THERMAL PHYSICS

I.Choose the best answer

1. The value of universal gas constant
a) 3.81 mol–1 K–1 b) 8.03 mol–1 K–1 c) 1.38 mol–1 K–1 d) 8.31 mol–1 K–1
Ans : d) 8.31 $mol^{-1}K^{-1}$

2. If a substance is heated or cooled, the change in mass of that substance is
a) positive b) negative c) zero d) none of the above
Ans : c) zero

3. If a substance is heated or cooled, the linear expansion occurs along the axis of
a) X or –X b) Y or –Y c) both (a) and (b) d) (a) or (b)
Ans : c) both (a) and (b)

4. Temperature is the average _____ of the molecules of a substance.
a) difference in K.E and P.E b) sum of P.E and K.E
c) difference in T.E and P.E d) difference in K.E and T.E
Ans : c) difference in T.E. and P.E

5. In the Given diagram, the possible direction of heat energy transformation
a) A ← B, A ← C, B ← C b) A → B, A → C, B → C
c) A → B, A ← C, B → C d) A ← B, A → C, B ← C
Ans: a) A ← B, A ← C, B ← C

II. Book Exercise – Fill in the blanks

1. The value of Avogadro number _____. Ans : 6.023×10^{23}/mol
2. The temperature and heat are _____ quantities. Ans : Scalar
3. One calorie is the amount of heat energy required to raise the temperature of _____ of water through _____. Ans : 1g ; 1°C
4. According to Boyle's law, the shape of the graph between pressure and reciprocal of volume is _____. Ans : straight line

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III. Book Exercise – State whether the following statements are true or false, if false explain why?

1. For a given heat in liquid, the apparent expansion is more than that of real expansion.
Ans : False. For a given heat in liquid, the real expansion is more or less than that of apparent expansion.

2. Thermal energy always flows from a system at higher temperature to a system at lower temperature.
Ans : True.

3. According to Charles's law, at constant pressure, the temperature is inversely proportional to volume.
Ans : False. According to Charles's law, at constant pressure, the volume is directly proportional to temperature

IV. Match the items in column-I to the items in column-II

	Column I	Column II
1	Linear expansion	d) change in length
2	Superficial expansion	e) change in area
3	Cubical expansion	a) change in volume
4	Heat transformation	b) hot body to cold body
5	Boltzmann constant	c) $1.381\times 10–23\ JK^{-1}$

V. Assertion and reason type questions:

1. Assertion: There is no effects on other end when one end of the rod is only heated.
Reason: Heat always flows from a region of lower temperature to higher temperature of the rod.
Ans : c. Assertion is true but the reason is false.

2. Assertion: Gas is highly compressible than solid and liquid.
Reason: Interatomic or intermolecular distance in the gas is comparably high.
Ans : a. Both the assertion and the reason are true and the reason is the correct explanation of the assertion.

VI. Answer in briefly

1. Define one calorie.

Calorie: One calorie is defined as the amount of heat energy required to rise the temperature of 1 gram of water through 1°C

2. Distinguish between linear, cubical and superficial expansion.

1. Linear expansion: When a body is heated or cooled, the length of the body changes due to change in its temperature. Then the expansion is said to be linear or longitudinal expansion.

2. Superficial expansion: If there is an increase in the area of a solid object due to heating, then the expansion is called superficial or areal expansion.

3. Cubical expansion: If there is an increase in the volume of a solid body due to heating, then the expansion is called cubical or volumetric expansion.

3. What is co-efficient of cubical expansion?

The ratio of increase in volume of the body per degree rise in temperature to its unit volume is called as coefficient of cubical expansion. This is also measured in K^{-1}.

4. State Boyle's law

Boyle's law: When the temperature of a gas is kept constant, the volume of a fixed mass of gas is inversely proportional to its pressure. $P \alpha 1/V$

5. State-the law of volume

Charles's law (The law of volume): According to this law, When the pressure of gas is kept constant, the volume of a gas is directly proportional to the temperature of the gas.

$$V \alpha T$$

$$\text{or } \frac{V}{T} = \text{constant}$$

6. Distinguish between ideal gas and real gas.

Real Gases If the molecules or atoms of a gases interact with each other with a definite amount of intermolecular or inter atomic force of attraction, then the gases are said to be real gases.

Ideal Gases: If the atoms or molecules of a gas do not interact with each other, then the gas is said to be an ideal gas or a perfect gas.

7. What is co-efficient of real expansion?

Coefficient of real expansion is defined as the ratio of the true rise in the volume of the liquid per degree rise in temperature to its unit volume. The SI unit of coefficient of real expansion is K^{-1}.

8. What is co-efficient of apparant expansion?

Coefficient of apparent expansion is defined as the ratio of the apparent rise in

the volume of the liquid per degree rise in temperature to its unit volume. The SI unit of coefficient of apparent expansion is K^{-1}

VIII. Answer in detail

1. Derive the ideal gas equation.

Ideal Gas Equation

The ideal gas equation is an equation, which relates all the properties of an ideal gas. An ideal gas obeys Boyle's law and Charles' law and Avogadro's law. According to Boyle's law,

$$PV = \text{constant} \qquad (3.1)$$

According to Charles's law,

$$V/T = \text{constant} \qquad (3.2)$$

According to Avogadro's law,

$$V/n = \text{constant} \qquad (3.3)$$

After combining equations (3.1), (3.2) and (3.3), you can get the following equation.

$$PV/nT = \text{constant} \qquad (3.4)$$

The above relation is called the combined law of gases. If you consider a gas, which contains μ moles of the gas, the number of atoms contained will be equal to μ times the Avogadro number, N_A.

i.e. $n = \mu N_A$. (3.5)

Using equation (3.5), equation (3.4) can be written as

$$PV/ \mu N_A T = \text{constant}$$

The value of the constant in the above equation is taken to be k_B, which is called as Boltzmann constant (1.38×10^{-23} JK^{-1}). Hence, we have the following equation:

$$PV/ \mu N_A T = k_B$$

$$PV = \mu N_A k_B T$$

Here, $\mu N_A k_B = R$, which is termed as universal gas constant whose value is 8.31 J $mol^{-1}K^{-1.}$

$$PV = RT \qquad (3.6)$$

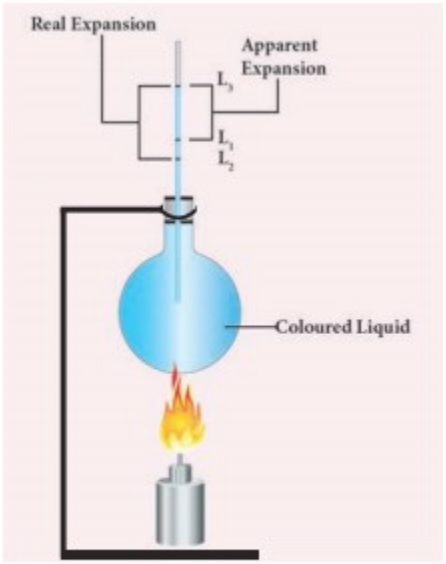
Ideal gas equation is also called as equation of state because it gives the relation between the state variables and it is used to describe the state of any gas.

2. Explain the experiment of measuring the real and apparent expansion of a liquid with a neat diagram.

Experiment to measure real and apparent expansion of liquid

To start with, the liquid whose real and apparent expansion is to be determined is poured in a container up to a level. Mark this level as L_1. Now, heat the container and the liquid using a burner as shown in the Figure Initially, the container receives the thermal energy and it expands. As a result, the volume of the liquid appears to have reduced. Mark this reduced level of liquid as L_2.

On further heating, the thermal energy supplied to the liquid through the container results in the expansion of the liquid. Hence, the level of liquid rises to L_3. Now, the difference between the levels L_1 and L_3 is called as **apparent expansion**, and the difference between the levels L_2 and $L_3$is called **real expansion**. The real expansion is always more than that of apparent expansion.



ure 3.5 Real and apparent expansion of liquid

Real expansion = $L_3 - L_2$

Apparent expansion = $L_3 - L_1$