

Name _____

Thinkin' Problems

Answers to Concept Checks

- 4-1 No, the net force is not an actual force. It is the vector sum of the actual forces.
- 4-2 No, it is the net force that causes the acceleration of the mass.
- 4-3 No, they do not.
- 4-4 No. Doing so would be contrary to Newton's third law.
- 4-5 No. Doing away with friction in the bearing is one thing, but the pulley still has mass. A difference in tension is needed in order to change the rate of rotation of the pulley wheel. Pulleys with non-negligible mass are studied in Chapter 8.

Answers to Practice Problems

- 4-1 1.5 kg
- 4-2 0.47 lb
- 4-3 13 cm
- 4-4 3.0 cm
- 4-5 $T = C\sqrt{m/k}$ where C is some dimensionless constant. The correct expression for the period, as we will see in Chapter 14, is $T = 2\pi\sqrt{m/k}$.
- 4-6 1.9 kN
- 4-7 Applying Newton's second law (for y components), we see from the free-body diagram (Figure 4-18) that $\Sigma F_y = ma_y \Rightarrow F_n - F_g \cos \theta = 0$, where we have used that a_y equals zero. Thus, $F_n = F_g \cos \theta$.
- 4-8 $a = 27.8 \text{ m/s}^2$, $\theta = 70.5^\circ$
- 4-9 967 N
- 4-10 (a) $a_t = 0.66g$, (b) $a_t = 0.60g$

Problems

In a few problems, you are given more data than you actually need; in a few other problems, you are required to supply data from your general knowledge, outside sources, or informed estimate.

Interpret as significant all digits in numerical values that have trailing zeros and no decimal points.

For all problems, use $g = 9.81 \text{ m/s}^2$ for the free-fall acceleration due to gravity and neglect friction and air resistance unless instructed to do otherwise.

- Single-concept, single-step, relatively easy
 - Intermediate-level, may require synthesis of concepts
 - Challenging
 - SSM Solution is in the *Student Solutions Manual*
- Consecutive problems that are shaded are paired problems.

CONCEPTUAL PROBLEMS

- 1 • While on a very smooth level transcontinental plane flight, your coffee cup sits motionless on your tray. Are there forces acting on the cup? If so, how do they differ from the forces that would be acting on the cup if it sat on your kitchen table at home?
- 2 • You are passing another car on a highway and determine that, relative to you, the car you pass has an acceleration \vec{a} toward the west. However, the driver of the other car is maintaining a constant speed and direction relative to the road. Is the reference frame of your car an inertial one? If not, in which direction (east or west) is your car accelerating relative to the other car?
- 3 • **CONTEXT-RICH** You are riding in a limousine that has opaque windows that do not allow you to see outside. The car is on a flat horizontal plain, so the car can accelerate by speeding up, slowing down, or turning. Equipped with just a small heavy object on the end of a string, how can you use it to determine if the limousine is changing either speed or direction? Can you determine the limousine's velocity? **SSM**
- 4 •• If only a single nonzero force acts on an object, does the object accelerate relative to all inertial reference frames? Is it possible for such an object to have zero velocity in some inertial reference frame and not in another? If so, give a specific example.

- 5 •• A baseball is acted upon by a single known force. From this information alone, can you tell in which direction the baseball is moving relative to some reference frame? Explain.
- 6 •• A truck moves directly away from you at constant velocity (as observed by you while standing in the middle of the road). It follows that (a) no forces act on the truck, (b) a constant net force acts on the truck in the direction of its velocity, (c) the net force acting on the truck is zero, (d) the net force acting on the truck is its weight.
- 7 • **ENGINEERING APPLICATION** Several space probes have been launched that are now far out in space. *Pioneer 10*, for example, was launched in the 1970s and is still moving away from the Sun and its planets. Is the mass of *Pioneer 10* changing? Which of the known fundamental forces continue to act on it? Does it have a net force on it?
- 8 •• **ENGINEERING APPLICATION** Astronauts in apparent weightlessness during their stay on the International Space Station must carefully monitor their masses because significant loss of body mass is known to cause serious medical problems. Give an example of how you might design equipment to measure the mass of an astronaut on the orbiting space station.
- 9 •• **CONTEXT-RICH** You are riding in an elevator. Describe two situations in which your apparent weight is greater than your true weight. **SSM**

10 •• Suppose you are in a train moving at constant velocity relative to the ground. You toss a ball to your friend several seats in front of you. Use Newton's second law to explain why you cannot use your observations of the tossed ball to determine the train's velocity relative to the ground.

11 •• Explain why, of the fundamental interactions, gravitational interaction is the main concern in our everyday lives. One other on this list also plays an increasingly significant role in our rapidly advancing technology. Which one is that? Why are the others not obviously important?

12 •• Give an example of an object that has three forces acting on it, and (a) accelerates, (b) moves at constant (nonzero) velocity, and (c) remains at rest.

13 •• Suppose a block of mass m_1 rests on a block of mass m_2 and the combination rests on a table as shown in Figure 4-33. Tell the name of the force and its category (contact versus action-at-a-distance) for each of the following forces: (a) force exerted by m_1 on m_2 , (b) force exerted by m_2 on m_1 , (c) force exerted by m_2 on the table, (d) force exerted by the table on m_2 , (e) force exerted by Earth on m_2 . Which, if any, of these forces constitute a Newton's third-law pair of forces? **SSM**

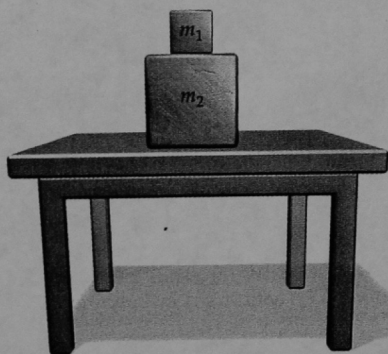


FIGURE 4-33 Problem 13

14 •• **CONTEXT-RICH** You yank a fish you have just caught on your line upward from rest into your boat. Draw a free-body diagram of the fish after it has left the water and as it gains speed as it rises. In addition, tell the type (tension, spring, gravity, normal, friction, etc.) and category (contact versus action-at-a-distance) of each force on your diagram. Which, if any, pairs of the forces on your diagram constitute a Newton's third-law pair? Can you tell the relative magnitudes of the forces on your diagram from the information given? Explain.

15 •• If you gently set a fancy plate on the table, it will not break. However if you drop it from a height, it might very well break. Discuss the forces that act on the plate (as it contacts the table) in both these situations. Use kinematics and Newton's second law to describe what is different about the second situation that causes the plate to break?

16 •• For each of the following forces, give what produces it, what object it acts on, its direction, and the reaction force. (a) The force you exert on your briefcase as you hold it while standing at the bus stop. (b) The normal force on the soles of your feet as you stand barefooted on a horizontal wood floor. (c) The gravitational force on you as you stand on a horizontal floor. (d) The horizontal force exerted on a baseball by a bat as the ball is hit straight up the middle toward center field for a single.

17 •• For each case, identify the force (including its direction) that causes the acceleration. (a) A sprinter at the very start of the race. (b) A hockey puck skidding freely but slowly coming to rest on the ice. (c) A long fly ball at the top of its arc. (d) A bungee jumper at the very bottom of her descent.

18 • True or false:

(a) If two external forces that are both equal in magnitude and opposite in direction act on the same object, the two forces can never be a Newton's third-law pair.

(b) The two forces of a Newton's third-law pair are equal only if the objects involved are not accelerating.

19 •• An 80-kg man on ice skates is pushing his 40-kg son, also on skates, with a force of 100 N. Together, they move across the ice steadily gaining speed. (a) The force exerted by the boy on his father is (1) 200 N, (2) 100 N, (3) 50 N, or (4) 40 N. (b) How do the magnitudes of the two accelerations compare? (c) How do the directions of the two accelerations compare?

20 •• A girl holds a stone in her hand and can move it up or down or keep it still. True or false: (a) The force exerted by her hand on the rock is always the same magnitude as the force of gravity on the stone. (b) The force exerted by her hand on the rock is the reaction force to the force of gravity on the stone. (c) The force exerted by her hand on the stone is always the same magnitude as the force on her hand by the stone, but in the opposite direction. (d) If the girl moves her hand down at a constant speed, then her upward force on the stone is less than the force of gravity on the stone. (e) If the girl moves her hand downward but slows the stone to rest, then the force of the stone on the girl's hand is the same magnitude as the force of gravity on the stone.

21 •• A 2.5-kg object hangs at rest from a string attached to the ceiling. (a) Draw a free-body diagram of the object, indicate the reaction force to each force drawn and tell what object the reaction force acts on. (b) Draw a free-body diagram of the string, indicate the reaction force to each force drawn, and tell what object each reaction force acts on. Do not neglect the mass of the string. **SSM**

22 •• (a) Which of the free-body diagrams in Figure 4-34 represents a block sliding down a frictionless inclined surface? (b) For the correct diagram, label the forces and tell which are contact forces and which are action-at-a-distance forces. (c) For each force in the correct diagram, identify the reaction force, the object it acts on and its direction.

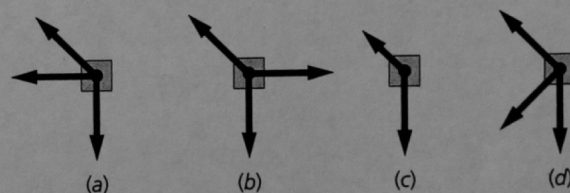


FIGURE 4-34 Problem 22

23 •• A wooden box on the floor is pressed against a compressed, horizontal spring that is attached to a wall. The horizontal floor beneath the box is frictionless. Draw the free-body diagram of the box in the following cases. (a) The box is held at rest against the compressed spring. (b) The force holding the box against the spring no longer exists, but the box is still in contact with the spring. (c) When the box no longer has contact with the spring.

24 •• Imagine yourself seated on a wheeled desk chair at your desk. Consider friction forces between the chair and the floor to be negligible. However, the friction forces between the desk and the floor are not negligible. When sitting at rest, you decide you need