

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

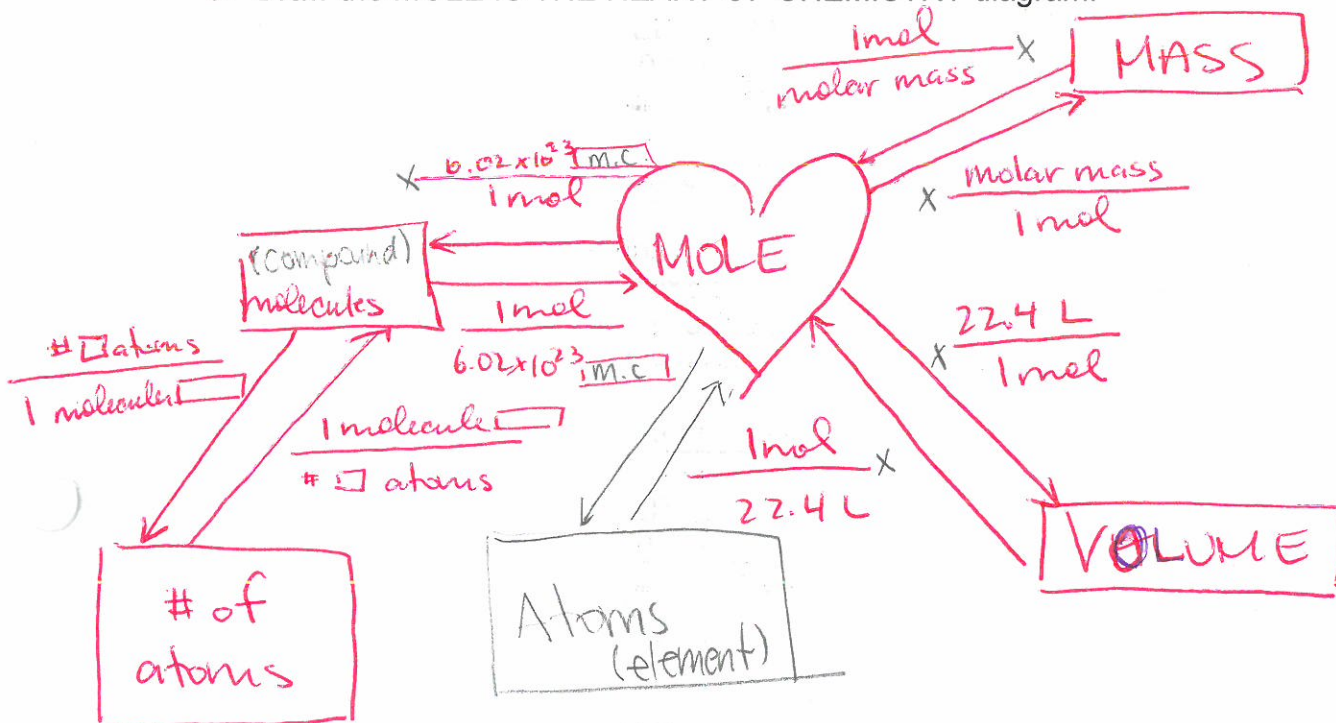
1. State Avogadro's Hypothesis

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:



$$2K = 78.2$$

$$C = 12.0$$

$$3O = 48.0$$



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

$$341.2 \text{ g } K_2CO_3 \times \frac{1 \text{ mol}}{138.2 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 1.49 \times 10^{24} \text{ molecules } K_2CO_3$$

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

$$Cu = 63.5$$

$$S = 32.1$$

$$4O = 64.0$$

$$\hline 159.6$$

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

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

$$2.53 \times 10^{-13} \text{ moles} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{1 \text{ "O" atom}}{1 \text{ molecule } H_2O} = 1.52 \times 10^{11} \text{ "O" atoms}$$

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

$$9.50 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 2.55 \times 10^{23} \text{ molecules } SO_2$$

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

$$3.25 \times 10^{13} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 1.21 \times 10^{-35} \text{ L } CH_4$$

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

$$Fe = 55.8$$

$$3Cl = 106.5$$

$$\hline 162.3 \text{ g}$$

$$15.6 \text{ g } FeCl_3 \times \frac{1 \text{ mol}}{162.3 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ "Cl" atoms}}{1 \text{ molecule } FeCl_3} = 1.74 \times 10^{23} \text{ Cl atoms}$$

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

$$196.0 \text{ g } Ag \times \frac{1 \text{ mol}}{107.9 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 1.09 \times 10^{24} \text{ Ag atoms}$$

PART II: MOLAR MASS AND PERCENT COMPOSITION

1. Calculate the molar mass of the following molecules:

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

$$Cu = 63.5$$

$$2N = 28.0$$

$$6O = 96.0$$

$$187.5 \text{ g}$$

$$Cu(NO_3)_2$$

$$3N = 42.0$$

$$12H = 12.0$$

$$P = 31.0$$

$$4O = 64.0$$

$$149.0 \text{ g}$$

$$(NH_4)_3PO_4$$

$$K = 39.1$$

$$Al = 27.0$$

$$2S = 64.2$$

$$8O = 128.0$$

$$258.3 \text{ g}$$

$$24H = 24.0$$

$$12O = 192.0$$

$$\hline 216.0$$

$$\Rightarrow 474.3 \text{ g}$$

$$KAl(SO_4)_2 \cdot 12H_2O$$

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

a. $\text{Cu}(\text{NO}_3)_2$

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

b. $(\text{NH}_4)_3\text{PO}_4$

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

3. What is the percent composition of **water** in $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$?

$$\frac{216.0\text{g}}{474.3\text{g}} \times 100\% = \boxed{45.5\% \text{ H}_2\text{O}}$$

Part III: EMPIRICAL FORMULA AND MOLECULAR FORMULA

1. Find the Empirical Formula for the following compounds:

a. 70.0% Fe and 30.0 % O

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

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

$\therefore \boxed{\text{Fe}_2\text{O}_3}$

b. 91.2% P and 8.82% H

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

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

$\therefore \boxed{\text{PH}_3}$

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

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

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

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

$\therefore \boxed{\text{K}_2\text{Cr}_2\text{O}_7}$

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?

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

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

$\therefore \boxed{\text{NO}_2}$

$$\text{N} = \frac{92.1}{46.0\text{g}} \times \text{NO}_2 = \boxed{\text{N}_2\text{O}_4} \quad \frac{4.11\text{g}}{1\text{L}} \times \frac{22.4\text{L}}{1\text{mol}} = 92.1\text{ g/mol}$$

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?

$$\text{CH}_2 \therefore 14.0 \text{ g} = \text{empirical mass}$$

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

$$n = \frac{44.0 \text{ g}}{14.0 \text{ g}} = 3 \therefore 3 \times \text{CH}_2 = \boxed{\text{C}_3\text{H}_6}$$

Part IV: MOLARITY

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

$$\begin{array}{r} \text{Na} = 23.0 \\ \text{Cl} = 35.5 \\ \hline 58.5 \text{ g} \end{array}$$

$$3.25 \text{ g NaCl} \times \frac{1 \text{ mol}}{58.5 \text{ g NaCl}} = \frac{5.56 \times 10^{-2} \text{ mol}}{0.500 \text{ L}} = \boxed{1.11 \times 10^{-1} \text{ M NaCl}}$$

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

$$\frac{0.300 \text{ mol K}_2\text{SO}_4}{1 \text{ L}} \times 0.1000 \text{ L} = \boxed{0.0300 \text{ mol K}_2\text{SO}_4}$$

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

$$\begin{array}{r} \text{Mg} = 24.3 \\ 2 \text{Cr} = 104.0 \\ 7 \text{O} = 112.0 \\ \hline 240.3 \text{ g} \end{array}$$

$$\frac{0.0200 \text{ mol MgCr}_2\text{O}_7}{1 \text{ L}} \times 0.0110 \text{ L} = 0.000220 \text{ mol} \times \frac{240.3 \text{ g}}{1 \text{ mol}} = \boxed{5.29 \times 10^{-2} \text{ g MgCr}_2\text{O}_7}$$

4. What is the molar concentration when 24.2 g of $\text{Fe}_2(\text{SO}_4)_3$ is dissolved in 250. mL of water?

$$\begin{array}{r} 2 \text{Fe} = 111.6 \\ 3 \text{S} = 96.3 \\ 12 \text{O} = 192.0 \\ \hline 399.9 \text{ g} \end{array}$$

$$24.2 \text{ g} \times \frac{1 \text{ mol}}{399.9 \text{ g}} = \frac{6.05 \times 10^{-2} \text{ mol Fe}_2(\text{SO}_4)_3}{0.250 \text{ L}} = \boxed{0.242 \text{ M Fe}_2(\text{SO}_4)_3}$$

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

$$\begin{array}{r} \text{Na} = 23.0 \\ \text{O} = 16.0 \\ \text{H} = 1.0 \\ \hline 40.0 \text{ g} \end{array}$$

$$120.5 \text{ g} \times \frac{1 \text{ mol}}{40.0 \text{ g}} = \frac{3.01 \text{ mol NaOH}}{6.0 \text{ M}} = \boxed{0.50 \text{ L NaOH}}$$

Part V: DILUTION

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

$$V_1 = \frac{0.240 \text{ M} \times 0.750 \text{ L}}{2.0 \text{ M}} = \boxed{0.090 \text{ L HCl}}$$

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?

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

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

$$\boxed{0.99 \text{ M KBr}}$$

3. When 75.0 mL of 0.500 M BaCl₂ is mixed with 85.0 mL of 1.25 M CaCl₂:
a. What is the final concentration of BaCl₂?

$$BaCl_2 = \frac{0.500 \text{ M} \times 0.0750 \text{ L}}{0.1600 \text{ L}} = \boxed{0.234 \text{ M BaCl}_2}$$

b. What is the final concentration of CaCl₂?

$$CaCl_2 = \frac{1.25 \text{ M} \times 0.0850 \text{ L}}{0.160 \text{ L}} = \boxed{0.664 \text{ M CaCl}_2}$$

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?

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

$$= \boxed{61.9 \text{ mol Cu}}$$

2. What is the volume occupied by 3.2 mols of methane (CH₄) if the density of methane is 0.987 g/mL?

$$C = 12.0$$

$$H = 4.0$$

$$\hline 16.0 \text{ g}$$



$$\frac{0.987 \text{ g}}{0.001 \text{ L}} \times \frac{1 \text{ mol}}{16.0 \text{ g}} = \frac{61.7 \text{ mol CH}_4}{1 \text{ L}}$$

$$L = \frac{3.2 \text{ mol}}{61.7 \text{ M}} = \boxed{5.2 \times 10^{-2} \text{ L CH}_4}$$

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

$$\frac{0.0321 \text{ mol NaCl}}{1 \cancel{\text{L}}} \times 0.1250 \cancel{\text{L}} = 4.01 \times 10^{-3} \text{ mol NaCl} \times \frac{6.02 \times 10^{23} \text{ m.c.}}{1 \text{ mol}} = 2.42 \times 10^{21} \text{ molecules} \times \frac{1 \text{ Cl atom}}{1 \text{ molecule}} = \boxed{2.42 \times 10^{21} \text{ Cl atoms}}$$

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

$$\frac{0.200 \text{ mol MgCr}_2\text{O}_7}{1 \cancel{\text{L}}} \times 0.1100 \cancel{\text{L}} = 0.0220 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ m.c.}}{1 \text{ mol}} = 1.32 \times 10^{22} \text{ molecules} \times \frac{7 \text{ "O" atoms}}{1 \text{ molecule}} = \boxed{9.27 \times 10^{22} \text{ "O" atoms}}$$

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

$$\frac{0.185 \text{ mol HBr}}{1 \cancel{\text{L}}} \times 0.0250 \cancel{\text{L}} = 4.63 \times 10^{-3} \text{ mol} \times \frac{6.02 \times 10^{23} \text{ m.c.}}{1 \text{ mol}} = \boxed{2.78 \times 10^{21} \text{ molecules HBr}}$$

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?

$$\text{NaCl}_1 = \frac{2.50 \text{ M} \times 0.0150 \text{ L}}{0.0900 \text{ L}} = 0.417 \text{ M NaCl}$$

$$\text{NaCl}_2 = \frac{0.500 \text{ M} \times 0.0750 \text{ L}}{0.0900 \text{ L}} = 0.417 \text{ M NaCl}$$
$$\frac{0.417 \text{ M NaCl} + 0.417 \text{ M NaCl}}{0.834 \text{ M NaCl}}$$

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

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