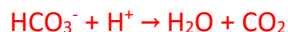


Practice Exam for Exam 1

1. Calculate the number of chromium atoms in a sphere of a chromium alloy that is 53.84% chromium by mass. The density of the sphere is $6.83 \times 10^3 \text{ kg m}^{-3}$. The radius of the sphere is 19.54 inches. The volume of sphere is $\frac{4}{3}\pi r^3$. $1 \text{ m} = 39.37 \text{ in}$

$$\begin{aligned} \frac{4}{3}\pi r^3 &= \frac{4}{3}\pi (19.54 \text{ in})^3 \times \left(\frac{1 \text{ m}}{39.37 \text{ in}}\right)^3 \times \frac{6.83 \times 10^3 \text{ kg}}{\text{m}^3} \times \frac{10^3 \text{ g}}{1 \text{ kg}} \times \frac{53.84 \text{ g Cr}}{100.00 \text{ g alloy}} \times \frac{1 \text{ mol Cr}}{51.996 \text{ g Cr}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} \\ &= 2.18 \times 10^{28} \text{ atoms} \end{aligned}$$

2. 15.00 g of sodium bicarbonate reacts with 0.5250 L of 0.7658 M nitric acid to produce sodium nitrate, water and carbon dioxide gas. Write the **balanced chemical and net ionic equations** for the reaction. How many **grams of sodium nitrate** can be produced by the reaction? If only 15.00 g of sodium nitrate are made, what is the **percent yield**?



$$15.00 \text{ g NaHCO}_3 \times \frac{1 \text{ mol NaHCO}_3}{84.0066 \text{ g NaHCO}_3} \times \frac{1 \text{ mol NaNO}_3}{1 \text{ mol NaHCO}_3} \times \frac{84.9947 \text{ g NaNO}_3}{1 \text{ mol NaNO}_3} = 15.18 \text{ g NaNO}_3$$

$$0.5250 \text{ L HNO}_3 \times \frac{0.7658 \text{ mol HNO}_3}{1 \text{ L HNO}_3} \times \frac{1 \text{ mol NaNO}_3}{1 \text{ mol HNO}_3} \times \frac{84.9947 \text{ g NaNO}_3}{1 \text{ mol NaNO}_3} = 34.17 \text{ g NaNO}_3$$

15.18 g of sodium nitrate can be produced. The percent yield is: $\frac{15.00 \text{ g NaNO}_3}{15.18 \text{ g NaNO}_3} \times 100 = 98.81\%$

3. Prozac is a common antidepressant that contains carbon, hydrogen, fluorine, nitrogen and oxygen. 0.2543 g of Prozac is analyzed by combustion analysis. There are 0.6151 g of CO₂, 0.1333 g of H₂O, 0.0666 g of OF₂ and 0.0115 g of N₂ produced. The molar mass is 309.3 g/mol.

a. What is the **empirical formula** of Prozac?

$$0.6151 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.0095 \text{ g CO}_2} \times \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.013977 \text{ mol C} \times \frac{12.0107 \text{ g C}}{1 \text{ mol C}} = 0.1679 \text{ g C}$$

$$0.1333 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.0153 \text{ g H}_2\text{O}} \times \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.014798 \text{ mol H} \times \frac{1.00794 \text{ g H}}{1 \text{ mol H}} = 0.0149 \text{ g H}$$

$$0.0666 \text{ g OF}_2 \times \frac{1 \text{ mol OF}_2}{53.9962 \text{ g OF}_2} \times \frac{2 \text{ mol F}}{1 \text{ mol OF}_2} = 0.0024668 \text{ mol F} \times \frac{18.9984032 \text{ g F}}{1 \text{ mol F}} = 0.0469 \text{ g F}$$

$$0.0115 \text{ g N}_2 = 0.0115 \text{ g N} \times \frac{1 \text{ mol N}}{14.0067 \text{ g N}} = 0.0008210 \text{ mol N}$$

$$\text{g O} = 0.2543 - 0.1679 \text{ g C} - 0.0149 \text{ g H} - 0.0469 \text{ g F} - 0.0115 \text{ g N} = 0.0131 \text{ g O}$$

$$0.0131 \text{ g O} \times \frac{1 \text{ mol O}}{15.9994 \text{ g O}} = 0.0008188 \text{ mol O}$$

$$\frac{0.013977 \text{ mol C}}{0.0008188 \text{ mol O}} = 17.07 \quad \frac{0.014798 \text{ mol H}}{0.0008188 \text{ mol O}} = 18.07 \quad \frac{0.0024668 \text{ mol F}}{0.0008188 \text{ mol O}} = 3.01$$

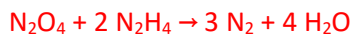
$$\frac{0.0008210 \text{ mol N}}{0.0008188 \text{ mol O}} = 1.00 \quad \frac{0.0008188 \text{ mol O}}{0.0008188 \text{ mol O}} = 1.00$$

The empirical formula of Prozac is C₁₇H₁₈F₃NO

b. What is the **molecular formula** of Prozac?

The empirical mass is 309.3261 g mol⁻¹. Because this is the same as the molar mass the molecular formula is the same as the empirical formula, C₁₇H₁₈F₃NO.

4. When dinitrogen tetroxide and hydrazine react they produce water and nitrogen gas. The density of dinitrogen tetroxide is 1.44 g cm^{-3} and the density of hydrazine is 1.02 g cm^{-3} . What volume of hydrazine, in L, is needed to react completely with 15.3 L of dinitrogen tetroxide?

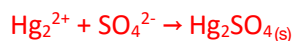


$$15.3 \text{ L N}_2\text{O}_4 \times \frac{10^3 \text{ cm}^3}{1 \text{ L}} \times \frac{1.44 \text{ g N}_2\text{O}_4}{\text{cm}^3} \times \frac{1 \text{ mol N}_2\text{O}_4}{92.0110 \text{ g N}_2\text{O}_4} \times \frac{2 \text{ mol N}_2\text{H}_4}{1 \text{ mol N}_2\text{O}_4} \times \frac{30.0293 \text{ g N}_2\text{H}_4}{1 \text{ mol N}_2\text{H}_4} \times \frac{1 \text{ cm}^3}{1.02 \text{ g N}_2\text{H}_4} \times \frac{1 \text{ L}}{10^3 \text{ cm}^3}$$
$$= 14.1 \text{ L N}_2\text{H}_4$$

5. A stable element is discovered with an atomic number of 134. There are two naturally occurring isotopes of this element. One has an abundance of 42.63% and a relative atomic mass of 334.907863 amu. The other has a relative atomic mass of 336.916354 amu. Calculate the **relative average atomic mass** of the element.

$$(334.907863 \text{ amu})(0.4263) + (336.916354 \text{ amu})(0.5737) = 336.0601343 \text{ amu} \\ = 336.1 \text{ amu}$$

6. A lab analyzes a sample of river water for the amount of mercury(I) ion present. The lab technician adds enough sodium sulfate solution to a 25.00 mL aliquot of the river water to ensure that all the mercury precipitates out. She filters and dries the precipitate and determines the mass to be 33.27 mg. What is the **molar concentration of mercury(I) ion** in the river water?



$$\frac{33.27 \text{ mg Hg}_2\text{SO}_4}{25.00 \text{ mL sample}} \times \frac{1 \text{ mol Hg}_2\text{SO}_4}{497.24 \text{ g Hg}_2\text{SO}_4} \times \frac{1 \text{ mol Hg}_2^{2+}}{1 \text{ mol Hg}_2\text{SO}_4} = 0.002676 \text{ M Hg}_2^{2+}$$

7. Modern pennies are made with a core of zinc and a thin cladding of copper. The density of copper is 8.69 g cm^{-3} and the density of zinc is 7.140 g cm^{-3} . A stack of pennies has a mass of 37.500 g and a volume of 5228.68 mm^3 . What is the percent by mass of copper in a penny?

$$m_{\text{Cu}} + m_{\text{Zn}} = 37.500 \text{ g}$$

$$V_{\text{Cu}} + V_{\text{Zn}} = 5228.68 \text{ mm}^3 \text{ which can be rewritten as } \frac{m_{\text{Cu}}}{d_{\text{Cu}}} + \frac{m_{\text{Zn}}}{d_{\text{Zn}}} = 5228.68 \text{ mm}^3$$

$$m_{\text{Zn}} = 37.500 \text{ g} - m_{\text{Cu}}$$

$$\frac{m_{\text{Cu}}}{d_{\text{Cu}}} + \frac{(37.500 \text{ g} - m_{\text{Cu}})}{d_{\text{Zn}}} = 5228.68 \text{ mm}^3 \left(\frac{1 \text{ cm}}{10 \text{ mm}} \right)^3 = 5.22868 \text{ cm}^3 = \frac{m_{\text{Cu}} d_{\text{Zn}}}{d_{\text{Cu}} d_{\text{Zn}}} + \frac{(37.500 \text{ g} - m_{\text{Cu}}) d_{\text{Cu}}}{d_{\text{Zn}} d_{\text{Cu}}}$$

$$5.22868 \text{ cm}^3 d_{\text{Cu}} d_{\text{Zn}} = m_{\text{Cu}} d_{\text{Zn}} + (37.500 \text{ g} - m_{\text{Cu}}) d_{\text{Cu}} = m_{\text{Cu}} d_{\text{Zn}} + 37.500 \text{ g} d_{\text{Cu}} - m_{\text{Cu}} d_{\text{Cu}} = 37.500 \text{ g} d_{\text{Cu}} + m_{\text{Cu}} (d_{\text{Zn}} - d_{\text{Cu}})$$

$$m_{\text{Cu}} = \frac{5.22868 \text{ cm}^3 d_{\text{Cu}} d_{\text{Zn}} - 37.500 \text{ g} d_{\text{Cu}}}{d_{\text{Zn}} - d_{\text{Cu}}}$$

$$m_{\text{Cu}} = \frac{5.22868 \text{ cm}^3 (8.69 \text{ g cm}^{-3}) (7.140 \text{ g cm}^{-3}) - 37.500 \text{ g} (8.69 \text{ g cm}^{-3})}{(7.140 \text{ g cm}^{-3}) - (8.69 \text{ g cm}^{-3})} = 0.937537 \text{ g}$$

$$\% \left(\frac{m}{m} \right) \text{Cu} = \frac{0.937537}{37.500} \times 100 = 2.50\%$$

8. Balance the following oxidation-reduction reactions:

