Ideal Gas

1. Gas Law ✓
2. Dalton's Law
3. *Graham's Law
4. KTG

$PV = nRT$

$P = Pa$, $V = m^3$, $R = 8.314$ J/mole-k

$P = atm$, $V = lit$, $R = 0.0821$ lit atm/k-mole

Pressure

$1 \text{ bar} = 10^5 \text{ Pa}$

$1 \text{ atm} = 1.01325 \text{ bar}$

$= 76$ Cm of Hg

$= 760$ mm of Hg (or torr)

Volume

$1 m^3 = 10^3 dm^3$ (or lit)

$1 dm^3 = 10^3 cm^3$ (or ml)

or cc

Gas Law

Boyle's Law $\Rightarrow$ $P.V = \text{Cont}$ at Cont n, T

Charle's Law $\Rightarrow$ $\frac{V}{T} = \text{Cont}$ at Cont n, P

Avogadro's Law $\Rightarrow$ $\frac{V}{n} = \text{Cont}$ at Cont P, T

Gay Lussac's Law $\Rightarrow$ $\frac{P}{T} = \text{Cont}$ at Cont V, n

$$\boxed{PV = nRT}$$

If the pressure of a gas contained in a closed vessel is increased by 0.4% when heated by 1° C its initial temperature must be:

(a) 250 K (b) 250° C (c) 25° C (d) 25 K

a

$$\frac{PV = nRT}{1.004PV = nR(T+1)} \Rightarrow \underline{T = 250K}$$

2.5 L of a sample of a gas at 27° C and 1 bar pressure is compressed to a volume of 500 mL keeping the temperature constant, the percentage increase in pressure is:

(a) 100% (b) 400% (c) 500% (d) 80%

b

$$P_1V_1 = P_2V_2$$

$$1 \times 2.5 = P_2 \times 0.5 \Rightarrow P_2 = 5 \text{ bar}$$

$$100 \times \frac{\Delta P}{1} = \frac{4}{1} \times 100 = 400\%$$

The density of gas A is twice that of a gas B at the same temperature. The molecular weight of gas B is thrice that of A. The ratio of the pressure acting on A and B will be:

(a) 6 : 1 (b) 7 : 6 (c) 2 : 5 (d) 1 : 4

a

$$PM = dRT \Rightarrow \frac{P_AM_A}{P_BM_B} = \frac{d_A}{d_B} \Rightarrow \frac{P_A}{P_B} \times \frac{1}{3} = \frac{2}{1}$$

$$P_A/P_B = 6/1$$

A gas cylinder containing cooking gas can with stand a pressure of 14.9 atmosphere. The pressure gauge of cylinder indicates 12 atmosphere at 27° C. Due to sudden fire in the building temperature starts rising. The temperature at which cylinder will explode is:

(a) 372 K (b) 99.5° C (c) 199° C (d) 472.5 K

b

$$\frac{P_1}{P_2} = \frac{T_1}{T_2} \Rightarrow \frac{12}{14.9} = \frac{300}{T_2} \Rightarrow T_2 = 372.5K$$

$$= 99.5\,°C$$

0.1 mole of argon has pressure P and temperature T K in the vessel. On keeping the vessel at 50° C higher temperature, 0.8 gm of argon was given out to maintain same pressure. The original temperature was: [Ar = 40]

(a) 273 K (b) 200 K (c) 100 K (d) 300 K

b

$n_1 T_1 = n_2 T_2 \Rightarrow 0.1 \times T = \frac{3.2}{40} \times (T + 50)$

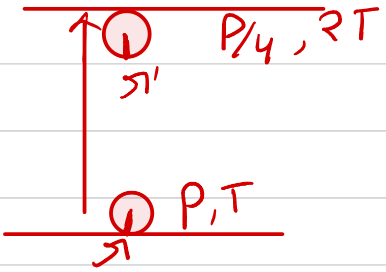
$4T = 3.2T + 3.2 \times 50$

$T = \frac{3.2 \times 50}{0.8} = \underline{200\,k}$

A spherical air bubble is rising from the depth of a lake when pressure is P atm and temperature is T K The percentage increase in its radius when it comes to the surface of lake will be: (Assume temperature and pressure at the surface to be respectively 2 T K and $\frac{P}{4}$)

(a) 100 % (b) 50 % (c) 40 % (d) 200 %

a



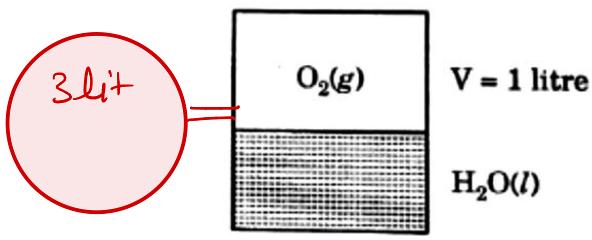
$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{P \times \frac{4}{3}\pi r^3}{T} = \frac{P}{4} \times \frac{\frac{4}{3}\pi (r')^3}{2T} \Rightarrow (r')^3 = 8r^3$

$\underline{r' = 2r}$

O_2 gas is placed in a 4 litre container containing 3 L of liquid water as shown and total pressure exerted by gases is 720 mm Hg. What will be the pressure of $O_2(g)$ if given container is attached to a empty container of 3 litre at same temperature?

Given: [V.P. of H_2O at 27° C = 20 mm of Hg]



$P_T = 720\,mm = \underset{P_{H_2O}}{20} + \underset{P_{O_2}}{700}$

$\Downarrow$

$P_{H_2O} = 20\,mm$

(a) 175 mm of Hg (b) 350 mm of Hg (c) 200 mm of Hg (d) 800 mm of Hg

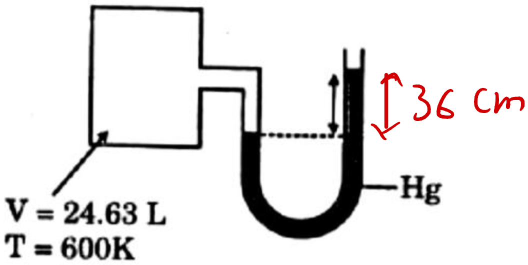
: a

$700 \times 1 = P_{O_2} \times 4$

$P_{O_2} = \frac{700}{4} = 175\,mm$

$P_T = 175 + 20 = 195$

From the following set–up, calculate moles of the gas present in the container of volume 24.63 litre at 600 K if the level of mercury in the open tube of the manometer is 36 cm higher. [Given: Atmospheric pressure = 78 cm of mercury]



1 atm = 78 cm

(a) 1.5 moles (b) 0.73 moles (c) 3 moles (d) 1 mole

b

$$P_{gas} = P_{atm} + 36\ cm$$
$$= 78 + 36\ cm$$
$$= 1.46\ atm$$

$$n_{gas} = \frac{1.46 \times \cancel{24.63}}{0.\cancel{0821} \times \cancel{600}_{2}} = \underline{0.73\ mole}$$

Dalton's Law of partial Pressure :-

A	P_A
B	P_B
C	P_C

Non-reacting

$$\boxed{P_T = P_A + P_B + P_C}$$

$$\boxed{P_A = X_A P_T}$$

$N_2 + H_2$ ✗

$NH_3 + HCl$ ✗

$Ar + N_2$ ✓

A mixture of hydrogen and oxygen at one bar pressure contains 20% by weight of hydrogen. Partial pressure of hydrogen will be:

(a) 0.2 bar (b) 0.4 bar (c) 0.6 bar (d) 0.8 bar

d

$\frac{20}{2} = 10$ mole H_2 $\frac{\cancel{80}\,5}{\cancel{32}\,2} = 2.5$ mole O_2

$P_{H_2} = \frac{10}{12.5} \times 1 = 0.8$ bar

Equal weights of ethane and hydrogen are mixed in an empty container at 25° C, the fraction of the total pressure exerted by hydrogen is:

(a) 1 : 2 (b) 1 : 1 (c) 1 : 16 (d) 15 : 16

d

$\frac{30}{30} = 1$ mole C_2H_6 $\frac{30}{2} = 15$ mole H_2

$\frac{P_{H_2}}{P_T} = X_{H_2} = \left(\frac{15}{16}\right)$ ✓

A gaseous mixture of three gases A, B and C has a pressure of 10 atm. The total number of moles of all the gases is 10. If the partial pressure of A and B are 3.0 and 1.0 atm respectively and if C has mol. wt. of 2.0, what is the weight of C in g present in the mixture?

(a) 6 (b) 8 ✓(c) 12 (d) 3

c

1 mole $\Rightarrow$ 1 atm

$P_T = 10 = 3 + 1 + P_c$

$= 6$ atm $=$ 6 mole

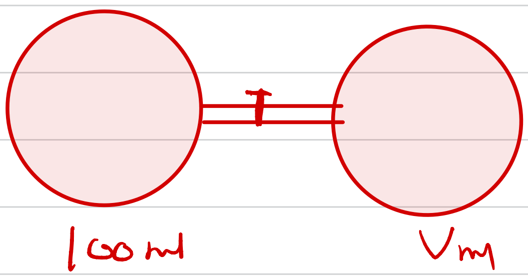
$\Downarrow$

$6 \times 2 = 12$ gm

Two glass bulbs A and B are connected by a very small tube having a stop cock. Bulb A has a volume of 100 cm^3 and contained the gas, while bulb B was empty. On opening the stop cock, the pressure fell down to 40%. The volume of the bulb B must be:

(a) 75 cm^3 (b) 125 cm^3 (c) 150 cm^3 (d) 250 cm^3

c



$$P \times 100\ \text{ml} = 0.4P \times (100+V)\ \text{ml}$$

$$100 + V = \frac{100}{0.4} = 250$$

$$\underline{V = 150\ \text{ml}}$$

Dalton's law cannot be applied for which gaseous mixture at normal temperatures?

(a) O_2 and N_2 (b) NH_3 and HCl (c) He and N_2 (d) CO_2 and O_2

b