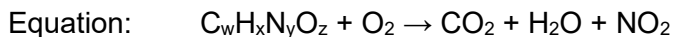CHEM 103
R&R 4
4 June 2024
Adapted from an 8 June 2021 document

1. The combustion of 1.38 g of a compound which contains C, H, O, and N yields 1.72 g CO_2 and 1.18 g H_2O. Another sample of the compound with a mass of 22.34 g is found to contain 6.75 g O. What is the empirical formula of the compound?

       Equation: $C_wH_xN_yO_z + O_2 \rightarrow CO_2 + H_2O + NO_2$

2. Write balanced equations corresponding to the following descriptions.

       a. When hydrogen sulfide gas is passed over hot solid iron(III) hydroxide, the resultant reaction produces solid iron(III) sulfide and gaseous water.

       b. When liquid phosphorus trichloride is added to water, it reacts to form aqueous phosphorous acid, H_3PO_3 (aq), and aqueous hydrochloric acid.

       c. The complete combustion of acetic acid (CH_3COOH), the main active ingredient in vinegar.

3. Washing soda is a compound used to prepare hard water for washing laundry. Its formula is represented as $Na_2CO_3 \cdot x\ H_2O$, where x is the number of moles of H_2O per mole of Na_2CO_3. When a 2.558 g sample of washing soda is heated, all of the water of hydration is lost, leaving 0.948 g of anhydrous Na_2CO_3 left. What is x?
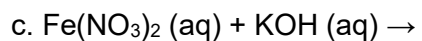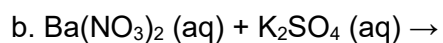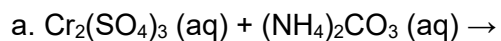
4. Determine the oxidation number of each element in each of the following substances:

    a. SO_2

    b. $COCl_2$

    c. $HBrO$

    d. $BaCrO_4$

    e. $HClO_4$

    f. PO_4^{3-}

    g. CH_3CH_2OH

5. Which of the following are redox reactions? For reaction that are, indicate which elements are being oxidized and reduced. For reactions that are not, indicate whether they are neutralization or precipitation reactions.

    a. P_4 (s) + 10 HClO (aq) + 6 H_2O (l) → 4 H_3PO_4 (aq) + 10 HCl (aq)

    b. Br_2 (l) + 2 K (s) → 2 KBr (s)

    c. CH_3CH_2OH (l) + 3 O_2 (g) → 3 H_2O (l) + 2 CO_2 (g)

    d. $ZnCl_2$ (aq) + 2 NaOH (aq) → $Zn(OH)_2$ (s) + 2 NaCl (aq)

6. Write the overall balanced equation, total ionic equation, and net ionic equations for each of the following cases. Identify the spectator ions.

      a. $Cr_2(SO_4)_3$ (aq) + $(NH_4)_2CO_3$ (aq) $\rightarrow$

      b. $Ba(NO_3)_2$ (aq) + K_2SO_4 (aq) $\rightarrow$

      c. $Fe(NO_3)_2$ (aq) + KOH (aq) $\rightarrow$

7. Write the balanced chemical and net ionic equations for the following situations.

      a. Reaction of acetic acid (CH_3COOH) with water

      b. HCl (aq) + NaOH (aq) $\rightarrow$
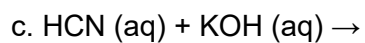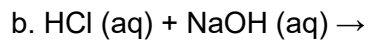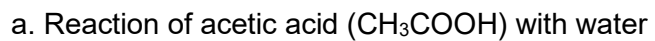
      c. HCN (aq) + KOH (aq) $\rightarrow$ (hint: HCN is a weak acid)

8.

a. How many grams of PF_5 can be formed from 9.46 g PF_3 and 9.42 g of XeF_4 in the following unbalanced reaction?

$$PF_3 + XeF_4 \rightarrow PF_5 + Xe$$
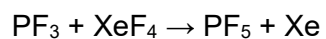
b. Identify the species being oxidized and the one being reduced. What is the oxidizing agent; what is the reducing agent?

9. You combine 0.871 moles of sodium phosphate with 1.23 L of water. What is the molarity of the solutions, of sodium ions, and of phosphate ions?

10. I purchased a stock solution of 15 M HNO_3 with the goal of dissolving a penny.

a. If I pour 15 mL of the stock solution into a beaker, how many O atoms are inside the beaker **without** considering the O atoms that are part of the water?

b. How many milliliters of water do I need to add to my beaker to dilute the 15 mL stock solution to a concentration of 3.0 M HNO_3?

c. I successfully diluted my stock solution and was ready to dissolve my penny (yay!). However, I was very clumsy and spilled 34 mL of my stock solution into the beaker of 3.0 M HNO_3. What is the new concentration of nitric acid in the beaker?