



Al-Mustaqbal University / College of Technical Engineering
Department of Aircraft Technical Engineering
Class (First Year)
Subject (**Physics**) / Code (**UOMU0210022**)
Lecturer (Asst. Lect. Sameer Saad Raheem)
2nd term – Lecture No.9 & Lecture Name (**Temperature**)

Topics: Temperature, Heat Transfer, and Thermodynamic Laws

1. Introduction

In this lecture, we study the fundamentals of thermodynamics, focusing on temperature, heat transfer mechanisms, and the basic laws governing energy systems. These concepts are essential in engineering applications such as engines, refrigeration systems, and heat exchangers.

2. Temperature

2.1 Definition

Temperature is a measure of the thermal state of a body and determines the direction of heat transfer between systems.



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2.2 Temperature Scales

- Celsius (°C)
- Fahrenheit (°F)
- Kelvin (K)

2.3 Conversion Equations

$$K = ^\circ C + 273$$

$$^\circ F = (9/5)^\circ C + 32$$



3. Heat and Heat Capacity

3.1 Heat (Q)

Heat is a form of energy transfer due to temperature difference between systems.

3.2 Heat Capacity (C)

The amount of heat required to raise the temperature of a body by 1°C.

3.3 Specific Heat (c)

The heat required to raise the temperature of 1 kg of a substance by 1°C.

$$Q = m c \Delta T$$



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4. Heat Transfer Mechanisms

4.1 Conduction

Heat transfer through a solid medium without movement of particles.

4.2 Convection

Heat transfer through fluid motion (liquids or gases).

4.3 Radiation

Heat transfer through electromagnetic waves without the need for a medium.



5. Volumetric Expansion

When temperature increases, materials expand.

$$\Delta V = \beta V_0 \Delta T$$

Where:

- ΔV : Change in volume
- β : Coefficient of volumetric expansion
- V_0 : Initial volume



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6. Laws of Thermodynamics

6.1 First Law

Energy cannot be created or destroyed, only transformed.

$$Q = \Delta U + W$$

6.2 Second Law

Heat flows naturally from a higher temperature to a lower temperature.



7. Solved Engineering Examples

Example 1: Temperature Conversion

Problem:

Convert 25°C to Kelvin and Fahrenheit.

Solution:

$$\mathbf{K = 25 + 273 = 298 K}$$

$$\mathbf{^{\circ}F = (9/5 \times 25) + 32 = 77^{\circ}F}$$



Example 2: Heat Transfer

Problem:

Calculate the heat required to raise the temperature of 3 kg of water by 20°C.

($c = 4180 \text{ J/kg}\cdot^\circ\text{C}$)

Solution:

$$Q = m c \Delta T$$

$$Q = 3 \times 4180 \times 20 = 250800 \text{ J}$$

Final Answer: $Q = 2.51 \times 10^5 \text{ J}$



Example 3: Volumetric Expansion

Problem:

A liquid has an initial volume of 0.01 m^3 and is heated by 30°C . If $\beta = 0.00021$, find ΔV .

Solution:

$$\Delta V = \beta V_0 \Delta T$$

$$\Delta V = 0.00021 \times 0.01 \times 30 = 0.000063 \text{ m}^3$$



Example 4: First Law of Thermodynamics

Problem:

A system receives 500 J of heat and does 200 J of work. Find the change in internal energy.

Solution:

$$Q = \Delta U + W$$

$$\Delta U = Q - W = 500 - 200 = 300 \text{ J}$$

Final Answer: $\Delta U = 300 \text{ J}$



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8. Summary of Key Formulas

$$K = {}^{\circ}C + 273$$

$${}^{\circ}F = (9/5){}^{\circ}C + 32$$

$$Q = m c \Delta T$$

$$\Delta V = \beta V_0 \Delta T$$

$$Q = \Delta U + W$$