# Review of Chem 170

1. Report the answer for $\left(\frac{21.15}{3.46}\right) + 5.7$ to the correct number of significant figures.

   For multiplication or division, we round the answer to the same number of significant figures as the measurement with the fewest significant figures; thus, when we divide 21.15 by 3.46, we round the answer of 6.1127… to 6.11. For addition and subtraction, we round the answer to the last decimal place that is significant for each measurement in the calculation; thus, when we add 5.7 to 6.11, we round the answer of 11.81 to 11.8. Note: When completing a multistep calculation, we often carry an extra signficant figure through the calculation, rounding to the correct number of significant figures at the end.

2. A portable radiator provides 2050 BTUs of energy per hour. Given that 1 BTU is equivalent to 1.055 kJ, how many megajoules are produced if the radiator is operated 24 hours per day for 90 days?

$$\frac{2050\ \mathrm{BTU}}{\mathrm{hr}} \times \frac{24\ \mathrm{hr}}{\mathrm{d}} \times 90\ \mathrm{d} \times \frac{1.055\ \mathrm{kJ}}{\mathrm{BTU}} \times \frac{1\ \mathrm{MJ}}{1000\ \mathrm{kJ}} = 4.67 \times 10^{3}\ \mathrm{MJ}$$

3. How many hydrogen atoms are in 5.10 mol of $NH_4S$?

$$5.10\ \mathrm{mol\ NH_4S} \times \frac{4\ \mathrm{mol\ H}}{\mathrm{mol\ NH_4S}} \times \frac{6.022 \times 10^{23}\ \mathrm{atoms\ H}}{\mathrm{mol\ H}} = 1.22 \times 10^{25}\ \mathrm{atoms\ H}$$

4. A 30.6 g sample of the compound $X_2O_3$ contains 14.4 g of oxygen atoms. What is the identity of the element X?

   To determine the identity of X, we need to determine its atomic mass. We know the compound contains 30.6 g – 14.4 g = 16.2 g of X. The moles of X in the 30.6 g sample is

$$14.4\ \mathrm{g\ O} \times \frac{1\ \mathrm{mol\ O}}{16.00\ \mathrm{g\ O}} \times \frac{2\ \mathrm{mol\ X}}{3\ \mathrm{mol\ O}} = 0.600\ \mathrm{mol\ X}$$

   The atomic mass for X, therefore, is 16.2 g/0.600 mol, or 27.0 g/mol, which corresponds to aluminum.

5. A compound is 54.33% C, 9.15% H, and 36.32% O by mass. What is its empirical formula?

   If we assume a 100.0 g sample of the compound, then it contains 54.33 g C, 9.15 g H, and 36.32 g O. If we convert each mass to the equivalent number of moles, then we can find the simplest mole ratio between the elements.

$$54.33\ \mathrm{g\ C} \times \frac{1\ \mathrm{mol\ C}}{12.01\ \mathrm{g\ C}} = 4.524\ \mathrm{mol\ C}$$

$$9.15\ \mathrm{g\ H} \times \frac{1\ \mathrm{mol\ H}}{1.008\ \mathrm{g\ H}} = 9.08\ \mathrm{mol\ H}$$

$$36.32\ \mathrm{g\ O} \times \frac{1\ \mathrm{mol\ O}}{16.00\ \mathrm{g\ O}} = 2.270\ \mathrm{mol\ O}$$

   There are fewer moles of oxygen than of carbon or oxygen, so we use oxygen to establish the ratios. The ratio of carbon to oxygen is 4.524/2.270 = 2, and the ratio of hydrogen to oxygen is 9.08/2.270 = 4; thus, the compound's empirical formula is $C_2H_4O$.

6. When heated, $KClO_3$ decomposes to form KCl and $O_2$. Write a balanced chemical reaction for this process and report the mass of $O_2$ produced by the reaction of 20.5 g of $KClO_3$.

   The balanced chemical reaction is $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$; thus

$$20.5\text{ g KClO}_3 \times \frac{1\text{ mol KClO}_3}{122.55\text{ g KClO}_3} \times \frac{3\text{ mol O}_2}{2\text{ mol KClO}_3} \times \frac{32.00\text{ g O}_2}{1\text{ mol O}_2} = 8.03\text{ g O}_2$$

7. Zinc reacts with hydrochloric acid to form a solution of zinc chloride and hydrogen gas. Write a balanced chemical reaction for this process and report the mL of 4.50 M HCl needed to react with 3.45 g Zn.

   The balanced chemical reaction is $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$; thus

$$3.45\text{ g Zn} \times \frac{1\text{ mol Zn}}{65.38\text{ g Zn}} \times \frac{2\text{ mol HCl}}{1\text{ mol Zn}} \times \frac{1\text{ L HCl}}{4.5\text{ mol HCl}} \times \frac{1000\text{ mL HCl}}{\text{L HCl}} = 23.5\text{ mL HCl}$$

8. Write a balanced reaction showing the precipitation of $PbI_2$ upon combining separate solutions of $Pb(NO_3)_2$ and NaI. What mass of $PbI_2$ forms when mixing 1.50 L of 0.0400 M $Pb(NO_3)_2$ and 0.600 L of 0.140 M NaI.

   The balanced reaction is $Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow PbI_2(s) + 2NaNO_3(aq)$. To determine the mass of $PbI_2$ we first need to determine the limiting reagent. We have

$$1.5\text{ L Pb(NO}_3)_2 \times \frac{0.0400\text{ mol Pb(NO}_3)_2}{\text{L}} = 0.0600\text{ Pb(NO}_3)_2$$

$$0.600\text{ L NaI} \times \frac{0.140\text{ mol NaI}}{\text{L}} = 0.084\text{ mol NaI}$$

   Given the 2:1 stoichiometry between NaI and $Pb(NO_3)_2$, we see that NaI is the limiting reagent because the 0.084 mol available is less than the 0.120 mol needed to react completing with the $Pb(NO_3)_2$; thus

$$0.084\text{ mol NaI} \times \frac{1\text{ mol PbI}_2}{2\text{ mol NaI}} \times \frac{461.0\text{ g PbI}_2}{1\text{ mol PbI}_2} = 19.4\text{ g PbI}_2$$