the individual amplitudes are equal, then the total amplitude is zero! This cancellation or partial cancellation of the individual waves is called destructive interference. The condition for destructive interference in the situation shown in Fig. 9 – 2(a) is

$$r_2 - r_1 = \left(m + \frac{1}{2}\right)\lambda\,(m = 0, \pm 1, \pm 2, \pm 3, \ldots)\,(\text{destructive interference, sources in phase}) \quad (9-2)$$

The path difference at point c in Fig. 9 – 2(a) satisfies Eq. (9 – 2) with m = – 3.

The interference patterns in Fig. 9 – 2(a) are not [4]**standing waves**, though they have some similarities to the standing-wave patterns. In a standing wave, the interference is between two waves propagating in opposite directions; a stationary pattern of antinodes and nodes appears, and there is no net energy flow in either direction (the energy in the wave is left "standing"). In the situation shown in Fig. 9 – 2(a), there is likewise a stationary pattern of antinodal and nodal curves, but there is a net flow of energy outward from the two sources. From the energy standpoint, all that interference does is to "channel" the energy flow so that it is greatest along the antinodal curves and least along the nodal curves.

9.2 生词表 New Words

vibrant *adj.* (颜色)鲜艳的
sinusoidal *adj.* 正弦的,正弦曲线的
snapshot *n.* 快照
helium *n.* 氦(2 号元素,符号为 He)

neon *n.* 氖(10 号元素,符号 Ne)
in unison 同时,一起
agitator *n.* 搅拌器
transmitter *n.* 发射机,发报机
not necessarily 未必,不一定
coherent *adj.* 相干的
transverse *adj.* 横向的
polarization *n.* 极化

9.3 课文注释 Text Annotation

【1】An ugly black oil spot on the pavement can become a thing of beauty after a rain, when the oil reflects a rainbow of colors.

人行道上肮脏的油污也可以在雨后折射出绚丽的彩虹。

spot:*n.* 地点,场所;斑点,污点;[股票]现货;职位,职务。*v.* 弄上污渍,弄上斑点;污辱,玷污;认出,发现;散步

►1. enemy troops spotted 发现敌军

►2. bird spotting scope 观鸟镜

►3. blind spot (视网膜上的)盲点;(视力以外的)盲区



It can be very dangerous if there's a vehicle in your blind spot.

如果车辆出现在盲区会非常危险。

I am quite good at English, but I have a bit of a blind spot where spelling is concerned.

我对英语颇为在行,但拼写算是一个小小的盲区。

►4. penalty spot 罚球点

【2】We have already learned that light is fundamentally a wave, and in some situations we have to consider its wave properties explicitly.

我们已经了解到光本质上是一种波,在某些情况下必须明确地考虑其波动特性。

explicitly: *adv.* 明白地,明确地。与之相反的是 implicitly, *adv.* 含蓄地;暗示地(并非直接表达)。一般情况下很好区分这两个单词。但有一种情况需要注意,implicit 还表示"完全的,无疑义的",与 explicitly 有点相似。

All her life she had implicit faith in socialism.

她一生完全信仰社会主义。(这里不能理解成她一生含蓄地信仰社会主义)

【3】not necessarily

necessary:*adj.* 必要的;必需的;必然的。但其副词的用法比较固定,一般都用于否定,意思是"不一定"。

e. g. :Something is cheap doesn't necessarily mean it's of low quality.

价格便宜不一定质量差。

【4】standing waves

standing wave:驻波,频率和振幅均相同、振动方向一致、传播方向相反的两列波叠加后形成的波。波在介质中传播时其波形不断向前推进,故称行波(travelling wave)。

9.4 扩展阅读 Extended Reading

Contact Lens

wikipedia

People choose to wear contact lenses(隐形眼镜) *for many reasons. Aesthetics and cosmetics are often motivating factors for people who would like to avoid wearing glasses or would like to change the appearance of their eyes. Other people wear contacts for more visual reasons. When compared with spectacles, contact lenses typically provide better peripheral vision, and do not collect moisture such as rain, snow, condensation, or sweat. This makes them ideal for sports and other outdoor activities. Additionally, there are conditions such as keratoconus and aniseikonia that are typically corrected better by contacts than by glasses.*

A spherical contact lens bends light evenly in every direction (horizontally, vertically, etc.). They are typically used to correct myopia(近视) *and hyperopia*(远视). *A toric contact lens has a different focusing power horizontally than it does vertically, and as a result can correct for astigmatism*(散光). *Some spherical rigid lenses can also correct for astigmatism. Because a toric lens must have the proper orientation to correct for a person's astigmatism, a toric contact lens must have additional design characteristics to prevent the lens from rotating out of the ideal alignment. This can be done by weighting the bottom of the lens or by using other physical characteristics to rotate the lens back into position. Some toric contact lenses have marks or etchings that can assist the eye doctor in fitting the lens. The first disposable toric lenses were introduced in* 2000 *by Vistakon.*



Corrective contact lenses are designed to improve vision, most commonly by correcting refractive error. This is done by directly focusing the light so that it enters the eye with the proper power for clear vision. Recently, there has been renewed interest in orthokeratology(角膜矫正术), *the correction of myopia by deliberate overnight flattening of the corneal epithelium* (角膜上皮), *leaving the eye without a refractive error during the day.*

A cosmetic contact lens is designed to change the appearance of the eye. These lenses may also correct refractive error. Although many brands of contact lenses are lightly tinted to make them easier to handle, cosmetic lenses worn to change the color of the eye are far less common, accounting for only 3% *of contact lens fits in* 2004.

Soft lenses are often used in the treatment and management of non-refractive disorders of the eye. A bandage contact lens protects an injured or diseased cornea from the constant rubbing of blinking eyelids thereby allowing it to heal. They are used in the treatment of conditions including bullous keratopathy, dry eyes, corneal abrasions and erosion, keratitis, corneal edema, descemetocele, corneal ectasis, Mooren's ulcer, anterior corneal dystrophy, and neurotrophic keratoconjunctivitis(角膜结膜炎). *Contact lenses that deliver drugs to the eye have also been developed.*

Complications(并发症) *due to contact lens wear affect roughly* 5% *of contact lens wearers each year. Most complications arise when lenses are worn differently than prescribed* (*improper wear schedule or lens replacement*). *Sleeping in lenses not designed or approved for extended wear is a common cause of complications. Many people go too long before replacing their lenses, wearing lenses designed for* 1, 14, *or* 30 *days of wear for multiple months or years. While this does save on the cost of lenses, it risks permanent damage to the eye and loss of sight.*

The way contact lenses interact with the natural tear layer is a major factor in determining lens comfort and visual clarity. People that suffer from dry eyes are particularly vulnerable to mild discomfort and episodes of brief blurry vision.

9.5 常用用法 Usages and Expressions

希腊字母 Greek Alphabet

编 号	希腊字母(大写,小写)	英语拼写	读 音	中文音译	常用用法
1	A,α	alpha	['ælfə]	阿尔法	小写:角加速度;alpha 粒子;alpha 衰变
2	B,β	beta	UK:['bitə]] US:['beitə]	贝塔	小写:beta 粒子;beta 衰变;狭义相对论中速率与光速的比值
3	Γ,γ	Gamma	['gæmə]	伽马	电导系数
4	Δ,σ	delta	['deltə]	德尔塔	变化;密度;屈光度
5	E,ε	epsilon	['epsln]	埃普西隆	介电常数
6	Z,ζ	zeta	['zitə]	截塔	黎曼 zeta 函数
7	H,η	eta	['i tə]	伊塔	卡诺循环的效率 机械效率;η^2 用作偏回归系数;配基前标示 ηn 表示其哈普托数为 n;粒子的赝快度
8	Θ,θ	theta	['θitə]['θeitə]	西塔	小写:平面的角 大写:世界地球日的标志是白色背景上绿色的 Θ
9	I,ι	Iota	[a'tə]	约塔	/
10	K,κ	kappa	['kæpə]	卡帕	振动的扭转系数;爱因斯坦引力常数
11	Λ,λ	lambda	['læmdə]	兰布达	波长;衰变常数;线性代数特征值
12	M,μ	mu	[mju]	缪	磁导率;微(千分之一);粒子物理学上,缪子的符号;摩擦系数

Cont.

编　号	希腊字母（大写，小写）	英语拼写	读　音	中文音译	常用用法
13	N，ν	nu	[nju]	纽	大写：牛顿（单位）。请注意牛顿的单位是希腊字母，而不是英文字母 N，写法几乎相同，但读音不一样 小写：波的频率；三种中微子
14	Ξ，ξ	xi	[za] or [sa]	克希、克西	（读音参考了 New Oxford American Dictionary，2nd Edition，可以看出中文音译其实是不准确的，不利于国际交流） 大写：Ξ 重子 小写：随机变量
15	O，o	Omicron	[ˈɔməkrn]	奥密克戎	由于与英文字母 O 相似，不做符号用途
16	Π，π	pi	[pa]	派	大写：连乘算子 小写：圆周率；介子；物价指数；利润
17	P，ρ	rho	[rə]	柔、若	小写：密度；电阻率；总体的相关关系
18	Σ，σ	sigma	[ˈsgmə]	西格马	大写：总和；Σ 重子 小写：σ 键；标准差；应力；斯特藩 - 玻尔兹曼常数
19	T，τ	tau	[t]	套	小写：力矩；透明度；子（轻子的一种）
20	Y	υ	[upsilon][jupsln]	宇普西龙	/
21	Φ，φ	phi	[fa]	佛爱、斐	大写：磁通量；1 表示单相电，3 表示三相电 小写：波动的相；相位；电势；黄金分割；复数的轭；欧拉函数；苯基的简写 注意北欧的拉丁字母 φ 表示直径或数学上的空集，与希腊字母 φ 很相似
22	X，χ	chi	[ka]	西、喜	（中文音译误差较大） 小写：卡方分布，电感；色数图像；欧拉示性数
23	Ψ，ψ	psi	[psa] [sa]	普西	磁链；稀有核苷酸伪尿苷酸；蛋白质的二面角的骨干；确定流流体力学函数曲线的流速始终相切；薛定谔方程和整个量子力学，代表波的函数；ψ 介子；海王星
24	Ω，ω	omega	[əˈmgə]	欧米伽	大写：电阻的单位（读成欧姆 ohm） 小写：角速度；溶质质量分数；1 的立方虚根

9.6 同义词辨析 Synonyms

target, mark, point, aim, destination, ambition, objective, purpose, intention, plan, idea, goal, object, end

These are all words for something that you are trying to achieve.

以上各词均指“目标;目的”。

◆ target a result that you try to achieve 试图达到的目标、指标

eg: the target of a one-third reduction in road accidents

交通事故减少三分之一的目标

Higher degrees are a target for foreign students.

获得更高学位是外国学生的目标。

◆ mark a target 目标;靶子

e. g. : Although it contains a certain amount of truth, this theory ultimately misses the mark.

这个理论虽然有一定的真实性,但是从根本上说还是没有达到目的。

◆ point the purpose or aim of sth. 意图;目的;理由

e. g. : I suppose we could save one or two of the trees, but what's the point?

我想我们可以拯救一两棵树,不过那有什么意义呢?

What's the point of this meeting anyway?

这次会议的目的到底是什么?

【习惯用法】

point of view 观点

off the point 说题外话

◆ aim the purpose of doing sth. ; what sb. is trying to achieve 做某事的目的、目标

e. g. : The aim of the research is to find new food sources.

此项研究的目的是寻找新的食物来源。

The main aim of the course is to improve your writing.

这一课程的主要目的是提高写作能力。

◆ destination a place to which sb. /sth. is going or being sent 目的地,终点

e. g. : Maui is a popular tourist destination.

毛伊岛是一个受欢迎的旅游目的地。

Allow plenty of time to get to your destination.

允许你有足够的时间到达目的地。

◆ ambition sth. that you want to do or achieve very much 目标,夙愿

e. g. : She fulfilled her ambition to run the 10,000 meters in less than 30 minutes.

她实现了自己的夙愿,1 万米跑用时不到 30 分钟。

He always had this burning ambition (= very strong desire) to start his own business.
他总是雄心勃勃想自己开公司。

【习惯用法】

an ambition for 对……的欲望

a high ambition 远大抱负

◆ objective (rather formal) something that you are trying to achieve 目标

e. g. :He vowed to achieve certain objectives before the end of his presidency.
他发誓要在总统任期结束之前达到一定的目标。

The degree program has two main objectives.
学位课程有两个主要目标。

【习惯用法】

be objective about 对……持客观态度

◆ purpose the intention, aim or function of sth. ; the thing that is supposed to achieve 意图,目的;用途

e. g. :The purpose of this meeting is to elect a new chairman.
此次会议的目的是选举一个新主席。

What is the purpose of your visit?
你此行的目的是什么?

【习惯用法】

for the purpose of 为了……的目的

with the purpose of 为了……的目的

on purpose 有目的的

to the purpose 有目的,切合需要的

◆ intention what you intend or plan to do; your aim 打算,计划,意图,目的

e. g. :I have no intention of retiring just yet.
我还没有打算退休。

They went into town with the intention of visiting the library.
他们进入城市的目的是参观图书馆。

◆ plan something that you intend to do or achieve 计划;打算

e. g. :His plan is to get a degree in economics and then work abroad for a year.
他的计划是获得经济学学位,然后在国外工作一年。

We don't have any plans for the weekend—why don't you come over?
我们周末没有计划——你为什么不过来?

【习惯用法】

plan for 打算,计划

plan out 做出计划

plan on (doing) sth. 打算做某事

◆ idea the aim or purpose of sth. 目的,意图

e. g. :The idea behind the outing is to encourage employees to get to know each other.
郊游背后的目的是鼓励员工去了解彼此。
They wanted Mike to go to law school, but he had other ideas.
他们希望迈克去法学院,但他有其他的想法。

【习惯用法】
have no idea of 没有……观念
have an idea that 认为……
the idea of sth. ……的目标

◆ goal something that you hope to achieve 目标,目的

e. g. :His ultimate goal was to set up his own business.
他的最终目标是建立自己的业务。
They achieved their goal of increasing sales by five percent.
他们实现了销量增长百分之五的目标。

◆ object the purpose of sth. ; sth. that you plan to achieve 目的,目标,宗旨

e. g. :The object of the game is to improve children's math skills.
比赛的目的是提高孩子们的数学能力。
My object was to explain the decision simply.
我的目的是简单地解释决定。

◆ end something that you plan to achieve 目的,目标

e. g. :She'll do anything to achieve her own ends.
她会做任何事来达到自己的目的。
40% of all research is undertaken for military ends.
40%的研究进行用于军事目的。

【习惯用法】
end in 以……为结果

9.7 练习题 Exercise

(9-1)完形填空,然后把短文译成汉语。

From the original measurements of G. von Békésy until a few years ago, the basilar membrane was considered to undergo simple passive linear vibration. Recent measurements have completely altered this notion. It is now known that the BM is highly nonlinear and very sharply tuned. Indeed, BM can now account for most of the properties of the eighth nerve response to sound. The non ____[1]____ can be approximated by a hyperbolic function and appears to be part of an active process in the outer hair cell. At the characteristic frequency, CAP threshold (10 dB SPL) corresponds to 0.3 nm motion and the nonlinearity shows half saturation at 10 nm. The

sigmoid shape of the full range BM input-output curve is ____[2]____ to the combination of a less sensitive linear passive component with the added sensitivity of the active nonlinear function. A hyperbolic input-output function is also ____[3]____ in the cochlear microphonics, and at low frequencies the half saturation value again corresponds to 10 nm BM displacement. With induced threshold loss (e. g. noise trauma) the nonlinearity disappears from the BM, but is still present in the CM. This suggests that the pathology is in the active mechanical feedback ____[4]____, rather than in the receptor system. It appears that BM mechanics at low amplitudes near the resonant frequency is controlled by a nonlinear mechano-electrical transducer followed by a vulnerable, linear, active mechanism feeding back ____[5]____ positive phase onto BM vibration. (Hearing Research 2013)

[1]	A. curvity	B. linearity	C. linear	D. straight
[2]	A. because	B. result	C. according	D. due
[3]	A. existing	B. present	C. exist	D. presented
[4]	A. process	B. procedure	C. course	D. track
[5]	A. out	B. out of	C. inside	D. in

(9-2)完形填空。

The nature of light is not wholly known, but it is generally believed to be matter, as in its ____[1]____, it obeys the laws ____[2]____ matter. So closely is it connected with heat and electricity that there can be ____[3]____ doubt of their all being ____[4]____ different modifications of the same substance. The effects of light ____[5]____ other bodies and how light is affected by them ____[6]____ some important principles.

Rays of light are reflected from one surface to ____[7]____. It is by this reflection of light that objects are ____[8]____ visible. However, unless light falls directly ____[9]____ the eye they are invisible, and are not ____[10]____ felt until after a certain series of operations upon the various coverings of the eye. Smooth and ____[11]____ surfaces reflect light most powerfully, and send to the eye the images of the objects ____[12]____ the light proceeded before reflection. Glass would be of no use to us as a mirror, were it not first ____[13]____ on one side, interrupting the rays in their ____[14]____ from the glass into the air. The reason why trees, rocks and animals are not all mirrors is that their surfaces are ____[15]____, and rays of light reflected from such a surface are ____[16]____ in every direction. Stand before a mirror and your image is formed and appears to be as far ____[17]____ the glass as you are before it. Rays of light ____[18]____ reflected at the same ____[19]____ at which they fall upon a mirror, two persons can stand in ____[20]____ position that each can see the image of the other without seeing his own.

[1]	A. actions	B. moves	C. motions	D. motives
[2]	A. regulating	B. organizing	C. supervising	D. modifying
[3]	A. some	B. great	C. few	D. little
[4]	A. but	B. still	C. hardly	D. narrowly
[5]	A. for	B. in	C. with	D. on
[6]	A. change	B. involve	C. depend	D. use

[7] A. other	B. the others	C. the other	D. another
[8] A. used	B. served	C. made	D. showed
[9] A. upon	B. in	C. off	D. down
[10] A. rationally	B. sensibly	C. consciously	D. reasonably
[11] A. shiny	B. clean	C. polished	D. flat
[12] A. that	B. when	C. with which	D. from which
[13] A. coated	B. painted	C. drawn	D. overlapped
[14] A. trail	B. lane	C. path	D. passage
[15] A. unequal	B. uneven	C. irregular	D. unstable
[16] A. diffused	B. spread	C. scattered	D. separated
[17] A. back	B. in front of	C. behind	D. beside
[18] A. /	B. are	C. were	D. be
[19] A. way	B. angle	C. point	D. form
[20] A. such	B. quite a	C. so much a	D. /

(9-3). 用下面方框内单词的适当形式填空。

chemical	created	electrical	light
mechanical	radiant	sound	transformations

Energy ____[1]____ are occurring everywhere around you. The Law of Conservation of Energy states that energy can never be ____[2]____ or destroyed; it can only be transformed. The items that we use every day to make our lives easier also transform energy. When you wake up in the morning for school and turn the lights on, it changes ____[3]____ energy into light energy. When your mom puts gas in the car to take you to school, the car is transforming chemical energy into ____[4]____ energy. When you turn on the car radio, it is converting electrical energy to ____[5]____ energy as you hear your favorite song being played. At the school, you get out of the car and walk indoors. Your breakfast has provided you with the ____[6]____ energy needed to get your body moving with mechanical energy so you can have a great day at school.

(9-4)选词填空。

colors, allow, blocked, formed, radiant, reflective, bend

[1] Light is a form of _____ energy that can be felt.

[2] Light is made up of _____ but travels in a wavelike motion.

[3] Although we cannot _____ light energy, we can feel its effects.

[4] Objects that are _____ block light from passing through them.

[5] Objects that are _____ allow light waves to bounce back.

[6] Materials that _____ light waves are called refractive objects.

[7] When an object reflects all the _____ of light the object appears white in color.

[8] Translucent objects _____ some of the light energy to pass through them.

[9] When light is _____ by an object a region of shadow forms.

[10] Rainbow is _____ when the light is separated into the band of colors.

(9-5)选词填空。

sublimation	melting	volume	density	mass	matter
solidification	refraction	reflect	concave lens	convex lens	diverging

[1]A lens cannot _____ the light rays falling on it.

[2]A _____ always forms images that are upright.

[3]A concave lens is also called _____ lens.

[4]A _____ is thicker in the middle than at the edges.

[5]All the types of lenses show _____ of light.

[6]The amount of matter in an object is called _____.

[7]The amount of space in an object takes up is called _____.

[8]Anything that has mass and volume is called _____ .

[9]A solid changing to a liquid is called _____.

[10]A solid changing directly to a gas is called _____.

[11]A liquid changing to a solid is called _____.

[12]The amount of mass in a certain volume is called _____.

(9-6)判断对错。

[1]____ Signals from the retina are sent to the brain in the form of light rays.

[2]____ The pupil of an eye becomes smaller in dim light.

[3]____ A nerve that sends signals to the brain is called optic nerve.

[4]____ The image appears on the retina by the convex lens is upright.

[5]____ In far-sightedness you can look more clear than far away.

[6]____ The shape of solid is fixed but volume is not fixed.

[7]____ The particles of a gas cannot move freely in the container.

[8]____ The particles of a liquid move about in the liquid.

[9]____ The particles of a solid can vibrate only as they lie in the same place.

[10]____ A plane mirror is rough irregularly shaped.

[11]____ The term diverging means to spread apart the light rays when falling on a mirror.

[12]____ The focal point is a point where the light rays diverge.

[13]____ All the types of mirror reflect light, so they are called diverging mirrors.

[14]____ The convex mirror is curved outward.

[15]____ Microwaves have higher frequency than visible light.

[16]____ Gamma rays can be used to kill cancer cells.

[17]____ The frequency of the electromagnetic radiation increases as the wavelength increases.

[18]____ Microwaves are a type of ultraviolet rays.

[19]____ Both X-rays and infrared waves have higher frequency than ultraviolet rays.

(9-7) 阅读并用自己的话复述短文,可以借助黑板、多媒体等工具,培养科技英语阅读和口头表达能力。

The northern lights, one of several astronomical phenomena called polar lights (aurora pola-

ris), are shafts or curtains of colored light visible on occasion in the night sky.

Polar lights (aurora polaris) are a natural phenomenon found in both the northern and southern hemispheres that can be truly inspiring. Northern lights are also called by their scientific name, aurora borealis, and southern lights are called aurora australis.

Sten Odenwald, author of *The 23rd Cycle: Learning to Live with a Stormy Star* (New York, Columbia University Press, c2001), provides insight to how northern lights are formed:

The origin of the aurora begins on the surface of the sun when solar activity ejects a cloud of gas. Scientists call this a coronal mass ejection (CME). If one of these reaches earth, taking about 2 to 3 days, it collides with the Earth's magnetic field. This field is invisible, and if you could see its shape, it would make Earth look like a comet with a long magnetic "tail" stretching a million miles behind Earth in the opposite direction of the sun.

When a coronal mass ejection collides with the magnetic field, it causes complex changes to happen to the magnetic tail region. These changes generate currents of charged particles, which then flow along lines of magnetic force into the Polar Regions. These particles are boosted in energy in Earth's upper atmosphere, and when they collide with oxygen and nitrogen atoms, they produce dazzling auroral light.

Odenwald further tells us "Aurora are beautiful, but the invisible flows of particles and magnetism that go on at the same time can damage our electrical power grid and satellites operating in space. This is why scientists are so keen to understand the physics of aurora and solar storms, so we can predict when our technologies may be affected."

(9-8)翻译。

Light therapy or phototherapy consists of exposure to daylight or to specific wavelengths of light using lasers, light-emitting diodes, fluorescent lamps, dichroic lamps or very bright, full-spectrum light—by a so-called light box.

The light is administered for a prescribed amount of time and, in some cases, at a specific time of day.

Light therapy directed at the skin is used to treat acne vulgaris and neonatal jaundice.

Light therapy which strikes the retina of the eyes is used to treat circadian rhythm disorders such as delayed sleep phase syndrome and can also be used to treat seasonal affective disorder, with some support for its use also with non-seasonal psychiatric disorders.

参考文献

[1]Wikipedia: contact lens, light therapy.

[2]The Library of Congress, What are the northern lights?

第四章 电 学

Lesson 10

内容 10.1 电路中的能量和功率 Energy and Power in Electric Circuits
10.2 生词表 New Words
10.3 课文注释 Text Annotation
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10.1 电路中的能量和功率
Energy and Power in Electric Circuits

[1]**Let's now look at some energy and power relations in electric circuits.** The box in Fig. 10 – 1 represents a circuit element with potential difference $V_a - V_b = V_{ab}$ between its terminals and current I passing through it in the direction from a toward b. This element might be a resistor, a battery, or something else; the details don't matter. As charge passes through the circuit element, the electric field does work on the charge. In a source of emf, additional work is done by the force $\vec{F}$n.

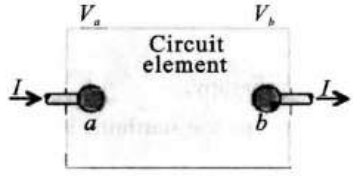


Fig. 10 – 1 The power input P to the portion of the circuit between a and b is $P = V_{ab} I$.

The total work done on a charge q passing through the circuit element is equal to the product of q and the potential difference V_{ab} (work per unit charge). When V_{ab} is positive, the electric

force (and possibly a non-electric force) does a positive amount of work qV_{ab} on the charge as it "falls" from potential V_a to lower potential V_b. If the current is I, then in a time interval dt, an amount of charge $dQ = Idt$ passes through. The work dW done on this charge is

$$dW = V_{ab}\, dQ = V_{ab}\, I\, dtj.$$

This work represents electrical energy transferred into this circuit element. This time rate of energy is power, denoted by P.[2] **Dividing the above equation by dt, we obtain the rate at which the rest of the circuit delivers electrical energy to this circuit element:**

$$\frac{dW}{dt} = P = V_{ab}\, I \text{ (rate of delivering electrical energy to a circuit element).} \qquad (10-1)$$

It may happen that the potential at b is higher than that at a; then V_{ab} is negative, and there is a net transfer of energy out of the circuit element. The element is then acting as a source, delivering electrical energy into the circuit in which it is connected.[3] **This is the usual situation for a battery, which converts chemical energy into electrical energy and delivers it to the external circuit.** Similarly, a generator converts mechanical energy to electrical energy and delivers it to the external circuit. Thus Eq. (10 – 1) can represent either the rate at which energy is delivered to a circuit element or the time rate at which energy is extracted from that element.

The unit of V_{ab} is one volt, or one joule per coulomb, and the unit of I is one ampere, or one coulomb per second. Hence the unit of $V_{ab}\, I$ is one watt, as it should be:

$$(1\ \text{J/C})\ (1\ \text{C/s}) = 1\text{J/s} = 1\text{W}.$$

Let's consider a few special cases.

Pure Resistance

If the circuit element in Fig. 10 – 1 is a resistor, the potential difference is $V_{ab} = IR$. From Eq. (10 – 1) the electrical power delivered to the resistor by the circuit is

$$P = V_{ab}I = I^2R = \frac{V_{ab}^2}{R} \text{ (power delivered to a resistor).} \qquad (10-2)$$

In this case the potential at a (where the current enters the resistor) is always higher than that at b (where the current exits). Current enters the higher-potential terminal of the device, and Eq. (10 – 1) represents the rate of transfer of electric potential energy into the circuit element.

What becomes of this energy? The moving charges collide with atoms in the resistor and transfer some of their energy to these atoms, increasing the internal energy of the material. Either the temperature of the resistor increases or there is a flow of heat out of it, or both. In any of these cases we say that energy is dissipated in the resistor at a rate $I^2 R$. Every resistor has a power rating, the maximum power the device can dissipate without becoming overheated and damaged. In practical applications the power rating of a resistor is often just as important a characteristic as its resistance value. Of course, some devices, such as electric heaters, are designed to get hot and transfer heat to their surroundings. But if the power rating is exceeded, even such a device may

melt or even explode.

Power Output of a Source

The upper rectangle in Fig. 10 – 2(a) represents a source with emf ε and internal resistance r, connected by ideal (resistanceless) conductors to an external circuit represented by the lower box. This could describe a car battery connected to one of the car's headlights (Fig. 10 – 2(b)). Point a is at higher potential than point b, so $V_a > V_b$ and V_{ab} is positive. Note that the current I is leaving the source at the higher-potential terminal (rather than entering there). Energy is being delivered to the external circuit, and the rate of its delivery to the circuit is given by Eq. (10 – 1):

$$P = V_{ab}I.$$

For a source that can be described by an emf ε and an internal resistance r, we may use Eq. (10 – 3):

$$V_{ab} = \varepsilon - Ir.$$

Multiplying this equation by I, we find

$$P = V_{ab}I = \varepsilon I - I^2 r. \qquad (10-3)$$

What do the terms εI and $I^2 r$ mean? We defined the emf ε as the work per unit charge performed on the charges by the non-electrostatic force as the charges are pushed "uphill" from b to a in the source. In a time dt, a charge $dQ = Idt$ flows through the source; the work done on it by this non-electrostatic force is $\varepsilon dQ = \varepsilon I dt$. Thus εI is the rate at which work is done on the circulating charges by whatever agency causes the non-electrostatic force in the source. This term represents the rate of conversion of non-electrical energy to electrical energy within the source. The term $I^2 r$ is the rate at which electrical energy is dissipated in the internal resistance of the source. The difference $\varepsilon I - I^2 r$ is the net electrical power output of the source—that is, the rate at which the source delivers electrical energy to the remainder of the circuit.

Power Input to a Source

Suppose that the lower rectangle in Fig. 10 – 2(a) is itself a source, with an emf larger than that of the upper source and with its emf opposite to that of the upper source. Fig. 10 – 3 shows a practical example, an automobile battery (the upper circuit element) being charged by the car's alternator (the lower element). The current I in the circuit is then opposite to that shown in Fig. 10 – 2; the lower source is pushing current backward through the upper source. Because of this reversal of current, we have for the upper source

$$V_{ab} = \varepsilon + Ir$$

and instead of Eq. (10 – 3), we have

$$P = V_{ab}I = \varepsilon I + I^2 r. \qquad (10-4)$$

Work is being done on, rather than by, the agent that causes the non-electrostatic force in the upper source. There is a conversion of electrical energy into non-electrical energy in the upper

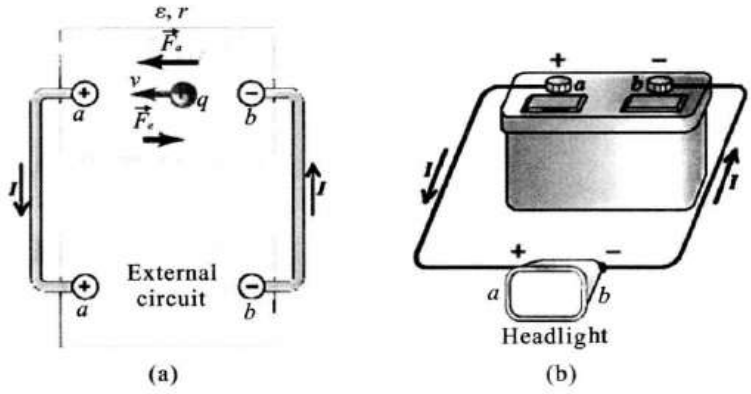


Fig. 10 – 2 (a) The rate of conversion of non-electrical to electrical energy in the source equals εI. The rate of energy dissipation in the source is $I^2 r$. The difference $\varepsilon I - I^2 r$ is the power output of the source. (b) A car battery connected to a headlight is a real-life example of the generic circuit in part (a).

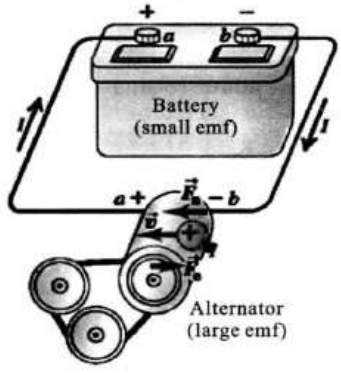


Fig. 10 – 3 When two sources are connected in a simple loop circuit, the source with the larger emf delivers energy to the other source.

source at a rate εI. The term $I^2 r$ in Eq. (10 – 4) is again the rate of dissipation of energy in the internal resistance of the upper source, and the sum $\varepsilon I + I^2 r$ is the total electrical power input to the upper source. This is what happens when a rechargeable battery (a storage battery) is connected to a charger. The charge supplies electrical energy to the battery; part of it is converted to chemical energy, to be reconverted later, and the remainder is dissipated (wasted) in the battery's internal resistance, warming the battery and causing a heat flow out of it. If you have a power tool or laptop computer with a rechargeable battery, you may have noticed that it gets warm while it is charging.

10.2 生词表 New Words

resistor *n.* 电阻器
electric field 电场
product *n.* 乘积
transferred into 转化到
net transfer 净转移
deliver into 传送到
connect *v.* 连接
convert into 转变
external circuit 外电路
collide with 与……相撞
dissipate *v.* 耗尽
overheated *adj.* 过热的
explode *v.* 爆炸
headlight *n.*(汽车等的)前灯;照明灯
multiply *v.* 乘
electrostatic force 静电力
alternator *n.* 交流发电机
opposite to 与……相反
reversal of current 逆电流
instead of 代替

10.3 课文注释 Text Annotation

【1】Let's now look at some energy and power relations in electric circuits.

现在让我们来看看电路中能量和功率的关系。

此句话是祈使句。祈使句表请求、命令、叮嘱、邀请、劝告等。

▶祈使句分为第二人称祈使句及第一、三人称祈使句两大类。

(1) 第二人称祈使句:通常用来向听话者发出命令、提出要求或建议。这种祈使句的主语 you 通常不表示出来,而是以动词原形开头。

e. g. : Stand up!

起立!

Don't worry about!

别担心!

①如果说话时有多人在场,就得把主语表示出来,或加呼语,以便指明是向谁提出请求或发出命令。

e. g. : Mary clean the windows, and you boys wash the floor!

玛丽擦窗户,你们男孩子洗地板!

Come in, everybody!

大家都进来!

②有时将主语表示出来是为了加强语气或表示不高兴、厌烦、鄙视等情绪。

e. g. : Don't you be late again!

你可别再迟到了!

You get out of here!

你给我滚出去!

Mind your own business, you!

你少管闲事!

（2）第一、三人称祈使句：是以第一人称和第三人称代词或者名词等作为祈使的对象，这类祈使句通常以 let 为引导词表建议。

e. g. : Let's go home!

让我们回家吧！

Let him be here by 10 o'clock.

让他十点到这儿来。

【2】Dividing the above equation by dt, we obtain the rate at which the rest of the circuit delivers electrical energy to this circuit element.

上述方程除以 dt，我们就可以得到其他电路给这个电路元件传递电能量的速率。

Dividing the above equation by dt, *分词在句子中作状语。*

分词（或分词短语）常见的语法功能是在句中作状语。分词作状语时，一般要有逗号与句子的其他部分分开，通常处于主语前或句尾。分词的逻辑主语就是句子的主语，因此根据主语与分词所表示动作的主、被动关系而使用现在分词或过去分词。下面根据分词作状语时在句中的两种主要位置来加以说明。

►分词作状语时在句中的位置和特点

（1）在主语前：分词在主语前作状语时主要表示时间和条件，分别译成“当……时候”和“如果”，其次是表示原因，译成“因为，由于”等。

e. g. : Flowing through a circuit, the current will lose part of its energy.

电流流过电路时，要损耗掉一部分能量。（表示时间）

Given current and resistance, we can find out voltage.

若已知电流和电阻，我们就能求出电压。（表示条件）

Having a large number of free electrons, copper is a good conductor.

因为铜具有大量的自由电子，所以是良导体。（表示原因）

（2）在句尾：当分词处于句尾时，分词前面多数情况下有逗号，主要表示伴随情况或进一步说明，其次可表示结果，译成“因此，这样就”。少数情况下也可以表示方式、条件等。

e. g. : Sliver is the best conductor, followed by copper.

银是最好的导体，其次是铜。（表示附加说明）

The two N regions are separated by a P region, creating two opposing P – N junctions.

两个 N 区由一个 P 区所分开，从而形成了两个相对的 P – N 结。（表示结果）

Equation may be solved using the Laplace transformation.

方程可以用拉普拉斯变换来解。（表示方式）

【3】This is the usual situation for a battery, which converts chemical energy into electrical energy and delivers it to the external circuit.

通常情况下电池将化学能转化为电能并将其传递到外部电路。

句子中 and 连接两个并列成分。

►表示并列关系的并列连词

◆and 和，同，与，又，并且

e. g. : Stand over there and you'll be able to see it better.

站在那里，你就能看得更清楚。

(2) not only... but also... 不仅……而且……

e. g. : Not only I but also Jane and Mary are tired of having one examination after another.
不仅我而且简和玛丽都已经厌倦了一个接一个的考试。

(3) neither... nor... 既不……也不……

e. g. : They worked neither for fame nor for personal gains.
他们工作一不为名,二不为利。

(4) both... and... 既……又……

e. g. : A man should have both courage and wisdom.
人既要有勇气又要有智慧。

10.4 扩展阅读 Extended Reading

Molecular Model of Induced Charge

We have discussed induced surface charges on a dielectric in an electric Field. Now let's look at how these surface charges can come about. If the material were a conductor, the answer would be simple. Conductors contain charge that is free to move, and when an electric field is present, some of the charge redistributes itself on the surface so that there is no electric field inside the conductor. But an ideal dielectric has no charges that are free to move, so how can a surface charge occur?

To understand this, we have to look again at rearrangement of charge at the molecular level. Some molecules, such as H_2O *and* N_2O, *have equal amounts of positive and negative charge but a lopsided distribution, with excess positive charge concentrated on one side of the molecule and negative charge on the other. As we described before, such an arrangement is called an electric dipole, and the molecule is called a polar molecule. When no electric field is present in a gas or liquid with polar molecules, the molecules are oriented randomly* (Fig. 10 – 4(a)). *When they are placed in an electric field, however, they tend to orient themselves as in* Fig. 10 – 4(b), *as a result of the electric-field torques. Because of thermal agitation, the alignment of the molecules with* $\vec{E}$ *is not perfect.*

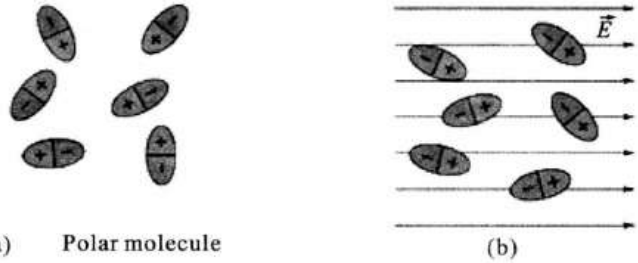
Even a molecule that is not ordinarily polar becomes a dipole when it is placed in an electric field because the field pushes the positive charges in the molecules in the direction of the field and pushes the negative charges in the opposite direction . This causes a redistribution of charge within the molecule (Fig. 10 – 5). *Such dipoles are called induced dipoles.*

With either polar or non-polar molecules the redistribution of charge caused by the field leads to the formation of a layer of charge on each surface of the dielectric material (Fig. 10 – 6). *These layers are the surface charge; their surface charge density is denoted by* σ_i. *The charges are not free to move indefinitely, as they would be in a conductor, because each charge is bound to a molecule. They are in fact called bound charges to distinguish them from the free charges that are added to and removed from the conducting capacitor plates. In the interior of the material the net charge per unit volume remains zero. As we have seen, this redistribution of charge is called polarization, and we*

say that the material is polarized.

The four pans of Fig. 10 – 7 *show the behavior of a slab of dielectric when it is inserted in the field between a pair of oppositely charged capacitor plates.* Fig. 10 – 7(a) *shows the original field.* Fig. 10 – 7(b) *is the situation after the dielectric has been inserted but before any rearrangement of charges has occurred.* Fig. 10 – 7(c) *shows by thinner arrows the additional field set up in the dielectric by its induced surface charges. This field is opposite to the original field, but it is not great enough to cancel the original field completely because the charges in the dielectric are not free to move indefinitely. The resultant field in the dielectric, shown in* Fig. 10 – 7(d), *is therefore decreased in magnitude. In the field-line representation, some of the field lines leaving the positive plate go through the dielectric, while others terminate on the induced charges on the faces of the dielectric.*

As we discussed before, polarization is also the reason a charged body, such as an electrified plastic rod, can exert a force on an uncharged body such as a bit of paper or a pith ball. Fig. 10 – 8 *shows an uncharged dielectric sphere B in the radial field of a positively charged body A. The induced positive charges on B experience a force toward the right, while the force on the induced negative charges is toward the left. The negative charges are closer to A, and thus are in a stronger field, than are the positive charges. The force toward the left is stronger than that toward the right, and B is attracted toward A, even though its net charge is zero. The attraction occurs whether the sign of A's charge is positive or negative. Furthermore, the effect is not limited to dielectrics; an uncharged conducting body would be attracted in the same way.*



(a) Polar molecule (b)

Fig. 10 – 4 (a) Polar molecules have random orientations when there is no applied electric field. (b) The molecules tend to line up with an applied electric field $\vec{E}$.



(a) (b)

Fig. 10 – 5 (a) Non-polar molecules have their positive and negative charge centers at the same point. (b) These centers become separated slightly by the applied electric field $\vec{E}$.

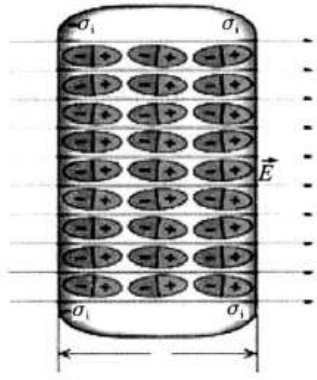


Fig. 10 – 6 Polarization of a dielectric in an electric field gives rise to thin layers of bound charges on the surfaces, creating surface charge densities σ_i and $-\sigma_i$. The sizes of the molecules are greatly exaggerated for clarity.

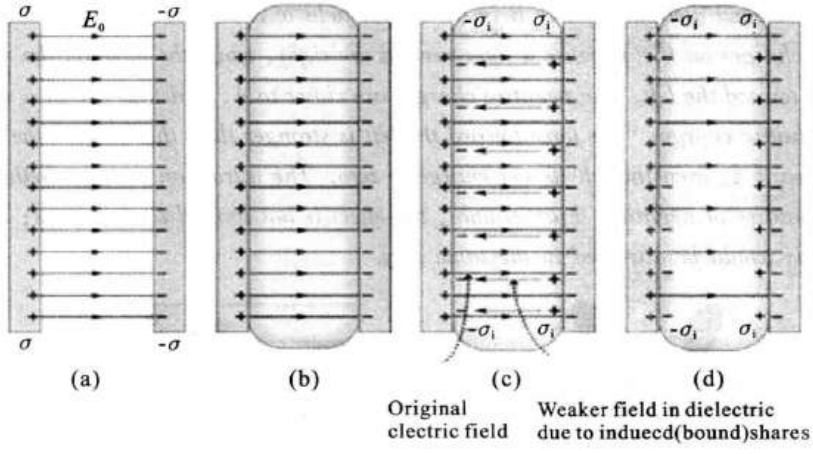


Fig. 10 – 7 (a) Electric field of magnitude E_0 between two charged plates.

(b) Introduction of a dielectric of dielectric constant K.

(c) The induced surface charges and their field (thinner lines).

(d) Resultant field of magnitude E_0/K when a dielectric is between charged plates.

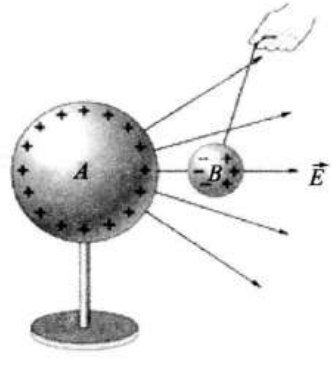


Fig. 10 – 8 A neutral sphere B in the radial electric field of a positively charged sphere A is attracted to the charge because of polarization .

10.5 常用用法 Usages and Expressions

电磁学常用的器件和设备 Devices and Equipment in Electromagnetism

交流/直流桥 AC/DC bridge
交流/直流电阻箱 AC/DC resistance
交流/直流毫伏计/毫安计 AC/DC millivoltmeter/milliammeter
可调节电容器/电感器/电阻器 adjustable capacitor/inductance/resistor
空气磁芯电感器 air core inductance
空气介质电容器 air dielectric capacitor
碱性蓄电池 alkaline accumulator
安培计 ammeter/amperemeter
旁路电阻 by-pass resistor
换向调节器/整流马达/换向整流器 commutator modulator/motor/rectifier
直流稳压电源 DC regulated power supply
直流分压器 DC voltage divider
十进制电容箱/电感箱 decimal capacitance/ inductance box
干电池 dry accumulator
验电器 electroscope
热敏电阻 heat-variable resistor/thermistor
磁滞回线 hysteresis loop
开尔文桥 Kelvin bridge
万用表 universal meter
光敏电阻 photoresistor
球形电容器 spherical capacitor
薄膜电阻 thin-film resistor
伏安特性测试仪 volt-ampere tester
绕组电阻器 wire-wound resistor
交流发电机 alternator
弧光灯 arc lamp
电弧整流器 arc rectifier
电枢 armature
电枢线圈 armature coil
异步发电机 asynchronous generator
异步电动机 asynchronous motor
电子束功率放大器 beam power amplifier
镉镍蓄电池 cadmium-nickel accumulator
阴极射线加速器 cathode ray accelerator
电导仪 conductivity meter

铜锌蓄电池 copper-zinc accumulator
峰值电流计 crest ammeter
直流放大器 DC amplifier
二极管 diode
电子加速器 electron accelerator
静电激发器 electrostatic actuator
反馈继电放大器 feedback relay amplifier
回旋加速器 helical accelerator
液压蓄能器 hydraulic accumulator
铁镍蓄电池 iron-nickel accumulator
热胀安培计 thermal expansion ammeter
热偶安培计 thermocouple ammeter
晶体管 transistor

10.6 同义词辨析 Synonyms

think, consider, imagine, speculate, reason, suppose, presume, believe, hold, feel, reckon, calculate, judge, be under the impression, be of the opinion

These words all mean to have an idea that sth. is true or possible or to have a particular opinion about sb./sth.

以上各词均含“以为,认为”之义。

◆ think to have an idea that sth. is true or possible, although you are not completely certain; to have a particular opinion about sb./sth. 以为、认为某人/事物……(但不肯定)

e. g. :I think that you're being unfair.

我认为你这么做不公平。

The recession lasted longer than anyone thought it would.

谁也没有想到这次经济的萧条会持续这么久。

【习惯用法】

think about sth. 考虑,想起

take better of sb. 看中某人,对某人持较高的看法

think of 考虑;打算;记起

◆ consider to think of sb./sth. in a particular way 以特定的方式看待事物;认为,以为,觉得

e. g. I did not consider it necessary to report the incident.

我认为没必要把这件事报告上去。

We are considering whether to change our advice to tourists.

我们正在考虑是否要改变对游客的建议。

◆ imagine to think that sth. is probably true 对某事物的一种猜测,料想,认为

e. g. : You are obviously tired and I imagine that nothing would make you admit it.

你明显是累了,但我想你是不会承认的。

【习惯用法】

imagine doing sth. 想干某事

◆ speculate ~ (about/on sth.) to form an opinion about sth. without knowing all the details or facts (在并非知道所有细节和信息的基础上)推测,推断

e. g. : She refused to speculate.

她拒绝胡思乱想。

Some analysts speculated that jobs will be lost.

一些分析家推测工作职位将会减少。

◆ reason to form a judgement about a situation by considering the facts and using your power to think in a logical way(以逻辑推理的方式)推理,推论,推断

e. g. : They reasoned that other businesses would soon copy the idea.

他们推断其他企业也会很快效仿这个办法。

◆ suppose to think or believe that sth. is true or possible(based on the knowledge that you have) (根据所知)认为,推断,料想

e. g. : I suppose you're right.

我想你是对的。

I suppose you thought you were being clever!

我看你是自作聪明!

【习惯用法】

be supposed to 被期望;要求;应该

supposing 假如,倘若

◆ presume (formal) to accept sth. as true or existing and to act on that basis 设定,设想,假设

e. g. : Each of you will make a speech, I presume?

我想你们每个人都会发言,是吗?

I presume we'll be there by six o'clock.

我想我们会在六点之前到那儿。

◆ believe to have an idea that sth. is true or possible, although you are not completely certain; to have a particular opinion about sb./sth. 以为、认为某人/事物……(但不肯定)

e. g. : Detectives believe that the victim knew his killer.

侦探认为被害人认识凶手。

【习惯用法】

believe in 相信某人的人格、信誉

make believe 假装,装作

THINK OR BELIEVE ? 用 think 还是 believe?

①When you are expressing an idea that you have or that sb. has of what is true or possible, "believe" is more formal than "think". It is used especially for talking about ideas that other people have; "think" is used more often for talking about your own ideas. 表达自己或别人认为真实或有可能的想法时,believe 较 think 正式。believe 尤用于别人的想法,think 较常用于自己的想法。

e. g. : Police believe... 警方认为……

I think... 我认为……

②When you are expressing an opinion, "believe" is stronger than "think" and is used especially for matters of principle. "Think" is used more for practical matters or matters of personal taste. 表达意见时,believe 语气较 think 强烈,尤用于原则性事情;think 多用于实际事情或个人喜好。

◆ hold to have a belief or an opinion about sb./sth. (对某人或某事)怀有,持有(信念、意见)

e. g. : Experts hold varying opinions as to the causes of the disease.

专家们对该病的起因各持己见。

This view is not widely held.

该观点并不普遍。

◆ feel to have a particular opinion about sth. that has happened or about what you/sb. ought to do 认为(已发生的事情……);相信(应该……)

e. g. : When his dad left, he felt as though his world had turned upside-down.

爸爸出走后,他觉得自己的世界完全乱了套。

◆ reckon (informal) to think that sth. is true or possible 认为,以为

e. g. : Do you reckon he'll agree to see us?

你认为他会同意见我们吗?

The police reckon that whoever killed his dad was with him earlier that day.

警方认为杀害爸爸的人那天早些时候是和他在一起的。

◆ calculate to guess sth. or form an opinion by using all the information available (利用所知的信息)预测,推测

e. g. : Researchers calculated that this group was at a higher risk of heart disease.

研究人员估测这一群体的心脏病的发病几率更高。

◆ judge to form an opinion about sb./sth., based on the information you have(依据所掌握的信息)判断,断定,认为

e. g. : You should never judge a person by his looks.

绝不要以貌取人。

The economic results of the reforms are very difficult to judge.

这些改革所带来的经济成效很难评价。

【习惯用法】

judge sb. by sth. 以某物来判断某人

judge that 认为……

◆ be under the impression to have an idea that sth. is true 以为某事……

e. g. : I'm sorry. I was under the impression that you were the manager.
对不起,我以为你是经理呢。

◆ be of the opinion (formal) to believe or think that... 相信,认为

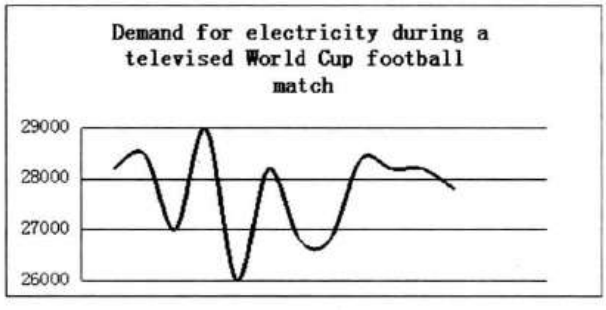
e. g. : I was firmly of the opinion that we should not give Jackson any more money.
我坚决主张不要再给杰克逊更多的钱了。

10.7 练习题 Exercise

(10-1)用括号内所给动词的适当形式(包括谓语动词和非谓语动词)填空。

The aim of this work is ____[1]____ (evaluate) the reliability of non-destructive test (NDT) techniques for the inspection of welds ____[2]____ (employ) in the petroleum industry. Radiography, manual and automatic ultrasonic techniques using plus-echo and time of flight diffraction (TOFD) ____[3]____ (employ). Three classes of defects ____[4]____ (analyze): lack of penetration (LP), lack of fusion (LF) and undercut (UC). The tests ____[5]____ (carry out) on specimen made from pipelines ____[6]____ (contain) defects, which ____[7]____ (artificially insert) on laying the weld bead. The results ____[8]____ (show) the superiority of the automatic ultrasonic tests of defect detection ____[9]____ (compare) with the manual ultrasonic and radiographic tests. Additionally artificial neural networks (ANN) ____[10]____ (use) in the detection and automatic classification of the defects.

(10-2) Complete the sentences about graph below, using the prompts below. 根据提示完成下面有关图表的句子。



[1] At the start _____.

[2] There is a _____ during the first _____ but then _____.

[3] Demands falls again _____ lowest point _____.

[4] In the last forty minutes _____.

[5] However, at the beginning _____ plateau _____ resume _____ normal _____.

Lesson 11

内容 11.1 基尔霍夫定律 Kirchhoff's Rules
11.2 生词表 New Words
11.3 课文注释 Text Annotation
11.4 扩展阅读 Extended Reading: Physiological Effects of Currents
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电路中的量及其单位 Quantities and Units in Circuits
11.6 同义词辨析 Synonyms
11.7 练习题 Exercise

11.1 基尔霍夫定律 Kirchhoff's Rules

Many practical resistor networks cannot be reduced to simple series-parallel combinations. Fig. 11 – 1(a) shows a dc power supply with emf ε_1 charging a battery with a smaller emf ε_2 and feeding current to a light bulb with resistance R. Fig. 11 – 1(b) is a "bridge" circuit, used in many different types of measurement and control systems. We don't need any new principles to compute the currents in these networks, but there are some techniques that help us handle such problems systematically. We will describe the techniques developed by the German physicist Gustav Robert Kirchhoff (1824 – 1887).

First, here are two terms that we will use often. A junction in a circuit is a point where three or more conductors meet. Junctions are also called nodes or branch points. A loop is any closed conducting path. The circuit in Fig. 11 – 1(a) has two junctions, a and b. In Fig. 11 – 1(b) the points a, b, c, and d are junctions, but points e and f are not. Some possible loops in Fig. 11 – 1(b) are the closed paths *acdba*, *acdefa*, *abdefa*, and *abcdefa*.

Kirchhoff's Rules are the following two statements:

(1) Kirchhoff's junction rule: The algebraic sum of the currents into any junction is zero. That is,

$$\sum I = 0 \quad (\textit{junction rule, valid at any junction}). \tag{11-1}$$

(2) Kirchhoff's loop rule: The algebraic sum of the potential differences in any loop, including those associated with emf's and those of resistive elements, must equal zero. That is,

$$\sum V = 0 \text{ (loop rule, valid for any closed loop).} \qquad (11-2)$$

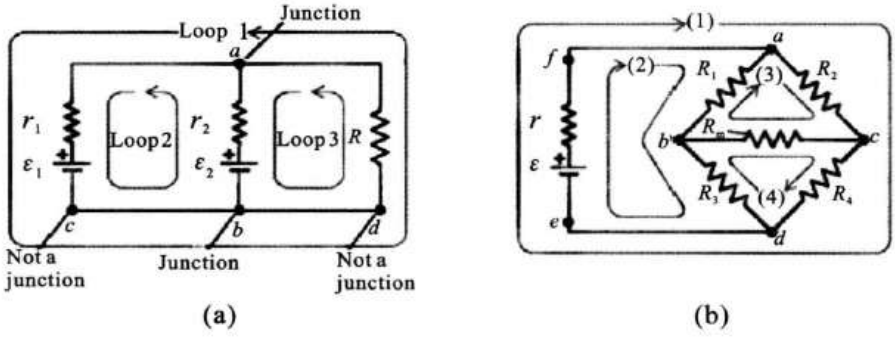


Fig. 11 – 1 Two networks that cannot be reduced to simple series-parallel combinations of resistors.

The junction rule is based on conservation of electric charge. No charge can accumulate at a junction, so the total charge entering the junction per unit time must equal the total charge leaving per unit time. Charge per unit time is current, so if we consider the currents entering to be positive and those leaving to be negative, the algebraic sum of currents into a junction must be zero. It's like a T branch in a water pipe; if you have one liter per minute coming in one pipe, you can't have three liters per minute going out the other two pipes.

[1] **The loop rule is a statement that the electrostatic force is conservative.** Suppose we go around a loop, measuring potential differences across successive circuit elements as we go. When we return to the starting point, we must find that the algebraic sum of these differences is zero; otherwise, we could not say that the potential at this point has a definite value.

In applying the loop rule, we need some sign conventions. Problem-Solving Strategy describes in detail how to use these, but here's a quick overview. [2] **We first assume a direction for the current in each branch of the circuit and mark it on a diagram of the circuit. Then, starting at any point in the circuit, we imagine traveling around a loop, adding emf's and *IR* terms as we come to them.** When we travel through a source in the direction from − to +, the emf is considered to be positive; when we travel from + to −, the emf is considered to be negative. When we travel through a resistor in the same direction as the assumed current, the *IR* term is negative because the current goes in the direction of decreasing potential. When we travel through a resistor in the direction opposite to the assumed current, the *IR* term is positive because this represents a rise of potential.

Kirchhoff's two rules are all we need to solve a wide variety of network problems. Usually, some of the emf 's, currents, and resistances are known, and others are unknown. We must always obtain from Kirchhoff's rules a number of independent equations equal to the number of unknowns so that we can solve the equations simultaneously. Often the hardest part of the solution is not in understanding the basic principles but in keeping track of algebraic signs!

11.2 生词表 New Words

practical *adj.* 实际的
reduce to 折合到
series-parallel combinations 串并联排列
feeding current 馈电电流
"bridge" circuit 桥式电路
systematically *adv.* 系统地
term *n.* 术语
junction *n.* 节点
loop *n.* 回路
algebraic sum 代数和
that is 更确切地说;即;换句话说
base on 建立在……基础上
conservation of electric charges 电荷守恒
accumulate *v.* 堆积,积累
per unit time 单位时间
confess *v.* 承认
definite value 定值
sign convention 符号标记惯例
problem-solving strategy 解决问题策略
in detail 详细地
diagram *n.* 图表;图解
simultaneously *adv.* 同时地

11.3 课文注释 Text Annotation

基尔霍夫（Gustav Robert Kirchhoff,1824—1887),德国物理学家。1824 年 3 月 12 日生于普鲁士的柯尼斯堡(今为俄罗斯加里宁格勒),1887 年 10 月 17 日卒于柏林。基尔霍夫在柯尼斯堡大学读物理,1847 年毕业后去柏林大学任教,3 年后去布雷斯劳作临时教授。1854 年由化学家本生推荐任海德堡大学教授。1875 年到柏林大学作理论物理教授,直到逝世。



1845 年,21 岁的他发表了第一篇论文,提出了稳恒电路网络中电流、电压、电阻关系的两条电路定律,即著名的基尔霍夫电流定律(KCL)和基尔霍夫电压定律(KVL),解决了电器设计中电路方面的难题。后来又研究了电路中电的流动和分布,从而阐明了电路中两点间的电势差和静电学的电势这两个物理量在量纲和单位上的一致,使基尔霍夫电路定律具有更广泛的意义。直到现在,基尔霍夫电路定律仍旧是解决复杂电路问题的重要工具。基尔霍夫被称为"电路求解大师"。

【1】The loop rule is a statement that the electrostatic force is conservative.

回路定律表明,静电场力是守恒的。

that the electrostatic force is conservative 是 statement 的同位语从句。

●同位语从句

▶1. 定义:当一个分句作其前面某个抽象名词的同位语时,该分句就称为该名词的同位语从句。

※ 有一些同位语从句纯粹是补充说明其前面那个名词所含的具体内容;有些同位语从句则在逻辑概念上是前面那个名词逻辑上的"宾语从句",这时该名词具有动词的含义,如 suggestion (建议),requirement (要求),assurance (保证)等。

判别图:

the a 无冠词 no 形容词 物主代词 this	+ 抽象名词	requirement assurance evidence fact statement + that + 主 + 谓 + 其他 suggestion doubt advantage …

►2. 同位语从句的引导词:引导同位语从句的词语通常有连词 that, whether, 连接代词 what, who, whom, whose 和连接副词 where, when, why, how 等。

e. g. : The fact that everything around us is matter is known to all.

我们周围的一切东西均是物质这一事实是大家都知道的。

I have no idea what the equipartition theorem is about.

我不知道均分定理是什么内容。

The question whether the atom can or cannot be split up is known to have interested scientists from ancient times.

原子能否再分割的问题从远古就令科学家们感兴趣。

His forecast when the hurricane would come is found entirely successful.

他对飓风何时到来的预报是完全成功的。

The reason why the nucleus of an atom can stay together is that the strong nuclear force holds them together.

原子内的核子之所以能够聚集在一起是由于强核力的作用。

【2】We first assume a direction for the current in each branch of the circuit and mark it on a diagram of the circuit. Then, starting at any point in the circuit, we imagine traveling around a loop, adding emf' s and *IR* terms as we come to them.

我们首先在电路的各支路上假设电流方向并在电路中标记出电流方向,然后,从电路中的任何一点,沿着整个回路添加各个部分的电动势和 *IR* 大小。

该段使用了叙述法来组织段落。

●一般段落发展的手段有以下几种。

►1. 因果分析法(cause and effect): 在阐述某一现象的段落中,常采用因果分析法。

常用于因果分析法的连接词有:because, so, as a result 等。

►2. 举例法(example): 通过举出具体事例来阐述、说明主题句的内容,严格地讲,举例法也是列举法的一种,它们的区别在于:列举法侧重罗列事实,所列事实力求全面;而举例法侧重通过举出典型事例来解释观点, 且事例可多可少。

常用于因果举例法的连接词有:for example, for another example, besides, take sb./sth. as an example。

►3. 叙述法(narration):叙述法发展段落主要是按照事物本身的时间或空间的排列顺序,通过使用一些连接词,有层次分步骤地表达主题句的一种写作手段。用这种方法展开段

落,能够清楚连贯地交代事物的本末,从而可以使读者清晰、完整地理解文章的含义。

常用于叙述法的连接词有:first, at the beginning, to start with, after that, later, then, afterwards, in the end, finally 等。

▶4. 对比法或比较法(contrast of comparison):将同类的事物按照某种特定的规则进行比较分析是一种常用的思维方法。通过对比,更容易阐述所述对象之间的异同和优缺点。常用于对比法或比较法的连接词有 than, compared with 等。

11.4 扩展阅读 Extended Reading

Physiological Effects of Currents

Travel has a cylindrical membrane with one conducting fluid inside and another outside (Fig. 11 -3(a)). *In the resting condition the only charged bodies that can cross the membrane are positively charged potassium ions, which leak out of the axon into the surroundings. This leaves the inside of t Electrical potential differences and currents play a vital role in the nervous systems of animals* (Fig. 11 -2). *Conduction of nerve impulses is basically an electrical process, although the mechanism of conduction is much more complex than in simple materials such as metals. A nerve fiber, or axon, along which an electrical impulse can be axon with a net negative charge and a potential of about* -70 mV (-0.07 V) *with respect to the outer fluid.*

When an electrical stimulus is applied to the axon, the membrane temporarily becomes more permeable to other ions in the fluids, leading to a local change in potential difference (Fig. 11 -3 (b)). *This disturbance, called the action potential, propagates along the membrane as a pulse with a speed of the order of* 30 m/s. *The entire pulse passes a given point along the axon in a few milliseconds, after which the membrane recovers and the potential difference returns to its initial value* (Fig. 11 -3(c)).

The electrical nature of nerve impulses explains why the body is sensitive to externally supplied electrical currents. Currents through the body as small as 0.1A *can be fatal because they interfere with essential nerve processes such as those in the heart. Even smaller currents can also be very dangerous. A current of* 0.01A *through an arm or leg causes strong, convulsive muscle action and considerable pain; with a current of* 0.02A, *a person holding the conductor that is inflicting the shock is typically unable to release it. Currents of this magnitude through the chest can cause ventricular fibrillation, a disorganized twitching of heart muscles that pumps very little blood. Surprisingly, very large currents (over* 0.1A) *are somewhat less likely to cause fatal fibrillation because the heart muscle is "clamped" in one position. The heart actually stops beating and is more likely to resume normal beating when the current is removed. The electric defibrillators used for medical emergencies apply a large current pulse to stop the heart (and the fibrillation) to give the heart a chance to restore normal rhythm.*



Fig. 11 – 2 Potassium ions (K^+) play an essential role in nerve conduction. A healthy diet includes foods rich in potassium, such as bananas, tomatoes, spinach, and oranges.

Body fluids are usually quite good conductors because of their substantial ion concentrations. By comparison the resistance of skin is relatively high, ranging from 500 $k\Omega$ *for very dry skin to* 1000 Ω *or so for wet skin, depending also on the area of contact. If* $R = 1000\ \Omega$, *a current of* 0.1 A *requires a potential difference of* $V = IR = (0.1\ \text{A})(1000\ \Omega) = 100\ \text{V}$. *Were it not for the high resistance of skin, even an ordinary* 1.5-V *flashlight battery could produce a hazardous shock.*

In summary, electric current poses three different kinds of hazards: Interference with the nervous system, injury caused by convulsive muscle action, and burns from I^2R *heating. The moral of this rather morbid story is that under certain conditions, voltages as small as* 10V *can be dangerous. All electrical circuits and electrical equipment should always be approached with respect and caution.*

On the positive side, alternating currents with frequencies of the order of 10^6 Hz *do not interfere appreciably with nerve processes and can be used for therapeutic heating for arthritic conditions, sinusitis, and other disorders. If one electrode is made very small, the resulting concentrated heating can be used for local destruction of tissue such as tumors or for cutting tissue in certain surgical procedures.*

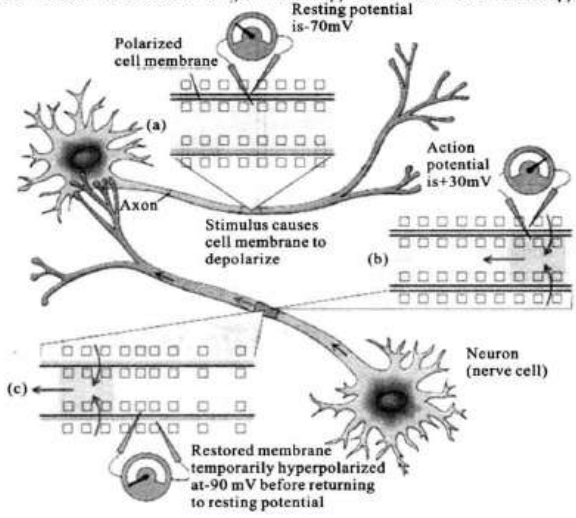


Fig. 11 – 3 (a) The cell membrane around an axon maintains a resting potential difference of about – 70mV between inner and outer fluids. (b) An electrical stimulus depolarizes the membrane, and the potential difference suddenly rises to about 30 mV. (c) The change in potential difference, called the action potential, propagates along the axon. After the pulse passes, the potential difference first overshoots to about – 90 mV, then recovers its original value.

The study of particular nerve impulses is an important diagnostic tool in medicine. The most familiar examples are electrocardiography (ECG) and electroencephalography (EEG). Electrocardiograms, obtained by attaching electrodes to the chest and back and recording the regularly varying potential differences, are used to study heart function. Electrodes attached to the scalp permit study of potentials in the brain, and the resulting patterns can be helpful in diagnosing disorders such as epilepsy or brain tumors.

11.5 常用用法 Usages and Expressions

电路中的量及其单位 Quantities and Units in Circuits

电路中的量	英文表示	单　位	电路中的量	英文表示	单　位
电压 U	voltage	伏特 V	平均值	mean	
电流 I	current	安培 A	有效值	effective value	
电阻 R	resistance	欧姆 Ω	有用功率 P	active power	瓦特 W
电容 C	capacitance	法拉 F	无功功率 Q	reactive power	乏 var
电感 L	inductance	亨利 H	视在功率 S	apparent power	伏安 VA
电阻率 ρ	resistivity	欧姆·米 Ω·m	功率因数 $\cos\varphi$	power factor	
电导 G	conductance	西门子 S	相电压	phase voltage	伏特 V
电导率 k	conductivity	西门子每米 S/m	线电压	line Voltage	伏特 V
电动势 E	electromotive force	伏特 V	相电流	phase current	安培 A
感抗 X_L	inductive reactance	欧姆 Ω	线电流	line current	安培 A
容抗 X_C	capacitive reactance	欧姆 Ω	相量	phasor	
振幅 Am	amplitude	米 m	磁通 Φ	magnetic flux	韦伯 Wb
磁阻 R_m	reluctance	1/亨 1/H	磁通密度 B	magnetic flux density	特斯拉 T
磁导率 μ	permeability	亨/米 H/m	电荷 q	electric charge	库伦 C
介电常数 ε	dielectric constant	法/米 F/m	电功率 P	electric power	瓦特 W

11.6 同义词辨析 Synonyms

right, true, exact, precise, accurate, real, actual, proper, decent, appropriate, fitting, suitable, healthy, correct, sound

All these words describe a belief, opinion, decision or method that is suitable or the best one for a particular situation.

以上各词均指看法、意见、决定或方法等“恰当,合适”。

◆ right If sb. is right to do or think sth., that is a good thing to do or think in that situation 正确的;妥当的;恰当的

e. g. :I think she's definitely the right person for the job.

我认为她绝对是这份工作的合适人选。

A huge development like this isn't right for such a small village.

像这样大的新建住宅区不适合这么小的一个村庄。

【习惯用法】

all right 是的,可以

be in the right 有道理,没错

e. g. :He is in the right in saying that they have made the wrong decision.

他说他们做了错误的决定是有道理的。

◆ true connected with facts rather than things that have been invented or guessed 符合事实的;确实的;如实的

e. g. :It's not true that I'm going to marry him.

我要嫁给他的说法不是真的。

No, honestly, it's a true story.

不,老实说,这是一个真实的故事。

◆ exact correct in every detail (每一个细节)精确的;准确的

e. g. :Police are still investigating the exact cause of the accident.

警察还在调查这起事故的确切原因。

The exact location of the hostages is unknown.

人质所处的确切位置并不清楚。

◆ precise clear and accurate 清楚的,准确的;确切的;精确的;明确的

e. g. :It was difficult to get precise information.

很难得到确切的消息。

She's a lot older than you, isn't she? Fifteen years, to be precise.

她比你大很多,是不是? 准确地说,是大十五岁。

◆ accurate able to give completely correct information or to do sth. in an exact way 完全正确的;精确的;准确的

e. g. :Police believe Derek gave a reasonably accurate account of what happened.

警方相信德里克对事情的叙述是比较准确的。

The evidence she gave to the court was not strictly accurate.

她向法院提供的证词并不完全准确。

◆ real (only before noun) actual or true, rather than what appears to be true 真正的;确实的;真实的

e. g. :She had never seen a real live elephant before.

她以前从未见过活生生的大象。

Dreams can sometimes seem very real.

梦境有时显得非常真实。

◆ actual used to emphasize sth. that is real or exists in fact (强调事实)存在的,真实的;实际的

e. g. :I'm not joking. Those were his actual words.

我不是开玩笑,那都是他的原话。

I know Germany won, but I can't tell you the actual score.

我知道德国队胜了,但不知道确切的比分。

◆ proper (only before noun) right, appropriate or correct; according to the rules 正确的;恰当的;符合规则的

e. g. :Everything was in its proper place.

每样东西都放在恰当的位置。

The proper name for Matthew's condition is hyperkinetic syndrome.

马修的病正确的名称是多动症。

◆ decent acceptable to people in a particular situation 适合某一特定场合的;得体的;合宜的;恰当的

e. g. :Are you decent? Can I come in?

你穿好了吗? 我可以进来了吗?

◆ appropriate suitable, acceptable or correct for the particular circumstances 合适的;恰当的

e. g. :It would not be appropriate for me to discuss that now.

我现在来讨论那件事不合时宜。

I didn't feel that this was an appropriate time to mention the subject of money.

我觉得这个时候不适合提钱的问题。

◆ fitting suitable or right for the occasion 适合(某场合)的;恰当的

e. g. :It's only fitting that Simon propose the first toast tonight.

今晚让西蒙第一个祝酒是最合适的。

I thought the memorial was fitting tribute to the President.

我认为这座纪念碑恰如其分地表达了对总统的敬意。

◆ suitable right or appropriate for a particular purpose or occasion 合适的;适宜的;恰当的;适用的

e. g. :We are hoping to find a suitable school.

我们希望能找到一所合适的学校。

The house is not really suitable for a large family.

这所房子并不适合大家庭居住。

◆ healthy normal and sensible 正常的;合理的

e. g. :I don't think it's healthy for her to spend so much time alone.

我认为她独处的时间太长不正常。

◆ correct (of a method, belief, opinion or decision) right and suitable in a particular situation. (方法、看法、意见或决定)正确的,恰当的,合适的

e. g. : You are absolutely correct; the Missouri is the longest river in the US.

你说的完全正确,密苏里河是美国最长的河流。

When lifting heavy weights, make sure that your back is in the correct position.

举重物时背部保持恰当的姿势。

◆ sound sensible; that you can rely on and that will probably give good results 明智的;合理的;正确的;可靠的

e. g. : The book is full of sound advice.

这本书里有许多合理的建议。

a man of great integrity and sound judgement

一个非常正直且判断力极强的人

【习惯用法】

be/fall sound asleep 酣睡

e. g. : The men fell sound asleep after he had drunken a bottle of wine.

那个男人喝完一瓶酒后就酣睡了。

RIGHT OR CORRECT? 用 right 还是 correct?

"Correct" is more formal than "right." It is more often used for methods and "right" is more often used for beliefs, opinions and decisions. correct 比 right 更正式,多用于指方法正确;而 right 多用于指信念、观点、决定正确。

11.7 练习题 Exercise

(11 - 1) 回答以下问题并翻译句子。

These days timing is everything. Between meetings and appointments, deadlines and conference calls, my schedule requires that I know the time down to the minute. Even on weekends. I've got a football team to coach, shows to tape, and planes to catch. If I'm late, I'm sunk. The problem is that it's hard if my clocks aren't correct. Even the digital clocks can display time inaccurately. Dead batteries, can cause a clock to be inaccurate. Now there is no need to worry, because advanced radio technology has produced a clock which gets the time directly from the U. S. Atomic Clock in Fort Collins, Colorado, the standard for time-keeping the world over. The Atomic Clock by Acron is the most accurate, reliable and convenient timepiece you can have.

Every morning at 1:00 a. m., this "smart" clock tunes into the radio time signal emitted by the U. S. Atomic Clock in Colorado and automatically resets itself to the exact hour, minute and second. The U. S. Atomic Clock is accurate to ten billionths of a second per day. This means that the clock deviates less than one second over a one million year period. The Atomic Clock even adjusts automatically for daylight savings time, so you don't have to remember to "spring forward" or "fall back." The desktop clock model is the only atomic clock that will not lose time with low

power or when you change its batteries.

The most accurate clock in the world is of no use if it is difficult to operate. The Acron Atomic Clock is engineered in Germany using the latest scientific technology; it conics in two the wall clock and the desktop model. Both are designed to be functional and easy to use. The desk clock's display features the exact time (in hours, minutes and seconds), month and date you can choose to display any two U. S. or world time zones. It weighs only eight ounces. It also has dual alarms, perfect for couples. Both the desktop and the models have an internal antenna for good reception without unattractive wires.

[1] 回答以下问题。

1. What is the main idea of the passage?

A. The importance of timing.

B. The accuracy of the U. S. Atomic Clock in Colorado.

C. The working principle of an atomic clock.

D. A brief introduction of the Acron Atomic Clock.

2. The writer needs to know the time down to the minute because _____.

A. he has got so many meetings and appointments

B. he has to coach a football team

C. he should catch planes on weekends

D. all of the above

3. The U. S. Atomic Clock is so accurate that _____.

A. it gains less than one second over a one million year period

B. it loses less than one second over a one million year period

C. its deviation is within one second over a one million year period

D. its deviation cannot be detected even over a one million year period

4. The Acron Atomic Clock even adjusts automatically for _____.

A. spring time B. summer time C. fall (autumn) time D. winter time

5. Which of the following statements about the functions of the Acron Atomic Clock is NOT true?

A. It has an outside antenna.

B. It has dual alarms.

C. It is a travel clock due to its lightweight.

D. It displays two time zones.

[2] 将以下句子译成汉语。

1. In order for the electrons to move through a metal conductor, a source of emf must be applied.

2. Television makes it possible for us to see a distant scene.

3. The computer must be told how to solve any given problem.

4. We have now to consider what path of integration to take.

5. Electrons are too small for us to see.

6. It will tell the computer where to find that number.

7. There should be a way for the energy to be dissipated. (dissipate 消耗)

(11-2) Read paragraph below. What are the topic and main idea?

Time is one of the fundamental quantities of the physical world, being similar to length and mass in this respect. Three methods of measuring time are in use at present. The first two methods are based on the daily rotation of the earth on its axis. These methods are determined by the apparent motion of the sun in the sky (solar time) and by the apparent motion of the stars in the sky (sidereal time). The third method of measuring time is based on the revolution of the earth around the sun (ephemeris time).

(11-3)分析句子的成分,并将句子译成汉语。

[1]The electric current can flow easily through copper.

[2]We wind the wire round the iron rod.

[3]The battery gives us an electric current.

[4]The iron rod is now a magnet.

[5]We join the two ends of the wire to the battery.

[6]You can see the thin wire inside an electric lamp.

Lesson 12

内容 12.1 交流电路中的共振 Resonance in Alternating-Current Circuits
12.2 生词表 New Words
12.3 课文注释 Text Annotation
12.4 扩展阅读 Extended Reading: The Direct-Current Motor
12.5 常用用法 Usages and Expressions
电子学和电路中常见的缩写 Abbreviation in Electronics and Circuits
12.6 同义词辨析 Synonyms
12.7 练习题 Exercise

12.1 交流电路中的共振
Resonance in Alternating-Current Circuits

Much of the practical importance of $L-R-C$ series circuits arises from the way in which such circuits respond to sources of different angular frequency ω. For example, one type of tuning circuit used in radio receivers is simply an $L-R-C$ series circuit. A radio signal of any given frequency produces a current of the same frequency in the receiver circuit, but the amplitude of the current will be greatest if the signal frequency equals the particular frequency to which the receiver circuit is "tuned." This effect is called resonance. The circuit is designed so that signals at other than the tuned frequency produce currents that are too small to make an audible sound come out of the radio's speakers.

To see how an $L-R-C$ series circuit can be used in this way, suppose we connect an ac source with constant voltage amplitude V but adjustable angular frequency ω across an $L-R-C$ series circuit. The current that appears in the circuit has the same angular frequency as the source and a current amplitude $I = V/Z$, *where* Z is the impedance of the $L-R-C$ series circuit. This impedance depends on the frequency. Fig. 12-1(a) shows graphs of R, X_L, X_C, and Z as functions of ω.

[1] **We have used a logarithmic angular frequency scale so that we can cover a wide range of frequencies.** As the frequency increases, X_L increases and X_C decreases; hence there is always one frequency at which X_L and X_C are equal and $X_L - X_C$ is zero. At this frequency the impedance $z = \sqrt{R^2 + (X_L - X_C)^2}$ has its smallest value, equal simply to the resistance R.

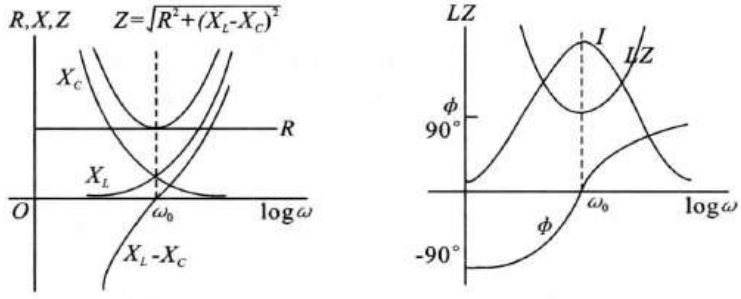


Fig. 12 – 1 (a) Reactance, resistance, and impedance as functions of angular frequency (logarithmic angular frequency scale). (b) Impedance, current, and phase angle as functions of angular frequency (logarithmic angular frequency scale).

As we vary the angular frequency ω of the source, the current amplitude $I = V/Z$ varies as shown in Fig. 12 – 1(b); the maximum value of I occurs at the frequency at which the impedance Z is minimum. This peaking of the current amplitude at a certain frequency is called resonance. The angular frequency ω_0 at which the resonance peak occurs is called the resonance angular frequency. This is the angular frequency at which the inductive and capacitive reactances are equal, so at resonance,

$$X_L = X_C, \omega_0 L = \frac{1}{\omega_0 C}, \ \omega_0 = \frac{1}{LC} \ (L-R-C \text{ series circuit at resonance}). \qquad (12-1)$$

Note that this is equal to the natural angular frequency of oscillation of an $L-C$ circuit. The resonance frequency f_0 is $\omega_0/2\pi$. This is the frequency at which the greatest current appears in the circuit for a given source voltage amplitude; in other words, f_0 is the frequency to which the circuit is "tuned."

It's instructive to look at what happens to the voltages in an $L-R-C$ series circuit at resonance. The current at any instant is the same in L and C. The voltage across an inductor always leads the current by 90°, or 1/4 cycle, and the voltage across a capacitor always lags the current by 90°. Therefore the instantaneous voltages across L and C always differ in phase by 180°, or 1/2 cycle; they have opposite signs at each instant. At the resonance frequency, and only at the resonance frequency, $X_L = X_C$ and the voltage amplitudes $V_L = IX_L$ and $V_C = IX_C$ are equal; then the instantaneous voltages across L and C add to zero at each instant, and the total voltage across the $L-C$ combination is exactly zero. The voltage across the resistor is then equal to the source voltage. So at the resonance frequency the circuit behaves as if the inductor and capacitor weren't there at all!

The phase of the voltage relative to the current is given. At frequencies below resonance, X_C is greater than X_L; the capacitive reactance dominates, the voltage lags the current, and the phase angle ϕ is between zero and $-90°$. Above resonance the inductive reactance dominates; the voltage leads the current, and the phase angle is between zero and $+90°$. This variation of ϕ with angular frequency is shown in Fig. 12 – 1(b).

If we can vary the inductance L or the capacitance C of a circuit, we can also vary the resonance frequency.[2] **This is exactly how a radio or television receiving set is "tuned" to receive a particular station.** In the early days of radio this was accomplished by use of capacitors with movable metal plates whose overlap could be varied to change C. A more modern approach is to vary L by using a coil with a ferrite core that slides in or out.

In a series $L-R-C$ circuit the impedance reaches its minimum value and the current its maximum value at the resonance frequency. The middle curve in Fig. 12-2 is a graph of current as a function of frequency for such a circuit, with source voltage amplitude $V=100$ V, $L=2.0$ H, $C=0.50$ μF, and $R=500$ Ω. This curve is called a response curve or a resonance curve. The resonance angular frequency is $\omega_0 = (LC)^{-1/2} = 1000$ rad/s. As we expect, the curve has a peak at this angular frequency.

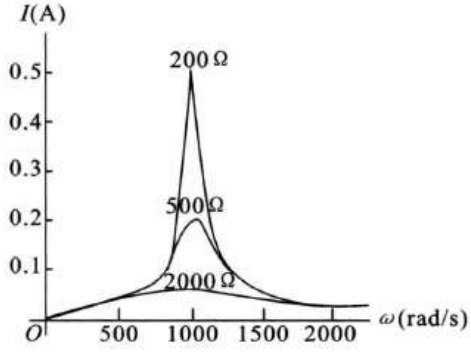


Fig. 12-2 Graph of current amplitude I as a function of angular frequency ω for an $L-R-C$ series circuit with $V=100$ V, $L=2.0$ H, $C=0.50$ μF, and $R=500$ Ω. The other curves show the relationship for different values of the resistance, $R=2000$ Ω and $R=200$ Ω.

The resonance frequency is determined by L and C; what happens when we change R? Fig. 12-2 also shows graphs of I as a function of ω for $R=200$ ω and for $R=2000$ ω. The curves are similar for frequencies far away from resonance, where the impedance is dominated by X_L or X_C. But near resonance, where X_L and X_C nearly cancel each other, the curve is higher and more sharply peaked for small values of R and broader and flatter for large values of R. At resonance, $Z=R$ and $I=V/R$, so the maximum height of the curve is inversely proportional to R.

The shape of the response curve is important in the design of radio and television receiving circuits. The sharply peaked curve is what makes it possible to discriminate between two stations broadcasting on adjacent frequency bands. But if the peak is too sharp, some of the information in the received signal is lost, such as the high-frequency sounds in music. The shape of the resonance curve is also related to the overdamped and underdamped oscillations. A sharply peaked resonance curve corresponds to a small value of R and a lightly damped oscillating system; a broad, flat curve goes with a large value of R and a heavily damped system.

In this section we have discussed resonance in an $L-R-C$ series circuit. Resonance can also occur in an ac circuit in which the inductor, resistor, and capacitor are connected in parallel.

[3] **Resonance phenomena occur not just in ac circuits, but in all areas of physics.** We discussed examples of resonance in mechanical systems. The amplitude of a mechanical oscillation peaks when the driving-force frequency is close to a natural frequency of the system; this is analogous to the peaking of the current in an $L-R-C$ series circuit. We suggest that you review the sections on mechanical resonance now, looking for the analogies. Other important examples of resonance occur in atomic and nuclear physics and in the study of fundamental particles (high-energy physics).

12.2 生词表 New Words

arise from 产生于
angular frequency 角频率
tuning circuit 调谐电路
receiver circuit 接收电路
amplitude *n.* 振幅
resonance *n.* 共振
audible sound 可听声
adjustable *adj.* 可调节的
impedance *n.* 阻抗
logarithmic angular frequency scale 对数角频率尺度
inductive reactance 感抗
capacitive reactance 容抗
oscillation *n.* 振动
instant *n.* 瞬间,时刻
lead *v.* 领先
lag *v.* 滞后
inductance *n.* 电感;自感系数
capacitance *n.* 电容
coil with a ferrite core 带铁磁芯的线圈
minimum value 最小值
maximum value 最大值
overdamped *adj.* 过阻尼的
underdamped *adj.* 欠阻尼的
flat curve 平缓曲线
go with 相伴,伴随
mechanical system 机械系统
driving-force 驱动力
be analogous to 类似于,与……相似
high-energy physics 高能物理学

12.3 课文注释 Text Annotation

【1】We have used a logarithmic angular frequency scale so that we can cover a wide range of frequencies.

我们使用对数角频率尺度,这样可以覆盖很宽的频率范围。

so that we can cover a wide range of frequencies 是结果状语从句。

结果状语从句常用引导词有:so...that, so that, such... that, 特殊引导词有:such that, to the degree that, to the extent that, to such a degree that 等。结果状语从句一般表示已经发生的事情。

e. g. :Her parents made many sacrifices so that she could go to university.

她父母为她上大学在多方面作了牺牲。

Our normalization is such that the curves in fig. 3 can be regarded as probability distributions.

我们的标准化处理使得图3中的曲线可以被看做概率分布曲线。

This needs to increase the height of the column and beam sizes, since such buildings can be more robust to the extent that the permissible limits under a wind load without bending and tilt.

这样的高度需要增大柱和梁的尺寸,这样一来可以使建筑物更加坚固以便在允许的限度范围内承受风荷载而不产生弯曲和倾斜。

【2】This is exactly how a radio or television receiving set is "tuned" to receive a particular station.

这正是广播或电视是如何"调谐"接收特定的发射信号的。

该句 how a radio or television receiving set is "tuned" to receive a particular station 是表语从句。

●表语从句

▶1. 定义:名词性从句在 be 等系动词后作表语时被称为表语从句。可接表语从句的连系动词有 be, look, seem, sound, appear 等。

▶2. 表语从句的种类:

(1)从属连词 whether, as, as if/though 引导的表语从句。

e. g. : The point is whether we should recommend him.

问题是我们应否推荐他。

I feel as if I have some fever.

我感到好像发烧了。

(2) because, why 引导的表语从句。

e. g. : It is because he didn't turn off the stove that caused the fire.

正是因为他没关炉子导致了这场火灾。

It is why compounds obey this law.

这就是为什么化合物受这一定律的支配。

(3) 连接代词 who, whom, whose, what, which, whoever, whatever, whichever 和连接副词 where, when, how, why 引导的表语从句。

e. g. : The problem is who we can get to carry out the experiment.

问题是我们找谁去做实验。

The question is how we can determine the direction of each particle in the medium.

问题是如何确定媒质中每个粒子的运动方向。

That's where Aristotle was wrong.

这就是亚里士多德的错误所在。

(4)从属连词 that 引导的表语从句。

e. g. : Lucky it is that we know her name.

幸运的是我们知道她的名字。

(5)使用虚拟语气的表语从句。当句子的主语是 advice, demand, decision, desire, idea, insistence, instruction, order, plan, proposal, recommendation, request, requirement, suggestion, wish 等表示建议、劝告、命令含义的名词时,表语从句中的谓语动词须用虚拟语气。

e. g. : My advice is that you should get their permission as early as possible.
我的忠告是你应该尽早得到他们的允诺。
My suggestion is that we should set up a working group.
我的建议是我们应该建立一个工作小组。
My wish is that I would enter a famous university.
我的希望是上一所重点大学。

【3】Resonance phenomena occur not just in ac circuits, but in all areas of physics.
共振现象不只发生在交流电路中,在物理学的各个领域都会发生。
"not just ... but ..." 翻译为"不仅……还……,不仅……而且……"。
e. g. : We seek not just freedom but opportunity.
我们不仅追求自由,而且追求机会。
This is why a discipline requires not just research but also teaching.
这就是为什么一个学科不仅需要研究还需要教育。

12.4 扩展阅读 Extended Reading

The Direct-Current Motor

No one needs to be reminded of the importance of electric motors in contemporary society. In a motor a magnetic torque acts on a current-carrying conductor, and electric energy is converted to mechanical energy. As an example, let's look at a simple type of direct-current (dc) motor, shown in Fig. 12 - 3.

The moving part of the motor is the rotor, a length of wire formed into an open-ended loop and free to rotate about an axis. The ends of the rotor wires are attached to circular conducing segments that form a commutator. In Fig. 12 - 3(a), *each of the two commutator segments makes contact with one of the terminals, or brushes, of an external circuit that includes a source of emf. This causes a current to flow into the rotor on one side, shown in near pole N and out of the rotor on the other side, shown in near ople S. Hence the rotor is a current loop with a magnetic moment* $\vec{\mu}$. *The rotor lies between opposing poles of a permanent magnet, so there is a magnetic field that exerts a torque* $\vec{\tau} = \vec{\mu} \times \vec{B}$ *on the rotor. For the rotor orientation shown in* Fig. 12 - 3(a) *the torque causes the rotor to turn counterclockwise, in the direction that will align* $\vec{\mu}$ *with* $\vec{B}$.

In Fig. 12 - 3(b) *the rotor has rotated by* 90° *from its orientation in* Fig. 12 - 3(a). *If the current through the rotor were constant, the rotor would now be in its equilibrium orientation; it would simply oscillate around this orientation. But here's where the commutator comes into play; each brush is now in contact with both segments of the commutator. There is no potential difference between the commutator, so at this instant no current flows through the rotor, and the magnetic moment is zero. The rotor continues to rotate counterclockwise because of its inertia, and current again flows through the rotor as in* Fig. 12 - 3(c). *But now current enters on the near N side of the rotor*

and exits on the near S side, just the opposite of the situation in Fig. 12 – 3(a). *While the direction of the current has reversed with respect to the rotor, the rotor itself has rotated* 180° *and the magnetic moment* $\vec{\mu}$ *is in the same direction with respect to the magnetic field. Thanks to the commutator, the current reverses after every* 180° *of rotation, so the torque is always in the direction to rotate the rotor counterclockwise. When the motor has come "up to speed," the average magnetic torque is just balanced by an opposing torque due to air resistance, friction in the rotor bearings, and friction between the commutator and brushes.*

The simple motor shown in Fig. 12 – 3 *has only a single turn of wire in its rotor. In practical motors, the rotor has many turns; this increases the magnetic moment and the torque so that the motor can spin larger loads. The torque can also be increased by using a stronger magnetic field, which is why many motor designs use electromagnets instead of a permanent magnet. Another drawback of the simple design in* Fig. 12 – 3 *is that the magnitude of the torque rises and falls as the rotor spins. This can be remedied by having the rotor include several independent coils of wire oriented at different angles.*

Because a motor converts electric energy to mechanical energy or work, it requires electric energy input. If the potential difference between its terminals is V_{ab} *and the current is I, then the power input is* $P = V_{ab} I$. *Even if the motor coils have negligible resistance, there must be a potential difference between the terminals if P is to be different from zero. This potential difference results principally from magnetic forces exerted on the currents in the conductors of the rotor as they rotate through the magnetic field. The associated electromotive force* ε *is called an induced emf; it is also called a back emf because its sense is opposite to that of the current.*

In a series motor the rotor is connected in series with the electromagnet that produces the magnetic field; in a shunt motor they are connected in parallel. In a series motor with internal resistance r, V_{ab} *is greater than* ε, *and the difference is the potential drop Ir across the internal resistance. That is,*

$$V_{ab} = \varepsilon + Ir. \tag{12-2}$$

Because the magnetic force is proportional to velocity, ε *is not constant but is proportional the speed of rotation of the rotor.*

A dc motor with its rotor and field coils connected in series has an internal resistance of 2.00 Ω. *When running at full load on a* 120-V *line, it draws a current of* 4.00 A.

a) What is the emf in the rotor?

b) What is the power delivered to the motor?

c) What is the rate of dissipation of energy in the resistance of the motor?

d) What is the mechanical power developed?

e) What is the efficiency of the motor?

f) What happens if the machine the motor is driving jams and the rotor suddenly stops turning?

***Solution*:**

a) From Eq. $V_{ab} = \varepsilon + Ir$, *we have* 120 V $= \varepsilon +$ (4.0 A)(2.0 Ω), *and so* $\varepsilon =$ 112 V.

b) The power input P from the source is $P_{input} = V_{ab} I =$ (120 V)(4.0 A) = 480 W.

c) The power P dissipated in the resistance r is $P_{\text{dissipated}} = I^2 r = (4.0\ \text{A})^2(2.0\ \Omega) = 32\ \text{W}$.

d) The mechanical power output is the electric power input minus the rate of dissipation of energy in the motor's resistance (assuming that there are no other power losses): $P_{\text{output}} = P_{\text{input}} - P_{\text{dissipated}} = 480\ \text{W} - 32\ \text{W} = 448\ \text{W}$.

e) The efficiency e is the ratio of mechanical power output to electric power input: $e = P_{\text{output}}/P_{\text{input}} = 448\ \text{W}/480\ \text{W} = 0.93 = 93\%$.

f) With the rotor stalled, the back emf ε *(which is proportional to rotor speed) goes to zero. From* Eq. (12-2) *the current becomes*

$$I = V_{ab}/r = 120\ \text{V}/2.0\ \Omega = 60\ \text{A},$$

and the power dissipation P in the resistance r becomes

$$P_{\text{dissipated}} = I^2 r = (60\ \text{A})^2(2\ \Omega) = 7200\ \text{W}.$$

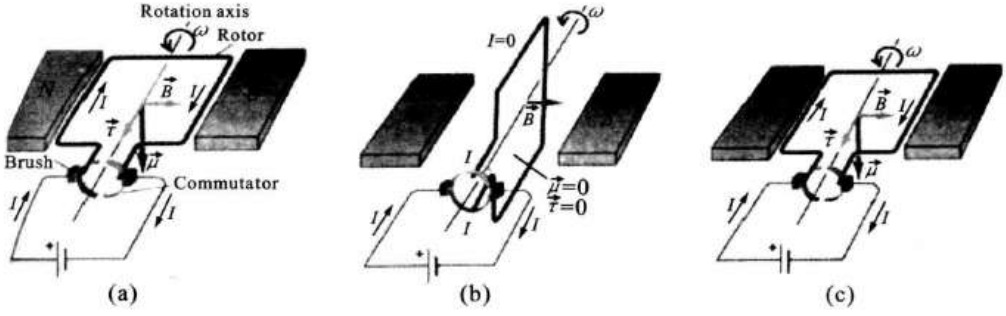


Fig. 12-3 Schematic diagram of a simple dc motor. The rotor is a wire loop that is free to rotate about an axis; the rotor ends are attached to the two curved conductors that form the commutator. The commutator segments are insulated from one another. (a) The brushes are aligned with the commutator segments, and current flows into one side of the rotor and out of the other side. The magnetic torque causes the rotor to spin counterclockwise. (b) The rotor has turned by 90°. Each brush is in contact with both commutator segments, so the current bypasses the rotor altogether. (c) As the rotor rotates beyond the position in (b), current again flows through the commutator into the rotor, but now current flows into the near N side and out of the near S side. The magnetic torque acts in the same direction as in (a).

If this massive overload doesn't blow a fuse or trip a circuit breaker, the coils will quickly melt. When the motor is first turned on, there's a momentary surge of current until the motor picks up speed. This surge causes greater-than-usual voltage drops (V = IR) in the power lines supplying the current. Similar effects are responsible for the momentary dimming of lights in a house when an air-conditioner or dishwasher motor starts.

12.5 常用用法 Usages and Expressions

电子学和电路中常见的缩写 Abbreviation in Electronics and Circuits

DC Direct Current 直流电

DIS Disable 不允许端

DPDT Double-Pole Double-Throw 双刀双掷开关

DS Digital Select 数字选择端
E Enable 允许端
ECL Emitter-Coupled Logic 发射核耦合逻辑
EPROM Erasable PROM 可擦除可编程
F Frequency 频率
FET Field-Effect Transistor 场效应晶体管
FF Flip-Flop 触发器
Gen Generatol 发生器,振荡器
H High Level 高电平
Hi-Fi High Fidelity 高保真度
Hz Hertz 赫,赫兹
IC Integrated Circuit 集成电路
I2L Integrated Injection Logic 集成注入逻辑
I/O Input/Output 输入输出
L Low Level 低电平
LC Liquid Crystal 液晶
LCD Liquid Crystal Display 液晶显示器
LD Latch Disable 锁存不允许端
LE Latch Enable 锁存允许端
LED Light-Emitting Diode 发光二极管
A/D Analog to Digital Converter 模数转换器
AC Alternating Current 交流电
AF Audio Frequency 音频
APL Automatic Phase Lock 自动相位同步
BCD Binary Coded Decimal 二进制编码的十进制
BP Bandpass 低通
BS Button Switch 按钮开关
CE Chip Enable 片允许端
CLK Clock 时钟脉冲,时钟
CLR Clear 清零,清除
CMOS Complementary Metal-Oxide Semiconductor 互补金属氧化物半导体
CPU Central Processing Unit 中央处理单元
CS Chip Select 片选端
D Data 数据
D/A Digital to Analog Converter 数字—模拟转换器
LSB Least-Significant Bit (or Byte) 最小标志位
LSI Large-Scale Integration 大规模集成电路
MODEM Modulator/Demodulato 调制器/解调器
MOS Metal-Oxides Semiconductor 金属氧化物半导体

MR Master Reset 主复位
MSB Most Significant Bit(or Byte) 最高标志位
NAND Not And 与非
NC NO Connection 悬空端
NMOS N-Channel MOS N 沟道金属氧化物半导体
NOR Not Or 或非门
NSC National Semiconductor Corporation(美国)全国半导体公司
OF Over Flow 溢出
OP Amp Operational Amplifier 运算放大器
Out Output 输出
PA Power Amplifier 功率放大器
PA Port A A 口
PB Port B B 口
PC Port C C 口
PLL Phase—Locked Loop 锁相环
RAM Random Access Memory 随机存取器
RBI Ripple Blanking Input 逐位消隐输入
RBO Ripple Blanking Output 逐位消隐输出
RCA Radio Corporation of America 美国无线电公司
RD Read 读
ROM Read-Only Memory 只读存储器
RS Reset-Set 复位置位
RST Reset 复位
R/W Read/Write 读/写
S Select 选择
SAD Serial Analog Delay 串联模拟延迟器
SCR Silicon-Controlled Rectifier 可控硅整流器
SER IN Serial Input 串行输入
SID Serial Input Data 串行输入数据
SIG Signal 信号
SLFO Super Low Frequency Oscillator 超低频振荡器
SOD Serial Output Data 行输出数据
SPKR Speaker 扬声器
SSI Small Scale Integration 小规模集成电路
TTL Transistor-Transistor Logic 晶体管—晶体管逻辑电路
VCO Voltage Controlled Oscillation 压控振荡器

WE Write Enable 写允许端
WR Write 写线
XOR Exclusive Or 异或门
XTAL Crystal 晶振连接端

12.6 同义词辨析 Synonyms

wrong, incorrect, abnormal, bad, improper, inappropriate, immoral, unfair, unjust, sinful, false, unnatural, mistaken, inaccurate, misguided, untrue

These words all describe sth. that is not right or correct, or sb. who is not right about sth.
以上各词均指“错误;不正确;犯错”。

◆ wrong not right or correct; (of a person) not right about sb./sth. 错误的,不正确的;(人)出错,搞错,有错误

e. g. : Your calculations must be wrong.
你肯定算错了。
I think I got question 3 wrong.
我想我第三题做错了。

【习惯用法】
go wrong 发生故障,出毛病

◆ incorrect (rather formal) wrong according to the facts containing mistakes 与事实不符的,不准确的,不正确的

e. g. : The information you gave us was incorrect.
你给我们的信息是错误的。

◆ abnormal different from what is usual or expected, especially in a way that is worrying, harmful or not wanted 不正常的;反常的;变态的;畸形的

e. g. : My parents thought it was abnormal for a boy to be interested in ballet.
我父母认为一个男孩子对芭蕾舞感兴趣不正常。

◆ bad not appropriate in a particular situation 不适合的,不适当的

e. g. : Cutting spending at this time is a bad idea.
这个时候削减开支不是个好主意。
Making big changes in your diet all at once is a bad thing to do.
饮食一下子有很大的改变不好。

【习惯用法】
be bad at 拙于……
go bad 变坏,腐烂
from bad to worse 越来越坏

◆ improper not suited or appropriate to the situation 不适合的;不适当的;不得体的

e. g. :It would be improper for me to comment before the election outcome is known.
在选举结果未知的情况下我要作出评论是不恰当的。

◆ inappropriate not suitable or appropriate in a particular situation 不适当的;不合适的

e. g. :His comments were wholly inappropriate on such a solemn occasion.
他在这么严肃的场合中说这样的话完全不恰当。

◆ immoral not considered to be good or honest by most people 不道德的;邪恶的

e. g. :Deliberately making people suffer is immoral.
故意使人吃苦头是不道德的。

◆ unfair not right or fair according to a set of rules or principles; not treating people equally 不公正的;不公平的;待人不平等的

e. g. :law aimed at preventing unfair competition
旨在防止不公平竞争的法令
Many employers have recognized that age discrimination is unfair.
许多雇主已经认识到年龄歧视是不公平的。

◆ unjust not deserved or fair 不公平的;不公正的;非正义的

e. g. :The attack on Charles was deeply unjust.
对查尔斯的攻击甚为不公。
He spent 25 years campaigning against racist and unjust immigration laws.
他用了 25 年的时间与带有种族歧视色彩和没有公正可言的移民法作斗争。

◆ sinful morally wrong or evil 不道德的;邪恶的

e. g. :Dancing was believed to be sinful.
跳舞曾被认为是不道德的。

◆ false not true or correct; wrong because it is based on sth. that is not true or correct 不正确的;不真实的

e. g. :I don't want to give you any false hopes.
我不想给你任何错误的希望。
Please decide whether the following statements are true or false.
请判断下面说法的对错。

【习惯用法】
false identity 假身份证
false hair 假发

◆ unnatural different from anything in nature 不正常的,怪异的

e. g. :It was very cold, which seemed unnatural for late spring.
天很冷,对于晚春来说似乎不正常。

◆ mistaken wrong in your opinion or judgement; based on a wrong opinion or bad judgement (意见或判断)不正确的

e. g. : Marijuana has few withdrawal effects, and this has given rise to the mistaken belief that it is not addictive.

大麻的脱瘾症状不多,这就让人们错误地认为它不会使人上瘾。

◆ inaccurate wrong according to the facts; containing mistakes 与事实不符的;不准确的;不正确的

e. g. : A lot of what has been written about him is inaccurate.

关于他的描述有大量失实之处。

INCORRECT OR INACCURATE? 用 incorrect 还是 inaccurate?

A fact, figure or spelling that is wrong is incorrect; information, a belief or a description based on incorrect facts can be incorrect or inaccurate; something that is produced, such as a film, report or map, that contains incorrect facts is inaccurate. 事实、数据或拼写错误用 incorrect; 以错误事实为基础的信息、看法或描述可用 incorrect 或 inaccurate; 影片、报告或地图等制品与事实不符用 inaccurate。

◆ misguided wrong because you have understood or judged a situation badly (理解、判断)失误的

e. g. : His parents still adhere to the misguided belief that his common sense would keep him out of serious trouble.

他的父母还是坚持这个错误想法,以为他的常识会让他避开大的麻烦。

◆ untrue not based on facts, but invented or guessed 无事实根据的,捏造的,猜想的

e. g. : It's untrue to say that the situation has not changed.

说情况没有改变,这是没有根据的。

12.7 练习题 Exercise

(12-1)阅读文章并回答问题。

On a Monday morning in July, the world's first atom bomb exploded in the New Mexico desert. Forty seconds later, the shock waves reached the base camp where the Italian-American physicist Enrico Fermi and his team stood. After a mental calculation, Fermi announced to his team that the bomb's energy had equated 10,000 tons of TNT. The bomb team was impressed, but not surprised. Fermi's genius was known throughout the scientific world. In 1938 he had won a Nobel Prize. Four years later he produced the first nuclear chain reaction, leading us into the nuclear age. Since Fermi's death in 1954, no physicist has been at once a master experimentalist and a leading theoretician.

Like all virtuosos, Fermi had a distinctive style. He preferred the most direct route to an answer. He was very good at dividing difficult problems into small, manageable bits—talent we all can use in our daily lives.

To develop this talent in his students, Fermi would suggest a type of question now known as a

Fermi problem. Upon first hearing one of these, you haven't the remotest notion of the answer, and you feel certain that too little information had been given to solve it. Yet when the problem is broken into sub-problems, each answerable without the help of experts or books, you can come close to the exact solution.

Suppose you want to determine Earth's circumference without looking it up. Everyone knows that New York and Los Angeles are about 3,000 miles apart and that the time difference between them is three hours. Three hours is one-eighth of a day, and a day is the time it takes the planet to complete one rotation, so its circumference must be eight times 3,000 or 24,000 miles. The answer differs from the true value, 24,902.45 miles, by less than four percent.

Ultimately the value of dealing with everyday problems the way Fermi did lies in the rewards of making independent discoveries and inventions. It doesn't matter whether the discovery is as important as determining the power of an atom or as small as measuring the distance between New York and Los Angeles. Looking up the answer, or letting someone else find it, deprives you of the pleasure and pride that accompany creativity, and deprives you of an experience that builds up self-confidence. Thus, approaching personal dilemmas as Fermi problems can become a habit that enriches your life.

[1] Fermi's team was impressed by Fermi's announcement in the base camp because he could even work out the power of the atom bomb in his mind.

A. True B. False C. Not mentioned

[2] Fermi, an experimentalist as well as a theoretician, won a Nobel Prize for reducing the first nuclear chain reaction in the world.

A. True B. False C. Not mentioned

[3] Dividing a big problem into small problems is a talent Fermi had and a talent that has practical value in life.

A. True B. False C. Not mentioned

[4] Fermi problem is to develop the talent of breaking a seemingly unanswerable problem into sub-problems and finding the solution to it, which is a typical Fermi problem.

A. True B. False C. Not mentioned

[5] Then the fourth paragraph tells us how Fermi solved the problem of earth's circumference without looking up.

A. True B. False C. Not mentioned

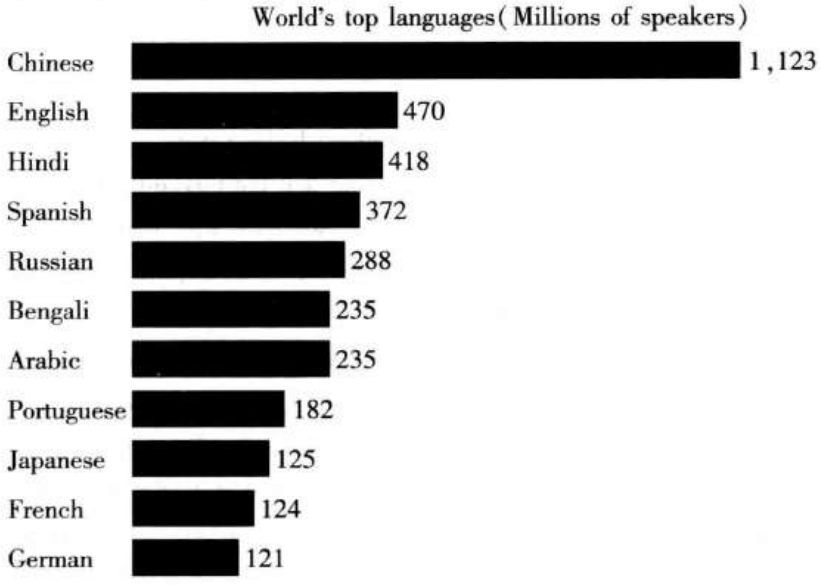
[6] The last paragraph concludes the whole writing by stressing the value of important inventions and small discoveries.

A. True B. False C. Not mentioned

[7] Fermi was famous for inventing a device to calculate bomb's energy accurately.

A. True B. False C. Not mentioned

(12-2)根据图表完成填空。



The chart shows the world's top ten languages. These include the main European and Indian languages as well as ____[1]____ and Arabic. According to the graph, Chinese is the ____[2]____ widely used language in the world with ____[3]____ speakers. English is the ____[4]____ most popular language with a total of ____[5]____ speakers. Hindi is also very ____[6]____ spoken and in fourth place we find Spanish, which is the ____[7]____ most popular European language, closely followed by Russian, Bengali and Arabic. The number of Japanese speakers currently stands at ____[8]____ which, we can see, is slightly ____[9]____ than the 124 million French speakers. The ____[10]____ widely spoken language mentioned in the chart is German which has the ____[11]____ small number of 121 million speakers.

第五章 近代物理学

Lesson 13

内容 13.1 引言 Introduction
13.2 物理定律的不变性 Invariance of Physical Laws
13.3 生词表 New Words
13.4 课文注释 Text Annotation
13.5 扩展阅读 Extended reading:
Ⅰ. 时空图 Spacetime Diagrams
Ⅱ. 电磁波的多普勒效应 The Doppler Effect for Electromagnetic Waves
13.6 常用用法 Usages and Expressions
近代物理及综合设计实验仪器 Modern Physics and Comprehensive Experimental Instruments
13.7 同义词辨析 Synonyms
13.8 练习题 Exercise

13.1 引言 Introduction

When the year 1905 began, Albert Einstein was an unknown 25-year-old clerk in the Swiss patent office. By the end of that amazing year he had published three papers of extraordinary importance. One was an analysis of Brownian motion; a second (for which he was awarded the Nobel Prize) was on the photoelectric effect. In the third, Einstein introduced his special theory of relativity, proposing drastic revisions in the Newtonian concepts of space and time.

The special theory of relativity has made wide-ranging changes in our understanding of nature, but[1] **Einstein based it on just two simple postulates. One states that the laws of physics are the same in all inertial frames of reference; the other states that the speed of light in vacuum is the same in all inertial frames.** These innocent-sounding propositions have far-reaching implications. Here are three: (1) Events that are simultaneous for one observer may not be simultaneous for another. (2) When two observers moving relative to each other measure a time interval or a length, they may not get the same results. (3) For the conservation principles for momentum and energy to be valid in all inertial systems, Newton's second law and the equations for momentum and kinetic energy have to be revised.

Relativity has important consequences in all areas of physics, including electromagnetism, atomic and nuclear physics, and high-energy physics. Although many of the results derived in this charter run counter to your intuition, the theory is in solid agreement with experimental observations.

13.2 物理定律的不变性 Invariance of Physical Laws

Einstein's First Postulate

Einstein's first postulate, called the principle of relativity, states: The laws of physics are the same in every inertial frame of reference. If the laws differed, that difference could distinguish one inertial frame from the others or make one frame somehow more "correct" than another. Here are two examples. Suppose you watch two children playing catch with a ball while the three of you are aboard a train moving with constant velocity. Your observations of the motion of the ball, no matter how carefully done, can't tell you how fast (or whether) the train is moving. This is because Newton's laws of motion are the same in every inertial frame.

Another example is the electromotive force (emf) induced in a coil of wire by a nearby moving permanent magnet. In the frame of reference in which the coil is stationary (Fig. 13 - 1(a)), the moving magnet causes a change of magnetic flux through the coil, and this induces an emf. In a different frame of reference in which the magnet is stationary (Fig. 13 - 1(b)), the motion of the coil through a magnetic field induces the emf.

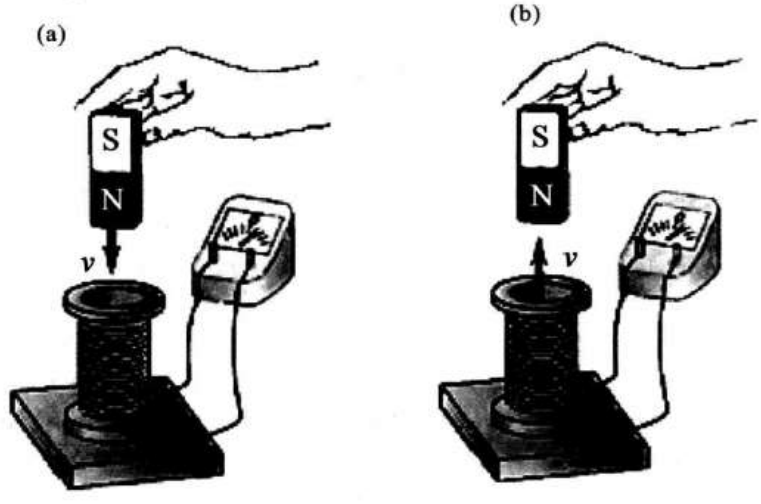


Fig. 13 - 1 The same result from two different reference frames. (a) In the fame of reference of the coil, the moving magnet increases the magnetic flux through the stationary coil, including an emf. (b) In the reference fame of the magnet, the moving coil increases the magnetic flux to induce the emf.

According to the principle of relativity, both of these frames of reference are equal valid. Hence the same emf must be induced in both situations shown in Fig. 13 – 1. As we saw, this is indeed of case, so Faraday's law is consistant with the principle of relativity. Indeed, all of the laws of electromagnetism are the same in every inertial frame of reference.

Equally significant is the prediction of the speed of electromagnetic radiation, derived from Maxwell's equations. According to this analysis, light and all other electromagnetic waves travel in vacuum with a constant speed, now defined to equal exactly 299,792,458 m/s. (We often use the approximate value $c = 3.00 \times 10^8$ m/s, which is within one part in 1000 of the exact value.) As we will see, the speed of light in vacuum plays a central role in the theory of relativity.

Einstein's Second Postulate

[2] **During the 19th century, most physicists believed that light traveled through a hypothetical medium called the ether, just as sound waves travel through air.** If so, the speed of light measured by observers would depend on their motion relative to the ether and would therefore be different in different directions. The Michelson-Morley experiment was an effort to detect motion of the earth relative to the ether. Einstein's conceptual leap was to recognize that if Maxwell's equations are valid in all inertial frames, then the speed of light in vacuum should also be the same in all frames and in all directions. In fact, Michelson and Morley detected no ether motion across the earth, and the ether concept has been discarded. Although Einstein may not have known about this negative result, it supported his bold hypothesis of the constancy of the speed of light in vacuum.

Thus Einstein was led to his second postulate: The speed of light in vacuum is the same in all inertial frames of reference and is independent of the motion of the source. Let's think about what this means. Suppose two observers measure the speed of light in vacuum. One is at rest with respect to the light source, and the other is moving away from it. Both are in initial frames of reference. According to the principle of relativity, the two observers must obtain the same result, despite the fact that one is moving with respect to the other.

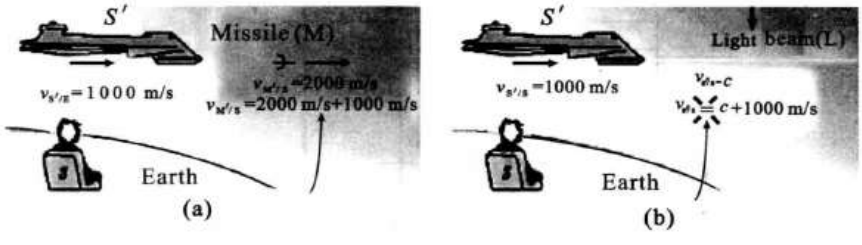


Fig. 13 – 2 A spaceship (S') moves with speed $v_{S'/E}$ = 1000 m/s relative to the earth (E). It fires a missile (M) with speed v M/S′ = 2000 m/s relative to the spaceship. (a) Newtonian mechanics tells us that the missile moves at a speed of 3000 m/s relative to the earth. (b) Newtonian mechanics tells us that the light beam emitted by the spaceship moves at a speed greater than c relative to the earth; this contradicts Einstein's second postulate.

If this seems too easy, consider the following situation. A spacecraft moving past the earth at 1000 m/s fires a missile straight ahead with a speed of 2000 m/s (relative to the spacecraft) (Fig. 13 – 2). What is the missile's speed relative to the earth? Simple, you say: This is an elementary problem in relative velocity. The correct answer, according to Newtonian mechanics, is 3000 m/s. But now suppose the spacecraft turns on a searchlight, pointing in the same direction in which the missile was fired. An observer on the spacecraft measures the speed of light emitted by the searchlight and obtains the value c. According to Einstein's second postulate, the motion of the light after it has left the source cannot depend on the motion of the source. So the observer on earth who measures the speed of this same light must also obtain the value c, not $c + 1000$ m/s. This result contradicts our elementary notion of relative velocities, and it may not appear to agree with common sense. But "common sense" is intuition based on everyday experience, and this does not usually include measurements of the speed of light.

Einstein's second postulate immediately implies the following result: It is impossible for an inertial observer to travel at c, the speed of light in vacuum. We can prove this by showing that travel at c implies a logical contradiction. Suppose that the spacecraft S' in Fig. 13 – 2(b) is moving at the speed of light relative to an observer on the earth, so that $v_{S'/E} = c$. If the spacecraft turns on a headlight, the second postulate now asserts that the earth observer S measures the headlight beam to be also moving at c. Thus this observer measures that the headlight beam and the spacecraft move together and are always at the same point in space. But Einstein's second postulate also asserts that the headlight beam moves at a speed c relative to the spacecraft, so they cannot be at the same point in space. This contradictory result can be avoided only if it is impossible for an inertial observer, such as a passenger on the spacecraft, to move at c. As we go through our discussion of relativity, you may find yourself asking the question Einstein asked himself as a 16-year-old student, "What would I see if I were traveling at the speed of light?" Einstein realized only years later that his question's basic flaw was that he could not travel at c.

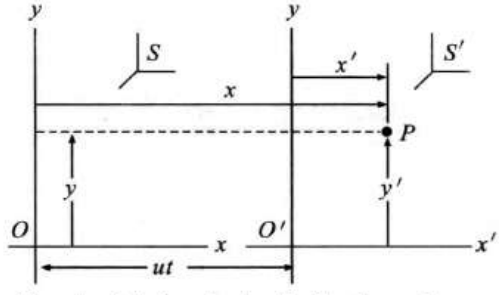


Fig. 13 – 3 The position of particle P can be described by the coordinates x and y in frame of reference S or by x' and y' in S'. Frame S' moves relative to S with constant velocity u along the common $x - x'$ – axis The two origins O and O' coincide at time $t = 0 = t'$.

Defining Inertial Frames of Reference

Let's restate this argument symbolically, using two inertial frames of reference, labeled S for the observer on earth and S' for the moving spacecraft, as shown in Fig. 13 – 3. To keep things as

simple as possible, we have omitted the z – axes. The x – axes of the two frames lie along the same line, but the origin O' of frame S' moves relative to the origin O of frame S with constant velocity u along the common $x - x'$ – axis. We on earth set our clocks so that the two origins coincide at time $t = 0$, so their separation at a later time t is ut.

Caution

Many of the equations derived in this chapter are true only if you define your inertial reference frames as stated in the preceding paragraph. For instance, the positive x – direction must be the direction in which the origin O' moves relative to the origin O. In Fig. 13 – 3 this direction is to the right; if instead O' moves to the left relative to O, you must define the positive x – direction to be to the left.

[3] **Now think about how we describe the motion of a particle *P*.** This might be an exploratory vehicle launched from the spacecraft or a pulse of light from a laser. We can describe the position of this particle by using the earth coordinates (x, y, z) in S or the spacecraft coordinates (x', y', z') in S'. Fig. 13 – 3 shows that these are simply related by

$$x = x' + ut \quad y = y' \quad z = z' \text{(Galilean coordinate transformation)}. \tag{13-1}$$

These equations, based on the familiar Newtonian notions of space and time, are called the Galilean coordinate transformation.

If particle P moves in the x – direction, its instantaneous velocity v as measured by an observer stationary in S is $v = \mathrm{d}x/\mathrm{d}t$. Its velocity v' as measured by an observer stationary in S' is $v' = \mathrm{d}x'/\mathrm{d}t$. We can derive a relationship between v and v' by taking the derivative with respect to t of the first of Eqs. (13 – 1):

$$\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{\mathrm{d}x'}{\mathrm{d}t} + u.$$

Now $\mathrm{d}x/\mathrm{d}t$ is the velocity v measured in S, and $\mathrm{d}x'/\mathrm{dt}$ is the velocity v' measured in S', so we get the Galilean velocity transformation for one-dimensional motion:

$$v = v' + u \text{ (Galilean velocity transformation)} \tag{13-2}$$

Although the notation differs, this result agrees with our discussion of relative velocities.

Now here's the fundamental problem. Applied to the speed of light in vacuum, Eq. (13 – 2) says that $c = c' + u$. Einstein's second postulate, supported subsequently by a wealth of experimental evidence, says that $c = c'$. This is a genuine inconsistency, not an illusion, and it demands resolution. If we accept this postulate, we are forced to conclude that Eqs. (13 – 1) and (13 – 2) cannot be precisely correct, despite our convincing derivation. These equations have to be modified to bring them into harmony with this principle.

The resolution involves some very fundamental modifications in our kinematic concepts. The first idea to be changed is the seemingly obvious assumption that the observers in frames S and S' use the same time scale, formally stated as $t = t'$. Alas, we are about to show that this everyday assumption cannot be correct; the two observers must have different time scales. We must define the velocity v'in frame S'as $v' = \mathrm{d}x'/\mathrm{d}t'$, not as $\mathrm{d}x'/\mathrm{d}t$; the two quantities are not the same. The

difficulty lies in the concept of simultaneity. A careful analysis of simultaneity will help us develop the appropriate modifications of our notions about space and time.

13.3 生词表 New Words

amazing *adj.* 令人惊奇的
extraordinary *adj.* 非凡的,特别的
Brownian motion 布朗运动
the Nobel Prize 诺贝尔奖
theory of relativity 相对论
drastic *adj.* 激烈的;猛烈的
photoelectric effect 光电效应
revision *n.* 修订,修改
high-energy physics 高能物理
inertial frames of reference 惯性参照系
no matter how 不管如何
Michelson-Morley experiment 迈克尔逊—莫雷实验
moving-magnet 可动磁铁
ether *n.* 以太
predict *v.* 预言,预测
discard *v.* 丢弃,抛弃
constancy *n.* 稳定性
with respect to 关于,至于
spacecraft *n.* (航天)宇宙飞船
impassible *adj.* 无感觉的
restate *v.* 再次声明,重申
symbolically *adv.* 象征性地
lie in 在于
harmony *n.* 一致

13.4 课文注释 Text Annotation

阿尔伯特·爱因斯坦(1879—1955),美籍德裔犹太人,1921 年诺贝尔物理学奖获得者,现代物理学的开创者、奠基人,相对论——"质能关系"的创立者,"决定论量子力学诠释"的捍卫者(振动的粒子)——不掷骰子的上帝。



他创立了代表现代科学的相对论,为核能开发奠定了理论基础,在现代科学技术和他的深刻影响下开创了现代科学新纪元,被公认为是自伽利略、牛顿以来最伟大的科学家、物理学家。1999 年 12 月 26 日,爱因斯坦被美国《时代周刊》评选为"世纪伟人"。

【1】Einstein based it on just two simple postulates. One states that the laws of physics are the same in all inertial frames of reference; the other states that the speed of light in vacuum is the same in all inertial frames.

爱因斯坦基于这样的两个简单假设。一个假设表明,物理定律在所有惯性参照系中都是相同的,另一个假设表明光速在真空中与在所有惯性系中是相同的。

one ...the other... 表示并列关系的列举。

物理学专业科技英语中经常会用到多项内容的列举,例如同一对象呈现出的多种特性、变化,支持同一结论的各种依据、原因、理论、方法等。各项内容之间的关系也不尽相同,可以是并列、递进或对比等。这些内容之间的关系可以通过使用过渡词来更为准确、清楚地表

达，同时增加了内容的条理性，不会使某些方面被忽略。这些过渡词语让我们把两个观点更好地衔接在一起，使行文或口语表达紧凑、流畅、条理清晰。

► 常见的表示列举的过渡词语：

(1)表示并列、顺序与附加关系：

at the same time 同时
as well as 也，以及
first of all 首先
in addition 除此之外
similar 类似的
both...and... ……和……都
in the same way 同样地
meanwhile 同时
also 也，而且，此外
first...second...third... next 首先……其次……再者……然后……
neither... nor... ……既不……也不
not only...but also... 不但……而且……
for one thing... ,for another... 一方面……另一方面……

(2) 表示递进关系：

even more 更
further 此外，进一步
moreover 此外，加之
furthermore 而且，此外
generally... furthermore... finally... 总的来说……此外……最后……
on the one hand... , on the other hand... 一方面……另一方面……

(3) 表示转折、让步与对照关系：

although 尽管，虽然
but 但是
compared to 与……相比
in spite of 尽管
however 然而
instead 代替，也可以
rather... than... 不是……而是……
otherwise 否则，要不然
yet 然而
not... but... 不是……而是……
sometimes... but not always... 有时……有时……

【2】During the 19th century, most physicists believed that light traveled through a hypothetical medium called the ether, just as sound waves travel through air.

19 世纪，大多数物理学家认为，光穿过一个假设的称为以太的介质传播，就像声波通过

空气传播一样。

just as 引导方式状语从句。

●方式状语从句常用的引导词有 as, just as, as if, how, as though 等。特殊引导词有 the way。

e. g. :The work was all properly ordered, just as he wanted it.

工作安排得井井有条,就像他要求的那样。

We must try to carry on as if nothing had happened.

我们必须继续下去,就当作什么都没有发生过。

If you don't like the way we're doing the job, sound off!

要是你不喜欢我们的工作方式就说出来。

【3】Now think about how we describe the motion of a particle *P*.

现在想想,我们如何描述一个粒子 *P* 的运动。

该句中 how 引导宾语从句。

● 宾语从句

► 1. 定义:宾语从句就是在复合句中作宾语的名词性从句。宾语从句通常放在主句谓语动词(及物动词)或介词之后。

► 2. 引导词:宾语从句通常由连词 that, whether/if, 连接代词 which, what, who/whom, whichever, whatever, 连接副词 how, where, why, 关系代词 what 引导。

e. g. :He told me (that) he would go to college the next year.

他告诉我他明年上大学。

I don't know if there will be a bus any more.

我不知道是否还会有公交车。

Nobody knew whether he could pass the exam.

没有人知道他是否会通过考试。

Do you know who has won *Red Alert* game?

你知道是谁赢得了《红色警戒》的游戏么?

The book will show you what the best CEOs should know.

这本书会告诉你最好的执行总裁该了解什么。

Have you determined whichever you should buy, a Motorola or Nokia cell phone?

你决定好是买诺基亚还是摩托罗拉的手机了吗?

He didn't tell me when we should meet again.

他没有告诉我什么时候我们能再见面。

Could you please tell me how you use the new panel?

你能告诉我怎么用这个新的操作盘吗?

None of us knows where these new parts can be bought.

没有人知道这些新零件能在哪里买到。

13.5 扩展阅读 Extended Reading

Ⅰ. 时空图 Spacetime Diagrams

We found that graphical representations can make kinematic concepts less abstract and also give useful information. For example, not only does a $v-t$ graph for one-dimensional motion show the velocity at any instant, but its slopes give accelerations, and areas under it give displacements. For relativity the transformations $y'=y$ and $z'=z$ are easy to understand, so we'll just consider the $\pm x$ directions.

The usual convention in relativity is to graph ct on the vertical axis and x on the horizontal axis. Such a graph provides us with a spacetime diagram. We use ct rather than t so that both scales can have the same unit and the same scale. The path of a particle forms a line, called its worldline, as the particle moves in one-dimensional motion. At any point, the slope of the worldline is $\mathrm{d}(ct)/\mathrm{d}x=(c\ \mathrm{d}t)/(v\ \mathrm{d}t)=c/v$. Thus a light pulse with $v=\pm c$ has a slope of ± 1 on a spacetime diagram, giving angles of $45°$ with the $\pm x-$axes. Since material particles have speeds less than c, all worldlines for material particles are steeper than those $45°$ angles. That is, nothing known has a worldline with a slope between -1 and 1. the worldline of a particle at rest is vertical and so has infinite slope. Fig. 13-4 *shows six worldlines, three of light pulses and three of particles. Can you show that these six worldlines agree with the statements made in this paragraph about their slopes?*

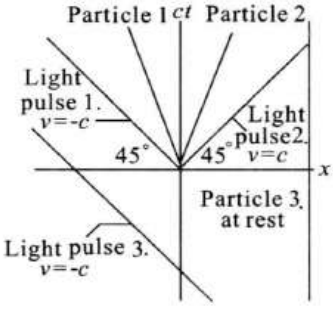


Fig. 13-4 A spacetime diagram showing worldlines of three light pulses and three particles. Particles 1 and 2 leave x=0 at t=0, accelerating from rest in opposite directions.

How does the S′ reference frame appear on our $ct-x$ spacetime diagram? Recall that we always set $x'=0$ at $S=0$ when $t'=0=t$ and let S′ move at a speed u in the $+x-$direction. But $x'=0$ all along the $ct'-$axis, so $x'=0$ and the $ct'-$axis have a worldline of slope c/u on our $ct-x$ spacetime diagram. For example, if $u=0.600c$, the $ct'-$axis is at an angle of arctan $(1/0.600)=59.0°$ *from the $x-$axis or $90.0°-59.0°=31.0°$ from the $ct-$axis.*

Surprisingly enough, the $x'-$axis is not drawn perpendicular to the $ct'-$axis on our $ct-x$ spacetime diagram. Since $ct'=0$ (so $t'=0$) along the $x'-$axis, the Eq. gives $(t-ux/c^2)=0$ or $ct=(u/c)x$ for the $x'-$axis. Thus the $x'-$axis is drawn with a slope of u/c on our $ct-x$ spacetime diagram. For $u=0.600c$ the $x'-$axis is at an angle of arctan $(0.600)=31.0°$ *from the x*

– axis. That is, the x′ – axis makes the same angle with the x – axis as the ct′ – axis makes with the ct – axis. We see in Fig. 13 – 5 *that the worldline of a light pulse leaving x′ = 0 = x at t′ = 0 = t with a velocity + c bisects the angle between either set of axes.*

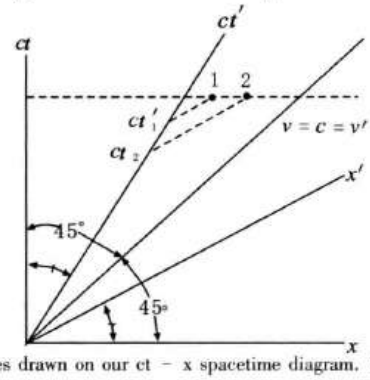


Fig. 13 – 5 The ct′ – and x′ – axes drawn on our ct – x spacetime diagram. Notice the two sets of equal angles.

On our spacetime diagram, the scale for the S′ axes is not the same as the scale for the S axes. For example, consider the dashed line x′ = 1 in Fig. 13 – 6, *which must be drawn parallel to the ct′ – axis. (We have left off the unit for generality; it could be x′ = 1 meter, x′ = 1 light year, or whatever is convenient.) This dashed line intercepts the x – axis at ct = 0. Substituting t = 0 in the Lorentz transformation x′ = γ(x – ut) gives x = 1/γ for the x′ = 1 line. In* Fig. 13 – 6, *u = 0. 60c and this intercept is at x = 0. 8. We can see that the symmetry of our spacetime diagram gives us the same scaling ratio for the ct′ – and ct – axes. To summarize, in comparison to the ct and x – axes, the ct′ – and x′ – axes are rotated through an angle* arctan(*u/c) toward the common v = c = v′ line at 45° and are stretched in scale so that the x′ = 1 line intercepts the x – axis at x = 1/γ.*

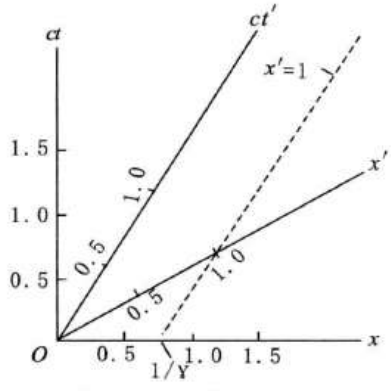


Fig. 13 – 6 A spacetime diagram for u = 0. 600c. The dashed line x′ = 1 intercepts the x′ – axis at x = 1 /γ = 0. 800. The scale of the S′ – axes is greater than that of the S – axes.

Let's finish this discussion with a simple example of length contraction. Mavis, at rest in frame S′, holds a meter stick with its left end at x′ = 0 and its right end at x′ = 1 m. *Thus in* Fig. 13 – 6 *the units are meters. At any time t′ measured in frame S′, the left end is at x′ = 0 (on the ct′ – axis) and the right end is on the x′ = 1 dashed line. In frame S the positions of both ends of the meter stick are measured at the same time t, then subtracted to find the length. For instance, at t = 0 (on the x – axis) we see from* Fig. 13 – 6 *that the left end of her stick is at x = 0 and the right end is at*

$x = 1/\gamma$. *Thus in S the meter stick has a contracted length of* $1/\gamma$.

Ⅱ. 电磁波的多普勒效应 The Doppler Effect for Electromagnetic Waves

An additional important consequence of relativistic kinematics is the Doppler effect for electromagnetic waves. In our previous discussion of the Doppler effect we quoted without proof the formula for the frequency shift that results from motion of a source of electromagnetic waves relative to an observer. We can now derive that result.

Here's a statement of the problem. A source of light is moving with constant speed u toward Stanley, who is stationary in an inertial frame (Fig. 13 – 7). *As measured in its rest frame, the source emits light waves with frequency* f_0 *and period* $T_0 = 1/f_0$. *What is the frequency f of these waves as received by Stanley?*

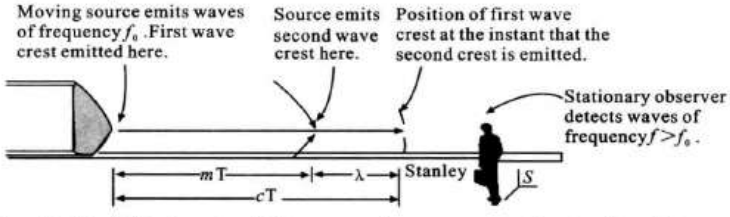


Fig. 13 – 7 The Doppler effect for light. A moving light source emits a wave crest, then travels a distance uT toward an observer and emits the next crest. In Stanley's reference frame S, the second crest is a distance λ behind the first, and the crests arrive a time λ/c apart, where $\lambda = (c - u)T$ and $T = \gamma T_0$.

Let T be the time interval between emissions of successive wave crests as observed in Stanley's reference frame. Note that this is not the interval between the arrival of successive crests at his position, because the crests are emitted at different points in Stanley's frame. In measuring only the frequency f he receives, he does not take into account the difference in transit times for successive crests. Therefore the frequency he receives is not $1/T$. *What is the equation for f ?*

During a time T the crests ahead of the source move a distance cT, and the source moves a shorter distance uT in the same direction. The distance λ *between successive crests—that is, the wavelength is thus* $\lambda = (c - u)T$, *as measured in Stanley's frame. The frequency that he measures is* c/γ. *Therefore*

$$f = \frac{c}{(c-u)T}. \tag{13-3}$$

So far we have followed a pattern similar to that for the Doppler effect for sound from a moving source. Our next step was to equate T to the time T_0 *between emissions of successive wave crests by the source. However, due to time dilation it is not relativistically correct to equate T to* T_0. *The time* T_0 *is measured in the rest frame of the source, so it is a proper time. The* T_0 *and T are related by*

$$T = \frac{T_0}{\sqrt{1 - u^2/c^2}} = \frac{cT_0}{\sqrt{c^2 - u^2}}$$

or, since $T_0 = 1/f_0$,

$$\frac{1}{T} = \frac{\sqrt{c^2 - u^2}}{cT_0} = \frac{\sqrt{c^2 - u^2}}{c} f_0.$$

Remember, $1/T$ is not equal to f. We must substitute this expression for $1/T$ into Eq. (13 - 3) *to find f:*

$$f = \frac{c}{c-u}\frac{\sqrt{c^2-u^2}}{c}f_0.$$

Using $c^2 - u^2 = (c-u)(c+u)$ gives

$$f = \sqrt{\frac{c+u}{c-u}}f_0 \qquad (\textit{Doppler effect, electromagnetic waves}). \qquad (13-4)$$

This shows that when the source moves toward the observer, the observed frequency f is greater than the emitted frequency f_0. The difference $f - f_0 = \Delta f$ is called the Doppler frequency shift. When u/c is much smaller than 1, the fractional shift $\Delta f/f$ is also small and is approximately equal to u/c:

$$\frac{\Delta f}{f} = \frac{u}{c}.$$

When the source moves away from the observer, we change the sign of u in Eq. (13 - 4) *to get*

$$f = \sqrt{\frac{c-u}{c+u}}f_0. \qquad (13-5)$$

This agrees with the Eq. (*Doppler effect for light*), *which we quoted previously, with minor notation changes.*

With light, unlike sound, there is no distinction between motion of source and motion of observer; only the relative velocity of the two is significant.

13.6 常用用法 Usages and Expressions

近代物理及综合设计实验仪器 Modern Physics and Comprehensive Experimental Instruments

physics design-orientated experimental modules 物理设计性实验模块

physics design-orientated experiment facilities 物理设计性实验装置

experiment facility of string vibration and sound 弦音实验仪

string vibration research experiment facility 弦振动研究实验仪

DC sputtering plasma experiment facility 直流溅射等离子实验装置

rotational inertia tester 转动惯量实验仪

experiment facility of temperature characteristics of PN junction positive voltage drop PN 结正向压降温度特性实验仪

superconducting maglev demonstration unit 超导磁浮车演示装置

sensor experiment table 传感器实验台

plasma diagnosis experiment facility 等离子体诊断实验仪

electrical meter reform and calibration experiment facility
电表改装与校准实验仪
tester of charge-to-mass ratio of the electron 电子荷质比测定仪
comprehensive design-orientated dynamic experiment facility
动力学综合设计性实验装置
multi-function microwave plasma experiment facility
多功能微波等离子体实验装置
multi-function vacuum experiment facility 多功能真空实验仪
Doppler effect and sound velocity comprehensive experiment facility
多普勒效应及声速综合实验仪
Doppler effect experiment facility 多普勒效应实验仪
Franck – Hertz experiment facility 夫兰克—赫兹实验仪
solid measurement unit 固体测量装置
photosensor experiment facility 光电传感器实验仪
photoresistance characteristics experiment facility 光敏电阻特性实验仪
NMR experiment facility 核磁共振实验仪
glow plasma experiment facility 辉光等离子体实验
Young's modulus tester with Hall position sensor
霍氏位置传感器杨氏模量测定仪
AC circuit comprehensive experiment facility 交流电路综合实验装置
Planck constant tester 普朗克常数测定仪
atmosphere heat treatment program-controlled high-temperature furnace
气氛热处理程控高温炉
portable holograph experiment facility 轻便全息照相实验仪
sound velocity tester and signal source 声速测定仪及信号源
manual levitation force measurement unit 手动磁浮力测量装置
experiment facility of principle of digital electrical meter and design of universal
数字电表原理及万用表设计实验仪
double-grating weak vibration meter 双光栅微弱振动测量仪
temperature-sensing experiment facility 温度传感实验装置

13.7 同义词辨析 Synonyms

structure, form, shape, organization, formation, building, framework, composition, constitution, ingredient, construction, fabric, make-up

These are all words for the way the different parts of sth. combine together or the way that sth. has been made.

以上各词均指事物各个不同部分的"组合,构造"。

◆ structure the way in which the parts of sth. are connected together or arranged; a particular arrangement of parts 结构,构造

e. g. : the social structure of organizations

组织的社会结构

These kids require a lot of structure and stability.

这些孩子需要大量精心的安排和相当的稳定。

a high wooden structure with a curved roof

带拱顶的高大木结构建筑物

◆ form the arrangement of parts in a whole, especially in a work of art or piece of writing (艺术作品或文章的)结构,形式

e. g. : the distinction between form and content

形势与内容的区别

【习惯用法】

in the form of	以……的形式
in form	形式上

◆ shape the form of the outer edges or surfaces of sth. ; an example of sth. that has a particular form 形状;外形;呈……形状的事物

e. g. : You can recognize a tree by the shape of its leaves.

可以根据树叶的形状辨认出是什么树。

The plants grow in every shape and size.

这些植物有各种形状、各种大小。

【习惯用法】

get sth. into shape	整理;安排;使成形
take shape(in)	具体化;成形
in shape	处于良好状态

◆ organization a group of people who from a business, club, etc. together in order to achieve a particular aim(为了特定的目的形成的)组织;团体;机构

e. g. :The public expect high standards from any large organization.

公众对任何大型机构都期望很高。

the World Trade Organization

世界贸易组织

◆ formation the action of forming sth. ; the process of being formed 组成;形成

e. g. : the formation of a new government
新政府的组成
We now know a lot more about the early stages of planetary formation.
我们现在对行星形成过程的早期阶段有了更多的了解。

◆ building a structure such as a house or school that has a roof and walls 建筑物;房子;楼房

e. g. : They need money to pay for new buildings.
他们需要钱买新房子。
The offices are on the top two floors of the building.
办公室在大楼最顶端的两层。

◆ framework a set of beliefs, ideas or rules that forms the basis of a system or society (构成某个体系或社会基础的)信仰;观点;准则

e. g. : This paper provides a framework for future research.
这篇论文为今后的研究提供了一个框架。

◆ composition (rather formal) the different parts or people that combine to form sth. ; the way in which they combine 不同部分或人的构成、组合方式

e. g. : The composition of the group that is studied depends on the interest of the researcher.
作为研究对象的小组,其组成由研究者的兴趣而定。
Some minerals have complex chemical compositions.
有些矿物的化学成分很复杂。

◆ constitution the way sth. is formed or organized 构成;构造

e. g. : What's the chemical constitution of the dye?
这种染料的化学组成是什么?

◆ ingredient one of the things from which sth. is made, especially one of the foods that are used together to make a particular dish. 成分;(尤指烹饪)原料

e. g. : The food is home-cooked using fresh ingredients.
饭菜是用新鲜的材料在家里做的。
John has all the ingredients of a great player.
约翰具备一个伟大运动员的一切素质。

◆ construction the way that sth. has been built or made 建造;构造

e. g. : Work out the exact design before you start construction.
开始施工之前要先搞好具体的设计。

◆ fabric (rather formal) the basic structure of a society or an organization that enables it to

function successfully (社会、机构等的)基本结构

e. g. : Drug abuse poses a major threat to the fabric of our society.

吸毒对我们的社会结构造成严重威胁。

The country's social fabric is disintegrating.

该国的社会结构正在瓦解。

◆ make-up the way different people or things that combine to form sth. ; the way in which they combine(不同人或事物的)构成;构成方式

e. g. : We should change the make-up of the team.

我们应该改变我们团队的结构。

I don't usually wear much make-up.

我一般不化浓妆。

COMPOSITION OR MAKE UP ? 用 composition 还是 make-up ?

The main difference between these words is the level of formality. "Composition" is more often used in scientific and technical contexts; "make-up" is more often used in speech and journalism. "Make-up "also means the different qualities that combine to form sb. 's character. 上述两词的主要区别在于使用场合的正式程度。composition 较常用于科技语境,make-up 则较常用于口语和新闻报道中。make-up 亦指人的性格、气质。

13.8 练习题 Exercise

(13 - 1) 阅读文章并回答以下问题。

Daniel Gabriel Fahrenheit and Anders Celsius both began work on their respective temperature scales in the 18th century.

A Dutch instrument maker, Fahrenheit (1688 - 1736) built on the work of Danish astronomer. Ole Romer, who spent considerable time making meteorological observations and experimenting with thermometers. During the late 1600s and early 1700s, Isaac Newton led the fields in experimenting with thermometry. According to Newton, 12 degrees should separate the temperature of a water, ice, and salt solution from the temperature of the human body. Fahrenheit believed that the thermometer he invented in 1714 had eight times the accuracy of Newton's thermometer, and therefore 96 degrees should separate these benchmarks (eight times Newton's range). Using this new scale, a combination of water, ice and salt solution stayed at 0°, and body temperature registered as 96°. With these marks intact, a combination of water and ice (the freezing point) equated 32°. Scientists later found that water boiled at 212° according to the Fahrenheit scale. After more accurate testing 95.6° became the corrected body temperature that we know today.

Celsius (1701 - 1744), a Swedish astronomer, developed the centigrade scale a bit later in

1742. He assigned 100° to the freezing point and 0° to the boiling point. This scale appeared in Sweden and France, but with the numbers reversed, the Celsius system received broad recognition for his work in 1948 when his name became the official title of this temperature scale.

Opinion is still divided as to why one scale found favour in some parts of the world while the other was widely accepted elsewhere. Daniel Kelves, a historian offers this theory. "Part of the reason," he says, "is that the Fahrenheit system was developed first, and by a Dutchman; Holland and England enjoyed friendly relations at the time. The system later travelled to the American colonies. After the invention of the Celsius system, the French under Napoleon were at loggerheads with England, probably enforcing the division as well," he says.

To convert degrees Fahrenheit to degrees Celsius, subtract 32, then multiply the result by five-ninths. To convert from Celsius to Fahrenheit, multiply by nine-fifths, then add 32.

[1] According to the passage, which of the following about the invention of thermometers is not true?

A. Fahrenheit invented the thermometer in 1714.

B. The Fahrenheit scale is more accurate than Newton's one.

C. The Celsius scale came into being earlier than the Fahrenheit one.

D. The Fahrenheit scale was developed earlier than the Celsius one.

[2] Why did Fahrenheit assign 96° to body temperature and 0° to the combination of water and ice solution?

A. These numbers, he thought, were easy to remember.

B. His scale, he thought, would have the eight times accuracy of the Newton's one.

C. The highest number, he thought, should not be larger than 100.

D. Its reason has not been given by the passage.

[3] When was the Celsius scale widely accepted in some parts of the world?

A. In 1742. B. Long after 1742.

C. Soon after 1742. D. In 1714.

[4] France chose the Celsius scale _____.

A. for political reasons B. for economic reasons

C. for scientific reasons D. for no reasons

[5] What does the last paragraph tell us?

A. A comparison of the two temperature scales.

B. The advantages of each temperature scale over the other.

C. Possibility of unifying these two temperature scales.

D. Mutual conversion of the two temperature scales.

(13-2)分析句中介词短语的语法功能,并将句子译成汉语。

[1]There are a large number of free electrons in a metal.

[2]The free electrons in a wire can flow easily under the influence of electric.

[3]There are two switches on a wall near the door of this room.

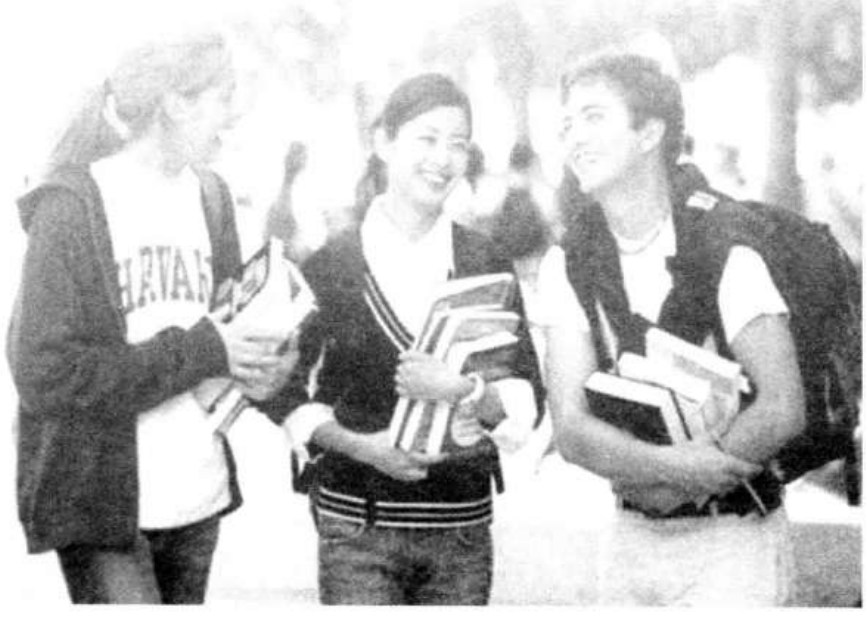
[4]Two wires lead to the lamps in the house.

[5]These wires carry the current to our houses.

[6]There are copper wires in millions of houses in the world.

Part Two

物理学专业英语应用



第六章　科技英语写作

英语是当前科技信息交流最主要的语言，科技英语论文是国际间科学技术交流最具有广泛性和权威性的载体。为了更好地与国际同行进行国际学术交流，写作科技论文是每一个科技工作者都应必备的能力。

● 科技论文的整体结构可以分为以下几个部分，下面逐个做以介绍。

1. 标题　Title
2. 摘要　Abstract
3. 关键词　Key Words
4. 引言　Introduction
5. 材料和方法　Materials and Method
6. 结果和讨论　Results and Discussion
7. 结论　Conclusion
8. 致谢　Acknowledgements
9. 参考文献　References

1. 标题 Title

一篇论文的题目是作者对自己工作成果冠以的专有名词，既然是专有名词，就有其独一无二性，是区别于其他论文的身份标志。科学引文索引(Science Citation Index, SCI)，工程索引(Engineering Index, EI)和化学文摘(Chemical Abstracts, CA)等著名的权威数据库和文献检索系统都是依据论文题目来进行摘引和编制索引的，故写好标题十分重要。

标题至少有三个功能：总结全文、吸引读者、协助检索。因此作者要高度概括研究主题，也就是用最少的词传达最多的信息，所以要求用词精准、结构简单，让人一目了然。

► 1. 科技论文标题的写法

学术文章的标题主要有三种结构：

(1)名词性词组：名词性词组由名词及其修饰语构成。名词的修饰语可以是形容词、介词短语，有时也可以是另一个名词。名词修饰名词时，往往可以缩短标题的长度。以下各标题分别由两个名词词组构成。

e. g. : Absorption and nonlinear optical properties of Te/TeO_2 – SiO_2 composite films TeO_2 – SiO_2复合薄膜的吸收和非线性光学特性（名词 + 名词词组）

Terahertz dual air core fiber directional coupler

太赫兹双空芯光纤定向耦合器（名词词组）

Precise frequency control of an Er-doped fiber comb

长时间精密锁定的掺 Er 光纤飞秒光学频率梳（名词词组）

(2)介词词组：介词词组由介词 + 名词或名词词组构成。如果整个标题就是一个介词词

组的话，一般这个介词是“on”，意思是“对……的研究”。

e. g. :On the schemes of cavity photon elimination in circuit-quantum electrodynamics systems

关于电路量子电动力学系统中光子自由度的消除方案（介词词组 + 介词词组）

(3)名词/名词词组 + 介词词组：这是标题中用得最多的结构。标题中的介词词组一般用来修饰名词或名词词组，从而限定某研究课题的范围。这种结构与中文的“的”字结构相似，区别是中文标题中修饰语在后，中心词在后。英文正好相反，名词在前，而作为修饰语的介词短语在后。

常用的结构：

A Theoretical and Experimental Study on ...	……的理论和实践研究
Experimental Investigation for ...	……的实验研究
Development of the... Research on...	……的研制
Research Report on ...	……的研究报告
Recent Advances in ... Recent Progress in …	……的新进展
A Computational Method of ...	……计算方法
A Theoretical Calculation of...	……的理论计算
Some Comments on ...	……的述评
A Discussion on ...	……的商榷

e. g. :Influence of liquid flow on cellular and dendritic spacings

液相对流对定向凝固胞/枝晶间距的影响（名词 + 介词词组 + 介词词组）

Investigation on characteristics of solar cells made of MOPPV/ZnSe quantum dots composite system

聚对苯乙炔 MOPPV/ZnSe 量子点复合材料太阳电池性能研究（名词 + 介词词组）

(4)其他形式：对于值得争议的问题，偶尔可用疑问句作为论文的标题，以点明整个论文讨论的焦点。

e. g. :Is the normal heart rate chaotic?

正常的心率是混沌的吗？

► 2. 标题的目的和质量

(1) 标题对于作者的目的：

a. 作者可以选用足够的关键词以便于搜索引擎的搜索。

b. 吸引读者的注意。

c. 简要地指出作者的贡献。

d. 与其他论文区分。

(2) 标题对于读者的目的：

a. 帮助读者判断是否值得进一步阅读论文。

b. 提供给读者对论文内容的第一印象：新方法、新思路、新数据、新算法、新发现等。

c. 提供论文类型的线索（综述性论文或介绍性论文），论文的学科范围（专业的或宽泛的），论文的理论水平和特性（模拟或实验）。也用来帮助读者判断阅读该论文是否可以从中受益。

(3)标题的质量：

评估标题的质量，可以从这几方面去检验：

a. Unique. 标题是独特的，你的标题要与其他人的标题有所区别。

b. Lasting. 标题存在的时间比较久远。

c. Concise. 标题是简洁的，有些关键词过于详细，在不影响标题独特性的前提下尽量省略这些词。

d. Clear. 标题是清楚的，避免一长串起修饰作用的名词，否则会导致不精确和误解。

e. Easy to find. 标题是容易被发现的，应仔细选择关键词。

f. Honest. 标题要坦诚且能凝练地反映论文内容，设置预期并回答它们。

g. Catchy. 标题要尽可能容易记忆，要记住你只有一次机会，且只有两秒的时间来吸引读者。

如何提高标题的质量？

看看下面这个标题的质量。

"The neural regulating mechanism of birds singing"

这个标题简单而有趣，作者期望这是一篇关于研究鸟类发声的神经调控机理的文章，通过动物生理学、声学、神经生物学等综合手段研究鸟脑发声和学习记忆的机理。但是文章标题范围太笼统，对鸟类习鸣的神经调控机理这一科学问题没有凝练，所要解决的科学问题不明确。再来看下面被改进的标题：

"Neural regulation and phonation modes of birds singing"

尽管作者将"鸟类习鸣的神经调控机理"改为"鸟类习鸣的神经调控和发声模式"，但题目的范围还是太大，凝练得仍不到位，科学问题不够具体。然后作者又把标题改为：

"The relationship and regulation modes between birds singing and singing loop"

"鸟类发声和习鸣回路的关系及其调控模式"。旨在通过生物声学和神经生物学的综合研究手段，探索和揭示鸟类发声和习鸣回路的关系。虽说将鸟类习鸣的神经调控问题凝练到鸟类发声和习鸣回路的关系上，在科学问题的凝练上有很大的进步，但是这个标题仍然宽泛。作者再次总结了自己的工作，并结合相关的研究积累和文献调研，对自己所解决的科学问题进行了高度的凝练，提出了下面的标题：

"The synaptic transmission and sound control mode in birds forebrain singing loop"

"鸟类前脑习鸣回路的突触传递及控声模式"。这个标题更加具体，要解决的科学问题是了解鸣禽发声学习敏感期内前脑发声习鸣神经回路相关核团与神经元功能联系和突触传递效能，了解前脑有关核团在鸣啭发育和学习记忆中的作用及其声音调控模式，进而对前脑不同区域在鸣声控制中的作用做出科学解释。

作者从最初的标题"鸟类习鸣的神经调控机理"到最后的标题"鸟类前脑习鸣回路的突触传递及控声模式"，进行了高度的凝练，使得读者更加清楚作者研究的问题。

好的标题有助于吸引读者并提高被引用的机会。应该说领域内的专家读者会更多地使用作者名或引证情况来搜索，这种形式的搜索比关键词搜索来得更快更有效果。但是，要想成为被搜索的对象，首先需要从好的研究和好的标题开始。

► 3. 标题的规范

标题是论文的眼睛，所以标题要遵循一定的规范。标题的规范性主要从以下两个方面

入手:一是标题的大小写,二是标题的实词与虚词。

(1)标题的大小写:

a. 采用第一个词首字母大写,专有名词首字母大写,其他一律小写的办法。

e. g. :Process in preparation-catalyzed grapheme

金属催化制备石墨烯的研究进展

Application research of symplectic Runge-Kutta method of solving Lagrange-Maxwell equation

Runge-Kutta 方法在求解 Lagrange-Maxwell 方程中的应用研究

Chaos analysis of the conic in planar unit area

平面单位区域内二次曲线混沌特性研究

b. 采用实词首字母大写,虚词首字母小写,标题第一个字母一律大写的办法(注:冒号后面第一个词的首字母大写)。

e. g. :Analysis of Partial Oscillation Phenomenon in a Digital-controlled Three-phase Inverter

一种数字控制三相逆变电路的局部振荡行为分析

Experience with SAND-Tcl: A Scripting Tool for Spatial Databases

关于空间数据库的脚本工具 SAND-Tcl 的实验

c. 采用标题所有单词首字母一律大写的方法。

例:Rolling Effects On Electronic Characteristics For Graphene Nanoribbons

石墨烯纳米带卷曲效应对其电子特性的影响

Femtosecond Laser Fine Machining Of Energetic Materials

飞秒激光精细加工含能材料

(2)标题中的实词和虚词也要遵循一定的规范:

a. 标题一般不宜超过 20 字,外文标题一般不超过 10 个实词。实词包括:名词、动词、形容词、副词、代词、数词、量词;虚词包括:介词、冠词、连词等。

b. 英语标题中的实词较少使用副词;动词一般都是非谓语动词,即-ing, -ed, to 等形式。

c. 英语标题中介词的使用频率最高,尤其以 on, of, in, at, with 等为主;标题中的冠词能够省略的就尽量省去;连词一旦用上就不能省略。

2. 摘要 Abstract

摘要位于标题之下、引言之上,是一篇完整的科技论文不可缺少的部分。摘要高度概括了论文的实质性内容,甚至可以视为论文的微缩版本。摘要往往要在限制的长度之内,清楚地阐述论文研究课题的背景信息、研究的主要目的和范围、采用的材料和方法、研究所得到的主要创新成果以及论文所作的研究工作导出的结论。论文的摘要要具有短、精、完整三大特点。

▶ 1. 英文摘要的结构:

看下面的一个例子,阐述摘要的结构。

Dynamic complexity detection in short-term physiologic series using base-scale entropy

① The complexity of heart rate variability (HRV) signal can reflect physiological functions

and healthy status of heart system. Detecting complexity of the short-term HRV signal has an important practical meaning. ② We introduce the base-scale entropy method for analyzing the complexity of time series. ③ For the well-known chaotic dynamical system—logistic map, it is shown that our complexity behaves similar to Lyapunov exponents, and is especially effective in the presence of stochastic gaussian noise. This paper demonstrates the utility of base-scale entropy method by applying it to 3 low-dimensional nonlinear deterministic systems. At last, we apply this idea to short-term HRV signal, and the result shows the method could robustly identify patterns generated from healthy and pathologic states, as well as aging. ④ The advantages of our method are its simplicity, extremely fast calculation for very short data and anti-noise characteristic. The base-scale entropy can provide convenience for practically applications.

① 心率变异性信号的复杂性能够反映心脏系统的生理功能和健康状态,从短时的心率变异性信号中探测到复杂性特征具有重要的现实意义。② 本文提出一种基本尺度熵方法来探讨时间序列的复杂性。③ 该方法对于低维的混沌序列 logistic 映射,其基本尺度熵的计算结果与李亚普诺夫指数的计算结果非常相似,并且叠加上随机高斯噪声依然显示方法的有效性。通过用低维的三个非线性确定性混沌系统检验,表明该方法有效。我们把它应用到短时心率变异性信号,该方法能够很有效地区分出不同的生理、病理信号。④ 方法简单、运算快速、有一定的抗干扰能力,使其能够为实际的应用提供方便。

摘要第①句清楚地阐述论文研究课题的背景信息、研究的主要目的和意义。摘要第②句提出了文章所用的方法。摘要第③句介绍了研究所得到主要创新成果。摘要第④句阐明论文所作的研究工作导出的结论。

▶ 2. 英文摘要的时态:

英文摘要时态的运用也以简练为佳,一般现在时、一般过去时比较常用,现在完成时、过去完成时比较少用,进行时态和其他复合时态基本不用。

(1)一般现在时:用于说明研究目的、叙述研究内容、描述结果、得出结论、提出建议或讨论等。涉及公认事实、自然规律、永恒真理等时,要用一般现在时。

常用的句型举例:

This paper deals with ...	The apparatus for ... is described.
This paper develops ...	Automation of ... is discussed.
This paper studies and analyses...	An account of ... is given.
This paper reviews...	The result shows (reveals) ...
This paper points out that ...	It is found that...
The object of this study is ...	The conclusions are...
The principle of ... is outlined.	The author suggests...

(2)一般过去时:用于叙述过去某一时刻(时段)的发现、某一研究过程(实验、观察、调查、医疗等过程)。用一般过去时描述的发现、现象,往往是尚不能确认为自然规律、永恒真理的,而只是当时如何,所描述的研究过程也明显带有过去时间的痕迹。

e. g. : An analysis of... was carried out.

(3)现在完成时:现在完成时表示过去发生的现象、过程对现在一直有影响。

e. g. : The study of ...has been the hot issue.

...has been studied for many years.

▶ 3. 英文摘要的语态

(1)被动语态:使用被动语态不仅可以省略施动者,避免出现"We"等主观意味较强的单词,而且还可以使需强调的事物作主语而突出了它们的地位,有利于说明事实;从英语语言思维模式来讲,科技论文语言特点符合行文的思维方式,即先把重要信息突出出来。另外,英文摘要采用第三人称的被动语态,可以避免提及有关执行者,使行文显得客观;同时,被动语态的句子在结构上有较大的调节余地,有利于使用恰当的修辞手段,扩展名词短语,扩大句子信息量。

e. g. :A method of distance and depth estimation was studied using a single hydrophone based on the dispersive characteristic and time-frequency analysis for low frequency underwater acoustic pulse signals in shallow water environment.

针对浅海环境中低频宽带水声脉冲信号,研究基于频散特征结合时频分析的单水听器距离和深度估计方法。

In this paper, a novel testing method for the assembled performances of the helix slow-wave structure (SWS) with a supported rod is proposed based on heat distribution of SWS.

本文提出了一种由螺旋线慢波结构热分布特性来获知其夹持性能的方法。

上面的两个句子分别用了"A method...was studied using ..." 和 "a novel testing method... is proposed based on ..." 的句型,属于被动语态。

(2)主动语态:用主动语态比用被动语态在结构上更简练,表达更直接有力,可以突出动词所表达的内容,使文章清晰自然,不必回避第一、第二人称。

e. g. :In this paper, using the energy aggregation in an optimal fractional Fourier transform domain of chirp signal, we propose a new signal-to-noise ratio defined in an optimal fractional domain to study the stochastic resonance of over-damped bistable system driven by chirp signal and Gaussian white noise.

本文利用线性调频信号在最优分数阶傅立叶变换域上的能量聚集性,首次提出以最优分数阶傅立叶变换域上定义的信噪比作为测量手段,研究了线性调频信号叠加高斯白噪声激励过阻尼双稳系统的随机共振现象。

To cope with the high complex properties and high costs of measuring the metamale-rial absorber in the free space, in this paper we experimentally discuss the absorption characteristics of four kinds of metamaterial absorbers based on different electric resonators in a closed X-band (8 ~ 12 GHz) rectangular waveguide.

针对在自由空间中测试超介质吸波材料的高复杂性及高成本特点,实验研究了四种由电谐振单元构成的超介质吸波材料在 X 波段(8 ~ 12 GHz)矩形波导里的吸波性能。

上面的两个句子分别用了"In this paper, ...we propose a new signal-to-noise ratio ..."和"in this paper we experimentally discuss the absorption characteristics..." 的句型,属于主动语态。

3. 关键词 Key Words

关键词位于摘要之下，其作用是反映主题，便于检索，确保科技论文的科学性、准确性。一篇学术论文的关键词选用得是否妥当，关系到该论文被检索的概率和该成果的利用率。正确理解关键词的写作与使用，将直接影响论文自身的有效价值。

► 1. 关键词的特点

(1) 关键性，对全文内容具有串联作用。关键词要完整地反映论文的主题，关键词的排列次序有一定的顺序性，要充分反映词与词之间的逻辑关系和中英文关键词的次序对应关系，使文献检索者能够根据关键词的逻辑顺序去理解论文的主要内容。

(2) 便于检索和索引，易于计算机技术处理。

(3) 必须是名词或名词性词组。

► 2. 关键词的筛选要点

(1)从题目中找

e. g. :**Title**: Parameter estimation of nonlinear map based on second-order discrete variational method

Key words: nonlinear map, parameter estimation, second-order discrete variational method

题目:基于二阶离散变分方法的非线性映射参数估计

关键词:非线性映射　参数估计　二阶离散变分方法

(2)从摘要中找:

e. g. :

Chaotic behaviors and fractal self-similar analysis of particles transport properties in RIKEN mesoscopic devices

Abstract: The theoretical model of RIKEN mesoscopic device in our study is one kind of the two-dimensional Sinai billiards, which is an ideal model to investigate the chaotic and fractal behaviors in particle escape curves. In the analysis of the escape curves, we use two methods: qualitative comparison and quantitative calculation of the fractal dimensions. Then we obtain the influence of the distribution of chaotic areas caused by the opening width, cavity length, corner positions, arc radius, etc. In the results, we find the fractal self-similar structure of the escape curves in which the similarity is very good, and they display the chaotic property of the transmission in the RIKEN device. Moreover, we use the "eye-style structure" analysis and the comparation between similar ratios to investigate the fractal self-similar structure.

Key words: mesoscopic devices, chaotic properties, fractal self-similar, fractal dimension

RIKEN 介观器件腔中粒子输运过程的混沌性质及分形自相似结构研究

摘要:研究了粒子在 RIKEN 介观器件中的输运性质，RIKEN 器件的理论模型是二维 Sinai 台球的一种，是研究粒子逃逸曲线混沌性质和分形规律的理想模型之一。采用逃逸曲线定性比较和分形维数定量计算两种方法，得到了开口宽度、腔长、拐角位置、圆弧半径等器件参数对逃逸曲线混沌区域分布的影响规律。结果发现逃逸曲线中存在分形自相似结

构，揭示了粒子在 RIKEN 介观器件腔中输运过程存在的混沌性质，并运用“眼式结构”分析和相似比比较等方法对分形自相似结构进行了验证。

关键词：介观器件，混沌性质，分形自相似，分形维数

(3)从结论中找：

e. g.：

Title: The analysis of short-term HFECG base on ApEn method

Conclusion: There are much more advantages to estimate ApEn for short-term SHFECG based on multi-resolution analysis than that based on original signals analysis. Firstly, the ApEn of HFDS will be stable and convergent in short term. Secondly, we can analyze some interesting detail signals with a specific range of frequencies but ignore other band signals with strong noise or power-line interferences. It is convenient for us to eliminate the false and retain the true. Finally, analysis for HFDS can avoid the effect of basal waveform of SHFECG, which is slowly fluctuating curves with broad amplitude, so that it is of great benefit to extract characteristics for some small significant components from SHFECG. ApEn analysis based on multi-resolution indicates that the entropy value of HFDS from morbid subjects' SHFECG is generally higher than that of the healthy, which can predicate the small inequality of the inner cardiac configuration. It is this small inequality that disturbs the HFDS waveform, increases irregularities of SHFECG, and results in the increase of the ApEn value. The increasing trend of ApEn of healthy subjects with aging, is similar to that of disease subjects. This indicates that aging has the same characters with diseases on some aspects, and more studies are necessary to find out the reason.

Key words: short-term high frequency electrocardiogram, approximate entropy, multi-resolution, extract characteristic

题目：短时高频心电图的近似熵分析

结论：基于多分辨率的短时高频心电信号近似熵分析比直接对该信号的近似熵分析有诸多优越性。第一，含有较高频率的细节信号其近似熵在短时内能够很快收敛稳定；第二，可以有选择地分析某几个层次的细节信号，对于含有较强噪声频段的细节信号可以弃之不用，有利于去伪存真；第三，对细节信号的分析可以不受信号大幅度缓慢变化的低频基波的影响，有利于高频心电信号中细微成分的特征提取。基于多分辨率的近似熵分析表明：心肌梗死、冠心病患者的高频心电图细节信号的熵值普遍要高于健康人，这意味着心脏内部结构的细微不均匀性扰乱了正常心电图，增加了其不规则性，导致了近似熵的增加。健康人的心电信号近似熵估计值随着年龄的增加，其不规则性有朝着与疾病信号相类似的方向增加的趋势，反映了衰老与疾病的某些共性，其深层原因有待进一步研究。

关键词：短时高频心电图，近似熵，多分辨率，特征提取

4. 引言 Introduction

引言(也称为前言、序言或概述)经常作为科技论文的开端，提出文中要研究的问题，引导读者阅读和理解全文。引言作为论文的开场白，应以简短的篇幅介绍论文的写作背景和目的，以及相关领域内前人所做的工作和研究的概况，说明本研究与前人工作的关系、目前

研究的热点、存在的问题及作者工作的意义，引出本文的主题给读者以引导。引言也可点明本文的理论依据、试验基础和研究方法，简单阐述其研究内容，预示本研究的结果、意义和前景，但不展开讨论。

► 1. 引言的写作要求

(1) 开门见山，不绕圈子。避免大篇幅地讲述历史渊源和立题研究过程。

(2) 言简意赅，突出重点。不应过多叙述同行熟知的及教科书中的常识性内容，确有必要提及他人的研究成果和基本原理时，只需以参考引文的形式标出即可。在引言中提示本文的工作和观点时，意思应明确，语言应简练。

(3) 尊重科学，实事求是。在论述本文的研究意义时，应注意分寸，切忌使用“有很高的学术价值”“填补了国内外空白”“首次发现”等不适之词；同时也要注意不用客套话，如“才疏学浅”“水平有限”“恳求指教”“抛砖引玉”之类的语言。

(4) 引言的内容不应与摘要雷同，也不应是摘要的注释。引言一般应与结论相呼应，在引言中提出的问题，在结论中应有解答，但也应避免引言与结论雷同。

(5) 引言不必交代开题过程和成果鉴定程序，也不必引用有关合同公文和鉴定的全部结论。

(6) 引言最好不要分段论述，不要插图列表和数学公式的推导证明。

(7) 引言的基本步骤：

① 背景资料。先介绍作者的研究领域，叙述有关该领域的一般信息，并针对研究论文将要探讨的问题或现象提供背景知识。

②文献回顾。介绍并评论其他学者对该问题或现象曾经发表的相关研究。

③指出问题。指出仍然有某个问题或现象值得进一步研究。

④研究目的。介绍作者的研究目的或研究活动。

e. g. :

Introduction: ①Dynamic complexity detection for outputting time series of complex systems is one of the most important problems in physics, biomedicine, engineering and economic sciences. Especially in biomedicine, accurate detection of the dissimilarity between normal and abnormal states may improve diagnosis and treatment and also provide convenience for clinical applications. ②Many ingenious algorithms and methods have been developed during the last 20 years in order to estimate complexity measures from real-world time series, such as dimensions and Lypunov exponents. They are both working well, but they generally require long datasets for statistically significant results, which results in inconvenience in clinical studies and applications. Another main type of complexity measures are entropies. Entropies have the advantages of simplicity, extremely fast calculation, and anti-noise ability. They provide convenience for detecting and capturing useful information of time series. ③Some entropy methods based on symbolic dynamics adopted a range-partition to generate partition in symbolization transform, but these meaningful results may be compromised by the non-stationarity of time series. R. Steuer et al. reported the partition according to the principle of maximized entropy gave a better tool to differentiate sequences than the usually used homogeneous partition. For the well-known chaotic dynamic system — logistic map, the T-entropy values, introduced by W. Ebeling, et al., approach the Lyapunov expo-

nent asymptotically for increasing string length. From their work we got the idea that entropy measure should play an important role if we use a much more reasonable partition method. The datasets obtained from most clinical and physiological studies usually are non-stationary, rather short, and noisy, such as heart rate variability (HRV) signals. ④Our objective was to find an effective method that requires very short data for statistically significant results, provides the ability to make fast calculations, and can be used to analyze non-stationary and noisy data, which is convenient for the analysis of real-world time series.

引言:①探测复杂系统的动力学改变及区别不同复杂系统输出时间序列的复杂性在物理、生物医学、工程学和经济学上都具有重要的现实意义。尤其在生物医学上,准确地探测到正常和不正常的生理状态会促进医生对疾病的诊断和治疗,为临床应用提供有价值的信息。②在过去的二十多年来,为了探测时间序列的复杂性,研究者提出了许多的计算方法,例如维数和李雅普诺夫指数方法。这些方法在分析数据时提供了很多的信息,但是采用这些方法计算时都需要大量的数据,使得在临床研究和实际应用中不太方便。熵测度也是探测时间序列复杂性的一个好方法。熵测度以其方法简单、运算快速、抗干扰能力强的优点为探测和捕捉时间序列中的有用信息提供了方便。③有些应用符号动力学的熵测度在划分符号序列时采用静态的划分标准,使得一些有用的信息因为信号本身的不平稳性而无法敏感地探测出来。R. Steuer 等人提出利用最大化熵原理进行序列分割比单一静态分割具有明显的优势。W. Ebeling 等人介绍的 T 熵方法,应用到 logistic 映射,对于不断增长的数据序列,熵值逼近李雅普诺夫指数的渐近线。从他们的研究结果我们得到启示,如果能够采用更加合理的分割,那么熵测度就可以起到更大的作用。临床和生理学研究得到的数据通常都是不平稳、比较短、有噪声干扰的,例如心率变异性信号。④我们的目的就是寻找一种普遍适用的方法,力求计算所需数据量少,运算速度快,有一定的抗干扰能力,能够为分析实际的时间序列提供方便。

在这段前言中,第①句介绍了作者的研究领域,并针对研究论文将要探讨的问题或现象提供背景知识。第②句是文献回顾,介绍并评论其他学者对该问题或现象曾经发表的相关研究。第③句:有些应用符号动力学的熵测度在划分符号序列时采用静态的划分标准,使得一些有用的信息因为信号本身的不平稳性而无法敏感地探测出来。这句话指出仍然有某个问题值得进一步研究。第④句介绍作者的研究目的。

▶ 2. 引言的时态

从上面的引言的例子可以看出,引言部分主要有一般现在时、现在完成时和一般过去时三种时态。

(1)背景介绍:一般现在时或者现在完成时

e. g. :Dynamic complexity detection for outputting time series of complex systems is one of the most important problems in physics, biomedicine, engineering and economic sciences.
探测复杂系统的动力学改变及区别不同复杂系统输出时间序列的复杂性在物理、生物医学、工程学和经济学上都具有重要的现实意义。

用一般现在时,表示该研究课题具有重要的现实意义,是一个普遍接受的事实。

Polymer mechanical properties have become very important to the plastics industry, particularly in the production of durable building materials, automobile parts, furniture, suitcase and

computer cases.

聚合材料的力学性能对于塑料工业十分重要，尤其对于生产耐用建材、汽车零部件、家具、旅行箱以及电脑外壳等产品。

用现在完成时，表示该性能的重要性已经变成了大家都接受的事实。

(2)文献回顾：一般现在时或者现在完成时

e. g. : Many ingenious algorithms and methods have been developed during the last 20 years in order to estimate complexity measures from real-world time series, such as dimensions and Lypunov exponents.

在过去的二十多年来，为了探测时间序列的复杂性，研究者提出了许多的计算方法，例如维数和李雅普诺夫指数方法。

某个研究课题的发现、研究和结果是一个普遍接受的事实，用现在完成时或一般现在时。

e. g. : R. Steuer et al. reported the partition according to the principle of maximized entropy gave a better tool to differentiate sequences than the usually used homogeneous partition.

R. Steuer 等人提出利用最大化熵原理进行序列分割比单一静态分割具有明显的优势。

某个研究课题的发现仅仅局限于那个课题，而不能被广为接受为事实，用一般过去时。

(3)指出问题：一般过去时

e. g. : Some entropy methods based on symbolic dynamics adopted a range-partition to generate partition in symbolization transform, but these meaningful results may be compromised by the non-stationarity of time series.

有些应用符号动力学的熵测度在划分符号序列时采用静态的划分标准，使得一些有用的信息因为信号本身的不平稳性而无法敏感地探测出来。

提出了前人没有做的事或者还存在的问题，用一般过去时。

(4)研究目的：一般过去时或现在完成时

e. g. : Our objective was to find an effective method that requires very short data for statistically significant results, provides the ability to make fast calculations, and can be used to analyze non-stationary and noisy data, which is convenient for the analysis of real-world time series.

我们的目的就是寻找一种普遍适用的方法，力求计算所需数据量少，运算速度快，有一定的抗干扰能力，能够为分析实际的时间序列提供方便。

阐明作者的研究目的，用一般过去时。

e. g. : In the current research we have repeated the Peabody experiments and examined the samples under high resolution phase contrast microscopy.

本研究重复了 Peabody 的实验，并且用高分辨相衬显微镜方法考察了各种样品。

阐明本文目的，用现在完成时。

5. 材料和方法 Materials and Method

在论文中，这一部分用于说明实验的对象、条件、使用的材料、实验步骤或计算的过程、

公式的推导、模型的建立等。对过程的描述要完整具体，符合其逻辑步骤，以方便读者重复实验。

► 1. 具体要求

(1) 对材料的描述应清楚、准确。材料描述中应该清楚地指出研究对象(样品或产品、动物、植物、病人)的数量、来源和准备方法。如果实验对象是人，就要注意提供一些特殊信息，如年龄、性别和生理学状态等与论文主题相关的信息。

e. g. :

Sampling of HRV signal: The experimental subjects are 30 healthy persons with the ages between 19 to 75 years old. All subjects remained in a supine resting state in sinus rhythm without distractions. The ECGs (electrocardiograms) were recorded on an ECG workstation developed by our lab, with a 12 – bit A/D converter. The sampling rate was 1000Hz. Each continuous R wave was annotated using an automated detection algorithm, and each beat annotation was verified by visual inspection. The RR interval (heartbeat interval) time series for each subject was then computed. The sampling time was about 6 ~ 7 minutes and the total amount of data was about 500. Then we got the discrete RR interval time series $\{\}$, $n = 1, 2, \ldots N$, $N = 500$.

HRV **信号采集**：实验对象 30 例，年龄 19 ~ 75，健康。实验装置采用自行研制的多功能心电采集分析系统。所有实验对象保持平躺休息状态，体表心电信号 ECG 经放大器放大处理后直接送给机内的专用 A/D 采集卡，A/D 转换精度为 12 位，采样频率为 1000Hz。HRV 信号为从采集的 ECG 信号实时提取的连续 R 波波峰的间期。采集约 6 ~ 7 分钟，数据量约为 500。这样我们得到离散 RR 间期时间序列。

(2)对方法的描述要详略得当、重点突出。应遵循的原则是给出足够的细节信息以便让同行能够重复实验。如果方法新颖且不曾发表过，应提供所有必需的细节；如果所采用的方法已经公开报道过，引用相关的文献即可(如果报道该方法期刊的影响力很有限，可稍加详细的描述)。

e. g. :

Methods: Below, we will heuristically introduce the methods of data processing.

Spectral analysis. The power spectral density of the RR interval series was computed using auto-regressive model (Burg algorithm) as recommended by the Task Force. Because interpolated time series were required for HRV spectral estimations, data used for spectral analysis were cubic spline interpolated at 4 Hz to ensure equidistant sampling in each time series. After that in each dataset, the linear trend was removed to avoid its contribution to low frequencies power. A Hanning window in the time domain was used to attenuate side effects. The power spectrum distribution of auto-regressive model (AR) was calculated by the squared absolute value of the transfer function, which was multiplied by the sampling period and by the variance of the prediction error of the model. We let the order of AR modeling equal 16. Spectral components were evaluated as the integral of power spectral density within the low frequency (LF) band (0.04 ~ 0.15 Hz) and high frequency (HF) band (0.15 ~ 0.4 Hz).

Base-scale entropy analysis. Base-scale entropy was calculated as described elsewhere as a measure of quantifying the uncertainty of the occurrence of m-words form π. The larger entropy

denotes the more uncertain occurrence of m-words form π. This method is completely different from other symbol dynamic methods in symbolization transforming. Since the base scale of each m-dimensional vector is different, the standard of partitioning is also changed dynamically. The base-scale entropy use dynamical adaptive partitioning approach in transforming time series into symbol series.

分析方法:下面将介绍分析数据的方法。

频谱分析:HRV 信号功率谱密度的计算采用 Task Force 提出的自回归模型,因为对 HRV 时间序列功率谱估计需要首先对原始序列进行插值,所有数据序列均采用三次样条插值然后以 4Hz 的频率重新采样来保证时间序列采样点的等距,再消除每一序列的线性趋势以避免其对低频功率产生影响。再然后,在时间域加海宁窗口以减轻边沿效应的影响。自回归模型功率谱密度的计算是通过对传递函数的绝对值平方乘以采样周期和预测误差而得到的。我们取 AR 模型的阶数为 16,各段功率谱是通过对功率谱密度在低频带内(0.04 ~ 0.15Hz)和高频带内(0.15 ~ 0.4Hz)求和来评价。

基本尺度熵分析:基本尺度熵方法是量化 m-words 的形式出现的不确定性措施。较大的熵值代表 m-words 的形式出现得更加不确定。这种方法与以前的符号动力学分析方法进行符号转化是完全不同的,因为每一个 m 维向量的基本尺度是不同的,所以符号化过程中的标准是动态变化的。基本尺度熵方法采用了动态的自适应划分符号的方法来得到符号序列。

(3)时态和语态:描写实验步骤的句子通常使用一般过去时和一般现在时。若描述的内容为不受时间影响的事实,即不是在本实验中所采用的方法,是大家惯常的方法,采用一般现在时。若描述的内容为特定、过去的行为或事件,则采用一般过去时。

e. g. :The experimental system was composed of four parts, i. e. indirectly electrical heated furnace, pyrolysis reactor, online sample collected analyzer, and gas condenser and collector.

实验设备由四个部分构成,即间接电热炉、热解反应器、在线样品收集分析仪以及气体冷凝器和收集器。

在过去为特定的实验而设计的设备,使用一般过去时。

一般描写实验步骤的句子采用被动语态和主动语态。方法章节的焦点在于描述实验中所进行的每个步骤以及所采用的材料,由于所涉及的行为与材料是讨论的焦点,而且读者已知道进行这些行为和采用这些材料的人就是作者自己,因而一般都习惯采用被动语态。如果涉及表达作者的观点或看法,则应采用主动语态。

e. g. :Approximate entropy analysis. ① Approximate entropy (ApEn) was calculated as described elsewhere as a measure of the irregularity of a time series. ② We used a standard ApEn ($2, \delta, N$) index with an embedded dimension of 3 and a tolerance of δ (usually 0.1 ~ 0.25, here 0.2), which are typical for HRV analysis.

近似熵分析:① 近似熵主要是从衡量时间序列不规则性的角度来度量信号中产生新模式概率的大小。② 本文采用标准近似熵 ($2, \delta, N$) 分析 HRV 时间序列,其中嵌入维度为 3,δ 为容忍度(通常取 0.1 ~ 0.5,本文取 0.2)。

第一句话表明近似熵方法被用来做信号复杂性的量度,是被研究者普遍采用的方法。

重点在于强调这种方法，所以用近似熵作主语采用了被动语态。第二句话是作者自己根据经验取了特定的参数值，表达作者自己的观点，所以采用了主动语态。

6. 结果和讨论 Results and Discussion

▶ 1. 科技论文的结果

科技论文的结果部分主要介绍研究结果，常附以图、照片、表格等形式来表述研究发现或实验数据；对重要结果进行描述、评论、说明、解释、与他人结果进行比较等。

(1)用图片来表述：

e. g. : In order to compare the results obtained by this model with the one-dimensional models, i. e. , the radial and thickness mono-dimensional models, the input admittances of calculated and measured ones are shown in Fig. 3, for a thin PZT8 ring (a) and a thick PZT4 disk (b). (一般现在时)

为了同径厚耦合振动一维模型得到的结果做以对比，数值模拟和实验测量的输入导纳的结果在图 3 中显示，(a)图是薄压电圆片 PZT8 的结果，(b) 图是厚压电圆片 PZT4 的结果。

(2)用表格来表述：

e. g. : To explicitly observe these data, a comparison is given in Table 1. (一般现在时)

为了清楚地观察数据，表 1 给出了比较结果。

指出结果所在的图或表，用一般现在时。

(3)对重要结果进行描述：

e. g. : The coefficient of correlation was found to be significant at the 0.001 level. (一般过去时)

结果表明，相关系数在 0.001 级别上十分显著。

It is evident that strong coupling occurs between the second radial mode and the first thickness mode when $G < 1$ and the two first mono-dimensional modes when $G > 1$, while the third radial mode is little affected. When $G \to 0$, the 2D spectrum gradually converges with 1D spectrum, so does $G \to \infty$, although a big shift exists between the first resonant frequencies calculated by the two models. (一般现在时)

可以看出在 $G < 1$ 时，二阶径向模与一阶厚度模耦合很强；在 $G > 1$ 时，一阶径向与厚度模耦合很强，而三阶径向模几乎不受耦合影响。在 $G \to 0$ 和 ∞ 时，二维模型所得频谱逼近一维模型所得频谱，但两种模型所得基频频率差别比较大。

在叙述研究结果或对结果作总结时，因为所述的内容是过去事件，所以通常采用一般过去时。

▶ 2. 科技论文的讨论

对重要结果进行解释：

e. g. :

In this work, 2D equivalent circuit model of piezoelectric ring is proposed, which is obtained

as an approximated analytical solution of 3D constitutive equations in the hypothesis of axial symmetry when the shearing stress and torsion is ignored. In this model the two dimensional vibration is coupled electrically and mechanically in explicit form. The model can be used in calculating various character relations of piezoelectric ring, although only the electrical admittance is studied when the ring is without outer load. By virtue of this, the resonant frequency is determined and it is found that the model is not only valid in calculating the radial and thickness vibration models when the ring is thin, but also effective in describing the coupled vibration of ring between the two dimensions when the ring is fairly thick. However, when the ring becomes thicker, the accuracy of the model will be weaker. Slightly modified, the model is also applicable to piezoelectric disk.

本文基于轴对称结构的三维本构方程,忽略剪切应力与应变,近似求解得到了压电环的二维等效电路模型,清晰表征了径向与轴向振动的机电耦合。虽然该模型在文中仅被用于压电环空载下的电导纳的计算,但也可以求解其他品质参数。基于电导纳求解谐振频率发现,该模型不但可以有效计算压电环很薄时的径向与轴向谐振模式,还可以表征两个方向的耦合振动模式,但环厚增加,计算精度有所下降。该模型稍加调整,又可用于压电圆片的计算。

对于研究结果进行解释和推论,说明作者的研究工作是否有新颖独到之处,并指出结果的理论意义和进一步的应用。如果作者认为自己的结果具有普遍有效性,也可以使用一般现在时。

7. 结论 Conclusion

科技论文的讨论部分主要探讨所得结果与研究目的或假设的关系,是否符合原来的期望,与他人研究的结果进行对比和分析;对研究结果进行解释;如果不符合期望的结果,原因是什么;阐述研究结果的意义或推论。

e. g. :

Conclusion. ① In order to study the underlying dynamics mechanism, we plotted the correlation of entropy and HF power in the Fig. 4(a). Every point is the mean value for the corresponding time segment for every group, that is, there are 48 points for every state. The X – axis indicates the HF power and the Y – axis is base-scale entropy. ② In the day, the suppression of vagal tone and dominance of sympathetic tone in congestive heart failure (CHF) lead to more variability in the m -words due to trends in the data. So the higher base-scale entropy and the lower HF power belong to the CHF day series. The symbols of CHF day are located in the top left corner in Fig 4(a). Further, in the night, the RSA becomes more pronounced with slower breathing in the high frequencies range, and this contributes to the higher spectral power of HRV at night lead to much less variability in the m-words and lower base -scale entropy. So the symbols of CHF night is located in the lower right of the symbols in day, that is, the difference in the HF power compo-

nents account for these variability difference in the m-words. We also plotted the correlation of LF and HF power in the Fig 4(b). The X – axis indicates the HF power and the Y – axis is LF power. The LF power has the inverse result with the base-scale entropy. The symbols of CHF day located in the bottom left corner. The LF power has a little bit increase in the night comparing with the ones in the day for three groups. Hence, we refer to the fluctuation dynamics trend of data in three groups as "HF effect." ③ Our results provide a mechanistic and quantitative basis for the proper using the entropy method and spectral characteristics to analyze HRV series. These methods can be as noninvasive markers for cardiac mortality risk assessment in CHF and other cardiac dysfunctions in future.

④ The present study distinguishes itself from all previous studies of HRV by employing base-scale entropy, which have the characteristic circadian- , aging- and disease-dependent changes in their power spectrum that are closely related to the underlying dynamics mechanism. Ivanov Plamen Ch. et al have much research work about how circadian rhythms and sleep affect the scaling and complexity measures. Especially, they studied the scaling characteristics and complexity measures in the different stages of sleep. ⑤ In the next step, we will apply the base-scale entropy to the HRV series of different sleep stages in order to find the entropy information in sleep stages.

结论:① 为了研究心率潜在的动力学机制,我们在图 4(a)中画出了熵伴随高频功率的变化情况,图中的每一个点都是每一个组对应相同时间段的平均值,即每一种状态都有 48 个数据点。x 轴表示高频功率,y 轴表示基本尺度熵。② 在白天,CHF 患者由于迷走神经调控减弱而交感神经调控加强,导致数据中出现了更多的 m-words 组合,所以 CHF 患者白天的基本尺度熵较高,而高频功率较低,所以 CHF 患者的符号位于图 4(a)中的左上角。进一步的,在夜间,由于呼吸变慢导致 RSA 增大,使得 CHF 患者夜间的高频功率较高,另一方面由于交感神经调控减弱使得 m- words 组合变化减少,因此 CHF 患者夜间的基本尺度熵较低,所以图 4(a)中 CHF 患者夜间的符号位置位于白天的右下方。也就是说,高频成分的不同可以用来解释 m-words 变量上的差异。我们在图 4(b)中画出了高频和低频的关系。x 轴表示高频功率,y 轴表示低频功率。低频功率具有和基本尺度熵相反的结果。CHF 患者白天的符号位于左边底部。对于三个组来讲,低频功率在夜间比在白天都只有稍微一点的增加,因此,我们把三个组心率数据变化的趋势称为"高频效应"。③ 我们的研究提供了一个用基本尺度熵和功率谱定量研究 HRV 信号的基本方法,该方法也可在未来作为评估 CHF 患者死亡风险或者其他心脏功能障碍的无创性指标。

④ 本文的研究和以往对 HRV 信号的分析不同在于,采用基本尺度熵方法对紧密联系着动力学机制的功率谱的与昼夜节律、与年龄以及与疾病相关联的变化进行了分析。Plamen 等人就昼夜节律和睡眠如何影响尺度和复杂性的变化已经做了很多的研究工作。尤其,他们研究了睡眠的不同阶段这两个测度变化情况。⑤ 在接下来的工作中,为了发现不同睡眠阶段的熵信息,我们将应用基本尺度熵方法到不同睡眠阶段的 HRV 序列。

第①部分表示研究的结果显示在图 4(a)中;第②部分对结果进行具体的解释和说明;第③部分对方法的应用前景做一个展望;第④部分和以前的研究工作做以对比;第⑤部分建议下一步的研究工作。

8. 致谢 Acknowledgements

科技论文的致谢不仅能体现科技论文的严谨性、真实性和科学性，而且能体现论文本身的价值和可信程度，更重要的是体现对他人和知识产权的尊重。

► 1. 致谢的表达方式

致谢长则几百字词，短则几十字词，无论详细还是简短，都要用恳切、淳朴、实事求是、恰如其分的语言来表达，切忌浮夸或客套。致谢一般用 Acknowledgements 为标题，自成一节，标题和内容的字体字号与正文相同，作为论文的一部分排于结论之后、参考文献之前。时态用一般现在时。

► 2. 致谢的对象和范围

(1) 致谢人：指导或协助本研究工作的实验人员；参加过讨论或提出指导性意见的人员；提供实验材料、仪器及给予其他方便的人员；在论文撰写过程中提出建议和提供帮助的人员；提供过某种信息，但又非论文的共同作者，且不对论文负责的人员等。

e. g. : The authors thank Prof. Hu Guoan and Prof. Xie Jianing for the valuable discussion and recommendation.

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(2) 致谢基金项目：基金的提供者，包括基金组织、项目或计划、科研机构甚至政府机构等。当提到的是基金名称时，其后一般跟批准号(或合同号)。

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9. 参考文献 References

科技论著的参考文献主要指引文文献，即著者在撰写或编辑论著过程中，为正文中的直接引语(数据、公式、理论、观点等)或间接引语而提供的有关文献信息资源。

参考文献是科技论文的重要组成部分，参考文献可以提供论文的主题背景、依据和目的；可以揭示论文的起点和达到的高度；可方便地将作者的研究成果和他人的成果区分开

来,避免有抄袭或剽窃他人的成果之嫌;可以为读者查阅相关资料提供方便;在论文撰写过程中可避免对他人成果的详述,使行文更为简洁精练;可以为科技信息研究机构进行文献计量学研究、统计被引总频次、计算影响因子提供依据。

● 引用参考文献的注意事项:

(1)避免过多引用本人的文献;

(2)确保文献各著录项正确无误;

(3)文献的时限性,即多引5年内发表的最新文献,如达到50% ~70%;

(4)参考文献的数量要适中;

(5)避免转引;

(6)有些数据来自于某些数据库,可将数据库网址列入参考文献。

e. g. :Zachary M Weil, Greg J Norman and A Courtney DeVries, et al. Photoperiod alters autonomic regulation of the heart. PNAS, 2009,106 (11): 4525.

The physionet database can be available at http://www. physionet. org/physiobank/database.

注:以欧美为代表的西方国家,人名的书写习惯是名在前,姓在后。而以中国和日本为代表的东方国家,人名的书写习惯是姓在前,名在后,再加上西方人名组成的复杂性,使得作者常常在著录参考文献时怎么也不清楚哪个是姓、哪个是名、怎样缩写等。为此,我们提出以下几点规则做以参考:

(1)姓名的缩写只缩写名字而不缩写姓;

(2)无论是东方人还是西方人,缩写名的书写形式一律是姓在前、名在后;

(3)杂志作者名中,全大写的一定是姓;

(4)省略所有的缩写点。

e. g:John Quincy Pubic　全名书写名在前,姓在后,可以缩写为:Pubic J Q

第七章　科技英语交流

从广义上讲，科技英语交流包括书面的交流和口头的交流。不过本章主要介绍参加国际会议的口头交流。科技论文发表后通常会参加国际会议，将自己的研究成果与世界同行分享。陈述(oral presentation)是国际间科学交流最常见的形式。

在本节，我们给出了英文陈述准备、陈述组织的基本元素，并介绍了一些陈述方法和技巧。

1. 准备与计划　Preparation and Plan
2. 陈述的结构 The Structure of the Presentation
3. 一些技巧　Tricks
4. 练习题　Exercise

1. 准备与计划 Preparation and Plan

1.1 何时开始着手

参加国际会议一般要投一篇摘要或一篇全文。一旦提交了摘要或全文，就应该开始构思陈述的内容和结构了。阅读你的文章的背景知识、相关工作，反复查看自己的结果，思考最相关的结论，想象听众会是什么样的人，应该给出什么样的背景信息。

1.2 准备清单

下面是五个问题，包括了计划陈述必须考虑的核心元素，每个问题都需要仔细思考：

What is the aim?

What is my title?

Who am I talking to?

What are the key points?

What do I want the audience to do after the presentation?

要对听众做一些分析：

How much does the audience know about my subject?

How much does the audience know about me?

What does the audience expect from me?

What is their age group?

What is their attitude towards me?

What is their attitude towards my subject?

What is their educational background?

What is their cultural/ethnic background?

What kinds of cultural biases will they likely have towards me and my topic?

在正式陈述之前，应该去实地查看，弄清楚以下的问题：

- 在哪里？
- 房间多大？
- 房间里的设备有哪些？
- 需要哪一种设备？
- 设备能否工作？
- 是否需要白板或黑板？
- 是否有粉笔或毡尖笔？
- 是否需要投影仪和屏幕？
- 是否有讲台？讲稿应该放在哪里？
- 是否需要适配器或接线板？
- 屏幕（或幕布）是否清晰？
- 是否需要激光笔？
- 是否需要将灯光调暗或者拉上窗帘？
- 是否需要分发资料？需要多少？
- 着装是否合适？

2. 陈述的结构 The Structure of the Presentation

好的陈述必须有好的结构，好的结构会使听者很容易接受。典型的陈述包括三个部分：开始部分、中间部分和结尾部分，或称为引言、主体和结论。下面分别介绍。

2.1 引言

在开始部分与听者建立密切关系并引起他们的注意。

2.1.1 引起注意

在正式开始前，可以尝试一些语气词或简短的问句，目的是吸引听者注意，陈述马上就要开始了。例如：

Right.

Well.

OK.

Good.

Fine.

Great.

Shall we start?

Let's begin.

Can we start?

Let's get ball rolling.

Let's get down to business.

有时短暂的停顿更能吸引注意：

Mister Chairman, Ladies and Gentleman,... (followed by a few seconds of silence)

在停顿的过程中扫视听众，这样做将迫使听众集中注意力，同时也测试了音响系统，然后继续陈述。

2.1.2 向听众问好

问好非常重要，体现了陈述者的礼貌，也使听者感到受到尊重，建立良好的互动关系。可以采取如下的方式：

Hello.

Good morning.

Good afternoon.

Good evening.

Fellow colleagues.

Ladies and gentlemen.

Mr. Chairman/Chairwoman.

Thank you for your kind introduction.

2.1.3 介绍自己

介绍自己的目的不仅仅是让听众知道你是谁，也使听众能够判断你在这个领域的权威性，例如你是学生、研究者、行业新人、外行等等。

I'd like to start by introducing myself. My name is ...

I am a student at the NYU...

I am a researcher from...I've been working on the subject for 3 three years...

2.1.4 题目和主题

介绍陈述的题目，对涉及的主题进行阐述：

Today I'm going to talk about...

The subject of my presentation is ...

In today's talk, I am going to overview...

有时需要说明为什么要选择这个主题，而不选择其他主题：

I have chosen to speak about this because...

I was asked to speak about this because...

由于很多陈述的时间是严格限制的，需要提前说明：

I have limited my speech to ...

My talk will last about 10 minutes.

为了引入主题，有时向听众提出一个问题或有趣的事实是有益的：

Imagine...Do you think that's possible?

You may already know...

Have you ever heard of ...?

I feel sure that some of you may...

You've probably seen countless time...

You may have wondered...

Statistics show that ...

I remember when...

Suppose you ...

According to ...

When I think about...

2.1.5 说明目标

具体说明陈述的目标。

What I would like to do today is to illustrate.../to give you the essential .../to outline.../to have a look at...

2.1.6 宣读纲要

列出几个要点,通常两三个就足够了。注意语法的一致性。

I have broken my talk up/down into 3 parts.

I have divided my presentation (up) into 3 parts.

In the first part, I will ...

In the second part, I would like to ...

2.1.7 指出是否可以提问

在此部分可以指出听众在何时能够提问。

You may interrupt me at any moment to ask questions.

It's totally OK to stop me at any time...

There will be enough time at the end of my presentation.

2.1.8 转到主体部分

Now let us turn to part one.

Let us now move to ...

2.2 主体

2.2.1 内容

内容是你的陈述要传达的主要信息,内容应该为目的服务。由于你对你的研究非常熟悉,很容易假定听者也熟悉你的内容,但其实这种情况非常少见。因此,应介绍清楚背景,少用缩略语。

2.2.2 数量

因为有时间的限制，内容应该作适当的取舍。

2.2.3 顺序

内容的呈现必须按照一定的顺序。可能的顺序包括：逻辑顺序、时间顺序、一般到具体、已知到未知、无异议到有争议、原因到结果、问题到解决。标题需要保持语法的一致性。

2.2.4 吸引听众的注意

开头和结尾是听众最容易记住的部分。应该充分利用这一点对整个陈述进行优化调整。必须注意，陈述与书面报告的本质不同。在口头陈述中，听者必须跟随陈述者的陈述顺序。然而书面报告的读者可以略过一些部分直接预览其他的部分。上一课我们学到科技论文一般的顺序是“摘要、引言、材料和方法、结果和讨论、致谢、参考文献”。这个结构对于陈述是完全不适合的。不适合的原因是听者必须在结果部分来到之前记住所有的材料和方法，然后在讨论部分来临之前记住结果。将相关的内容组合形成多个子部分分别进行介绍可以避免产生这个问题。然而，你也许已经发现，当你听别人做陈述的时候，注意力很难保持集中，甚至不到一半就已经丧失了兴趣。到底是所陈述的内容还是陈述方式有问题？

很多陈述的内容是有趣的工作，但很难让人听懂。这是因为陈述者在不知不觉中犯了很多错误，其中的一个错误就是忽视了听众在听的时候的注意力规律。会议的大多数听众是愿意听的，但也很容易受到干扰。必须认识到，只有少量的听众是专门来听你的陈述，其他人可能只是为了等下一个陈述者，或者只是为了得到一个领域的概貌。

图 1 是注意力曲线（attention curve），描述了一般听众在听陈述的时候注意力随时间的变化趋势。在陈述开始的时候，几乎每个听众都在听。当进行到一半的时候，注意力降低到了大约 10%。在结束的时候，很多人又开始听，特别是当你说到“结论”部分的时候。

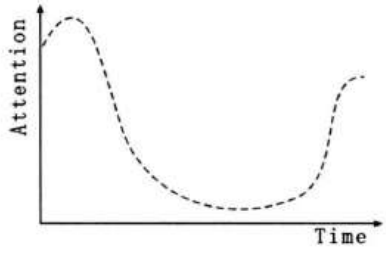


图 1　典型的听众注意力随时间变化曲线

怎样才能在整个陈述过程中都能抓取听众的注意力呢？从上述的注意力曲线我们可以得到一些启发。因为在开始部分每个人都在听，因此应利用这个时间说清楚你的主题是什么。同样的道理，因为最后的部分人的注意力提高，所以应该大声并清楚地说明你的结论。最重要的是中间部分，很多人的注意力已经严重减退，有没有办法能够抓住他们的注意力呢？EFCATS 建议将陈述划分为多个子部分，每个子部分都有相应的子结论。当子结论出现时会有一次注意力的提高，这样就能在整个陈述期间抓住听众的注意力。

2.2.5 经常性地表明进行到何处

当陈述往下进行的时候，听者由于不能完全集中注意力而不知讲到什么地方，所以陈述者应该在可能的情况下多做提示。

There are four things we have to deal with: A, B, C and D/ one, two, three, and four.

Now let us have a look at the second aspect.

First of all, ...

Secondly,...

In the first place...

Last but not least...

表明一个部分的结束和下一部分的开始：

That's all I have to say about... and now I will move to ...

Now that we've seen... let us ...

表明不同的意见和观点：

This is not the only way to see it...

Alternatively, we can view it from another perspective...

There seem to be two ways to ...

We cannot ignore the problems...

举例：

For example, ...

For instance, ...

e. g. , ...

An example of this...

To illustrate this...

Let's see through an example...

复述：

Let me rephrase that, ...

In other words,...

Another way to say that...

That is to say...

i. e. ...

总结：

To summarize, ...

To sum up,...

Let me summarize,...

In short, ...

To recap what we've seen so far,...

Briefly speaking,...

强调：

What I tried to bring out...

What we need to focus on...

What I do,...

What I have done,...

What is important to remember...

I'd like to emphasize the fact that ...

I'd like to stress the importance of...

To highlight...

To underline...

提到已经讲过的部分：

As we saw in part two...

As I have already said earlier...

提到将要讲的部分：

This will be the subject of next part.

We will see this later on.

We will discuss it in more detail on that later.

引用：

According to ...

As xxx says...

There is a well-known quotation that goes...

I quote the words of ...

常识：

It is generally accepted that...

As we all know...

As you might be aware ...

2.3 结束

2.3.1 内容

结论需要包括三个部分：简要地回顾陈述中所包含的主要观点、主要结论；对给予你研究工作帮助的人表示感谢，对机构的资助表示感谢，对听众耐心听讲表示感谢；邀请听众提出问题、建议和意见，或邀请听众讨论。

请注意，邀请提问和邀请讨论是有区别的。邀请提问将自己放在了专家的位置，但邀请讨论则放在了一个平等的位置。

提示陈述结束：

So, as we have seen today...

As a result we suggest that...

I'd like to summarize/sum up.

提出一些意见或提议：

As a result I suggest ...

I'd like to propose that...

In the light of what have seen today, I would like to...

最后结束：

I would like to finish by ...

In conclusion I would like to comment that...

My final comments concern...

2.3.2 转交

如果陈述由多个人共同完成，你陈述的部分结束后应该将讲台转交给下一位陈述人。例如：

I would like to conclude my discussion/report at this point and hand over to my partner/colleague xxx who will discuss/report the area/topic/perspective of...

2.3.3 回答提问

陈述结束后是回答提问环节。首先必须听清楚提问者的问题。为了确信这一点，可以：

- 向提问者反问一个问题；
- 用自己的话复述提问者的问题；
- 如果没有听清楚，可以请提问者再说一遍。

I do not understand your question; please explain.

听众的问题可能是很好的问题，可以这样回答：

Good point.

听众的问题可能是你已经给出的答案的，可以这样回答：

Well, as I mentioned earlier,...

如果是问题比较难，可以回答：

Interesting. What do you think?

That's a good question. I will think about it.

I wish I could answer that.

I'm afraid I don't have that information with me.

如果问题毫无关系，可以回答：

To be honest, I think that raises another issue.

在回答的时候，如果一时回答不出来，可以考虑用以下的方法延时：

It's a good question!

That's good point.

Can I answer it later?

如果实在回答不上来，直接承认是一个好办法：

That part has been done by one of my colleague.

I saw that from a paper...

Sorry, I don't know yet.

I agree with you but an alternative way to look at it is...

2.3.4 讨论

讨论环节与回答提问通常在一起,但讨论使用的语言有其特点,下面给出一些例子。

提出一个论点、问题:

An important perspective we should consider first is...

What do people think about...?

What if the result was...?

Has it occurred to you that...?

给出你的意见:

As far as I'm concerned...

I would say that...

It's quite clear that...

I think...

同意对方的意见:

I take your point.

I don't think any would disagree with that.

That is logical.

I'd go along with you on that.

不同意对方的观点:

I can't say I share your view.

I can't see how that can be.

But it could be argued that...

被打断时,可以:

Thank you. I was just coming to that.

I plan to deal with that later.

Can we leave that later?

Thank you, but some other points need to come first.

3. 一些技巧 Tricks

3.1 视觉辅助

大多数学术会议要求使用媒体辅助设施(visual aids),恰当地运用这些设施能够更清楚地辅助陈述者表达,吸引听众的注意力,将焦点从听觉转化为视觉,并能够节约大量时间。

媒体辅助设施包括多种元素:

图像　image

图形　graph

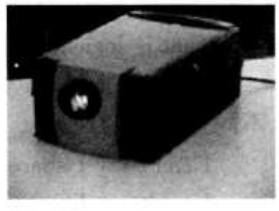
图表　chart
图画　drawing
相片　photo
视频　video/film

目前最常用的媒体辅助设施是投影仪，用于播放 Powerpoint 幻灯片。常见的设备包括：

黑板　blackboard
白板　whiteboard
纸板　paperboard
粉笔　chalk
记号笔　marker
毡尖笔　felt tip pen
讲台　podium
讲台　lectern
幻灯机　slide projector
高射投影仪　overhead projector（参看图片，不能错误地理解为现在固定到天花板上的液晶投影仪）
液晶投影仪　LCD projector（这是目前最常见的投影仪）


slide projector


overhead projector


LCD projector

指示器、教鞭　pointer
麦克风（话筒）　microphone

关于图表的一些术语包括：

线图　line graph
饼图　pie chart
柱形图　bar chart
框图　diagram
流程图　flow chart
组织机构图　organization chart
挂图　flip chart

在设备显示中尽量减少文字的使用，不必用完整的句子。在数量上两分钟一张片子比较合适，数量太多容易引起听众疲劳。图中的线条旁边直接标上文字，使听者不用借助图注就能看懂。一个图只比较一个因素的两种情况，不要将多个因素多种情况都杂合到一起。

在颜色的选取上尽量避免不清晰或刺激性的搭配。例如，很多人喜欢用蓝底，蓝底配合黄色字体和白色字体是最佳的，其他颜色都不够清晰。尤其要注意不要使用蓝底红字。背

景最好不要选用有纹路的。实际上，白底黑字总是不错的选择，在此基础上稍加修饰，能够达到既能清楚表达，又有一定个性的效果。

准备好视觉辅助材料后，还应该配合适当的方式将其表达出来。首先需要对听众做适当的引导，将注意力从听觉引导到视觉：

Let's have a look at the trend, as you can see...

I am going to show you now the results ...

This slide shows us the method...

Take a look at this...

I'd like you to look at this.

Here we can see...

The ... represents ... and the ... represents ...

Let's look at ... in more detail. As you can see...

I'd also like to draw your attention to ...

不要逐一叙述视觉辅助上的所有条目，而应该挑出重点：

As we can see here...

The dotted line of the figure shows...

What is interesting here is ...

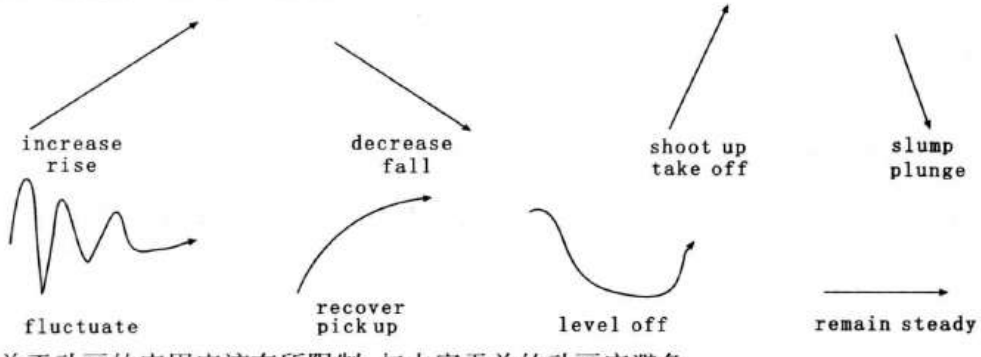
对于重要的观点应该用不同的方式复述，以便给听众更多的时间理解：

In other words, ...

That is to say,...

Let's look at it in another perspective...

描述趋势有一些固定的用法：



关于动画的应用应该有所限制，与内容无关的动画应避免。

3.2 抓住听众的兴趣

我们并不能肯定有多少听众对我们要做的陈述感兴趣，即使有些人感兴趣，也很容易受到干扰。从陈述的开始，就应该想办法抓住听众的兴趣，并一直坚持下去。方法包括：

- 给出不同寻常的事实
- 多使用第一、第二人称（显得亲近）
- 使用一些真实的故事

- 请听众做一些事情(举手提问)
- 向听众提问
- 设问(自问自答)

举几个设问的例子:

What does this mean? This means...

What can be done? We can...

How can we explain? We can explain this by ...

The obvious disadvantages of ... is...But what are the advantages? The advantages are...

举几个强调的例子,首先是直接说重点:

What is important is that...

The essential question behind it is...

用加强语气强调:

We designed the experiment,...

用助动词强调:

We did see the growth in ...

通过倒装强调:

What I'd like to show you is the contribution of ...

Good it may seem,...

通过重复强调:

Let me repeat...

As I've said previously...

通过排比强调:

What you need now is time, money, and effort.

通过对比强调:

Ten years ago we are...Today we're ...

3.3 肢体语言

交流理论专家 Mehrabian 告诉我们,肢体语言和语调占了全部信息影响力的 93%,实际的单词只占了 7%。肢体语言可以加强表达效果,但必须注意不能忸怩作态、弄巧成拙。最好是自然轻松的状态下表达肢体语言。

肢体语言包括:

- 眼神的交流 Eye contact
- 面部表情 Facial expressions
- 体态 Posture
- 动作 Movements
- 手势 Gestures

积极的肢体语言包括:

- 通过眼神的交流保持听众的注意
- 站姿端正放松

- 脸部表情自然友好
- 手势到位

消极的肢体语言包括：

- 失去眼神交流，盯着讲稿、屏幕、地面
- 目光呆滞
- 左右摇摆
- 背对着听众
- 手放在口袋里

眼神的交流很重要，但不能每次都盯着一个听者看，或盯着很少的听众看。一直站在一个地方不动是可以接受的，但位置的变化是可以加分的。

3.4 发音

正确的发音是交流的前提。如果发音不正确交流就无法正常进行，轻则影响理解，严重的会迫使听者放弃听讲。

单词的发音（pronunciation）包括两个部分：音素（phoneme）和重音（stress），二者对于发音都非常重要。尤其是陈述中反复出现的关键词必须发清楚。

句子也有重音，句子的重音通常间隔出现在某些单词，通常是对句子意义比较重要的名词、动词、形容词、副词、否定词、指示代词、疑问词。轻读的单词包括冠词、助动词、介词和连词。

避免照本宣科。照本宣科语速比正常的口语交流速度快很多，而且书面语比口语更复杂、更正式，这时听者会感到信息过载。其实即使口语中有一些错误听者也不会介意，因为在国际会议中，很多参加者都不是以英语为母语。

你可以适当做一些变化，以避免语音单调：

- change of tone (pitch)
- change of pace (speed)
- change of loudness (volume), and even elongation
- to avoid a presentation being monotonous

3.5 语速

每个人都或多或少有点口音，口音本身并不是什么问题，但由于英语不是我们的母语，所以应尽量放慢陈述的速度。据统计，英语非母语的演讲者说话会比较快。人在紧张的时候发音速度更快。因此我们应该有意识地放慢语速，放慢到我们自己觉得有点奇怪的程度可能在别人听来会觉得刚刚好。即使我们经过多次练习，感觉到已经能够以较快的速度陈述，也要放慢速度。一般来说，每分钟 80—100 个单词是比较合适的，但重要的内容应放慢速度。

3.6 语法和修辞

与书面语言不同，在词语的选择上应该多用动词，少用动作性名词：

Delivery of →... is delivered

Transmission of →... is transmitted

尽量用简单的单词、简单的句子，便于交流与理解。

与书面语相反，应尽量使用主动语态，少使用被动语态：

From this figure it was deduced that...

改为：This figure implies that ...

It was therefore concluded that ...

改为：Therefore, we conclude that ...

掌握一定的连接词：

On the contrary,...

Similarly,...

Nevertheless,...

Therefore,...

In addition,...

Furthermore,...

尽量减少一些不必要的语气词，例如：

Uh,...

Ah,...

You know,...

3.7 准备卡片

绝不要照本宣科，也不要尝试陈述时参考事先写好的详细文本，因为你很难定位你讲的部分在哪里。大多数情况下你应该很清楚你要讲什么，否则就不应该参加陈述。对于一些关键的单词、短语，可以准备几张卡片作为提示。卡片一定要编号，以防弄乱。在卡片上标明对应的幻灯片编号。

使用卡片的最佳时刻：

- 当你在屏幕上打出一个研究问题的时候
- 当你在屏幕上打出一幅图的时候
- 当你刚刚问了一个问题的时候

3.8 交流而不是表演

当你用与同事或同学交流的方式做陈述的时候，效果会达到最佳状态。陈述时并不需要更正式的语言。实际上，应该避免正式的语言，使听众更容易听懂。不要尝试使用一些新奇的单词、正式的结构、领域内的行话或不必要的缩略语。

3.9 对时间的掌握

仔细地掌控时间是非常必要的。超时是对听众的冒犯，也是对后面陈述者的冒犯。如果等到会议主席让你停止，但还没讲到结论的话是非常得不偿失的，因为结论部分是最重要的。建议平时练习的时候用秒表计时。

3.10 检验听众是否听懂

当说到一些难度较大的地方，最好能确认听众是否能跟上，以决定是否重复：

Does that make sense?

Is that clear?

3.11 对提问持开放的态度

有时，在你陈述的过程中会有听众举手提问，不要把此当成对你的冒犯，能够提出问题表明听众在听讲。如果能够回答就直接回答，如果不能回答可以说不知道，也可以请其他人回答。

3.12 克服紧张

只有少数人生来就是演说家，大多数人都会在陈述前感到紧张。紧张的表现有：吞咽、发抖、出汗等，这些都是机体对将要到来的重要事件的正常反应。这些反应能够提高身体的警觉性和灵敏性，从而提高性能。初学者很容易由紧张导致不自信，以为自己不适合陈述。实际上并非如此，你所需要做的是尽量准备充分。然而过分的紧张也会影响陈述效果，可以尝试以下的方法：

- 微笑
- 把听众看成朋友
- 承认自己紧张，听众会同情你
- 深呼吸
- 充分准备
- 将手头的资料等整理好，以免忙乱
- 慢下来

3.13 克服口头语

很多人有口头语，例如：

Um

Er

Yeah

Uh

you know

OK

Maybe

不断重复口语会使听众觉得不耐烦，与其每三秒说一次“uh”“you know”，还不如保持沉默。

3.14 避免讲笑话

适当的笑话(joke)能调节气氛。但是，除非你有说单口相声的天赋，否则我们不建议在

国际会议上讲笑话。一是国际会议比较正式;二是难以把握一个度;三是听众来自各个国家,文化间的差异使听众难以听懂。

3.15 致谢

致谢部分很重要,但要避免依次读出所有的名字,因为这不但占用时间而且听众很难记住。可以尝试用一些合作者的照片。

虽然谈论了很多的方法和技巧,其实这些方法和技巧只有两点:一是你要表达的内容,二是要使听众听得很明白。相信通过适当的练习、观摩,一定能够做好陈述,将自己的研究成果在国际会议上与同行进行有效的交流。

4. 练习题 Exercise

4.1 朗读下面的材料,注意发音、停顿、语音语调。

The world's most popular drink is water. You probably knew that already. After all, it's a basic requirement of life on earth. But, did you know that the world's second most popular drink is Coke? And that the human race drinks six hundred million Cokes a day? Now, let's just put that into some kind of perspective. It means that every week people drink enough Coke to fill the World Trade Center.

4.2 就某个主题在课堂上做陈述。

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