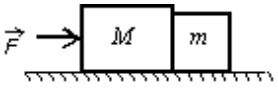
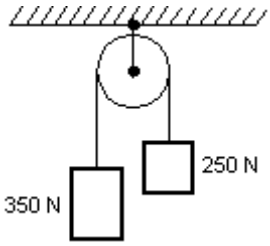
1. A sled is on an icy (frictionless) slope that is 30° above the horizontal. When a 40-N force, parallel to the incline and directed up the incline, is applied to the sled, the acceleration of the sled is 2.0 m/s^2, down the incline. The mass of the sled is:
   A) 3.8 kg
   B) 4.1 kg
   C) 5.8 kg
   D) 10.0 kg
   E) None of these

2. Two blocks with masses m and M are pushed along a horizontal frictionless surface by a horizontal applied force $\vec{F}$ as shown. The magnitude of the force of either of these blocks on the other is:



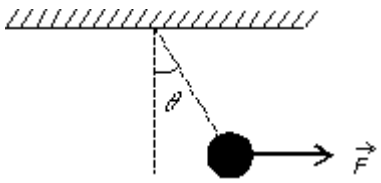
   A) mF/(m + M)
   B) mF/M
   C) mF/(M – m)
   D) MF/(M + m)
   E) None of these

3. 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:



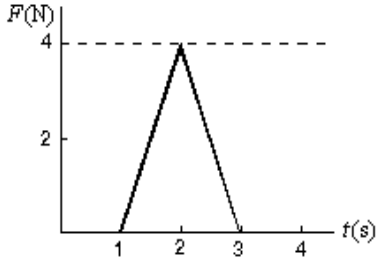
   A) 210 N
   B) 290 N
   C) 410 N
   D) 500 N
   E) None of these

4. 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 θ
B) 2/cos θ
C) $\sqrt{5}$
D) 1
E) none of these

5. A 5-kg object can move along the x axis. It is subjected to a force $\vec{F}$ in the positive x direction; a graph of F as a function of time t is shown below. The change in the velocity of the object is:

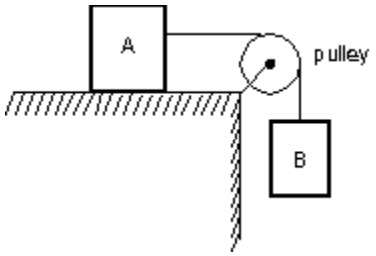


A) 0.8 m/s
B) 1.1 m/s
C) 1.6 m/s
D) 2.3 m/s
E) None of these

6. A student's life was saved in an automobile accident because an air bag expanded in front of his head. If the car had not been equipped with an air bag, the windshield would have stopped the motion of his head in a much shorter time. Compared to the windshield, the air bag:
A) causes a much smaller change in momentum
B) exerts a much smaller impulse
C) causes a much smaller change in kinetic energy
D) exerts a much smaller force
E) does much more work

7. A 2-kg cart, traveling with a speed of 3 m/s, collides with a stationary 4-kg cart. The carts stick together. The impulse exerted by one cart on the other has a magnitude (in N-s) of:
   A) 0
   B) 4
   C) 6
   D) 9
   E) 12

8. Block A, with a mass of 50 kg, rests on a horizontal table top. The coefficient of static friction is 0.40. A horizontal string is attached to A and passes over a massless, frictionless pulley as shown. The smallest mass (in kg) 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
   B) 30
   C) 40
   D) 50
   E) None of these

9. Circular freeway entrance and exit ramps are commonly banked to handle a car moving at 13 m/s. To design a similar ramp for 26 m/s one should:
   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 $\sqrt{2}$

10. The power output of a machine is varying with time according to the equation, P(t) = 3t + 20, where P is in watts, and t is in seconds. At time t =0 the machines begins to do work on a 4 kg object initially at rest. What will be the object's speed four seconds later, in m/s?
    A) 5.06
    B) 6.54
    C) 7.21
    D) 8.04
    E) None of these

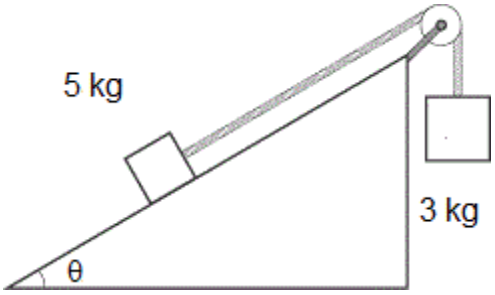
11. A 0.50-kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. When the spring is 0.04 m longer than its equilibrium length, the speed of the block is 0.50 m/s. The greatest speed of the block (in m/s) is:
    A) 0.23
    B) 0.32
    C) 0.55
    D) 0.78
    E) None of these

12. The potential energy of a 0.35-kg particle moving along the x axis is given by

    $U(x) = 8x^2 + 2x^4$.

    When the particle is at $x = 0.5$ m its magnitude of its acceleration is:
    A) 0
    B) 1.2 m/s^2
    C) 8.6 m/s^2
    D) 20.0 m/s^2
    E) None of these

13.



The coefficient of static friction between the block and the inclined plane in the figure is 0.20. What is the least angle θ at which the blocks will remain stationary?

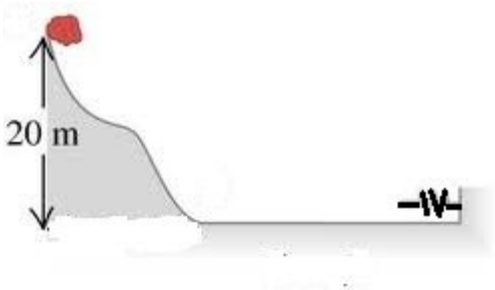
A) 18.7
B) 36.5
C) 21.3
D) 24.7
E) None of these

14. An object of mass 2 kg is moving to the left in one dimension with a velocity of -9.0 m/s. At that moment (at time t =0) a time-dependent force given by F(t) = 4t, where F is in newtons, and t is in seconds, begins to act on the object. What will be its velocity (in m/s) 3.0 seconds later?

A) zero
B) 4.0
C) 5.1
D) 5.5
E) None of these

15. A mass m moving to the right with velocity v collides head-on with a stationary object of mass 2 m. The collision is elastic. What will be the velocity of the heavier object after collision?

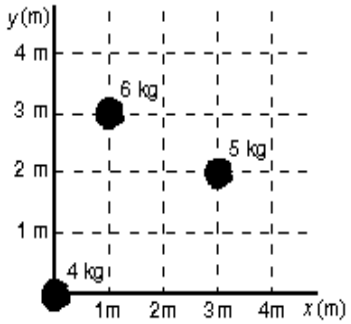
A) 3v/4
B) 2v/3
C) v/3
D) v/2
E) None of these

16. 

An object of mass 10 kg slides without friction down the hill in the figure, then slides without friction across the horizontal surface toward the spring. The spring constant is 1000 N/m. By how much (in meters) with the spring be compressed when the object's speed has been slowed by the spring to 11.80 m/s?

A) 0.68
B) 1.59
C) 2.02
D) 2.11
E) None of these

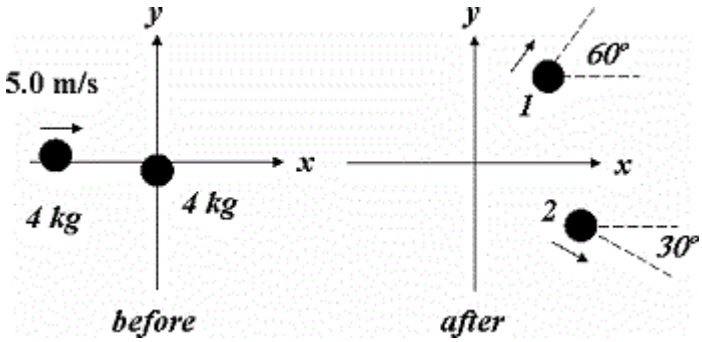
17. The *x* and *y* coordinates in meters of the center of mass of the three-particle system shown below are:



A) 0, 0
B) 1.3 m, 1.7 m
C) 1.4 m, 1.9 m
D) 1.9 m, 2.5 m
E) 1.4 m, 2.5 m

18. A 3.00-g bullet traveling horizontally at 400 m/s hits a 3.00-kg wooden block, which is initially at rest on a smooth horizontal table. The bullet buries itself in the block without passing through. The speed of the block after the collision is:

A) 1.33 m/s
B) 0.40 m/s
C) 12.0 m/s
D) 40.0 m/s
E) 160 m/s

19. 

An inelastic two-dimensional collision between two objects of equal mass occurs as shown in the figure. What is the speed (in m/s) of the object moving into the first quadrant, the one labeled "1"?

A) 3.33
B) 2.50
C) 3.25
D) 2.12
E) None of these

20. An object of mass 4 kg is moving at x = 0 in one dimension at a velocity of 5 m/s when a net force given by $F(x) = 5xe^x$ begins to act on the object. What will be the object's velocity (in m/s) 1.4 seconds later?

A) 5.62
B) 6.01
C) 3.12
D) 7.44
E) None of these

Answer Key

1. E
2. A
3. B
4. C
5. A
6. D
7. B
8. A
9. C
10. C
11. D
12. D
13. D
14. A
15. B
16. *(No Answer Provided)*
17. C
18. B
19. B
20. A