Chapter 5 – The Force Vector

Section Review 5.1

1. Indicate whether each of the following units of measurement are scalar or vector units:

Speed ____________ time _____________ mass ______________

Weight ____________ velocity _____________ temperature _____________

2. Draw a scaled diagram of a vector that represents a force of 200 N at 120°.

3. Draw the force vector (6, 8) N. Is this the same as the force vector (100 N, 53°)? Explain.

4. A box is being pushed across a carpeted floor. Draw a free-body diagram for the box.

Section Review 5.2

1. What is true about the net force acting on an object in equilibrium? What is true about the acceleration of an object in equilibrium?

2. Study Figure 5.9. Suppose the person pulling to the left only exerts 50 N of force, while everything else stays the same. What would be the x- and y- components of the third force, if the forces on the polar bear are to keep it at equilibrium?

3. What is a *normal* force? And why is it called that?

4. How does Newton's third law explain the existence of normal forces?

5. The spring in a scale stretches 1 centimeter when a 5-newton object hangs from it. How much does an object weigh if it stretches the spring 2 centimeters?

Section Review 5.3

1. Explain the causes of sliding friction and static friction. How are they different?

2. What do you know about the friction force on an object pulled at a constant speed?

3. What factors affect the friction force between two surfaces?

4. Provide an example of friction that is useful and one that is not useful. Use examples not mentioned in the book.

Section Review 5.4

1. List two ways in which torque is different from force.

   a.

   b.

2. In what units is torque measured?

3. Explain how the same force can create different amounts of torque on an object.

4. What is the net torque on an object in rotational equilibrium?

5. A boy and a cat sit on a seesaw as shown in Figure 5.30. Use the information in the picture to calculate the torque created by the cat. Then, calculate the boy's distance from the center of the seesaw.

Chapter 5 Review

Understanding Vocabulary

Select the correct term to complete the sentences.

1. The expression of a person's age as 15 years is an example of a(n) _______________ quantity.

2. The sum of the squares of the two __________________ of a force vector equals the square of the force vector.

Use the illustration on page 128 to answer questions 3 – 6.

3. The illustration of forces acting on an automobile is an example of a(n) __________________ diagram.

4. Because the automobile in the illustration is not accelerating, the four forces acting on it are in ____________________.

5. The force labeled $F_{Ground\text{-}on\text{-}car}$ could be labeled F_n and called the __________________ force.

6. The _________________ of the four forces in the illustration is zero.

7. If a carton is pushed at a constant speed along a level floor, the force directly opposing the motion is ________________ friction.

8. The pin in a hinge on a door represents the _______________ of the door.

9. A balanced see-saw and a bicycle wheel spinning at a constant speed are examples of ___________________.

Reviewing Concepts

Section 5.1

1. Provide two examples of vector quantities and two examples of scalar quantities.

Vector: a. b.

Scalar a. b.

2. List the three different ways in which a force vector can be described.

a. b. c.

3. Explain how to find the components of a vector.

4. Explain the Pythagorean theorem using and equation and a picture.

5. A 200-N television sits on a table. Draw a free-body diagram showing the two forces acting on the television.

Section 5.2

6. What is the net force on an object in equilibrium?

7. What is the mathematical meaning of the word *normal*?

8. As you sit on a chair, gravity exerts a downward force on you.

a. What other force acts on you?

b. What is the direction of this other force?

c. What do you know about the magnitude or strength of this other force?

9. If an object is in equilibrium, the forces in the x direction must add to __________________, and the forces in the y direction must add to ___________________.

10. You pull one end of a spring to the right.

a. What is the action force?

b. What is the reaction force?

c. How do the directions of the two forces compare?

d. How do the strengths of the two forces compare?

11. What happens to a spring's force as you stretch it?

12. What do you know about a spring if it has a large spring constant?

Section 5.3

13. List four types of friction.

a. b.

c. d.

14. In which direction does friction act?

15. What is the difference between static friction and sliding (dynamic) friction?

16. What causes friction?

17. Why is it easier to slide a cardboard box when it is empty compared to when it is full?

18. Explain the two ways friction can be reduced.

a. b.

19. Is friction something we always want to reduce? Explain.

Section 5.4

20. How are torque and force similar? How are they different?

21. Which two quantities determine the torque on an object?

a. b.

22. In what units is torque measured? Do these units have the same meaning as they do when measuring work? Explain.

23. Why is it easier to loosen a bolt with a long-handled wrench than with a short-handled one?

24. In which of the following cases would a force cause the greatest torque on the shovel? Why?

a. You press straight down on the shovel so it stays straight up and down.

b. You twist the shovel like a screwdriver.

c. You push to the right on the shovel's handle so it tilts towards the ground.

25. What does it mean to say an object is in rotational equilibrium?

Solving Problems

Section 5.1

1. Use a ruler to draw each of the following vectors with a scale of 1 cm = 1 N.

a. (5 N, 0°)	b. (7 N, 45°)
c. (3 N, 90°)	d. (6 N, 30°)

2. Use a ruler to draw each of the following vectors. State the scale you use for each.

a. (40 N, 0°)	b. (20 N, 60°)
c. (100 N, 75°)	d. (500 N, 90°)

3. Use a scaled drawing to find the components of each of the following vectors. State the scale you use for each.

a. (5 N, 45°)	b. (8 N, 30°)
c. (8 N, 60°)	d. (100 N, 20°)

Section 5.2

4. Find the net force on each box in the figure on page 129.

a. b. c.

5. A 20-kg monkey hangs from a tree limb by both arms. Draw a free-body diagram showing the forces on the monkey (Hint: Twenty kilograms is not a force!)

6. An 80-lb bag of cement is contained in a 5-lb bucket supported by a rope. Draw a free-body diagram to represent all the forces applied to the bucket. What is the tension in the rope?

7. A spring has a spring constant of 100 N/m. What forces does the spring exert on you if you stretch it 0.5 m?

8. If you stretch a spring 3 cm, it exerts a force of 50 N on your hand. What force will it exert if you stretch it 6 cm?

Section 5.3

9. Your backpack weighs 50 N. You pull it across a table at a constant speed by exerting a force of 20 N to the right. Draw a free-body diagram showing all of the forces on it. State the strength of each.

10. You exert a 50-N force to the right on a 300-N box but it does not move. Draw a free-body diagram for the box. Label all the forces and state their strengths.

Section 5.4

11. You push down on a lever with a force of 30 newtons at a distance of 2 m from its fulcrum. What is the torque on the lever?

12. You use a wrench to loosen a bolt. It finally turns when you apply 300 N of force at a distance of 0.2 m from the center of the bolt. What torque did you apply?

13. A rusty bolt requires 200 N•m of torque to loosen it. If you can exert a maximum force of 400 N, how long a wrench do you need?

14. Look at the figure of the seesaw on page 130. Calculate the net torque on the see-saw.

15. You and your cousin sit on a seesaw (as pictured in figure on page 130. You sit at 0.5 m from the fulcrum, and your cousin sits 1.5 m from the fulcrum. You weigh 600 N. How much does your cousin weigh?

Test Practice

Section 5.1

1. An example of a vector quantity is

a. speed. b. time. c. distance. d. force.

2. A force vector of 10 N is represented on a scale drawing by an arrow 5 cm in length. If the x-component is represented by an arrow 3 cm in length the y-component of the force is

a. 2 N. b. 4 N. c. 6 N. d. 8 N.

3. A worker slides a 50-N object to the right at a constant speed across a horizontal surface using a force of 200 N. Which free body diagram on page 130 best represents the forces acting on the object?

a. b. c. d.

Section 5.2

4. The diagram on page 131 represents two forces acting at point P. Which choice would create a condition of equilibrium with the forces shown?

a. b. c. d.

5. Which pair of forces acting on the same point could produce a resultant of 10 N?

a. 10 N, 10 N b. 10 N, 30 N c. 4.7 N, 4.7 N d. 4.7 N, 5 N

6. A force of 18 N is exerted to stretch a spring 0.3 m. The spring constant for this spring is

a. 0.0167 N/ m. b. 5.4 N/ m. c. 6 N/ m. d. 60 N/ m.

Section 5.3

7. The force exerted on you by the floor as you stand in place is the

a. gravitational force. b. mass.

c. normal force. d. weight.

8. Block A in figure on page 131 is pulled at a constant velocity up an incline as shown. Toward which point will the force of friction be directed?

a. b. c. d.

9. Which type of friction is most closely associated with a lack of motion?

a. sliding friction b. air friction

c. static friction d. rolling friction

10. To overcome sliding friction and keep an object sliding on a level surface, a 100-N force is used. The magnitude of the force needed to start the object sliding

a. is less than 100 N. b. equals 100 N.

c. is more than 100 N. d. cannot be calculated with the information given.

Section 5.4

11. The diagram on page 131 at the right shows two forces applied to a lever. The net torque applied to the lever is

a. +30 N•m. b. +60 N•m. c. -60 N•m. d. 0 N•m.