Short Answer Type Questions - I

Q. 1. What will be the minimum pressure required to compress 500 dm^3 of air at 1 bar to 200 dm^3 at 30ºC? [DDE, 2017-18]

Ans. P_1 = 1 bar

V_1 = 500 dm^3

V_2 = 200 dm^3

P_2 =?

According to Boyle's law,

$P_1 V_1 = P_2 V_2$

1 x 500 = P_2 x 200

$P_2 = \frac{1 \times 500}{200} = 2.5\ bar$

Q. 2. Name the intermolecular force present in-

(i) H_2O (ii) HCI [DDE, 2017-18]

Ans. (i) H- bonding

(ii) Dipole-dipole forces

Q. 3. Explain Avogadro's law. [DDE, 2017-18]

Ans. Avogadro's law: According to this law, "Equal volumes of all gases under the same conditions of temperature and pressure contain equal number of molecules." Mathematically, $V \propto n$

Where n = number of moles of gas the number of molecules in one mole of a gas has been determined to be 6.022 x 10^{23} and is called Avogadro constant.

Q. 4. A sample of helium has a volume of 500 cm^3 at 373 K. Calculate the temperature at which the volume will become 260 cm^3. Assume that the pressure is constant.

Ans. V_1 = 500 cm^3, V_2 = 260 cm^3

T_1 = 373 K, T_2 = ?

By Charle's Law,

$$\frac{v_1}{T_1} = \frac{v_2}{T_2}$$

$T_2 = \frac{v_2 T_1}{V_1}$

$= \frac{263 \times 373}{500}$

= 196.19 K.

Q. 5. A sample of nitrogen gas occupies a volume of 1.000 L at a pressure of 0.500 atm at 40^{o}C. Calculate the pressure if the gas is compressed at 225 cm^3 at – 6^o C.

Ans. P_1 = 0·500 atm, P_2 =?

V_1 = 1·00 L,

$V_2 = \frac{225}{1000}$ = 0.225 L

T_1 - 273 + 40 = 313 K

T_2 = 273 + 6 = 267 K

By applying ideal gas equation,

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$P_2 = \frac{P_1 V_1 \times T_2}{T_1 \times V_2}$

$= \frac{0 \cdot 500 \times 1 \times 267}{313 \times 0 \cdot 225}$

P_2 = 1·89 atm.

Q. 6. A balloon is filled with hydrogen at room temperature. It will burst if pressure exceeds 0.2 bar. If at 1 bar pressure the gas occupies 2.27 L volume, upto what volume can the balloon be expanded? [DDE, 2017-18]

Ans. According to Boyle's law,

$P_1 V_1 = P_2 V_2$

Given P_1 = 1 bar, V_1 = 2.27 L

P_2 = 0.2 bar, V_2 =?

∴ 1 x 2.27 = 0.2 x V_2

$V_2 = \frac{1 \times 2.27}{0.2} = 11.35\ L$

Since balloon bursts at 0.2 bar pressure, the volume of balloon should be less then 11.35 L.

Q. 7. On a ship sailing in Pacific Ocean where temperature is 23.4°C, a balloon is filled with 2L air. What will be the volume of the balloon when ship reaches Indian ocean, where temperature is 26.1°C?

Ans. V_1 = 2L, T_1 = 23.4 + 273 = 296.4 K

V_2 = ? T_2 = 26.1 + 273 = 299.1 K

According to Charle's law,

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

$$\therefore V_2 = \frac{V_1 T_2}{T_1} = \frac{2 \times 299 \cdot 1}{296 \cdot 4} = 2.018 \text{ L}$$

Q. 8. At 25°C and 760 mm of Hg pressure, a gas occupies 600 mL volume. What will be its pressure at a height where temperature is 10°O and volume of the gas is 640 mL. [DDE, 2017-18]

Ans. P_l = 760 mm Hg P_2 - ?

V_1 = 640 mL V_2 = 640 mL

T_1 = 25 + 273 = 298K T_2 = 10 + 273 = 283 K

According to Ideal gas equation,

$$\frac{P_1 V_1}{T_1} = \frac{P_1 V_2}{T_2}$$

$$P_1 = \frac{P_1 V_1 T_1}{T_1 V_2} = \frac{760 \text{ mm Hg} \times 600 \text{ ml} \times 283\text{K}}{298 \times 640 \text{ ml}}$$

= 676.6 mm Hg

Q. 9. Calculate the temperature of 4 moles of a gas occupying in 5 dm^3 at 3.32 bar. (R 0.083 bar dm^3 K^{-1} mol^{-1}) [DDE, 2017-18]

Ans. Given no. of moles (n) = 4

V = 5 dm^3

P = 3.32 bar

R = 0.083 bar dm^3 K^{-1} mol^{-1}

T = ?

According to ideal gas equation,

PV = nRT

$$T = \frac{PV}{nR} = \frac{3.32 \times 5}{4 \times 0.083} = 50 \text{ K}$$

Q. 10. A gas occupies a volume of 250 mL at 750 mm of Hg and 25° C. What additional pressure is required to reduce the gas volume to 200 mL at the same temperature?

Ans. Given, V_1 = 250 mL

P_1 = 750 mm Hg

V_2 = 200 mL

P_2 = ?

According to Boyle's law,

$P_1 V_1 = P_2 V_2$

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{750 \times 250}{200}$$

∴ Additional pressure 9375 – 750

= 187.5 Hg

Q. 11. 30 mL of oxygen were collected at 10°C and 750 mm Hg pressure. Calculate its volume at STP.

Ans. Given

V_1 = 30 mL

P_1 = 750 mm Hg

V_2 = ?

P_2 = 760 mm Hg

T_1 = 10 + 273 = 283 K

T_2 = 0 + 273 = 273 K

∴ By applying ideal gas equation,

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{750 \times 30 \times 273}{283 \times 760} = 28.56\ mL$$

Q. 12. (a) Write van der Waals equation for n moles of a gas.

(b) Critical temperature for CO_2 and CH_4 are 31.1°C and -81.9°C respectively. Which is easily liquefiable and why? [KVS, Silchar Region 2016-17]

Ans. (a) van der Waals equation for n moles of a gas:

PV = nRT

Where, P = Pressure

V = Volume

n = No. of moles

R = Gas constant

T = Absolute temperature

(b) Carbon dioxide (CO_2) can be easily liquefied because it has higher critical temperature that means it can be liquefied at higher temperature more easily. So, CO_2 has higher intermolecular forces than methane.

Q. 13. Compressibility factor 'Z' of a gas is given as Z = $\frac{PV}{nRT}$

(i) What is the value of Z for an ideal gas?

(ii) For real gas, what will be the effect on value of Z above Boyle temperature? [DDE, 2017-18]

Ans. (i) For an ideal gas Z = 1 at all temperatures and pressures because PV = nRT

(ii) For real gas, the value of Z will be greater than 1 above Boyle temperature.

Q. 14. Which term is given to energy that arises due to motion of atoms or molecules in a body, what is the effect of temperature on this energy?

Ans. The energy that arises due to motion of atoms or molecules in a body is called thermal energy. Thermal energy increases with increase in the temperature.

Q. 15. Calculate the kinetic energy of 4 g of oxygen at -25°C.

Ans. Number of moles of O_2 (n) = $\frac{4}{32}$ = 0.125 mol

T = 273 - 25 = 248 K

R = 8.314J K^{-1} mol^{-1}

∴ Kinetic energy (K.E.) = $\frac{3}{2}nRT$

$$= \frac{3}{2} \times 0.125 \times 8.314 \times 248 = 386.6J$$

Q. 16. Two moles of a real gas confined in a 5L flask exerts a pressure 9.1 atm at a temperature of 27°C. Calculate the value of 'a. The value of 'b' is 0.052 L mol^{-1}.

Ans. Given, n = 2 mol, V = 5L, P = 9.1 atm,

T = 273 + 27 = 300K

R = 0.082 L atm mol^{-1} K^{-1}

According to van der Waals equation,

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$$\text{Or a} = \left(\frac{nRT}{V - nb} - P\right) \times \frac{V^2}{n^2}$$

$$= \left(\frac{2 \times 0.082 \times 300}{5 - 2 \times 0.052} - 9.1\right) \times \frac{(5)^2}{(2)^2}$$

$$= \left(\frac{49.2}{4.896} - 9.1\right) \times \frac{25}{4}$$

$$= (10.05 - 9.1) \times \frac{25}{4}$$

$$= 0.95 \times \frac{25}{4}$$

= 5.938 atm L^2 mol^{-2}

Q. 17. Write the two wrong assumptions of the kinetic molecular theory of gases which led to the failure of the ideal gas law. [KVS, Guwahati Region 2015-16]

Ans. Two wrong assumptions of the kinetic theory of gases were:

(a) The molecules which are considered as point masses have negligible volume as compared to the total volume of the gas.

(b) It is assumed that there is no intermolecular forces between the molecules. They move independently.

Q. 18. Define the terms:

(i) Standard boiling point
(ii) Vapour pressure of liquid [DDE, 2017-18]

Ans. (i) Standard Boiling Point: If the pressure is 1 bar, the boiling point of the liquid is called standard boiling point.

(ii) Vapour Pressure of Liquid: The pressure exerted by the vapour of a liquid at a particular temperature in a state of dynamic equilibrium is called vapour pressure of that liquid at that temperature.

Q. 19. (i) Drops of liquid are spherical in nature. Explain. [KVS, Mumbai Region-2015-16]

(ii) Mention the effect of temperature on surface tension. [DDE, 2017-18]

Ans. (i) Liquid tends to have a minimum surface area due to surface tension. For a given volume of a liquid, sphere has the minimum surface area. So, the small drops of liquid are spherical in nature.

(ii) Surface tension decreases with increase in temperature because force acting per unit length decreases due to increase in kinetic energy of molecules.

Q. 20. Write the S.I. units of:

(i) Surface tension

(ii) Coefficient of viscosity [DDE, 2017-18]

Ans. (i) S.I. unit of surface tension = Nm^{-1}

(ii) S.I. unit of coefficient of viscosity = Nm^{-2} s or Kg ms^{-1} s^{-1}

Q. 21. Define viscosity. Mention the effect of temperature and pressure on viscosity of a liquid. [DDE, 2017-18]

Ans. Viscosity: It is a measure of resistance to flow which arises due to the internal friction between layers of fluid as they slip past one another while liquid flows.

Effect of Temperature on Viscosity: Viscosity decreases with increase in temperature because force required to maintain the flow decreases due to increase in velocity.

Effect of Pressure on Viscosity: increases with increase in pressure because force required to maintain the flow increases due to decrease in velocity gradient (du/dz) and increase in area (A) of contact.

Q. 22. Explain

(i) Fire polishing of glass
(ii) Liquid tend to rise in a capillary [DDE, 2017-18]

Ans. (i) Fire Polishing of Glass: When sharp glass edges are heated, these become smooth because on heating, the glass melts and takes up rounded shape at the edges which possesses minimum surface area. This is known as fire polishing of glass.

(ii) Liquid tend to rise in a capillary: Liquids tend to rise in a capillary due to surface tension.