1. Introduction to Heat

- **Heat** is a form of energy that flows from a body at a higher temperature to a body at a lower temperature.
- The **SI Unit of Heat** is the **Joule (J)**. However, in some cases, **Calorie (cal)** is used. 1 Calorie = 4.18 Joules.

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2. Temperature and Temperature Scales

- **Temperature** is a measure of the average kinetic energy of particles in a substance.
- The **SI Unit of Temperature** is **Kelvin (K)**.
- Common temperature scales:
    - **Celsius (°C)**: The most common scale.
    - **Fahrenheit (°F)**: Primarily used in the United States.
    - **Kelvin (K)**: Used in scientific experiments.

Conversion between temperature scales:

- **Celsius to Fahrenheit**: $F=95C+32$F = \frac{9}{5}C + 32
- **Celsius to Kelvin**: $K=C+273$K = C + 273

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3. Measurement of Heat

- The amount of heat energy required to change the temperature of a substance is given by the formula:
  $Q=mc\Delta T$Q = mc\Delta T

Where:

- **Q** is the heat energy absorbed or released (Joules or Calories).
- **m** is the mass of the substance (kg or g).
- **c** is the specific heat capacity of the substance (J/kg°C or cal/g°C).
- **ΔT** is the change in temperature (T2 - T1 in °C or K).

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4. Specific Heat Capacity

- **Specific Heat Capacity (c)** is the amount of heat required to raise the temperature of 1 kg of a substance by 1°C (or 1 K).
  - **Formula**: c=QmΔTc = \frac{Q}{m \Delta T}
  - Different materials have different specific heat capacities, which is why some materials heat up or cool down faster than others.

Example:

- The specific heat capacity of water is quite high (4200 J/kg°C), which is why water is used to regulate temperature in various systems (like cooling systems in engines).

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5. Latent Heat

- **Latent Heat** is the heat energy required to change the state of a substance without changing its temperature.
- Two main types of latent heat:
  - **Latent Heat of Fusion**: The heat required to convert a solid into a liquid at its melting point (no temperature change).
    - **Formula**: Q=mLfQ = mL_f

        - Where LfL_f is the latent heat of fusion.
    - **Latent Heat of Vaporization**: The heat required to convert a liquid into a gas at its boiling point (no temperature change).
        - **Formula**: Q=mLvQ = mL_v
        - Where LvL_v is the latent heat of vaporization.

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6. Modes of Heat Transfer

- Heat can be transferred in three ways:
    1. **Conduction**: Transfer of heat through a substance without the movement of particles. It occurs primarily in solids.
        - Example: A metal spoon gets hot when placed in hot water.
    2. **Convection**: Transfer of heat by the movement of particles in a fluid (liquids or gases).
        - Example: Warm air rising and cool air sinking.
    3. **Radiation**: Transfer of heat through electromagnetic waves. This doesn't require a medium (can occur in a vacuum).
        - Example: Heat from the Sun reaches Earth through radiation.

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7. Practical Applications of Heat

- **Thermometers**: Used to measure temperature.
    - Mercury or alcohol thermometers rely on the expansion of liquids with temperature.
- **Calorimetry**: Measurement of heat in physical and chemical processes.

    - **Calorimeter** is an instrument used to measure the amount of heat absorbed or released during a process.

- **Boiling and Melting Points**: Temperature at which a substance changes state.
    - **Boiling point**: Temperature at which a liquid turns into a gas.
    - **Melting point**: Temperature at which a solid turns into a liquid.

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8. Concept of Heat Engines

- Heat engines convert heat energy into mechanical work.
    - Examples: Internal combustion engines in cars.
- **Efficiency of Heat Engines**: The efficiency of a heat engine is determined by the ratio of useful work done to the total heat energy supplied.
    - **Efficiency** = WQ\frac{W}{Q}, where W is the work done and Q is the heat supplied.

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9. Laws of Thermodynamics

- **Zeroth Law of Thermodynamics**: If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.
- **First Law of Thermodynamics (Law of Energy Conservation)**: Energy cannot be created or destroyed, only converted from one form to another.
    - ΔU=Q−W\Delta U = Q - W, where ΔU is the change in internal energy, Q is the heat supplied, and W is the work done by the system.
- **Second Law of Thermodynamics**: Heat energy flows naturally from a body at a higher temperature to one at a lower temperature.
    - This law also introduces the concept of entropy (a measure of disorder).

- **Third Law of Thermodynamics**: As temperature approaches absolute zero, the entropy of a system approaches a minimum value.