Class 9 Science Chapter 11: Work and Energy (Detailed Notes with Practice Questions and Numericals)

1. Introduction to Work

- **Work**: Work is done when a force causes an object to move in the direction of the applied force.
  - **Formula**:

$$W = F \cdot d \cdot \cos\theta$$

  Where:

  - W = Work (in Joules),
  - F = Force (in Newtons),
  - d = Displacement (in meters),
  - θ = Angle between the force and the direction of displacement.
- **Work Done**:
  - **Positive Work**: When the force and displacement are in the same direction.
  - **Negative Work**: When the force and displacement are in opposite directions.

Practice Questions:

1. Define work and state its unit.
2. What is the work done when the force is perpendicular to the direction of displacement?
3. Calculate the work done by a 20 N force that moves an object 5 meters.

Numerical Problems:

1. A force of 50 N is applied to push a box 10 meters. Calculate the work done.

2. If a person lifts a 5 kg object to a height of 2 meters, how much work is done against gravity?

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2. Energy

- **Energy**: The capacity to do work.
    - **SI Unit**: Joule (J).

Types of Energy:

1. **Kinetic Energy (KE)**: The energy possessed by an object due to its motion.

- **Formula**:

$$KE = \frac{1}{2}mv^2$$

Where:

- m = Mass of the object (in kg),
- v = Velocity of the object (in m/s).

2. **Potential Energy (PE)**: The energy possessed by an object due to its position or configuration.

- **Formula**:

$$PE = mgh$$

Where:

- m = Mass of the object (in kg),
- g = Acceleration due to gravity ($9.8\,\mathrm{m/s^2}$),
- h = Height above the ground (in meters)

Practice Questions:

1. Define kinetic and potential energy with examples.
2. What factors affect the kinetic energy of an object?
3. Explain how potential energy changes as an object is raised to a height.

Numerical Problems:

1. Calculate the kinetic energy of a 10 kg object moving at a velocity of 5 m/s.
2. A stone of mass 2 kg is raised to a height of 10 m. Find the potential energy.

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3. Law of Conservation of Energy

- **Law of Conservation of Energy**: Energy can neither be created nor destroyed; it can only be transformed from one form to another.
    - **Example**: A pendulum's energy continuously transforms between kinetic and potential energy.

Practice Questions:

1. State the Law of Conservation of Energy.
2. Explain how energy transformation occurs in a simple pendulum.
3. Give two examples where energy is transformed from one form to another.

Numerical Problems:

1. A pendulum swings to a height of 5 m. If its mass is 2 kg, calculate the total mechanical energy at the highest point and when it reaches the lowest point.

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4. Power

- **Power**: The rate at which work is done or energy is transferred.
  - **Formula**:

$$P = \frac{W}{t}$$

  Where:

  - P = Power (in Watts),
  - W = Work done (in Joules),
  - t = Time taken (in seconds).
- **SI Unit**: Watt (W), where 1 W = 1 J/s.

Practice Questions:

1. Define power and state its unit.
2. How is power related to work and time?
3. If a machine does 1000 J of work in 10 seconds, what is its power?

Numerical Problems:

1. A machine does 500 J of work in 5 seconds. Calculate its power.
2. A car engine transfers 50,000 J of energy in 25 seconds. What is the power output?

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5. Commercial Unit of Energy

- **Commercial Unit of Energy**: Kilowatt-hour (kWh).
    - **Relation**:

$$1\,\text{kWh} = 3.6 \times 10^6\,\text{J}$$

Practice Questions:

1. What is the commercial unit of energy?
2. Convert 5 kWh into joules.
3. Why is the kilowatt-hour used as the commercial unit of electrical energy?

Numerical Problems:

1. A household uses 2 kWh of energy daily. Convert this energy into joules.
2. An appliance consumes 3 kWh of energy in 4 hours. What is its power rating?

Important Formulas

1. **Work**:

$$W = F \cdot d \cdot \cos\theta$$

2. **Kinetic Energy**:

$$KE = \frac{1}{2}mv^2$$

3. **Potential Energy**:

$$PE = mgh$$

4. **Power**:

$$P = \frac{W}{t}$$

5. **Commercial Unit of Energy**:

$$1\,\text{kWh} = 3.6 \times 10^6\,\text{J}$$

Revision Notes

1. Work is done when a force causes displacement in the direction of the force.
2. Kinetic energy depends on an object's mass and velocity, while potential energy depends on its mass, height, and gravity.
3. Energy cannot be created or destroyed; it only transforms from one form to another (Law of Conservation of Energy).
4. Power measures how fast work is done, and its unit is the watt.
5. The commercial unit of energy is kilowatt-hour (kWh), used to measure electrical energy consumption.