Chapter 6 – Motion in Two Dimensions

Section Review 6.1

1. What is the word for the horizontal distance a projectile travels?

2. What does it mean to say a projectile's horizontal and vertical velocities are independent of each other?

3. A football is kicked down a field. Describe what happens to its horizontal and vertical velocities as it moves through the air.

4. What launch angle gives a projectile its greatest range?

Section Review 6.2

1. Provide your own examples of rotating and revolving objects and an object that does both.

2. List two units in which angular speed can be measured.

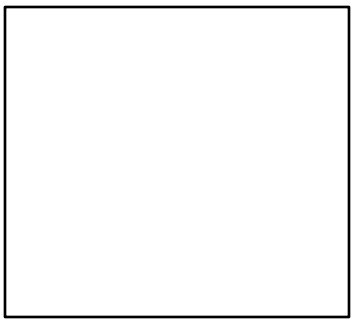
   a.

   b.

3. Several US cities have rotating restaurants high atop buildings. Does every person in such a rotating restaurant have the same angular speed and linear speed? Explain.

Section Review 6.3

1. Draw a diagram of a ball at the end of a string moving in a clockwise circle. Draw vectors to indicate the direction of the centripetal force and velocity at three different locations on the circle.



2. Explain the difference between centrifugal force and centripetal force.

3. What factors affect the force of gravity between two objects?

4. What is the force that keeps Earth in orbit around the Sun?

Section Review 6.4

1. Compare and contrast center of mass and center of gravity.

2. Explain how you can find an object's center of mass.

3. Is a pencil easier to balance on its sharp tip or its eraser? Why?

Chapter 6 Review

Understanding Vocabulary

Select the correct term on page 160 to complete the sentences.

1. A bullet fired into the air follows a curved trajectory called a(n) _____.

2. The Moon makes one monthly _____ around the Earth, while Earth makes only one daily _____ around its axis.

3. A(n) _____ is an object that orbits around another object.

4. A string attached to a ball you whirl overhead exerts _____ force on the ball.

5. An object's _____ is the average position of its weight.

Reviewing Concepts

Section 6.1

1. List the three ways to describe a displacement vector.

    a.

    b.

    c.

2. The directions north, south, east, and west can be described using angles. List the angle for each of the four directions.

3. Explain how a vector diagram can be used to find an object's displacement.

4. A velocity vector indicates the object's _____ and _____ of motion.

5. State whether each of the following is a projectile.

    a. a diver who has jumped off a diving board.

    b. a soccer ball flying toward the net.

    c. a bird flying up toward its nest.

6. What does it mean to say that the horizontal and vertical components of a projectile's velocity are independent of each other?

7. Is the horizontal velocity of a projectile constant? Is the vertical velocity of a projectile constant? Explain your answers.

8. Why does a projectile move in a curved path?

9. You kick a ball off the ground with a horizontal speed of 15 m/s and a vertical speed of 19.6 m/s. As it moves upward, its vertical speed _____ by _____ each second. It gets to its highest point _____ seconds after it is kicked. At the highest point, its vertical speed is _____ and its horizontal speed is _____.

10. At which angle should you kick a soccer ball if you want it to have the greatest range?

11. A ball kicked off the ground at an angle of 20 degrees and a ball kicked at an angle of _____ degrees have the same range.

Section 6.2

12. State whether each object is rotating or revolving.

a. satellite orbiting Earth

b. a toy train moving on a circular track

c. a fan blade

13. Which of the following units is appropriate for angular speed: rotations per second, meters per second, revolutions per minute?

14. How many degrees are in one revolution or rotation?

15. Two ants are sitting on a spinning record (see figure on page 160). One sits near the center and the other near the edge.

a. How do their angular speeds compare?

b. How do their linear speeds compare?

16. Rolling is a combination of _____ motion and _____ motion.

17. How far does the center of a wheel move in a line as the wheel rolls through one rotation?

Section 6.3

18. A force acts on a moving object. The force makes the object _____ if it acts in the same direction as the velocity. The force makes it _____ if it acts opposite the direction of velocity. The force makes it _____ if it is perpendicular to the velocity.

19. A sports car moves around a sharp curve (small radius) at a speed of 50 mph. A four-door family car moves around a wider curve (large radius) at the same speed. The cars are equal in mass.

a. Which car changes its direction more quickly?

b. Which car has the greater acceleration?

c. Which car has the greater centripetal force acting on it?

d. What provides the centripetal force on each car?

20. Explain the relationship between velocity and centripetal force in creating circular motion.

21. Explain how the centripetal force needed to move an object in a circle is related to its mass, speed, and the radius of the circle.

22. A force is needed to change an object's linear motion. What is needed to change its rotational motion?

23. What is centrifugal force? Is it a real force?

24. What keeps the Moon in orbit around the Earth?

25. Is there a gravitational force between you and your pencil? Do you notice this force? Explain.

26. You experience a gravitational force that attracts you to Earth. Does Earth also experience a force? Explain.

27. What is a satellite?

28. Do all satellites move in perfect circles? Explain.

Section 6.4

29. Explain how you can find the location of an object's center of mass.

30. What is the difference between the center of mass and the center of gravity?

31. Explain how you can find the location of a object's center of gravity.

32. Why is a tall SUV more likely to roll over in an accident than a car?

33. Tightrope walkers often use long poles to help them balance. Explain why this makes sense.

Solving Problems

Section 6.1

1. Use a scaled drawing to find the displacement for each of the following. Then check your work using the Pythagorean theorem.

a. an ant that walks 3 m north and 3 m east.

b. a cat who runs 6 m west and 2 m north.

c. a car that drives 8 km south and 6 km west.

d. a plane that flies 200 mi north, turns, and flies 200 mi south.

2. Draw a vector to scale to represent each velocity. Specify your scale.

a. (20 m/s, 60°)

b. (40 mph, 150°)

c. (500 km/h, 180°)

3. Calculate the speed of each velocity given in component form. Then draw the velocity vector to scale. State the scale you use.

a. (5, 8) m/s

b. (60, 20) m/s

4. You run straight off a high diving board at a speed of 6 m/s. You hit the water 2 s later.

a. How far did you travel horizontally during the 2 s?

b. How far did you travel vertically during the 2 s?

c. How fast were you moving horizontally when you hit the water?

d. How fast were you moving vertically when you hit the water?

5. A monkey throws a banana horizontally from the top of a tree, as illustrated on page 162. The banana hits the ground 3 s later and lands 30 m from the base of the tree.

a. How fast did the monkey throw the banana?

b. How high is the tree?

c. How fast was the banana moving horizontally as it hit the ground?

d. How fast was the banana moving vertically as it hit the ground?

e. What was the resultant velocity of the banana as it hit the ground?

6. A bowling ball rolls off a high cliff at 5 m/s. Complete the chart that describes its motion during each second it is in the air.

Time (s)	Horizontal velocity (m/s)	Vertical velocity (m/s)	Horizontal distance (m)	Vertical distance (m)

7. You kick a football off the ground with a horizontal velocity of 12 m/s to the right and a vertical velocity of 29.4 m/s upward, as illustrated on page 162. Draw a diagram showing the football's trajectory. Draw vectors showing its horizontal and vertical velocity at each second until it returns to the ground.

Section 6.2

8. Find the angular speed of a Ferris wheel that makes 12 rotations during a 3-min ride. Express your answer in rotations per minute.

9. A wheel makes 10 rotations in 5 s.

a. Find its angular speed in rotations per second.

b. How many degrees does it turn during the 5 s?

c. Find its angular speed in degrees per second.

10. You are sitting on a merry-go-round at a distance of 2 m from its center. It spins 15 times in 3 min.

a. What distance do you move as you make one revolution?

b. What is your angular speed in RPM?

c. What is your angular speed in degrees per minute?

d. What is your linear speed in meters per minute?

e. What is your linear speed in meters per second?

Section 6.3

11. A car requires a centripetal force of 5,000 N to drive around a bend at 20 mph. What centripetal force is needed for it to drive around the bend at 40 mph? At 60 mph?

12. A 1,000-kg car drives around a bend at 30 mph. A 2,000-kg truck travels around the same bend at the same speed. How does the centripetal force on the car compare to the force on the truck?

13. What would happen to the force of gravity on you if you doubled your distance from the center of Earth?

14. What would happen to the force of gravity on you if Earth's mass suddenly doubled but the radius remained the same?

15. Use Newton's law of universal gravitation to find the force of gravity between Earth and a 60-kg person.

16. Use Newton's law of universal gravitation to find the force of gravity between Earth and the Sun.

Section 6.4

17. Choose the point that is at the center of mass for each object pictured on page 163.

Pyramid Maple leaf Horseshoe

18. Which object(s) will topple in the figure on page 163? The center of gravity for each is indicated.

Test Practice

Section 6.1

A ball rolling at 4.00 m/s falls from a table 0.750 m high. Answer the following questions based upon this information.

1. The time required for the ball the hit the floor is

a. 0.153 s b. 0.391 s c. 1.91 s d. 3.68 s

2. What is the range of the ball before hitting the floor?

a. 0.111 m b. 0.600 m c. 1.56 m d. 3.00 m

3. What is the vertical speed of the ball the instant it hits the floor?

a. 3.8 m/s b. 1.9 m/s c. 0.080 m/s d. 0.039 m/s

Section 6.2
The wheel of a bicycle is 0.700 m in diameter and makes 2.00 rotations in 3.00 s as the bicycle rolls along a bike path. Answer the following questions using this information.

4. The angular speed of the wheel is

a. 1.4 m/s b. 2,40 degrees/s c. 2.2 m/s d. 0.67 rpm

5. What is the linear speed of the wheel at a distance of 0.200 m from the center of the wheel?

a. 1.88 m/s b. 2.09 m/s c. 2.46 m/s d. 6.28 m/s

6. What is the linear speed of the axle of the bicycle wheel as it rolls along the path?

a. 0.233 m/s b. 0.350 m/s c. 1.05 m/s d. 3.30 m/s

Section 6.3
Base your answers to the following questions on the diagram at right which represents a ball attached to a string. The ball moves at a constant speed around a flat horizontal circle of radius *R.*

7. If the speed of the ball is doubled, the centripetal force exerted by the string on the ball

a. is halved. b. is doubled. c. remains the same. d. is quadrupled.

8. If the length of string is cut in half while the speed of the ball remains the same, the centripetal force exerted by the string on the ball

a. is halved. b. is doubled. c. remains the same. d. is quadrupled.

9. A 60-kg adult and 30-kg child are passengers on a rotating amusement park ride. How does the centripetal acceleration experienced by the adult compare to that experienced by the child?

a. The child's is ½ as much as the adult's. b. The child's is twice that of the adult's.
c. The child's is the same as the adult's. d. The child's is ¼ as much as the adult's.

10. If the distance between two masses is increased by three times, the gravitational force between them is increased by

a. 3 times as much. b. 2 times as much. c. 9 times as much. d. 8 times as much.

11. Which graph on page 164 best represents the gravitational force between two bodies as a function of the distance between their centers of mass?

a. A b. B c. C d. D

Section 6.4
12. Where is the center of mass of a gold ring?

a. in the gold of the ring b. in the air at the center of the ring
c. in the air outside the ring d. it depends on the density of the gold