HOTS (Higher Order Thinking Skills)

(1 mark each)

Q. 1. Explain why Boyle's law cannot be used to determine the volume of a real gas when it is converted from its initial state to final state by an adiabatic expansion.

Ans. Boyle's law is applied at constant temperature condition only. However, during adiabatic expansion, temperature is decreased. So, this law cannot be used to determine the volume of a real gas in adiabatic expansion.

Q. 2. Boyle's law states that at constant temperature, if pressure is increased on a gas, volume decreases and vice-versa. But when we fill air in a balloon, volume as well as pressure increases, why?

Ans. Boyle's law is applicable only for a fixed mass of a gas. When we fill air in a balloon, we introduce much air into the balloon so mass of air increases. Thus, this law is not applicable.

Q. 3. What would have happened to the gas if the molecular collisions are not elastic?

Ans. Loss of energy takes place at each collision. As a result, speed of molecules decreases and ultimately these molecules settle down in the vessel. Moreover, the pressure would have gradually reduced to zero.

Q. 4. Explain why helium and hydrogen gases are not liquefied at room temperature by applying very high pressure?

Ans. It is due to lower values of their critical temperature than room temperature.

Q. 5. What happens if a liquid is heated to the critical temperature of its vapors?

Ans. The meniscus between the liquid and the vapour disappears. Surface tension of the liquid becomes zero.

Q. 6. Explain why temperature of a boiling liquid remains constant?

Ans. It is due to the fact that at the boiling point of liquid, the heat supplied is used up in breaking off the intermolecular forces of attraction of the liquid to change it into vapour and not for increasing the temperature of liquid.

(3 marks each)

Q. 7. What is the role of air in use of LPG as a fuel? Also explain the behaviour of the LPG gas in a liquid form filled in a cylinder.

Ans. All of us are quite familiar with a cooking gas cylinder which contains in its liquefied petroleum gas, often called L.P.G. It is a mixture of different gases such as propane, butane etc. These are so highly compressed that they are in the liquefied form. When the regulator is opened; the liquid escapes from the nozzle of the cylinder into a space where pressure is very

less. As a result, there is a sudden increase in volume and the liquid changes to gaseous state. The released gases get mixed with oxygen from air and ignite when burnt.

Q. 8. What are the reasons for deviation of real gases from ideal gas behaviour?

Ans. It is due to two assumptions which are made in formulating kinetic molecular theory:

(i) The molecules have negligible volumes, but all real molecules have definite volumes which cannot be neglected, especially at low temperature and high pressure.

(ii) It was assumed that there is negligible force of attraction between molecules, therefore, molecules moved independently. It is not true, especially at low temperature, and high pressure when the force of attraction between molecules is appreciable.

Q. 9. Give reasons for the following:

(i) Tires of automobiles are inflated to lesser pressure in summer than in winter.
(ii) The size of weather balloon becomes larger and larger as it moves into higher altitudes.

Ans. (i) In summer, the average kinetic energy of the air molecules inside the tyre increases due to high temperature i.e. the molecules move fast due to which the pressure on the walls of the tube increases. If pressure inside is not kept low at the time of inflation, at high temperature, the pressure may become so high that the tyre may burst.

(ii) The atmospheric pressure decreases on moving to higher altitudes. So, the pressure outside the balloon decreases. To regain equilibrium with the external pressure, the gas inside expands to decrease its pressure. Thus, the size of weather balloon becomes larger and larger as it moves into higher altitudes.

Q. 10. A balloon filled with an ideal gas is taken from the surface of the deep sea to a depth of 100 m. What will be its volume in terms of its original volume?

Ans. Pressure at the surface = 76 cm of Hg = 76 x 13·6 cm of H_2O

= 10· 3 m of H_2O

∴ Pressure at 100m depth

= 100 + 10· 3m = 110· 3

Applying Boyle's law,

$P_1V_1 = P_2V_2$,

(At surface) (At 100 m depth)

10· 3m x V = 110· 3 x V_2

Or V_2 = 0· 093 V

= 9· 3 % of V

Q. 11. At what temperature centigrade will the volume of a gas at 0°C double itself, pressure remaining constant?

Ans. Let the volume of the gas at 0°C = V ml

Thus, we have:

V_1 = V ml,

V_2 = 2V ml

T_I = 0 + 273

= 273 K

T_2 =?

By applying Charles Law,

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Substituting the corresponding values, we have

$$\frac{V}{273} = \frac{2V}{T_2}$$

$$T_2 = \frac{2V \times 273}{V} = 546\ K$$

T_2 = 546 – 273 = 273°C

Q. 12. What volume of air will be expelled from a vessel containing 400 cm^3 at 7°C when it is heated to 27°C at the same pressure?

Ans.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} i.e, \frac{400\ cm^3}{(273+7)K} = \frac{V_2}{(273+27)K}$$

$$or\ V_2 = \frac{400}{280} \times 300\ cm^3 = 482 \cdot 6\ cm^3$$

This is volume after expansion.

∴ Volume expelled

= (428·6 - 400) cm^3

= 28·6 cm^3

Q. 13. 35 ml of oxygen were collected at 6°C and 758 mm pressure. Calculate its volume at NTP.

Ans. Given conditions **Final conditions**

$V_1 = 35\ ml$ $V_2 = ?\ ml$

$P_1 = 758\ mm$ $P_2 = 760\ mm$

$T_1 = 6 + 273$ $T_2 = 0 + 273$

= 279 K = 273 K

By applying ideal gas equation, we have

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{758 \times 35}{279} = \frac{760 \times V_2}{273}$$

$$\therefore\ V_2 = \frac{758 \times 35}{279} \times \frac{273}{760}$$

= 34·16 ml

Volume of chlorine gas at NIP = 34·16 ml.

Q. 14. At 27ºC and one atmospheric pressure, a gas has volume V. What will be its volume at 177°C and a pressure of 1-5 atmosphere?

Ans. Given conditions **Final conditions**

$V_1 = V$ $V_2 = ?\ ml$

$P_1 = 1\ atm$ $P_2 = 1 \cdot 5\ atm,$

$T_1 = 273 + 27$ $T_2 = 273 + 177$

= 300 K = 450 K

Applying ideal gas equation, we have

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{1 \times V}{300} = \frac{1 \cdot 5 \times V_2}{450}$$

$$\therefore\ V_2 = \frac{1 \times V \times 450}{300 \times 1 \cdot 5} = V$$

∴ Volume of the gas = V.