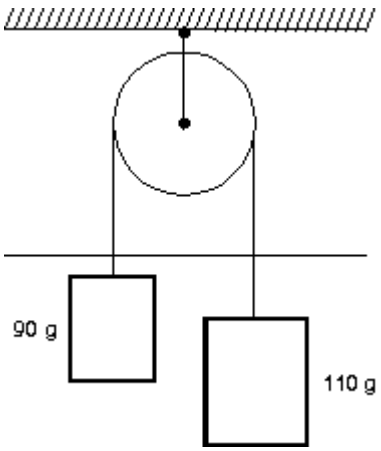
1. A 25-kg crate is pushed across a horizontal floor with a force of 90 N, directed 20° below the horizontal. The coefficient of kinetic friction between the crate and floor is 0.18. The acceleration of the crate is:
   A) 0.27 m/s^2
   B) 0.75 m/s^2
   C) 0.80 m/s^2
   D) 1.4 m/s^2
   E) None of these

2. A crane operator lowers a 16,000 N steel ball with a downward acceleration of 3 m/s^2. The tension in the cable, rounded to the nearest 1000 N, is:
   A) 4900 N
   B) 11,000 N
   C) 16,000 N
   D) 21,000 N
   E) None of these

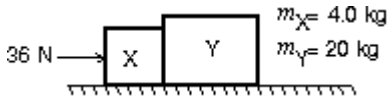
3. A sled is on an icy (frictionless) slope that makes an angle of 30° above the horizontal. When a 40-N force, parallel to the incline and directed up the incline, is applied to the sled, the acceleration of the sled is 2.0 m/s^2, down the incline.. The mass of the sled is:
   A) 3.8 kg
   B) 4.1 kg
   C) 13.8 kg
   D) 6.2 kg
   E) None of these

4. Two blocks, one having a mass of 90 grams, and the other having a mass of 110 grams, are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is:



A) 0.49 m/s^2
B) 0.20 m/s^2
C) 0.78 m/s^2
D) 0.98 m/s^2
E) None of these

5. Block X (4 kg) and Block Y (20 kg) are in contact on a rough horizontal surface. A 36-N constant force is applied to X as shown. The coefficient of kinetic friction between the blocks and the surface is 0.10. The magnitude of the force Block Y exerts on Block X is:

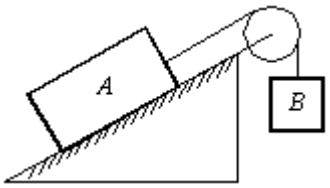


A) 15.5 N
B) 6.5 N
C) 29.2 N
D) 10.4 N
E) None of these

6. A horizontal force of 5.0 N pushes a 0.50-kg block against a vertical wall. The block is initially at rest. If μ_s = 0.60 and μ_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) None of these

7. 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 0.40, in what direction above the horizontal should the force be applied to obtain the greatest acceleration?
   A) zero degrees
   B) 22°
   C) 30°
   D) 27°
   E) None of these

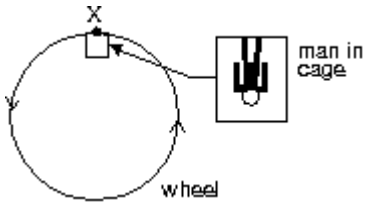
8. Block A, with a mass of 10 kg, is moving downward along a 30° incline. The coefficient of kinetic friction is 0.12. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 3.0 kg, is attached to the dangling end of the string. The magnitude of the acceleration of B is:



   A) 0.5 m/s^2
   B) 0.7 m/s^2
   C) 1.8 m/s^2
   D) 2.1 m/s^2
   E) None of these

9. An object moves at the end of a string in a horizontal circle. The tension in the string is 800 N. If the mass of the object were tripled, the speed halved and the length of the string length unchanged, then the new tension in the string would be
   A) 600 N
   B) 400 N
   C) 300 N
   D) 200N
   E) None of these

10. A giant wheel, having a radius of 20 m, is fitted with a cage and platform on which a man of mass 80 kg stands. The wheel is rotated in a vertical plane at 15 revolutions per minute. What radial force does the man exert on the cage? (Answers are rounded to the nearest 100N.)



A) 1140 N
B) 1480 N
C) 3160 N
D) 4880 N
E) None of these

11. An object of mass m = 8 kg is moving at 5.0 m/s along the x-axis. When it reaches x = 0, it experiences a net force that varies with location according to the equation, $F(x) = 5x + 3x^2$. What will be the object's speed when it reaches x = 3.0 m?
A) 8.4 m/s
B) 5.4 m/s
C) 6.1 m/s
D) 7.3 m/s
E) None of these

12. A baseball player catches a ball of mass m that is moving toward him with speed v. While bringing the ball to rest, her hand moves back a distance *d.* Assuming constant deceleration, the horizontal force exerted on the ball by her hand is:
A) mv/d
B) mvd
C) $mv^2/(2d)$
D) 2mv/d
E) None of these

13. An ideal (massless) spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 0.06 m from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 0.10 m. During the additional stretching from 0.06 m to 0.16 m, the work done by the spring on the mass is:
    A) –3.6 J
    B) –3.3 J
    C) –3.4 J
    D) -3.5 J
    E) None of these

14. A 4.0 kg crate is at rest 2.0 m above the top of a spring with spring constant of 400 N/m. It then falls onto the spring, compressing it. At its greatest compression the reading on the scale is about
    A) 180N
    B) 320 N
    C) 550 N
    D) 290 N
    E) None of these

15. A conservative force is given by the function $F(x) = 3x - 4x^2$, where F is in newtons, and x is in meters. What the potential energy of a particle under the influence of this force at the point x = 0.80 m, assuming that the potential energy is zero at x = 0?
    A) 0.31 J
    B) -1.41 J
    C) -0.28 J
    D) 1.12 J
    E) None of these

16. A 0.025-kg ball is released from rest 80 m above the surface of the Earth. During the fall the total internal energy (heat energy) of the ball and air increases due to friction. The speed of the ball upon impact with the ground is 33 m/s. What was the approximate internal energy increase of the ball and air?
    A) 6 J
    B) 8 J
    C) 12 J
    D) 15 J
    E) None of these

17. The center of mass of an isolated system does not change, even though parts of that system may change location. Consider the case of an ice-boat initially at rest on ice. The boat is uniform, 12 feet long, and has a mass of 60 kg. At one end is a person having a mass of 80 kg, and at the other end is a person having a mass of 50 kg. The persons stand and walk to the opposite ends of the boat, thereby exchanging positions, and after sitting down, the boat is once again at rest. How far did the boat move during this time?
    A) 2.8 ft
    B) 2.2 ft
    C) 1.8 ft
    D) 1.5 ft
    E) None of these

18. A net force acting on a 40-kg object varies with time according to the equation, $F(t) = 3t + 5t^2$, where F is in newtons, and t is in seconds. What is the approximate change in momentum (in kg-m/s)of the object during the time beginning at t = 1.5 s and ending at time t = 2.2 s?
    A) 16
    B) 20
    C) 24
    D) 36
    E) None of these

19. Blocks A and B are moving toward each other along the x axis. A has a mass of 2.0 kg and a velocity of 50 m/s, while B has a mass of 4.0 kg and a velocity of –25 m/s. They suffer an elastic collision and move off along the *x* axis. The kinetic energy transferred from A to B during the collision is:
    A) 0
    B) 2500 J
    C) 5000 J
    D) 7500 J
    E) 10000 J

20. An 800-kg automobile is traveling east toward an intersection at 10 m/s as a 500-kg automobile is traveling north toward the intersection at 15 m/s. The two automobiles collide inelastically and stick together. The combined wreck moves along an angle that is 30 degrees north of east, i.e., along the line that's 30 degrees above the x-axis.. What is the speed of the wreck just after collision?
    A) 4.54 m/s
    B) 5.69 m/s
    C) 7.34 m/s
    D) 8.44 m/s
    E) None of these

Answer Key

1. D
2. B
3. C
4. D
5. D
6. B
7. B
8. B
9. A
10. C
11. C
12. C
13. A
14. D
15. C
16. A
17. A
18. A
19. A
20. D