

Chem 115
Test 1 Review Problems
Answers

1. Fill in either the name or formula, as required.

Cu_2S	copper(I) sulfide
Ba_3N_2	barium nitride
$\text{Al}(\text{ClO}_3)_3$	aluminum chlorate
N_2O_6	dinitrogen hexoxide

2. Boron forms a large number of compounds with hydrogen, called boranes, which are named by their own nomenclature system. Consider a 25.00-g sample of pentaborane-9, B_5H_9 , [m.w. $\text{B}_5\text{H}_9 = 63.12$ u; at. wt. B = 10.81 u; at. wt. H = 1.008 u]
- a. How many moles of B_5H_9 are in the sample?

$$\text{mol B}_5\text{H}_9 = (25.00 \text{ g B}_5\text{H}_9) \left(\frac{1 \text{ mol B}_5\text{H}_9}{63.12 \text{ g B}_5\text{H}_9} \right) = 0.3961 \text{ mol B}_5\text{H}_9$$

- b. How many moles of hydrogen are in the sample?

$$\text{mol H} = (0.3961 \text{ mol B}_5\text{H}_9) \left(\frac{9 \text{ mol H}}{1 \text{ mol B}_5\text{H}_9} \right) = 3.565 \text{ mol H}$$

- c. How many boron atoms are in the sample?

$$\text{B atoms} = (0.3961 \text{ mol B}_5\text{H}_9) \left(\frac{5 \text{ mol B}}{1 \text{ mol B}_5\text{H}_9} \right) \left(\frac{6.022 \times 10^{23} \text{ B atoms}}{1 \text{ mol B}} \right) = 1.193 \times 10^{24} \text{ B atoms}$$

- d. What is the weight percentage of boron in the sample?

$$\% \text{ B} = \frac{(5)(10.81)}{63.12} \times 100\% = 85.63\%$$

3. Complete and balance the following reactions:



4. A compound is analyzed and found to consist of 43.58% phosphorus and 56.42% sulfur. What is its empirical formula? Assuming that the empirical and molecular formulas are the same, what is the name of the compound? [at. wt. P = 30.97 u; at. wt. S = 32.07 u]

Assume 100 g compound:

$$\text{mol P} = (43.58 \text{ g P}) \left(\frac{\text{mol P}}{30.99 \text{ g P}} \right) = 1.407 \text{ mol P}$$

$$\text{mol S} = (56.42 \text{ g S}) \left(\frac{\text{mol S}}{32.07 \text{ g S}} \right) = 1.759 \text{ mol S}$$

$$\text{mol P} : \text{mol S} = 1.00 : 1.25 = 4 : 5$$

empirical formula = P_4S_5 name = tetraphosphorus pentasulfide

5. A 0.7323-g sample of a certain hydrocarbon (compound of carbon and hydrogen only) is analyzed by combustion, yielding 2.218 g $\text{CO}_2(g)$ and 1.135 g $\text{H}_2\text{O}(l)$. If the molecular weight is found to be 58.12 u, what is the molecular formula? [m.w. CO_2 = 44.01 u; m.w. H_2O = 18.02 u; at. wt. C = 12.01 u; at. wt. H = 1.008 u].

$$\text{mol C} = (2.218 \text{ g CO}_2) \left(\frac{\text{mol CO}_2}{44.01 \text{ g CO}_2} \right) \left(\frac{\text{mol C}}{\text{mol CO}_2} \right) = 0.05040 \text{ mol C}$$

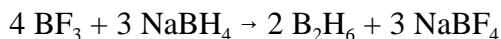
$$\text{mol H} = (1.135 \text{ g H}_2\text{O}) \left(\frac{\text{mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right) \left(\frac{2 \text{ mol H}}{\text{mol H}_2\text{O}} \right) = 0.1260 \text{ mol H}$$

$$\text{mol C} : \text{mol H} = 1.0 : 2.5 = 2 : 5$$

empirical formula = C_2H_5 f.w. = 29.06 u m.w./f.w. = 58.12/29.06 = 2

molecular formula = C_4H_{10}

6. Diborane, B_2H_6 (m.w. = 27.67 u), is a useful reagent in organic syntheses. It can be prepared by the reaction



How many grams of diborane should be produced in the reaction of 6.00 g of BF_3 (m.w. = 67.80 u) and 2.75 g of $NaBH_4$ (f.w. = 37.83 u)?

$$\text{mol}BF_3 = (6.00 \text{ g}BF_3) \left(\frac{\text{mol}BF_3}{67.80 \text{ g}BF_3} \right) = 0.0884_{96} \text{ mol}BF_3$$

$$\text{mol}NaBH_4 = (2.75 \text{ g}NaBH_4) \left(\frac{\text{mol}NaBH_4}{37.83 \text{ g}NaBH_4} \right) = 0.0726_{94} \text{ mol}NaBH_4$$

Using the “set” method to identify the limiting reagent, divide each number of moles by its stoichiometric coefficient. The smaller number identifies the limiting reagent.

$$BF_3 \text{ “sets”} = 0.0884_{95}/4 = 0.0221 \quad \Rightarrow \text{Limiting Reagent}$$

$$NaBH_4 \text{ “sets”} = 0.0726_{94}/3 = 0.0242$$

Now, base the calculation on the number of moles of BF_3 , the limiting reagent:

$$\text{g}B_2H_6 = (0.0884_{96} \text{ mol}BF_3) \left(\frac{2 \text{ mol}B_2H_6}{4 \text{ mol}BF_3} \right) \left(\frac{27.67 \text{ g}B_2H_6}{\text{mol}B_2H_6} \right) = 1.22 \text{ g}B_2H_6$$