CHAPTER 5 STUDY GUIDE

DISPLACEMENT AND FORCE IN TWO DIMENSIONS

SECTION 1 Vectors
In your textbook, read about vectors.

*For each statement below, write true or rewrite the italicized part to make it true.*

1. True The representation of a vector has both length and direction.
2. **F, velocity** Velocity and speed are both quantities, but only speed is a vector.
3. True Mass is not a vector.
4. True Force is a vector because it has both magnitude and direction.
5. **F, tip-to-tail** When adding two vectors on a graph, you place them tail-to-tail.

*For the following combinations of vectors, draw the resultant vector by connecting the tip of one vector to the tail of the other.*

6. 

7. 

*Circle the letter of the choice that best completes the statement.*

8. When adding two vectors that are perpendicular, it is best to use ____.
   - a. the Pythagorean theorem
   - b. the law of cosines
   - c. the law of sines
   - d. a free-body diagram
Find the direction for each of the vectors below.

9. \( \theta = 370 \)

10. \( \theta = 198 \)

11. \( \theta = 560 \)

Find the \( x \) and \( y \) component of each vector below.

12. \( \theta = 75^\circ \)
   \[ x = 10 \cos 75^\circ = 2.6 \text{ m} \]
   \[ y = 10 \sin 75^\circ = 9.7 \text{ m} \]

13. \( \theta = 42^\circ \)
   \[ x = 92 \cos 42^\circ = 68.4 \text{ N} \]
   \[ y = 92 \sin 42^\circ = 61.6 \text{ N} \]

14. \( \theta = 18^\circ \)
   \[ x = 61 \cos 18^\circ = 58 \text{ m/s} \]
   \[ y = 61 \sin 18^\circ = 18.9 \text{ m/s} \]

Find the resultant magnitude and direction.

15. A man walks 5.0 m east and then 10.0 m north. What is the direction and length of his total displacement?
   \[ R = \sqrt{5^2 + 10^2} = 12.5 \text{ m} \]
   \[ \theta = \tan^{-1} \left( \frac{10}{5} \right) = 63^\circ \]

16. An airplane is traveling 600.0 m/s at 35° degrees north of east when a tail wind starts to blow. The velocity of the tail wind is 100.0 m/s 15° west of north. What are the new direction and speed of the airplane?

   \[ R = \sqrt{410.6^2 + 410.9^2} \]
   \[ \theta = \tan^{-1} \left( \frac{410.9}{410.6} \right) = 43.4^\circ \]

SECTION 2 Friction

In your textbook, read about friction.

Circle the letter of the choice that best completes the statement or answers the question.

1. A box with a mass of 10 kg is at rest on a table. The normal force acting on the box is _____.
   a. 10 kg upward  
   b. 9.8 N upward  
   c. 98 N upward  
   d. 989 downward
2. An ice-skater who weighs 200 N is gliding across the ice. If the force of friction is 4 N, what is the coefficient of kinetic friction?
   a. 50    b. 0.02    c. 4    d. 4 N

3. A sofa is at rest on the floor. The mass of the sofa is 150 kg and the coefficient of static friction between the sofa and the floor is 0.30. The maximum force of static friction is approximately _____.
   a. 150 N    b. 1500 N    c. 440 N    d. 4500 N

4. A team of dogs is pulling a heavy sled through the snow in the direction of east. The direction of the force of friction acting on the sled is _____.
   a. east    b. upward    c. west    d. downward

5. A mover of household goods wants to push a heavy bureau at rest on the floor across the floor. He puts his shoulder against the bureau and begins to push. He gradually increases the force of his push until the bureau moves when he keeps the pushing force constant. The force of friction _____.
   a. decreases and then increases    b. increases and then decreases    c. remains the same    d. continues to increase

Refer to the passage below to answer questions 6–9.

A crate with a mass of 1000 kg is being pulled along greased tracks by a winch. The winch is exerting a force of 2000 N in the horizontal direction along the tracks. The coefficient of kinetic friction between the crate and the tracks is 0.2.

6. Draw a free-body diagram of the crate showing the gravitational force, the pulling force, and the force of friction.

7. What is the net force acting on the crate in the horizontal direction?
   \[ F_{\text{Net}} = 2000 - 1960 = 40 \text{ N} \]

8. Calculate the force of kinetic friction on the crate.
   \[ F_k = \mu_s N = 1000 \times 9.8 = 9800 \text{ N} \]
   \[ F_k = 0.2 \times 9800 = 1960 \text{ N} \]

   \[ a = \frac{\frac{40}{1000}}{1000} = 0.0004 \text{ m/s}^2 \]
SECTION 3  Force and Motion in Two Dimensions

In your textbook, read about force and motion in two dimensions.

Circle the letter of the choice that best completes the statement or answers the question.

1. The magnitude of the equilibrant of a 3 N force acting toward the east and a 4 N force acting toward the south is 
   a. 7 N   b. 5 N   c. 1 N   d. −7 N

Refer to the passage below to answer questions 2–6.

A toy sled with a mass of 1.0 kg is sliding down a ramp that makes an angle of 25° with the ground. The coefficient of kinetic friction between the toy sled and the ramp is 0.25.

2. In a coordinate system where the x-axis is parallel to the ramp and the y-axis is perpendicular to the ramp, what are the components of the toy sled’s weight?
   \[ F_{gx} = mg \sin \theta = (1)(-9.8) \sin 25° = 8.8 \, N \]
   \[ F_{gy} = mg \cos \theta = (1)(-9.8) \cos 25° = -4.14 \, N \]

3. How large is the normal force acting on the toy sled?
   \[ F_N = -F_{gy} = 4.14 \, N \]

4. What is the magnitude and direction of the force of friction acting on the toy sled?
   \[ F_k = (-25)(4.14) = 1.04 \, N \]

5. In a coordinate system where the x-axis is parallel to the ramp and the y-axis is perpendicular to the ramp, how large is the net force acting on the toy sled along the x-axis?
   \[ F_{net} = F_{gx} - F_k = 8.8 - 1.04 = 7.8 \, N \]

6. Using Newton’s second law, calculate the acceleration of the toy sled as it moves down the ramp.
   \[ \frac{7.8}{m} = a \]
   \[ a = 7.8 \, m/s^2 \]