CH 101 - Practice problems – 1/29/2013

Fundamentals.

1. Solve the following mathematical operations using the correct amount of significant figures. NO CALCULATORS are allowed. You should be able to solve these by hand.

1a. $35 : 17 + 230 - 9.23104 \times 2.1 =$ $2.1 + 230 - 19 = 210$

1b. $2.13\times10^{-7} + (5.000/2.3)\times10^{-2} + [\log(1.26/12600.)]\times10^{-3} =$ 1.7×10^{-2}

1c. $\sqrt{((641 : 4.0)\times10^{-9})} =$ 4.0×10^{-4}

1d. $\log 10^{9.21} + 120 =$ 130

1e. $\ln(e^{-4.265}/e^{2.00}) =$ -6.27

2. The following molecules have been analyzed by Mass spec and elemental analysis and the results are shown below. For each molecule, write the empirical formula and the molecular formula.

2a. MS: m/z: 137.05 (100.0%), 138.05 (7.7%); Elemental Analysis: C, 61.31; H, 5.15; N, 10.21; O, 23.33.

Empirical Formula: $C_7H_7NO_2$ Molecular formula: $C_7H_7NO_2$

2b. MS: m/z: 138.04 (100.0%), 139.05 (6.6%); Elemental Analysis: C, 52.17; H, 4.38; N, 20.28; O, 23.17.

Empirical Formula: C_3H_3NO Molecular formula: $C_6H_6N_2O_2$

2c. MS: m/z: 249.94 (100.0%), 251.94 (97.3%), 250.95 (8.8%), 252.95 (8.6%); Elemental Analysis: C, 38.28; H, 2.01; Br, 31.83; F, 15.14; O, 12.75.

Empirical Formula: $C_8H_5BrO_2F_2$ Molecular formula: $C_8H_5BrO_2F_2$

2d. MS: m/z: 273.13 (100.0%), 274.13 (19.6%), 275.13 (2.0%), 274.12 (1.1%); Elemental Analysis: C, 79.10; H, 5.53; N, 15.37.

Empirical Formula: C_6H_5N Molecular formula: $C_{18}H_{15}N_3$

3. Using dimensional analysis, express the following amounts of ethanol (d = 789.00 kg/m³) in mL (use scientific notations if needed).

3a. 1/8 Gal $= 0.125\ \text{Gal} \cdot \frac{3.78\ \text{L}}{1\ \text{Gal}} \cdot \frac{1000\ \text{mL}}{1\ \text{L}} = 473\ \text{mL}$

3b. 1 lb 6 oz $= 1.375\ \text{lbs} \cdot \frac{454\ \text{g}}{1\ \text{lbs}} \cdot \frac{1\ \text{L}}{789\ \text{g}} \cdot \frac{1000\ \text{mL}}{1\ \text{L}} = 791\ \text{mL}$

3c. 3.56 m³ $\cdot \frac{1000\ \text{L}}{1\ \text{m}^3} \cdot \frac{1000\ \text{mL}}{1\ \text{L}} = 3.56 \times 10^6\ \text{mL}$

3d. 2.3012 mol $\cdot \frac{46\ \text{g}}{1\ \text{mol}} \cdot \frac{1\ \text{L}}{789\ \text{g}} \cdot \frac{1000\ \text{mL}}{1\ \text{L}} = 134.16\ \text{mL}$

4. Calculate the amount of moles of:

4a. hydrogen atoms in 2.43 g of ammonia (NH_3)

$2.43\ g\ NH_3 \cdot \frac{1\ mol\ NH_3}{17\ g\ NH_3} \cdot \frac{3\ mol\ H}{1\ mol\ NH_3} = 0.429\ mol_H$

4b. ~~a sample of~~ nitrogen atoms in a sample of 25.4×10^{18} molecules of nitrogen gas (N_2)

$25.4 \times 10^{18}\ molecules_{N_2} \cdot \frac{2\ N\ atoms}{1\ molecule_{N_2}} \cdot \frac{1\ mol\ H}{6.022 \times 10^{23}\ atoms_N} = 8.44 \times 10^{-5}\ mol_H$

5. Complete the table below with the missing amounts for the reactions of combustion of these hydrocarbons: (NOTE: the reactions need to be balanced!)

5a.

	2 C_2H_2 +	5 O_2 →	4 CO_2 +	2 H_2O
Mass	15.0 g	46.2	50.8	10.4
Molar mass (g/mol)	26	32.0	44.0	18.0
Number of moles (mol)	0.577	1.44	1.15	0.577

5b.

	2 C_8H_{10} +	21 O_2 →	16 CO_2 +	10 H_2O
Mass	37.8	1.20 hg = 120 g	126.	32.2
Molar mass (g/mol)	106	32.0	44.0	18.0
Number of moles (mol)	0.357	3.75	2.86	1.79

Note: hg is not a typo, it stands for 1.20 hectograms of oxygen. You may express the masses of the other species in any unit you may find more convenient.

5c.

	2 C_6H_6 +	15 O_2 →	12 CO_2 +	6 H_2O
Mass (g)	211.	650.	713	146
Molar mass (g/mol)	78	32.0	44.0	18.0
Number of moles (mol)	2.70	20.3	16.2	8.10

6. For the reaction of combustion of octane (problem 5b), say whether the following amounts of octane and oxygen are in a stoichiometric ratio or there is an excess of a reagent. In this latter case, say which is the limiting reagent.

MM = 32

Note: these are millimoles

MM = 106

Amount of octane	Amount of oxygen gas	Stoichiometric ratio (Y/N)	Limiting reagent
12 g = 0.11 mol	2.1 mol	N	C_8H_{10}
13 mol	2.01 mg = 0.0628 mmol	N	O_2
1.5 mol	0.504 kg = 15.75 mol	Y	—
100.1 mg	203 mg	N	O_2

= 0.9443 mol

6.34 mol