Name: Key
Blk:_____ Date:

CHEMISTRY 11
UNIT IV TEST REVIEW

YOUR UNIT IV TEST IS SCHEDULED FOR _____.
The format of the test will be 40 marks multiple choice and 30 marks short answer. Your test will also include 20 % of flashback questions from the previous units. In order to help you prepare for your test you must complete the following package and hand it in at start of class on the day of the test.

There are FIVE Parts to this unit:
1. Moles, atoms, molecules, grams and volume @STP
2. Molar Mass and Percent Composition
3. Empirical Formula + Molecular Formula
4. Molarity
5. Dilution

PART I: Moles, atoms, molecules, grams and volume at STP

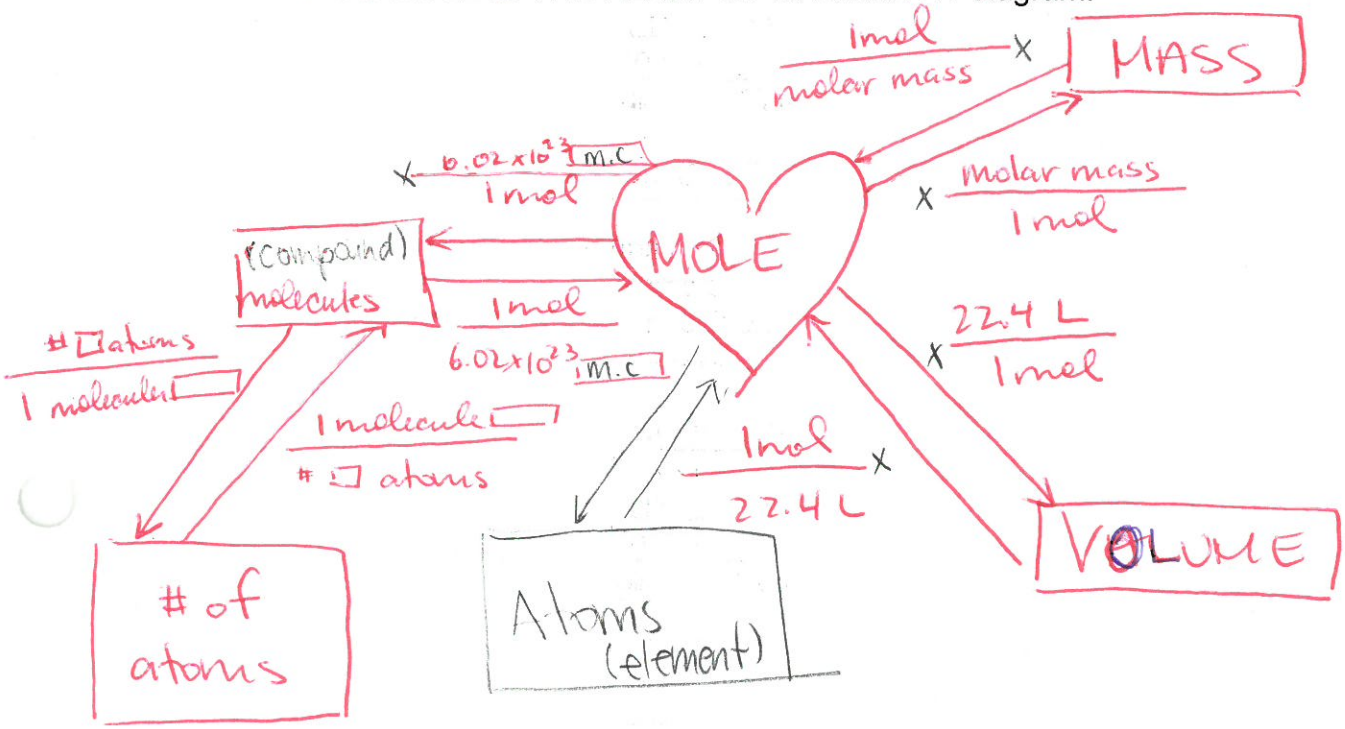
1. State Avogadro's Hypothesis

Equal volumes of gas (at the same temp (0°C) + pressure (101.3 kPa)) contain equal # of particles

2. What is a mole?

a mole is 6.02×10^{23} of anything.

3. Draw the MOLE IS THE HEART OF CHEMISTRY diagram:



K_2CO_3

2 K = 78.2
C = 12.0
3 O = 48.0
138.2 g

4. How many molecules of potassium carbonate are in a 341.2 g sample?

$$341.2\text{ g } K_2CO_3 \times \frac{1\text{ mol}}{138.2\text{ g}} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} = \boxed{1.49\times10^{24}\text{ molecules } K_2CO_3}$$

Cu = 63.5
S = 32.1
4 O = 64.0
159.6

5. How many moles are there in a 65.0 g sample of Copper (II) Sulphate?

$$65.0\text{ g } CuSO_4 \times \frac{1\text{ mol}}{159.6\text{ g } CuSO_4} = \boxed{0.407\text{ mol } CuSO_4}$$

6. How many oxygen atoms are in 2.53×10^{-13} moles H_2O?

$$2.53\times10^{-13}\text{ moles} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} \times \frac{1\text{ "O" atom}}{1\text{ molecule } H_2O} = \boxed{1.52\times10^{11}\text{ "O" atoms}}$$

7. How many molecules of SO_2 are present in a 9.50 L of SO_2 (g) at STP?

$$9.50\text{ L} \times \frac{1\text{ mol}}{22.4\text{ L}} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} = \boxed{2.55\times10^{23}\text{ molecules } SO_2}$$

8. What is the volume occupied by 3.25×10^{-13} molecules of methane gas (CH_4) at STP?

$$3.25\times10^{13}\text{ molecules} \times \frac{1\text{ mol}}{6.02\times10^{23}\text{ molecules}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \boxed{1.21\times10^{-35}\text{ L } CH_4}$$

Fe = 55.8
3 Cl = 106.5
162.3 g

9. How many chloride atoms are contained in 15.6 grams of Iron (III) chloride?

$$15.6\text{ g } FeCl_3 \times \frac{1\text{ mol}}{162.3\text{ g}} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} \times \frac{\text{"3" Cl atoms}}{1\text{ molecule } FeCl_3} =$$

$$\boxed{1.74\times10^{23}\text{ Cl atoms}}$$

10. How many atoms are there in 196.0 grams of Silver?

$$196.0\text{ g Ag} \times \frac{1\text{ mol}}{107.9\text{ g}} \times \frac{6.02\times10^{23}\text{ atoms}}{1\text{ mol}} = \boxed{1.09\times10^{24}\text{ Ag Atoms}}$$

PART II: MOLAR MASS AND PERCENT COMPOSTION

1. Calculate the molar mass of the following molecules:

a. $Cu(NO_3)_2$ b. $(NH_4)_3PO_4$ c. $KAl(SO_4)_2 \cdot 12H_2O$

Cu = 63.5
2 N = 28.0
6 O = 96.0
187.5 g $Cu(NO_3)_2$

3 N = 42.0
12 H = 12.0
P = 31.0
4 O = 64.0
149.0 g $(NH_4)_3PO_4$

K = 39.1
Al = 27.0
2 S = 64.2
8 O = 128.0
258.3 g

24 H = 24.0
12 O = 192.0
216.0

+

$\Rightarrow$ 474.3 g $KAl(SO_4)_2 \cdot 12H_2O$

2. Calculate the percent composition of **each element** in the above molecules:

a. $Cu(NO_3)_2$

$\frac{63.5g}{187.5g} \times 100\% = 33.9\%\ Cu$, $\frac{28.0g}{187.5g} \times 100\% = 14.9\%\ N$, $\frac{96.0g}{187.5g} \times 100\% = 51.2\%\ O$

b. $(NH_4)_3PO_4$

$\frac{42.0g}{149.0g} \times 100\% = 28.2\%\ N$, $\frac{12.0g}{149.0g} \times 100\% = 8.1\%\ H$, $\frac{31.0g}{149.0g} \times 100\% = 20.8\%\ P$, $\frac{64.0g}{149.0g} \times 100\% = 43.0\%\ O$

3. What is the percent composition of **water** in $KAl(SO_4)_2 \cdot 12H_2O$?

$\frac{216.0g}{474.3g} \times 100\% = 45.5\%\ H_2O$

Part III: EMPIRICAL FORMULA AND MOLECULAR FORMULA

1. Find the Empirical Formula for the following compounds:

a. 70.0% Fe and 30.0 % O

$70.0g\ Fe \times \frac{1mol}{55.8g} = 1.25\ mol\ Fe \div 1.25 = 1 \times 2 = 2$

$30.0g\ O \times \frac{1mol}{16.0g} = 1.88\ mol\ O \div 1.25 = 1.5 \times 2 = 3$

$\therefore Fe_2O_3$

b. 91.2% P and 8.82% H

$91.2g\ P \times \frac{1mol}{31.0g} = 2.94\ mol\ P \div 2.94 = 1$

$8.82g\ H \times \frac{1mol}{1.0g} = 8.82\ mol\ H \div 2.94 = 3$

$\therefore PH_3$

c. 26.6% K, 35.4% Cr and 38.0% O

$26.6g\ K \times \frac{1mol}{39.1g} = 0.680\ mol\ K \div 0.680 = 1 \times 2 = 2$

$35.4g\ Cr \times \frac{1mol}{52.0g} = 0.680\ mol\ Cr \div 0.680 = 1 \times 2 = 2$

$38.0g\ O \times \frac{1mol}{16.0g} = 2.38\ mol\ O \div 0.680 = 3.5 \times 2 = 7$

$\therefore K_2Cr_2O_7$

2. A gas has the percent composition: 30.4% N and 69.6% O. If the density of the gas is 4.11 g/L at STP, what is the molecular formula of the compound?

$30.4g\ N \times \frac{1mol}{14.0g} = 2.17\ mol\ N \div 2.17 = 1$

$69.6g\ O \times \frac{1mol}{16.0g} = 4.35\ mol\ O \div 2.17 = 2$

$\therefore NO_2$

$\frac{4.11g}{1L} \times \frac{22.4L}{1mol} = 92.1\ g/mol$

$N = \frac{92.1}{46.0g} \times NO_2 = N_2O_4$

3. A gas has an empirical formula CH_2 . If 500.0 mL of the gas at STP has a mass of 0.983 grams, what is the molecular formula of the compound?

CH_2 ∴ 14.0 g. = empirical mass

$$\frac{0.983\text{ g}}{0.500\text{ L}} \times \frac{22.4\text{ L}}{1\text{ mol}} = 44.0\text{ g} = \text{molar mass}$$

$$N = \frac{44.0\text{ g}}{14.0\text{ g}} = 3 \quad \therefore \quad 3 \times CH_4 = \boxed{C_3H_{12}}$$

Part V: MOLARITY

1. What is the molarity of the solution when 3.25 grams of NaCl is dissolved in 500.0 mL?

Na = 23.0
Cl = 35.5
58.5 g

$$3.25\text{ g NaCl} \times \frac{1\text{ mol}}{58.5\text{ g NaCl}} = 5.56 \times 10^{-2}\text{ mol} = \boxed{1.11 \times 10^{-1}\text{ M NaCl}}$$

2. How many moles of K_2SO_4 are needed to make a 0.300 M solution with a volume of 100.0 mL?

$$\frac{0.300\text{ mol } K_2SO_4}{1\text{ L}} \times 0.1000\text{ L} = \boxed{0.0300\text{ mol } K_2SO_4}$$

3. How many grams are needed to prepare a 11.0 mL solution of 0.0200 M $MgCr_2O_7$?

Mg = 24.3
Cr = 104.0
O = 112.0
240.3 g

$$\frac{0.0200\text{ mol } MgCr_2O_7}{1\text{ L}} \times 0.0110\text{ L} = 0.000220\text{ mol} \times \frac{240.3\text{ g}}{1\text{ mol}}$$

$$= \boxed{5.29 \times 10^{-2}\text{ g } MgCr_2O_7}$$

4. What is the molar concentration when 24.2 g of $Fe_2(SO_4)_3$ is dissolved in 250.mL of water?

Fe = 111.6
S = 96.3
O = 192.0
399.9 g

$$24.2\text{ g} \times \frac{1\text{ mol}}{399.9\text{ g}} = 6.05 \times 10^{-2}\text{ mol } Fe_2(SO_4)_3 = \boxed{0.242\text{ M } Fe_2(SO_4)_3}$$

5. What is the volume required to make a 6.0 M NaOH solution from 120.5 grams NaOH?

Na = 23.0
O = 16.0
H = 1.0
40.0 g

$$120.5\text{ g} \times \frac{1\text{ mol}}{40.0\text{ g}} = 3.01\text{ mol NaOH} = \boxed{0.50\text{ L NaOH}}$$

Part V: DILUTION

1. What volume of 2.0 M HCl is required to make 750.0 mL of 0.240 M HCl?

$V_1 = \frac{0.240\,M \times 0.750\,L}{2.0\,M} =$ **0.090 L HCl**

2. What is the final concentration of KBr when 25.0 mL of 5.0 M KBr is mixed with 135.0 mL of 0.250 M KBr?

$KBr_1 = \frac{5.0\,M \times 0.0250\,L}{0.1600\,L} = 0.78\,M$

$KBr_2 = \frac{0.250\,M \times 0.1350\,L}{0.1600\,L} = 0.211\,M$

$+$

0.99 M KBr

3. When 75.0 mL of 0.500M $BaCl_2$ is mixed with 85.0 mL of 1.25 M $CaCl_2$:

a. What is the final concentration of $BaCl_2$?

$BaCl_2 = \frac{0.500\,M \times 0.0750\,L}{0.1600\,L} =$ **0.234 M $BaCl_2$**

b. What is the final concentration of $CaCl_2$?

$CaCl_2 = \frac{1.25\,M \times 0.0850\,L}{0.160\,L} =$ **0.664 M $CaCl_2$**

QUESTIONS THAT TIE IT ALL TOGETHER :

1. How many moles of Cu are contained in a 289 mL sample if the density is 13.6 g/mL?

$\frac{13.6\,g}{0.001\,L} \times \frac{1\,mol}{63.5\,g} = \frac{214.2\,mol\,Cu}{L} \times 0.289\,L$

= **61.9 mol Cu**

2. What is the volume occupied by 3.2 mols of methane (CH_4) if the density of methane is 0.987 g/mL?

C = 12.0
H = 4.0
16.0 g

$\frac{0.987\,g}{0.001\,L} \times \frac{1\,mol}{16.0\,g} = \frac{61.7\,mol\,CH_4}{1\,L}$

$L = \frac{3.2\,mol}{61.7\,M} =$ **5.2×10^{-2} L CH_4**

3. How many chlorine atoms are present in 125.0 mL of 0.0321 M NaCl?

$$\frac{0.0321 \text{ mol NaCl}}{1 \text{ L}} \times 0.1250 \text{ L} = 4.01 \times 10^{-3} \text{ mol NaCl} \times \frac{6.02 \times 10^{23} \text{ m.c}}{1 \text{ mol}} =$$

$$2.42 \times 10^{21} \text{ molecules} \times \frac{1 \text{ Cl atoms}}{1 \text{ molecule}} = \boxed{2.42 \times 10^{21} \text{ Cl atoms}}$$

4. How many oxygen atoms are present in 110.0 mL of 0.200 M $MgCr_2O_7$?

$$\frac{0.200 \text{ mol } MgCr_2O_7}{1 \text{ L}} \times 0.1100 \text{ L} = 0.0220 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ m.c}}{1 \text{ mol}}$$

$$1.32 \times 10^{22} \text{ molecules} \times \frac{7 \text{ "O" atoms}}{1 \text{ molecule}} = \boxed{9.27 \times 10^{22} \text{ "O" atoms}}$$

5. How many HBr molecules are present in 25.0 mL of 0.185 M HBr?

$$\frac{0.185 \text{ mol HBr}}{1 \text{ L}} \times 0.0250 \text{ L} = 4.63 \times 10^{-3} \text{ mol} \times \frac{6.02 \times 10^{23} \text{ m.c}}{1 \text{ mol}}$$

$$\boxed{2.78 \times 10^{21} \text{ molecules HBr}}$$

HERE IS A CHALLENGE!!!

6. How many NaCl molecules are present in the final solution when 15.0 mL of 2.50 M NaCl is mixed with 75.0 mL of 0.500 M NaCl?

$$NaCl_1 = \frac{2.50 \text{ M} \times 0.0150 \text{ L}}{0.0900 \text{ L}} = 0.417 \text{ M NaCl}$$

$$NaCl_2 = \frac{0.500 \text{ M} \times 0.0750 \text{ L}}{0.0900 \text{ L}} = 0.417 \text{ M NaCl}$$

$$+$$

$$0.834 \text{ M NaCl}$$

$$\frac{0.834 \text{ mol NaCl}}{1 \text{ L}} \times 0.0900 \text{ L} = 0.0751 \text{ mol}$$

$$0.0751 \text{ mol NaCl} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = \boxed{4.52 \times 10^{22} \text{ molecules NaCl}}$$