Answers

1. 35 g
2. (a) 2.74×10^3 N [up]
   (b) 35 kg
3. (a) 1.55 m/s^2
   (b) 295 N
4. 1.2 kg
5. (a) 4.8 m/s^2
   (b) 19 N
6. (a) 194 N
   (b) 2.4 N
   (c) 0.79 m/s
   (d) 2.9 N
7. (a) 6.2×10^2 N
   (b) 2.0 m/s^2
8. (b) $mg - F_A \sin\theta$
   (c) $F_A \cos\theta$

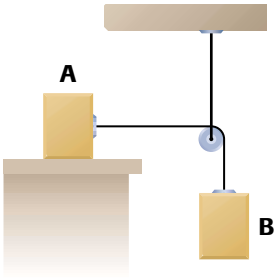

Figure 6
For question 5

Practice

Understanding Concepts

1. You apply a force of 0.35 N [up] to lift a fork. The resulting acceleration of the fork is 0.15 m/s^2 [up]. Determine the mass of the fork in grams.

2. A hot-air balloon experiences an acceleration of 1.10 m/s^2 [down]. The total mass of the balloon, the basket, and the contents of the basket is 315 kg.
(a) What is the upward (buoyant) force on the system?
(b) The balloonist wishes to change the acceleration to zero. There is no fuel left to heat the air in the balloon. Determine the mass of the ballast that must be discarded overboard. (Neglect air resistance.)

3. A tree house has a vertical "fire pole" of smooth metal, designed for quick exits. A child of mass 35.7 kg slides down the pole with constant acceleration, starting from rest. The pole is 3.10 m high. The journey to the ground takes 2.00 s.
(a) What is the magnitude of the downward acceleration of the child?
(b) What is the magnitude of the upward force of friction exerted by the pole on the child?

4. When an external net force is applied to a particular mass m, an acceleration of magnitude "a" results. When the mass is increased by 2.0 kg and the same net force is applied, the acceleration is $0.37a$. Determine the mass, m.

5. Blocks A and B are connected by a string passing over an essentially frictionless pulley, as in **Figure 6**. When the blocks are in motion, Block A experiences a force of kinetic friction of magnitude 5.7 N. If $m_A = 2.7$ kg and $m_B = 3.7$ kg, calculate the magnitude of
(a) the acceleration of the blocks
(b) the tension in the string

6. A boy pushes a lawn mower ($m = 17.9$ kg) starting from rest across a horizontal lawn by applying a force of 32.9 N straight along the handle, which is inclined at an angle of 35.1° above the horizontal. The magnitude of the mower's acceleration is 1.37 m/s^2, which lasts for 0.58 s, after which the mower moves at a constant velocity. Determine the magnitude of
(a) the normal force on the mower
(b) the frictional force on the mower
(c) the maximum velocity of the mower
(d) the force applied by the boy needed to maintain the constant velocity

7. A skier ($m = 65$ kg) glides with negligible friction down a hill covered with hard-packed snow. If the hill is inclined at an angle of 12° above the horizontal, determine the magnitude of
(a) the normal force on the skier
(b) the skier's acceleration (*Hint:* Remember to choose the $+x$ direction as the direction of the acceleration, which in this case is downward, parallel to the hillside.)

Applying Inquiry Skills

8. Groups of physics students are each given a force scale (to measure an applied force of magnitude F_A), an electronic balance (to measure the mass, m), a rectangular wooden block with a hook at one end, a protractor, and a piece of string. Each group must determine the force of kinetic friction acting on the block as it is pulled with a constant velocity along a horizontal lab bench. However, the applied force must be at an angle θ above the horizontal.
(a) Draw a system diagram and an FBD of the block for this investigation.
(b) Derive an equation for the magnitude of the normal force on the block in terms of the given parameters F_A, g, m, and θ.
(c) Derive an equation for the magnitude of friction on the block in terms of F_A and θ.

Making Connections

9. A physics student of mass 55.3 kg is standing on a weigh scale in an elevator. The scale shows the magnitude of the upward normal force (in newtons) on the student.

(a) Determine the reading on the scale when the elevator has an acceleration of 1.08 m/s^2 [up].

(b) The force calculated in (a) can be called the "apparent weight." How does the student's apparent weight in this case compare with the true weight? What happens to the apparent weight when the elevator is undergoing downward acceleration? undergoing free fall?

(c) To check your answers in (b), determine the student's apparent weight when the elevator has first a downward acceleration of 1.08 m/s^2, then a downward acceleration of 9.80 m/s^2.

(d) The term "weightless" is used to describe a person in free fall. Why is this term used? Is the term valid from the physics point of view? Explain your answer.

(e) Repeat (a) when the elevator has a constant velocity of 1.08 m/s [up].

Answers

9. (a) 602 N
   (c) 482 N; 0 N
   (e) 542 N

Practice

Understanding Concepts

10. A train consisting of two cars pulled by a locomotive experiences an acceleration of 0.33 m/s^2 [fwd]. Friction is negligible. Each car has a mass of 3.1×10^4 kg.
(a) Determine the force exerted by the first car on the second car.
(b) Determine the force exerted by the locomotive on the first car.

11. Two books are resting side by side, in contact, on a desk. An applied horizontal force of 0.58 N causes the books to move together with an acceleration of 0.21 m/s^2 horizontally. The mass of the book to which the force is applied directly is 1.0 kg. Neglecting friction, determine
(a) the mass of the other book
(b) the magnitude of the force exerted by one book on the other

Answers

10. (a) 1.0×10^4 N [fwd]
    (b) 2.0×10^4 N [fwd]
11. (a) 1.8 kg
    (b) 0.37 N

Section 2.3 Questions

Understanding Concepts

1. A basketball is thrown so that it experiences projectile motion as it travels toward the basket. Air resistance is negligible. Draw an FBD of the ball (a) as it is rising, (b) as it arrives at the top of its flight, and (c) as it moves downward.

2. A shark, of mass 95 kg, is swimming with a constant velocity of 7.2 m/s [32° above the horizontal]. What is the net force acting on the shark?

3. **Figure 8** shows three masses (5.00 kg, 2.00 kg, and 1.00 kg) hung by threads.
   (a) Draw an FBD for the bottom mass. Determine the magnitude of the tension in the lowest thread.
   (b) Repeat (a) for the middle mass and the tension in the middle thread.
   (c) Repeat (a) for the top mass and the tension in the highest thread.

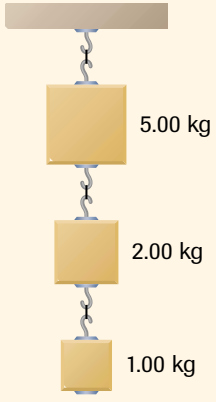

Figure 8

4. Just after a space shuttle is launched (**Figure 9**), its acceleration is about $0.50g$ [up]. The shuttle's mass, including fuel, is approximately 2.0×10^6 kg.
   (a) Calculate the approximate magnitude of the upward force on the shuttle.
   (b) What causes the upward force?

Figure 9
The space shuttle *Endeavour* is launched carrying astronauts to the International Space Station.

5. Two boxes, of masses $m_1 = 35$ kg and $m_2 = 45$ kg, are hung vertically from opposite ends of a rope passing over a rigid horizontal metal rod. The system starts moving from rest. Assuming that friction between the rod and the rope is negligible, determine the magnitude of
   (a) the acceleration of the boxes
   (b) the tension in the rope
   (c) the magnitude of each box's displacement after 0.50 s

6. Two blocks are held in place by three ropes connected at point P, as shown in **Figure 10**. The magnitude of the force of static friction on block A is 1.8 N. The magnitude of the force of gravity on blocks A and B is 6.7 N and 2.5 N, respectively.

(a) Draw an FBD for block B. Determine the magnitude of the tension in the vertical rope.

(b) Draw an FBD for block A. Determine the magnitudes of the tension in the horizontal rope and of the normal force acting on block A.

(c) Draw an FBD of point P. Calculate the tension (the magnitude and the angle θ) in the third rope.

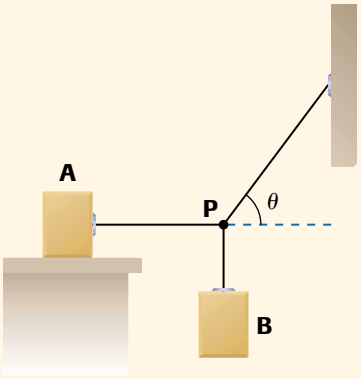

Figure 10

7. A store clerk pulls three carts connected with two horizontal cords (**Figure 11**) to move products from the storage room to the display shelves. The masses of the loaded carts are: $m_1 = 15.0$ kg; $m_2 = 13.2$ kg; and $m_3 = 16.1$ kg. Friction is negligible. A third cord, which pulls on cart 1 and is at an angle of 21.0° above the horizontal, has a tension of magnitude 35.3 N. Determine the magnitude of

(a) the acceleration of the carts

(b) the tension in the last cord

(c) the tension in the middle cord

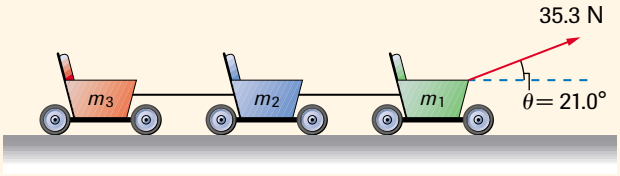

Figure 11

8. A hotel guest starts to pull an armchair across a horizontal floor by exerting a force of 91 N [15° above the horizontal]. The normal force exerted by the floor on the chair is 221 N [up]. The acceleration of the chair is 0.076 m/s^2 [fwd].

(a) Determine the mass of the chair.

(b) Determine the magnitude of the friction force on the chair.

9. A child on a toboggan slides down a hill with an acceleration of magnitude 1.5 m/s^2. If friction is negligible, what is the angle between the hill and the horizontal?

10. Blocks X and Y, of masses $m_X = 5.12$ kg and $m_Y = 3.22$ kg, are connected by a fishing line passing over an essentially frictionless pulley (**Figure 12**).

(a) Show that block X slides up the incline with a positive acceleration. Determine the magnitude of that acceleration. Friction is negligible.

(b) Determine the magnitude of the tension in the fishing line.

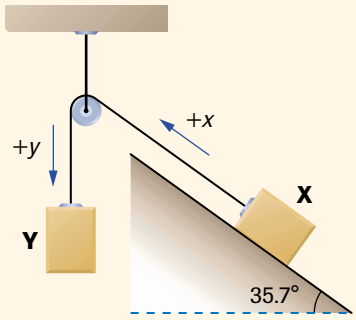

Figure 12

11. A figure skater of mass $m = 56$ kg pushes horizontally for 0.75 s with a constant force against the boards at the side of a skating rink. Having started from rest, the skater reaches a maximum speed of 75 cm/s. Neglecting friction, determine the magnitude of

(a) the (constant) acceleration

(b) the force exerted by the skater on the boards

(c) the force exerted by the boards on the skater

(d) the displacement of the skater from the boards after 1.50 s

Applying Inquiry Skills

12. (a) A constant net force is applied to various masses. Draw a graph of the magnitude of the resulting acceleration as a function of mass.

(b) A variable net force is applied to a constant mass. Draw a graph of the resulting acceleration as a function of the net force.

Making Connections

13. Discuss the physics principles illustrated by the following statement: "In front-end collisions, airbag deployment can pose extreme danger if the passenger is not wearing a seat belt or if the passenger is a small child."