CHAPTER 7 REVIEW

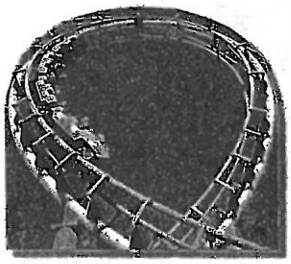
Key Terms

7.1
- equilibrant

7.2
- projectile
- trajectory
- maximum height
- range
- flight time

7.3
- uniform circular motion
- centripetal acceleration
- centripetal force
- rigid rotating object
- lever arm
- torque

Summary



7.1 Forces in Two Dimensions

- The force that must be exerted on an object in order to put it in equilibrium is called the equilibrant.
- The equilibrant is found by finding the sum of all forces on an object, then applying a force with the same magnitude but opposite direction.
- An object on an inclined plane has a component of the force of gravity in a direction parallel to the plane; the component can accelerate the object down the plane.

7.2 Projectile Motion

- The vertical and horizontal motions of a projectile are independent.
- Projectile problems are solved by first using the vertical motion to relate height, time in the air, and initial vertical velocity. Then the range, the distance traveled horizontally, is found.
- The range of a projectile depends upon the acceleration due to gravity and upon both components of the initial velocity.

7.3 Circular Motion

- An object moving in a circle at constant speed is accelerating toward the center of the circle (centripetal acceleration).
- Centripetal acceleration depends directly on the square of the object's speed and inversely on the radius of the circle.
- A force must be exerted in the centripetal direction to cause that acceleration.
- The torque that changes the velocity of circular motion is proportional to the force applied and the lever arm.

Reviewing Concepts

Section 7.1

1. Explain how you would set up a coordinate system for motion on a hill.
2. If your textbook is in equilibrium, what can you say about the forces acting on it?
3. Can an object in equilibrium be moving? Explain.
4. What is the sum of three vectors that, when placed tip to tail, form a triangle? If these vectors represent forces on an object, what does this imply about the object?
5. You are asked to analyze the motion of a book placed on a sloping table.
   a. Describe the best coordinate system for analyzing the motion.
   b. How are the components of the weight of the book related to the angle of the table?
6. For the book on the sloping table, describe what happens to the component of the weight force along the table and the friction force on the book as you increase the angle the table makes with the horizontal.
   a. Which components of force(s) increase when the angle increases?
   b. Which components of force(s) decrease?

Section 7.2

7. Consider the trajectory of the ball shown in **Figure 7–15.**
   a. Where is the magnitude of the vertical-velocity component greatest?
   b. Where is the magnitude of the horizontal-velocity component largest?

c. Where is the vertical velocity smallest?
d. Where is the acceleration smallest?

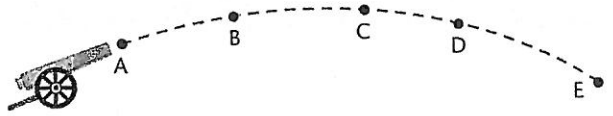


FIGURE 7-15

8. A student is playing with a radio-controlled race car on the balcony of a sixth-floor apartment. An accidental turn sends the car through the railing and over the edge of the balcony. Does the time it takes the car to fall depend upon the speed it had when it left the balcony?
9. An airplane pilot flying at constant velocity and altitude drops a heavy crate. Ignoring air resistance, where will the plane be relative to the crate when the crate hits the ground?

Section 7.3

10. Can you go around a curve
    a. with zero acceleration? Explain
    b. with constant acceleration? Explain.
11. To obtain uniform circular motion, how must the net force depend on the speed of the moving object?
12. If you whirl a yo-yo about your head in a horizontal circle, in what direction must a force act on the yo-yo? What exerts the force?
13. In general, a long-handled wrench removes a stuck bolt more easily than a short-handled wrench does. Explain.

Applying Concepts

14. If you are pushing a lawnmower across the grass, can you increase the horizontal component of the force you exert on the mower without increasing the magnitude of the force? Explain.
15. The transmitting tower of a TV station is held upright by guy wires that extend from the top of the tower to the ground. The force along the guy wires can be resolved into two perpendicular components. Which one is larger?
16. When stretching a tennis net between two posts, it is relatively easy to pull one end of the net hard enough to remove most of the slack, but you need a winch to take the last slack out of the net to make the top almost completely horizontal. Why is this true?
17. The weight of a book on an inclined plane can be resolved into two vector components, one along the plane, the other perpendicular to it.
    a. At what angle are the components equal?
    b. At what angle is the parallel component equal to zero?
    c. At what angle is the parallel component equal to the weight?
18. A student puts two objects on a physics book and carefully tilts the cover. At a small angle, object 1 starts to slide. At a large angle, object 2 begins to slide. Which has the greater coefficient of static friction?
19. A batter hits a pop-up straight up over home plate at an initial velocity of 20 m/s. The ball is caught by the catcher at the same height that it was hit. At what velocity does the ball land in the catcher's mitt? Neglect air resistance.
20. In baseball, a fastball takes about 1/2 s to reach the plate. Assuming that such a pitch is thrown horizontally, compare the distance the ball falls in the first 1/4 s with the distance it falls in the second 1/4 s.
21. You throw a rock horizontally. In a second throw, you gave it even more speed.
    a. How would the time it took to hit the ground be affected? Neglect air resistance.
    b. How would the increased speed affect the distance from the edge of the cliff to where the stone hit the ground?
22. A zoologist standing on a cliff aims a tranquilizer gun at a monkey hanging from a distant tree branch. The barrel of the gun is horizontal. Just as the zoologist pulls the trigger, the monkey lets go and begins to fall. Will the dart hit the monkey? Neglect air resistance.
23. A quarterback threw a football at 24 m/s at a 45° angle. If it took the ball 3.0 s to reach the top of its path, how long was it in the air?
24. You are working on improving your performance in the long jump and believe that the

information in this chapter can help. Does the height you reach make any difference? What does influence the length of your jump?

25. Imagine that you are sitting in a car tossing a ball straight up into the air.
    a. If the car is moving at constant velocity, will the ball land in front of, behind, or in your hand?
    b. If the car rounds a curve at constant speed, where will the ball land?
26. You swing one yo-yo around your head in a horizontal circle, then you swing another one with twice the mass, but you don't change the length of the string or the period. How do the tensions in the strings differ?
27. The curves on a race track are banked to make it easier for cars to go around the curves at high speed. Draw a free-body diagram of a car on a banked curve. From the motion diagram, find the direction of the acceleration.
    a. What exerts the force in the direction of the acceleration?
    b. Can you have such a force without friction?
28. Which is easier for turning a stuck screw, a screwdriver with a large diameter or one with a long handle?
29. Some doors have a doorknob in the center rather than close to the edge. Do these doors require more or less force to produce the same torque as a standard door of the same width and mass?

Problems

Section 7.1

LEVEL 1

30. An object in equilibrium has three forces exerted on it. A 33-N force acts at 90° from the x-axis and a 44-N force acts at 60°. What are the magnitude and direction of the third force?
31. A street lamp weighs 150 N. It is supported by two wires that form an angle of 120° with each other. The tensions in the wires are equal.
    a. What is the tension in each wire?
    b. If the angle between the wires is reduced to 90.0°, what is the tension in each wire?
32. A 215-N box is placed on an inclined plane that makes a 35.0° angle with the horizontal. Find the component of the weight force parallel to the plane's surface.

LEVEL 2

33. Five forces act on an object: (1) 60 N at 90°, (2) 40 N at 0°, (3) 80 N at 270°, (4) 40 N at 180°, and (5) 50 N at 60° What are the magnitude and direction of a sixth force that would produce equilibrium?
34. Joe wishes to hang a sign weighing 750 N so that cable A attached to the store makes a 30.0° angle, as shown in **Figure 7–16.** Cable B is horizontal and attached to an adjoining building. What is the tension in cable B?

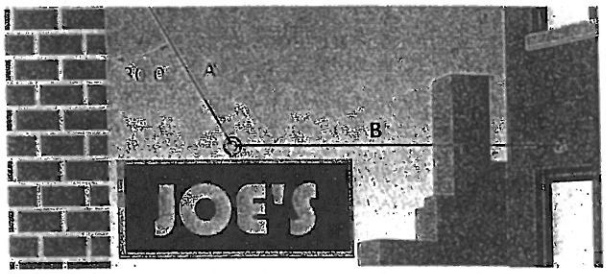


FIGURE 7-16

35. You pull your 18-kg suitcase at constant speed on a horizontal floor by exerting a 43-N force on the handle, which makes an angle θ with the horizontal. The force of friction on the suitcase is 27 N.
    a. What angle does the handle make with the horizontal?
    b. What is the normal force on the suitcase?
    c. What is the coefficient of friction?
36. You push a 325-N trunk up a 20.0° inclined plane at a constant velocity by exerting a 211-N force parallel to the plane's surface.
    a. What is the component of the trunk's weight parallel to the plane?
    b. What is the sum of all forces parallel to the plane's surface?
    c. What are the magnitude and direction of the friction force?
    d. What is the coefficient of friction?
37. What force must be exerted on the trunk in problem 36 so that it would slide down the

plane with a constant velocity? In which direction should the force be exerted?

38. A 2.5-kg block slides down a 25° inclined plane with constant acceleration. The block starts from rest at the top. At the bottom, its velocity is 0.65 m/s. The incline is 1.6 m long.
- **a.** What is the acceleration of the block?
- **b.** What is the coefficient of friction?
- **c.** Does the result of either **a** or **b** depend on the mass of the block?

Section 7.2

LEVEL 1

39. You accidentally throw your car keys horizontally at 8.0 m/s from a cliff 64 m high. How far from the base of the cliff should you look for the keys?

40. A toy car runs off the edge of a table that is 1.225 m high. If the car lands 0.400 m from the base of the table,
- **a.** how long did it take the car to fall?
- **b.** how fast was the car going on the table?

41. You take a running leap off a high-diving platform. You were running at 2.8 m/s and hit the water 2.6 s later. How high was the platform, and how far from the edge of the platform did you hit the water? Neglect air resistance.

42. An arrow is shot at 30.0° above the horizontal. Its velocity is 49 m/s and it hits the target.
- **a.** What is the maximum height the arrow will attain?
- **b.** The target is at the height from which the arrow was shot. How far away is it?

43. A pitched ball is hit by a batter at a 45° angle and just clears the outfield fence, 98 m away. Assume that the fence is at the same height as the pitch and find the velocity of the ball when it left the bat. Neglect air resistance.

LEVEL 2

44. The two baseballs in **Figure 7–17** were hit with the same speed, 25 m/s. Draw separate graphs of y versus t and x versus t for each ball.

45. An airplane traveling 1001 m above the ocean at 125 km/h is to drop a box of supplies to shipwrecked victims below.

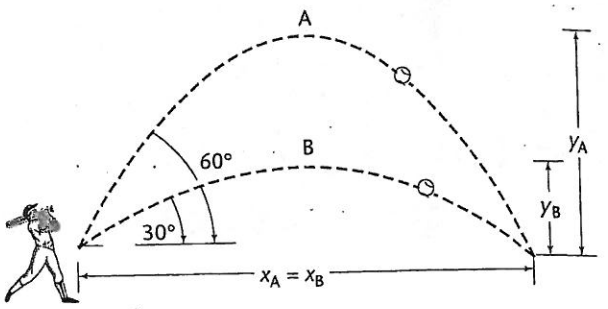


FIGURE 7–17

- **a.** How many seconds before being directly overhead should the box be dropped?
- **b.** What is the horizontal distance between the plane and the victims when the box is dropped?

46. Divers in Acapulco dive from a cliff that is 61 m high. If the rocks below the cliff extend outward for 23 m, what is the minimum horizontal velocity a diver must have to clear the rocks?

47. A dart player throws a dart horizontally at a speed of 12.4 m/s. The dart hits the board 0.32 m below the height from which it was thrown. How far away is the player from the board?

48. A basketball player tries to make a half-court jump shot, releasing the ball at the height of the basket. Assuming that the ball is launched at 51.0°, 14.0 m from the basket, what speed must the player give the ball?

Section 7.3

LEVEL 1

49. A 615-kg racing car completes one lap in 14.3 s around a circular track with a radius of 50.0 m. The car moves at constant speed.
- **a.** What is the acceleration of the car?
- **b.** What force must the track exert on the tires to produce this acceleration?

50. An athlete whirls in a 7.00-kg hammer tied to the end of a 1.3-m chain in a horizontal circle. The hammer makes one revolution in 1.0 s.
- **a.** What is the centripetal acceleration of the hammer?
- **b.** What is the tension in the chain?

51. A coin is placed on a vinyl stereo record making 33 1/3 revolutions per minute.

a. In what direction is the acceleration of the coin?
b. Find the magnitude of the acceleration when the coin is placed 5.0, 10, and 15 cm from the center of the record.
c. What force accelerates the coin?
d. In which of the three radii listed in **b** would the coin be most likely to fly off? Why?

52. According to the *Guinness Book of World Records* (1990) the highest rotary speed ever attained was 2010 m/s (4500 mph). The rotating rod was 15.3 cm (6 in.) long. Assume that the speed quoted is that of the end of the rod.
a. What is the centripetal acceleration of the end of the rod?
b. If you were to attach a 1.0-g object to the end of the rod, what force would be needed to hold it on the rod?

53. Early skeptics of the idea of a rotating Earth said that the fast spin of Earth would throw people at the equator into space. The radius of Earth is about 6400 km. Show why this objection is wrong by calculating
a. the speed of a 97-kg person at the equator.
b. the force needed to accelerate the person in the circle.
c. the weight of the person.
d. the normal force of Earth on the person, that is, the person's apparent weight.

LEVEL 2

54. The carnival ride shown in **Figure 7–18** has a 2.0-m radius and rotates once each 0.90 s.
a. Find the speed of a rider.
b. Find the centripetal acceleration of a rider.

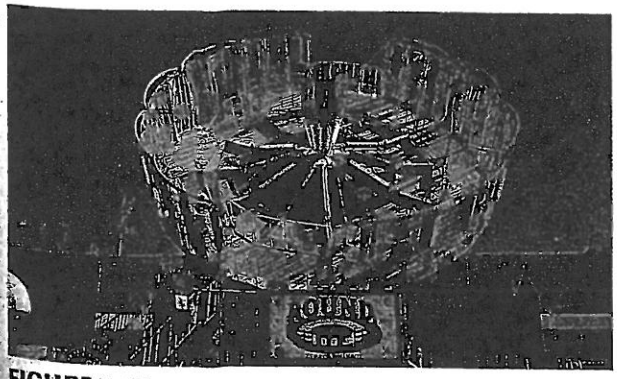


FIGURE 7–18

c. What produces this acceleration?
d. When the floor drops down, riders are held up by friction. Draw motion and free-body diagrams of the situation.
e. What coefficient of static friction is needed to keep the riders from slipping?

55. Friction provides the force needed for a car to travel around a flat, circular race track. What is the maximum speed at which a car can safely travel if the radius of the track is 80.0 m and the coefficient of friction is 0.40?

Critical Thinking Problems

56. A 3-point jump shot is released 2.2 m above the ground, 6.02 m from the basket, which is 3.05 m high. For launch angles of 30° and 60°, find the speed needed to make the basket.

57. For which angle in problem 56 is it more important that the player get the speed right? To explore this question, vary the speed at each angle by 5% and find the change in the range of the throw.

Going Further

Applying Computers and Calculators Ken Griffey, Jr. hits a belt-high (1.0 m) fastball down the left-field line in Fenway Park. The ball is hit with an initial velocity of 42.0 m/s at 26°. The left-field wall in Fenway Park is 96.0 m from home plate at the foul pole and is 14 m high. Write the equation for the height of the ball, y, as a function of its distance from home plate, x. Use a computer or graphing calculator to plot the path of the ball. Trace along the path to find how high above the ground the ball is at the wall. Is it a home run?
a. What is the minimum speed at which the ball could be hit and clear the wall?
b. If the initial velocity of a ball is 42.0 m/s, for what range of angles will the ball go over the wall?

internet CONNECTION

Follow the link on the Glencoe Homepage at **www.glencoe.com/sec/science** to find out more about this chapter.