

## First-Year Chemistry

### 2. Stoichiometry and Reactions

#### Further Problems:

- Consider the following equation where limestone ( $\text{CaCO}_3$ ) reacts with an acid:  $\text{CaCO}_3 + \text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ 
  - Give the physical state of each substance in the equation.
  - Balance the equation.
  - Determine the number of moles of carbon dioxide that would be produced if 0.500 moles of limestone were reacted with more than sufficient amount of the acid.
  - Determine the mass of  $\text{H}_2\text{O}$  that would be produced if 0.250 moles of limestone were reacted with more than sufficient amount of the acid.
  - Determine the mass of carbon dioxide that would be produced if 10.5 g of limestone were reacted with more than sufficient amount of acid.
  - Determine the number of molecules of water that would be produced when 20.0 g of limestone were reacted with more than a sufficient amount of the acid.
  - How many moles of the acid would be required to produce 14.0 g of carbon dioxide?
- If  $13.7 \text{ cm}^3$  of a 1.20 M  $\text{H}_2\text{SO}_4$  solution is diluted to  $100.0 \text{ cm}^3$  with distilled water in a volumetric flask, what is the final concentration of the acid?
- What is the molar concentration of each ion in each of the following salt solutions? (a) 1.20 M  $(\text{NH}_4)_2\text{SO}_4$ , (b) 0.250 M  $\text{CaCl}_2$ , (c) 0.400 M  $\text{Fe}_2(\text{SO}_4)_3$ .
- For the reaction between barium hydroxide and  $\text{HClO}_3$  (aq) calculate the number of moles of water molecules formed when 0.100 mol of the hydroxide is treated with 0.250 mol of the acid.
- What mass of solid is produced when aqueous solutions containing 2.00 g of silver nitrate and 4.00 g of potassium bromide are mixed?
- Determine whether a reaction takes place when the following reagent are mixed. If a reaction takes place, write a net ionic equation to represent it:
  - Aqueous solution of iron(III) sulfate and sodium hydroxide
  - Aqueous solution of silver nitrate and potassium carbonate.
  - Aqueous solution of lead(II) nitrate and sodium acetate.
  - Magnesium carbonate and sulfuric acid
  - Sodium hydrogen carbonate and hydroiodic acid.
  - Sodium hydroxide and ethanoic acid.
  - Aqueous ammonia and hydrobromic acid.
  - Magnesium oxide and hydrochloric acid.
- Determine the oxidation number of the italicized element: a)  $\text{IO}_3^-$  b)  $\text{HClO}$  c)  $\text{NO}$  d)  $\text{HNO}_3$  e)  $\text{MnO}_4^-$  f)  $\text{S}_2\text{O}_3^{2-}$  g)  $\text{SO}_4^{2-}$  h)  $\text{MnO}_4^{2-}$
- Balance the following redox reactions.
  - The production of titanium metal by metal,  $\text{TiCl}_4(\text{g}) + \text{Mg}(\text{l}) \rightarrow \text{MgCl}_2(\text{s}) + \text{Ti}(\text{s})$
  - The industrial production of elemental bromine from brine,  $\text{Cl}_2(\text{g}) + \text{Br}^-(\text{aq}) \rightarrow \text{Br}_2(\text{l}) + \text{Cl}^-(\text{aq})$
  - $\text{NH}_3(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{H}_2\text{O}(\text{l})$
  - $\text{CuO}(\text{s}) + \text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{Cu}(\text{s})$



9. Balance the following redox reactions using half-reactions. Identify the oxidizing and reducing agents.
- The reaction between oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) and manganate(VII) (permanganate) ion in acidic solution, in which the products are manganese(II) ions, water and carbon dioxide.
  - The reaction between manganate(VII) ions with bromide ions in basic solution, in which solid manganese(IV) oxide, and bromate(V) ions,  $\text{BrO}_3^-$ , are produced.
  - The reaction between copper and nitric acid (of course in acidic medium) in which the products are copper(II) ions and nitrogen monoxide gas.
  - The reaction of thiosulfate ion with chlorine gas in acidic medium, which produces chloride and sulfate ions.
  - The action of manganate(VII) ion on sulfurous acid producing manganese(II) ions and hydrogen sulfate ions (in acidic medium of course).
  - The reaction of hydrosulfuric acid with chlorine producing sulfur and chloride ions.
  - The reaction in basic medium of bromine in water producing bromate(V) and bromide ions.
  - The formation of chromate(VI) ions and manganese(II) ion from the reaction between chromium(III) ions and manganese(IV) oxide in basic medium.