CHAPTER3

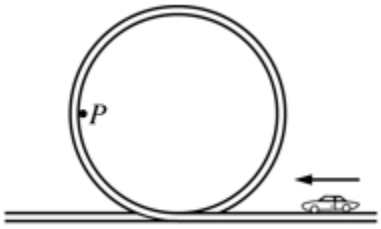
1. A 100 kg cart goes around the inside of a vertical loop of a roller coaster. The radius of the loop is 3 m and the cart moves at a speed of 6 m/s at the top. The force exerted by the track on the cart at the top of the loop is

(A) 200 N
(B) 800 N
(C) 1000 N
(D) 1200 N
(E) 2200 N

2. A car with speed v and an identical car with speed $2v$ both travel the same circular section of an unbanked road. If the frictional force required to keep the faster car on the road without skidding is F, then the frictional force required to keep the slower car on the road without skidding is

(A) $4F$
(B) $2F$
(C) F
(D) $F/2$
(E) $F/4$

3.



The toy car shown in the figure above enters the vertical circular loop with an initial velocity and moves completely around the loop without friction. If the car has no means of self-propulsion, which of the following is true of the car's acceleration at the instant it is at point P ?

(A) It is vertically upward.
(B) It is in the direction of the velocity.
(C) It is directly toward the center of the circle.
(D) It has components both downward and toward the center of the circle.
(E) It has components both downward and away from the center of the circle.

4. An artificial satellite orbits Earth at a speed of 7800 m/s and a height of 200 km above Earth's surface. The satellite experiences an acceleration due to gravity of

(A) 39 m/s^2
(B) less than 39 m/s^2 but greater than 9.8 m/s^2
(C) 9.8 m/s^2
(D) less than 9.8 m/s^2 but greater than zero
(E) zero

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A meteoroid is in a circular orbit $600\ \text{km}$ above the surface of a distant planet. The planet has the same mass as Earth but has a radius that is $90\ \%$ of Earth's (where Earth's radius is approximately $6370\ \text{km}$).

5. The acceleration of the meteoroid due to the gravitational force exerted by the planet is most nearly

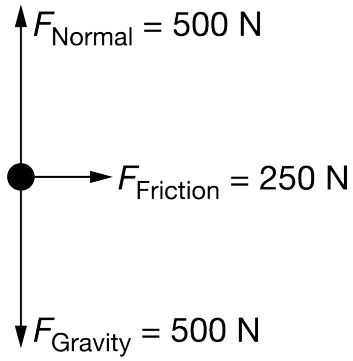
(A) $9\ \text{m/s}^2$ toward the center of the planet

(B) $9\ \text{m/s}^2$ in the direction of the meteoroid's motion

(C) $10\ \text{m/s}^2$ toward the center of the planet

(D) $10\ \text{m/s}^2$ in the direction of the meteoroid's motion

6.



A student rides a bicycle in a circle at a constant speed and constant radius. A force diagram for the student-bicycle system is shown in the figure above. The value for each force is shown in the figure. What is the acceleration of the student-bicycle system?

(A) $0\frac{m}{s^2}$

(B) $0.2\frac{m}{s^2}$

(C) $5\frac{m}{s^2}$

(D) $25\frac{m}{s^2}$

7. A child has a toy tied to the end of a string and whirls the toy at constant speed in a horizontal circular path of radius *R*. The toy completes each revolution of its motion in a time period *T*. What is the magnitude of the acceleration of the toy?

(A) Zero

(B) $4\pi^2R / T^2$

(C) $\pi R / T^2$

(D) g

(E) $2\pi g$

8. A newly discovered planet is found to have density 2/3 P_E and radius $2R_E$, where pE and R_E are the density and radius of Earth, respectively. The surface gravitational field of the planet is most nearly

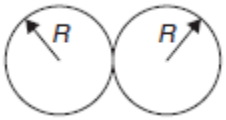
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(A) 1.7 N/kg
(B) 3.3 N/kg
(C) 6.7 N/kg
(D) 13 N/kg

9. A new planet is discovered that has twice the Earth's mass and twice the Earth's radius. On the surface of this new planet, a person who weighs 500 N on Earth would experience a gravitational force of

(A) 125 N
(B) 250 N
(C) 500 N
(D) 1000 N
(E) 2000 N

10.



Two solid spheres of radius R made of the same type of steel are placed in contact, as shown in the figures above. The magnitude of the gravitational force that they exert on each other is F_1. When two other solid spheres of radius $3R$ made of this steel are placed in contact, what is the magnitude of the gravitational force that they exert on each other?

(A) F_1
(B) $3F_1$
(C) $9F_1$
(D) $81F_1$

11. An object has a weight W when it is on the surface of a planet of radius R. What will be the gravitational force on the object after it has been moved to a distance of $4R$ from the center of the planet?

(A) $16W$
(B) $4W$
(C) W
(D) $\frac{1}{4}W$
(E) $\frac{1}{16}W$

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12. A planet of mass m orbits a star of mass M, where $m<<M$. The orbit is circular, its radius is r, and its period is T. True statements about the planet's orbit include which of the following?

I. The orbital speed equals $2\pi r / T$

II. The gravitational force equals GMm / r^2

III. If the orbital radius r were greater, T would also be greater.

(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

13. A planet with half Earth's mass and half Earth's radius is discovered. What would an astronaut who weighs 800 N on Earth weigh on the planet?

(A) 100 N
(B) 200 N
(C) 400 N
(D) 800 N
(E) 1600 N

14.



Side View

A rock attached to a string swings in a vertical circle, as shown above, with negligible air resistance. Which of the following diagrams could correctly show all the forces on the rock when the string is in the position above?

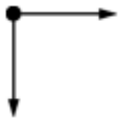
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(A) 

(B) 

(C) 

(D) 

(E) 

15. A rocket lifts a payload upward from the surface of Earth. The radius of Earth is R, and the weight of the payload on the surface of Earth is W. The force of Earth's gravity on the payload is $\frac{W}{2}$ when the rocket's distance from the center of Earth is

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

16. A satellite of mass m and speed v moves in a stable, circular orbit around a planet of mass M. What is the radius of the satellite's orbit?

(A) GM/mv
(B) Gv/mM
(C) GM/v^2
(D) GmM/v
(E) GmM/v^2

17. A small car with mass m and speed $2v$ and a large car with mass $2m$ and speed v both travel the same circular section of an unbanked road. If the frictional force required to keep the small car on the road without skidding is F, then the frictional force required to keep the large car on the road without skidding is

CHAPTER3

(A) $4F$

(B) $2F$

(C) F

(D) $F/2$

(E) $F/4$

18. A spacecraft is placed in a circular orbit around a planet with mass 6.4×10^{23} kg. The spacecraft orbits at a height of 4.5×10^{7} m above the planet's surface. What additional information is needed to calculate the speed of the spacecraft in the orbit?

(A) No additional information

(B) The planet's radius only

(C) The spacecraft's mass only

(D) Both the planet's radius and the spacecraft's mass

19. A spaceship is traveling from Earth to the Moon. Which of the following is true of the gravitational force on the ship due to the two objects when the ship is equidistant from Earth and the Moon?

(A) There is no net force because the ship is beyond the influence of Earth and the Moon.

(B) There is no net force because the forces exerted by Earth and the Moon balance.

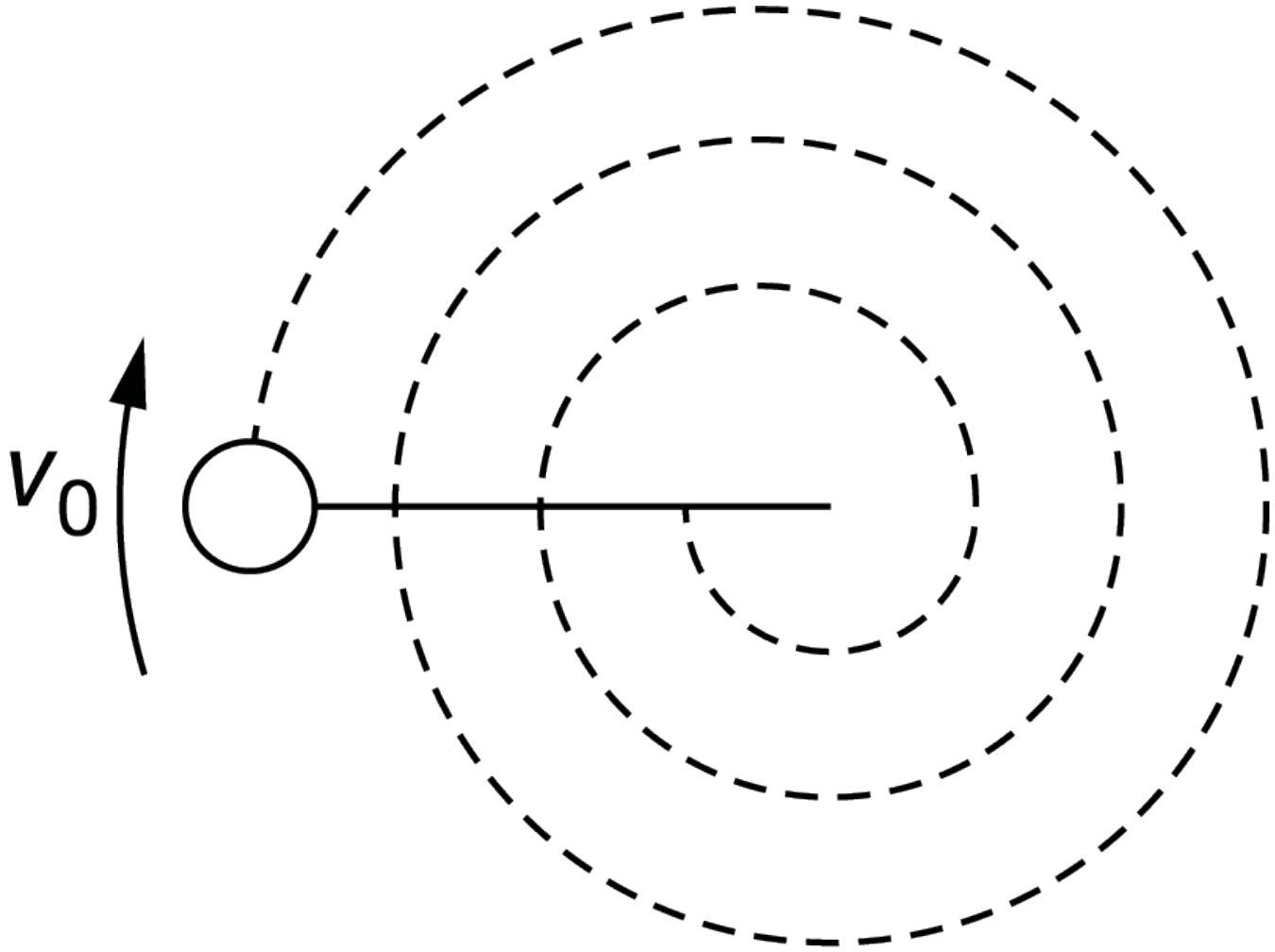
(C) There is a net force because the force exerted by Earth is smaller than that exerted by the Moon.

(D) There is a net force because the force exerted by Earth is greater than that exerted by the Moon.

(E) There is a net force because the ship must be accelerating toward the Moon.

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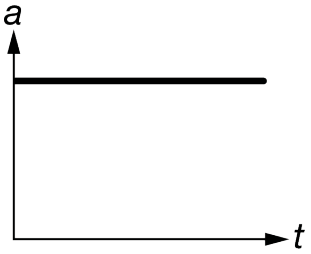
20.



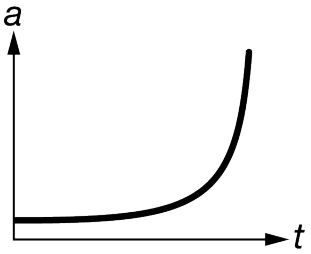
A ball of mass M swings in a horizontal circle at the end of a string of radius R at a constant tangential speed v_0. A student gradually pulls the string inward such that the radius of the circle decreases while keeping the tangential speed v_0 of the ball constant, as shown above. Which of the following graphs best represents the acceleration a of the ball as a function of time t?

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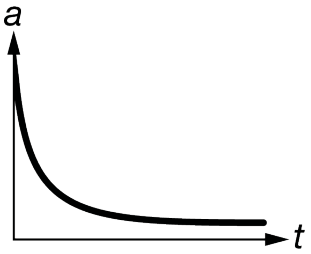
(A)



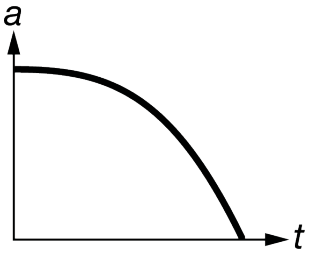
(B)



(C)



(D)



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21.

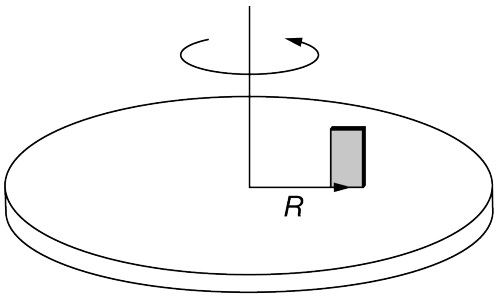
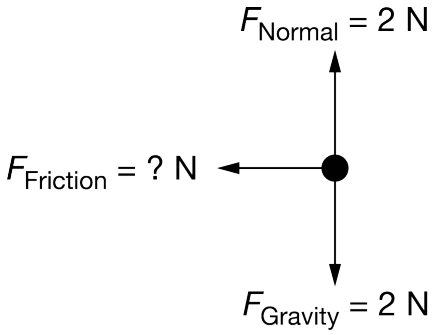


Figure 1



Note: Vectors are not drawn to scale.

Figure 2

During an experiment, an object is placed on a disk that rotates about an axle through its center, as shown in Figure 1. The block is a distance $\mathrm{R} = 0.10\ \mathrm{m}$ from the center and rotates with a constant tangential speed of $0.60\ \frac{\mathrm{m}}{\mathrm{s}}$. A free body diagram of the forces exerted on the block is shown in Figure 2 with an unknown force of friction. What is the force of friction exerted on the block?

(A) $0.50\,\mathrm{N}$

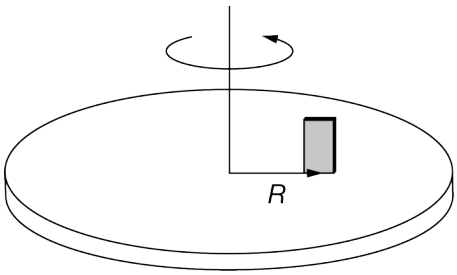
(B) $0.72\,\mathrm{N}$

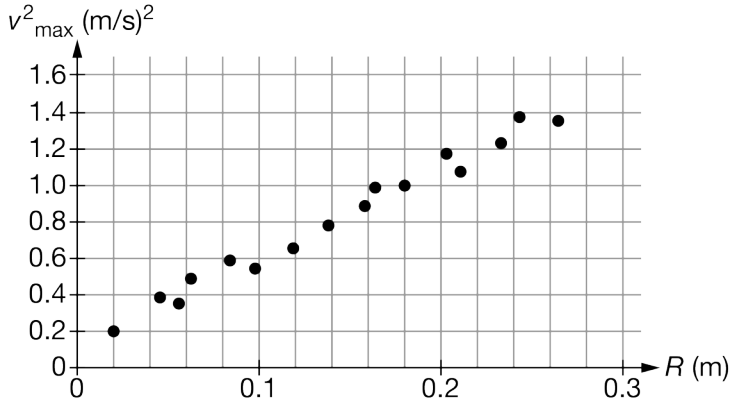
(C) $5.0\,\mathrm{N}$

(D) $7.2\,\mathrm{N}$

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22.





During an experiment, a block of mass $M = 0.20$ kg is placed on a disk that rotates about an axle through its center, as shown in the diagram. The block is moved to different distances R from the axle, and the tangential speed of the block is gradually increased until the mass begins to slip. The distance and maximum tangential speed before slipping, $v_{\max}$, are recorded. A student creates a graph of ${v_{\max}}^2$ as a function of R, as shown. How should the student use the graph to most accurately determine the experimental value of the coefficient of static friction μ_S between the block and the disk?

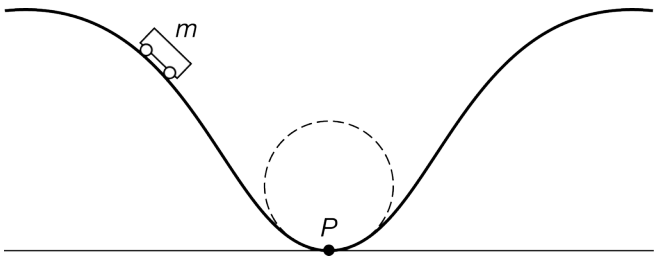
(A) Determine the slope of the best fit line, and it will be equal to μ_S.

(B) Determine the slope of the best fit line and set it equal to $\mu_S \mathrm{g}$.

(C) Determine the maximum value on the curve and use the data from that point in the equation $v^2 = \mu_S \mathrm{g} R$.

(D) Determine the midpoint value on the curve and use the data from that point in the equation $v^2 = \mu_S \mathrm{g} R$.

23.



A cart of mass m rolls past the circular bottom of a hill (point P). Which of the following statements about the normal force F_n exerted on the cart at point P is correct?

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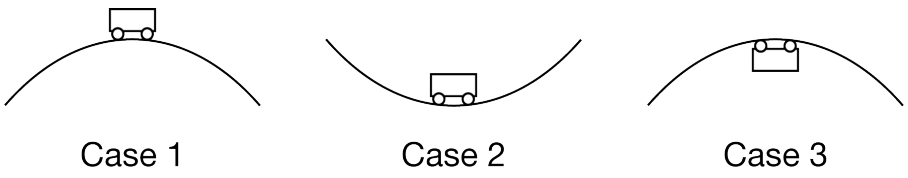
(A) $F_n = mg$, because the normal force on an incline is equal to $mg\ \cos\theta$ and $\theta = 0$ at point P.

(B) $F_n = mg$, because the speed of the cart is neither increasing nor decreasing at point P.

(C) F_n is equal to the centripetal force on the cart at point P, because only the track can exert a force toward the center of the circle.

(D) F_n is greater than mg at point P, because the cart is experiencing an upward acceleration.

24.



The figures show a cart moving over the top of a hill (Case 1), moving at the bottom of a dip (Case 2), and moving at the top of a vertical loop (Case 3). In each case, the normal force acting on the car is F_n and the weight of the car is F_g. In which case is it always true that $F_n > F_g$, and in which case is it always true that $F_n < F_g$?

(A)

$F_n > F_g$ Always	$F_n < F_g$ Always
Case 1	Case 3

(B)

$F_n > F_g$ Always	$F_n < F_g$ Always
Case 2	Case 1

(C)

$F_n > F_g$ Always	$F_n < F_g$ Always
Case 2	Case 3

(D)

$F_n > F_g$ Always	$F_n < F_g$ Always
Case 3	Case 1

25. A moon of mass 1×10^{20} kg is in a circular orbit around a planet. The planet exerts a gravitational force of 2×10^{21} N on the moon. The centripetal acceleration of the moon is most nearly

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(A) $0.05\ \frac{\text{m}}{\text{s}^2}$

(B) $10\ \frac{\text{m}}{\text{s}^2}$

(C) $20\ \frac{\text{m}}{\text{s}^2}$

(D) $2 \times 10^{41}\ \frac{\text{m}}{\text{s}^2}$

26. Two massive, positively charged particles are initially held a fixed distance apart. When they are moved farther apart, the magnitude of their mutual gravitational force changes by a factor of n. Which of the following indicates the factor by which the magnitude of their mutual electrostatic force changes?

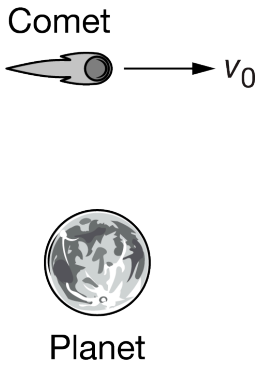
(A) $1/n^2$

(B) $1/n$

(C) n

(D) n^2

27.



Tangential Acceleration $\left(\text{m/s}^2\right)$	Centripetal Acceleration $\left(\text{m/s}^2\right)$	Force Due to Gravity on Comet from Planet (N)
0	0	1.67×10^{11}

A comet passes by a planet with a speed v_o such that the comet travels in a straight line at the instant shown in the figure. The comet's tangential acceleration, centripetal acceleration, and force due to gravity from the planet at this location are provided in the table. Astronomers observe that the comet continues to travel in a nearly straight line, even though calculations show that the gravitational force exerted by the planet should cause the comet to move in a circular orbit. Why does the comet not travel in a circular path around the planet after the instant shown in the figure?

(A) The comet is too far away to travel in a circular path around the planet.

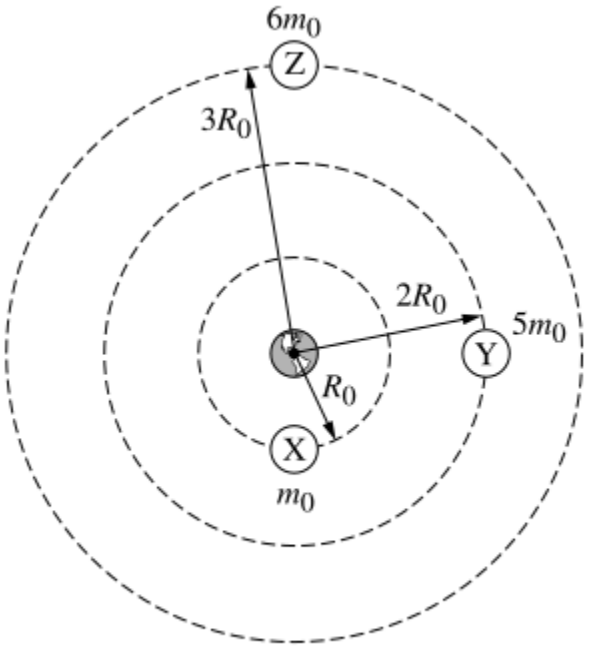
(B) The planet's gravitational force is not strong enough to cause the comet to have a centripetal acceleration.

(C) The comet's inertia is so great that the direction of the comet cannot be changed by the gravitational force exerted by the planet.

(D) There must be another object such that the gravitational forces exerted on the comet are balanced at this location.

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28.



Note: Figure not drawn to scale.

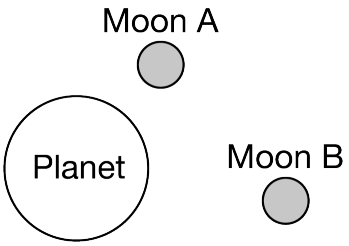
Satellites X, Y, and Z travel in circular orbits around Earth. The mass of each satellite and the distance of each satellite from Earth's center are shown. Which of the following compares the magnitudes of the gravitational forces F_{X}, F_{Y}, and F_{Z} exerted on satellites X, Y, and Z, respectively, by Earth?

(A) $F_{\mathrm{X}} > F_{\mathrm{Y}} > F_{\mathrm{Z}}$

(B) $F_{\mathrm{X}} > F_{\mathrm{Z}} > F_{\mathrm{Y}}$

(C) $F_{\mathrm{Y}} > F_{\mathrm{X}} > F_{\mathrm{Z}}$

(D) $F_{\mathrm{Z}} > F_{\mathrm{Y}} > F_{\mathrm{X}}$



A planet has two moons, Moon A and Moon B, that orbit at different distances from the planet's center, as shown. Astronomers collect data regarding the planet, the two moons, and their obits. The astronomers are able to estimate the planet's radius and mass.

29. The masses of the two moons are determined to be $2M$ for Moon A and M for Moon B. It is observed that the distance between Moon B and the planet is two times that of the distance between Moon A and the planet. How does force exerted from the planet on Moon A compare to the force exerted from the planet on Moon B ?

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(A) The gravitational force exerted from the planet on Moon A is two times larger than the gravitational force exerted from the planet on Moon B .

(B) The gravitational force exerted from the planet on Moon A is eight times larger than the gravitational force exerted from the planet on Moon B .

(C) The gravitational force exerted from the planet on Moon A is two times smaller than the gravitational force exerted from the planet on Moon B .

(D) The gravitational force exerted from the planet on Moon A is eight times smaller than the gravitational force exerted from the planet on Moon B .

30. What additional information is needed to determine the time required for one of the moons to make one complete revolution around the planet?

(A) The mass of each moon

(B) The radius of each moon

(C) The distance between the center of each moon and the planet.

(D) No additional information is needed.

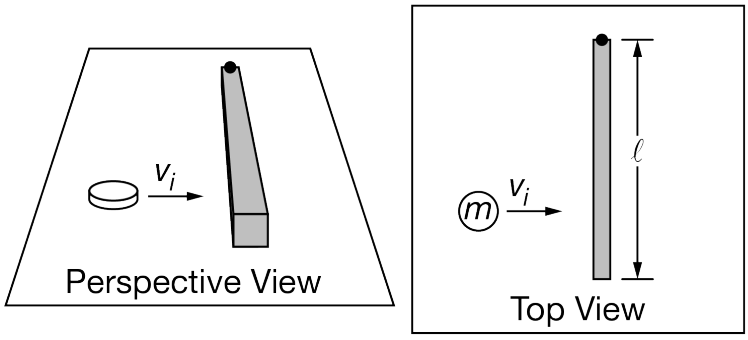


Figure 1

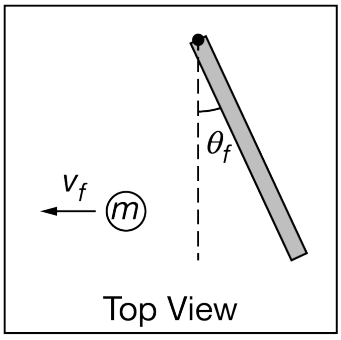


Figure 2

A disk of mass m slides with negligible friction to the right with speed v_i on a horizontal table. The disk collides elastically with a uniform rod of length ℓ that is at rest and free to pivot about one end, as shown in Figure 1 above. The disk rebounds to the left with speed v_f, and the rod rotates with friction and stops at a final angle θ_f from its initial position, as shown in Figure 2.

31. Which of the following describes the direction of the forces exerted by the disk and rod on each other during the collision?

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(A)

Direction of Force Exerted on Disk by Rod	Direction of Force Exerted on Rod by Disk
Down and to the left	To the right

(B)

Direction of Force Exerted on Disk by Rod	Direction of Force Exerted on Rod by Disk
To the left	To the right

(C)

Direction of Force Exerted on Disk by Rod	Direction of Force Exerted on Rod by Disk
Down and to the left	Up and to the right

(D)

Direction of Force Exerted on Disk by Rod	Direction of Force Exerted on Rod by Disk
To the left	Up and to the right

---

32. A student must design an experiment to determine the gravitational mass of an object. Which of the following experiments could the student use? Select two answers.

A. Place the object on one side of a lever at a known distance away from a fulcrum. Place known masses on the other side of the fulcrum so that they are also placed on the lever at known distances from the fulcrum. Move the known masses to a known distance such that the lever is in static equilibrium.

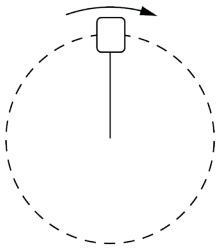
B. Place the object on a surface of negligible friction, and pull the object horizontally across the surface with a spring scale at a nonconstant speed such that a motion detector can measure how the object's speed as a function of time changes.

C. Place the object on a surface that provides friction between the object and the surface. Use a surface such that the coefficient of friction between the object and the surface is known. Pull the object horizontally across the surface with a spring scale at a nonconstant speed such that a motion detector can measure how the object's speed as a function of time changes.

D. Place the object on the end of a vertically hanging spring with a known spring constant. Allow the spring to stretch to a new equilibrium position, and measure the distance the spring is stretched from its original equilibrium position.

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33.



Side View

An object of unknown mass is swung in a vertical circle at the end of a light string, as seen in the figure above. A measurement is made of the object's tangential speed at the bottom circular path. A student must determine the tension in the string at the bottom of the circular path. Which of the following measurements, in conjunction with the object's tangential speed, are required to determine the tension in the string? Select two answers.

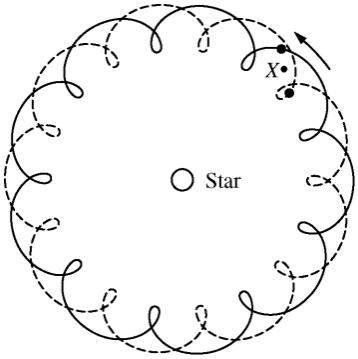
A The object's tangential speed at the top of the circle

B The object's mass

C The diameter of the circular path

D The time required for the object to complete one revolution

34.



The figure above represents the orbits of two planets of equal mass that orbit their star in the counterclockwise direction as a double-planet system. From the point of view of an observer on either planet, the planets appear to orbit each other while also orbiting the star. The dots on the orbits represent the position of the planets at time t_0, and X is the position of their center of mass at that time. Which of the following arrows best represents the acceleration of the center of mass of the double-planet system when it is at point X ?

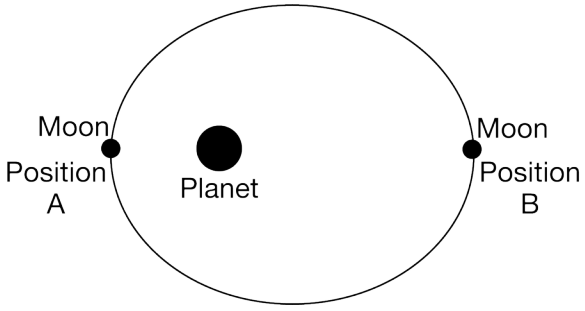
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(A) 

(B) 

(C) 

(D) 



The figure above shows the position of a moon that orbits a planet in an elliptical path. Two specific locations of the moon, position A and position B, are labeled.

35. In what direction is the net force exerted on the moon?

(A) Toward the planet

(B) Toward the center of the ellipse

(C) Away from the center of the ellipse

(D) Parallel to the direction that the moon is moving at any given instant

36. As the moon orbits the planet from position A to position B, is the magnitude of the planet's force due to gravity exerted on the moon constant? Why or why not?

(A) Yes, because the masses of the planet and moon remain constant.

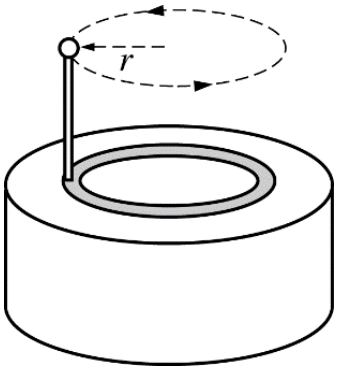
(B) Yes, because the elliptical path that the moon travels around the planet is the same for all revolutions.

(C) No, because the tangential speed of the moon is always changing.

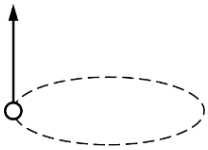
(D) No, because the moon's distance from the planet is always changing.

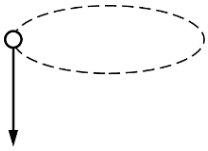
CHAPTER3

37.

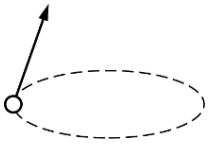


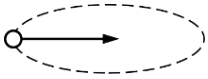
A steel ball supported by a stick rotates in a circle of radius *r*, as shown above. The direction of the net force acting on the ball when it is in the position shown is indicated by which of the following?

(A) 

(B) 

(C) 

(D) 

(E) 

38. An object is released from rest near the surface of a planet. The velocity of the object as a function of time is expressed in the following equation.

$$v_y = (-3\ \frac{\mathrm{m}}{\mathrm{s}^2})t$$

All frictional forces are considered to be negligible. What distance does the object fall $10\,\mathrm{s}$ after it is released from rest?

(A) $3\,\mathrm{m}$

(B) $30\,\mathrm{m}$

(C) $150\,\mathrm{m}$

(D) $500\,\mathrm{m}$

CHAPTER3

39. A $2\,\text{kg}$ object is a distance of $10{,}000{,}000\,\text{m}$ away from the center of Earth, which has a mass of nearly $6 \times 10^{24}\,\text{kg}$. What is the approximate gravitational field strength of Earth's gravitational field at the location of the $2\,\text{kg}$ object?

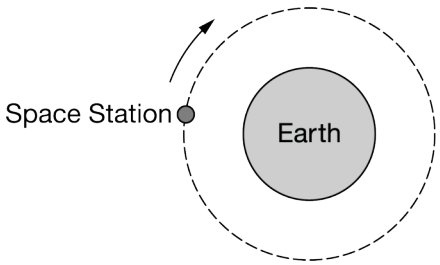
(A) $2\ \frac{\text{N}}{\text{kg}}$

(B) $4\ \frac{\text{N}}{\text{kg}}$

(C) $10\ \frac{\text{N}}{\text{kg}}$

(D) The gravitational field strength is negligible and, therefore, approximately zero.

A space station has a mass M and orbits Earth in a circular orbit at a height above Earth's surface.



40. A payload of mass m, where $\text{m} < \text{M}$, is delivered to the space station. Soon after, the space station's orbit is adjusted so that it is $50\,\text{km}$ farther away from Earth's surface than before. Which of the following best describes the effects of these changes on Earth's gravitational field strength at the space station's new location?

(A) The increase in mass of the space station has no effect on the field strength, and the increase in orbital radius decreases the field strength.

(B) The increase in mass increases the field strength, and the increase in orbital radius decreases the field strength; however, the field strength decreases overall.

(C) The increase in mass increases the field strength, and the increase in orbital radius decreases the field strength; however, the field strength increases overall.

(D) The field strength is unchanged because there is no gravitational field in space.

41. An astronaut in the space station appears weightless because the astronaut seems to float. Which of the following claims is true about the force exerted on the astronaut by Earth?

(A) There is no force exerted on the astronaut by Earth because the astronaut is $400\,\text{km}$ above Earth's surface.

(B) The force exerted on the astronaut by Earth is less than the force exerted on Earth by the astronaut because the astronaut is $400\,\text{km}$ above Earth's surface.

(C) The force exerted on the astronaut by Earth is equal to the force exerted on Earth by the astronaut.

(D) The force exerted on the astronaut by Earth is equal to the gravitational force of the space station that is exerted on the astronaut; the two equal forces balance to cause the astronaut to float.

CHAPTER3

42. When two charged, massive objects are placed a distance r apart, the gravitational force between them has magnitude F. When the distance between the objects is increased to $2r$, the magnitude of the gravitational force between them becomes $F/4$. Did the electrostatic force between the objects also decrease to one fourth its initial magnitude as a result of the change in position, and why?

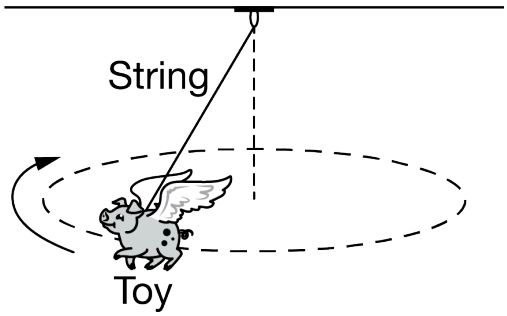
(A) No, because the gravitational constant is much smaller than the electrostatic constant.

(B) No, because the gravitational force is only attractive, and the electrostatic force can also be repulsive.

(C) Yes, because both forces have the same $1/r^2$ dependence.

(D) Yes, because the gravitational force always equals the electrostatic force at any given distance.

43.



One end of a string is attached to the ceiling with the other end attached to a toy. The toy can be set into motion such that it travels in a horizontal circular path at a constant tangential speed, as shown above. Which of the following measuring tools, when used together, could be used to determine the time it takes for the toy to complete one revolution around the circle? Select two answers.

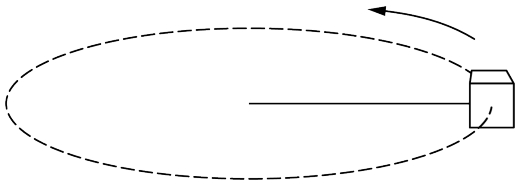
A Protractor

B Meterstick

C Force probe

D Motion sensor

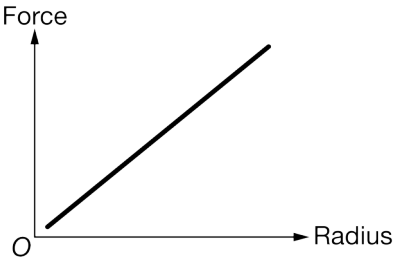
44.



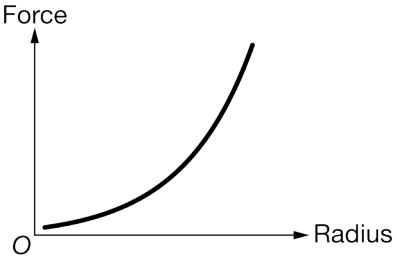
A block is attached to the end of a string and initially moves at a constant speed in a horizontal circle of constant radius, as shown. The radius is then increased slowly while the speed remains the same. Which of the following graphs best represents the force exerted on the block by the string as a function of the radius?

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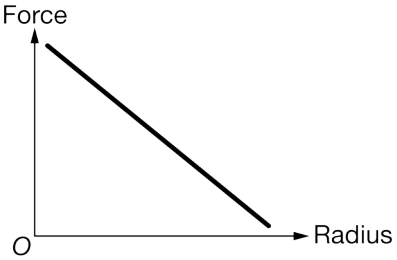
(A)



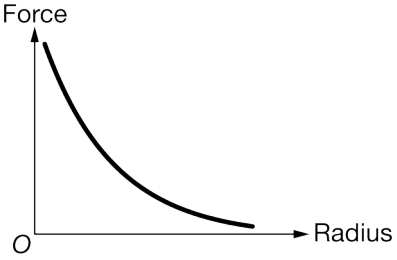
(B)



(C)

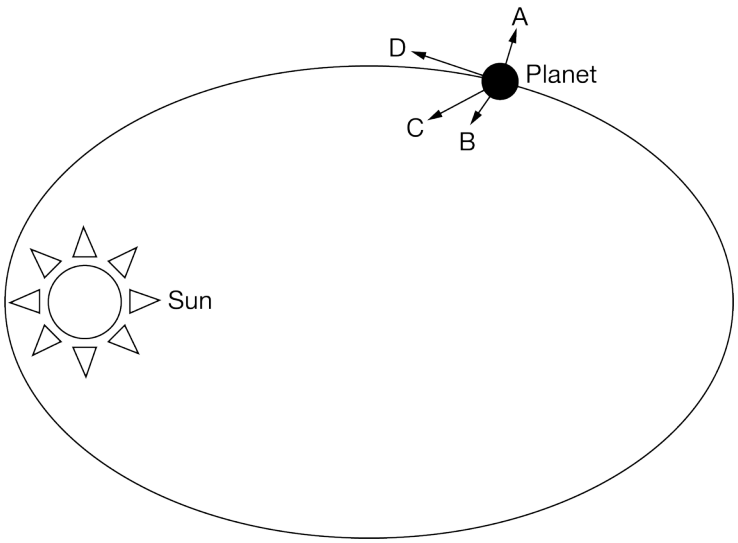


(D)



CHAPTER3

45.



A planet travels in an elliptical orbit around its star, as shown above. Which arrow best shows the direction of the net force exerted on the planet?

(A) A

(B) B

(C) C

(D) D

46. A satellite is a large distance from a planet, and the gravitational force from the planet is the only significant force exerted on the satellite. The satellite begins falling toward the planet, eventually colliding with the surface of the planet. As the satellite falls, which of the following claims is correct about how the force that the planet exerts on the satellite F_{ps} changes and how the force that the satellite exerts on the planet F_{sp} changes, if at all? What reasoning supports this claim?

(A) F_{ps} and F_{sp} both increase. The gravitational forces that two objects exert on one another decrease as the separation between the objects increases, and these forces are always equal in magnitude.

(B) F_{ps} increases while F_{sp} remains constant. The gravitational force exerted by a planet on a satellite decreases as the separation between the two objects increases, and the force exerted by the satellite on the planet remains negligibly small.

(C) F_{ps} remains constant while F_{sp} increases. The gravitational force exerted by a planet on a satellite is a constant equal to the weight of the satellite, and the gravitational force exerted by the satellite on the planet decreases as the separation between the two objects increases.

(D) F_{ps} and F_{sp} both remain constant. The gravitational forces that a planet and a satellite exert on one another is a constant equal to the weight of the satellite.

47. A $10\ \text{kg}$ object is near a planet's surface such that the gravitational field strength is $4\ \frac{\text{N}}{\text{kg}}$. With what force is the planet attracted to the $10\ \text{kg}$ object?

CHAPTER3

(A) $4\ \frac{\text{N}}{\text{kg}}$

(B) $10\ \text{N}$

(C) $40\ \text{N}$

(D) $100\ \text{N}$

48. A satellite of mass M_s is orbiting a planet of mass M_p in a circular orbit of radius R_0. What is the kinetic energy of the satellite?

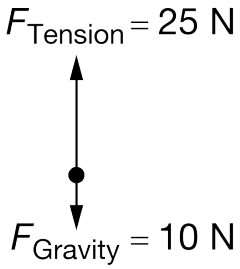
(A) $\frac{GM_\text{p}M_\text{s}}{2R_0}$

(B) $\frac{GM_\text{p}M_\text{s}}{R_0}$

(C) $\frac{GM_\text{p}M_\text{s}}{2R_0^2}$

(D) $\frac{GM_\text{p}M_\text{s}}{R_0^2}$

49.



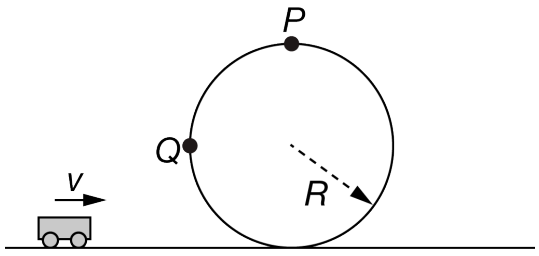
A ball is attached to one end of a string such that the ball travels in a vertical circular path near Earth's surface. The force diagram of the ball at its lowest point in the circular path is shown above. What is the net centripetal force exerted on the ball?

(A) $10\ \text{N}$

(B) $15\ \text{N}$

(C) $25\ \text{N}$

(D) $35\ \text{N}$



A cart of mass m is moving with speed v on a smooth track when it encounters a vertical loop of radius R, as shown above. The cart moves along the inside of the entire loop without leaving the track. All frictional forces are negligible.

50. Which of the following must be true for the cart to remain on the track when it is at point P ?

CHAPTER3

(A) The net force exerted on the cart must be less than the force that the track exerts on the cart.

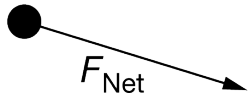
(B) The net force exerted on the cart must be equal to or greater than the weight of the cart.

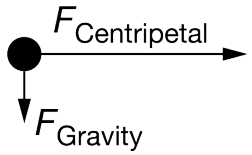
(C) The track must exert an upward force on the cart to prevent it from falling.

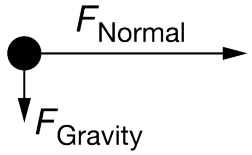
(D) The track must exert a force on the cart that is equal to the weight of the cart.

51. Which of the following free-body diagrams shows the force or forces exerted on the cart at point Q ?

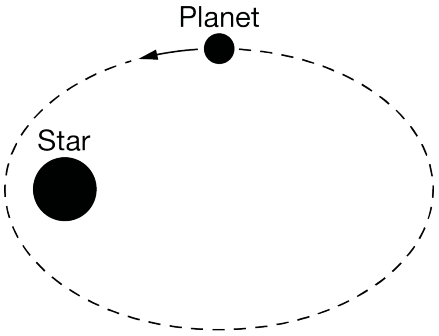
(A) 

(B) 

(C) 

(D) 

52.



A planet travels in an elliptical path around a star, as shown in the figure. As the planet gets closer to the star, the gravitational force that the star exerts on the planet increases. Which statement of reasoning best supports and correctly identifies what happens to the magnitude of the force that the planet exerts on the star as the planet gets closer to the star?

(A) The force remains constant because the mass of the planet remains constant.

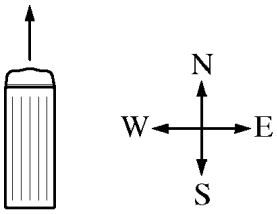
(B) The force increases because it is part of a Newton's third law pair of forces with the force that the star exerts on the planet.

(C) The force decreases because the planet increases its speed as it gets closer to the star.

(D) The force fluctuates such that it increases and decreases because the planet does not travel in a perfectly circular path.

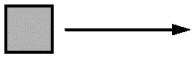
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53.

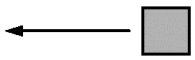


A bus is initially traveling north at a constant speed, as shown in the figure above. As the bus starts to make a left turn without changing speed, a passenger notices that a box on the floor starts sliding toward the right side of the bus. Which of the following top views of the box, when correctly labeled, would best represent all of the horizontal forces exerted on the box as it starts sliding?

(A)



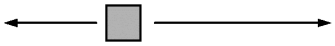
(B)



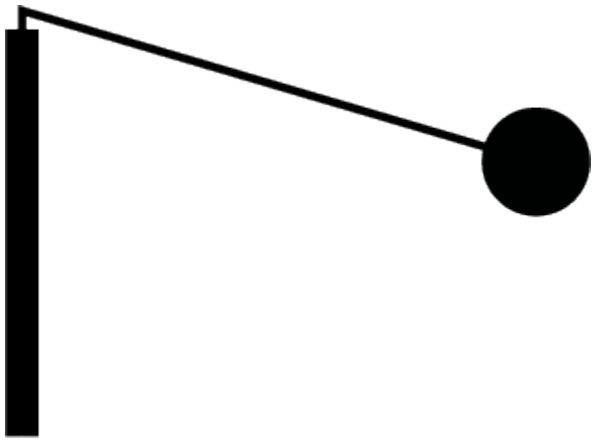
(C)



(D)



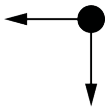
54.



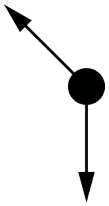
One end of a string is attached to a vertical pole with the other end of the string attached to a ball that swings in a horizontal circular path, as shown. Which of the following free body diagrams represents the forces exerted on the ball?

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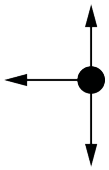
(A)



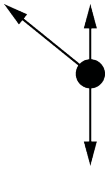
(B)



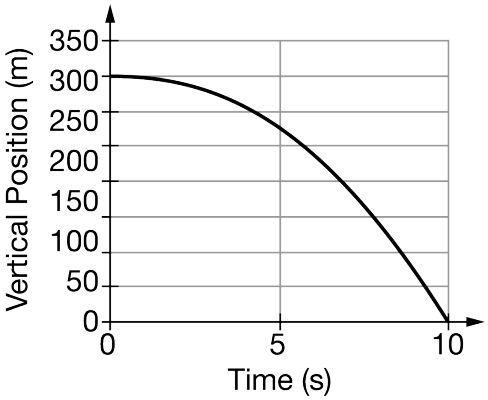
(C)



(D)



55.



An object is released from rest near the surface of a planet. The vertical position of the object as a function of time is shown in the graph. All frictional forces are considered to be negligible. The strength of the gravitational field is most nearly

(A) $3\ \frac{\text{N}}{\text{kg}}$

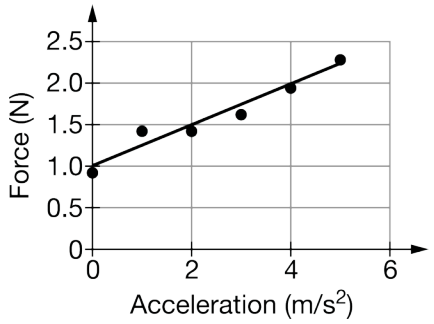
(B) $6\ \frac{\text{N}}{\text{kg}}$

(C) $10\ \frac{\text{N}}{\text{kg}}$

(D) The strength of the gravitational field cannot be determined without applying Newton's law of universal gravitation.

CHAPTER3

56.



A student must determine the inertial mass of a block that is pulled across a horizontal surface using a force probe and an accelerometer. The student's data are represented in the graph above. What must the student do to determine the inertial mass of the block?

(A) Determine the *y*-intercept.

(B) Calculate the slope.

(C) Calculate the area under the line.

(D) Determine the *x*-intercept.

57. A sphere is initially held at rest a distance R_0 above the center of a planet of mass M_0. The weight of the sphere at this initial location is W_0. The sphere is then moved to a new location above the same planet so that the weight of the sphere is $2W_0$. Which of the following expressions represents the strength of the gravitational field at the new location of the sphere?

(A) $\frac{GM_0}{4R_0^2}$

(B) $\frac{GM_0}{2R_0^2}$

(C) $\frac{GM_0}{R_0^2}$

(D) $\frac{2GM_0}{R_0^2}$

58. A satellite of mass $1000\,\text{kg}$ is in a circular orbit around a planet. The centripetal acceleration of the satellite in its orbit is $5\,\frac{\text{m}}{\text{s}^2}$. What is the gravitational force exerted on the satellite by the planet?

(A) $0\,\text{N}$

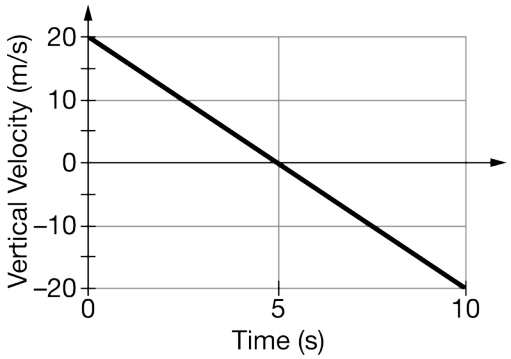
(B) $200\,\text{N}$

(C) $5000\,\text{N}$

(D) $10{,}000\,\text{N}$

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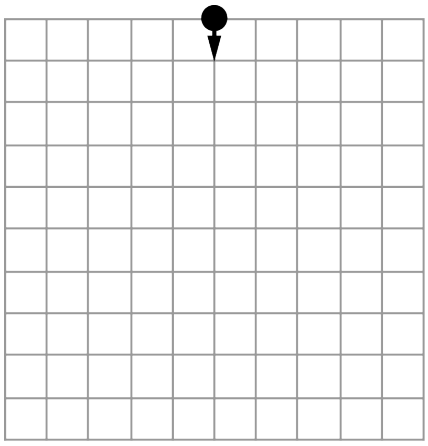
59.



On the surface of Planet X, a $2\,\mathrm{kg}$ object is thrown upward with a speed of $20\ \frac{\mathrm{m}}{\mathrm{s}}$. The object's vertical velocity as a function of time is shown in the graph. Which of the following free-body diagrams represents the gravitational force exerted on the object while it is in free fall?

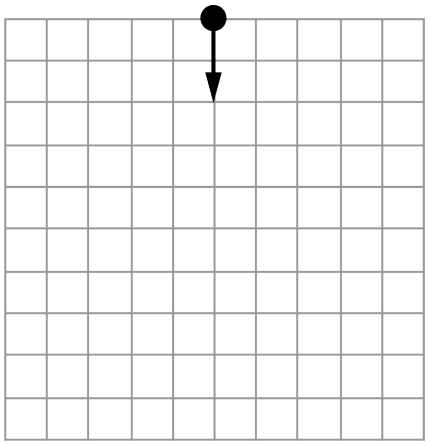
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(A)



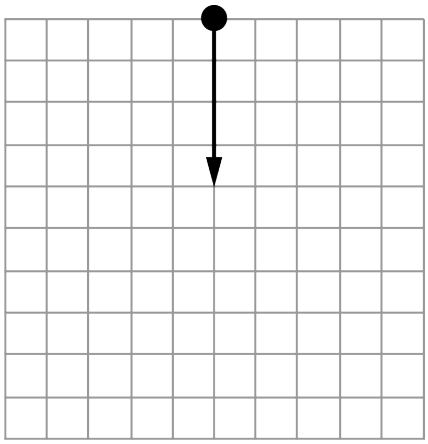
$F_{Gravity} = 2$ N

(B)



$F_{Gravity} = 4$ N

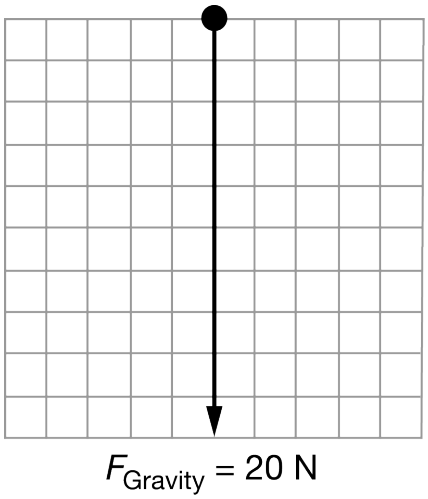
(C)



$F_{Gravity} = 8$ N

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(D)



60. An astronaut with mass M_{A} is within a satellite that orbits Earth at a height H above its surface. Earth has a mass M_{E} and radius R_{E}. Which of the following is a correct expression for the gravitational force exerted on the astronaut by Earth?

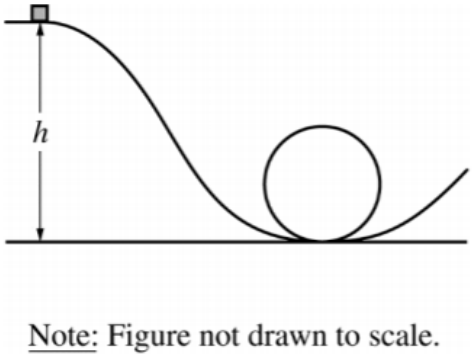
(A) $F_g = G\frac{M_E M_A}{H^2}$

(B) $F_g = G\frac{M_E M_A}{R_E^2}$

(C) $F_g = G\frac{M_E M_A}{(R_E+H)^2}$

(D) $F_g = 0$

61.



Note: Figure not drawn to scale.

A small block slides without friction along a track toward a circular loop. The block has more than enough speed to remain firmly in contact with the track as it goes around the loop. The magnitude of the block's acceleration at the top of the loop is

(A) Zero

(B) greater than zero but less than g

(C) equal to g

(D) greater than g

CHAPTER3

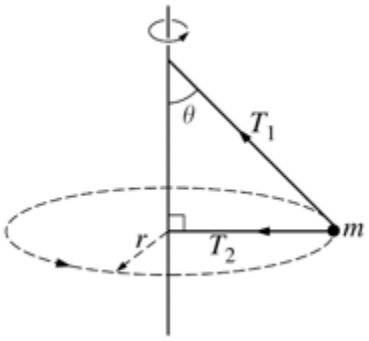
62. Planet X has twice Earth's mass and three times Earth's radius. The magnitude of the gravitational field near Planet X's surface is most nearly

(A) 2 N/kg

(B) 7 N/kg

(C) 10 N/kg

(D) 20 N/kg



A ball of mass m is attached to a vertical rod by two massless strings. The rod is rotated about its axis so that both strings are taut, with tensions T_1 and T_2, respectively. The strings and rod form the right triangle shown in the figure above. The ball rotates in a horizontal circle of radius r with speed v.

63. What is the magnitude of the net force on the ball?

(A) mv^2 / r

(B) mg

(C) T_2

(D) $T_2 + mv^2r$

(E) $T_1 + mg$

64. What is the tension T_1 in the upper string?

(A) $mg \cos \theta$

(B) $mg \sin \theta$

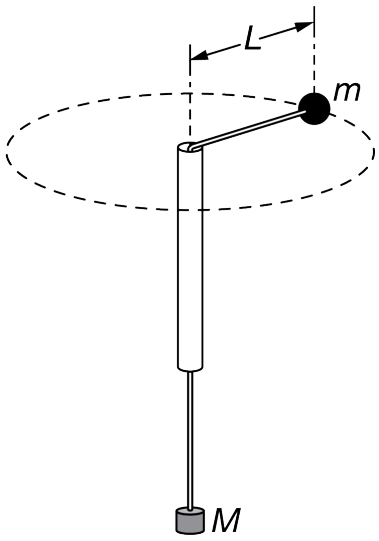
(C) $mg \tan \theta$

(D) $mg/\cos \theta$

(E) $mg/\sin \theta$

CHAPTER3

65.



A student builds the apparatus shown. One end of a light string is attached to an object of mass m_0, and the other end of the string is passed through a tube and attached to a second object of mass M. The student holds on to the tube and swings the object of mass m_0 in a horizontal circle while the object of mass M remains at a constant height. The time it takes for the object of mass m_0 to travel around its circular path is T. Which of the following options represents the essential measuring devices needed by the student to collect the necessary data to experimentally determine the gravitational field strength of the object of mass m_0 due to Earth's gravitational field?

(A) Mass balance

(B) Mass balance and meterstick

(C) Mass balance, meterstick, and timer

(D) Mass balance, meterstick, timer, and motion detector

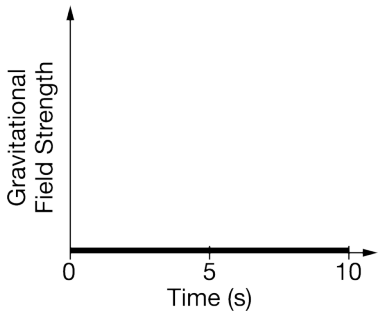
66.

Time (s)	Vertical Velocity (m)
0	0.0
1	−4.9
2	−10.2
3	−15.6
4	−19.7
5	−24.4
6	−30.9

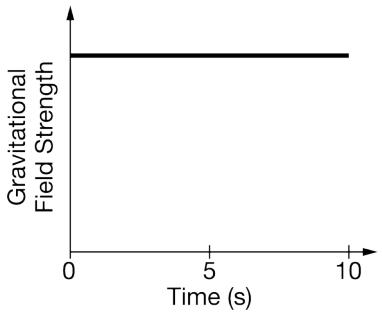
An astronaut performs an experiment near the surface of a moon by releasing an object at rest above a motion detector such that data can be collected about the object's vertical velocity as a function of time. The data are provided in the table. Which of the following graphs most likely represents the shape of the curve of the magnitude of the gravitational field strength near the surface of the moon as a function of time?

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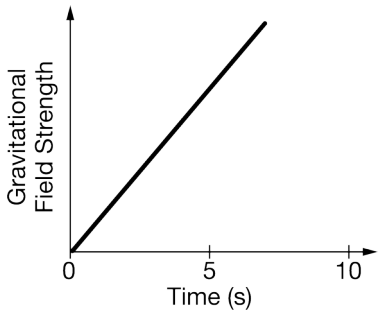
(A)



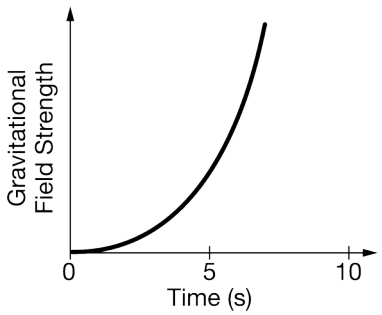
(B)



(C)

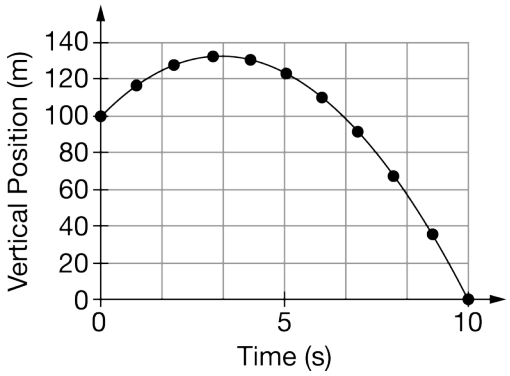


(D)



CHAPTER3

67.



An object is thrown upward with a speed of $20\ \mathrm{m/s}$ near the surface of a planet where the gravitational field strength is a constant magnitude of $6\ \mathrm{N/kg}$. The vertical position versus time of the object is shown in the graph. Is the object considered to be in free fall?

(A) Yes, because the only force exerted on the object is the force due to gravity from the planet.

(B) Yes, because any object that falls is considered to be in free fall.

(C) No, because the object does not fall with an acceleration of nearly $10\ \mathrm{m/s^2}$.

(D) No, because the object has an acceleration due to gravity that is different from the gravitational field strength of the planet.

A satellite of mass m orbits a moon of mass M in uniform circular motion with a constant tangential speed of v.

68. The gravitational field strength at a distance R from the center of moon is g_R. The satellite is moved to a new circular orbit that is $2R$ from the center of the moon. What is the gravitational field strength of the moon at this new distance?

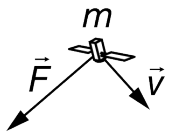
(A) $\frac{g_R}{4}$

(B) $\frac{g_R}{2}$

(C) $2g_R$

(D) $4g_R$

69.





The figure shows the net force exerted on the satellite by the moon and the direction of the tangential velocity of the satellite at time t_0. Which of the following statements is true regarding the motion of the satellite?

CHAPTER3

(A) The gravitational force exerted on the satellite by the moon will increase after time t_0.

(B) The satellite accelerates in a direction that is parallel to the direction of the tangential velocity.

(C) The satellite will move toward the moon after time t_0.

(D) The tangential velocity of the satellite does not remain constant.

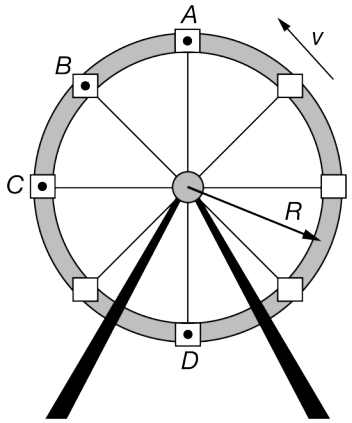
70. The satellite orbits at a distance R from the center of the moon. Which of the following is a correct expression for the time T it takes the satellite to make one complete revolution around the moon?

(A) $T = 2\pi\sqrt{\frac{R^3}{Gm}}$

(B) $T = 2\pi\sqrt{\frac{R^3}{GM}}$

(C) $T = 2\pi\sqrt{\frac{Gm}{R^3}}$

(D) $T = 2\pi\sqrt{\frac{GM}{R^3}}$



An amusement park ride consists of a large vertical wheel of radius R that rotates counterclockwise on a horizontal axis through its center, as shown above. The cars on the wheel move at a constant speed v. Points A and D represent the position of a car at the highest and lowest point of the ride, respectively. A person of weight F_g sits upright on a seat in one of the cars. As the seat passes point A, the seat exerts a normal force with magnitude $0.8F_g$ on the person. While passing point A, the person releases a small rock of mass m, which falls to the ground without hitting anything.

71. What is the normal force exerted on the rider when passing point D?

(A) $0.2F_g$

(B) $0.8F_g$

(C) $1.0F_g$

(D) $1.2F_g$

CHAPTER3

72.

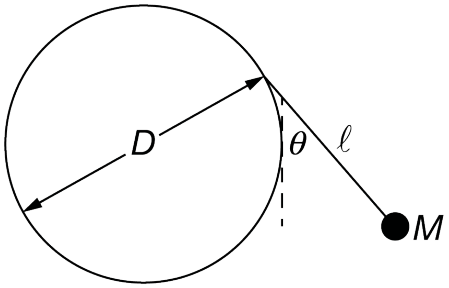


Figure 1

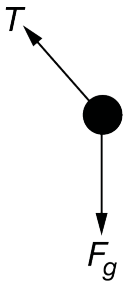


Figure 2



Figure 3

A solid disk of diameter D spins counterclockwise about its center at a constant speed. One end of a string of length l is attached to the edge of the disk with the other end attached to an object of mass M. At time t_0, as the disk spins, the string makes an angle θ with respect to the vertical, as shown in Figure 1. A force diagram of all of the forces exerted on the object at time t_0 are shown in Figure 2. The direction of the centripetal acceleration of the object at t_0 is shown in Figure 3. What is the magnitude of the acceleration of the object of mass M at time t_0?

(A) $T \cos\theta$

(B) $T \tan\theta$

(C) $g \sin\theta$

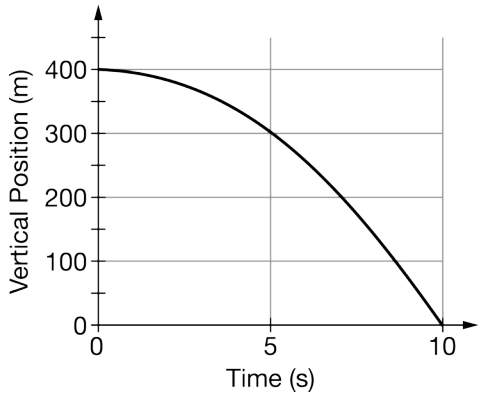
(D) $g \tan\theta$

73. An object is dropped near the surface of a planet such that the gravitational field at the object's location is $8\ \frac{\text{N}}{\text{kg}}$. If the object is thrown upward at a speed of $20\ \frac{\text{m}}{\text{s}}$, what is the position of the object in relation to the position in which the object was released and thrown upward after 3s ?

CHAPTER3

(A) $96\ \text{m}$ below the release position
(B) $36\ \text{m}$ below the release position
(C) $15\ \text{m}$ above the release position
(D) $24\ \text{m}$ above the release position

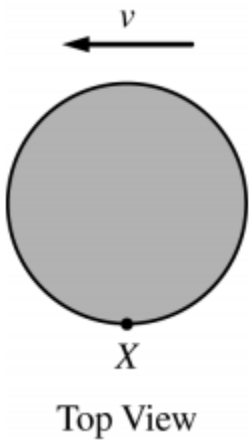
74.



A $5\ \text{kg}$ object is released from rest near the surface of a planet. The object's vertical position as a function of time is shown in the graph. Which of the following procedures can be used to determine the strength of the gravitational field on the planet?

(A) Determine the average slope of the graph.
(B) Use $v_y = v_{y0} + a_y t$. Use $10\ \text{s}$ for t, $0\ \frac{\text{m}}{\text{s}}$ for v_{y0}, and $-40\ \text{m/s}$ for v_{fy}. Solve for a_{y}.
(C) Use $y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$. Use $10\ \text{s}$ for t, $0\ \frac{\text{m}}{\text{s}}$ for v_{y0}, $400\ \text{m}$ for y_0, and $0\ \text{m}$ for y. Solve for a_{y}.
(D) Use $\frac{F_g}{m} = g$. Use $5\ \text{kg}$ for m and $10\ \frac{\text{m}}{\text{s}^2}$ for g. Solve for F_{g}.

75.



Top View

A stone disk is sliding on frictionless ice to the west with speed v, as shown in the figure above. As the disk slides by, a child uses a rubber mallet to hit the disk at point X, exerting a force directly toward the center of the disk. The child hits point X every half second for about 10 s, changing the trajectory of the disk but not causing it to rotate. Which of the following most closely approximates the path of the disk while the child is hitting it?

CHAPTER3

(A) 

A northward linear path

(B) 

A northwestward linear path

(C) 

A parabolic path

(D) 

A circular path

76. Planet 1 orbits Star 1 and Planet 2 orbits Star 2 in circular orbits of the same radius. However, the orbital period of Planet 1 is longer than the orbital period of Planet 2. What could explain this?

(A) Star 1 has less mass than Star 2.

(B) Star 1 has more mass than Star 2.

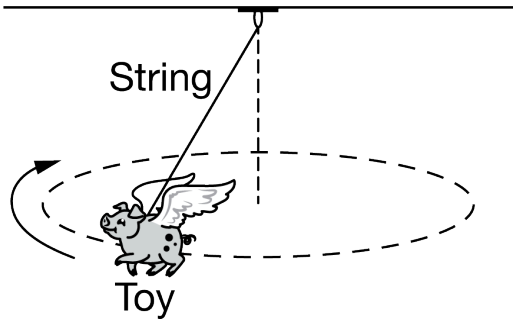
(C) Planet 1 has less mass than Planet 2.

(D) Planet 1 has more mass than Planet 2.

(E) The masses of the planets are much less than the masses of the stars.

CHAPTER3

77.



One end of a string is attached to the ceiling with the other end attached to a toy. The toy can be set into motion such that it travels in a horizontal circular path at a constant tangential speed, as shown above. The toy experiences a component of the tension force toward the center of the circular path that serves as the centripetal force exerted on the toy. Which of the following measurements could a student use to determine the net centripetal force exerted on the toy? Select two answers.

A Use a scale to determine the mass of the toy. Use a protractor to determine the angle θ between a vertical line and the angle that the string makes with the vertical line.

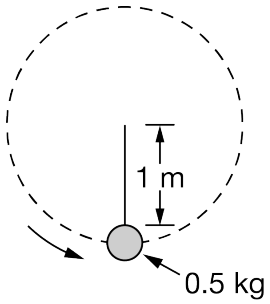
B Use a stopwatch to determine the time for the toy to complete one revolution. Use a meterstick to measure the radius of the toy's circular path, R. Use a scale to determine the mass of the toy.

C Use a stopwatch to determine the time for the toy to complete one revolution. Use a meterstick to determine the length, l, of the string. Use a meterstick to measure the radius of the toy's circular path, R.

D Use a stopwatch to determine the time for the toy to complete one revolution. Use a meterstick to determine the length, l, of the string. Use a scale to determine the mass of the toy.

CHAPTER3

78.



Side View

Trial	Tangential Speed $\left(\frac{\text{m}}{\text{s}}\right)$	Predicted Force of Tension (N)	Actual Force of Tension (N)
1	1	0.5	5.5
2	2	2	7
3	3	4.5	9.5

A student conducts an experiment in which a $0.5\,\text{kg}$ ball is spun in a vertical circle from a string of length $1\,\text{m}$, as shown in the figure. The student uses the following equation to predict the force of tension exerted on the ball whenever it reaches the lowest point of its circular path at a known tangential speed for various trials.

$$F_{\text{Tension}} = m\frac{v^2}{r}$$

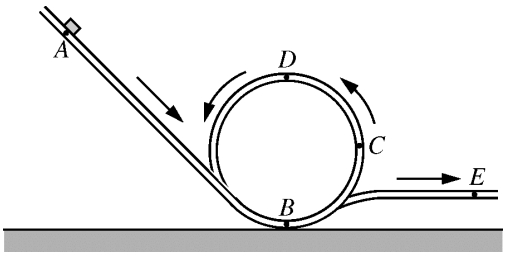
When the experiment is conducted, the student uses a force probe to measure the actual force of tension exerted on the ball. Why is the predicted force of tension different than the actual force of tension?

(A) The force probe has not been calibrated properly because the predicted tension forces are in agreement with their corresponding tangential speeds.

(B) Not enough trials were conducted to observe the spread of uncertainty with the collected values because the predicted tension forces are in agreement with their corresponding tangential speeds.

(C) The student did not account for the downward centrifugal force that occurs as a result of the inertia of the ball when it reaches the lowest point along its circular path.

(D) The student did not account for the downward force due to gravity at the ball's lowest point along its circular path, so the predicted force of tension is the net centripetal force exerted on the ball.



A block released from rest at position *A* slides with negligible friction down an inclined track, around a vertical loop, and then along a horizontal portion of the track, as shown above. The block never leaves the track.

CHAPTER3

79. Which of the following is true of the net force on the block when it is at position *C* ?

(A) It is directed vertically downward only.

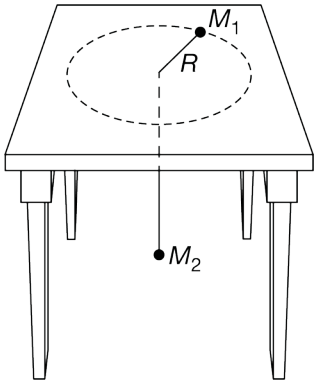
(B) It is directed vertically upward only.

(C) It is directed to the left only.

(D) It is directed to the right only.

(E) It has components both to the left and vertically downward.

80.



An object of mass M_1 travels in a circular path of radius R on a horizontal table. The object is attached to a string that passes through a hole in the center of the table. An object of mass M_2 is attached to the other end of the string and hangs vertically under the table, which produces a force on M_1. All frictional forces are considered to be negligible. Which quantity or quantities must be measured to determine the tangential speed required to keep the system in equilibrium?

(A) R only

(B) M_2 only

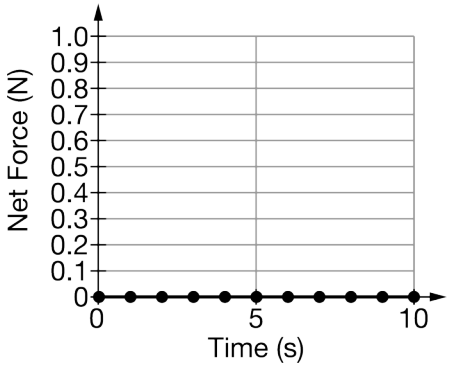
(C) M_1 and M_2

(D) R, M_1, and M_2

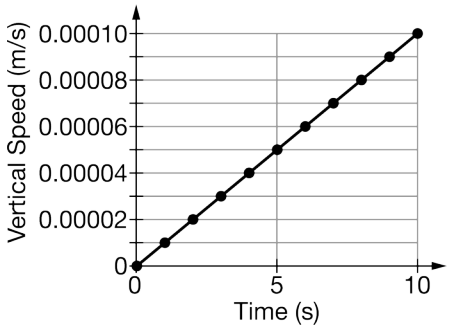
81. On the surface of a spherical asteroid, a small object of mass 1×10^{-5} kg and has a weight of 1×10^{-10} N is held above the surface. Which of the following graphs correctly shows the rock's motion if it is dropped from rest near the asteroid's surface? Select two answers.

CHAPTER3

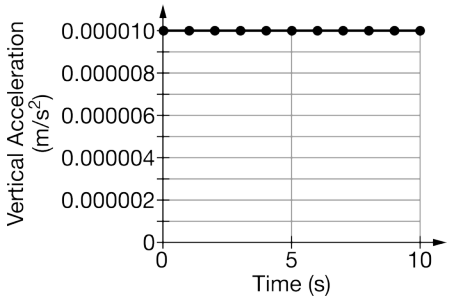
A



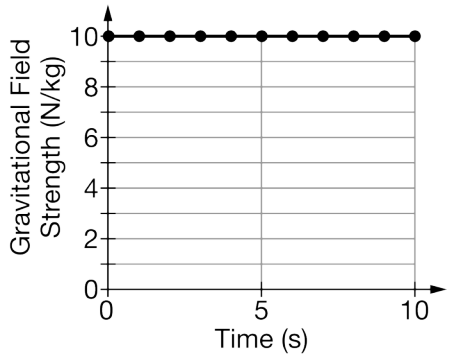
B



C



D



CHAPTER3

82.

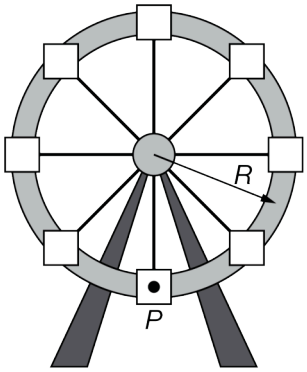


Figure 1

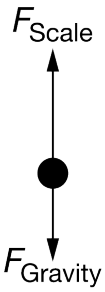


Figure 2

A student is riding a Ferris wheel that moves at a constant tangential speed around a vertical circular path of radius R, as shown in Figure 1. The student is sitting on a scale. At the instant the moving student is located at point P, the scale exerts a force of magnitude F_{Scale} on the student and Earth exerts a force of magnitude F_{Gravity} on the student, as shown in the free-body diagram in Figure 2. Which of the following statements provides reasoning that supports and correctly identifies the magnitude of the force that the student exerts on the scale when the student is at point P ?

(A) F_{Scale}, because that is the magnitude of the force exerted by the scale on the student.

(B) F_{Scale}, because that is the magnitude of the only upward force exerted on the student.

(C) F_{Gravity}, because Earth exerts a gravitational force on the scale.

(D) F_{Gravity}, because the magnitude of the force exerted on a scale must equal the weight of the person on the scale.

83. Two satellites are in circular orbits around Earth. Satellite *A* has speed v_A. Satellite *B* has an orbital radius nine times that of satellite *A*. What is the speed of satellite *B*?

(A) $v_A/9$

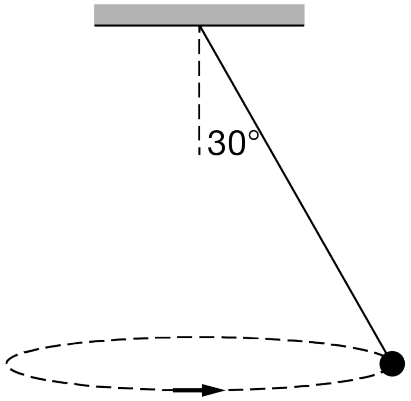
(B) $v_A/3$

(C) $3v_A$

(D) $9v_A$

CHAPTER3

84.



One end of a string is attached to the ceiling and the other end is attached to a small sphere traveling in a circular path, as shown above, with a constant speed of $1\ \mathrm{m/s}$. The string makes an angle of 30° to the vertical. If the tension in the string is $6\ \mathrm{N}$ and the circumference of the circle is $1\ \mathrm{m}$, how much work is done on the sphere by the string as the sphere travels through one revolution?

(A) $0\ \mathrm{J}$

(B) $3\ \mathrm{J}$

(C) $6\ \mathrm{J}$

(D) $12\ \mathrm{J}$

CHAPTER3

85.

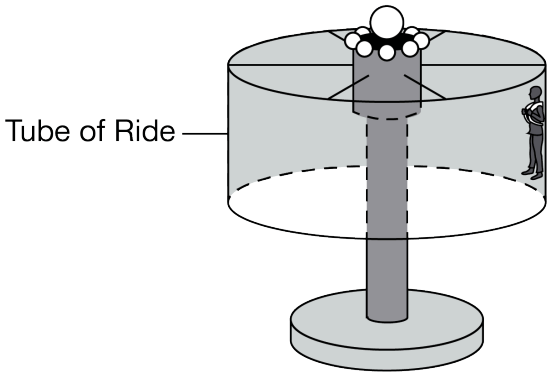


Figure 1

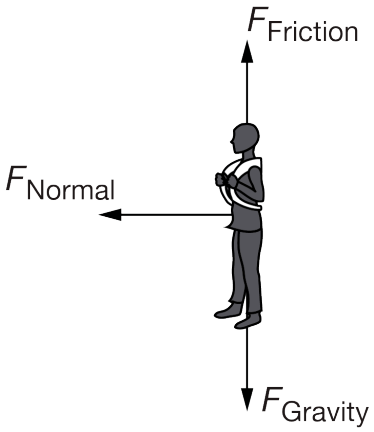


Figure 2

A student wants to investigate uniform circular motion for an object in an amusement park ride. The student will ride inside of a hollow cylindrical tube that pins the student to the inside wall of the tube as it spins. As the tube spins, the bottom of tube is removed such that the tube becomes open at the top and bottom. At the instant shown in figure 1, the student is pinned against the right side of the tube. A diagram showing the forces exerted on the student is shown in figure 2. When the ride is finished, the student safely falls onto the padded cushions below the floor of the tube. Which of the following represents the magnitude of the force that the student exerts on the right side of the tube?

(A) $\mathrm{F}_{\mathrm{Friction}}$, because the student is in direct contact with the tube.

(B) $\mathrm{F}_{\mathrm{Normal}}$, because the force that the student exerts on the right side of the tube is an action-reaction pair with the normal force that the tube exerts on the student.

(C) $\mathrm{F}_{\mathrm{Gravity}}$, because Earth's gravitational field is continually trying to pull the student down to Earth's surface.

(D) The vector sum of $\mathrm{F}_{\mathrm{Friction}}$ and $\mathrm{F}_{\mathrm{Normal}}$, because both forces are the result of the student being in direct contact with the right side of the tube and not sliding down.

CHAPTER3

86.

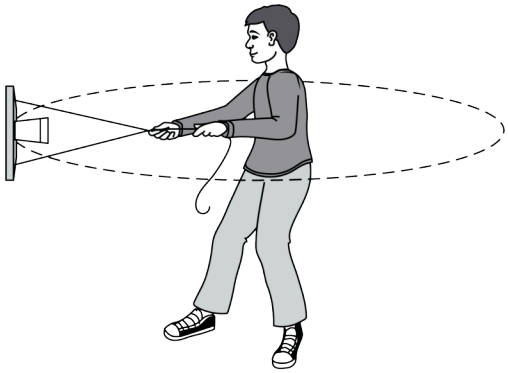


Figure 1

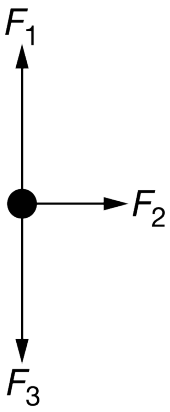


Figure 2

A student spins a cup that is in contact with a platform in a horizontal circular path at a constant speed, as shown in Figure 1. The platform is connected to two strings that are held by the student as the platform-cup system experiences uniform circular motion. A free-body diagram of the cup is shown in Figure 2. Which statement of reasoning best supports and correctly identifies the magnitude of the force the cup exerts on the platform?

(A) F_1, because this force represents the magnitude of the force of friction between the cup and the platform.

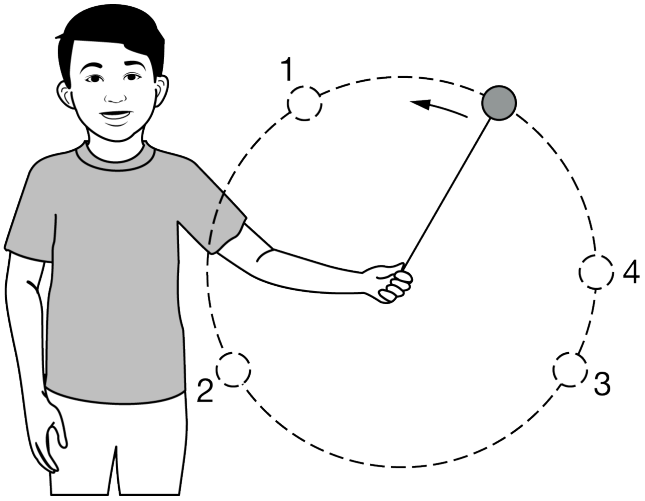
(B) F_2, because this force represents the magnitude of the normal force exerted on the cup by the platform.

(C) $\sqrt{F_1^2 + F_2^2}$, because this force represents the magnitude of the total force exerted on the platform by the cup.

(D) $\sqrt{F_1^2 + F_2^2 + F_3^2}$, because this represents the magnitude of the net force exerted on the cup.

CHAPTER3

87.



A student swings a ball on a light rod at a constant speed in a vertical circle, as shown in the figure. Which of the following correctly ranks the magnitudes of the forces exerted by the rod on the ball F_1, F_2, F_3, and F_4 when the ball is at locations 1, 2, 3, and 4, respectively?

(A) $F_1 = F_2 = F_3 = F_4$

(B) $(F_2 = F_3) > F_4 > F_1$

(C) $F_4 > F_1 > (F_2 = F_3)$

(D) $F_1 > F_4 > (F_2 = F_3)$

88.

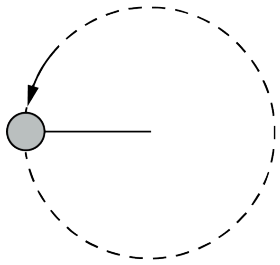


Figure 1.
Top View

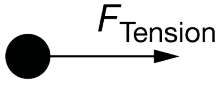


Figure 2.

A ball that is attached to a string travels in a horizontal, circular path, as shown in Figure 1. At time t_0, the ball has a speed v_0. The forces exerted on the ball at t_0 are represented by the free-body diagram, as shown in Figure 2. At a later time t_1, the tangential speed of the ball is increased to $2v_0$. What is the magnitude of the force that the ball exerts on the string at time t_1?

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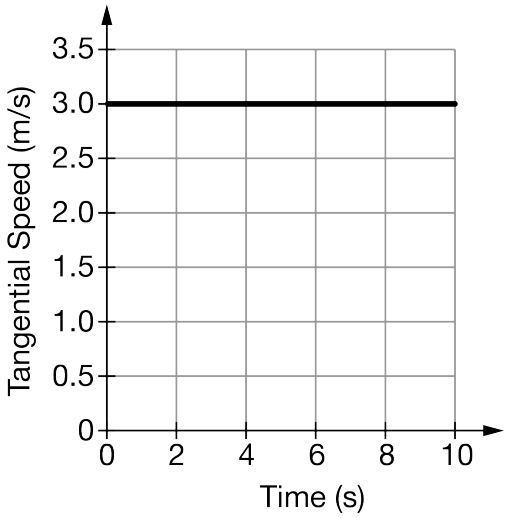
(A) $F_{Tension}$

(B) $2F_{Tension}$

(C) $4F_{Tension}$

(D) The answer cannot be determined unless the force that the ball exerts on the string at time t_0 is known.

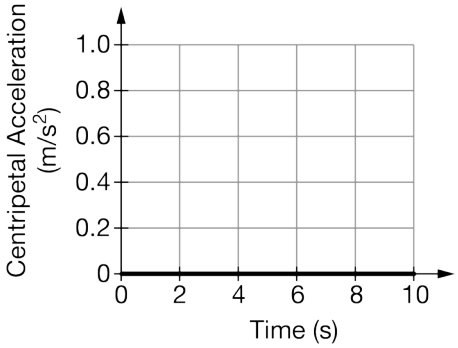
89.



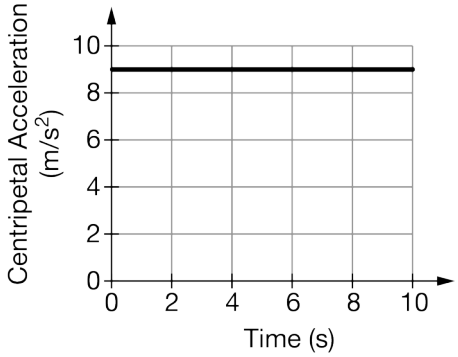
An object is spun in a horizontal circle such that it has a constant tangential speed at all points along its circular path of constant radius. A graph of the magnitude of the object's tangential speed as a function of time is shown in the graph. Which of the following graphs could show the magnitude of the object's centripetal acceleration as a function of time?

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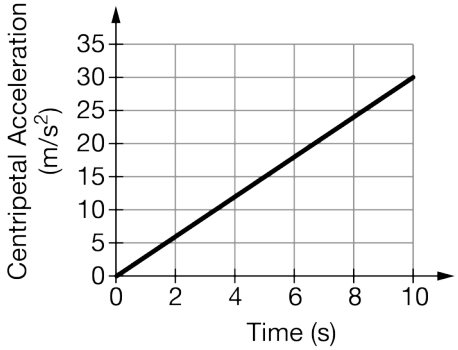
(A)



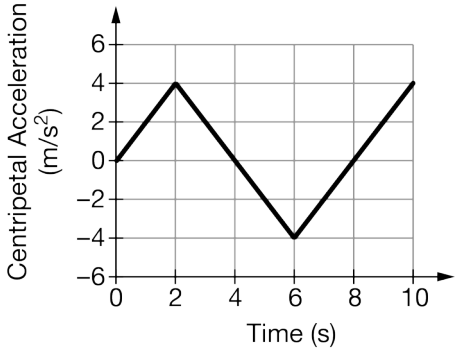
(B)



(C)



(D)



CHAPTER3

90.

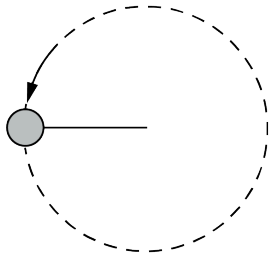


Figure 1.
Top View

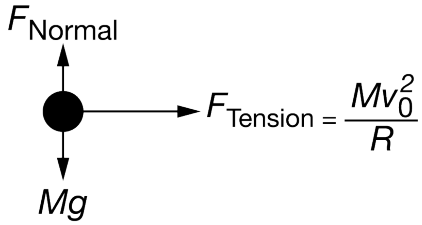


Figure 2

A ball of mass M is on a horizontal surface with negligible friction. One end of a string is attached to the ball so that it is spun in a horizontal circle of radius R at tangential speed v_0, as shown in Figure 1. A free-body diagram for the ball at an instant in time is shown in Figure 2. The magnitude of the tension force is also indicated in Figure 2. Which of the following equations represents the centripetal acceleration of the ball if its tangential speed is increased to $2v_0$?

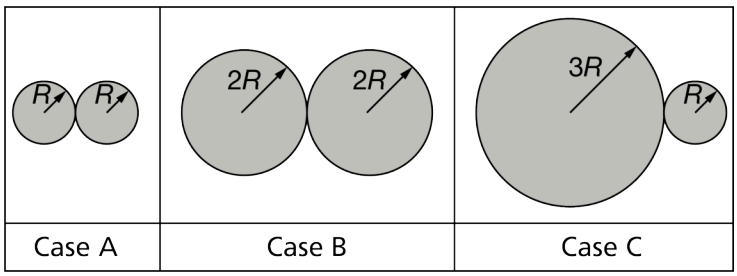
(A) $a_c = \frac{v_0^2}{2R}$

(B) $a_c = \frac{v_0^2}{R}$

(C) $a_c = \frac{2v_0^2}{R}$

(D) $a_c = \frac{4v_0^2}{R}$

91.



The figure shows three cases where two spheres are touching and attract each other with the gravitational force. The radii of the spheres in each case are shown. All of the spheres are made of material with the same density. Which of the following correctly ranks these cases based on the gravitational force between the spheres?

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(A) $(\mathrm{A} = \mathrm{B}) > \mathrm{C}$
(B) $\mathrm{A} > \mathrm{C} > \mathrm{B}$
(C) $\mathrm{B} > \mathrm{C} > \mathrm{A}$
(D) $\mathrm{C} > (\mathrm{A} = \mathrm{B})$

92. Two satellites are in circular orbits around Earth. Satellite 1 has mass m_0 and an orbital radius of $2R_E$, where R_E is the radius of Earth. Satellite 2 has mass $2m_0$ and an orbital radius of $3R_E$. Which of the following correctly compares the magnitude F of the force exerted by Earth on each satellite and the speed v of each satellite?

(A)

Force	Speed
$F_1 > F_2$	$v_1 > v_2$

(B)

Force	Speed
$F_1 > F_2$	$v_2 > v_1$

(C)

Force	Speed
$F_2 > F_1$	$v_1 > v_2$

(D)

Force	Speed
$F_2 > F_1$	$v_2 > v_1$

93. Two experiments are performed on an object to determine how much the object resists a change in its state of motion while at rest and while in motion. In the first experiment, the object is pushed with a constant known force along a horizontal surface. There is negligible friction between the surface and the object. A motion sensor is used to measure the speed of the object as it is pushed. In a second experiment, the object is tied to a string and pulled upward with a constant known force, and a motion sensor is used to measure the speed of the object as it is pulled upward. The student uses the data collected from the motion sensor to determine the mass of the object in both experiments. Which of the following classifies the type of mass that was determined in each experiment?

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(A)

Experiment 1	Experiment 2
Gravitational mass	Gravitational mass

(B)

Experiment 1	Experiment 2
Inertial mass	Gravitational mass

(C)

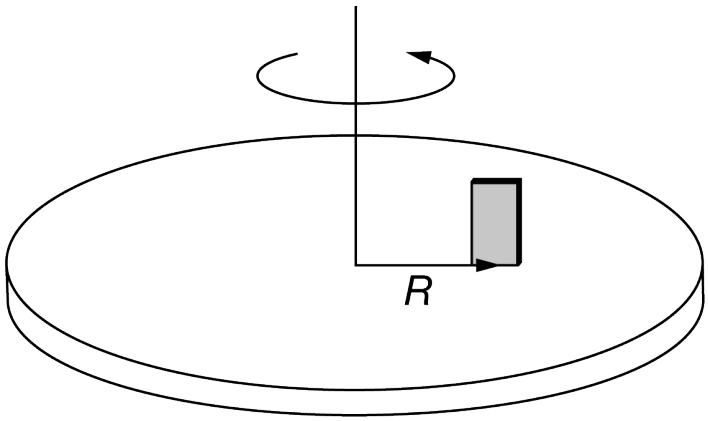
Experiment 1	Experiment 2
Gravitational mass	Inertial mass

(D)

Experiment 1	Experiment 2
Inertial mass	Inertial mass

CHAPTER3

94.



Distance (m)	0.05
Speed $(\mathrm{m/s})$	0.16
Force (N)	0.050

A block of known mass M is on a disk that rotates about its center, as shown above. The block travels with the disk and does not slip. The block travels at a constant tangential speed v when at a distance R from the center with a centripetal force of magnitude F exerted on it. The tangential speed v of the block represents the maximum speed of the block without the block slipping on the disk. Which of the following statements about other quantities that might be determined is correct? Select two answers.

A The centripetal force exerted on the block at a larger radius can be determined, since $F = mv^2/R$ can be applied using the given known quantities.

B The centripetal acceleration of the block can be determined, since $a_c = \frac{v^2}{r}$ since the block's tangential speed is known and the radius is known.

C The coefficient of friction between the block and the disk can be determined, since friction provides the centripetal force and the equation $F = \mu mg$ can be applied.

D The total distance traveled by block can be determined by using $\Delta x = x - x_0$ using the known quantities.

95. What is the kinetic energy of a satellite of mass *m* in that orbits the Earth, of mass *M,* in a circular orbit of radius *R* ?

(A) Zero

(B) $\frac{1}{2}\frac{GMm}{R}$

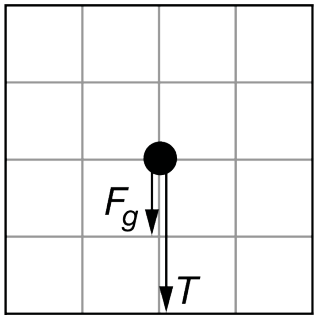
(C) $\frac{1}{4}\frac{GMm}{R}$

(D) $\frac{1}{2}\frac{GMm}{R^2}$

(E) $\frac{GMm}{R^2}$

CHAPTER3

96.



A ball is swung in a vertical circle such that at one point along its circular path the forces exerted on the ball can be represented by the free body diagram. The magnitude of the tension force exerted on the ball, T, is twice that of the force due to gravity exerted on the ball from Earth, F_g. What is the location of the ball, and what is the magnitude of the centripetal acceleration of the ball?

(A)

Location	Acceleration
Bottom of the circle	g

(B)

Location	Acceleration
Bottom of the circle	$3g$

(C)

Location	Acceleration
Top of the circle	g

(D)

Location	Acceleration
Top of the circle	$3g$

CHAPTER3

97.



Objects 1 and 2 have masses M_1 and M_2, respectively, where $M_1 < M_2$. The objects are in outer space far away from any other objects, as shown above. Point P is located halfway between their centers. At what location, if any, is the gravitational field due to the two objects equal to zero?

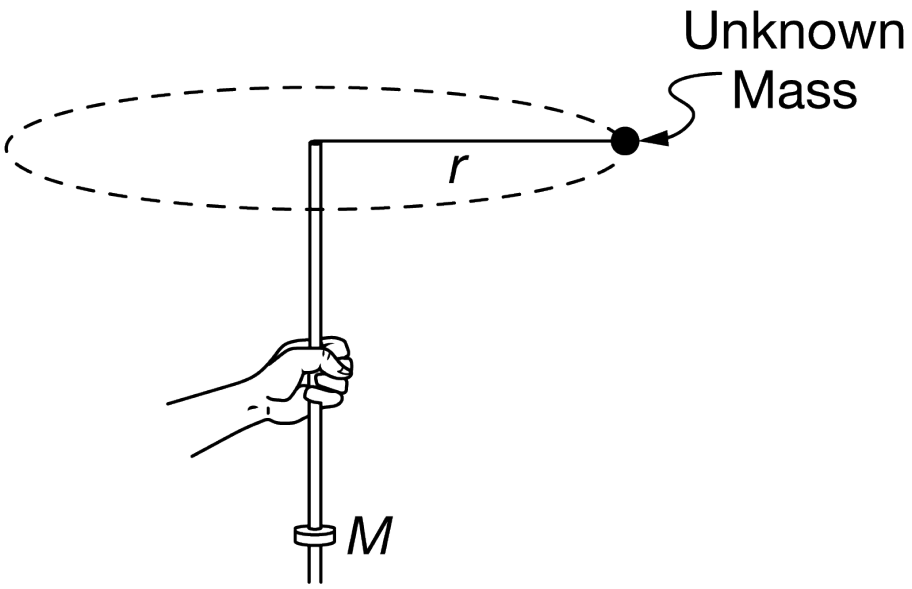
(A) Somewhere between object 1 and point P

(B) At point P

(C) Somewhere between point P and object 2

(D) The gravitational field due to the two objects is nonzero everywhere.

98.



A student builds the apparatus shown above. A light string is attached to an object of unknown mass and passed through a tube such that the other end of the string is attached to a second object of mass M. By holding on to the tube, the student swings the object of unknown mass in a horizontal circle of radius r while the object of mass M hanging from the string remains at a constant height. In each trial, the radius r of the circular path is changed and the tangential speed v of the object of unknown mass is calculated. How can the student determine the value of the unknown mass by using the radius of its circular path and its speed?

(A) Use the slope of a graph of R as a function of v^2.

(B) Use the y-intercept of a graph of R as a function of v^2.

(C) Use the slope of a graph of v as a function of R.

(D) Use the y-intercept of a graph of v as a function of R.

99. An astronaut stands on the surface of an asteroid. The astronaut then jumps such that the astronaut is no longer in contact with the surface. The astronaut falls back down to the surface after a short time interval. Which of the following forces CANNOT be neglected when analyzing the motion of the astronaut?

CHAPTER3

(A) The electromagnetic force between the subatomic particles of the astronaut and the subatomic particles of the asteroid

(B) The strong nuclear force between the subatomic particles of the astronaut and the subatomic particles of the asteroid

(C) The weak nuclear force between the subatomic particles of the astronaut and the subatomic particles of the asteroid

(D) The gravitational force between the astronaut and the asteroid

100. A moon orbits an isolated planet in deep space. Which of the following forces that the planet exerts on the moon can be considered as negligible?

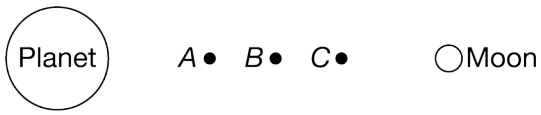
(A) The electric force

(B) The force due to gravity

(C) Both the electric force and the force due to gravity

(D) Neither the electric force nor the force due to gravity

101.



Note: Figure not drawn to scale.

A spaceship travels from a planet to a moon and passes through the three positions A, B, and C, shown above. Position B is midway between the centers of the planet and the moon. The planet has a larger mass than the moon. At which location could the net gravitational force exerted on the spaceship be approximately zero?

(A) Position A

(B) Position B

(C) Position C

(D) It cannot be determined without knowing the masses of the planet, the moon, and the spaceship, and the exact distance the spaceship is from the planet and the moon.