CH110: Gases Tutorial Sheet 2024

a) Write down the mathematical expressions of the following gas laws:

1. Boyle's law
2. Charles' law

b) Consider a mixture of two gases, A, and B, confined in a closed vessel. A quantity of a third gas, C, is added to the same vessel at the same temperature. State whether each of the following will increase, decrease, or remain the same.

1. The partial pressure of gas A
2. The total pressure in the vessel
3. The mole fraction of gas B

c) A diver releases a bubble of air which rises to the surface of the sea. The volume of the bubble increases from 4.0 cm3 to 10.0 cm3 during this process.

1. Why does the bubble expand as it rises?
2. Just below the surface, the pressure acting on the bubble is one atmosphere. What is the pressure (in atmospheres) acting on it before it starts to rise?
3. Which gas law is being applied in your calculation in c(ii) above?

d) An aerosol spray can with a volume of 250 ml contains 2.30 g of propane gas (C3H8) as a propellant.

1. If the can is at 230C, what is the pressure in the can?
2. What volume would the propane occupy at STP?
3. The can's label says that exposure to temperatures above 1300F may cause the can to burst. What is the pressure in the can at this temperature?

e) When 1.77 g of a gas was stored in a 1.500 L flask at 17 ºC, it exerted a pressure of 508 Torr. What is the molar mass of the gas?

f) A container of volume 5 dm3 was filled with 2.02 g of H2(g) and 71 g of Cl2(g). The mixture was then sparked leading to the formation of HCl(g) and then cooled to a temperature of 25 ºC. At the end of the reaction, determine the

1. Partial pressure
2. Partial pressure of each component gas
3. Total pressure in the container.
4. Mole fraction of each gas.

g) Between helium and ammonia gas, which one would you expect to exhibit behaviour close to ideal gas behaviour at low pressure? Provide brief explanation for your answer.

h) State the Van der Waals equation and define each of the terms involved.

Solution

* The total pressure **increases** as more moles of gas is added to the same volume

$P = \frac{nRT}{V}$, here everything is same except $\underline{\underline{n}}$ increases so P also **increases**

* The same amount of moles B is in the volume, but the total moles increases so mole fraction of B goes down or **decreased**.

$$\text{Mole fraction} = \frac{\text{moles of B}}{\text{total moles}}$$

* The partial pressure of gas A stays the **same** because the total pressure increases relatively with the addition of gas C.

c (ii) $P_1 V_1 = P_2 V_2$

$P_1 \times 4\,cm^3 = 10\,cm^3 \times 1\,atm$

$P_1 = \frac{10\,\cancel{cm^3}\,.\,atm}{4\,\cancel{cm^3}}$

$P_1 = 2.5\,atm.$

(iii) Boyle's Law

d. $nRT = PV$

(i) $P = \frac{nRT}{V}$

Finding n

$n = \frac{mass}{m.m}$

$= \frac{2.30g}{44.08}$

$= 0.0522\,mol$

Finding V

$V = 250\,ml$

$V = 0.25\,l$

finding T:

$K = °C + 273$

$K = 23 + 273$

$K = 296\,K$

$\therefore \; P = \frac{nRT}{V}$

$P = \frac{(0.0522)(0.0821) \times (296)}{0.25}$

$P = 5.07\,atm$

(ii) STP ⇒ Standard Temperature (273 K) and Pressure (1 atm)

at STP, molar volume is 22.4 L

$1\,mol = 22.4\,L$

$0.0522\,mol = x$

$x = 1.17\,L$

or;

$V = \frac{nRT}{P}$ where $n = 0.0522$, $R = 0.0821$, $T = 273$, $P = 1$

you'll get the same solutions.

iii $°C = (°F - 32°F) \times \frac{5}{9}$

$°C = (130 - 32) \times \frac{5}{9}$

$°C = 54.4°$

$K = °C + 273$

$K = 54.4 + 273$

$K = 327.4\,K$

$P = \frac{nRT}{V}$

$P = \frac{0.0522 \times 0.0821 \times 327.4}{0.25}$

$P = 5.61\ atm$

e $nRT = PV$

$n = \frac{PV}{RT}$

For P

$508\ torr = 508\ \cancel{mmHg} \times \frac{1\ atm}{760\ \cancel{mmHg}} = 0.6684\ atm$

For T

$K = °C + 273$

$K = 17 + 273 = 290\,K$

$$n = \frac{PV}{RT}$$

$$n = \frac{0.6684 \times 1.5}{0.0821 \times 290}$$

$$n = 0.04211 \text{ moles}$$

$$n = \frac{\text{mass}}{\text{m.m}}$$

$$\text{m.m} = \frac{\text{mass}}{n}$$

$$\text{m.m} = \frac{1.77g}{0.04211 \text{ mol}}$$

$$\text{m.m} = 42.03 \text{ g/mol}$$

f

(i) Partial Pressure ??.. of what kaili... kkk

(ii) $n(H_2) = \frac{2.02g}{2.02g/mol} = 1 \text{ mol}$

$n(Cl_2) = \frac{71g}{71g/mol} = 1 \text{ mol}$

$$P(H_2) = \frac{nRT}{V}$$

$$= \frac{1 \times 0.0821 \times 298}{5}$$

$$P(H_2) = 4.9 \text{ atm}$$

$$P(Cl_2) = \frac{nRT}{V}$$

$$= \frac{1 \times 0.0821 \times 298}{5}$$

$$P(Cl_2) = 4.9 \, atm$$

(iii) $P_T = P(H_2) + P(Cl_2)$

$= 4.9 \, atm + 4.9 \, atm$

$P_T = 9.8 \, atm$

iv $\cancel{X_{H_2} = \frac{P_{H_2}}{P_T} = \frac{4.9 \, atm}{9.8}}$

$$X_{H_2} = \frac{n_{H_2}}{n_T} = \frac{1}{2} = 0.5$$

$$X_{Cl_2} = \frac{n_{Cl_2}}{n_T} = \frac{1}{2} = 0.5$$

9 Helium

Reason ; Heliums monoatomic structure and weaker intermolecular forces result in minimal deviation from ideal gas behavious. While Ammonias Compound structure and stronger intermolecular forces lead to greater deviation from ideal gas behaviour at low pressure

(h)

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

P = pressure exerted by gas
V = Volum occupied by the gas
n = moles of the gas
a = Van der waals constant [representing the attraction between gas molecules]
b = Van der ~~wast~~ waals constant [representing volume occupied by gas molecules

R = Ideal gas Constant

T = Temp of gas.