AP Physics B

Section I (multiple choice)

Time – 45 minutes

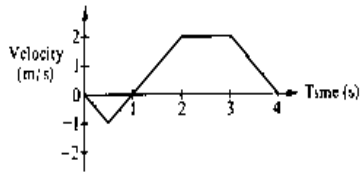
35 Questions

Name _____

Directions: Units associated with numerical quantities are abbreviated, using the abbreviations listed in the table of information. To simplify calculations, you may use $g = 10\ m/s^2$ in all problems. Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is **best** in each case. You will not get the chance to rework any problems so I will grade this like the true AP MC test. You will lose ¼ point for each incorrect answer.

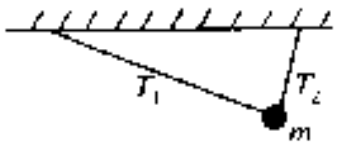
1. If the mass of a simple pendulum is doubled but its length remains constant, its period is multiplied by a factor of
   (A) $\frac{1}{2}$
   (B) $\frac{1}{\sqrt{2}}$
   (C) 1
   (D) $\sqrt{2}$
   (E) 2

2. A railroad flatcar of mass 2,000 kilograms rolls to the right at 10 meters per second and collides with a flatcar of mass 3,000 kilograms that is rolling to the left at 5 meters per second. The flatcars couple together. Their speed after the collision is
   (A) 1m/s
   (B) 2.5m/s
   (C) 5 m/s
   (D) 7 m/s
   (E) 7.5m/s

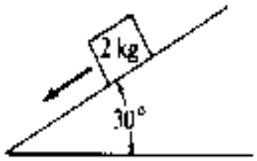


3. The graph above shows the velocity versus time for an object moving in a straight line. At what time after $t = 0$ does the object again pass through its initial position?
   (A) Between O and 1 s
   (B) 1 s
   (C) Between 1 and 2 s
   (D) 2 s
   (E) Between 2 and 3 s

4. Which of the following is true for a system consisting of a mass oscillating on the end of an ideal spring?
   (A) The kinetic and potential energies are equal at all times.
   (B) The kinetic and potential energies are both constant.
   (C) The maximum potential energy is achieved when the mass passes through its equilibrium position.
   (D) The maximum kinetic energy and maximum potential energy are equal, but occur at different times.
   (E) The maximum kinetic energy occurs at maximum displacement of the mass from its equilibrium position.



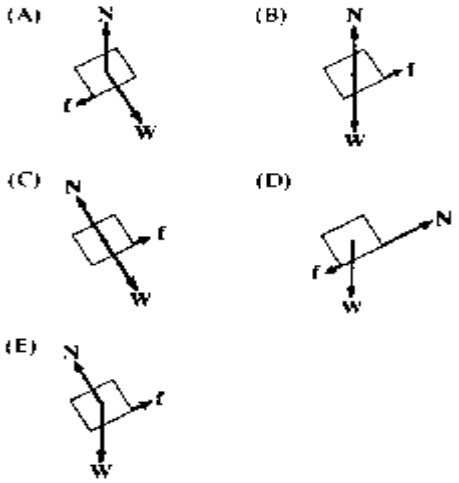
5. A ball of mass m is suspended from two strings of unequal length as shown above. The tensions T_1 and T_2 in the strings must satisfy which of the following relations?
   (A) $T_1 = T_2$
   (B) $T_1 > T_2$
   (C) $T_1 < T_2$
   (D) $T_1 + T_2 = mg$
   (E) $T_1 - T_2 = mg$



Questions 6-7

A 2-kilogram block slides down a 30° incline as shown above with an acceleration of 2 meters per second squared.

6. Which of the following diagrams best represents the gravitational force **W**, the frictional force **f**, and the normal force **N** that act on the block?



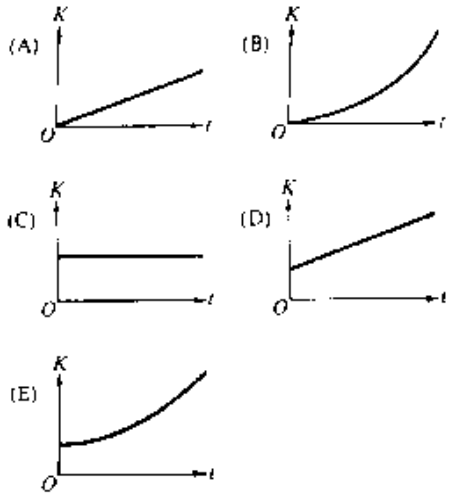
7. The magnitude of the frictional force along the plane is most nearly
   (A) 2.5 N
   (B) 5 N
   (C) 6 N
   (D) 10 N
   (E) 16 N

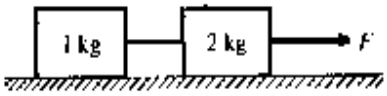
8. When a person stands on a rotating merry-go-round, the frictional force exerted on the person by the merry-go-round is
   (A) greater in magnitude than the frictional force exerted on the person by the merry-go-round
   (B) opposite in direction to the frictional force exerted on the merry-go-round by the person
   (C) directed away from the center of the merry-go-round
   (D) zero if the rate of rotation is constant
   (E) independent of the person's mass

9. Each of five satellites makes a circular orbit about an object that is much more massive than any of the satellites. The mass and orbital radius of each satellite are given below. Which satellite has the greatest speed?

	Mass	Radius
(A)	$\frac{1}{2}m$	R
(B)	m	$\frac{1}{2}R$
(C)	m	R
(D)	m	$2R$
(E)	$2m$	R

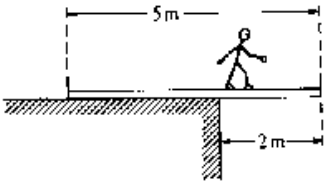
10. From the top of a high cliff, a ball is thrown horizontally with initial speed v_0. Which of the following graphs best represents the ball's kinetic energy K as a function of time t?



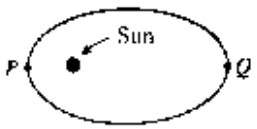


11. When the frictionless system shown above is accelerated by an applied force of magnitude F, the tension in the string between the blocks is
   (A) $2F$
   (B) F
   (C) $\frac{2}{3}F$
   (D) $\frac{1}{2}F$
   (E) $\frac{1}{3}F$

12. When a mass is attached to a spring, the period of oscillation is approximately 2.0 seconds. When the mass attached to the spring is doubled, the period of oscillation is most nearly
    (A) 0.5 s
    (B) 1.0 s
    (C) 1.4 s
    (D) 2.0 s
    (E) 2.8 s



13. A 5-meter uniform plank of mass 100 kilograms rests on the top of a building with 2 meters extended over the edge as shown above. How far can a 50-kilogram person venture past the edge of the building on the plank before the plank just begins to tip?
    (A) $\frac{1}{2}m$
    (B) 1 m
    (C) $\frac{2}{3}m$
    (D) 2 m
    (E) It is impossible to make the plank tip since the person would have to he more than 2 meters from the edge of the building.

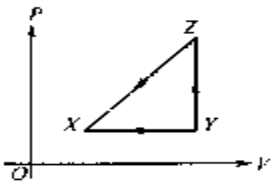


14. An asteroid moves in an elliptic orbit with the Sun at one focus as shown above. Which of the following quantities increases as the asteroid moves from point *P* in its orbit to point *Q*?
    (A) Speed
    (B) Angular momentum
    (C) Total energy
    (D) Kinetic energy
    (E) Potential energy

15. The maximum efficiency of a heat engine that operates between temperatures of 1500 K in the firing chamber and 600 K in the exhaust chamber is most nearly
    (A) 33%
    (B) 40%
    (C) 60%
    (D) 67%
    (E) 100%

16. An ideal gas is made up of *N* diatomic molecules, each of mass *M*. All of the following statements about this gas are true EXCEPT:
    (A) The temperature of the gas is proportional to the average translational kinetic energy of the molecules.
    (B) All of the molecules have the same speed.
    (C) The molecules make elastic collisions with the walls of the container.
    (D) The molecules make elastic collisions with each other.
    (E) The average number of collisions per unit time that the molecules make with the walls of the container depends on the temperature of the gas.

Questions 17-18

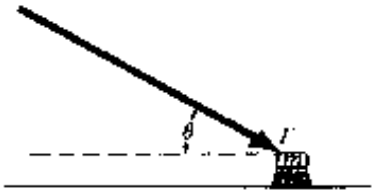


A thermodynamic system is taken form an initial state *X* along the path *XYZX* as shown in the *PV*-diagram above.

17. For the process $X \rightarrow Y$, ΔU is greater than zero and
    (A) Q<0 and W=0
    (B) Q<0 and W>0
    (C) Q>0 and W<0
    (D) Q>0 and W=0
    (E) Q>0 and W>0

18. For the process Y→Z, Q is greater than zero and
    (A) W<0 and ΔU=0
    (B) W=0 and ΔU<0
    (C) W=0 and ΔU>0
    (D) W>0 and ΔU=0
    (E) W>0 and ΔU>0

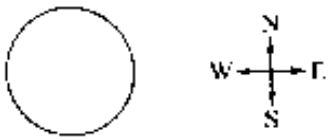
19. Two planets have the same size, but different masses, and no atmospheres. Which of the following would be the same for objects with equal mass on the surfaces of the two planets?
    I. The rate at which each would fall freely
    II. The amount of mass each would balance on an equal-arm balance
    III. The amount of momentum each would acquire when given a certain impulse
    (A) I only
    (B) III only
    (C) I and II only
    (D) II and II1 only
    (E) I, II, and III



20. A push broom of mass m is pushed across a rough horizontal floor by a force of magnitude T directed at angle θ as shown above. The coefficient of friction between the broom and the floor is μ. The frictional force on the broom has magnitude
    (A) $\mu(mg + T\sin\theta)$
    (B) $\mu(mg - T\sin\theta)$
    (C) $\mu(mg + T\cos\theta)$
    (D) $\mu(mg - T\cos\theta)$
    (E) μmg

21. A body moving in the positive x direction passes the origin at time $t = 0$. Between t = 0 and t = 1 second, the body has a constant speed of 24 meters per second. At $t = 1$ second, the body is given a constant acceleration of 6 meters per second squared in the negative x direction. The position x of the body at $t = 11$ seconds is
    (A) +99 m
    (B) +36 m
    (C) -36 m
    (D) -75 m
    (E) -99 m

22. A person weighing 800 newtons on Earth travels to another planet with twice the mass and twice the radius of Earth. The person's weight on this other planet is most nearly
    (A) 400 N
    (B) $\frac{800}{\sqrt{2}}N$
    (C) 800 N
    (D) $800\sqrt{2}N$
    (E) 1,600 N



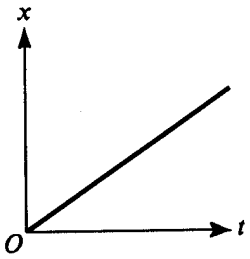
View of Track from Above

23. A racing car is moving around the circular track of radius 300 meters shown above. At the instant when the car's velocity is directed due east, its acceleration is directed due south and has a magnitude of 3 meters per second squared. When viewed from above, the car is moving
    (A) clockwise at 30 m/s
    (B) clockwise at 10 m/s
    (C) counterclockwise at 30 m/s
    (D) counterclockwise at 10 m/s
    (E) with constant velocity

24. An ideal gas confined in a box initially has pressure p. If the absolute temperature of the gas is doubled and the volume of the box is quadrupled, the pressure is
    (A) $\frac{1}{8}p$
    (B) $\frac{1}{4}p$
    (C) $\frac{1}{2}p$
    (D) p
    (E) $2p$

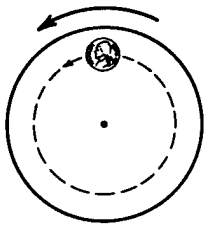
25. A ball attached to a string is whirled around in a horizontal circle having a radius r. If the radius of the circle is changed to $4r$ and the same centripetal force is applied by the string, the new speed of the ball is which of the following?
    (A) One-quarter the original speed
    (B) One-half the original speed
    (C) The same as the original speed
    (D) Twice the original speed
    (E) Four times the original speed

26. A person pushes a box across a horizontal surface at a constant speed of 0.5 meter per second. The box has a mass of 40 kilograms, and the coefficient of sliding friction is 0.25. The power supplied to the box by the person is
(A) 0.2 W
(B) 5 W
(C) 50 W
(D) 100 W
(E) 200 W



27. The displacement x of an object moving along the x-axis is shown above as a function of time t. The acceleration of this object must be

(A) zero
(B) constant but not zero
(C) increasing
(D) decreasing
(E) equal to g



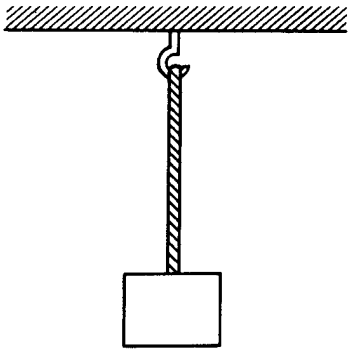
View from Above

28. The horizontal turntable shown above rotates at a constant rate. As viewed from above, a coin on the turntable moves counterclockwise in a circle as shown. Which of the following vectors best represents the direction of the frictional force exerted on the coin by the turntable when the coin is in the position shown?

(A) ←
(B) →
(C) ↙
(D) ↓
(E) ↑

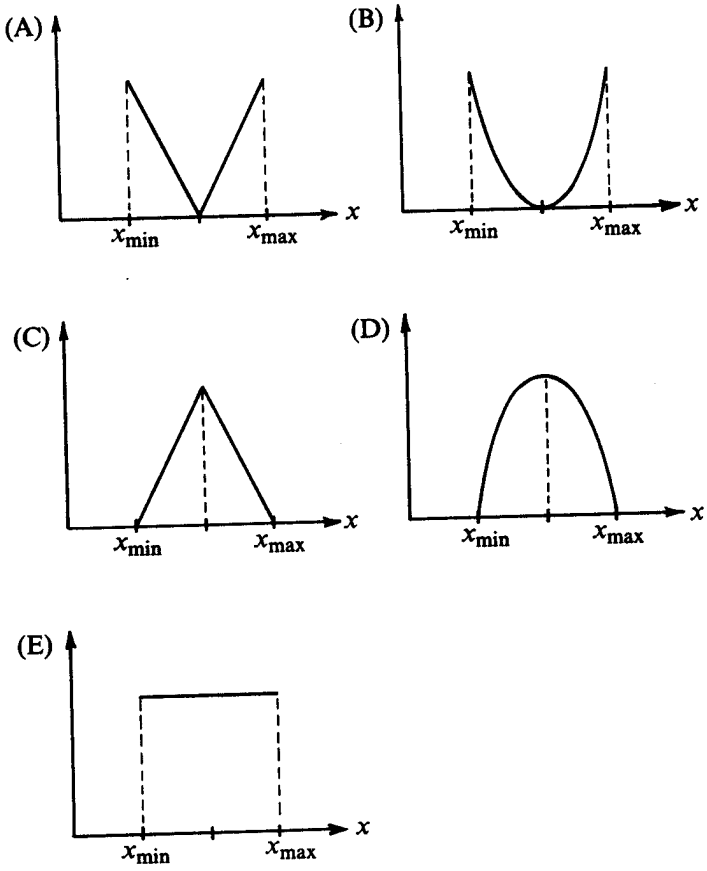
29. A diver initially moving horizontally with speed v dives off the edge of a vertical cliff and lands in the water a distance d from the base of the cliff. How far from the base of the cliff would the diver have landed if the diver initially had been moving horizontally with speed $2v$?

(A) d
(B) $\sqrt{2d}$
(C) $2d$
(D) $4d$
(E) It cannot be determined unless the height of the cliff is known.

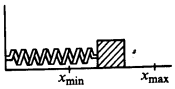


30. A uniform rope of weight 50 newtons hangs from a hook as shown above. A box of weight 100 newtons hangs from the rope. What is the tension in the rope?

    (A) 50 N throughout the rope
    (B) 75 N throughout the rope
    (C) 100 N throughout the rope
    (D) 150 N throughout the rope
    (E) It varies from 100 N at the bottom of the rope to 150 N at the top.



Questions 31 - 32

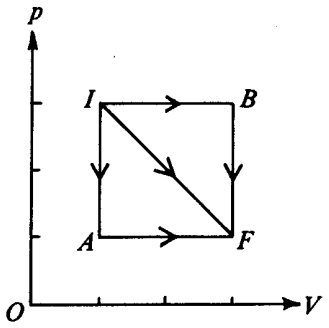


A block oscillates without friction on the end of a spring as shown above. The minimum and maximum lengths of the spring as it oscillates are, respectively, x_{min} and x_{max} The graphs below can represent quantities associated with the oscillation as functions of the length x of the spring.

31. Which graph can represent the total mechanical energy of the block-spring system as a function of x ?
    (A) A
    (B) B
    (C) C
    (D) D
    (E) E

32. Which graph can represent the kinetic energy of the block as a function of x ?

    (A) A
    (B) B
    (C) C
    (D) D
    (E) E

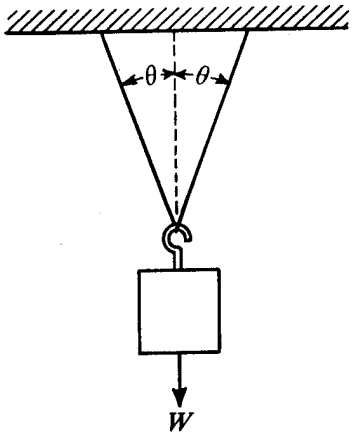


33. If three identical samples of an ideal gas are taken from initial state *I* to final state *F* along the paths *IAF*, *IF*, and *IBF* as shown in the *p*-*V*-diagram above, which of the following must be true?

(A) The work done by the gas is the same for all three paths.
(B) The heat absorbed by the gas is the same for all three paths.
(C) The change in internal energy of the gas is the same for all three paths.
(D) The expansion along path *IF* is adiabatic.
(E) The expansion along path *IF* is isothermal.

34. If the average kinetic energy of the molecules in an ideal gas at a temperature of 300 K is *E*, the average kinetic energy at a temperature of 600 K is

(A) $E / \sqrt{2}$
(B) E
(C) $\sqrt{2}E$
(D) $2E$
(E) $4E$



35. When an object of weight *W* is suspended from the center of a massless string as shown above, the tension at any point in the string is

(A) $2W\cos\theta$
(B) $\dfrac{W\cos\theta}{2}$
(C) $W\cos\theta$
(D) $\dfrac{W}{2\cos\theta}$
(E) $\dfrac{W}{\cos\theta}$