Blue

Chem 1151 Exam 1B-2 February 20, 2008 50 points

Name Key Lab Sec

N = 6.022E23 units/mol SHOW ALL WORK FOR CREDIT

1.(9) Consider this balanced equation

$Fe_2(SO_4)_3 + 6NH_3(g) + 6H_2O \rightarrow 2Fe(OH)_3 + 3(NH_4)_2SO_4$

a.(2) Calculate the molar mass of ammonium sulfate.

2 x 14.01
8 x 1.01
1 x 32.06
4 x 16.00
132.16 g/mol

b.(4) How many grams of iron (III) sulfate (molar mass = 400. g/mol) are required to make 1.50 kg iron (III) hydroxide (106. g/mol)?

$\frac{1500\ g}{106.\ \frac{g}{mol}} \quad \frac{1\ mol\ Fe_2(SO_4)_3}{2\ mol\ (OH)_3} \quad 400.\ \frac{g}{mol} = 2830\ g$

$= 2.83\ kg\ Fe_2(SO_4)_3$

c.(3) How many grams of ammonium sulfate are also produced in part b if excess ammonia and water are provided?

$\frac{1500\ g}{106.\ \frac{g}{mol}} \quad \frac{3\ mol\ (NH_4)_2SO_4}{2\ mol\ Fe(OH)_3} \quad 132.16\ \frac{g}{mol}$

$= 2805\ g = 2.81\ kg\ (NH_4)_2SO_4$

2.(6) The density of zirconium (Zr, Z = 40)) is 6511 kg m^3.

a. What is the volume of 1.0 mol of Zr in m^3?

$$d = \frac{m}{V} \quad \text{or} \quad V = \frac{m}{d}$$

$$\frac{91.22 \frac{g}{mol} \times 1.0 \text{ mol}}{6{,}511{,}000 \ g/m^3} = 1.4 \times 10^{-5} \ m^3$$

b. What is the volume of 1.0 mol of Zr in in^3? 1 in = 2.54 cm

$$1.4 \times 10^{-5} \ m^3 \left(\frac{100 \text{ cm}}{m}\right)^3 \left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)^3$$

$$= 0.8549 \ in^3 = 0.85 \ in^3$$

4(9) A sample of $Mg_3(SbO_4)_2$ (MM = 444.45 g/mol) contains 3.45E23 Sb atoms.

a. How many mol of Sb atoms are in this sample?

$$\frac{3.45 E23 \text{ Sb}}{6.022 E23 \frac{\text{Sb}}{\text{mol}}} = 0.573 \text{ mol Sb}$$

b. How many mol of compound are in this sample?

$$0.573 \text{ mol Sb} \quad \frac{1 \text{ mol cmp}}{2 \text{ mol Sb}} = 0.286 \text{ mol cmp}$$

c. What is the mass of this sample?

$$0.286 \text{ mol cmp} \times 444.45 \frac{g}{mol} = 127.9 \text{ cmp}$$

$100 - 23.1 - 15.4 = 61.5\ g\ O$

5.(7) An elemental analysis on an unknown compound yield this % composition: 23.1% Al, 15.4% C and the rest O. Determine the empirical formula for this compound.

$\frac{23.1\ g\ Al}{26.98\ g/mol} = 0.856\ mol\ Al$ → divide by 0.856 → 1 → x 2 → 2

$\frac{15.4\ g\ C}{12.01\ g/mol} = 1.282\ mol\ C \rightarrow 1.497 \rightarrow 3$

$\frac{61.5\ g\ O}{16.00\ g/mol} = 3.844\ mol\ O \rightarrow 4.4896 \rightarrow 9$

$Al_2C_3O_9$ or $Al_2(CO_3)_3$

6.(7) How many grams of titanium tetrachloride (MM = 189.68 g/mol) is produced when 22.54 g TiO_2 (MM = 79.88g/mol) and 5.22 g C are combined with excess chlorine?

$$3TiO_2(s) + 4C(s) + 6Cl_2(g) \rightarrow 3TiCl_4(g) + 2CO_2(g) + 2CO(g)$$

$\frac{22.54\ g}{79.88\ g/mol}$ $\frac{4\ mol\ C}{3\ mol\ TiO_2}$ $\frac{12.01\ g}{mol} = 4.52\ g\ C$ needed +2

5.22 g C on hand so +1 C = xs

TiO_2 = LR +1

$\frac{22.54\ g}{79.88\ \frac{g}{mol}}$ $\frac{3\ mol\ TiCl_4}{3\ mol\ TiO_2}$ $\frac{189.68\ g}{mol} = 53.5\ g\ TiCl_4$

+1 +1 +1

3-2

+3 for correct answer but no LR rationale

Problem 6-9 (3 pts each → 12 pts) Circle the correct answer.

6. "A specific compound always contains the same elements in the same ratio by mass" is a statement of

A. Law of the Conservation of Mass
B. Law of Definite Proportions
C. Atomic Theory of Matter
D. Law of Conservation of Energy
E. Law of Multiple Proportions

7. Determine the molecular formula for a compound with an empirical formula SNH and a molar mass of 188.35 g/mol)

A. SNH
B. $S_3N_6H_8$
C. $S_4N_4H_4$
D. S_5N_2H
E. $2(S_2N_2H_2)$

32.07
14.00
1.01
47.08

$\frac{188.35}{47.08} = 4$

$S_4N_4H_4$

8. A reaction under study actually produced 150. g of product and is known to have a 30% reaction yield. What is the theoretical yield of this reaction?

A. 500. g
B. 214. g
C. 150. g
D. 105. g
E. 45.0 g

$\frac{\text{Actual}}{\text{Theoretical}} \times 100 = \%\ \text{Yield}$

$\frac{150.9}{\text{Theor.}} \times 100 = 30 \Rightarrow$

$\text{Theoretical} = \frac{150.}{0.30} = 500.9$

9. Express your answer with the correct number of significant figures.

$$\frac{(0.2482 + 9.89)}{2.1485}$$

A. 4.71873
B. 4.7187
C. 4.719
D. 4.72
E. 4.7

0.2482
9.89
10.1382 ÷ 2.1485

5 s.f

4 s.f

= 4.71873

4.719