Review of Chemical Principles and Fundamentals

1. Balance the following equations below.

   a. $2\ HCl + 1\ Mg(OH)_2 \rightarrow 1\ MgCl_2 + 2\ H_2O$

   b. $1\ Al_2O_3 + 3\ H_2SO_4 \rightarrow 1\ Al_2(SO_4)_3 + 3\ H_2O$

   c. $3\ BaSO_4 + 2\ K_3PO_4 \rightarrow 1\ Ba_3(PO_4)_2 + 3\ K_2SO_4$

   d. $4\ B + 3\ O_2 \rightarrow 2\ B_2O_3$

2. What is the molar mass of a sample if a single molecule of it weighs $5.34\ x\ 10^3$ g?

   3.22 x 10^27 g/mol

3. What is the mass percent of the elements in $Sr(NO_2)_2$?

   Sr: 48.78%

   N: 15.60%

   O: 35.63%

4. 0.314 mol of a diatomic molecule has a mass of 10.05g. Identify the molecule.

   O2

5. Calculate the volume of 0.642M KOH (aq) that should be used to make 1.00 L of 0.101M KOH.

157 mL

6. Hard water is water that has high mineral content (mainly Calcium and Magnesium). A concentration above $5.30 \, x \, 10^{-3}$ M is considered to be very hard water. Assuming that there are no magnesium ions present, is a 0.400 L solution of 0.120 g $CaCO_3$ and 0.155g $CaSO_4$ very hard water?

yes

7. For the following equation, determine the limiting reagent if 21.4g of NH3 is reacted with 42.5g of O2.

$$NH_3 \quad + \quad O_2 \quad \rightarrow \quad NO \quad + \quad H_2O$$

O2

8. For the following reaction, how many grams of AlCl3 would be obtained if 5.43g of aluminum and 7.80g of hydrogen chloride (HCl) was used in the reaction?

$$Al_{(s)} \quad + \quad HCl_{(aq)} \quad \rightarrow \quad AlCl_{3\,(aq)} \quad + \quad H_{2\,(g)}$$

9.51g

9. You think you synthesized 2-Nitrotoluene. You find that the molecular mass is 137.1g/mol. You find that the empirical formula is $C_7H_7NO_2$. Find the molecular formula of the compound you have synthesized.

$C_7H_7NO_2$

10. You analyze a sample and find that it contains, in a 23.1g sample, 8.94g C, 2.25g H, and 11.92g O. Find the empirical formula of this compound.

CH3O

11. Determine the molecular formula of a compound with the following composition by mass: 18% C, 2.5% H, 63.5% I, x% O, and a molar mass of 400g/mol.

$C_6H_{10}O_4I_2$

(8) $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

$\uparrow$ 5.43g $\uparrow$ 7.80g

$\frac{5.43\,g\,Al}{26.98\,g/mol\,Al} = 0.201\,mol\,Al$

$\frac{7.80\,g\,HCl}{(1 + 35.45)\,g/mol\,HCl} = 0.214\,mol\,HCl$

$\frac{0.201\,mol\,Al}{2} = 0.1$ vs. $\frac{0.214\,mol\,HCl}{6} = 0.035$

$\uparrow$ * smaller

*HCl is limiting!

$0.214\,\cancel{mol\,HCl} \times \frac{2\,\cancel{mol\,AlCl_3}}{6\,\cancel{mol\,HCl}} \times \frac{(26.98 + 3(35.45))\,g}{1\,mol\,\cancel{AlCl_3}}$

$= 9.51\,g$

10. Determine the molecular formula of a compound with the following composition by mass: 18% C, 2.5% H, 63.5% I, x% O, and a molar mass of 400g/mol.

16 (100 − 18 − 2.5 − 63.5)

$\frac{18\text{g C}}{12.01\text{g C/mol}} = 1.50 \text{ mol C}$

$\frac{2.5\text{g H}}{1\text{ g H/mol}} = 2.48 \text{ mol H}$

$\frac{63.5\text{ g I}}{126.9\text{ g I/mol}} = 0.50038 \text{ mol I}$ ← smallest

$\frac{16\text{ g O}}{16\text{ g O/mol}} = 1 \text{ mol O}$

empirical formula : 3C : 5H : 1I : 2O

$= C_3H_5IO_2$

molar mass : 199.937 g/mol

$\frac{400}{199.937} = \sim 2$

↳ x2 every subscript

$= C_6H_{10}I_2O_4$

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