Chemistry Worksheet 2
Hydrated Compounds - Molar Volume – Mass % Composition

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Name Key Date _____ Period _____

Hydrated Compounds:

1. A hydrated compound of cupric chloride has the formula $CuCl_2 \cdot 2H_2O$. What is the formula mass for this compound?

$63.55 + 2(35.45) + 4(1.008) + 2(16.00)$

$= 170.482$

Answer: 170.48 **g/mol**

2. Iron(III)nitrate is a hydrated compound with a total formula mass of 404.0g/mol. How many water molecules are associated with each unit of iron(III)nitrate?

$Fe(NO_3)_3 = 241.86\ g/mol = 1\ mol$

$404.0 - 241.86 = 162.14\ g\ H_2O$

$mol\ H_2O = 162.14\ g / 18.016\ g/mol = 9\ mol\ H_2O$

Answer: $Fe(NO_3)_3 \cdot 9H_2O$ **water molecules**

3. A hydrated compound of zinc chloride is 44.23% water by mass. What is the empirical formula for this compound?

55.77% $ZnCl_2$ 44.23% H_2O

$mol = \frac{55.77\ g}{136.30\ g/mol} = .409\ mol$ $\frac{44.23\ g}{18.016\ g/mol} = 2.455\ mol$

$2.455 / .409 = 6$ water molecules

Answer: $ZnCl_2 \cdot 6H_2O$

Standard Molar Volume, Molar Mass and Density:

1. What is the volume of 0.500mol of O_2 gas at STP?

@ STP $1\ mol = 22.4\ L$

$.5\ mol = \boxed{11.2\ L}$

Answer: 11.2 **L**

2. How many liters would 1.000g of helium gas occupy at STP?

$\frac{1.000\ g}{4.003\ g/mol} = .250\ mol\ He$

$\frac{22.4\ L}{1\ mol}(.250\ mol) = \boxed{5.60\ L}$

Answer: 5.60 **L**

3. If sodium metal and chlorine gas are known to combine in a 2:1 ratio by number of moles, how many liters of chlorine gas are needed to react with 3.500g of sodium metal if the reaction takes place at STP?

$\frac{3.500\ g\ Na}{22.99\ g/mol} = .1522\ mol\ Na\left(\frac{1\ mol\ Cl_2}{2\ mol\ Na}\right) = .0761\ mol\ Cl_2$

$.0761\ mol\ Cl_2\left(\frac{22.4\ L}{1\ mol}\right) = \boxed{1.71\ L}$

Answer: 1.71 **L Cl_2**

4. How many molecules of Cl_2 would be contained in the volume you determined in question 3 above?

$.0761 \text{ mol } Cl_2 \left(\frac{6.022 \times 10^{23} \text{ molecules } Cl_2}{1 \text{ mol } Cl_2} \right)$

Answer: 4.58×10^{22} **molecules Cl_2** $= 4.58 \times 10^{22}$

5. What is the density of helium at STP? How does this compare to the density of oxygen (O_2)?

$1 \text{ mol} = 4.003 \text{ g} = 22.4 \text{ L}$ $4.003 \text{ g} / 22.4 \text{ L} = .179$ $1 \text{ mol} = 32.0 \text{ g} = 22.4 \text{ L}$

Answer: Density He = $.179$ **g/L Density of O_2 =** 1.429 **g/ L** $\frac{32.0 \text{ g}}{22.4 \text{ L}} = 1.429$

6. A monoatomic elemental gas has a density of ~~39.9~~ 1.78 g/L at STP. What is the identity of the gas?

$\frac{1.78 \text{ g}}{\text{L}} \left(\frac{22.4 \text{ L}}{1 \text{ mol}} \right) = 39.9 \text{ g/mol} = \text{Argon}$

Answer: Argon (Ar)

Mass Percent Composition:

1. What is the mass percentage of each of the elements contained in the citric acid molecule with a formula of $C_6H_8O_7$? molar mass $6(12.01) + 8(1.008) + 7(16.00) = 192.124 \text{ g/mol}$

$\frac{6(12.01)}{192.124} = .3750$ $\frac{8(1.008)}{192.124} = .04197$ $\frac{7(16.00)}{192.124} = .58295$

Answer: C = 37.50 **% H =** 4.20 **% O =** 58.30 **%**

2. The compound ethylene glycol (a common anti-freeze agent) is 38.70% carbon and 9.74% hydrogen by mass. What is the empirical formula for this compound? and the rest is oxygen

$\frac{38.70}{12.01} = 3.222$ $\frac{9.74}{1.008} = 9.662$ $\frac{51.56}{16.00} = 3.222$

$C_{\frac{3.222}{3.222}} H_{\frac{9.662}{3.222}} O_{\frac{3.222}{3.222}}$ CH_3O

Answer: CH_3O

3. If the actual molar mass of ethylene glycol is between 50.00 and 70.00 grams per mole. What is the molecular formula for this compound?

$CH_3O = 12.01 + 3(1.008) + 16.00$

$= 31.034 \text{ g/mol}$

$\times 2 = 62.068$ ✓ within range

Answer: $C_2H_6O_2$

4. How many molecules of ethylene glycol are in 100.00g of that substance?

$100.00 \text{ g} \left(\frac{1 \text{ mol}}{62.068 \text{ g}} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \right)$

$= 9.70 \times 10^{23}$ molecules

Answer: 9.70×10^{23} molecules

5. What is the mass percent of carbon in glucose, $C_6H_{12}O_6$?

$\frac{6C}{C_6H_{12}O_6}$ $\frac{6(12.01)}{[6(12.01) + 12(1.008) + 6(16.00)]}$

$\frac{72.06}{180.156} = .39998 = .400$

Answer: 40.0 **% C**