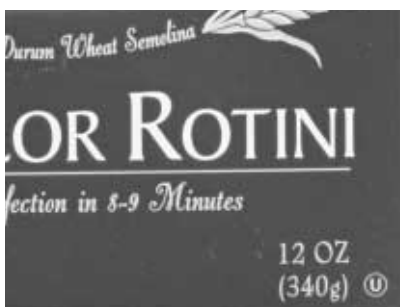


## Chapter 4 continued

55. When you look at the label of the product in **Figure 4-19** to get an idea of how much the box contains, does it tell you its mass, weight, or both? Would you need to make any changes to this label to make it correct for consumption on the Moon?



■ **Figure 4-19**

**The ounces tell you the weight in English units. The grams tell you the mass in metric units. The label would need to read “2 oz” to be correct on the Moon. The grams would remain unchanged.**

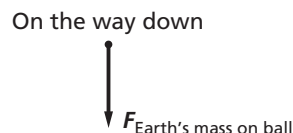
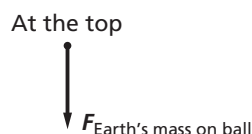
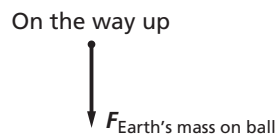
56. From the top of a tall building, you drop two table-tennis balls, one filled with air and the other with water. Both experience air resistance as they fall. Which ball reaches terminal velocity first? Do both hit the ground at the same time?

**The lighter, air-filled table tennis ball reaches terminal velocity first. Its mass is less for the same shape and size, so the friction force of upward air resistance becomes equal to the downward force of  $mg$  sooner. Because the force of gravity on the water-filled table-tennis ball (more mass) is larger, its terminal velocity is larger, and it strikes the ground first.**

57. It can be said that 1 kg equals 2.2 lb. What does this statement mean? What would be the proper way of making the comparison?

**It means that on Earth’s surface, the weight of 1 kg is equivalent to 2.2 lb. You should compare masses to masses and weights to weights. Thus 9.8 N equals 2.2 lb.**

58. You toss a ball straight up into the air.
- Draw a free-body diagram for the ball at three points during its motion: on the way up, at the very top, and on the way down. Specifically identify the forces acting on the ball and their agents.



- What is the velocity of the ball at the very top of the motion?

**0 m/s**

- What is the acceleration of the ball at this same point?

**Because the only force acting on it is the gravitational attraction of Earth,  $a = 9.80 \text{ m/s}^2$ .**

## Mastering Problems

### 4.1 Force and Motion

page 113

#### Level 1

59. What is the net force acting on a 1.0-kg ball in free-fall?

$$\begin{aligned} F_{\text{net}} &= F_g = mg \\ &= (1.0 \text{ kg})(9.80 \text{ m/s}^2) \\ &= 9.8 \text{ N} \end{aligned}$$

## Chapter 4 continued

- 60. Skating** Joyce and Efua are skating. Joyce pushes Efua, whose mass is 40.0-kg, with a force of 5.0 N. What is Efua's resulting acceleration?

$$\begin{aligned}F &= ma \\a &= \frac{F}{m} \\&= \frac{5.0 \text{ N}}{40.0 \text{ kg}} \\&= 0.12 \text{ m/s}^2\end{aligned}$$

- 61.** A car of mass 2300 kg slows down at a rate of 3.0 m/s<sup>2</sup> when approaching a stop sign. What is the magnitude of the net force causing it to slow down?

$$\begin{aligned}F &= ma \\&= (2300 \text{ kg})(3.0 \text{ m/s}^2) \\&= 6.9 \times 10^3 \text{ N}\end{aligned}$$

- 62. Breaking the Wishbone** After Thanksgiving, Kevin and Gamal use the turkey's wishbone to make a wish. If Kevin pulls on it with a force 0.17 N larger than the force Gamal pulls with in the opposite direction, and the wishbone has a mass of 13 g, what is the wishbone's initial acceleration?

$$\begin{aligned}a &= \frac{F}{m} \\&= \frac{0.17 \text{ N}}{0.013 \text{ kg}} \\&= 13 \text{ m/s}^2\end{aligned}$$

### 4.2 Using Newton's Laws pages 113–114

#### Level 1

- 63.** What is your weight in newtons?

$$F_g = mg = (9.80 \text{ m/s}^2)(m)$$

**Answers will vary.**

- 64. Motorcycle** Your new motorcycle weighs 2450 N. What is its mass in kilograms?

$$\begin{aligned}F_g &= mg \\m &= \frac{F_g}{g} = \frac{2450 \text{ N}}{9.80 \text{ m/s}^2} \\&= 2.50 \times 10^2 \text{ N}\end{aligned}$$

- 65.** Three objects are dropped simultaneously from the top of a tall building: a shot put, an air-filled balloon, and a basketball.

- a.** Rank the objects in the order in which they will reach terminal velocity, from first to last.

**balloon, basketball, shot put**

- b.** Rank the objects according to the order in which they will reach the ground, from first to last.

**shot put, basketball, balloon**

- c.** What is the relationship between your answers to parts a and b?

**They are inverses of each other.**

- 66.** What is the weight in pounds of a 100.0-N wooden shipping case?

$$(100.0 \text{ N})\left(\frac{1 \text{ kg}}{9.80 \text{ N}}\right)\left(\frac{2.2 \text{ lb}}{1 \text{ kg}}\right) = 22 \text{ lb}$$

- 67.** You place a 7.50-kg television on a spring scale. If the scale reads 78.4 N, what is the acceleration due to gravity at that location?

$$\begin{aligned}F_g &= mg \\g &= \frac{F_g}{m} \\&= \frac{78.4 \text{ N}}{7.50 \text{ kg}} \\&= 10.5 \text{ m/s}^2\end{aligned}$$

#### Level 2

- 68. Drag Racing** A 873-kg (1930-lb) dragster, starting from rest, attains a speed of 26.3 m/s (58.9 mph) in 0.59 s.

- a.** Find the average acceleration of the dragster during this time interval.

$$\begin{aligned}a &= \frac{\Delta v}{\Delta t} \\&= \frac{(26.3 \text{ m/s} - 0.0 \text{ m/s})}{0.59 \text{ s}} \\&= 45 \text{ m/s}^2\end{aligned}$$

- b.** What is the magnitude of the average net force on the dragster during this time?

$$\begin{aligned}F &= ma \\&= (873 \text{ kg})(45 \text{ m/s}^2) \\&= 3.9 \times 10^4 \text{ N}\end{aligned}$$

## Chapter 4 continued

- c. Assume that the driver has a mass of 68 kg. What horizontal force does the seat exert on the driver?

$$F = ma = (68 \text{ kg})(45 \text{ m/s}^2) \\ = 3.1 \times 10^3 \text{ N}$$

69. Assume that a scale is in an elevator on Earth. What force would the scale exert on a 53-kg person standing on it during the following situations?

- a. The elevator moves up at a constant speed.

$$F_{\text{scale}} = F_{\text{g}} \\ = mg \\ = (53 \text{ kg})(9.80 \text{ m/s}^2) \\ = 5.2 \times 10^2 \text{ N}$$

- b. It slows at  $2.0 \text{ m/s}^2$  while moving upward.

**Slows while moving up or speeds up while moving down,**

$$F_{\text{scale}} = F_{\text{g}} + F_{\text{slowing}} \\ = mg + ma \\ = m(g + a) \\ = (53 \text{ kg})(9.80 \text{ m/s}^2 - 2.0 \text{ m/s}^2) \\ = 4.1 \times 10^2 \text{ N}$$

- c. It speeds up at  $2.0 \text{ m/s}^2$  while moving downward.

**Slows while moving up or speeds up while moving down,**

$$F_{\text{scale}} = F_{\text{g}} + F_{\text{speeding}} \\ = mg + ma \\ = m(g + a) \\ = (53 \text{ kg})(9.80 \text{ m/s}^2 - 2.0 \text{ m/s}^2) \\ = 4.1 \times 10^2 \text{ N}$$

- d. It moves downward at a constant speed.

$$F_{\text{scale}} = F_{\text{g}} \\ = mg \\ = (53 \text{ kg})(9.80 \text{ m/s}^2) \\ = 5.2 \times 10^2 \text{ N}$$

- e. It slows to a stop while moving downward with a constant acceleration.

**Depends on the magnitude of the acceleration.**

$$F_{\text{scale}} = F_{\text{g}} + F_{\text{slowing}} \\ = mg + ma \\ = m(g + a) \\ = (53 \text{ kg})(9.80 \text{ m/s}^2 + a)$$

70. A grocery sack can withstand a maximum of 230 N before it rips. Will a bag holding 15 kg of groceries that is lifted from the checkout counter at an acceleration of  $7.0 \text{ m/s}^2$  hold?

**Use Newton's second law  $F_{\text{net}} = ma$ .**

**If  $F_{\text{groceries}} > 230$ , then the bag rips.**

$$F_{\text{groceries}} = m_{\text{groceries}}a_{\text{groceries}} + \\ m_{\text{groceries}}g \\ = m_{\text{groceries}}(a_{\text{groceries}} + g) \\ = (15 \text{ kg})(7.0 \text{ m/s}^2 + 9.80 \text{ m/s}^2) \\ = 250 \text{ N}$$

**The bag does not hold.**

71. A 0.50-kg guinea pig is lifted up from the ground. What is the smallest force needed to lift it? Describe its resulting motion.

$$F_{\text{lift}} = F_{\text{g}} \\ = mg \\ = (0.50 \text{ kg})(9.80 \text{ m/s}^2) \\ = 4.9 \text{ N}$$

**It would move at a constant speed.**

### Level 3

72. **Astronomy** On the surface of Mercury, the gravitational acceleration is 0.38 times its value on Earth.

- a. What would a 6.0-kg mass weigh on Mercury?

$$F_{\text{g}} = mg(0.38) \\ = (6.0 \text{ kg})(9.80 \text{ m/s}^2)(0.38) \\ = 22 \text{ N}$$