Force and Energy

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Concept 1: Force – Definition and Effects

Definition

Force is a push or pull acting on an object.

Unit

Newton (advanced level information).

Effects of Force

Change in shape.

Change in size.

Change in speed.

Change in direction of motion.

Start motion.

Stop motion.

Examples

Pushing a door.

Pulling a cart.

Kicking a ball.

Balanced and Unbalanced Forces

Balanced Forces

Equal forces acting in opposite directions.

No change in motion.

Unbalanced Forces

Unequal forces.

Cause change in motion.

Types of Forces

Contact Forces

Muscular Force

Force applied by muscles.

Example: lifting a bag.

Frictional Force

Force that opposes motion between two surfaces in contact.

Non-Contact Forces

Gravitational Force

Force by which Earth attracts objects toward its center.

Magnetic Force

Force exerted by magnets.

Electrostatic Force

Force between electrically charged objects.

Gravitational Force
Acts on all objects.
Gives weight to objects.
Always attractive.
Friction
Opposes motion.
Produces heat.
Depends on surface roughness.
Advantages of Friction
Helps in walking.
Allows writing on paper.
Prevents slipping.
Disadvantages of Friction
Causes wear and tear.
Produces unwanted heat.
Reducing Friction
Using lubricants.
Using wheels and ball bearings.
Magnetic Force
Like poles repel.
Unlike poles attract.
Magnetic materials
Iron
Nickel
Cobalt.
Electrostatic Force
Produced by rubbing objects.
Can attract light objects.
Common Examination Traps
Force always causes motion. Incorrect. Balanced forces may not cause motion.
Gravitational force acts only on Earth. Incorrect. It acts between all masses.
Friction is always harmful. Incorrect. It is useful in many cases.
Advanced Understanding
Net force determines acceleration.
More force produces greater change in motion.
Concept Linkage
Force causes motion and work.
Work requires force and displacement.

Concept 2: Simple Machines

Definition

A simple machine is a device that makes work easier by reducing effort or changing the direction of force.

Work

Work is done when a force moves an object through a distance.

Effort

Force applied.

Load

Object on which work is done.

Mechanical Advantage

Ratio of load to effort.

If mechanical advantage is greater than 1, machine reduces effort.

Types of Simple Machines

1. Lever

Definition

A rigid bar that rotates around a fixed point.

Fulcrum

Fixed point around which lever rotates.

Classes of Lever

First Class Lever

Fulcrum between effort and load.

Example: see-saw, scissors.

Second Class Lever

Load between fulcrum and effort.

Example: wheelbarrow, nutcracker.

Third Class Lever

Effort between fulcrum and load.

Example: fishing rod, human forearm.

Key Rule

Position of fulcrum, load and effort determines class.

1. Pulley

Definition

A wheel with a groove through which a rope passes.

Fixed Pulley

Changes direction of force.

Does not reduce effort.

Movable Pulley

Reduces effort.

Load attached to pulley.
Block and Tackle
Combination of pulleys.
Increases mechanical advantage.
1. Inclined Plane
Definition
Sloping surface used to raise objects.
Reduces effort by increasing distance.
Example
Ramp.
1. Wheel and Axle
Wheel attached to a smaller rod (axle).
Turning wheel rotates axle.
Example
Door knob.
Steering wheel.
1. Wedge
Two inclined planes joined together.
Used for cutting or splitting.
Example
Knife.
Axe.
1. Screw
Inclined plane wrapped around a cylinder.
Example
Bolt.
Jar lid.
Advantages of Simple Machines
Reduce effort.
Change direction of force.
Increase speed of work.
Important Principle
Machines do not reduce total work.
They trade force for distance.
Common Examination Traps
All pulleys reduce effort. Incorrect. Fixed pulley changes direction only.
In first class lever, load is always in middle. Incorrect. Fulcrum is in middle.
Wheel and axle increases distance but not force. Incorrect. It can increase force.
Advanced Understanding

Mechanical advantage depends on arrangement of parts.
Efficiency of machine affected by friction.
Concept Linkage
Force is required for work.
Simple machines modify force to make work easier.

Concept 3: Energy – Forms and Transformations

Definition
Energy is the capacity to do work.
Unit
Joule (advanced information).
Main Forms of Energy
Mechanical Energy
Heat Energy
Light Energy
Sound Energy
Electrical Energy
Chemical Energy
Solar Energy
Mechanical Energy
Energy possessed by an object due to motion or position.
Two Types
Kinetic Energy
Energy of motion.
Example: moving car.
Potential Energy
Stored energy due to position or shape.
Example: stretched rubber band, water stored in dam.
Conversion between Potential and Kinetic
Object at height has potential energy.
When it falls, potential converts to kinetic energy.
Heat Energy
Energy due to temperature.
Produced by burning fuels and friction.
Light Energy
Energy that enables us to see.
Sun is major natural source.
Sound Energy
Energy produced by vibrating objects.

Electrical Energy
Energy produced by flow of electric current.
Chemical Energy
Energy stored in food, fuels and batteries.
Solar Energy
Energy obtained from Sun.
Source of almost all energy on Earth.
Law of Conservation of Energy
Energy cannot be created or destroyed.
It can only change from one form to another.
Examples of Energy Conversion
Electric bulb
Electrical energy to light and heat.
Fan
Electrical energy to mechanical energy.
Solar panel
Solar energy to electrical energy.
Human body
Chemical energy from food to mechanical energy.
Hydroelectric plant
Potential energy of water to electrical energy.
Renewable Energy Sources
Solar energy
Wind energy
Hydropower
Non-Renewable Energy Sources
Coal
Petroleum
Natural gas
Advantages of Renewable Energy
Non-polluting.
Sustainable.
Disadvantages of Non-Renewable Energy
Limited supply.
Cause pollution.
Common Examination Traps
Energy is lost when used. Incorrect. It changes form.
Sound energy can exist without vibration. Incorrect. It requires vibration.
Potential energy exists only at height. Incorrect. It can also be stored due to

compression or stretching.

Advanced Understanding

Mechanical energy equals sum of kinetic and potential energy.

Efficiency of energy conversion is never 100 percent due to heat loss.

Concept Linkage

Force does work.

Work requires energy.

Simple machines help use energy efficiently.