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Workshop #5: Stoichiometry

Show calculation setups and answers for all problems below.

1. How many molecules are there in a 600.0 g sample of $Na_3PO_4(s)$? How many Na^+ ions are present?

2. A compound of copper and sulfur was produced in the lab by heating copper and sulfur together in a crucible. The following data was collected:

Mass of crucible and cover	28.71 g
Mass of crucible, cover, and copper	30.25 g
Mass of crucible, cover, and copper-sulfur compound	30.64 g

   Determine the empirical formula of this compound.

3. Isopentyl acetate ($C_7H_{14}O_2$), the compound responsible for the scent of bananas, can be produced commercially. Calculate the percent composition of $C_7H_{14}O_2$.

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4. A compound consisting of mainly cetyl palmitate is comprised entirely of carbon, hydrogen, and oxygen. Combustion of a 2.3836 g sample of cetyl palmitate produced 6.9807 g of CO_2 and 2.8575 g of H_2O. Determine the empirical formula of the compound. If the formula weight of the compound is 480.9 g/mol, what is the molecular formula of this compound?

5. Washing soda, a compound used to prepare hard water for laundry, is a hydrate whose formula can be written as $Na_2CO_3 \cdot xH_2O$. When a 2.558 g sample of washing soda is heated at 125 °C, all the water of hydration is lost, leaving behind 0.948 g of the anhydrous salt. Determine the value of *x*.

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6. Liquid mercury and bromine gas will react under appropriate conditions to produce solid mercury(II) bromide.

   A. Write the balanced chemical equation for this process.
   B. What is the maximum mass of $HgBr_2$ that can be produced from the reaction of 10.0 g Hg and 9.00 g Br_2?
   C. Determine the remaining mass of each reactant (if any) available upon conclusion of the reaction.
   D. If 15.3 g of mercury(II) bromide is produced in this reaction, determine the percentage yield of product.

7. Silicon nitride (Si_3N_4), a valuable ceramic, is made by the direct combination of silicon and nitrogen at high temperature.

   A. Write the balanced chemical equation for this process.
   B. How many grams of silicon must react with excess nitrogen to prepare 125 g silicon nitride if the yield of the reaction is 85.0%?

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8. Consider the following unbalanced reaction:

$$XNO_3(aq) + CaCl_2(aq) \rightarrow XCl(s) + Ca(NO_3)_2(aq)$$

If 30.8 g of $CaCl_2$ produced 79.6 g of XCl, determine the identity of X. Quantify your response. Random guessing will not earn any credit for this problem!