Chapter 3 Unit Notes

Lesson 1: Describing Motion

**acceleration** to cause to move faster
**displacement** distance between an object’s initial, or starting, position and its final position
**distance** total length of an object’s path
**motion** process of changing position
**reference point** starting point used to describe the motion or the position of an object
**satellite** an object in orbit around another object
**speed** distance an object moves divided by the time it took to move that distance
**velocity** speed and direction of an object’s motion

A. Motion
   1. **Motion** is the process of changing position.
   2. The starting point used to describe the motion or position of an object is called the **reference point**.
   3. **Distance** is the total length of your path of motion.
   4. The distance between your final position and your starting position is **displacement**.
   5. A complete description of motion includes a(n) **reference** point, your **displacement**, and your direction.

B. Speed
   1. **Speed** is the distance an object moves divided by the time it took to move that distance.
   2. Speed can be **constant** or changing.
      a. A constant speed is **unchanging** because the distance traveled per unit of time remains the same.
      b. Speed is **changing** when the distance traveled per unit of time does not remain the same.
      c. **Average** speed is the ratio of the distance moved and the time it took to move that distance.

C. Velocity
   1. The speed and direction of an object’s motion is the **velocity** of the object.
   2. Velocity is often represented by using a(n) **arrow**.
      a. The total **length** of the arrow shows speed.
      b. The **direction** of the arrow shows the direction the object moves.
   3. When an object’s speed and direction remain the same, the object has **constant** velocity.
   4. Velocity **changes** when the speed or the direction of the motion of the object changes.
   5. The measure of how quickly an object’s velocity changes is called **acceleration**.

D. Calculating Acceleration
   1. Acceleration can be calculated by dividing the change in velocity by the **time** it took for the velocity to change.
   2. When an object **speeds up**, its acceleration is positive.
   3. When an object **slows down**, it has negative acceleration, which is sometimes referred to as **deceleration**.

E. Using Graphs to Represent Motion
   1. A(n) **displacement-time** graph shows time on the x-axis and displacement from a(n) **reference point** on the y-axis.
a. A line on this type of graph represents average speed.
b. The line does not show the actual path of motion.

2. A(n) **speed-time** graph shows time on the x-axis and speed on the y-axis.
   a. A point on the line on this type of graph represents the speed of the object at that time.
   b. A(n) **horizontal** line at \( y = 0 \) on a displacement-time graph or a speed-time graph shows that the object is at rest.
   c. The term **constant speed** means **average** speed.

**Lesson 2: Forces**

**balanced forces** forces that act on an object, resulting in a net force of \( 0 \) N
**combine** to unite, join together
**contact force** push or pull on one object by another object that is touching it
**force** push or pull that one object exerts on another
**friction** contact force that resists the sliding motion between two objects that are touching
**gravity** noncontact attractive force that exists between all objects that have matter
**noncontact force** push or pull on an object without touching it
**unbalanced forces** forces that act on an object, resulting in a net force that is not \( 0 \) N

**A. What are forces?**
   1. A(n) **force** is a push or a pull that one object exerts on another object.
   2. A force has a size and a(n) **direction**.
      a. The length of a force arrow relates to the **size** of the force.
      b. The direction of a force arrow shows the **direction** of the force.
   3. The unit of force is the **newton**.
   4. A force can change an object’s velocity, which is the **speed** and direction of an object, causing **acceleration**.

**B. Types of Forces**
   1. A(n) **contact** force is a push or a pull on one object by another object that is touching it.
   2. Contact forces are also called **mechanical** forces.
   3. A(n) **noncontact** force is a force that pushes or pulls an object without touching it.
   4. Examples of noncontact forces include **magnetism** and gravity.

**C. Friction**
   1. **Friction** is a contact force that resists the sliding motion between two objects that are touching.
   2. The direction of the force of friction is **opposite** the direction of the motion.
   3. Rougher surfaces produce greater friction than smoother surfaces do.

**D. Gravity**
   1. The noncontact attractive force existing between all objects with mass is **gravity**.
   2. The measure of the amount of gravity acting on an object is its **weight**.
   3. The amount of gravitational force decreases as the distance between two objects increases; thus, an astronaut’s weight decreases as she or he moves away from Earth into space.
   4. Gravity is also affected by mass. As the amount of mass increases, the force of gravity between two objects increases.
      a. The effect of the force of gravity is most noticeable if one object is very **massive**.
      b. Although the force of gravity acts equally on two objects, the less massive object **accelerates** more quickly.
E. Combining Forces

1. The net force is the sum of all forces acting on an object.
   a. When forces act in the same direction, you can add the forces together.
   b. If forces act in the opposite direction, add them just as you add positive and negative numbers.

2. Forces are balanced or unbalanced.
   a. If the net force acting on an object is 0 N, the forces acting on it are balanced forces.
   b. Balanced forces do not affect the motion of an object.
   c. Unbalanced forces are the result of a net force that does not equal zero that acts on an object.
   d. The motion of an object changes when unbalanced forces act on it.

Lesson 3: Newton’s Laws of Motion

accelerate change in velocity
force pair two forces that result from two objects exerting forces on each other
inertia tendency of an object to resist a change in motion

Newton’s first law of motion states that if the net force on an object is zero, the motion of the object does not change.
Newton’s second law of motion states that the acceleration of an object is equal to the net force exerted on the object divided by the object’s mass.

Newton’s third law of motion states that when one object exerts a force on a second object, the second object exerts a force of the same size, but in the opposite direction, on the first object.

A. Newton’s Laws
   1. Forces are measured in newtons (N).
   2. Isaac Newton studied the motion of objects and summarized his findings in three laws.

B. Newton’s First Law
   1. Inertia is the tendency of an object to resist a change in its motion.
   2. Newton’s first law of motion states that if the net force acting on an object is zero, the motion of the object does not change.
   3. Sometimes Newton’s first law of motion is called the law of inertia.
   4. Newton’s first law explains the effect of balanced forces on an object.
      a. If balanced forces act on an object at rest, the object remains at rest.
      b. If balanced forces act on a moving object, the object continues to move at the same velocity.
   5. The motion of an object changes only when a(n) net force acts on it according to Newton’s first law.
      a. Unbalanced forces can cause an object to accelerate, or speed up.
      b. They also can cause an object to decelerate, or slow down.
      c. They also can cause acceleration by causing the object to change direction.

C. Newton’s Second Law of Motion
   1. Newton’s second law of motion states that the acceleration of an object equals the force exerted on the object divided by the mass of the object.
   2. Newton’s second law explains the relationship among force, mass, and acceleration.
D. Newton’s Third Law
1. Newton’s third law states that when one object exerts a(n) **force** on a second object, the second object exerts a force of the same **size** but in the opposite **direction** on the first object.
   a. The initial force is called the **action** force.
   b. The force exerted in response is called the **reaction** force.
2. When two objects exert forces on each other, the two forces are a(n) **force pair**.
   a. Each force in a force pair acts on a(n) **different** object.
   b. Newton’s laws work **together**.

E. Newton’s Laws in Action
1. Newton’s laws do not apply to very **small** objects, such as atoms.
2. They also do not apply to objects whose motion approaches the **speed of light**.