Q1W4-Physics-Qs. Bank

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is the cause of an acceleration?
a. speed
b. inertia
c. force
d. velocity

____ 2. Which of the following statements does *not* describe force?
a. Force causes objects at rest to remain stationary.
b. Force causes objects to start moving.
c. Force causes objects to stop moving.
d. Force causes objects to change direction.

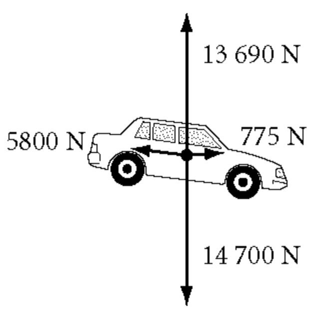
____ 3. What causes a moving object to change direction?
a. acceleration
b. velocity
c. inertia
d. force

____ 4. Which of the following forces arises from direct physical contact between two objects?
a. gravitational force
b. fundamental force
c. contact force
d. field force

____ 5. A newton is equivalent to which of the following quantities?
a. kg
b. kg•m/s
c. $kg\bullet m/s^2$
d. $kg\bullet (m/s)^2$

____ 6. The length of a force vector represents the
a. cause of the force.
b. direction of the force.
c. magnitude of the force.
d. type of force.

____ 7. A free-body diagram represents all of the following *except*
a. the object.
b. forces as vectors.
c. forces exerted by the object.
d. forces exerted on the object.

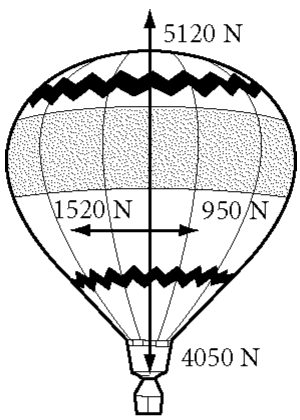


____ 8. The free-body diagram shown above represents a car being pulled by a towing cable. In the diagram, which of the following is the gravitational force acting on the car?
a. 5800 N
b. 775 N
c. 14 700 N
d. 13 690 N

____ 9. The free-body diagram shown above represents a car being pulled by a towing cable. In the diagram, the 5800 N force is
a. the gravitational force acting on the car.
b. the backward force the road exerts on the car.

c. the upward force the road exerts on the car.
d. the force exerted by the towing cable on the car.

____ 10. A free-body diagram of a ball falling in the presence of air resistance would show
a. only a downward arrow to represent the force of air resistance.
b. only a downward arrow to represent the force due to gravity.
c. a downward arrow to represent the force due to gravity and an upward arrow to represent the force of air resistance.
d. an upward arrow to represent the force due to gravity and a downward arrow to represent the force of air resistance.



____ 11. In the free-body diagram shown above, which of the following is the gravitational force acting on the balloon?
a. 1520 N
b. 950 N
c. 4050 N
d. 5120 N

____ 12. Which of the following is the tendency of an object to maintain its state of motion?
a. acceleration
b. inertia
c. force
d. velocity

____ 13. A crate is released on a frictionless plank inclined at angle θ with respect to the horizontal. Which of the following relationships is true? (Assume that the *x*-axis is parallel to the surface of the incline.)
a. $F_y = F_g$
b. $F_x = 0$
c. $F_y = F_x$
d. none of the above

____ 14. A late traveler rushes to catch a plane, pulling a suitcase with a force directed 30.0° above the horizontal. If the horizontal component of the force on the suitcase is 60.6 N, what is the force exerted on the handle?
a. 53.0 N
b. 70.0 N
c. 65.2 N
d. 95.6 N

____ 15. A waitperson carrying a tray with a platter on it tips the tray at an angle of 12° below the horizontal. If the gravitational force on the platter is 5.0 N, what is the magnitude of the force parallel to the tray that tends to cause the platter to slide down the tray? (Disregard friction.)
a. 0.42 N
b. 1.0 N
c. 4.9 N
d. 5.0 N

____ 16. A car goes forward along a level road at constant velocity. The additional force needed to bring the car into equilibrium is
a. greater than the normal force times the coefficient of static friction.
b. equal to the normal force times the coefficient of static friction.
c. the normal force times the coefficient of kinetic friction.

d. zero.

____ 17. A single force acts on an object. The components of this force act along the +*x*-axis and the –*y*-axis. The single force that will bring the object into equilibrium has components that act along the

a. +*x*-axis and +*y*-axis.
b. +*x*-axis and –*y*-axis.
c. –*x*-axis and +*y*-axis.
d. –*x*-axis and –*y*-axis.

____ 18. As an object falls toward Earth,

a. the object does not exert a force on Earth.
b. the object exerts a downward force on Earth.
c. Newton's third law does not apply.
d. the upward acceleration of Earth is negligible because of its large mass.

____ 19. A sculpture is suspended in equilibrium by two cables, one from a wall and the other from the ceiling of a museum gallery. Cable 1 applies a horizontal force to the right of the sculpture and has a tension, F_{T1}. Cable 2 applies a force upward and to the left at an angle of 37.0° to the negative *x*-axis and has a tension, F_{T2}. The gravitational force on the sculpture is 5.00×10^3 N. What is F_{T2}?

a. 4440 N
b. 6640 N
c. 8310 N
d. 3340 N

____ 20. If a nonzero net force is acting on an object, then the object is definitely

a. at rest.
b. moving with a constant velocity.
c. being accelerated.
d. losing mass.

____ 21. Which statement about the acceleration of an object is correct?

a. The acceleration of an object is directly proportional to the net external force acting on the object and inversely proportional to the mass of the object.
b. The acceleration of an object is directly proportional to the net external force acting on the object and directly proportional to the mass of the object.
c. The acceleration of an object is inversely proportional to the net external force acting on the object and inversely proportional to the mass of the object.
d. The acceleration of an object is inversely proportional to the net external force acting on the object and directly proportional to the mass of the object.

____ 22. In general, $\mathbf{F}_{\mathbf{net}}$ equals

a. $\mathbf{F}_{\mathbf{f}}$.
b. $\mathbf{F}_{\mathbf{g}}$.
c. $\mathbf{F}_{\mathbf{n}}$.
d. $\Sigma\mathbf{F}$.

____ 23. According to Newton's second law, when the same force is applied to two objects of different masses,

a. the object with greater mass will experience a great acceleration, and the object with less mass will experience an even greater acceleration.
b. the object with greater mass will experience a smaller acceleration, and the object with less mass will experience a greater acceleration.
c. the object with greater mass will experience a greater acceleration, and the object with less mass will experience a smaller acceleration.
d. the object with greater mass will experience a small acceleration, and the object with less mass will experience an even smaller acceleration.

____ 24. A net force of 6.8 N accelerates a 31 kg scooter across a level parking lot. What is the magnitude of the scooter's acceleration?

a. 0.22 m/s^2
b. 0.69 m/s^2
c. 3.2 m/s^2
d. 4.6 m/s^2

____ 25. An airplane with a mass of 1.20×10^4 kg tows a glider with a mass of 0.60×10^4 kg. If the airplane propellers provide a net forward thrust of 3.60×10^4 N, what is the acceleration of the glider? (Disregard friction.)

a. 2.00 m/s^2 c. 6.00 m/s^2
b. 3.00 m/s^2 d. 9.80 m/s^2

____ 26. A sled traveling at a speed of 3.0 m/s slows to a stop 4.0 m from the point where its passenger rolled off. What is the magnitude of the horizontal net force that slows the 110 N sled? (Assume $a_g = 9.81 \text{ m/s}^2$.)
a. 130 N c. 37 N
b. 34 N d. 13 N

____ 27. Two perpendicular forces, one of 45.0 N directed upward and the other of 60.0 N directed to the right, act simultaneously on an object with a mass of 35.0 kg. What is the magnitude of the resultant acceleration of the object?
a. 2.14 m/s^2 c. 5.25 m/s^2
b. 3.00 m/s^2 d. 1.41 m/s^2

____ 28. The statement by Newton that for every action there is an equal but opposite reaction is which of his laws of motion?
a. first c. third
b. second d. fourth

____ 29. Which are simultaneous equal but opposite forces resulting from the interaction of two objects?
a. net external forces c. gravitational forces
b. field forces d. action-reaction pairs

____ 30. Newton's third law of motion involves the interactions of
a. one object and one force. c. two object and one force.
b. one object and two forces. d. two objects and two forces.

____ 31. A hammer drives a nail into a piece of wood. Identify an action-reaction pair in this situation.
a. The nail exerts a force on the hammer; the hammer exerts a force on the wood.
b. The hammer exerts a force on the nail; the wood exerts a force on the nail.
c. The hammer exerts a force on the nail; the nail exerts a force on the hammer.
d. The hammer exerts a force on the nail; the hammer exerts a force on the wood.

____ 32. A hockey stick hits a puck on the ice. Identify an action-reaction pair in this situation.
a. The stick exerts a force on the puck; the puck exerts a force on the stick.
b. The stick exerts a force on the puck; the puck exerts a force on the ice.
c. The puck exerts a force on the stick; the stick exerts a force on the ice.
d. The stick exerts a force on the ice; the ice exerts a force on the puck.

____ 33. A leaf falls from a tree and lands on the sidewalk. Identify an action-reaction pair in this situation.
a. The tree exerts a force on the leaf; the sidewalk exerts a force on the leaf.
b. The leaf exerts a force on the sidewalk; the sidewalk exerts a force on the leaf.
c. The leaf exerts a force on the tree; the sidewalk exerts a force on the leaf.
d. The leaf exerts a force on the sidewalk; the tree exerts a force on the leaf.

____ 34. A ball is dropped from a person's hand and falls to Earth. Identify an action-reaction pair in this situation.
a. The hand exerts a force on the ball; Earth exerts a force on the hand.
b. Earth exerts a force on the ball; the hand exerts a force on Earth.
c. Earth exerts a force on the hand; the hand exerts a force on the ball.
d. Earth exerts a force on the ball; the ball exerts a force on Earth.

____ 35. As a basketball player starts to jump for a rebound, the player begins to move upward faster and faster until his shoes leave the floor. At the moment the player begins to jump, the force of the floor on the shoes is
a. greater than the player's weight.
b. equal in magnitude and opposite in direction to the player's weight.
c. less than the player's weight.
d. zero.

____ 36. The magnitude of the gravitational force acting on an object is

a. frictional force.
b. weight.
c. inertia.
d. mass.

____ 37. A measure of the quantity of matter is
a. density.
b. weight.
c. force.
d. mass.

____ 38. A change in the gravitational force acting on an object will affect the object's
a. mass.
b. coefficient of static friction.
c. weight.
d. inertia.

____ 39. A sled weighing 1.0×10^2 N is held in place on a frictionless 20.0° slope by a rope attached to a stake at the top. The rope is parallel to the slope. What is the normal force of the slope acting on the sled?
a. 94 N
b. 47 N
c. 37 N
d. 34 N

____ 40. A book with a mass of 2.0 kg is held in equilibrium on a board with a slope of 60.0° by a horizontal force. What is the normal force exerted on the book?
a. 39 N
b. 61 N
c. 15 N
d. 34 N

____ 41. What are the units of the coefficient of friction?
a. N
b. 1/N
c. N^2
d. The coefficient of friction has no units.

____ 42. There are six books in a stack, and each book weighs 5 N. The coefficient of static friction between the books is 0.2. With what horizontal force must one push to start sliding the top five books off the bottom one?
a. 1 N
b. 5 N
c. 3 N
d. 7 N

____ 43. A crate is carried in a pickup truck traveling horizontally at 15.0 m/s. The truck applies the brakes for a distance of 28.7 m while stopping with uniform acceleration. What is the coefficient of static friction between the crate and the truck bed if the crate does not slide?
a. 0.400
b. 0.365
c. 0.892
d. 0.656

____ 44. An ice skater moving at 10.0 m/s coasts to a halt in 1.0×10^2 m on a smooth ice surface. What is the coefficient of friction between the ice and the skates?
a. 0.025
b. 0.051
c. 0.102
d. 0.205

Short Answer

1. How does the theory of field forces explain how objects could exert forces on each other without touching?
2. The newton is the SI unit of what physical quantity?
3. The amount of force equal to 1 $kg \bullet m/s^2$ defines what SI unit?
4. What is the abbreviation of the unit newton?
5. Briefly describe how applying the brakes to stop a bicycle is an example of force.
6. How are force vectors represented in force diagrams?
7. In a free-body diagram of an object, why are forces exerted by the object not included in the diagram?
8. The length of the force vector is proportional to what property of a force?

9. Why is force *not* a scalar quantity?
10. Construct a free-body diagram of a car being towed.
11. State Newton's first law of motion.
12. What happens to an object in motion when it experiences a nonzero net external force?
13. What is the natural tendency of an object that is in motion?
14. What term is used to describe the vector sum of all the forces acting on an object?
15. If two teams playing tug-of-war pull on a rope with equal but opposite forces, what is the net external force on the rope?
16. Describe the forces acting on a car as it moves along a level highway in still air at a constant speed.
17. For an object to be in equilibrium, the net force acting on the object must have what value?
18. In the equation form of Newton's second law, $\Sigma\mathbf{F} = m\mathbf{a}$, what does $\Sigma\mathbf{F}$ represent?
19. If $\mathbf{F_{net}} = \mathbf{F_g}$, what is the magnitude and direction of the acceleration of the object? Assume that the object is on Earth's surface.
20. In the equation $\mathbf{F_{net}} = m\mathbf{a}$, what is the direction of the acceleration?
21. Why does it require much less force to accelerate a low-mass object than it does to accelerate a high-mass object the same amount?
22. A block of wood supported by two concrete blocks is chopped in half by a karate instructor. Identify an action-reaction pair, and compare the forces exerted by each object.
23. Do action-reaction pairs result in equilibrium? Explain.
24. When a horse pulls on a cart, the cart pulls on the horse with an equal but opposite force. How is the horse able to pull the cart?
25. How do mass and weight vary with altitude?
26. Distinguish between mass and weight.
27. In what direction does the force of air resistance act?
28. What happens to air resistance when an object accelerates?
29. When a car is moving, what happens to the velocity and acceleration of the car if the air resistance becomes equal to the force acting in the opposite direction?
30. Why is air resistance considered a form of friction?
31. When a falling object reaches terminal speed (where the acceleration on the object is zero), what is the relationship between $\mathbf{F_R}$, the force of air resistance on the object, and $\mathbf{F_g}$?
32. How does the force of static friction on a crate you cannot budge compare to the force you exert on it? Assume that the crate is on a flat surface.
33. How does the coefficient of static friction for two surfaces in contact compare to the coefficient of kinetic friction for the same two surfaces?
34. In this text, what does the symbol μ_k represent?

Problem

1. In a game of tug-of-war, a rope is pulled by a force of 182 N to the right and by a force of 108 N to the left. What is the magnitude and direction of the net horizontal force on the rope?
2. Two ice-hockey players simultaneously strike a puck with their sticks. The stick of one player exerts an eastward force on the puck of 15 N. The other player's stick exerts a northward force of 11 N on the puck. Assuming that there is no frictional force between the puck and the ice, what is the magnitude of the net horizontal force on the puck?
3. A package of meteorological instruments is held aloft by a balloon that exerts an upward force of 511 N on the package. The gravitational force acting on the package is 312 N. What is the magnitude and direction of the force that a scientist must exert on a rope attached to the package to keep it from rising?
4. A sled is pulled at a constant velocity across a horizontal snow surface. If a force of 4.0×10^1 N is being applied to the sled rope at an angle of 11° to the ground, what is the magnitude of the force of friction of the snow acting on the sled?
5. A trapeze artist on a rope is momentarily held to one side by a partner on a platform The rope makes an angle of 26.0° with the vertical. Insuch a condition of static equilibrium, what is the magnitude of the horizontal force being applied by the partner? The weight of the artist is 7.61×10^2 N.
6. A wagon having a mass of 91 kg is accelerated across a level road at 0.97 m/s^2. What net force acts on the wagon horizontally?
7. A farmhand attaches a 27 kg bale of hay to one end of a rope passing over a frictionless pulley connected to a beam in the hay barn. Another farmhand then pulls down on the opposite end of the rope with a force of 397 N. Ignoring the mass of the rope, what will be the magnitude and direction of the bale's acceleration if the gravitational force acting on it is 265 N?
8. A warehouse worker pulls on the handles of a 83.0 kg cart with a net force of 111 N an angle of 53.0° above the horizontal. Attached to the cart is a second cart having a mass of 55.0 kg. What is the magnitude of the horizontal acceleration of the less massive cart?
9. A sailboat with a mass of 2.1×10^3 kg experiences an ocean current force of 3.45×10^3 N directed to the east and a wind force against its sails with a magnitude of 6.53×10^3 N directed toward the northwest (45.0° N of W). What is the magnitude of the resultant acceleration of the boat?
10. An elevator weighing 2.58×10^5 N is supported by a steel cable. What is the tension in the cable when the elevator is accelerated upward at a rate of 3.33 m/s^2? (g = 9.81 m/s^2)
11. Basking in the sun, a 1.97 kg lizard lies on a flat rock tilted at an angle of 15.9° with respect to the horizontal. What is the magnitude of the normal force exerted by the rock on the lizard?
12. A three-tiered birthday cake rests on a table. From bottom to top, the cake tiers weigh 15 N, 8 N, and 6 N, respectively. What is the magnitude and direction of the normal force acting on the base of the second tier?
13. A stagehand starts sliding a large piece of stage scenery originally at rest by pulling it horizontally with a force of 177 N. What is the coefficient of static friction between the stage floor and the 230 N piece of scenery?
14. A row of five 1.2 N wooden blocks is being pushed across a tabletop at a constant speed by a toy tractor that exerts a force of 1.7 N on the row. What is the coefficient of kinetic friction between the wooden blocks and the tabletop?

15. A waitperson pushes the bottom of a glass tumbler full of water across a tabletop at constant speed. The tumbler and its contents have a mass of 0.86 kg, and the coefficient of kinetic friction for the surfaces in contact is 0.46. What force does the waitperson exert on the glass? $g = 9.81$ m/s^2)

16. A rope attached to an engine pulls a 240 N crate up an 14.7° ramp at constant speed. The coefficient of kinetic friction for the surfaces of the crate and ramp is 0.32. What is the magnitude of the force that the rope exerts on the crate parallel to the ramp? ($g = 9.81$ m/s^2)

17. A couch with a mass of 1.00×10^2 kg is placed on an adjustable ramp connected to a truck. As one end of the ramp is raised, the couch begins to move downward. If the couch slides down the ramp with an acceleration of 0.79 m/s^2 when the ramp angle is 12.0°, what is the coefficient of kinetic friction between the ramp and the couch? ($g = 9.81$ m/s^2)

18. An Olympic skier moving at 19.0 m/s down a 26.0° slope encounters a region of wet snow and slides 136 m before coming to a halt. What is the coefficient of friction between the skis and the snow? ($g = 9.81$ m/s^2)

Q1W4-Physics-Qs. Bank
Answer Section

MULTIPLE CHOICE

1.	ANS: C	PTS: 1	DIF: I	OBJ: 4-1.1
2.	ANS: A	PTS: 1	DIF: I	OBJ: 4-1.1
3.	ANS: D	PTS: 1	DIF: I	OBJ: 4-1.1
4.	ANS: C	PTS: 1	DIF: I	OBJ: 4-1.1
5.	ANS: C	PTS: 1	DIF: I	OBJ: 4-1.1
6.	ANS: C	PTS: 1	DIF: I	OBJ: 4-1.2
7.	ANS: C	PTS: 1	DIF: I	OBJ: 4-1.2
8.	ANS: C	PTS: 1	DIF: II	OBJ: 4-1.2
9.	ANS: D	PTS: 1	DIF: II	OBJ: 4-1.2
10.	ANS: C	PTS: 1	DIF: II	OBJ: 4-1.2
11.	ANS: C	PTS: 1	DIF: II	OBJ: 4-1.2
12.	ANS: B	PTS: 1	DIF: I	OBJ: 4-2.1
13.	ANS: D	PTS: 1	DIF: I	OBJ: 4-2.2

14. ANS: B

Given
F_y = 60.0 N
θ = 30.0°

Solution

$$\cos\theta = \frac{F_y}{F}$$

$$F = \frac{F_y}{\cos\theta} = \frac{60.6\ \mathrm{N}}{\cos\ 30.0^\circ} = 70.0\ \mathrm{N}$$

PTS: 1 DIF: IIIA OBJ: 4-2.2

15. ANS: B

Given
F_g = 5.0 N
α = 12°

Solution

$$\theta = 90^\circ - 12^\circ = 78^\circ$$

$$\Sigma F_x = F_{g,x} = F_g \cos\theta = (5.0\ \mathrm{N})(\cos 78^\circ) = 1.0\ \mathrm{N}$$

PTS: 1 DIF: IIIA OBJ: 4-2.2

16.	ANS: D	PTS: 1	DIF: I	OBJ: 4-2.3
17.	ANS: C	PTS: 1	DIF: II	OBJ: 4-2.3

18. ANS: D PTS: 1 DIF: II OBJ: 4-3.3

19. ANS: C

Given

$F_g = 5.00 \times 10^3$ N

$\theta = 37.0°$

Solution

$\Sigma F_{net,y} = F_g - F_{T2,y} = 0$

$F_g = F_{T2,y}$

$$F_{T2} = \frac{F_{T2,y}}{\sin\theta} = \frac{F_g}{\sin\theta} = \frac{5.00 \times 10^3 \text{ N}}{\sin 37.0°} = 8.31 \times 10^3 \text{ N}$$

PTS: 1 DIF: IIIC OBJ: 4-2.3

20. ANS: C PTS: 1 DIF: I OBJ: 4-3.1

21. ANS: A PTS: 1 DIF: I OBJ: 4-3.1

22. ANS: D PTS: 1 DIF: II OBJ: 4-3.1

23. ANS: B PTS: 1 DIF: II OBJ: 4-3.1

24. ANS: A

Given

$F_{applied} = 6.8$ N

$m = 31$ kg

Solution

$F_{net} = \sum F_x = F_{applied} = ma_x$

$$a_x = \frac{F_{applied}}{m} = \frac{6.8 \text{ N}}{31 \text{ kg}} = 0.22 \text{ m/s}^2$$

PTS: 1 DIF: IIIA OBJ: 4-3.2

25. ANS: A

Given

$F_{net} = 3.60 \times 10^4$ N, forward

$m_1 = 1.20 \times 10^4$ kg

$m_2 = 0.60 \times 10^4$ kg

Solution

$F_{net} = ma = (m_1 + m_2)a$

$$a = \frac{F_{net}}{m_1 + m_2} = \frac{3.60 \times 10^4 \text{ N}}{(1.20 \times 10^4 \text{ kg}) + (0.60 \times 10^4 \text{ kg})} = 2.00 \text{ m/s}^2$$

PTS: 1 DIF: IIIA OBJ: 4-3.2

26. ANS: D

Given
$v_{x,i} = 3.0$ m/s
$\Delta x = 4.0$ m
$v_{x,f} = 0.0$ m/s
$F_g = 110$ N
$a_g = 9.81$ m/s^2

Solution
$F_g = ma_g$, so $m = \frac{F_g}{a_g}$

Because $v_{x,f} = 0$, $a_x = \frac{-(v_{x,i})^2}{2\Delta x}$

$$F_{net,x} = ma_x = \left(\frac{F_g}{a_g}\right)\left(\frac{-(v_{x,i})^2}{2\Delta x}\right) = \frac{-(110\text{ N})(3.0\text{ m/s})^2}{(9.81\text{ m/s}^2)(2)(4.0\text{ m})}$$

$F_{net,x} = -13$ N
magnitude of horizontal net force = 13 N

PTS: 1 DIF: IIIB OBJ: 4-3.2

27. ANS: A

Given
$\mathbf{F_1} = 45.0$ N, upward
$\mathbf{F_2} = 60.0$ N, to the right
$m = 35.0$ kg

Solution
$F_{net} = \sqrt{F_1{}^2 + F_2{}^2}$

$$a = \frac{F_{net}}{m} = \frac{\sqrt{F_1{}^2 + F_2{}^2}}{m} = \frac{\sqrt{(45.0\text{ N})^2 + (60.0\text{ N})^2}}{35.0\text{ kg}} = 2.14\text{ m/s}^2$$

PTS: 1 DIF: IIIB OBJ: 4-3.2

28.	ANS: C	PTS: 1	DIF: I	OBJ: 4-3.3
29.	ANS: D	PTS: 1	DIF: I	OBJ: 4-3.3
30.	ANS: D	PTS: 1	DIF: I	OBJ: 4-3.3
31.	ANS: C	PTS: 1	DIF: II	OBJ: 4-3.3
32.	ANS: A	PTS: 1	DIF: II	OBJ: 4-3.3
33.	ANS: B	PTS: 1	DIF: II	OBJ: 4-3.3
34.	ANS: D	PTS: 1	DIF: II	OBJ: 4-3.3
35.	ANS: A	PTS: 1	DIF: II	OBJ: 4-3.3

36. ANS: B PTS: 1 DIF: I OBJ: 4-4.1
37. ANS: D PTS: 1 DIF: I OBJ: 4-4.1
38. ANS: C PTS: 1 DIF: I OBJ: 4-4.1
39. ANS: A

Given
$F_g = 1.0 \times 10^2$ N
$\theta = 20.0°$

Solution
$\Sigma F_y = F_n - F_{g,y} = 0$

$F_n = F_{g,y} = F_g \cos\theta = (1.0 \times 10^2 \text{ N})(\cos 20.0°) = 94 \text{ N}$

PTS: 1 DIF: IIIA OBJ: 4-4.2

40. ANS: A

Given
$m = 2.0$ kg
$\theta = 60.0°$
$g = 9.81 \text{ m/s}^2$

Solution
$\Sigma F_x = F_{applied,x} - F_{g,x} = 0$

$F_{applied,x} = F_{g,x} = F_g \sin\theta$

$\Sigma F_y = F_n - F_{g,y} - F_{applied,y} = 0$

$F_n = F_{g,y} + F_{applied,y}$

$F_{g,y} = F_g \cos\theta$

$F_{applied,y} = F_{applied,x} \tan\theta$

$F_n = F_{g,y} + F_{applied,y} = F_g \cos\theta + F_{applied,x} \tan\theta = F_g \cos\theta + (F_g \sin\theta)\tan\theta$

$F_n = F_g [\cos\theta + (\sin\theta)(\tan\theta)]$

$F_n = (2.0 \text{ kg})(9.81 \text{ m/s}^2)[\cos 60.0° + (\sin 60.0°)(\tan 60.0°)]$

$F_n = 39 \text{ N}$

PTS: 1 DIF: IIIB OBJ: 4-4.2

41. ANS: D PTS: 1 DIF: I OBJ: 4-4.4
42. ANS: B

Given
$F_{g,book} = 5$ N
$\mu_s = 0.2$

Solution
$\Sigma F_x = F_{applied} - F_{s,max} = 0$

$F_{applied} = F_{s,max} = \mu_s F_n = \mu_s F_g$

$F_g = (5\text{N} + 5\text{N} + 5\text{N} + 5\text{N} + 5\text{N}) = 25\text{N}$

$F_{applied} = (0.2)(25\text{N}) = 5\text{N}$

PTS: 1 DIF: IIIA OBJ: 4-4.4

43. ANS: A

Given
v_i = 15.0 m/s
Δx = 28.7 m
g = 9.81 m/s^2

Solution
$\Sigma F_x = F_{applied} - F_{s,max} = 0$

$F_{s,max} = F_{applied}$
$\mu_s mg = ma$

$\mu_s = \dfrac{a}{g}$

Because $v_f = 0$, $a = \dfrac{-(v_i)^2}{2(\Delta x)}$

$a = \dfrac{-(15.0\text{ m/s})^2}{2(28.7\text{ m})} = -3.92\text{ m/s}^2$, so the magnitude of $a = 3.92\text{ m/s}^2$

$\mu_s = \dfrac{a}{g} = \dfrac{3.92\text{ m/s}^2}{9.81\text{ m/s}^2} = 0.400$

PTS: 1 DIF: IIIB OBJ: 4-4.4

44. ANS: B

Given
v_i = 10.0 m/s
g = 9.81 m/s^2
$\Delta x = 1.0 \times 10^2$ m

Solution

$\Sigma F_x = F_f = ma$

$\Sigma F_y = 0$, so $F_n = F_g$

$F_f = \mu_k F_n = \mu_k F_g = \mu_k mg = ma$

$\mu_k g = a$

$\mu_k = \frac{a}{g}$

Because $v_f = 0$, $a = \frac{-(v_i)^2}{2\Delta x}$

$a = \frac{-(10.0\ \text{m/s})^2}{(2)(1.0 \times 10^2\ \text{m})} = -0.50\ \text{m/s}^2$, magnitude of $a = 0.50\ \text{m/s}^2$

$\mu_k = \frac{a}{g} = \frac{0.50\ \text{m/s}^2}{9.81\ \text{m/s}^2} = 0.051$

PTS: 1 DIF: IIIC OBJ: 4-4.4

SHORT ANSWER

1. ANS:
Objects exert forces on each other when their fields interact.

PTS: 1 DIF: I OBJ: 4-1.1

2. ANS:
force

PTS: 1 DIF: I OBJ: 4-1.1

3. ANS:
newton

PTS: 1 DIF: I OBJ: 4-1.1

4. ANS:
N

PTS: 1 DIF: I OBJ: 4-1.1

5. ANS:
Force causes an acceleration, or a change in an object's velocity. Applying the brakes decelerates the bicycle (accelerates it in the negative direction) and causes a change in the bicycle's velocity because the bicycle slows down.

PTS: 1 DIF: II OBJ: 4-1.1

6. ANS:
The force vectors are represented by arrows.

PTS: 1 DIF: I OBJ: 4-1.2

7. ANS:
Forces exerted by the object do not change its motion.

PTS: 1 DIF: I OBJ: 4-1.2

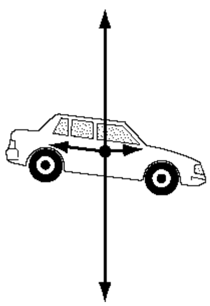
8. ANS:
magnitude

PTS: 1 DIF: I OBJ: 4-1.2

9. ANS:
A scalar quantity has only magnitude. Force has both magnitude and direction, so it cannot be a scalar quantity.

PTS: 1 DIF: II OBJ: 4-1.2

10. ANS:



PTS: 1 DIF: II OBJ: 4-1.2

11. ANS:
An object at rest remains at rest, and an object in motion continues in motion with constant velocity unless it experiences a net external force.

PTS: 1 DIF: I OBJ: 4-2.1

12. ANS:
The object experiences an acceleration.

PTS: 1 DIF: I OBJ: 4-2.1

13. ANS:
The natural condition for a moving object is to remain in motion once it has been set in motion.

PTS: 1 DIF: I OBJ: 4-2.1

14. ANS:
net force

PTS: 1 DIF: I OBJ: 4-2.1

15. ANS:
zero

PTS: 1 DIF: I OBJ: 4-2.2

16. ANS:

Gravity exerts a downward force on the car that is balanced by the normal force of the road acting upward on the car. The car's forward motion is opposed by the friction between the road and the tires and by the resistance of the air. The sum of these opposing forces is balanced by an equal and opposite force exerted by the engine and applied to the tires, where the road exerts a reaction force that is directed forward.

PTS: 1 DIF: II OBJ: 4-2.2

17. ANS:
zero

PTS: 1 DIF: I OBJ: 4-2.3

18. ANS:
$\Sigma \mathbf{F}$ is the vector sum of the external forces acting on the object.

PTS: 1 DIF: I OBJ: 4-3.1

19. ANS:
9.81 m/s^2, downward

PTS: 1 DIF: I OBJ: 4-3.1

20. ANS:
The acceleration is in the direction of $\mathbf{F_{net}}$.

PTS: 1 DIF: I OBJ: 4-3.1

21. ANS:
An object with smaller mass has less inertia, or tendency to maintain velocity, than does an object with greater mass.

PTS: 1 DIF: II OBJ: 4-3.1

22. ANS:
The hand exerts a force on the wood, and the wood exerts an equal force on the hand. Each end of the wood exerts a force on a block, and each block exerts an equal force on the wood.

PTS: 1 DIF: II OBJ: 4-3.3

23. ANS:
No, action-reaction pairs do not result in equilibrium because they act on different objects.

PTS: 1 DIF: II OBJ: 4-3.3

24. ANS:
The horse and the cart are not necessarily at equilibrium. The forces in the action-reaction pair are each applied to different objects.

PTS: 1 DIF: II OBJ: 4-3.3

25. ANS:
Mass remains constant, but weight decreases with altitude.

PTS: 1 DIF: I OBJ: 4-4.1

26. ANS:
Mass is the amount of matter in an object and is an inherent property of an object. Weight is not an inherent property of an object and is the magnitude of the force due to gravity acting on the object.

PTS: 1 DIF: II OBJ: 4-4.1

27. ANS:
Air resistance acts in the direction opposite the direction of an object's motion.

PTS: 1 DIF: I OBJ: 4-4.3

28. ANS:
In most cases, air resistance increases with increasing speed.

PTS: 1 DIF: I OBJ: 4-4.3

29. ANS:
The acceleration is then zero, and the car moves at a constant velocity.

PTS: 1 DIF: I OBJ: 4-4.3

30. ANS:
Air resistance is a form of friction because it is a retarding force. It acts in the direction opposite an object's motion.

PTS: 1 DIF: I OBJ: 4-4.3

31. ANS:
The two forces are equal in magnitude and opposite in direction.

PTS: 1 DIF: I OBJ: 4-4.3

32. ANS:
The magnitude of the force of static friction equals the magnitude of the force you exert, and the forces are opposite in direction.

PTS: 1 DIF: I OBJ: 4-4.4

33. ANS:
The coefficient of static friction is larger than the coefficient of kinetic friction for the same two surfaces in contact.

PTS: 1 DIF: I OBJ: 4-4.4

34. ANS:
coefficient of kinetic friction

PTS: 1 DIF: I OBJ: 4-4.4

PROBLEM

1. ANS:
74 N, to the right

Given

$\mathbf{F_1} =$ 182 N, to the right

$\mathbf{F_2} =$ 108 N, to the left

Solution

$\mathbf{F}_{net} = \mathbf{F}_1 + \mathbf{F}_2$

$F_{net} = F_1 - F_2 = 182\ \text{N} - 108\ \text{N} = 74\ \text{N}$
$\mathbf{F}_{net} =$ 74 N, to the right

PTS: 1 DIF: IIIA OBJ: 4-2.2

2. ANS:
19 N

Given
$\mathbf{F_x} =$ 15 N, east
$\mathbf{F_y} =$ 11 N, north

Solution

$$F_{net} = \sqrt{F_x{}^2 + F_y{}^2} = \sqrt{(15\ \text{N})^2 + (11\text{N})^2}$$

$$F_{net} = \sqrt{230\ \text{N}^2 + 120\text{N}^2}$$

$$F_{net} = 19\ \text{N}$$

PTS: 1 DIF: IIIA OBJ: 4-2.2

3. ANS:
199 N, downward

Given
$\mathbf{F}_{\mathbf{balloon,y}} =$ 511 N, upward
$\mathbf{F_g} =$ 312 N, downward

Solution

$$\Sigma F_y = F_{balloon,y} - F_g - F_{applied,y} = 0$$

$$F_{applied,y} = F_{balloon,y} - F_g = 511\ \text{N} - 312\ \text{N} = 199\ \text{N}$$

$$\mathbf{F}_{\mathbf{applied,y}} = 199\ \text{N, downward}$$

PTS: 1 DIF: IIIA OBJ: 4-2.3

4. ANS:
39 N

Given
$F = 4.0 \times 10^1$ N
$\theta = 11°$

Solution

$$\Sigma F_x = F_f - F_{applied,x} = 0$$

$$F_f = F_{applied,x} = F\cos\theta = (4.0 \times 10^1\ \text{N})(\cos 11°)$$

$$F_f = (4.0 \times 10^1\ \text{N})(0.98)$$

$$F_f = 39\ \text{N}$$

PTS: 1 DIF: IIIB OBJ: 4-2.3

5. ANS:
3.71×10^2 N

Given
$F_{g,2} = 7.61 \times 10^2$ N
$\theta = 26.0°$

Solution
$$\sum F_y = F_{Tension,y} - F_g = 0$$
$$F_{Tension,y} = F_{Tension}\cos\theta = F_g$$
$$\sum F_x = F_{Tension,x} - F_{applied} = 0$$
$$F_{Tension,x} = F_{Tension}\sin\theta = F_{applied}$$
$$\frac{F_{Tension,x}}{F_{Tension,y}} = \frac{F_{Tension}\sin\theta}{F_{Tension}\cos\theta} = \tan\theta$$
$$\frac{F_{applied}}{F_g} = \tan\theta$$
$$F_{applied} = F_g\tan\theta = \left(7.61 \times 10^2\text{ N}\right)(\tan 26.0°)$$
$$F_{applied} = \left(7.61 \times 10^2\text{ N}\right)(0.488)$$
$$F_{applied} = 3.71 \times 10^2\text{N}$$

PTS: 1 DIF: IIIC OBJ: 4-2.3

6. ANS:
88 N

Given
$m = 91$ kg
$a_x = 0.97$ m/s^2

Solution
$$\Sigma F_x = ma_x = (91\text{ kg})(0.97\text{ m/s}^2) = 88\text{ N}$$

PTS: 1 DIF: IIIA OBJ: 4-3.2

7. ANS:
4.9 m/s^2, upward

Given
$F_{applied,y} = 397$ N

$F_g = 265$ N

$m = 27$ kg

Solution

$\Sigma F_y = F_{applied,y} - F_g = ma$

$$a = \frac{F_{applied,y} - F_g}{m} = \frac{397\text{ N} - 265\text{ N}}{27\text{ kg}} = 4.9\text{ m/s}^2$$

$\mathbf{a} = 4.9$ m/s^2, upward

PTS: 1 DIF: IIIA OBJ: 4-3.2

8. ANS:

0.484 m/s^2

Given

$F_{applied} = 111$ N

$\theta = 53.0°$

$m_1 = 83.0$ kg

$m_2 = 55.0$ kg

Solution

$\Sigma F_x = F_{applied,x} = m_T a_x$

$F_{applied,x} = F_x \cos\theta \qquad m_T = m_1 + m_2$

$$a_x = \frac{F_x \cos\theta}{m_1 + m_2} = \frac{(111\text{ N})(\cos 53.0°)}{(83.0\text{kg} + 55.0\text{ kg})}$$

$$a_x = \frac{F_x \cos\theta}{m_1 + m_2} = \frac{(111\text{ N})(0.602)}{(83.0\text{kg} + 55.0\text{ kg})}$$

$$a_x = 0.484\text{ m/s}^2$$

PTS: 1 DIF: IIIB OBJ: 4-3.2

9. ANS:

2.3 m/s^2

Given

$\mathbf{F_1} = 3.45 \times 10^3$ N, east

$\mathbf{F_2} = 6.53 \times 10^3$ N, 45.0° N of W

$m = 2.1 \times 10^3$ kg

Solution

$F_{net,x} = \Sigma F_x = F_1 - F_{2,x} = F_1 - F_2 \cos\theta$

$$F_{net,x} = \left(3.45 \times 10^3 \text{ N}\right) - \left(6.53 \times 10^3 \text{ N}\right)(\cos 45.0°)$$

$$F_{net,x} = \left(3.45 \times 10^3 \text{ N}\right) - \left(6.53 \times 10^3 \text{ N}\right)(0.707)$$

$$F_{net,x} = \left(3.45 \times 10^3 \text{ N}\right) - \left(4.62 \times 10^3 \text{ N}\right)$$

$$F_{net,x} = 1.17 \times 10^3 \text{ N, west}$$

$$F_{net,y} = \Sigma F_y = F_{2,y} = F_2 \sin\theta$$

$$F_{net,y} = \left(6.53 \times 10^3 \text{ N}\right)(\sin 45.0°)$$

$$F_{net,y} = \left(6.53 \times 10^3 \text{ N}\right)(0.707)$$

$$F_{net,y} = 4.62 \times 10^3 \text{ N, north}$$

$$F_{net} = \sqrt{\left(F_{net,x}\right)^2 + \left(F_{net,y}\right)^2}$$

$$a = \frac{F_{net}}{m} = \frac{\sqrt{\left(F_{net,x}\right)^2 + \left(F_{net,y}\right)^2}}{m} = \frac{\sqrt{\left(1.17 \times 10^3 \text{ N}\right)^2 + \left(4.62 \times 10^3 \text{ N}\right)^2}}{\left(2.1 \times 10^3 \text{ kg}\right)}$$

$$a = \frac{\sqrt{1.37 \times 10^6 \text{ N}^2 + 2.13 \times 10^7 \text{ N}^2}}{\left(2.1 \times 10^3 \text{ kg}\right)}$$

$$a = \frac{\sqrt{2.27 \times 10^7 \text{ N}^2}}{\left(2.1 \times 10^3 \text{ kg}\right)}$$

$$a = \frac{4.76 \times 10^3 \text{ N}}{2.1 \times 10^3 \text{ kg}}$$

$a = 2.3 \text{ m/s}^2$

PTS: 1 DIF: IIIB OBJ: 4-3.2

10. ANS:

3.46×10^5 N

Given

$F_g = 2.58 \times 10^5$ N

$g = 9.81 \text{ m/s}^2$

$a = +3.33 \text{ m/s}^2$

Solution

$$F_{net} = F_T - F_g = ma = \frac{F_g}{g}a$$

$$F_T = F_g + \frac{F_g}{g}a$$

$$F_T = 2.58 \times 10^5 \text{ N} + \frac{(2.58 \times 10^5 \text{ N})(3.33 \text{ m/s}^2)}{9.81 \text{ m/s}^2}$$

$$F_T = 2.58 \times 10^5 \text{ N} + 8.76 \times 10^4 \text{ N}$$

$$= 3.46 \times 10^5 \text{ N}$$

PTS: 1 DIF: IIIB OBJ: 4-3.2

11. ANS:
18.6 N

Given
m = 1.97 kg
θ = 15.9°
g = 9.81 m/s^2

Solution
$$F_{net,y} = \Sigma F_y = F_n - F_{g,y} = 0$$

$$F_n = F_{g,y} = F_g \cos\theta = mg\cos\theta$$

$$F_n = (1.97\text{kg})(9.81 \text{ m/s}^2)(\cos 15.9°)$$

$$F_n = (1.97\text{kg})(9.81 \text{ m/s}^2)(0.962)$$

$$F_n = 18.6 \text{ N}$$

PTS: 1 DIF: IIIA OBJ: 4-4.2

12. ANS:
14 N, upward

Given
$F_{g,1}$ = 6 N
$F_{g,2}$ = 8 N
$F_{g,3}$ = 15 N

Solution
$$F_{net,y} = \Sigma F_y = F_n - F_{g,1} - F_{g,2} = 0$$
$$F_n = F_{g,1} + F_{g,2} = 6 \text{ N} + 8 \text{ N} = 14 \text{ N}$$
$\mathbf{F_n}$ = 14 N, upward

PTS: 1 DIF: IIIA OBJ: 4-4.2

13. ANS:

0.77

Given
$F_{applied} = 177$ N
$F_g = 230$ N

Solution
$\Sigma F_y = F_n - F_g = 0$

$F_n = F_g$

$\Sigma F_x = F_{applied} - F_{s,max} = 0$

$F_{s,max} = F_{applied}$

$$\mu_k = \frac{F_{s,max}}{F_n} = \frac{F_{applied}}{F_g} = \frac{177\text{N}}{230\text{ N}} = 0.77$$

PTS: 1 DIF: IIIB OBJ: 4-4.4

14. ANS:
0.28

Given
$F_g = (5)(1.2\text{ N}) = 6.0$ N
$F_{applied} = 1.7$ N

Solution
$F_{net,y} = F_n - F_g = 0$

$F_n = F_g$

$F_{net,x} = F_{applied} - F_f = 0$

$F_{applied} = F_f$

$$\mu_k = \frac{F_f}{F_n} = \frac{F_{applied}}{F_g} = \frac{1.7\text{ N}}{6.0\text{ N}} = 0.28$$

PTS: 1 DIF: IIIA OBJ: 4-4.4

15. ANS:
3.9 N

Given
$m = 0.86$ kg
$\mu_k = 0.46$
$g = 9.81\text{ m/s}^2$

Solution

$F_{net,y} = F_n - F_g = 0$

$F_n = F_g$

$F_{net,x} = F_{applied} - F_f = 0$

$F_{applied} = F_f$

$F_f = \mu_k F_n = \mu_k F_g = \mu_k mg = (0.46)(0.86\ \text{kg})(9.81\ \text{m/s}^2) = 3.9\ \text{N}$

$F_{applied} = F_f = 3.9\ \text{N}$

PTS: 1 DIF: IIIA OBJ: 4-4.4

16. ANS:
135 N

Given
$F_g = 240\ \text{N}$
$\theta = 14.7°$
$\mu_k = 0.32$

Solution
$F_{net,y} = \Sigma F_y = F_n - F_{g,y} = 0$
$F_n = F_{g,y} = F_g \cos\theta$
$F_{net,x} = \Sigma F_x = F_{applied} - F_f - F_{g,x} = 0$
$F_{applied} = F_f + F_{g,x}$
$F_f = \mu_k F_n = \mu_k F_g \cos\theta = (0.32)(240\ \text{N})(\cos 14.7°)$

$F_f = (0.32)(240\ \text{N})(0.967)$
$F_f = 74\ \text{N}$
$F_{g,x} = F_g \sin\theta = (240\ \text{N})(\sin 14.7°)$

$F_{g,x} = F_g \sin\theta = (240\ \text{N})(0.254)$

$F_{g,x} = 61\ \text{N}$
$F_{applied} = F_f + F_{g,x} = 74\ \text{N} + 61\ \text{N} = 135\ \text{N}$

PTS: 1 DIF: IIIB OBJ: 4-4.4

17. ANS:
0.131

Given
$m = 1.00 \times 10^2\ \text{kg}$
$a_x = 0.79\ \text{m/s}^2$
$\theta = 12.0°$
$g = 9.81\ \text{m/s}^2$

Solution

$$\Sigma F_y = F_n - F_{g,y} = 0$$

$$F_n = F_{g,y} = mg\cos\theta$$

$$\Sigma F_x = F_{g,x} - F_f = F_{net,x} = ma_x$$

$$F_f = F_{g,x} - ma_x$$

$$F_f = \mu_k F_n = \mu_k mg\cos\theta$$

$$F_{g,x} - ma_x = \mu_k mg\cos\theta$$

$$F_{g,x} = mg\sin\theta$$

$$\mu_k = \frac{F_{g,x} - ma_x}{mg\cos\theta} = \frac{mg\sin\theta - ma_x}{mg\cos\theta} = \frac{\sin\theta}{\cos\theta} - \frac{a_x}{g\cos\theta}$$

$$\mu_k = \frac{\sin 12.0°}{\cos 12.0°} - \frac{0.79\ \text{m/s}^2}{(9.81\ \text{m/s}^2)(\cos 12.0°)}$$

$$\mu_k = \frac{0.208°}{0.978} - \frac{0.79\ \text{m/s}^2}{(9.81\ \text{m/s}^2)(0.978)}$$

$$\mu_k = 0.213 - 0.082$$

$$\mu_k = 0.131$$

PTS: 1 DIF: IIIC OBJ: 4-4.4

18. ANS:
0.337

Given:
$v_{x,i}$ = 19.0 m/s
Δx = 136 m
θ = 26.0°
g = 9.81 m/s^2

Solution
Choose a coordinate system such that the positive *x*-direction is down the ski slope. The force of friction will be in the negative *x*-direction.

Because $\Sigma F_y = 0$, $F_n = F_{g,y} = mg\cos\theta$

$$F_f = \mu_k F_n = \mu_k mg\cos\theta$$

$$\Sigma F_x = F_{net,x} = F_{g,x} - F_f = ma_x$$

Because $v_{x,f} = 0$, $a_x = \left(\dfrac{(v_{x,i})^2}{2\Delta x}\right)$

$$F_{net,x} = ma_x = m\left(\frac{(v_{x,i})^2}{2\Delta x}\right)$$

$$F_{g,x} = F_g \sin\theta = mg\sin\theta$$

$$F_f = F_{g,x} - F_{net,x}$$

$$\mu_k mg\cos\theta = mg\sin\theta - m\left(\frac{(v_{x,i})^2}{2\Delta x}\right)$$

$$\mu_k = \frac{\sin\theta}{\cos\theta} - \frac{(v_{x,i})^2}{2g\Delta x\cos\theta}$$

$$\mu_k = \frac{\sin 26.0^\circ}{\cos 26.0^\circ} - \frac{(19.0\ \text{m/s})^2}{2(9.81\ \text{m/s}^2)(136\ \text{m})(\cos 26.0^\circ)}$$

$$\mu_k = \frac{0.438}{0.899} - \frac{361\ \text{m}^2/\text{s}^2}{2(9.81\ \text{m/s}^2)(136\ \text{m})(0.899)}$$

$$\mu_k = 0.487 - 0.150$$

$$\mu_k = 0.337$$

PTS: 1 DIF: IIIC OBJ: 4-4.4