IB practice test topic1

Name Key

Per. _____

1) A 2.4L sample of an ideal gas at STP is compressed to a volume of 1.5L. Assuming that the temperature and amount of material is kept constant what is the pressure of the gas at the final volume?

$PV = nRT$ (constant) $\Rightarrow P_1V_1 = P_2V_2$ $\quad P_2 = \frac{P_1V_1}{V_2}$ $\quad P_2 = \frac{(1\,atm)(2.4L)}{1.5L}$

$P_2 = 1.6\,atm$ or $101.3\,kPa$

2) A 5.0 ± 0.5 mL sample of gas has a measured pressure of 3.25 ± 0.01 atm, and a measured temperature of 20.0 ± 0.5 °C. How many mols of the gas are in the sample? $R = 0.08206$

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

$\frac{0.5}{5} = 10\%$ $\quad \frac{0.5}{20.0} = 2.5\%$ $\quad \frac{0.01}{3.25} = 0.3\%$

$\frac{(3.25 \pm 0.3\%)(5.0 \pm 10\%)}{(0.08206)(20.0 \pm 2.5\%)} = \frac{16 \pm 10.3\%}{1.64 \pm 2.5\%}$

$= 9.8 \pm 12.8\%$ mols

$= 9.8 \pm 1.3$ mols

3) Dimethylhydrazine is a carbon-hydrogen-nitrogen compound with important uses in rocket fuels. When burned completely in oxygen gas, a 0.312g sample yields 0.458 g CO_2 and 0.374 g of H_2O. From a separate 0.525 g sample, the nitrogen content was converted to 0.244 g N_2. What is the empirical formula of dimethylhydrazine?

$0.312g = 0.458g\,CO_2 \times 27.3\% = 0.125g\,C + 0.374g\,H_2O \times 5.6\% = 0.021g\,H$

%H in H_2O $= \frac{1.01}{18.02}(100) = 5.6\%$

%C in CO_2 $= \frac{12.01}{44.01}(100) = 27.3\%$

%C in compound $= \frac{0.125g}{0.312g} = 40.1\%$

%H in compound $= \frac{0.021g}{0.312g} = 6.7\%$

%N in compound $= \frac{0.244g\,N}{0.525g} = 46.5\%$

→ emp. formula on Back.

3) 50mL of a 6.0M solution of HCl is mixed with 100mL of a 2.5M solution of NaOH.

$HCl + NaOH \rightarrow NaCl + H_2O$

a) What is the final concentration of Na^+ ion.

b) HCl and NaOH react to form water and NaCl, and any access in either would lead to either excess H^+ or OH^- in solution please determine the concentration of the excess ion (H^+ or OH^-).

c) How many NaOH particles where involved in this reaction?

a) $0.1L\left(\frac{2.5mol\,NaOH}{1L}\right)\left(\frac{1mol\,Na^+}{1mol\,NaOH}\right)\left(\frac{1}{0.15L}\right) = 1.6M \Rightarrow 2M\,Na^+$

b) $0.05L\left(\frac{6mol\,HCl}{1L}\right) = 0.3mol\,HCl$ $\quad 0.1L\left(\frac{2.5mol\,NaOH}{1L}\right) = 0.25mol$

one-to-one mol ratio so $0.3 - 0.25 = 0.05$ mol HCl left $\Rightarrow 0.05mol\,H^+$

$\frac{0.05mol\,H^+}{0.15L} = 0.3M\,H^+$

3) Empirical Formula (assume 100 g sample)

$40.1\,g\,C\left(\frac{1\,mol\,C}{12.01\,g}\right) = 3.34 \div 3.32 = 1.01 \Rightarrow 1$

$6.7\,g\,H\left(\frac{1\,mol\,H}{1.01\,g}\right) = 6.6 \div 3.32 = 1.99 \Rightarrow 2$

$46.5\,g\,N\left(\frac{1\,mol\,N}{14.01\,g}\right) = 3.32 \div 3.32 = 1$

Empirical formula of Dimethylhydrazine is CH_2N

4) Malonic acid is an organic compound with a molecular mass of 104.06 g/mol, and a composition of 34.62% C, 3.88% H, and 61.50% O, by mass.

$C_3H_4O_4 + 2O_2 \longrightarrow 3CO_2 + 2H_2O$

a) Write a chemical equation for the complete combustion in oxygen of malonic acid
b) Determine the theoretical yield of CO_2 in the combustion reaction above if you start with 7.85g of melonic acid and an excess of O_2.

Empirical Formula

$34.62\,g\,C\left(\frac{1\,mol\,C}{12.01\,g}\right) = 2.883 \div 2.883 = 1 \times 3 = 3$

$3.88\,g\,H\left(\frac{1\,mol\,H}{1.01\,g}\right) = 3.842 \div 2.883 = 1.333 \times 3 = 4$

$61.50\,g\,O\left(\frac{1\,mol\,O}{16.00\,g}\right) = 3.844 \div 2.883 = 1.333 \times 3 = 4$

$C_3H_4O_4 \rightarrow$ mass = 104.07 ✓ $\rightarrow$ molecular formula

b) $7.85\,g\,C_3H_4O_4\left(\frac{1\,mol}{104.06\,g}\right)\left(\frac{3\,CO_2}{1\,C_3H_4O_4}\right)\left(\frac{44.01\,g}{1\,mol\,CO_2}\right) = \boxed{9.96\,g\,CO_2}$

5) Calculate the volume a 1.8g sample of O_2 gas at STP. If you increased the temperature by 10°C and held the Volume constant what would the new pressure be?

$1.8\,g\,O_2\left(\frac{1\,mol\,O_2}{32.00\,g}\right)\left(\frac{22.4\,dm^3}{1\,mol}\right) = \boxed{1.26\,dm^3}$

$PV = nRT$

$\frac{P}{T} = \frac{nR}{V}$ constant

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

$\frac{P_1 T_2}{T_1} = P_2 \qquad \frac{(1\,atm)(283\,K)}{(273\,K)} = \boxed{1.04\,atm}$

or

$1.04\,atm\left(\frac{101.3\,kPa}{1\,atm}\right) = \boxed{105\,kPa}$

6) Calculate the atomic weight of the unknown element M, if the molar mass of the compound $Na_2M_2O_3$ is 156 g/mol

$2Na = 45.98\,g$

$3O = 48.00\,g$

$Na_2O = 93.98\,g$

$156 - 93.98 = 62.02$

$M_2 = 62.02$

$62.02 \div 2 = M = \boxed{31.01\,g/mol}$

M = Phosphorus