

Chapter 6 Newton's Second Law of Motion—Force and Acceleration

Summary

THE BIG IDEA : An object accelerates when a net force acts on it.

6.1 Force Causes Acceleration

- ✓ Unbalanced forces acting on an object cause the object to accelerate.
 - The combination of forces acting on an object is the net force; acceleration depends on net force.
 - Doubling the force on an object doubles its acceleration.
 - An object's acceleration is directly proportional to the net force acting on it.

6.2 Mass Resists Acceleration

- ✓ For a constant force, an increase in the mass will result in a decrease in the acceleration.
 - The same force applied to twice as much mass results in only half the acceleration.
 - For a given force, the acceleration produced is inversely proportional to the mass. Inversely means that the two values change in opposite directions.

6.3 Newton's Second Law

- ✓ Newton's second law states that the acceleration produced by a net force on an object is directly proportional to the magnitude of the net force, is in the same direction as the net force, and is inversely proportional to the mass of the object.
 - Newton's second law describes the relationship among an object's mass, an object's acceleration, and the net force on an object.
 - In equation form, Newton's second law is written as follows:
$$\text{acceleration} = \frac{\text{net force}}{\text{mass}} \quad \text{or} \quad a = \frac{F}{m}$$
 - Acceleration is equal to the net force divided by the mass.

6.4 Friction

- ✓ The force of friction between the surfaces depends on the kinds of material in contact and how much the surfaces are pressed together.
 - Friction acts on materials that are in contact with each other, and it always acts in a direction to oppose relative motion.
 - Liquids and gases are called **fluids** because they flow. Fluid friction occurs when an object moves through a fluid.
 - **Air resistance** is the friction acting on something moving through air.
 - A diagram showing all of the forces acting on an object is called a **free-body diagram**.

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Exercises

6.1 Force Causes Acceleration (page 87)

1. When a hockey puck is struck with a hockey stick, a(n) _____ acts on the puck and the puck _____.
2. Circle the letter of the type of force that causes acceleration.
 - a. balanced
 - b. negligible
 - c. zero
 - d. unbalanced
3. The combination of forces acting on an object is known as the _____ force.
4. The acceleration of an object is directly proportional to the net force acting on it. This means that, as the net force acting on the object increases, the acceleration of the object _____.
5. Circle the letter of each statement about force and acceleration that is true.
 - a. Balanced forces cause constant acceleration.
 - b. The forces acting on an object at rest are unbalanced.
 - c. A net force acting on an object causes acceleration.
 - d. Force is not required for an object to accelerate.
6. Two shopping carts of equal mass are pushed by two different people. One cart accelerates three times as fast as the other cart. Describe the forces acting on each cart.

6.2 Mass Resists Acceleration (page 87)

7. For a constant force, how does an increase in an object's mass affect its acceleration?

8. What does it mean for two quantities to be inversely proportional to one another?

9. Circle the letter showing how mass and acceleration are related.
 - a. acceleration \sim mass
 - b. acceleration $\sim 1/\text{mass}$
 - c. acceleration $\sim \text{mass}^2$
 - d. acceleration $\sim \frac{1}{2}$ mass

6.3 Newton's Second Law (pages 88–89)

10. Circle the letter of each quantity related by Newton's second law.
 - a. mass
 - b. force
 - c. time
 - d. acceleration

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11. Circle the letter of each statement related to Newton's second law that is true.
- a. Acceleration is directly proportional to the net force.
 - b. The direction of acceleration is the same as the net force.
 - c. Acceleration is inversely proportional to mass.
 - d. Net force and mass are always equal.
12. When using the equation for Newton's second law, if force is measured in newtons, then the unit for acceleration is _____ and the unit for mass is _____.
13. Is the following sentence true or false? The acceleration of an object is equal to the net force acting on it divided by the object's mass.

14. A 100-N force is used to accelerate a large push cart across the floor. Circle the letter of the force required to accelerate the push cart twice as fast.
- a. 50 N
 - b. 100 N
 - c. 150 N
 - d. 200 N
15. An object accelerates when a net force is applied to it. Circle the letter describing the conditions that would double the object's acceleration.
- a. doubling the mass
 - b. halving the force
 - c. doubling the mass and halving the force
 - d. halving the mass
16. During a lab experiment, a net force is applied to an object and the object accelerates. The mass of the object is then doubled, and the net force applied to it also doubles. Describe the object's acceleration.

17. Circle the letter of the equation that describes Newton's second law of motion.
- a. $a = \frac{F}{m}$
 - b. $F = ma^2$
 - c. $F = \frac{a}{m}$
 - d. $F = \frac{1}{2}(am)^2$

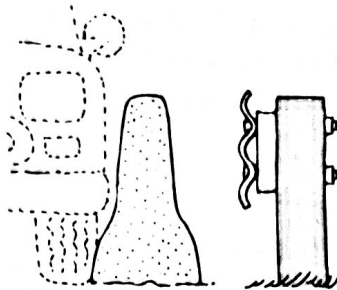
6.4 Friction (page 90–91)

18. Describe what causes friction between two solid surfaces.

19. Is the following sentence true or false? Friction does not depend on the types of materials in contact with each other. _____
20. Is the following sentence true or false? Friction depends on how much the materials in contact are pushed together. _____

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21. The figure above shows where an out-of-control car might strike a concrete road divider. In terms of friction, explain why the concrete barrier is superior to the steel barrier in the figure.
- _____
- _____
22. Substances that are liquids or gases are also called _____.
23. Is the following sentence true or false? When friction is present, an object can move with constant velocity even when an outside force is applied.
- _____
24. A _____ is a diagram in which all of the forces acting on an object are shown.