Chapter 5: FORCE AND MOTION — I

1. An example of an inertial reference frame is:
   - A. any reference frame that is not accelerating
   - B. a frame attached to a particle on which there are no forces
   - C. any reference frame that is at rest
   - D. a reference frame attached to the center of the universe
   - E. a reference frame attached to Earth

   ans: B

2. An object moving at constant velocity in an inertial frame must:
   - A. have a net force on it
   - B. eventually stop due to gravity
   - C. not have any force of gravity on it
   - D. have zero net force on it
   - E. have no frictional force on it

   ans: D

3. In SI units a force is numerically equal to the ______, when the force is applied to it.
   - A. velocity of the standard kilogram
   - B. speed of the standard kilogram
   - C. velocity of any object
   - D. acceleration of the standard kilogram
   - E. acceleration of any object

   ans: D

4. Which of the following quantities is NOT a vector?
   - A. Mass
   - B. Displacement
   - C. Weight
   - D. Acceleration
   - E. Force

   ans: A

5. A newton is the force:
   - A. of gravity on a 1 kg body
   - B. of gravity on a 1 g body
   - C. that gives a 1 g body an acceleration of $1\,\mathrm{cm/s^2}$
   - D. that gives a 1 kg body an acceleration of $1\,\mathrm{m/s^2}$
   - E. that gives a 1 kg body an acceleration of $9.8\,\mathrm{m/s^2}$

   ans: D

6. The unit of force called the newton is:
   A. $9.8\,\text{kg}\cdot\text{m/s}^2$
   B. $1\,\text{kg}\cdot\text{m/s}^2$
   C. defined by means of Newton's third law
   D. 1 kg of mass
   E. 1 kg of force

   ans: B

7. A force of 1 N is:
   A. $1\,\text{kg/s}$
   B. $1\,\text{kg}\cdot\text{m/s}$
   C. $1\,\text{kg}\cdot\text{m/s}^2$
   D. $1\,\text{kg}\cdot\text{m}^2\text{/s}$
   E. $1\,\text{kg}\cdot\text{m}^2\text{/s}^2$

   ans: C

8. The standard 1-kg mass is attached to a compressed spring and the spring is released. If the mass initially has an acceleration of $5.6\,\text{m/s}^2$, the force of the spring has a magnitude of:
   A. 2.8 N
   B. 5.6 N
   C. 11.2 N
   D. 0
   E. an undetermined amount

   ans: B

9. Acceleration is always in the direction:
   A. of the displacement
   B. of the initial velocity
   C. of the final velocity
   D. of the net force
   E. opposite to the frictional force

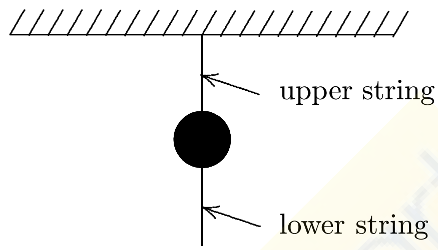
   ans: D

10. The term "mass" refers to the same physical concept as:
   A. weight
   B. inertia
   C. force
   D. acceleration
   C. volume

   ans: B

11. The inertia of a body tends to cause the bodv to:
   A. speed up
   B. slow down
   C. resist any change in its motion
   D. fall toward Earth
   E. decelerate due to friction
   ans: C

12. A heavy ball is suspended as shown. A quick jerk on the lower string will break that string but a slow pull on the lower string will break the upper string. The first result occurs because:



   A. the force is too small to move the ball
   B. action and reaction is operating
   C. the ball has inertia
   D. air friction holds the ball back
   E. the ball has too much energy
   ans: C

13. When a certain force is applied to the standard kilogram its acceleration is $5.0\,\mathrm{m/s^2}$. When the same force is applied to another object its acceleration is one-fifth as much. The mass of the object is:
   A. 0.2 kg
   B. 0.5 kg
   C. 1.0 kg
   D. 5.0 kg
   E. 10 kg
   ans: D

14. Mass differs from weight in that:
   A. all objects have weight but some lack mass
   B. weight is a force and mass is not
   C. the mass of an object is always more than its weight
   D. mass can be expressed only in the metric system
   E. there is no difference
   ans: B

15. The mass of a body:
   - A. is slightly different at
   - B. is a vector
   - C. is independent of the free-fall acceleration
   - D. is the same for all bodies of the same volume
   - E. can be measured most accurately on a spring scale

   ans: C

16. The mass and weight of a body:
   - A. differ by a factor of 9.8
   - B. are identical
   - C. are the same physical quantities expressed in different units
   - D. are both a direct measure of the inertia of the body
   - E. have the same ratio as that of any other body placed at that location

   ans: E

17. An object placed on an equal-arm balance requires 12 kg to balance it. When placed on a spring scale, the scale reads 12 kg. Everything (balance, scale, set of weights and object) is now transported to the Moon where the free-fall acceleration is one-sixth that on Earth. The new readings of the balance and spring scale (respectively) are:
   - A. 12 kg, 12 kg
   - B. 2 kg, 2 kg
   - C. 12 kg, 2 kg
   - D. 2 kg, 12 kg
   - E. 12 kg, 72 kg

   ans: C

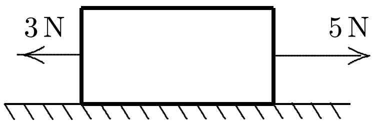
18. Two objects, one having three times the mass of the other, are dropped from the same height in a vacuum. At the end of their fall, their velocities are equal because:
   - A. anything falling in vacuum has constant velocity
   - B. all objects reach the same terminal velocity
   - C. the acceleration of the larger object is three times greater than that of the smaller object
   - D. the force of gravity is the same for both objects
   - E. none of the above

   ans: E

19. A feather and a lead ball are dropped from rest in vacuum on the Moon. The acceleration of the feather is:
   - A. more than that of the lead ball
   - B. the same as that of the lead ball
   - C. less than that of the lead ball
   - D. $9.8\,\mathrm{m/s^2}$
   - E. zero since it floats in a vacuum

   ans: B

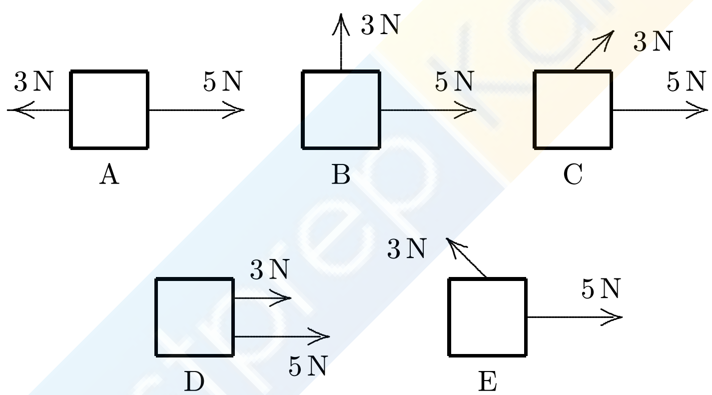
20. The block shown moves with constant velocity on a horizontal surface. Two of the forces on it are shown. A frictional … the block. The frictional force is:



A. 0
B. 2 N, leftward
C. 2 N, rightward
D. slightly more than 2 N, leftward
E. slightly less than 2 N, leftward

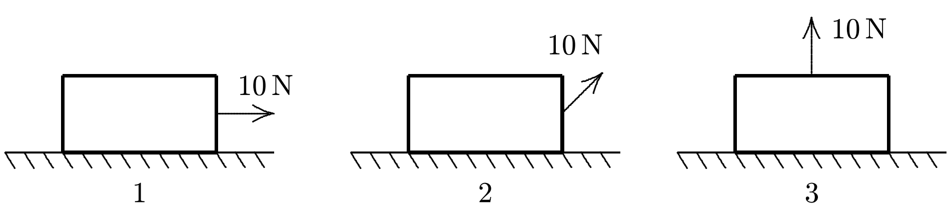
ans: B

21. Two forces, one with a magnitude of 3 N and the other with a magnitude of 5 N, are applied to an object. For which orientations of the forces shown in the diagrams is the magnitude of the acceleration of the object the least?



ans: A

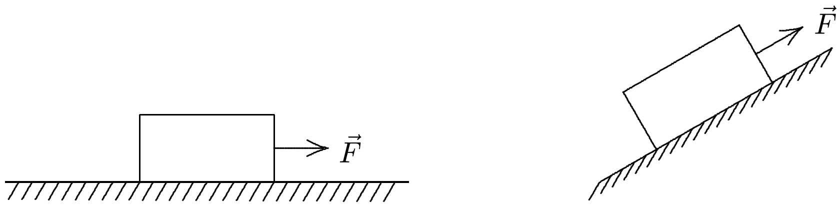
22. A crate rests on a horizontal surface and a woman pulls on it with a 10-N force. Rank the situations shown below according to the magnitude of the normal force exerted by the surface on the crate, least to greatest.



A. 1, 2, 3
B. 2, 1, 3
C. 2, 3, 1
D. 1, 3, 2
E. 3, 2, 1

ans: E

23. A heavy wooden block is dragged by a force $\vec{F}$ along a rough steel plate, as shown in the diagrams for two cases. Tl [illegible] The normal force in (ii), as compared with the normal force in (i) is:



(i) (ii)

A. the same
B. greater
C. less
D. less for some angles of the incline and greater for others
E. less or greater, depending on the magnitude of the applied force $\vec{F}$.

ans: C

24. Equal forces $\vec{F}$ act on isolated bodies A and B. The mass of B is three times that of A. The magnitude of the acceleration of A is:

A. three times that of B
B. 1/3 that of B
C. the same as B
D. nine times that of B
E. 1/9 that of B

ans: A

25. A car travels east at constant velocity. The net force on the car is:

A. east
B. west
C. up
D. down
E. zero

ans: E

26. A constant force of 8.0 N is exerted for 4.0 s on a 16-kg object initially at rest. The change in speed of this object will be:

A. 0.5 m/s
B. 2 m/s
C. 4 m/s
D. 8 m/s
E. 32 m/s

ans: B

27. A 6-kg object is moving south. A net force of 12 N north on it results in the object having an acceleration of:
   A. $2\,\text{m/s}^2$, north
   B. $2\,\text{m/s}^2$, south
   C. $6\,\text{m/s}^2$, north
   D. $18\,\text{m/s}^2$, north
   E. $18\,\text{m/s}^2$, south

   ans: A

28. A 9000-N automobile is pushed along a level road by four students who apply a total forward force of 500 N. Neglecting friction, the acceleration of the automobile is:
   A. $0.055\,\text{m/s}^2$
   B. $0.54\,\text{m/s}^2$
   C. $1.8\,\text{m/s}^2$
   D. $9.8\,\text{m/s}^2$
   E. $18\,\text{m/s}^2$

   ans: B

29. An object rests on a horizontal frictionless surface. A horizontal force of magnitude F is applied. This force produces an acceleration:
   A. only if F is larger than the weight of the object
   B. only while the object suddenly changes from rest to motion
   C. always
   D. only if the inertia of the object decreases
   E. only if F is increasing

   ans: C

30. A 25-kg crate is pushed across a frictionless horizontal floor with a force of 20 N, directed 20° below the horizontal. The acceleration of the crate is:
   A. $0.27\,\text{m/s}^2$
   B. $0.75\,\text{m/s}^2$
   C. $0.80\,\text{m/s}^2$
   D. $170\,\text{m/s}^2$
   E. $470\,\text{m/s}^2$

   ans: B

31. A ball with a weight of 1.5 N is thrown at an angle of 30° above the horizontal with an initial speed of 12 m/s. At its highest point, the net force on the ball is:
   A. 9.8 N, 30° below horizontal
   B. zero
   C. 9.8 N, up
   D. 9.8 N, down
   E. 1.5 N, down

   ans: E

32. Two forces are applied to a 5.0-kg crate: one is 6.0 N to the north and the other is 8.0 N to the west. The magnitude of th

A. $0.50\,\mathrm{m/s^2}$
B. $2.0\,\mathrm{m/s^2}$
C. $2.8\,\mathrm{m/s^2}$
D. $10\,\mathrm{m/s^2}$
E. $50\,\mathrm{m/s^2}$

ans: B

33. A 400-N steel ball is suspended by a light rope from the ceiling. The tension in the rope is:

A. 400 N
B. 800 N
C. zero
D. 200 N
E. 560 N

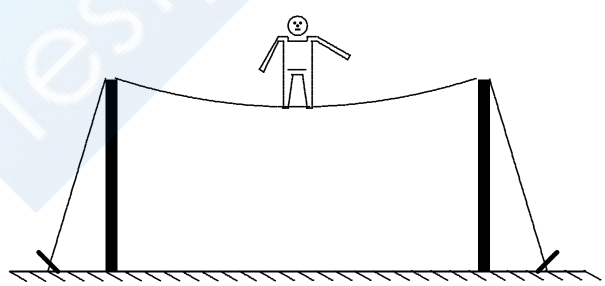
ans: A

34. A heavy steel ball B is suspended by a cord from a block of wood W. The entire system is dropped through the air. Neglecting air resistance, the tension in the cord is:

A. zero
B. the difference in the masses of B and W
C. the difference in the weights of B and W
D. the weight of B
E. none of these

ans: A

35. A circus performer of weight W is walking along a "high wire" as shown. The tension in the wire:



A. is approximately W
B. is approximately $W/2$
C. is much less than W
D. is much more than W
E. depends on whether he stands on one foot or two feet

ans: D

36. A 1000-kg elevator is rising and its speed is increasing at $3\,\text{m/s}^2$. The tension force of the cable on the elevator is:

A. 6800 N
B. 1000 N
C. 3000 N
D. 9800 N
E. 12800 N

ans: E

*37. A 5-kg block is suspended by a rope from the ceiling of an elevator as the elevator accelerates downward at $3.0\,\text{m/s}^2$. The tension force of the rope on the block is:

A. 15 N, up
B. 34 N, up
C. 34 N, down
D. 64 N, up
E. 64 N, down

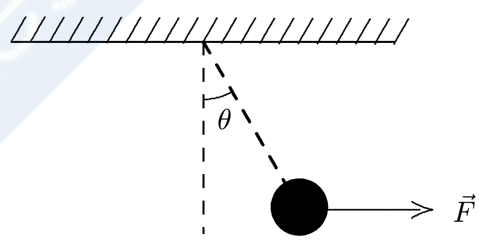
ans: B

38. A crane operator lowers a 16,000-N steel ball with a downward acceleration of $3\,\text{m/s}^2$. The tension force of the cable is:

A. 4900 N
B. 11,000 N
C. 16,000 N
D. 21,000 N
E. 48,000 N

ans: B

39. A 1-N pendulum bob is held at an angle θ from the vertical by a 2-N horizontal force F as shown. The tension in the string supporting the pendulum bob (in newtons) is:



A. $\cos\theta$
B. $2/\cos\theta$
C. $\sqrt{5}$
D. 1
E. none of these

ans: C

40. A car moves horizontally with a constant acceleration of $3\,\mathrm{m/s^2}$. A ball is suspended by a string from the ceiling of [illegible] the car. What angle does the string make with the vertical?

A. 17°
B. 35°
C. 52°
D. 73°
E. Cannot be found without knowing the length of the string

ans: A

41. A man weighing 700 Nb is in an elevator that is accelerating upward at $4\,\mathrm{m/s^2}$. The force exerted on him by the elevator floor is:

A. 71 N
B. 290 N
C. 410 N
D. 700 N
E. 990 N

ans: E

42. You stand on a spring scale on the floor of an elevator. Of the following, the scale shows the highest reading when the elevator:

A. moves upward with increasing speed
B. moves upward with decreasing speed
C. remains stationary
D. moves downward with increasing speed
E. moves downward at constant speed

ans: A

43. You stand on a spring scale on the floor of an elevator. Of the following, the scale shows the highest reading when the elevator:

A. moves downward with increasing speed
B. moves downward with decreasing speed
C. remains stationary
D. moves upward with decreasing speed
E. moves upward at constant speed

ans: B

44. When a 25-kg crate is pushed across a frictionless horizontal floor with a force of 200 N, directed 20° below the horizontal, the magnitude of the normal force of the floor on the crate is:

A. 25 N
B. 68 N
C. 180 N
D. 250 N
E. 310 N

ans: E

45. A block slides down a frictionless plane that makes an angle of 30° with the horizontal. The acceleration of the block is

A. $980\,\mathrm{cm/s^2}$
B. $566\,\mathrm{cm/s^2}$
C. $849\,\mathrm{cm/s^2}$
D. zero
E. $490\,\mathrm{cm/s^2}$

ans: E

46. A 25-N crate slides down a frictionless incline that is 25° above the horizontal. The magnitude of the normal force of the incline on the crate is:

A. 11 N
B. 23 N
C. 25 N
D. 100 N
E. 220 N

ans: B

47. A 25-N crate is held at rest on a frictionless incline by a force that is parallel to the incline. If the incline is 25° above the horizontal the magnitude of the applied force is:

A. 4.1 N
B. 4.6 N
C. 8.9 N
D. 11 N
E. 23 N

ans: D

48. A 25-N crate is held at rest on a frictionless incline by a force that is parallel to the incline. If the incline is 25° above the horizontal the magnitude of the normal force of the incline on the crate is:

A. 4.1 N
B. 4.6 N
C. 8.9 N
D. 11 N
E. 23 N

ans: E

49. A 32-N force, parallel to the incline, is required to push a certain crate at constant velocity up a frictionless incline that is 30° above the horizontal. The mass of the crate is:

A. 3.3 kg
B. 3.8 kg
C. 5.7 kg
D. 6.5 kg
E. 160 kg

ans: D

50. A sled is on an icy (frictionless) slope that is 30° above the horizontal. When a 40-N force, parallel to the incline and [illegible] the sled is $2.0\,\mathrm{m/s^2}$, down the incline. The mass of the sled is:

A. 3.8 kg
B. 4.1 kg
C. 5.8 kg
D. 6.2 kg
E. 10 kg

ans: E

51. When a 40-N force, parallel to the incline and directed up the incline, is applied to a crate on a frictionless incline that is 30° above the horizontal, the acceleration of the crate is $2.0\,\mathrm{m/s^2}$, up the incline. The mass of the crate is:

A. 3.8 kg
B. 4.1 kg
C. 5.8 kg
D. 6.2 kg
E. 10 kg

ans: C

52. The "reaction" force does not cancel the "action" force because:

A. the action force is greater than the reaction force
B. they are on different bodies
C. they are in the same direction
D. the reaction force exists only after the action force is removed
E. the reaction force is greater than the action force

ans: B

53. A book rests on a table, exerting a downward force on the table. The reaction to this force is:

A. the force of Earth on the book
B. the force of the table on the book
C. the force of Earth on the table
D. the force of the book on Earth
E. the inertia of the book

ans: B

54. A lead block is suspended from your hand by a string. The reaction to the force of gravity on the block is the force exerted by:

A. the string on the block
B. the block on the string
C. the string on the hand
D. the hand on the string
E. the block on Earth

ans: E

55. A 5-kg concrete block is lowered with a downward acceleration of $2.8\,\mathrm{m/s^2}$ by means of a rope. The force of the block on t

A. 14 N, up
B. 14 N, down
C. 35 N, up
D. 35 N, down
E. 49 N, up

ans: D

56. A 90-kg man stands in an elevator that is moving up at a constant speed of $5.0\,\mathrm{m/s}$. The force exerted by him on the floor is about:

A. zero
B. 90 N
C. 880 N
D. 450 N
E. 49 N

ans: C

57. A 90-kg man stands in an elevator that has a downward acceleration of $1.4\,\mathrm{m/s^2}$. The force exerted by him on the floor is about:

A. zero
B. 90 N
C. 760 N
D. 880 N
E. 1010 N

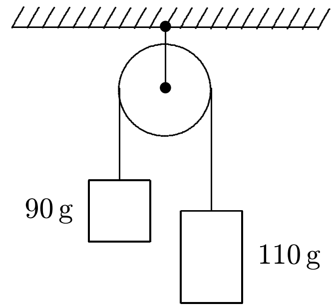
ans: C

58. A 5-kg concrete block is lowered with a downward acceleration of $2.8\,\mathrm{m/s^2}$ by means of a rope. The force of the block on Earth is:

A. 14 N, up
B. 14 N, down
C. 35 N, up
D. 35 N, down
E. 49 N, up

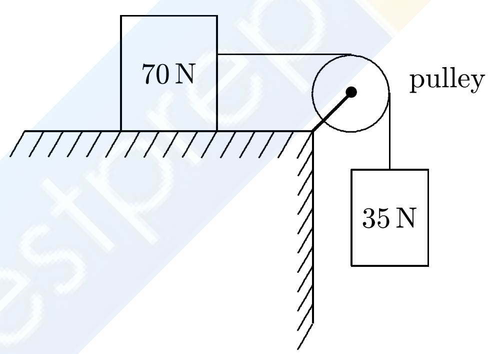
ans: E

59. Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitud



A. $0.049\,m/s^2$
B. $0.020\,m/s^2$
C. $0.0098\,m/s^2$
D. $0.54\,m/s^2$
E. $0.98\,m/s^2$
ans: E

60. A 70-N block and a 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 35-N block is:



A. $1.6\,m/s^2$
B. $3.3\,m/s^2$
C. $4.9\,m/s^2$
D. $6.7\,m/s^2$
E. $9.8\,m/s^2$
ans: B

61. A 13-N weight and a 12-N weight are connected by a massless string over a massless, frictionless pulley. The 13-N weight h[illegible]eely falling body times:

A. 1
B. 1/12
C. 1/13
D. 1/25
E. 13/25

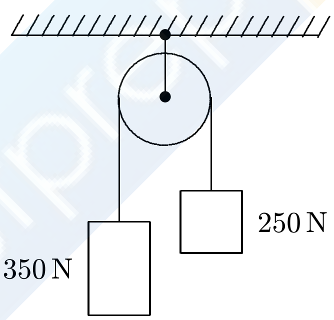
ans: D

62. A massless rope passes over a massless pulley suspended from the ceiling. A 4-kg block is attached to one end and a 5-kg block is attached to the other end. The acceleration of the 5-kg block is:

A. $g/4$
B. $5g/9$
C. $4g/9$
D. $g/5$
E. $g/9$

ans: E

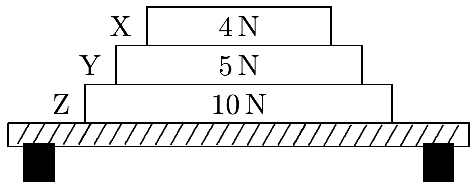
63. Two blocks, weighing 250 N and 350 N, respectively, are connected by a string that passes over a massless pulley as shown. The tension in the string is:



A. 210 N
B. 290 N
C. 410 N
D. 500 N
E. 4900 N

ans: B

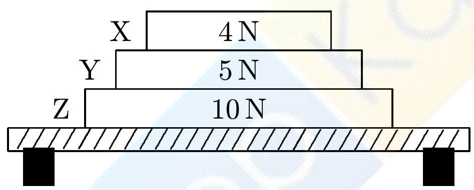
64. Three books (X, Y, and Z) rest on a table. The weight of each book is indicated. The net force acting on book Y is:



A. 4 N down
B. 5 N up
C. 9 N down
D. zero
E. none of these

ans: D

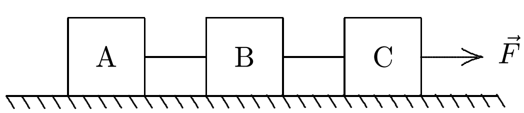
65. Three books (X, Y, and Z) rest on a table. The weight of each book is indicated. The force of book Z on book Y is:



A. 0
B. 5 N
C. 9 N
D. 14 N
E. 19 N

ans: C

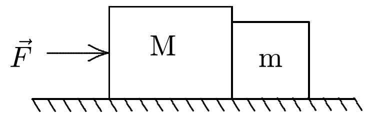
66. Three blocks (A,B,C), each having mass M, are connected by strings as shown. Block C is pulled to the right by a force $\vec{F}$ that causes the entire system to accelerate. Neglecting friction, the net force acting on block B is:



A. zero
B. $\vec{F}/3$
C. $\vec{F}/2$
D. $2\vec{F}/3$
E. $\vec{F}$

ans: B

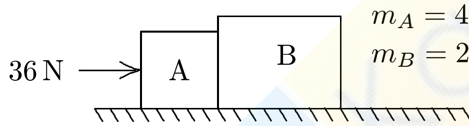
67. Two blocks with masses m and M are pushed along a horizontal frictionless surface by a horizontal applied force $\vec{F}$ on the other is:



A. $mF/(m+M)$
B. mF/M
C. $mF/(M-m)$
D. $MF/(M+m)$
E. MF/m

ans: A

68. Two blocks (A and B) are in contact on a horizontal frictionless surface. A 36-N constant force is applied to A as shown. The magnitude of the force of A on B is:



A. 1.5 N
B. 6.0 N
C. 29 N
D. 30 N
E. 36 N

ans: D

69. A short 10-g string is used to pull a 50-g toy across a frictionless horizontal surface. If a 3.0×10^{-2}-N force is applied horizontally to the free end, the force of the string on the toy, at the other end, is:

A. 0.15 N
B. 6.0×10^{-3} N
C. 2.5×10^{-2} N
D. 3.0×10^{-2} N
E. 3.5×10^{-2} N

ans: C

Chapter 6: FORCE AND MOTION — II

1. A brick slides on a horizontal surface. Which of the following will increase the magnitude of the frictional force on it?

   A. Putting a second brick on top
   B. Decreasing the surface area of contact
   C. Increasing the surface area of contact
   D. Decreasing the mass of the brick
   E. None of the above

   ans: A

2. The coefficient of kinetic friction:

   A. is in the direction of the frictional force
   B. is in the direction of the normal force
   C. is the ratio of force to area
   D. can have units of newtons
   E. is none of the above

   ans: E

3. When the brakes of an automobile are applied, the road exerts the greatest retarding force:

   A. while the wheels are sliding
   B. just before the wheels start to slide
   C. when the automobile is going fastest
   D. when the acceleration is least
   E. at the instant when the speed begins to change

   ans: B

4. A forward horizontal force of 12 N is used to pull a 240-N crate at constant velocity across a horizontal floor. The coefficient of friction is:

   A. 0.5
   B. 0.05
   C. 2
   D. 0.2
   E. 20

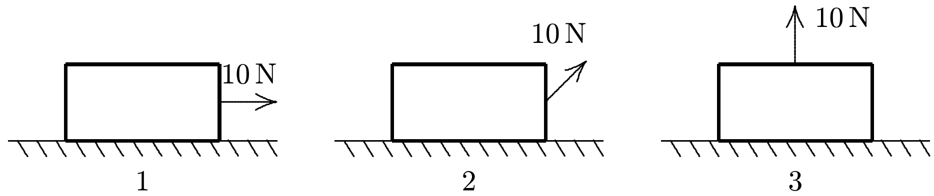
   ans: B

5. The speed of a 4.0-N hockey puck, sliding across a level ice surface, decreases at the rate of $0.61\,\mathrm{m/s^2}$. The coefficient of kinetic friction between the puck and ice is:

   A. 0.062
   B. 0.41
   C. 0.62
   D. 1.2
   E. 9.8

   ans: A

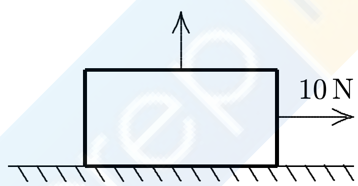
6. A crate rests on a horizontal surface and a woman pulls on it with a 10-N force. No matter what the orientation of th low according to the magnitude of the frictional force of the surface on the crate, least to greatest.



A. 1, 2, 3
B. 2, 1, 3
C. 2, 3, 1
D. 1, 3, 2
E. 3, 2, 1

ans: E

7. A crate with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on it with a force of 10 N and it does not move. To start it moving, a second person pulls vertically upward on the crate. If the coefficient of static friction is 0.4, what is the smallest vertical force for which the crate moves?



A. 4 N
B. 10 N
C. 14 N
D. 25 N
E. 35 N

ans: D

8. A 40-N crate rests on a rough horizontal floor. A 12-N horizontal force is then applied to it. If the coefficients of friction are $\mu_s = 0.5$ and $\mu_k = 0.4$, the magnitude of the frictional force on the crate is:

A. 8 N
B. 12 N
C. 16 N
D. 20 N
E. 40 N

ans: B

9. A 24-N horizontal force is applied to a 40-N block initially at rest on a rough horizontal surface. If the coefficients of frictio[illegible] on the block is:

A. 8 N
B. 12 N
C. 16 N
D. 20 N
E. 400 N

ans: C

10. A horizontal shove of at least 200 N is required to start moving a 800-N crate initially at rest on a horizontal floor. The coefficient of static friction is:

A. 0.25
B. 0.125
C. 0.50
D. 4.00
E. none of these

ans: A

11. A force $\vec{F}$ (larger than the largest possible force of static friction) is applied to the left to an object moving to the right on a horizontal surface. Then:

A. the object must be moving at constant speed
B. $\vec{F}$ and the friction force act in opposite directions
C. the object must be slowing down
D. the object must be speeding up
E. the object must come to rest and remain at rest

ans: C

12. A bureau rests on a rough horizontal surface ($\mu_s = 0.50$, $\mu_k = 0.40$). A constant horizontal force, just sufficient to start the bureau in motion, is then applied. The acceleration of the bureau is:

A. 0
B. $0.98\,\mathrm{m/s^2}$
C. $3.3\,\mathrm{m/s^2}$
D. $4.5\,\mathrm{m/s^2}$
E. $8.9\,\mathrm{m/s^2}$

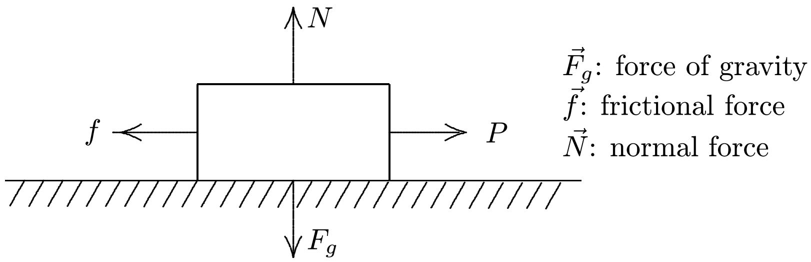
ans: B

13. A car is traveling at 15 m/s on a horizontal road. The brakes are applied and the car skids to a stop in 4.0 s. The coefficient of kinetic friction between the tires and road is:

A. 0.38
B. 0.69
C. 0.76
D. 0.92
E. 1.11

ans: A

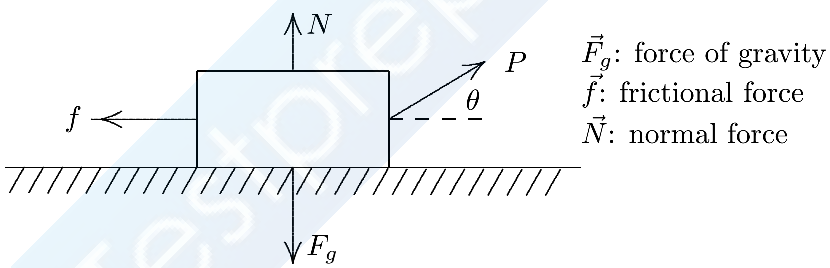
14. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force $\vec{P}$ as shown. In the diagra[illegible]e of the normal force, and F_g is the magnitude of the force of gravity. Which of the following must be true?



A. $P = f$ and $N = F_g$
B. $P = f$ and $N > F_g$
C. $P > f$ and $N < F_g$
D. $P > f$ and $N = F_g$
E. none of these

ans: A

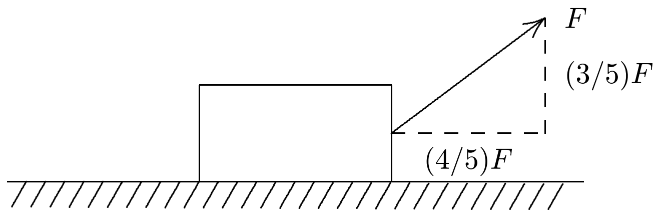
15. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force $\vec{P}$ as shown. In the diagram f is the magnitude of the force of friction, N is the magnitude of the normal force, and F_g is the magnitude of the force of gravity. Which of the following must be true?



A. $P = f$ and $N = F_g$
B. $P = f$ and $N > F_g$
C. $P > f$ and $N < F_g$
D. $P > f$ and $N = F_g$
E. none of these

ans: C

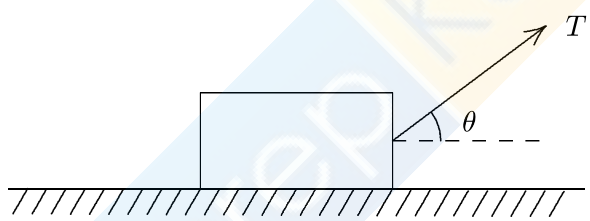
16. A 400-N block is dragged along a horizontal surface by an applied force $\vec{F}$ as shown. The coefficient of kinetic friction is ude of $\vec{F}$ is:



A. 100 N
B. 150 N
C. 200 N
D. 290 N
E. 400 Nb

ans: B

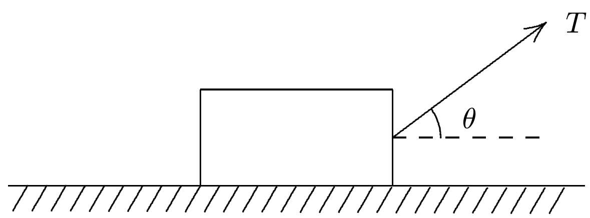
17. A block of mass m is pulled at constant velocity along a rough horizontal floor by an applied force $\vec{T}$ as shown. The magnitude of the frictional force is:



A. $T\cos\theta$
B. $T\sin\theta$
C. zero
D. mg
E. $mg\cos\theta$

ans: A

18. A block of mass m is pulled along a rough horizontal floor by an applied force $\vec{T}$ as shown. The vertical component of



A. mg
B. $mg - T\cos\theta$
C. $mg + T\cos\theta$
D. $mg - T\sin\theta$
E. $mg + T\sin\theta$

ans: D

19. A 12-kg crate rests on a horizontal surface and a boy pulls on it with a force that is 30° below the horizontal. If the coefficient of static friction is 0.40, the minimum magnitude force he needs to start the crate moving is:

A. 44 N
B. 47 N
C. 54 N
D. 56 N
E. 71 N

ans: E

20. A crate resting on a rough horizontal floor is to be moved horizontally. The coefficient of static friction is 0.40. To start the crate moving with the weakest possible applied force, in what direction should the force be applied?

A. Horizontal
B. 24° below the horizontal
C. 22° above the horizontal
D. 24° above the horizontal
E. 66° below the horizontal

ans: C

21. A 50-N force is applied to a crate on a horizontal rough floor, causing it to move horizontally. If the coefficient of kinetic friction is 0.50, in what direction should the force be applied to obtain the greatest acceleration?

A. Horizontal
B. 60° above the horizontal
C. 30° above the horizontal
D. 27° above the horizontal
E. 30° below the horizontal

ans: D

22. A professor holds an eraser against a vertical chalkboard by pushing horizontally on it. He pushes with a force that [illegible] of friction exerted by the board on the eraser increases if he:

A. pushes with slightly greater force
B. pushes with slightly less force
C. stops pushing
D. pushes so his force is slightly downward but has the same magnitude
E. pushes so his force is slightly upward but has the same magnitude

ans: D

23. A horizontal force of 12 N pushes a 0.5-kg book against a vertical wall. The book is initially at rest. If the coefficients of friction are $\mu_s = 0.6$ and $\mu_k = 0.8$ which of the following is true?

A. The magnitude of the frictional force is 4.9 N
B. The magnitude of the frictional force is 7.2 N
C. The normal force is 4.9 N
D. The book will start moving and accelerate
E. If started moving downward, the book will decelerate

ans: A

24. A horizontal force of 5.0 N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If the coefficients of friction are $\mu_s = 0.6$ and $\mu_k = 0.80$, the magnitude of the frictional force is:

A. 0
B. 4.9 N
C. 3.0 N
D. 5.0 N
E. 4.0 N

ans: E

25. A horizontal force of 12 N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If $\mu_s = 0.6$ and $\mu_k = 0.80$, the acceleration of the book in m/s^2 is:

A. 0
B. $9.4\,m/s^2$
C. $9.8\,m/s^2$
D. $14.4\,m/s^2$
E. $19.2\,m/s^2$

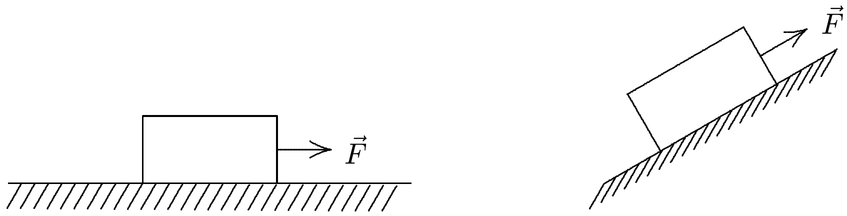
ans: A

26. A horizontal force of 5.0 N pushes a 0.50-kg block against a vertical wall. The block is initially at rest. If $\mu_s = 0.60$ and $\mu_k = 0.80$, the acceleration of the block in m/s^2 is:

A. 0
B. 1.8
C. 6.0
D. 8.0
E. 9.8

ans: B

27. A heavy wooden block is dragged by a force $\vec{F}$ along a rough steel plate, as shown below for two possible situations. Th ude of the frictional force in (ii), as compared with that in (i) is:



(i) (ii)

A. the same
B. greater
C. less
D. less for some angles and greater for others
E. can be less or greater, depending on the magnitude of the applied force.

ans: C

28. A block is first placed on its long side and then on its short side on the same inclined plane, as shown. The block slides down the plane on its short side but remains at rest on its long side. A possible explanation is:

(ii) (ii)

A. the short side is smoother
B. the frictional force is less because the contact area is less
C. the center of gravity is higher in the second case
D. the normal force is less in the second case
E. the force of gravity is more nearly down the plane in the second case

ans: A

29. A box rests on a rough board 10 meters long. When one end of the board is slowly raised to a height of 6 meters above the other end, the box begins to slide. The coefficient of static friction is:

A. 0.8
B. 0.25
C. 0.4
D. 0.6
E. 0.75

ans: E

30. A block is placed on a rough wooden plane. It is found that when the plane is tilted 30° to the horizontal, the block v [illegible] ion of the block with the plane is:

A. 0.500
B. 0.577
C. 1.73
D. 0.866
E. 4.90

ans: B

31. A crate is sliding down an incline that is 35° above the horizontal. If the coefficient of kinetic friction is 0.40, the acceleration of the crate is:

A. 0
B. $2.4\,\text{m/s}^2$
C. $5.8\,\text{m/s}^2$
D. $8.8\,\text{m/s}^2$
E. $10.3\,\text{m/s}^2$

ans: B

32. A 5.0-kg crate is resting on a horizontal plank. The coefficient of static friction is 0.50 and the coefficient of kinetic friction is 0.40. After one end of the plank is raised so the plank makes an angle of 25° with the horizontal, the force of friction is:

A. 0
B. 18 N
C. 21 N
D. 22 N
E. 44 N

ans: C

33. A 5.0-kg crate is resting on a horizontal plank. The coefficient of static friction is 0.50 and the coefficient of kinetic friction is 0.40. After one end of the plank is raised so the plank makes an angle of 30° with the horizontal, the force of friction is:

A. 0
B. 18 N
C. 21 N
D. 22 N
E. 44 N

ans: B

34. A 5.0-kg crate is on an incline that makes an angle of 30° with the horizontal. If the coefficient of static friction is 0.50, tl [illegible] ıold the crate at rest is:

A. 0
B. 3.3 N
C. 30 N
D. 46 N
E. 55 N

ans: B

35. A 5.0-kg crate is on an incline that makes an angle of 30° with the horizontal. If the coefficient of static friction is 0.5, the maximum force that can be applied parallel to the plane without moving the crate is:

A. 0
B. 3.3 N
C. 30 N
D. 46 N
E. 55 N

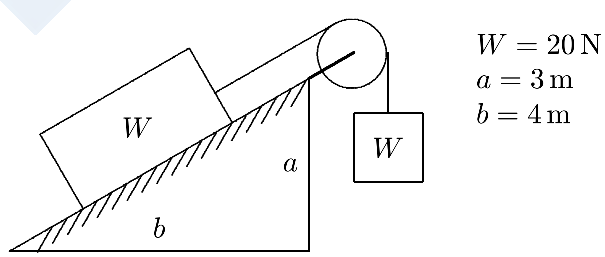
ans: D

36. Block A, with mass m_A, is initially at rest on a horizontal floor. Block B, with mass m_B, is initially at rest on the horizontal top surface of A. The coefficient of static friction between the two blocks is μ_s. Block A is pulled with a horizontal force. It begins to slide out from under B if the force is greater than:

A. $m_A g$
B. $m_B g$
C. $\mu_s m_A g$
D. $\mu_s m_B g$
E. $\mu_s (m_A + m_B) g$

ans: E

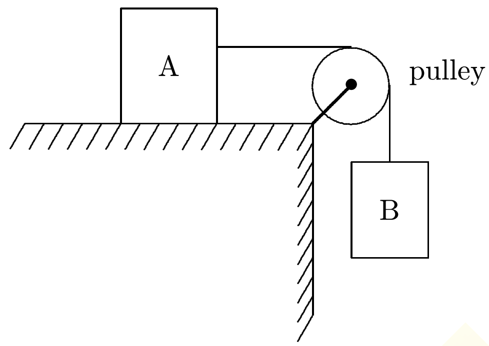
37. The system shown remains at rest. Each block weighs 20 N. The force of friction on the upper block is:



A. 4 N
B. 8 N
C. 12 N
D. 16 N
E. 20 N

ans: B

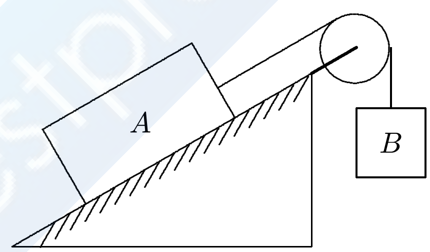
38. Block A, with a mass of 50 kg, rests on a horizontal table top. The coefficient of static friction is 0.40. A horizontal strin y as shown. The smallest mass m_B of block B, attached to the dangling end, that will start A moving when it is attached to the other end of the string is:



A. 20 kg
B. 30 kg
C. 40 kg
D. 50 kg
E. 70 kg

ans: A

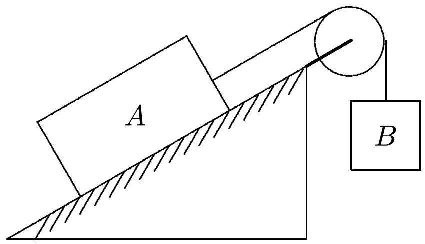
39. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. The largest mass m_B of block B, attached to the dangling end, for which A begins to slide down the incline is:



A. 2.5 kg
B. 3.5 kg
C. 5.9 kg
D. 9.0 kg
E. 10.5 kg

ans: A

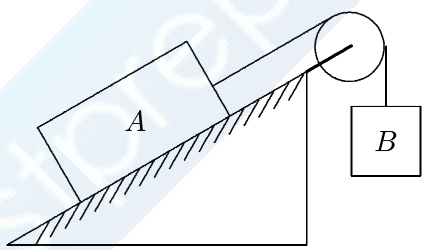
40. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is para[illegible] at the top. The largest mass m_B, attached to the dangling end, for which A remains at rest is:



A. 2.5 kg
B. 3.5 kg
C. 5.9 kg
D. 9.0 kg
E. 10.5 kg

ans: D

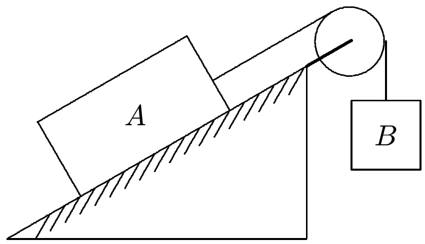
41. Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string. The acceleration of B is:



A. $0.69\,\mathrm{m/s^2}$, up the plane
B. $0.69\,\mathrm{m/s^2}$, down the plane
C. $2.6\,\mathrm{m/s^2}$, up the plane
D. $2.6\,\mathrm{m/s^2}$, down the plane
E. 0

ans: B

42. Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is par at the top. Block B, with a mass of 3.0 kg, is attached to the dangling end of the string. The acceleration of B is:



A. $0.20\,\text{m/s}^2$, up
B. $0.20\,\text{m/s}^2$, down
C. $2.8\,\text{m/s}^2$, up
D. $2.8\,\text{m/s}^2$, down
E. 0

ans: A

43. A 1000-kg airplane moves in straight flight at constant speed. The force of air friction is 1800 N. The net force on the plane is:

A. zero
B. 11800 N
C. 1800 N
D. 9800 N
E. none of these

ans: A

44. Why do raindrops fall with constant speed during the later stages of their descent?

A. The gravitational force is the same for all drops
B. Air resistance just balances the force of gravity
C. The drops all fall from the same height
D. The force of gravity is negligible for objects as small as raindrops
E. Gravity cannot increase the speed of a falling object to more than 9.8 m/s

ans: B

45. A ball is thrown downward from the edge of a cliff with an initial speed that is three times the terminal speed. Initially its acceleration is

A. upward and greater than g
B. upward and less than g
C. downward and greater than g
D. downward and less than g
E. downward and equal to g

ans: A

46. A ball is thrown upward into the air with a speed that is greater than terminal speed. On the way up it slows down and the top of its trajectory:

A. its speed is constant
B. it continues to slow down
C. it speeds up
D. its motion becomes jerky
E. none of the above

ans: B

47. A ball is thrown upward into the air with a speed that is greater than terminal speed. It lands at the place where it was thrown. During its flight the force of air resistance is the greatest:

A. just after it is thrown
B. halfway up
C. at the top of its trajectory
D. halfway down
E. just before it lands.

ans: A

48. Uniform circular motion is the direct consequence of:

A. Newton's third law
B. a force that is always tangent to the path
C. an acceleration tangent to the path
D. a force of constant magnitude that is always directed away from the same fixed point
E. a force of constant magnitude that is always directed toward the same fixed point

ans: E

49. An object moving in a circle at constant speed:

A. must have only one force acting on it
B. is not accelerating
C. is held to its path by centrifugal force
D. has an acceleration of constant magnitude
E. has an acceleration that is tangent to the circle

ans: D

50. An object of mass m and another object of mass $2m$ are each forced to move along a circle of radius 1.0 m at a constant speed of 1.0 m/s. The magnitudes of their accelerations are:

A. equal
B. in the ratio of $\sqrt{2} : 1$
C. in the ratio of $2 : 1$
D. in the ratio of $4 : 1$
E. zero

ans: A

51. The magnitude of the force required to cause a 0.04-kg object to move at 0.6 m/s in a circle of radius 1.0 m is:

A. 2.4×10^{-2} N
B. 1.4×10^{-2} N
C. $1.4\pi \times 10^{-2}$ N
D. $2.4\pi^2 \times 10^{-2}$ N
E. 3.13 N

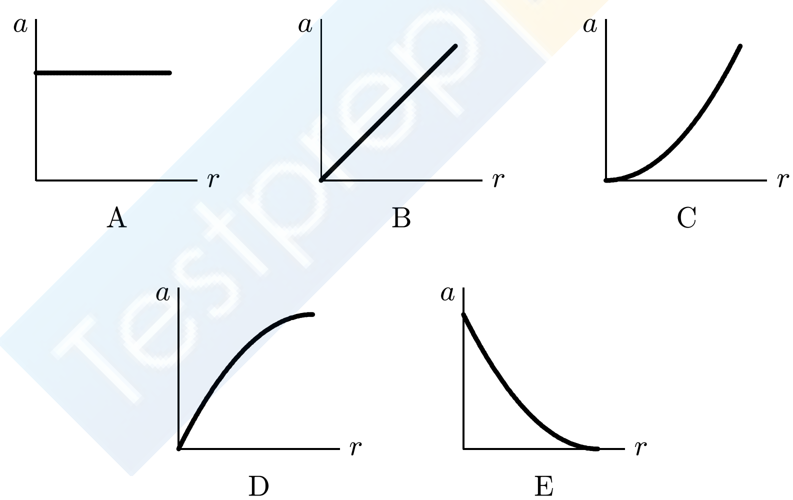
ans: B

52. A 0.2-kg stone is attached to a string and swung in a circle of radius 0.6 m on a horizontal and frictionless surface. If the stone makes 150 revolutions per minute, the tension force of the string on the stone is:

A. 0.03 N
B. 0.2 N
C. 0.9 N
D. 1.96 N
E. 30 N

ans: E

53. Which of the following five graphs is correct for a particle moving in a circle of radius r at a constant speed of 10 m/s?



ans: E

54. An object moves around a circle. If the radius is doubled keeping the speed the same then the magnitude of the centripetal force must be:

A. twice as great
B. half as great
C. four times as great
D. one-fourth as great
E. the same

ans: B

55. An object moves in a circle. If the mass is tripled, the speed halved, and the radius unchanged, then the magnitude of the

A. 3/2
B. 3/4
C. 9/4
D. 6
E. 12

ans: B

56. If a satellite moves above Earth's atmosphere in a circular orbit with constant speed, then:

A. its acceleration and velocity are always in the same direction
B. the net force on it is zero
C. its velocity is constant
D. it will fall back to Earth when its fuel is used up
E. its acceleration is toward the Earth

ans: E

57. A 800-N passenger in a car presses against the car door with a 200 N force when the car makes a left turn at 13 m/s. The (faulty) door will pop open under a force of 800 N. Of the following, the least speed for which the passenger is thrown out of the car is:

A. 14 m/s
B. 19 m/s
C. 20 m/s
D. 26 m/s
E. 54 m/s

ans: D

58. If a certain car, going with speed v_1, rounds a level curve with a radius R_1, it is just on the verge of skidding. If its speed is now doubled, the radius of the tightest curve on the same road that it can round without skidding is:

A. $2R_1$
B. $4R_1$
C. $R_1/2$
D. $R_1/4$
E. R_1

ans: B

59. An automobile moves on a level horizontal road in a circle of radius 30 m. The coefficient of friction between tires and road is 0.50. The maximum speed with which this car can round this curve is:

A. 3.0 m/s
B. 4.9 m/s
C. 9.8 m/s
D. 12 m/s
E. 13 m/s

ans: D

60. The driver of a 1000-kg car tries to turn through a circle of radius 100 m on an unbanked curve at a speed of 10 m/s. Th [illegible] is a magnitude of 900 N. The car.

A. slides into the inside of the curve
B. makes the turn
C. slows down due to the frictional force
D. makes the turn only if it goes faster
E. slides off to the outside of the curve

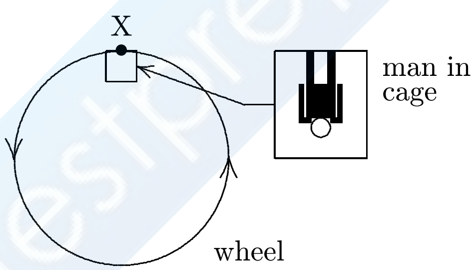
ans: E

61. A car rounds a 75-m radius curve at a constant speed of 18 m/s. A ball is suspended by a string from the ceiling the car and moves with the car. The angle between the string and the vertical is:

A. 0
B. 1.4°
C. 24°
D. 90°
E. cannot be found without knowing the mass of the ball

ans: C

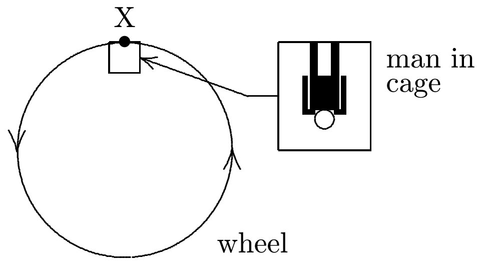
62. A giant wheel, having a diameter of 40 m, is fitted with a cage and platform on which a man of mass m stands. The wheel is rotated in a vertical plane at such a speed that the force exerted by the man on the platform is equal to his weight when the cage is at X, as shown. The net force on the man at point X is:



A. zero
B. mg, down
C. mg, up
D. $2mg$, down
E. $2mg$, up

ans: D

63. A giant wheel, 40 m in diameter, is fitted with a cage and platform on which a man can stand. The wheel rotates at such [illegible] by the man on the platform is equal to his weight. The speed of the man is:



A. 14 m/s
B. 20 m/s
C. 28 m/s
D. 80 m/s
E. 120 m/s

ans: B

64. A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is g. Select the correct combination of forces that act on her when she is at the top. In the table F_g = force of gravity, down; F_b = seat belt force, down; and F_s = seat force, up.

	F_g	F_b	F_s
A.	0	mg	0
B.	mg	0	0
C.	0	0	mg
D.	mg	mg	0
E.	mg	0	mg

ans: B

65. One end of a 1.0-m long string is fixed, the other end is attached to a 2.0-kg stone. The stone swings in a vertical circle, passing the bottom point at 4.0 m/s. The tension force of the string at this point is about:

A. 0
B. 12 N
C. 20 N
D. 32 N
E. 52 N

ans: E

66. One end of a 1.0-m string is fixed. the other end is attached to a 2.0-kg stone. The stone swings in a vertical circle, (in newtons) at this point is about.

A. 0
B. 12
C. 20
D. 32
E. 52

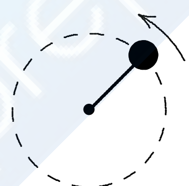
ans: B

67. A coin is placed on a horizontal phonograph turntable. Let N be the magnitude of the normal force exerted by the turntable on the coin, f be the magnitude of the frictional force exerted by the turntable on the coin, and $f_{\text{s, max}}$ be the maximum possible force of static friction. The speed of the turntable is increased in small steps. If the coin does not slide, then

A. N increases, f increases, and $f_{\text{s, max}}$ stays the same
B. N increases, f increases, and $f_{\text{s, max}}$ increases
C. f increases and both N and $f_{\text{s, max}}$ stay the same
D. N, f, and $f_{\text{s, max}}$ all stay the same
E. N, f, and $f_{\text{s, max}}$ all increase

ans: C

68. The iron ball shown is being swung in a vertical circle at the end of a 0.7-m long string. How slowly can the ball go through its top position without having the string go slack?



A. 1.3 m/s
B. 2.6 m/s
C. 3.9 m/s
D. 6.9 m/s
E. 9.8 m/s

ans: B

69. A block is suspended by a rope from the ceiling of a car. When the car rounds a 45-m radius horizontal curve at 22 m/s (about 50 mph), what angle does the rope make with the vertical?

A. 0
B. 25°
C. 48°
D. 65°
E. 90°

ans: C

70. Circular freeway entrance and exit ramps are commonly banked to handle a car moving at 13 m/s. To design a simila

A. increase radius by factor of 2
B. decrease radius by factor of 2
C. increase radius by factor of 4
D. decrease radius by factor of 4
E. increase radius by factor of $\sqrt{2}$

ans: C

71. At what angle should the roadway on a curve with a 50 m radius be banked to allow cars to negotiate the curve at 12 m/s even if the roadway is icy (and the frictional force is zero)?

A. 0
B. 16°
C. 18°
D. 35°
E. 73°

ans: B