1. Water is added to 4.267 grams of UF₆. The only products are 3.730 grams of a solid containing only uranium, oxygen, and fluorine and 0.970 gram of a gas. The gas is 95.0% fluorine, and the remainder is hydrogen.

   a) From these data, determine the empirical formula of the gas.

   \[
   UF_6 + H_2O \rightarrow U_x O_y F_z + HF
   \]

   Assume 100 g UF₆

   \[
   H: \quad 5.079 g H \times \frac{1 \text{ mol of } H}{1.0079 g H} = 4.96 \text{ mol of } H
   \]

   \[
   F: \quad 95.0 g F \times \frac{1 \text{ mol of } F}{19.0 g F} = 5.00 \text{ mol of } F
   \]

   \[
   x : 1.01 \times 1
   \]

   HF

   b) What fraction of the fluorine of the original compound is in the solid and what fraction in the gas after the reaction?

   \[
   \% \text{ comp of } F \text{ in } UF_6 = \frac{114.0 g F \times 100\%}{352.0 g UF_6} = 32.38\% F
   \]

   \[
   4.267 g UF_6 \times 32.38\% = 1.382 g F
   \]

   0.970 g (HF) × 95% F = 0.922 g F in gas

   \[
   \frac{0.922}{1.382} = 0.667 \times \sqrt[3]{\frac{2}{3} \text{ F in gas}} \rightarrow \frac{1}{3} \text{ F in solid}
   \]

   c) What is the formula of the solid product?

   \[
   1.382 g F = 0.922 g F = 0.460 g F \text{ in solid}
   \]

   \[
   F: \quad 0.460 g F \times \frac{1 \text{ mol of } F}{19.0 g F} = 0.0242 \text{ mol of } F
   \]

   \[
   4.267 g UF_6 - 1.382 g F = 2.885 g U
   \]

   \[
   U: \quad 2.885 g U \times \frac{1 \text{ mol of } U}{233.0 g U} = 0.0121 \text{ mol of } U
   \]

   \[
   \frac{0.365 g O_x}{16.0 g O} = 0.0241
   \]

   \[
   0.365 g O_x - 2.885 g \rightarrow 0.0241 = 2
   \]

   \[
   0.365 g O_x - 4.0 g \rightarrow 0.0241 = 2
   \]

   \[
   0.0241 \times 12 = 0.293
   \]

   \[
   UO_{2}F_2
   \]

   d) Write the balanced equation for the reaction between UF₆ and H₂O. Assume that the empirical formula of the gas is the true formula.

\[
UF_6 + 2H_2O \rightarrow UO_2F_2 + 4HF
\]

2. A hydrocarbon mixture consists of 60.0% by mass of C₃H₈ and 40% of C₄H₁₀. When 10.0 grams of this mixture is burned, it yields 29.0 g CO₂ and 18.8 g H₂O as the only products. What is the formula of the unknown hydrocarbon?

\[
\text{(rxn 1)} C_3H_8 + CO_2 \rightarrow 3CO_2 + H_2O \quad \text{(rxn 2)} C_xH_y + O_2 \rightarrow CO_2 + H_2O
\]

\[
\frac{4.0 g}{44.094 g} \times 1 \text{ mol of } C_3H_8 = 0.0907 \text{ mol of } C_3H_8
\]

\[
\frac{18.8 g}{18.015 g} \times 1 \text{ mol of } H_2O = 1.046 \text{ mol of } H_2O
\]

\[
\frac{29.0 g}{44.094 g} \times 1 \text{ mol of } CO_2 = 0.657 \text{ mol of } CO_2
\]

\[
\text{Equation: } C_3H_8 + 4.95 g \text{ of } C_4H_{10} \times \frac{4 \text{ mol of } H_2O}{1 \text{ mol of } C_3H_8} \times \frac{1 \text{ mol of } CO_2}{1 \text{ mol of } H_2O} = 9.805 g \text{ of } H_2O
\]

\[
\text{From RXN 1: } \text{ RXN 2 = 18.8 - 9.805 \text{ g of } H_2O}
\]

\[
\text{RXN 2 = 8.995 g of } C_4H_{10}
\]
3. A thoroughly dried 1.271 g sample of Na₂SO₄ is exposed to the atmosphere and found to gain 0.387 g in mass. What is the percent, by mass, of Na₂SO₄·10H₂O in the resulting mixture of hydrate and Na₂SO₄?

\[ 2Na₂SO₄ + 10H₂O → Na₂SO₄·10H₂O + Na₂SO₄ \text{ total:} \]
\[ 1.271 \text{ g} \quad 0.387 \text{ g} \quad 1.658 \text{ g} \]
\[ 1.387 \text{ g} H₂O \times \frac{1 \text{ mol H₂O}}{19.0188 \text{ g H₂O}} \times \frac{1 \text{ mol Na₂SO₄·10H₂O}}{1 \text{ mol H₂O}} = 0.69 \text{ g Na₂SO₄·10H₂O} \]
\[ 0.69 \text{ g Na₂SO₄·10H₂O} \times \frac{100\%}{1.658 \text{ g product}} = 41.79\% \text{ Na₂SO₄·10H₂O} \]

4. A certain brand of lunch meat contains 0.10% sodium benzoate, NaC₆H₅O₂, by mass as a preservative. If a person eats 2.52 ounces of this meat, how many mg Na will that person consume?

\[ 2.52 \text{ oz of meat} \times \frac{0.001 \text{ oz NaC₆H₅O₂}}{1 \text{ oz meat}} \times \frac{22.99 \text{ g Na}}{1 \text{ mol NaC₆H₅O₂}} \times \frac{1 \text{ mol Na}}{144 \text{ g NaC₆H₅O₂}} \times \frac{1000 \text{ mg Na}}{1 \text{ g Na}} = 11.4 \text{ mg Na} \]

5. Three different brands of "liquid chlorine" for use in purifying water in home swimming pools all cost $1.00 per gallon and are water solutions of NaOCl. Brand A contains 10% OCl by mass; brand B, 7% available chlorine (Cl) by mass; and brand C, 14% NaOCl by mass. Which of the three brands would you buy?

\[ \text{NaOCl:} \quad \text{Molar mass: 74.443 g} \quad \text{Assume 100 g} \]

\[ \text{A: 10% OCl} \]
\[ \text{Na: 30.487 g} \quad \text{A:} \quad 10 \text{ g OCl} \times \frac{1 \text{ mol OCl}}{14.453 \text{ g OCl}} \times \frac{22.99 \text{ g Na}}{1 \text{ mol OCl}} \times \frac{1 \text{ mol Na}}{14.453 \text{ g Na}} = 6.59 \text{ g Na} \]

\[ \text{B: 7% Cl} \]
\[ \text{Cl: 47.62%} \]

\[ \text{C: 14% NaOCl} \]

\[ \text{B contains most Cl} \]

6. A 0.1510 gram sample of a hydrocarbon produces 0.5008 gram CO₂ and 0.1282 gram H₂O in combustion analysis. Its molecular weight is found to be 106. For this hydrocarbon, determine (a) its percent composition; (b) its empirical formula; (c) its molecular formula.

\[ \text{C}_x + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2 \text{O} \]

\[ \text{C:} \quad 0.5008 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \times \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.1167 \text{ g C} \]

\[ \text{H:} \quad 0.1282 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.015 \text{ g H}_2\text{O}} \times \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} \times \frac{1 \text{ mol H}}{1 \text{ mol H}} = 0.0143 \text{ g H} \]

\[ \text{C:} \quad 0.1167 \text{ g C} \times 12 = 1.4 \text{ mol C} \]

\[ \text{H:} \quad 0.0143 \text{ g H} \times 1 = 0.0143 \text{ mol H} \]

\[ \text{X:} \quad 0.1510 \text{ g} - 0.0143 \text{ g H} - 1.167 \text{ g C} = 0.1124 \text{ g X} \]

\[ \text{Mol ratio} \]

\[ \text{C: 14} \text{ g C} \times \frac{1 \text{ mol C}}{12 \text{ g C}} = 1.17 \text{ mol C} \]

\[ \text{H: 0.1434 \ g H} \times \frac{1 \text{ mol H}}{1 \text{ g H}} = 0.1434 \text{ mol H} \]

\[ \text{X:} \quad 0.1124 \text{ g X} \times \frac{1 \text{ mol X}}{1 \text{ mol C}} = 0.0816 \text{ mol X} \]

\[ \text{Empirical formula:} \quad \text{C}_{14} \text{H}_{14.5} \text{O} \]

\[ \text{Molecular formula:} \quad \text{C}_{4} \text{H}_{5} \text{O} \]