University of Science and Technology

Faculty of Engineering

First Year - Semester One - Academic Year:2025-2026

Physics (1)

Lec (7)

Heat

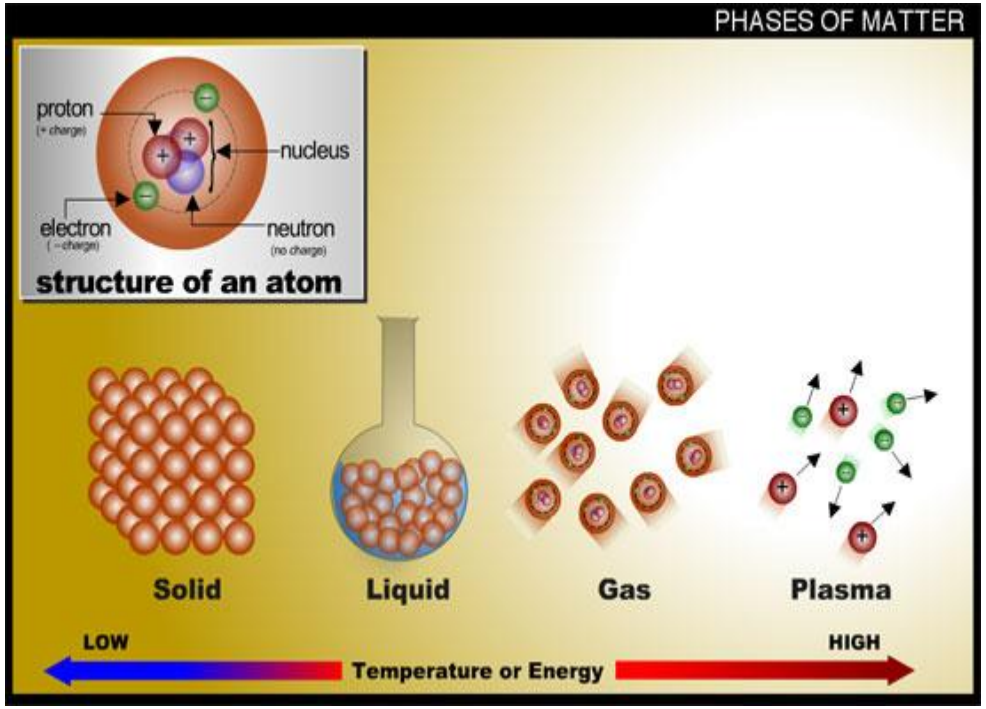
THE KINETIC THEORY OF MATTER

- All of the particles that make up matter are constantly in motion

- **SOLID=** vibrating atoms
- **LIQUID=** flowing atoms
- **GAS=** move freely
- **PLASMA=**

  move incredibly

  fast and freely



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Deeper Definition: Heat is **energy that transfers between bodies due to a temperature difference**. It is not stored in the body as a static property; it appears only during **energy transfer**.

Methods of Heat Transfer:

1. **Conduction:**
    - Transfer of heat through solids without the bulk movement of material.
    - Example: Placing a metal spoon in hot water — the spoon gradually heats up.
2. **Convection:**
    - Heat transfer through the movement of liquids or gases.
    - Example: Heating water in a pot — hot water rises and cold water sinks.
3. **Radiation:**
    - Transfer of heat through electromagnetic waves without a physical medium.
    - Example: The Sun’s heat reaching the Earth.

Important Properties:

- The amount of heat depends on **mass, material type, and temperature difference**.
- Formula:

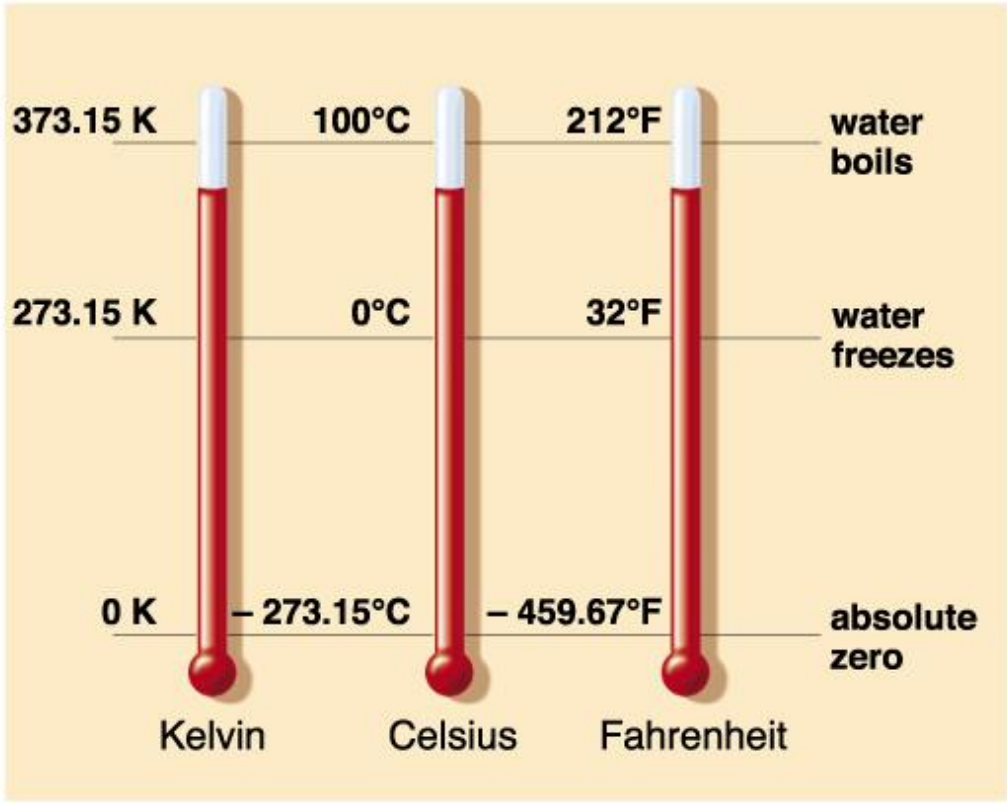
$$Q=m\cdot c\cdot \Delta T$$

Where:

  - Q = heat energy
  - m = mass
  - c = specific heat capacity
  - ΔT = temperature change

TEMPERATURE

- The Measure of the average kinetic energy of all the particles in the object
- The atoms mass and speed determine the temperature of the object



Temperature

Deeper Definition: Temperature is a **measure of the average kinetic energy of particles in a body**. The faster the particles move, the higher the temperature.

Scales:

1. **Kelvin (K):** The scientific standard, starting from absolute zero, where particle motion nearly stops.
2. **Celsius (°C):** Starts at the freezing point of water (0°C) and boiling point (100°C).
3. **Fahrenheit (°F):** Common in some countries like the USA.

Practical Examples:

- Water at 25°C: particles move at moderate speed.
- Fire at 800°C: particles move extremely fast.

Difference Between Heat and Temperature

Property	Heat	Temperature
What is it?	Energy that transfers	Measure of average particle motion
Does it transfer?	Yes, from hot to cold	No, it only measures
Unit	Joule (J), calorie (cal)	Kelvin (K), Celsius (°C)
Example	Pouring hot water on ice melts the ice	Water at 80°C has fast-moving particles

Relationship Between Heat and Temperature:

- Adding heat usually raises temperature, **but not always**:
  - During **phase changes** (melting, boiling), heat is absorbed **without a temperature change**, called **latent heat**.
  - Example: Melting 1 kg of ice at 0°C requires energy, but the temperature remains 0°C until all ice melts.

1. Types of Thermometers

1. Mercury Thermometer

- Contains a mercury column inside a glass tube.
- Measures temperature very accurately.
- Commonly used for high-precision measurements.

2. Alcohol Thermometer

- Contains colored alcohol inside a glass tube.
- Suitable for very low temperatures, as alcohol freezes below 0°C.

1. **Digital Thermometer**
    - Measures temperature electronically using sensors.
    - Displays the reading directly on a digital screen.
    - Fast and convenient for home and lab use.
2. **Resistance Thermometer (RTD)**
    - Based on the change in resistance of metallic wires with temperature.
    - Used in precise industrial applications.
3. **Infrared Thermometer**
    - Measures the surface temperature without touching the object.
    - Useful for hot or moving objects.

THERMOMETRIC PROPERTIES

Thermometer	Thermometric Property
Mercury thermometer	Length of mercury column
Constant-volume gas thermometer	Pressure of the gas
Thermocouple	Voltage
Thermogram or Ear thermometer	Infrared radiation

2. Temperature Scales

Celsius (°C)

- Based on the freezing and boiling points of water:
    - Freezing: 0°C
    - Boiling: 100°C

Fahrenheit (°F)

- Based on the freezing and boiling points of water:
    - Freezing: 32°F
    - Boiling: 212°F

THE KELVIN TEMPERATURE SCALE

Kelvin temperature scale has greater scientific significance.

It was introduced by Kelvin (1824–1907).

A temperature of 300 K (not 300 °K) is read as “three hundred kelvins,” not “three hundred degrees kelvin.”

The kelvin is the SI base unit for temperature.

Kelvin (K)

- The scientific standard scale, starting from **absolute zero** where particle motion nearly stops.
- Conversion from Celsius:

$$K = °C + 273.15$$

3. Conversion Formulas

1. Celsius to Fahrenheit: $°F=(°C\times 9/5)+32$
2. Fahrenheit to Celsius: $°C=(°F-32)\times 5/9$
3. Celsius to Kelvin: $K=°C+273.15$
4. Kelvin to Celsius: $°C=K-273.$

. Practical Examples

1. **Room Temperature:**
    - 25°C = 77°F = 298.15 K
2. **Boiling Point of Water:**
    - 100°C = 212°F = 373.15 K
3. **Freezing Point of Water:**
    - 0°C = 32°F = 273.15 K
4. **Absolute Zero (lowest possible temperature):**
    - -273.15°C = -459.67°F = 0 K