

PART I: MULTIPLE CHOICE QUESTIONS

Choose the best answer for Questions 1-15 below. Mark your answer on your scantron form using a #2 pencil.

1. A 55.0-kg box rests on a horizontal surface. The coefficient of static friction between the box and the surface is 0.300. A horizontal force of 156 N is applied to the box. Does the box move?

- a) Yes
- b) No

2. A truck travels with constant speed around a flat circular turn of radius 45.0 m. If the coefficient of static friction between the truck's tires and the road is 0.975, what is the maximum speed the truck can have without skidding?

- a) 113 m/s
- b) 49.0 m/s
- c) 12.9 m/s
- d) 20.7 m/s
- e) 72.3 m/s

3. A traffic light hangs suspended in equilibrium by two cables, as shown in Figure 1. The tension in the cable on the left is 34.6 N and the tension in the cable on the right is 60.0 N, as shown in the figure. What is the weight of the traffic light?

- a) 78.9 N
- b) 42.1 N
- c) 19.5 N
- d) 89.7 N
- e) 69.3 N

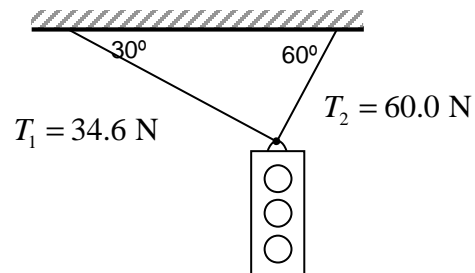


Fig. 1.

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4. A child swings a yo-yo of mass 0.0750 kg in a horizontal circle of radius 0.100 m, as shown in Figure 2. The yo-yo's string makes an angle of 30.0° with the vertical, as shown in the figure. If the tension in the string is 0.849 N, what must be the tangential speed of the yo-yo?

- a) 0.893 m/s
- b) 0.490 m/s
- c) 0.129 m/s
- d) 0.207 m/s
- e) 0.752 m/s

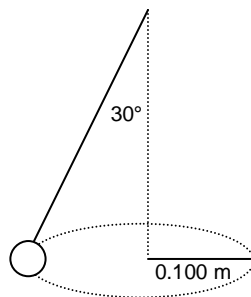


Fig. 2

5. A tow rope aligned parallel to the water pulls a water skier horizontally for a distance of 86.0 m. The work done by the tension in the rope is 1.90×10^4 J. Find the magnitude of the tension.

- a) 100 N
- b) 9.80 N
- c) 220 N
- d) 135 N
- e) 307 N

6. A 5.0×10^4 -kg space probe is traveling at a speed of 11,000 m/s through deep space. Retrorockets are fired along the line of motion to reduce the probe's speed. The retrorockets generate a force of 4.0×10^5 N over a distance of 2500 km. What is the final speed of the probe?

- a) zero
- b) 9.0×10^3 m/s
- c) 2.5×10^3 m/s
- d) 1.3×10^4 m/s
- e) 1.2×10^3 m/s

7. Jill pushes a 75.0-N crate up a ramp 12.0 m in length and inclined at an angle of 17.0° above the horizontal. What is the change in the gravitational potential energy of the crate?

- a) +263 J
- b) -263 J
- c) zero
- d) +861 J
- e) -861 J

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8. A child rides a sled in wintertime down a hill icy enough to be regarded as a frictionless hill. If the child and sled start from rest at the top of the hill and have a speed of 5.00 m/s at the bottom of the hill, what is the height of the hill? Let the combined mass of the child and sled be m .
- a) 4.80 m
 - b) 1.28 m
 - c) 0.523 m
 - d) 5.40 m
 - e) 9.62 m
9. A 1.70-kg block slides on a horizontal, frictionless surface until it encounters a spring with spring constant $k = 955$ N/m. The block comes to rest after compressing the spring a distance of 4.60 cm. Find the speed of the block just before it came into contact with the spring. (Ignore air resistance.)
- a) 1.09 m/s
 - b) 0.00 m/s
 - c) 2.39 m/s
 - d) 0.560 m/s
 - e) 0.750 m/s
10. The spring constant for a spring in a dart gun is 1400 N/m. When the gun is cocked, the spring is compressed 0.075 m from its relaxed length. What is the speed of a 0.024-kg dart when it leaves the gun if the gun is fired horizontally? (Neglect all friction forces.)
- a) 12 m/s
 - b) 15 m/s
 - c) 18 m/s
 - d) 21 m/s
 - e) 24 m/s
11. In preparation for shooting a ball in a pinball machine, a spring ($k = 675$ N/m) is compressed 0.0650 m from its relaxed length. The ball ($m = 0.0585$ kg) is at rest against the spring at Point A. When the spring is released, the ball slides (without rolling and without colliding with other objects) to Point B, which is 0.300 m higher than Point A. How fast is the ball moving at B? (Neglect all friction forces.)
- a) 3.28 m/s
 - b) 9.26 m/s
 - c) 6.55 m/s
 - d) 10.2 m/s
 - e) 12.3 m/s

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12. If the mass and velocity of an object are doubled, the kinetic energy is increased by a factor of:

- a) zero
- b) 8
- c) 2
- d) 9
- e) 27

13. Complete the following sentence: The (linear) **momentum** of a system is **conserved** when:

- a) the moon is full.
- b) the mass is not changing.
- c) the work that the net external force does on the system is independent of the path.
- d) there are no non-conservative forces doing any work on the system.
- e) the net external force on the system is zero.

14. Two ice skaters stand at rest in the center of an ice rink. When they push off against one another the 45-kg skater acquires a speed of 0.62 m/s. If the speed of the other skater is 0.89 m/s, what is this skater's mass? Ignore the force of friction between the skates and the ice.

- a) 31 kg
- b) 45 kg
- c) 55 kg
- d) 40 kg
- e) 60 kg

15. A marble of mass 6.40 g moving to the right with speed 0.450 m/s undergoes a head-on elastic collision with a second marble of mass 2.30 g that is initially at rest. What is the speed of the 6.40-g marble just after the collision?

- a) 0.212 m/s
- b) 0.0545 m/s
- c) 0.550 m/s
- d) 0.102 m/s
- e) 0.351 m/s

PART II: FREE-RESPONSE (“SHOW-YOUR-WORK”) QUESTIONS

For Questions 16-18, write your answers in the space provided. If you need additional space, you may write on the backs of these pages or ask for scratch paper. **Be sure to show all of your work.**

16. A 3.50-kg block on a smooth tabletop is attached by a string to a hanging block of mass 2.80 kg, as shown in Figure 3. The blocks are released from rest and allowed to move freely. The pulley is essentially an *ideal pulley*. That is, its mass is negligibly small and it rotates without friction. Also, ignore air resistance.

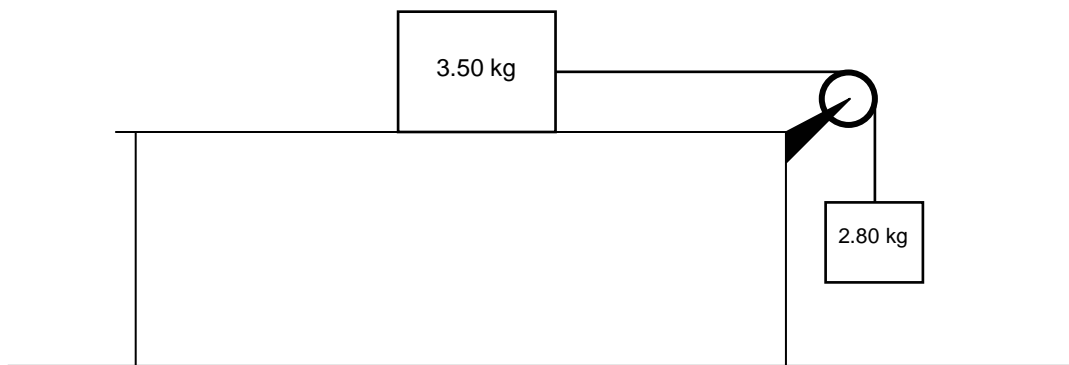


Figure 3

- (a.) Is the tension in the string greater than, less than, or equal to the weight of the hanging mass?
- (b.) Find the acceleration of the blocks and the tension in the string.

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17. A block of mass m slides from rest on a frictionless loop-the-loop track of radius $r = 0.25$ m , as shown in Figure 4.

- (a.) If the block is released from a height of 0.75 m, what is the speed of the block at the top of the loop?
- (b.) If the mass of the block is 0.010 kg, what is the normal force that the track exerts on the block at the moment when the block is at the top of the loop?

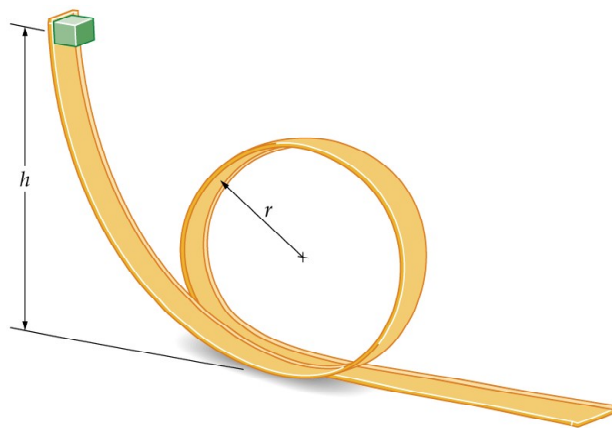


Fig. 4

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18. Figure 5 shows a collision between two pucks on an air-hockey table. Puck A has a mass of 0.025 kg and is moving along the x axis with a velocity of +5.5 m/s. It makes a collision with Puck B, which has a mass of 0.050 kg and is initially at rest. After the collision, the two pucks fly apart with the angles shown in the drawing. Find the final speeds of the two pucks.

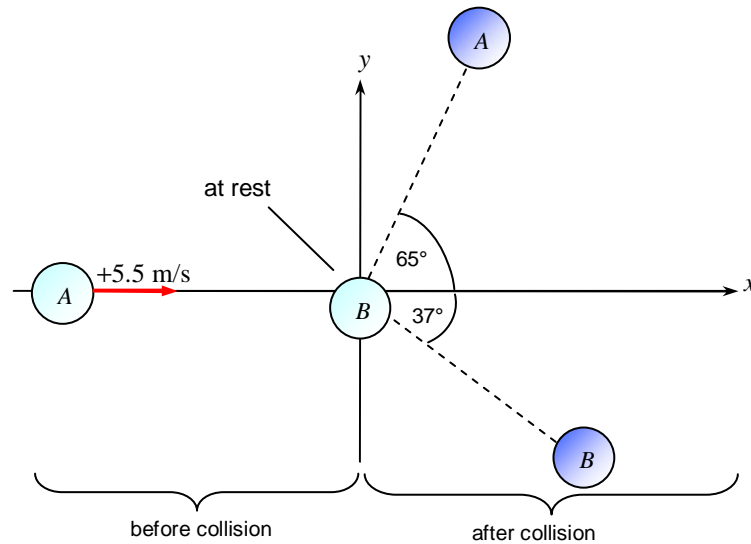


Fig. 5