

Blue

Chem 1151

Exam 1B-2

February 20, 2008

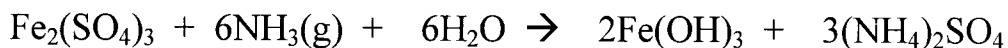
50 points

Name Key Lab Sec _____

N = 6.022E23 units/mol

SHOW ALL WORK FOR CREDIT

1.(9) Consider this balanced equation



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

$$\begin{array}{r}
 2 \times 14.01 \\
 8 \times 1.01 \\
 1 \times 32.06 \\
 4 \times 16.00 \\
 \hline
 132.16 \text{ g/mol}
 \end{array}$$

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)?

$$\begin{array}{l}
 \frac{1500 \text{ g}}{106. \frac{\text{g}}{\text{mol}}} \times \frac{1 \text{ mol } \text{Fe}_2(\text{SO}_4)_3}{2 \text{ mol } (\text{OH})_3} \times 400. \frac{\text{g}}{\text{mol}} = 2830 \text{ g} \\
 = 2.83 \text{ kg } \text{Fe}_2(\text{SO}_4)_3
 \end{array}$$

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

$$\begin{array}{l}
 \frac{1500 \text{ g}}{106. \frac{\text{g}}{\text{mol}}} \times \frac{3 \text{ mol } (\text{NH}_4)_2\text{SO}_4}{2 \text{ mol } \text{Fe}(\text{OH})_3} \times 132.16 \frac{\text{g}}{\text{mol}} \\
 = 2805 \text{ g} = 2.81 \text{ kg } (\text{NH}_4)_2\text{SO}_4
 \end{array}$$

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 ?

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

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

b. What is the volume of 1.0 mol of Zr in in^3 ? $1 \text{ in} = 2.54 \text{ cm}$

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

$$= 0.8549 \text{ in}^3 = 0.85 \text{ in}^3$$

4(9) A sample of $\text{Mg}_3(\text{SbO}_4)_2$ ($\text{MM} = 444.45 \text{ g/mol}$) contains $3.45\text{E}23$ Sb atoms.

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

$$\frac{3.45 \text{E} 23 \text{ Sb}}{6.022 \text{E} 23 \frac{\text{Sb}}{\text{mol}}} = 0.573 \text{ mol Sb}$$

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

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

c. What is the mass of this sample?

$$0.286 \text{ mol comp} \times 444.45 \frac{\text{g}}{\text{mol}} = 127. \text{ g comp}$$

2-2

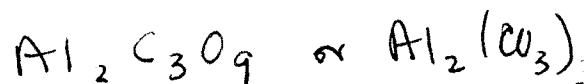
$$100 - 23.1 - 15.4 = 61.5 \text{ g O}$$

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.

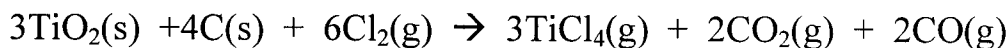
$$\frac{23.1 \text{ g Al}}{26.98 \text{ g/mol}} = 0.856 \text{ mol Al} \xrightarrow{\text{divide by } 0.856} 1 \xrightarrow{\times 2} 2$$

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

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



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?



$$\frac{22.54 \text{ g}}{79.88 \text{ g/mol}} \quad \frac{4 \text{ mol C}}{3 \text{ mol TiO}_2} \quad \frac{12.01 \text{ g}}{\text{mol}} = 4.52 \text{ g C needed}$$

$$5.22 \text{ g C on hand so } \begin{matrix} +1 \\ \text{C} = \text{XS} \end{matrix} \quad \begin{matrix} +2 \\ \text{TiO}_2 = \text{LR} \\ +1 \end{matrix}$$

$$\frac{22.54 \text{ g}}{79.88 \text{ g/mol}} \quad \frac{3 \text{ mol TiCl}_4}{3 \text{ mol TiO}_2} \quad 189.68 \frac{\text{g}}{\text{mol}} = 53.5 \text{ g TiCl}_4$$

+1

+1

+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. S₃N₆H₈
 - C. S₄N₄H₄
 - D. S₅N₂H
 - E. 2(S₂N₂H₂)
- $$\begin{array}{r} 32.07 \\ 14.00 \\ 1.01 \\ \hline 47.08 \end{array} \quad \frac{188.35}{47.08} = 4$$

$$S_4N_4H_4$$

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

$$\frac{150. \text{ g}}{\text{Theor.}} \cdot 100 = 30 \Rightarrow$$

$$\text{Theoretical} = \frac{150.}{0.30} = 500. \text{ g}$$

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

- $$\frac{(0.2482 + 9.89)}{2.1485}$$
- $$\begin{array}{r} 0.2482 \\ 9.89 \\ \hline 10.1382 \end{array} \div 2.1485$$
- $$= 4.71873$$
- $$4.719$$
- A. 4.71873
 - B. 4.7187
 - C. 4.719
 - D. 4.72
 - E. 4.7
- 4 s.f. 5 s.f.