

Chapter 12 Forces and Motion

Summary

12.1 Forces

➡ A force can cause a resting object to move, or it can accelerate a moving object by changing the object's speed or direction.

- A **force** is a push or a pull that acts on an object. One **newton** is the force that causes a 1-kilogram mass to accelerate at a rate of 1 meter per second each second.
- The **net force** is the overall force acting on an object after all the forces are combined.

➡ When the forces on an object are balanced, the net force is zero and there is no change in the object's motion.

➡ When an unbalanced force acts on an object, the object accelerates.

➡ There are four main types of friction: static friction, sliding friction, rolling friction, and fluid friction.

- **Friction** is a force that opposes the motion of objects that touch as they move past each other.
- **Static friction** is the friction force that acts on objects that are not moving.
- **Sliding friction** is a force that opposes an object's direction of motion as it slides over a surface.
- **Rolling friction** is the friction force that acts on rolling objects.
- The force of **fluid friction** opposes an object's motion through a fluid. **Air resistance** is fluid friction that acts on an object moving through the air.

➡ Earth's gravity acts downward toward the center of Earth.

- **Gravity** is a force that acts between any two masses. It is an attractive force.

➡ Gravity causes objects to accelerate downward, whereas air resistance acts in the direction opposite to the motion and reduces acceleration.

- **Terminal velocity** is the constant velocity of a falling object when the force of air resistance equals the force of gravity.

➡ The combination of an initial forward velocity and the downward vertical force of gravity causes the ball to follow a curved path.

- **Projectile motion** is a falling object's motion after it is given a forward velocity.

12.2 Newton's First and Second Laws of Motion

➡ According to Newton's first law of motion, the state of motion of an object does not change as long as the net force acting on the object is zero.

- Inertia is the tendency of an object to resist a change in its motion.

➡ According to Newton's second law of motion, the acceleration of an object is equal to the net force acting on it divided by the object's mass.

➡ Mass is a measure of the inertia of an object; weight is a measure of the force of gravity acting on an object.

- Mass depends on the amount of matter the object contains.

12.3 Newton's Third Law of Motion and Momentum

➡ According to Newton's third law of motion, whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first object.

➡ An object has a large momentum if the product of its mass and velocity is large.

- **Momentum** is the product of an object's mass and its velocity.
- According to the **law of conservation of momentum**, if no net force acts on a system, then the total momentum of the system does not change.

➡ In a closed system, the loss of momentum of one object equals the gain in momentum of another object—momentum is conserved.

12.4 Universal Forces

➡ Electric force and magnetic force are the only forces that can both attract and repel.

- Electromagnetic force is associated with charged particles.

➡ Two forces, the strong nuclear force and the weak nuclear force, act within the nucleus to hold it together.

- The **strong nuclear force** is a powerful force of attraction that acts only on the neutrons and protons in the nucleus, holding them together.
- The **weak nuclear force** is an attractive force that acts only over a short range.
- **Gravitational force** is an attractive force that acts between any two masses.

➡ Newton's law of universal gravitation states that every object in the universe attracts every other object.

- A **centripetal force** is a center-directed force that continuously changes an object's direction to make it move in a circle.