Learning objective 1.17 The student is able to express the law of conservation of mass quantitatively and qualitatively using symbolic representations and particulate drawings. [*See* **SP 1.5; Essential knowledge 1.E.1**]
Learning objective 1.18 The student is able to apply conservation of atoms to the rearrangement of atoms in various processes. [*See* **SP 1.4; Essential knowledge 1.E.2**]
Learning objective 1.18 The student is able to apply conservation of atoms to the rearrangement of atoms in various processes. [**See SP 1.4]**
Learning objective 1.19 The student can design, and/or interpret data from, an experiment that uses gravimetric analysis to determine the concentration of an analyte in a solution. [**SP4.2,5.1,6.4**]
Learning objective 1.20 The student can design, and/or interpret data from, an experiment that uses titration to determine the concentration of an analyte in a solution. [**See SP 4.2, 5.1, 6.4]**
Learning objective 3.1 Students can translate among macroscopic observations of change, chemical equations, and particle views. [See SP 1.5, 7.1; Essential knowledge components of 3.A–3.C] Learning objective 3.2 The student can translate an observed chemical change into a balanced chemical equation and justify the choice of equation type (molecular, ionic, or net ionic) in terms of utility for the given circumstances. [See SP 1.5, 7.1; Essential knowledge 3.A.1]

1. Write a balanced, net ionic equation and draw a particulate level diagram for each of the following reactions: Combustion, Synthesis, Single Replacement, Double Replacement

2. Reaction Prediction: Write balanced, net ionic reactions for the following:

1. Sulfur trioxide gas is added to excess water.
2. Solid sodium oxide is added to water.
3. Solid calcium oxide is mixed with sulfer trioxide gas.
4. Carbon disulfide vapor is burned in excess oxygen.
5. Electric current is passed through water.
6. Ethanol(C_2H_5OH) is completely burned in air.
7. Solid zinc reacts with a solution of cupric nitrate.
8. Chlorine gas is passed through a solution of potassium bromide.
9. Solid Zinc reacts with aqueous solution of strontium chloride.
10. Dilute hydrochloric acid is added to a dilute solution of mercury (I) nitrate.
11. Hydrogen sulfide gas is added to a solution of cadmium nitrate.
12. Solutions of zinc sulfate and sodium phosphate are mixed.
13. Sodium carbonate solution is mixed with dilute hydrochloric acid solution.
14. The gases boron trifluoride and ammonia are mixed.

Answers:

1. $SO_3 + HOH \rightarrow H_2SO_4 \rightarrow H^+ + HSO_4^-$
2. $Na_2O + HOH \rightarrow 2\ Na^+ + 2OH^-$
3. $CaO + SO_3 \rightarrow CaSO_4$
4. $CS_2 + 3\ O_2 \rightarrow CO_2 + 2\ SO_2$
5. $2\ H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$
6. $2\ C_2H_5OH + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$
7. $Pb_{(s)} + Cu^{2+}_{(aq)} \rightarrow Pb^{2+}_{(aq)} + Cu_{(s)}$
8. $Cl_{2\ (aq)} + 2\ KBr_{(aq)} \rightarrow 2\ KCl_{(aq)} + Br_{2\ (aq)}$
9. $Zn_{(s)} + Sr^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Sr_{(s)}$

10. $Hg_2^{2+} + 2Cl^- \rightarrow Hg_2Cl_2(s)$
11. $H_2S_{(g)} + Cd^{2+}_{(aq)} \rightarrow CdS_{(s)} + 2H^+_{(aq)}$
12. $3\ Zn^{2+}_{(aq)} + 2\ PO_4^{3-} \rightarrow Zn_3(PO_4)_{2(s)}$
13. $CO_3^{2-}{}_{(aq)} + 2\ H^+{}_{(aq)}{}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$
14. $BF_{3(g)} + NH_{3(g)} \rightarrow NH_3BF_3$

3. Strong Acid-Strong Base Titration Read about the methodology and do the practice problems, as many as you need to feel comfortable
http://chemwiki.ucdavis.edu/Analytical_Chemistry/Quantitative_Analysis/Titration/Titration_Of_A_Strong_Acid_With_A_Strong_Base

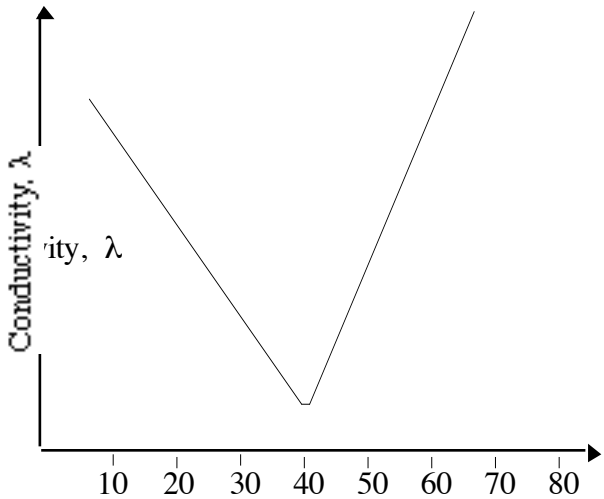
1. How many liters of 3.4 M HI will be required to reach the equivalence point with 2.1 L of 2.0 M KOH?

2. What is the pH when 48.00 ml of 0.100 M NaOH solution have been added to 50.00 ml of 0.100 M HCl solution?

3. What is the **pOH** when 5.0 L of a 0.45 M solution of sulfuric acid (H_2SO_4) is titrated with 2.3 L of a 1.2 M lithium hydroxide (LiOH) solution?

4. Find the pH at the following points in the titration of 30 mL of 0.05 M $HClO_4$ with 0.1 M KOH. **a**) Before adding any KOH b) When 5 mL of 0.1 M KOH is added c) When 15 mL of 0.1 M KOH is added d) draw a particulate level drawing of a-c steps.

5. A solution of barium hydroxide is titrated with 0.1–M sulfuric acid and the electrical conductivity of the solution is measured as the titration proceeds. The data obtained are plotted on the graph below.



Millilitres of 0.1–M H_2SO_4

(a) For the reaction that occurs during the titration described above, write a balanced net ionic equation.
(b) Explain why the conductivity decreases, passes through a minimum, and then increases as the volume of H_2SO_4 added to the barium hydroxide is increased.

(c) Calculate the number of moles of barium hydroxide originally present in the solution that is titrated.

(d) Explain why the conductivity does not fall to zero at the equivalence point of this titration.

Answer:

1. 1.2 L
2. 2.69
3. 13.4
4. a. 1.30 b. 1.54 c. 7.0
5. a) $Ba^{2+} + 2\ OH^- + 2\ H^+ + SO_4^{2-} \rightarrow BaSO_4(s) + 2\ H_2O$

b) The initial conductivity is high because of the presence of Ba^{2+} and OH^- ions. The conductivity decreases because Ba^{2+} forms insoluble $BaSO_4$ with the addition of SO_4^{2-}. The conductivity also decreases because OH^- combines with the addition of H^+ ions by forming H_2O.
Beyond the equivalence point conductivity increases as H^+ and SO_4^{2-} ions are added.

c) # mol $Ba(OH)_2$ = # mol H_2SO_4
$=0.1M \times 0.04$ L = 0.004 mol

d) $BaSO_4(s)$ dissociates slightly to form Ba^{2+} and SO_4^{2-}, while the water ionizes slightly to form H^+ and OH^-.