CW

Chapter-9
Heat and Temperature

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1. **Temperature**
Temperature is the average kinetic energy of all molecules of present in that body. It is measured by thermometer and its SI unit is kelvin.

2. **Heat**
Heat is defined as the sum of ~~all molecules of a substance~~ kinetic energy of all molecules of that substance.

3. **Effect of heat**
When heat is applied to a body, it brings the following changes;
i. Change in temperature
ii. Change in volume
iii. Change of state of matter
iv. Electric effect
v. Generation of light energy
vi. Change in resistance

4. **Thermal Equilibrium**
Two bodies are said to be in thermal equilibrium with each other when no heat flows from one body to another when they are brought in thermal contact.

5. **Zeroth law of Thermodynamics**
It states that if two system are seperately in thermal equilibrium with a third system then they must be in thermal equilibrium with each other.

Thermodynamic System: The system which can be explained by thermodynamic parameters (Temperature, pressure, volume, heat exchange).

6. Thermometry

Thermometry is the science of temperature and its measurement.

Three main steps of thermometry;

i. Construction ii) Calibration iii) Sensitiveness

7. Temperature scale and their relation

Measuring Scale	L.F.P	U.F.P
Celsius scale	0	100
Fahrenheit Scale	32	212
Kelvin Scale	273	373
Reaumer scale	0	80

Relation between them:

$$\frac{C-0}{100} = \frac{F-32}{180} = \frac{K-273}{100} = \frac{R-0}{80}$$

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9. At what temperature will the kelvin scale reading double the fahrenheit reading.

Solution:

Let the temperature in kelvin be 'K'

By question: K = 2F

We know,

$$\frac{F-32}{180} = \frac{K-273}{100}$$

or, $\frac{F-32}{180} = \frac{2F-273}{100}$

or, $100f - 3200 = 360f - 49140$

or, $45940 = 260f$

$\therefore f = 176.69$

~~Also, 2f = 176.69 × 2 = 353.38~~

Hence, at 176.69°F or 353.38K temperature reading will be double

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1. Convert 30°c into ~~kelvin scale~~ fahrenheit scale.

Solution:

Given, Temperature in celsius (C) = 30°C

Temperature in fahrenheit (f) = ?

We know,

$$\frac{C-0}{100} = \frac{f-32}{180}$$

or, $\frac{30}{100} = \frac{f-32}{180}$

or, $\frac{30 \times 180}{100} + 32 = f$

$\therefore f = 86°f$

Hence, 30°c = 86°f

2. At what temperature will the celsius reading double of fahrenheit reading.

Solution:

Let the temperature in celsius be '2x' and fahrenheit be 'x'

We know,

$$\frac{C-0}{100} = \frac{f-32}{180}$$

or, $\frac{2x}{100} = \frac{x-32}{180}$

or, $360x = 100x - 3200$

$\therefore x = -12.307°f$

Hence, at -12.307°f, celsius reading ~~will~~ will double the fahrenheit reading.

3 At what temperature celsius scale reading consites with fahrenheit scale.

Solution:

Let the temperature in celsius and fahrenheit scale be 'x'.

We know,

$$\frac{C-0}{100} = \frac{f-32}{180}$$

or, $\frac{x}{100} = \frac{x-32}{180}$

or, $180x = 100x - 3200$

$\therefore x = -40^\circ C$ or $-40^\circ F$

$\therefore$ At -40° celsius Scale consites with fahrenheit scale.

4. A faulty thermometer has its fixed point marked at 2 and 98. What is the correct temperature on the celsius scale when the thermometer reads $20^\circ C$.

Solution:

Given, L.F.P of faulty thermometer (LFP_f) = $2^\circ C$

U.F.P of faulty thermometer (UfP_f) = $98^\circ C$

Temperature measured in faulty thermometer (C_f) = $20^\circ C$

LFP of correct thermometer (LFP) = $0^\circ C$

UFP of correct thermometer (UfP) = $100^\circ C$

Correct reading in celsius (C) = ?

We know,

$$\frac{C_f - LfP_f}{UfP_f - LfP_f} = \frac{C - LFP}{UfP - LFP}$$

$$\text{or, } \frac{20-2}{98-2} = \frac{C-0}{100-0}$$

$$\text{or, } \frac{18}{96} = \frac{C}{100}$$

$$\therefore C = 18.75^\circ C$$

Hence, the correct reading in celsius is 18.75°C.

5. At what point of thermometric scale does kelvin scale reading coincide with fahrenheit scale reading.

Solution:

Let the temperature in kelvin scale and fahrenheit scale be 'x'

We know,

$$\frac{F-32}{180} = \frac{k-273}{100}$$

$$\text{or, } \frac{x-32}{180} = \frac{x-273}{100}$$

$$\text{or, } 100x - 3200 = 180x - 49140$$

$$\text{or, } 49140 - 3200 = 180x - 100x$$

$$\therefore x = 574.25^\circ k \text{ or } 574.25^\circ F$$

6. Fahrenheit thermometer reads 99° when a standard centigrade thermometer reads 37°C. Find the error in fahrenheit scale.

Solution:

Fahrenheit reading = 99°F

Standard centigrade reading = 37°C

Equivalent temperature of 37°c into fahrenheit is

$$\frac{C-0}{100} = \frac{f-32}{180}$$

or, $\frac{37}{100} = \frac{f-32}{180}$

or, $6660 = 100f - 3200$

$\therefore f = 98.6°$

Now,

fault in fahrenheit scale = 99°f - 98.6°f.

= 0.4°f

7. You work in a materials testing lab and your boss tells you to increase the temperature of a sample by 40°c. The only ~~temper~~ thermometer you can find at your work bench reads °f. If the initial temperature of the sample is 68.2°F what is the final temperature in °f when the desired temp. is increased.

Solution:

Initial temperature in °f = 68.2°f

Required change in temperature = 40°c

Final temp. in °f = ?

we know,

100 parts in °c = 180 parts in °f

or 1 parts in °c = $\frac{180}{100}$ parts in °f

or, 40 parts in °c = $\frac{180}{100} \times 40$ parts in °f

= 72°f

Now, Final temperature = 68.2°f + 72°f
= 140.2°f

8. What are the temperature in celsius and fahrenheit scale when $\frac{2}{3}$ of fahrenheit scale is $\frac{1}{2}$ of celsius scale?

Solution:
By Question:

$$\frac{2}{3}\,^\circ f = \frac{1}{2}\,^\circ C$$

$$\text{or, } ^\circ f = \frac{3}{4}\,^\circ C$$

We know,

$$\frac{C-0}{100} = \frac{f-32}{180}$$

$$\text{or, } \frac{3/4}{100} = \frac{f-32}{180} \quad \frac{C}{100} = \frac{0.75C-32}{180}$$

$$\text{or, } 180C = 75C - 3200$$

$$\text{or, } 180C - 75C = -3200$$

$$\therefore C = -30.48$$

Now,

$$F = \frac{3}{4}\,^\circ C$$

$$\text{or, } F = \frac{3}{4} \times (-30.48)$$

$$\therefore f = -22.86^\circ f$$

9. A celsius scale reads 30°C, when a standard kelvin scale reads 300k. What is the error in celsius scale?

Solution:

Here, Reading in °C = 30°C

Standard Kelvin scale reading = 300k

Now,

Corresponding temperature of 300k into °C.

We know, $\frac{C-0}{100} = \frac{k-273}{100}$

or, $\frac{C}{100} = \frac{300-273}{100}$

or, $C = 27°C$

Now, Error in celsius scale reading = 30°C - 27°C

= 3°C

10. A thermometer has wrong calibration. It reads the melting point of ice -10°C. It reads 60°C in place of 50°C. What is the temperature of boiling point of water, on this scale?

Solution:

Here, Lower fixed point of faulty thermometer (LFP_f) = -10°C

Reading of faulty thermometer (C_f) = 60°C

Correct reading of thermometer (C) = 50°C

Upper fixed point of faulty thermometer (UFP_f) = ?

We know,

$$\frac{C_f - LFP_f}{UFP_f - LFP_f} = \frac{C-0}{UFP-LFP}$$

$$\text{or, } \frac{60-(-10)}{x-(-10)} = \frac{50-0}{100-0}$$

$$\text{or, } \frac{70}{x+10} = \frac{50}{100}$$

$$\text{or, } 7000 = 50x + 500$$

$$\text{or, } \frac{7000-500}{50} = x$$

$$\therefore x = 130^\circ C$$

11. In an arbitrary scale of temperature, water freezes at 40°C and boils at 290°C. Find the boiling point of a liquid in this scale if it boils at 62°C.

Solution:

LFP of faulty thermometer (LFP_f) = 40°C

UFP of faulty thermometer (UFP_f) = 290°C

Boiling point of liquid in faulty thermometer (C_f) = ?

Accurate boiling point of water in thermometer (C) = 62°C

We know,

$$\frac{C-0}{UFP-LFP} = \frac{C_f - LFP_f}{UFP_f - LFP_f}$$

$$\text{or, } \frac{62}{200} = \frac{C_f - 40}{290-40}$$

$$\text{or, } \frac{62}{100} = \frac{C_f - 40}{250}$$

$$\text{or, } 15500 = 100C_f - 4000$$

$$\therefore C_f = 195^\circ C$$

12. The distance between LFP and UPF is ~~18 cm~~ 80 cm. Find the temperature on the celsius scale if the mercury level rises to hight of 10.4 cm, above the lower fixed point.

Solution:

Distance between ~~lower fixed~~ LFP and UFP = 80 cm

We know,

$$80 \text{ cm} = 100 \text{ parts in celsius thermometer}$$

$$1 \text{ cm} = \frac{100}{80} \text{ parts}$$

$$10.4 \text{ cm} = \frac{100}{80} \times 10.4 \text{ parts}$$

$$= 13 \text{ parts.}$$

Here, 1 part = 1°C. So 13 parts = 13°C.

Original Method :-

Height of 80 cm in thermometer = 100°C

Height of 1 cm in thermometer = $\frac{100}{80}$ °C

Height of 10.4 cm in thermometer = $\frac{100}{80} \times 10.4$ °C

$$= 13°C$$

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Short Questions

1. Does temperature depend on the amount of heat.

⇒ Yes, temperature depend on the amount of heat supplied, nature and mass of substance.

2. Can an object be hotter than another if they are at the same temperature? Explain

Ans: No, one object cannot be hotter than another if they are at the same temperature.

3. If you have a bucket of cold water and a cup of hot tea which one of them have greater temperature? What about heat.