Name _____ Date _____ Class _____

The Nature of Force

Key Concepts

- How is a force described?
- How do balanced and unbalanced forces affect an object's velocity?

A **force** is a push or a pull. **A force is described by its magnitude and by the direction in which it acts.** The strength of a force is measured using the SI unit called the **newton,** named for Isaac Newton, an English mathematician. Picking up a small lemon requires you to exert a force of about one newton. Forces can be shown using arrows. The length of the arrow represents the size of the force, and the direction of the arrow shows the direction of the force.

The overall force on an object, called the **net force,** is found by combining all of the forces acting on the object. The size of the net force determines whether the object's motion changes. The direction of the net force determines the direction of the object's motion. When two forces act in the same direction, the net force is found by adding the strengths of the individual forces. When forces act in opposite directions, they are combined by subtracting the smaller force from the larger force. The direction of the resulting force is the direction of the larger original force.

When there is a net force acting on an object, the forces are said to be unbalanced. **Unbalanced forces** can cause the velocity of an object to change. It can speed up, slow down, or change direction. **Unbalanced forces acting on an object result in a net force and cause a change in the object's velocity.**

Equal forces acting on one object in opposite directions are called **balanced forces. Balanced forces acting on an object do not change the object's velocity.** When equal forces are exerted in opposite directions, there is no net force.

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What Is a Force? (pp. 374–375)

1. In science, a force is _____.
2. When one object pushes or pulls another object, the first object is _____ a force on the second object.
3. Circle the letters of the two ways that forces are described.
   - **a.** direction
   - **b.** velocity
   - **c.** strength
   - **d.** acceleration
4. The SI unit used to measure the strength of a force is the _____.

Combining Forces (pp. 375–377)

5. The overall force on an object after all the forces are added together is called the _____.
6. When two forces act in the same direction, they are _____ together.
7. Adding a force acting in one direction to a force acting in the opposite direction is the same as adding a(n) _____ number and a(n) _____ number.
8. Unbalanced forces can cause an object to change its motion in three ways. What are they?

   _____

   _____
9. Is the following sentence true or false? Unbalanced forces acting on an object will change the object's velocity. _____
10. Equal forces acting on one object in opposite directions are called _____.
11. Is the following sentence true or false? Balanced forces acting on an object will change the object's velocity. _____
12. When you add equal forces exerted in opposite directions, there is no _____.

Name _____ Date _____ Class _____

Newton's First and Second Laws

Key Concepts

- What is Newton's first law of motion?
- What is Newton's second law of motion?

The English mathematician Sir Isaac Newton restated Galileo's ideas about motion in the first of his three laws of motion. **Newton's first law of motion states that an object will remain at rest or move at a constant velocity unless it is acted upon by an unbalanced force.** An unbalanced force will cause an object to speed up, slow down, or change direction. If an object is not moving, it will not move until a force acts on it.

Newton's first law is also called the law of inertia. **Inertia** is the tendency of an object to resist a change in motion. The amount of inertia an object has depends on its mass. Objects with greater mass have more inertia and require a greater force to cause a change in motion.

Newton's second law of motion states that acceleration depends on the net force acting on the object and on the object's mass. This relationship can be written in an equation.

$$\text{Acceleration} = \frac{\text{Net force}}{\text{Mass}}$$

When acceleration is measured in meters per second per second (m/s^2) and mass is measured in kilograms, force is measured in kilograms times meters per second per second ($kg \cdot m/s^2$). This unit is called the newton (N). One newton equals the force required to accelerate one kilogram of mass at 1 meter per second per second.

$$1\ N = 1\ kg \times 1\ m/s^2$$

The acceleration of an object will increase if the force increases. According to the equation, acceleration and force change in the same way—both get larger. The equation also shows that the acceleration will increase if the mass decreases. Acceleration and mass are inversely proportional.

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The First Law of Motion (pp. 389–390)

1. If an object is not moving, it will not move until a(n) _____ acts on it.
2. What is Newton's first law of motion?

   _____

   _____

   _____

   _____
3. What is inertia?

   _____

   _____
4. What is another name for Newton's first law?

   _____
5. The amount of inertia an object has depends on its _____.

The Second Law of Motion (pp. 390–392)

6. What is Newton's second law of motion?

   _____

   _____

   _____
7. What is the equation that describes the relationship among the quantities of force, mass, and acceleration?

   _____
8. Circle the letters of the two answers below that are the same unit of measure.

   a. m/s^2
   b. N
   c. $kg \cdot m/s^2$
   d. kg
9. How can you use Newton's second law to find force?

   _____
10. What are two ways to increase the acceleration of an object?

    _____

    _____

    _____

    _____