CHE 101 Quiz 3:

1) What is the correct chemical formula for lithium phosphate, calcium nitrite, aluminum oxide, and iron (III) oxide:

a) Li_3PO_3, $Cu(NO_3)_2$, Al_2O_3, Fe_2O_3

(b) Li_3PO_4, $Ca(NO_2)_2$, Al_2O_3, Fe_2O_3

c) Li_2HPO_4, $Ca(NO_3)_2$, Al_2O_3, Fe_3O_2

d) Li_2SO_4, $Ca(NO_2)_2$, Al_2O_3, FeO

lithium (Li^+) phosphate (PO_4^{3-}): Li_3PO_4

(We should have 3 Li ions to generate charge of +3 for the compound to be neutral, meaning the total charge should be zero)

Calcium (Ca^{2+}, +2) nitrite (NO_2^-, -1): $Ca(NO_2)_2$: we should have 2 of NO_2 to have charge of +2.

aluminum (Al^{3+}) oxide (O^{2-}): Al_2O_3

we should find lowest common denominator between 2 and 3 which is 6

Divide 6 by +3 $\Rightarrow$ +2 $\rightarrow$ You should have 2 Al

Divide 6 by -2 $\rightarrow$ -3 $\rightarrow$ You should have 3 O

Iron (Fe^{3+}) (III) oxide (O^{2-}): Fe_2O_3 (same as Al_2O_3 "similar")

2) Which statement is not correct?

a) Matter is ultimately composed of atoms, and those atoms are often combined in compounds.

b) The formula mass of a compound is the sum of ~~charges~~ atomic masses of all the atoms in the chemical formula for the compound.

c) Besides being the characteristic mass of a molecule or formula unit, formula mass is important in many calculations involving the composition of compounds and quantities in chemical reactions.

d) Most of the matter you encounter is in the form of compounds

3) What is the formula mass of CCl_2F_2, hydrobromic acid (HBr), phosphorus pentafluoride (PF_5), and manganese (III) oxide (Mn_2O_3):

a) 120.91, 96.91, 182.97, 102.94

(b) 120.91, 80.91, 125.97, 157.88

c) 120.91, 96.91, 182.97, 102.94

d) 120.91, 80.91, 125.97, 196.82

Formula mass of $HBr = H + Br = 1.01 + 79.90 = 80.91$ (Atomic mass of H, Atomic mass of Br)

Formula mass of $PF_5 = 30.97 + (19 \times 5) = 125.97$ $(1 \times P) + (5 \times F)$

Formula mass of $Mn_2O_3 = (2 \times Mn) + (3 \times O) = (2 \times 54.94) + (3 \times 16) = 157.88$

Formula mass of $CCl_2F_2 = (1 \times C) + (2 \times Cl) + (2 \times F) = 120.91$ (12.01, 35.45, 19)

4) Imagine we have 10 moles of the following compounds. which sample is the heaviest and which one is an ionic compound?

BrF_5, HNO_3, $MgSO_4$, NI_3

a) heaviest = BrF_5, Ionic ~~=~~ $\neq BrF_5$ (No metal, No NH_4^+)

b) heaviest = NI_3, Ionic ~~=~~ $= NI_3$ (No metal, No NH_4^+)

c) heaviest = BrF_5, Ionic = $MgSO_4$ ✓

d) heaviest = NI_3, Ionic = $MgSO_4$ ✓

Ionic compounds are composed of 1 or more cations paired with 1 or more anions. In most cases (Not Always), the cations are metals and anions are non metals. NH_4^+ (ammonium) is not a metal but when paired with an anion forms an ionic compound.

$$? \text{ g } BrF_5 = 10 \text{ mol } BrF_5 \times \frac{180.47 \text{ g } BrF_5}{1 \text{ mol } BrF_5} =$$

$$? \text{ g } NI_3 = 10 \text{ mol } NI_3 \times \frac{394.71 \text{ g } NI_3}{1 \text{ mol } NI_3}$$

Just compaing 180.47 and 394.71, we realize NI_3 is heavier.

5) Which compound name is correct?

a) CaO: Calcium (~~II~~) oxide

b) KNO_3: Potassium ~~nitrite~~ nitrate

c) $Fe(OH)_2$: Iron (II) ~~oxide~~ hydroxide

(d) NH_4NO_3: Ammonium nitrate

6) We have 10 g of each of the following compounds. Which of them consists of the least grams of oxygen?

(a) Copper (I) chlorate $CuClO_3$

(b) Potassium permanganate $KMnO_4$

(c) Lithium hydrogen sulfite $LiHSO_3$

(d) All have the same grams of oxygen

Calculating molar masses:

$CuClO_3 = 63.55 + 35.45 + 16 \times 3 = 147$

$CuClO_3 = (1 \times Cu) + (1 \times Cl) + (O \times 3)$

$KMnO_4 = (1 \times \overset{39.10}{K}) + (1 \times \overset{54.94}{Mn}) + (4 \times \overset{16}{O}) = 158.04$

$LiHSO_3 = (1 \times \overset{6.94}{Li}) + (1 \times \overset{1.01}{H}) + (1 \times \overset{32.06}{S}) + (3 \times \overset{16}{O}) = 88.01$

$? \text{ g O} = 10 \text{ g } CuClO_3 \times \frac{1 \text{ mol } CuClO_3}{147 \text{ g } CuClO_3} \times \frac{3 \text{ mol O}}{1 \text{ mol } CuClO_3} \times \frac{16 \text{ g O}}{1 \text{ mol O}} = 3.26 \text{ g}$

$? \text{ g O} = 10 \text{ g } KMnO_4 \times \frac{1 \text{ mol } KMnO_4}{158.04 \text{ g } KMnO_4} \times \frac{4 \text{ mol O}}{1 \text{ mol } KMnO_4} \times \frac{16 \text{ g O}}{1 \text{ mol O}} = 4.05 \text{ g}$

$= 10 \text{ g } LiHSO_3 \times \frac{1}{88.01} \times \frac{3}{1} \times 16 = 5.45 \text{ g}$

7) Sort option 1, option 2, option 3, and option 4 from smallest to the greatest value:

Option 1: Mass of Cl in 15 g of chlorous acid $HClO_2$

option 2: Mass of N in 35 g of nitric acid HNO_3

Option 3: Mass of C in 20 g of acetic acid $HC_2H_3O_2$

option 4: Mass of S in 20 g of sulfurous acid H_2SO_3

a) option 1 < option 2 < option 3 < option 4

b) option 4 < option 3 < option 2 < option 1

c) option 1 < option 3 < option 4 < option 2

(d) option 1 < option 2 < option 4 < option 3

$$?\ g\,Cl = 15\ g\,HClO_2 \times \frac{1\ mol\ HClO_2}{68.46\ g\ HClO_2} \times \frac{1\ mol\ Cl}{1\ mol\ HClO_2} \times \frac{35.45\ g\ Cl}{1\ mol\ Cl} = 7.767$$

option 1

$$HClO_2 = (1\times H) + (1\times Cl) + (2\times O) = 68.46\ \frac{g}{mol}$$

(1.01, 35.45, 16)

$$?\ g\,N = 35\ g\,HNO_3 \times \frac{1\ mol\ HNO_3}{63.02\ g\ HNO_3} \times \frac{1\ mol\ N}{1\ mol\ HNO_3} \times \frac{14.01\ g\ N}{1\ mol\ N} = 7.7805$$

$$HNO_3 = (1\times H) + (1\times N) + (3\times O) = (1\times 1.01) + (1\times 14.01) + (3\times 16) = 63.02$$

option 2

$$?\ g\,C = 20\ g\,HC_2H_3O_2 \times \frac{1\ mol\ HC_2H_3O_2}{60.06\ g\ HC_2H_3O_2} \times \frac{2\ mol\ C}{1\ mol\ HC_2H_3O_2} \times \frac{12.01\ g\ C}{1\ mol\ C} = 7.998$$

option 3

$$HC_2H_3O_2 = (4\times H) + (2\times C) + (2\times O) = 60.06\ \frac{g}{mol}$$

(1.01, 12.01, 16)

$$? \text{ g S} = 20 \text{ g } H_2SO_3 \times \frac{1 \text{ mol } H_2SO_3}{82.08 \text{ g } H_2SO_3} \times \frac{1 \text{ mol S}}{1 \text{ mol } H_2SO_3}$$

$$\times \frac{32.06 \text{ g S}}{1 \text{ mol S}} = \underbrace{7.8118}_{\text{option 4}}$$

$$H_2SO_3 = (2 \times H) + (1 \times S) + (3 \times O)$$
$$= (2 \times 1.01) + (1 \times 32.06) + (3 \times 16) = 82.08 \frac{g}{mol}$$

option 1 : 7.767 smallest
option 2 : 7.7805
option 3 : 7.998 → largest
option 4 : 7.8118

option 1 < < < option 3

8) Which sample contains the most number of atoms?

a) One gram of cobalt

b) one gram of carbon

c) one gram of lead

d) All have the same number of atoms.

$$?\ \#\ \text{Co atoms} = 1\ \text{g Co} \times \frac{1\ \text{mol Co}}{58.93\ \text{g Co}} \times \frac{6.022\times10^{23}\ \#\ \text{Co atoms}}{1\ \text{mol Co}}$$

$$?\ \#\ \text{C atoms} = 1\ \text{g C} \times \frac{1\ \text{mol C}}{12.01\ \text{g C}} \times \frac{6.022\times10^{23}\ \#\ \text{C atoms}}{1\ \text{mol C}}$$

$$?\ \text{Pb atoms} = 1\ \text{g Pb} \times \frac{1\ \text{mol Pb}}{207.2\ \text{g Pb}} \times \frac{6.022\times10^{23}\ \#\ \text{Pb atoms}}{1\ \text{mol Pb}}$$

When comparing ratios, the one that has smallest denominator, has the largest value. So C has the most number of atoms.

9) Fluoride is often added to water as sodium fluoride. What is the mass percent composition of F in sodium fluoride. How many grams of sodium fluoride must be added to 1500 L of water to fluoridate it at a level of 1.0 $\frac{mg\ f}{L}$?

a) 45 %, 3.3 mg
b) 90%, 3.3 g
c) 45%, 3.3 g
d) 90%, 3.3 mg

$$?\ g\ F = 100\ g\ NaF \times \frac{1\ mol\ NaF}{41.99\ g\ NaF} \times \frac{1\ mol\ F}{1\ mol\ NaF} \times \frac{19\ g\ F}{1\ mol\ F}$$

$$= 45.249$$

Mass percent composition of F is 45.25% $\cong$ 45 %

From 100 g NaF, 45.25 g is F $\Rightarrow$

$NaF = \overset{Na}{22.99} + \overset{F}{19} = 41.99\ \frac{g}{mol}$

$$?\ g\ NaF = 1500\ L \times \frac{1\ mg\ F}{1\ L} \times \frac{10^{-3}\ g\ F}{1\ mg\ F} \times \frac{1\ mol\ F}{19\ g\ F} \times \frac{1\ mol\ NaF}{1\ mol\ F} \times \frac{41.99\ g\ NaF}{1\ mol\ NaF}$$

$$= 3.315\ g \cong 3.3\ g$$

10) Which statement is NOT correct:

a) The molecular formula of sulfur hexafluoride is SF_6.

b) HCl is a ionic ~~compound~~ Acid with H having charge of +1 and Cl having the charge of -1

c) Dihydrogen monoxide is the other name of water

d) Gold (IV) oxide has the chemical formula of AuO_2

Gold (IV) oxide

Au^{4+} O^{2-} AuO_2

+4 $2 \times (-2) = -4$

11) Which statement is NOT correct:

a) The value of an element's molar mass in grams per mole is numerically equal to the element's atomic mass in atomic mass units

b) The mass of one mole of atoms of an element is its molar mass

c) Just as the weight of 1 doz nails is different changes ~~constant~~ for different types of nails, so the mass of 1 mol of atoms is ~~constant~~ changes for different atoms.

d) Avogadro's number, the number of atoms in a mole, is defined as the number of atoms in exactly 12 g of carbon-12

12) We are told that 3.24 g sample of titanium reacts with oxygen and forms 5.40 g of the metal oxide. We are told all the oxygen and titanium in this reaction would be consumed to produce metal oxide. We are also given the periodic table of elements. What information CANNOT directly be inferred from this information:

a) The empirical formula of metal oxide is TiO_2

b) 2.16 g of oxygen reacts with 3.24 g of titanium

c) 0.135 mol of oxygen reacts with 0.0677 mol of titanium

(d) The molecular formula of metal oxide is Ti_2O_4

Just by looking at the data given, we realize we cannot find the molecular formula because the molar mass of the molecular formula is not being provided.

3.24 g Ti + O → 5.40 g Titanium oxide

g of O = 5.40 − 3.24 = 2.16 g ⇒ b is correct

? mol Ti = $3.24\ g\,Ti \times \frac{1\ mol\,Ti}{47.88\ g\,Ti} = 0.0677$

? mol O = $2.16\ g\,O \times \frac{1\ mol\,O}{16\ g\,O} = 0.135$

} option (C) is correct.

$Ti_{0.0677}\ O_{0.135}$ ⟹ divide both sides by the smallest number (0.0677)

$Ti_{\frac{0.0677}{0.0677}}\ O_{\frac{0.135}{0.0677}}$

$Ti\ O_{1.99}$ ⟹ The numbers should be whole-numbers

$Ti\ O_2$ ⟹ Empirical formula ⟹ (a) is correct.

13) Which of the following consists of only metals?

a) hydrogen (Nonmetal), lithium, sodium, potassium

b) beryllium, maynesium, calcium, silicon (Metalloids — not a metal)

c) germanium (Metalloid — not a metal), tellurium (Metalloid — not a metal), boron (Metalloid — not a metal), vanadium

(d) aluminum, copper, zinc, mercury : All metal

(d) 14) Sort the following elements based on their atomic mass (remember atomic mass numerically equals molar mass):

C = 12.01 Carbon, N = 14.01 nitrogen, Ca = 40.08 calcium, P = 30.97 phosphorous, Cl = 35.45 chlorine, Ar = 39.95 argon, palladium, iridium, sodium, potassium

Pd = 106.42, Ir = 192.22, Na = 22.99, K = 39.10

12.01 < 14.01 < 22.99 < 30.97 < 35.45 < 39.10 < 39.95 < 40.08 < 106.42 < 192.22

Carbon < nitrogen < sodium < phosphorous < chlorine < potassium < Argon < calcium < palladium < iridium

option (d) is the answer

15) which of the following answers contain all metals with invariant charges?

lead(II) Pb^{2+} , lead(IV) Pb^{4+}

a) cesium, calcium, silver, zinc, lead

Copper(I) Cu^{+}, Copper(II) Cu^{2+}

b) copper, zinc, sodium, strontium, barium

Sn^{2+}, Sn^{4+} Hg_2^{2+}, Hg^{2+}

c) tin, mercury, zinc, silver, lead

tin(II) tin(IV)

mercury(I) mercury(II)

(d) silver, aluminum, magnesium, cesium, lithium

Refer to tables 5.4 and 5.5

16) Which statement is correct?

have invariant charges ← Zn^{2+}, Ag^{+}

a) (All transition) metals form more than one type of ion and as a result form second type of ionic compounds.

not all : Zn and Ag are exceptions

b) Cr, Fe, (Zn), Zr are examples of transition metals that form more than one type of ion

We only can have Zn^{2+}

c) Ionic compounds usually ~~for sure~~ consist of a metal and non-metal. If we do not see a metal in a compound, we can be sure it is not an ionic compound. (we should have cation, NH_4^{+} is non-metal still forms an ionic compound)

(d) We categorize chemical formulas into tree types: empirical, molecular, and structural

17) Which statement is NOT correct?

All correct refer to Section 5.2

a) Even though atoms combine in whole-number ratios, their mass ratios are not necessarily whole numbers

b) The ratio of hydrogen to oxygen in a mixture is variant

c) The ratio of hydrogen to oxygen in water is fixed

d) Molecular elements do not normally exist in nature with single atoms as their basic units (Refer to Molecular elements in Section 5.4)

18) Which of the following is an ionic compound?

a) NO → Molecular

(b)) NH_4ClO_4 → composed of NH_4^+ and ClO_4^- ⇒ Ionic

c) Au ⇒ Metal Not a compound

NH_4^+ Cation

ClO_4^- Anion

d) CCl_4 ⇒ Molecular

19) Which of these elements exist as diatomic molecules?

a) Ba: Barium, metal group 2A
b) Bi: Bismuth, metal group 5A
c) Br: Bromine : ~~not~~ non metal, group 7A
d) Be: Beryllium: Metal, group 2A

Refer to table 5.2 and Figure 5.9

List of elements that occur as Diatomic Molecules:

hydrogen	H_2
nitrogen	N_2
oxygen	O_2
fluorin	F_2
chlorine	Cl_2
bromine	Br_2
iodine	I_2

Ba: metal: Group 2A: Barium

Bi: Bismuth: Metal: Group 5A

20) Which formula represents the greatest total number of atoms?

a) $Al(C_2H_3O_2)_3$

$1+6+9+6=22$

1 Al
$2\times3=6$ C
$3\times3=9$ H
$2\times3=6$ O

22

b) $Al_2(CrO_7)_3$

$2+6+21=29$

2 Al
$2\times3=6$ Cr
$7\times3=21$ O

29

c) $Pb(HSO_4)_4$

$1+4+4+16=25$

1 Pb
4 H
4 S
$4\times4=16$ O

25

d) $(NH_4)_3PO_4$

$3+12+1+4=20$

3 N
$4\times3=12$ H
1 P
4 O

20

21) Which of the following is NOT an acid?

a, b, c ⇒ All have hydrogen ⇒ acid

a) $HC_2H_3O_2$: Acetic acid

b) HCl : Hydrochloric acid

c) $HClO_2$: chlorous acid

d) Al_2O_3 ⇒ Ionic compound

metal (cation) nonmetal (anion)

22) Which of the following samples has the smallest mass?

CF_4

a) 2.32 mol carbon tetrafluoride

$$?\ g\ CF_4 = 2.32\ mol\ CF_4 \times \frac{88.01\ g\ CF_4}{1\ mol\ CF_4} = \boxed{204.18}\ g\ CF_4$$

Molar mass of $CF_4 = (1 \times C) + (4 \times F) = 88.01\ \frac{g}{mol}$ (C: 12.01, F: 19)

MgF_2

b) 0.66 mol magnesium fluoride

$$?\ g\ MgF_2 = 0.66\ mol\ MgF_2 \times \frac{62.31\ g\ MgF_2}{1\ mol\ MgF_2} = \boxed{41.12}\ g\ MgF_2$$

Molar mass of $MgF_2 = (1 \times Mg) + (2 \times F) = 62.31\ \frac{g}{mol}$ (Mg: 24.31, F: 19)

CS_2

c) 1.99 mmol carbon disulfide

$$?\ g\ CS_2 = 1.99\ mmol\ CS_2 \times \frac{76.13\ g\ CS_2}{10^{+3}\ mmol\ CS_2} = 0.151498\ 7\ g\ CS_2$$

Molar mass of $CS_2 = (1 \times C) + (2 \times S) = 76.13\ \frac{g}{mol}$ (C: 12.01, S: 32.06)

$$?\ g\ CS_2 = 1.99\ mmol\ CS_2 \times \frac{10^{-3}\ mol\ CS_2}{1\ mmol\ CS_2} \times \frac{76.13\ g\ CS_2}{1\ mol\ CS_2} = \boxed{0.151}\ g\ CS_2$$

SO_3

d) 2.21 kmol sulfur ~~of~~ trioxide

$g\,SO_3$

176932.6

$$? \text{ g } SO_3 = 2.21 \text{ kmol } SO_3 \times \frac{1000 \text{ mol } SO_3}{1 \text{ kmol } SO_3} \times \frac{8.06 \text{ g } SO_3}{1 \text{ mol } SO_3}$$

Molar mass of SO_3 = $(1 \times S) + (3 \times O)$ = 80.06 $\frac{g}{mol}$

(32.06 for S, 16 for O)

option (C) is the smallest number.

23) A mothball is composed of naphtalene ($C_{10}H_8$) and has a mass of 2.32 g. How many naphthalene molecules does it contain?

a) 1.09×10^{22}
b) 8.72×10^{22}
c) 8.72×10^{23}
d) 1.09×10^{23}

$$? \text{ } C_{10}H_8 \text{ molecules} = 2.32 \text{ g } C_{10}H_8 \times \frac{1 \text{ mol } C_{10}H_8}{128.18 \text{ g } C_{10}H_8} \times \frac{6.022 \times 10^{23} \text{ \# of } C_{10}H_8 \text{ molecules}}{1 \text{ mol } C_{10}H_8}$$

Molar mass:

$$C_{10}H_8 = (10 \times C) + (8 \times H) = 128.18$$

(12.01 for C, 1.01 for H)

$$? \text{ } C_{10}H_8 \text{ molecules} = \frac{2.32 \times 6.022 \times 10^{23}}{128.18} = 1.09 \times 10^{22}$$

24) Which sample has the most number of molecules?

Molar mass of each:

a) 10 g H_2O $H_2O = (H \times 2) + (1 \times O) = 18.02 \frac{g}{mol}$ (H: 1.01, O: 16)

b) 100 g N_2 $N_2 = (N \times 2) = 28.02 \frac{g}{mol}$ (N: 14.01)

c) 100 g CCl_4 $CCl_4 = (1 \times C) + (4 \times Cl) = 153.81 \frac{g}{mol}$ (C: 12.01, Cl: 35.45)

d) 30 g $C_6H_{12}O_6$ $C_6H_{12}O_6 = (C \times 6) + (H \times 12) + (O \times 6) = 180.18 \frac{g}{mol}$ (C: 12.01, H: 1.01, O: 16)

a) $?\ \#\ H_2O\ molecules = 10\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.02\ g\ H_2O} \times \frac{6.022 \times 10^{23}\ \#\ H_2O\ molecules}{1\ mol\ H_2O}$

$= \frac{10 \times 6.022 \times 10^{23}}{18.02} = \boxed{0.555} \times 6.022 \times 10^{23}$

$= 3.34 \times 10^{23}$

b) $?\ \#\ N_2\ molecules = 100\ g\ N_2 \times \frac{1\ mol\ N_2}{28.02\ g\ N_2} \times \frac{6.022 \times 10^{23}\ \#\ N_2\ molecules}{1\ mol\ N_2}$

$= \frac{100}{28.02} \times 6.022 \times 10^{23} = \boxed{3.57} \times 6.022 \times 10^{23}$

$= 2.15 \times 10^{24}$

c) ? # CCl_4 molecules = 100 g CCl_4 $\times \frac{1 \text{ mol } CCl_4}{153.81 \text{ g } CCl_4}$

$\times \frac{6.022 \times 10^{23} \text{ \# } CCl_4 \text{ molecules}}{1 \text{ mol } CCl_4}$

$= \frac{100}{153.81} \times 6.022 \times 10^{23} = \boxed{0.65} \times 6.022 \times 10^{23}$

$= 3.91 \times 10^{23}$

d) ? # $C_6H_{12}O_6$ molecules = 30 g $C_6H_{12}O_6$ $\times \frac{1 \text{ mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6}$

$\times \frac{6.022 \times 10^{23} \text{ \# } C_6H_{12}O_6 \text{ molecules}}{1 \text{ mol } C_6H_{12}O_6}$

$= \frac{30}{180.18} \times 6.022 \times 10^{23} = \boxed{0.166} \times 6.022 \times 10^{23}$

$= \boxed{1} \times 10^{23}$

Since we are only comparing the answers, we do not need to multiply the ratios by Avogadro's number. However, you are welcome to find the molecules in each case.

25) What is the mass percent composition of H in $C_2H_8N_2$?

a) 3.36%

(b) 13.44%

c) 4.2%

d) 46.6%

$$\text{Mass percent of element X} = \frac{\text{Mass of element X in 1 mol of compound}}{\text{Mass of 1 mol of compound}} \times 100\%$$

$$\text{Mass percent composition of H} = \frac{\text{Mass of H in 1 mol of } C_2H_8N_2}{\text{Mass of 1 mol of } C_2H_8N_2} \times 100\%$$

$$\text{Mass percent composition of H} = \frac{8 \times \text{Molar mass of H}}{\text{Molar mass of } C_2H_8N_2} \times 100\%$$

$$= \frac{8 \times 1.01}{(2 \times 12.01) + (8 \times 1.01) + \underbrace{(14.01 \times 2)}_{28.02}} \times 100\%$$

$$= \frac{8 \times 1.01}{60.12} \times 100\% = 13.44\%$$