

Unit 7 Thermal Properties of Matter

Important Formulas

➤ Celsius To Fahrenheit Scale

$$T_F = \frac{9}{5} T_C + 32$$
$$T_F = 1.8 T_C + 32$$

➤ Celsius to Kelvin Scale

$$T_K = 273 + T_C$$

7.1. Normal human body temperature is 98.6°F . Convert it into Celsius scale and Kelvin scale.

Given Data

$$\text{Temperature in Fahrenheit} = T_F = 98.6^\circ\text{F}$$

To Find

$$\text{Temperature in Celsius} = T_C = ?$$

$$\text{Temperature in Kelvin} = T_K = ?$$

Solution

By using Fahrenheit scale

$$T_F = \frac{9}{5} T_C + 32$$
$$T_F = 1.8 T_C + 32$$
$$98.6 = 1.8 T_C + 32$$
$$98.6 - 32 = 1.8 T_C$$
$$66.6 = 1.8 T_C$$
$$\frac{66.6}{1.8} = T_C$$
$$37 = T_C$$
$$T_C = 37^\circ\text{C}$$

Now by using Kelvin scale

$$T_K = 273 + T_C$$
$$T_K = 273 + 37$$
$$T_K = 310 \text{ K}$$

7.2. At what temperature Celsius and Fahrenheit thermometer reading would be the same?

Given Data

$$\text{Let temperature in Celsius} = T_C = T$$

$$\text{And temperature in Fahrenheit} = T_F = T$$

To Find

$$\text{Temperature at which} = T = T_C = T_F$$

Solution

By using Fahrenheit scale

$$T_F = \frac{9}{5} T_C + 32$$
$$T = \frac{9}{5} T + 32 \quad \because T = T_C = T_F$$
$$T = 1.8 T + 32$$
$$T - 1.8 T = 32$$
$$-0.8 T = 32$$
$$T = \frac{32}{-0.8}$$
$$T = -40$$

OR

$$T_F = \frac{9}{5} T_C + 32$$
$$T = \frac{9}{5} T + 32 \quad \because T = T_C = T_F$$
$$T = \frac{9 T + 160}{5}$$

$$5 T = 9 T + 160$$

$$5 T - 9 T = 160$$

$$-4 T = 160$$

$$T = \frac{160}{-4}$$

$$T = -40$$

7.3. Convert 5°F to Celsius and Kelvin scale.

Given Data

$$\text{Temperature in Fahrenheit} = T_F = 5^\circ\text{F}$$

To Find

$$\text{Temperature in Kelvin} = T_K = ?$$

Solution

By using Fahrenheit scale

$$T_F = 1.8 T_C + 32$$
$$5 = 1.8 T_C + 32$$
$$5 - 32 = 1.8 T_C$$
$$-27 = 1.8 T_C$$
$$\frac{-27}{1.8} = T_C$$
$$-15 = T_C$$
$$T_C = -15^\circ\text{C}$$

Now by using Kelvin scale

$$T_K = 273 + T_C$$
$$T_K = 273 + (-15)$$
$$T_K = 273 - 15$$
$$T_K = 258 \text{ K}$$

7.4. What is equivalent temperature of 25°C on Fahrenheit and Kelvin scales?

Given Data

$$\text{Temperature in Celsius} = T_C = 25^\circ\text{C}$$

To Find

$$\text{Temperature in Fahrenheit} = T_F = ?$$

$$\text{Temperature in Kelvin} = T_K = ?$$

Solution

By using formula of Fahrenheit scale

$$T_F = 1.8 T_C + 32$$
$$T_F = 1.8 (25) + 32$$
$$T_F = 45 + 32$$
$$T_F = 77^\circ\text{F}$$

Now by using Kelvin scale

$$T_K = 273 + T_C$$
$$T_K = 273 + 25$$
$$T_K = 298 \text{ K}$$

7.5. The ice and steam points on an ungraduated thermometer are found to be 192 mm apart. What temperature will be on Celsius scale if the length of mercury thread is at 67.2 mm above the ice point mark?

Given Data

$$\text{Length between ice and steam points} = l_{100} = 192 \text{ mm}$$

$$\text{Length of mercury thread} = l_\theta = 67.2 \text{ mm}$$

To Find

$$\text{Temperature on Celsius scale} = T_C = ?$$

Solution

We use the formula for temperature on a linear scale:

$$T_C = \frac{l_\theta}{l_{100}} \times 100$$

$$T_C = \frac{67.2}{192} \times 100$$

$$T_C = 35^\circ\text{C}$$

7.6. The length between the fixed point of liquid-in-glass thermometer is 20 cm. If the mercury level is 4.5 cm above the lower mark, what is the temperature on the Fahrenheit scale?

Given Data

$$\text{Length between fixed points} = l_{100} = 20 \text{ cm}$$

$$\text{Length of mercury thread} = l_\theta = 4.5 \text{ cm}$$

To Find

$$\text{Temperature on Fahrenheit scale} = T_F = ?$$

Solution

We use the formula for temperature on a linear scale:

$$T_C = \frac{l_\theta}{l_{100}} \times 100$$

$$T_C = \frac{4.5}{20} \times 100$$

$$T_C = 22.5^\circ\text{C}$$

By using Fahrenheit scale

$$T_F = 1.8 T_C + 32$$

$$T_F = (1.8)(22.5) + 32$$

$$T_F = 40.5 + 32$$

$$\mathbf{T_F = 72.5^\circ\text{F}}$$