

# Chapter 2: Work, Energy & Power

## ◆ 1. Work

- **Work is done** when a force causes displacement in an object.
- **Formula:**  
 $W = F \times S \times \cos\theta$   
Where:  
F = Force,  
S = Displacement,  
 $\theta$  = Angle between force and displacement
- **Units:**  
SI Unit = Joule (J),  
 $1 \text{ J} = 10^7 \text{ erg (CGS unit)}$
- **Special Cases:**
  - $\theta = 0^\circ \rightarrow$  **Maximum Work**
  - $\theta = 90^\circ \rightarrow$  **Zero Work**
  - $\theta = 180^\circ \rightarrow$  **Negative Work**

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## ◆ 2. Energy

- **Energy** is the capacity to do work.
- **Units:** Joule (J), kilojoule (kJ), calorie ( $1 \text{ cal} = 4.18 \text{ J}$ ), kilowatt-hour ( $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$ )
- **Types of Energy:**
  - **Mechanical Energy** = Potential + Kinetic
    - **Potential Energy (PE):**  
 $PE = mgh$
    - **Kinetic Energy (KE):**  
 $KE = \frac{1}{2}mv^2$
  - **Other Forms:**
    - Heat, Light, Chemical, Sound, Electrical, Nuclear, Magnetic, etc.

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## ◆ 3. Power

- **Power** is the rate at which work is done.  
 $P = \frac{W}{t}$
- **Units:**
  - SI Unit: Watt (W)

- Larger Units: Kilowatt (kW), Megawatt (MW), etc.
- 1 HP (Horsepower) = 746 W
- **Average Power:**

$$P_{\text{avg}} = \frac{\text{Total work done}}{\text{Total time taken}}$$

#### ◆ 4. Commercial Unit of Energy

- 1 kilowatt-hour (1 kWh) = 1000 W × 3600 s =  **$3.6 \times 10^6$  J**
- Used in electricity bills.

#### ◆ 5. Law of Conservation of Energy

- **Energy can neither be created nor destroyed.**
- It only **transforms** from one form to another.
- Total energy in an isolated system remains **constant**.

#### ◆ 6. Practical Examples

- **Hydroelectric Dam:** PE → KE → Electrical
- **Spring Toy:** Elastic → Mechanical
- **Battery:** Chemical → Electrical
- **Solar Panel:** Solar → Electrical
- **Fan:** Electrical → Mechanical

#### ◆ 7. Key Equations to Remember

| Concept           | Formula                                     |
|-------------------|---------------------------------------------|
| Work              | $W = FScos\theta$                           |
| Kinetic Energy    | $KE = \frac{1}{2}mv^2$                      |
| Potential Energy  | $PE = mgh$                                  |
| Power             | $P = \frac{W}{t}$                           |
| Energy Conversion | $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$ |

