Motion, Forces, and Energy

Frames of Reference

- All movement is compared with a background that is assumed to be stationary. This background is called a frame of reference.
- An object that is stationary in one frame of reference may be moving in another frame of reference. Any frame of reference can be chosen to describe a given movement, but the most common frame of reference is the Earth.

Measuring Motion

- Motion involves a change in position during a certain amount of time. The characteristics of position and time are used to measure motion.
- The rate at which an object moves is speed. Any object that is changing its position has speed. Speed can be determined by dividing the distance traveled by the time taken to travel that distance.
- Speed that does not change is called constant speed. For an object moving at constant speed, the speed at any point is the same as the average speed. For an object whose speed varies, you calculate the average speed.
- Speed in a given direction is velocity.
- Velocities that have the same direction combine by addition. Velocities that have opposite directions combine by subtraction.

Changes in Velocity

- Acceleration is the rate of change in velocity. It is equal to the change in velocity divided by time it takes to make the change.
- An object that is accelerating is speeding up, slowing down, or changing direction
- Negative acceleration is also known as deceleration.
- Circular motion always involves acceleration because the object's direction is constantly changing.

Momentum

- Momentum is equal to the mass of an object multiplied by its velocity. An object with a large momentum is very difficult to stop.
- The total momentum of any group of objects remains the same unless outside forces act on the objects.

What is force?

- A force is a push or pull. A force may give energy to an object, setting the object in motion, stopping it, or changing its direction.
- Forces in the same direction combine by addition. Forces in opposite directions combine by subtraction.
- Unbalanced forces cause a change in motion. When forces are balanced, there is no change in motion. Balanced forces are opposite in direction and equal in size.

Friction: A Force Opposing Motion

- Friction is a force that opposes motion.
- The three kinds of friction are sliding, rolling, and fluid friction.

Newton's Laws of Motion

- Inertia is the tendency of matter to resist a change in motion.
- Newton's first law of motion states that an object at rest will remain at rest and an object in motion will remain in motion at constant velocity unless acted upon by an unbalanced force.
- Newton's second law of motion describes how force, acceleration, and ,mass are related. Force equals mass times acceleration.
- Newton's third law of motion states that forces always occur in pairs. Every action has an equal and opposite reaction.

Gravity

- The acceleration due to gravity at the surface of the Earth is 9.8 m/sec/sec.
- Gravity is a force of attraction that exists between all objects in the universe.
- The size of the force of gravity depends on the masses of the two objects and the distance between them.
- Weight and mass are different quantities. Weight is a measure of the pull of gravity on a given mass. Mass is a measure of the amount of matter in an object. Mass is constant; weight can change.

Nature of Energy

- Energy is the ability to do work.
- Energy appears in many forms: mechanical, heat, chemical, electromagnetic, and nuclear.

Kinetic and Potential

- Energy that an object has due to its motion is called kinetic energy.
- Kinetic energy equals one half the product of the mass times the square of the velocity.
- Energy that an object has due to its shape or position is called potential energy.
- Potential energy that an object has due to its height above the Earth's surface and its weight is called gravitational potential energy.

Energy Conversions

- Energy can change from one form to another. Changes in the form of energy are called energy conversions.
- The most common energy conversions occur between kinetic energy and potential energy. But all forms of energy can be converted to another form.

Conservation of Energy

- The law of conservation of energy states that energy can neither be created nor destroyed by ordinary means.

Physics and Energy

- Energy is involved in every physical activity or process.
- An increase in speed or velocity is accompanied by an increase in kinetic energy.
- An object that has kinetic energy also has momentum.
- A force doing work on an object to change its motion is giving energy to the object.
- Power is the rate at which energy is used.
- The conservation of work can be understood because energy is conserved.