Gas Law Problems: A Smorgasbord $2H_2O \rightarrow 2H_2 + O_2$

1. Calculate the cubic meters of oxygen gas that can be produced by the electrolysis of 5.00 g of water at 25.0 °C and 73.5 cm Hg of pressure. ($V = 3.51 \times 10^{-3} m^3$)

1. $5.00g\ H_2O \times \frac{1\ mol\ H_2O}{18.02g\ H_2O} = 0.2775\ mol\ H_2O$

$73.5cm\ Hg \times \frac{10mm}{1cm} \times \frac{101.3\ kPa}{760mm\ Hg} = 97.97\ kPa$

$25.0°C = 298.0K$

2. $5.00g\ H_2O \times \frac{1\ mol\ H_2O}{18.02g\ H_2O} \times \frac{1\ mol\ O_2}{2\ mol\ H_2O} = 0.1387\ mol\ O_2$

3. $PV = nRT$

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

$= \frac{(0.1387\ mol\ O_2)(8.314\ \frac{kPa\ L}{mol\ K})(298.0K)}{97.97\ kPa}$

$= 3.51\ L$

$= 3.51\ dm^3$

$= 3.51 \times 10^{-3} m^3$

2. A student performs an experiment involving the reaction of magnesium with hydrochloric acid to form hydrogen gas. From the data, calculate the mass of Mg used. $Mg + 2HCl \rightarrow MgCl_2 + H_2$ (0.041 g Mg)

Volume of H_2 formed (mL)	42.0	= 0.0420L
Temperature of air (°C)	20.0	= 293.0K
Pressure (kPa)	99.3	

1. $\frac{PV}{RT} = \frac{nRT}{RT}$

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

$= \frac{(99.3kPa)(0.0420L)}{(8.314\ \frac{kPa \cdot L}{mol \cdot K})(293.0K)}$

$= 1.712 \times 10^{-3} mol\ H_2$

2. $1.712 \times 10^{-3} mol\ H_2 \times \frac{1\ mol\ Mg}{1\ mol\ H_2} \times \frac{24.31g}{1\ mol\ Mg} = 0.042g\ Mg$

3. If excess chlorine gas reacts with a solution containing 20.0 g of aqueous potassium bromide, how many mL of bromine gas can be produced at 23.0 °C and 1.07 atm. ($1910 mL\ Br_2$)

$2KBr + Cl_2 \rightarrow 2KCl + Br_2$

1. $20.0g\ KBr \times \frac{1\ mol\ KBr}{119\ g\ KBr} \times \frac{1\ mol\ Br_2}{2\ mol\ KBr} = 0.08403\ mol\ Br_2$

2. $1.07atm \times \frac{101.3\ kPa}{1\ atm} = 108.4\ kPa$

$PV = nRT$

$V = \frac{(0.08403mol)(8.314\ \frac{kPa\ L}{mol\ K})(296.0K)}{108.4\ kPa}$

$= 1911 = 1910mL$

4. Place the following gases in decreasing order of molecular velocities: (nitrogen, oxygen, methane, water, hydrogen and sulfur dioxide). $H_2 \rightarrow CH_4 \rightarrow H_2O \rightarrow N_2 \rightarrow O_2 \rightarrow SO_2$

mm
- N_2 : 28.02g/mol
- CH_4 : 16.05g/mol
- H_2O : 18.02g/mol
- H_2 : 2.02 g/mol
- O_2 : 32g /mol
- SO_2 : 64.07g/mol

↓mm , ↑v

Ans: H_2, CH_4, H_2O, N_2, O_2, SO_2

5. Gases are used for different purposes such as:

1. disinfection
2. air conditioning
3. energy production

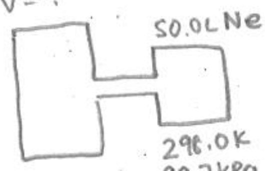
In order, which gases serve the purposes listed above?

(A)	1. Chlorine	2.Freon	3.Methane
B)	1.Nitrogen	2.Oxygen	3.Chlorine
C)	1.Methane	2.Nitrogen	3.Carbon dioxide
D)	1.Oxygen	2.Freon	3.Carbon dioxide

(A)

6. The volume of a large gas tank, sealed except for necessary gas fittings, could not be determined by normal calculation of its irregular shape. A vessel which contains 50.0 L of neon at 25.0 °C and 99.7 kPa was connected to the tank and the valve between them opened, allowing the neon to escape into the larger tank. After distributing itself uniformly through the total volume of the system, the neon pressure was 10.6 kPa. Calculate the volume of the larger tank. (420 mL)

V = ?



1 $\frac{P_1V_1}{P_2} = \frac{P_2V_2}{P_2}$

$V_2 = \frac{P_1V_1}{P_2}$

$= \frac{(99.7kPa)(50.0L)}{10.6kPa}$

$= 470.\ L$

2

$470.L - 50.0L = 420.L$

7. A 2.00 g sample of gas occupies 8.4 L at 20.0 °C and 1.0 atm of pressure.

a) What is its volume at 91.0 °C and a pressure of 1.013×10^3 kPa?

b) What is its density at 91.0 °C?

a) $T_2 \cdot \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \cdot T_2$

$V_2 = \frac{P_1V_1T_2}{T_1P_2}$

$= \frac{(101.3\,kPa)(8.4\,L)(364\,K)}{(293\,K)(1.013\times10^3\,kPa)}$

$= \boxed{1.0\,L}$

b) $D = \frac{m}{V}$

$= \boxed{\frac{2.00\,g}{1\,L}}$

1.0 L

$V_2 = 10.0\,L$

$P = 0.20\,g/L$

$D = \frac{2.00\,g}{L}$

8. A mole of water vapour at 150.0 °C and 250 kPa occupies 14.1 dm^3.

What volume would the mole of water occupy STP?

(22.4L)

$T_1 = 423.0\,K$

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

$\frac{T_2P_1V_1}{T_1} \Big/ P_2 = \frac{P_2V_2}{P_2}$

$V_2 = \frac{T_2P_1V_1}{T_1P_2}$

$= \frac{(273\,K)(250\,kPa)(14.1\,L)}{(423.0\,K)(101.3\,kPa)}$

$= \boxed{22.4\,L}$

9. Calculate the mass of 40.0 L of NO gas at ~~standard conditions~~ STP.

$40.0\,L \times \frac{1\,mol}{22.4\,L} \times \frac{30.01\,g\,NO}{1\,mol\,NO} = \boxed{53.6\,g}$

53.6

(~~54.0~~ g NO)