Titration Problem

1. a. The equivalence point in a strong acid/strong base titration is when the moles of H^+ and OH^- added are equal (and the resulting solution is neutral). To determine whether the equivalence point has been reached, we first need to calculate the numbers of moles of H^+ and OH^- that have been added:

$$37.2\text{ ml} \times \frac{0.325\text{ mol HNO}_3}{1000\text{ ml}} \times \frac{1\text{ mol H}^+}{1\text{ mol HNO}_3} = 0.01209\text{ mol H}^+$$

$$47.0\text{ ml} \times \frac{0.115\text{ mol Ba(OH)}_2}{1000\text{ ml}} \times \frac{2\text{ mol OH}^-}{1\text{ mol Ba(OH)}_2} = 0.01081\text{ mol OH}^-$$

No, the equivalence point has not been reached because the moles of H^+ are still more than the moles of OH^- added.

b. To find the H^+ concentration, we must find the moles of H^+ remaining and divide by the total volume:

$$\text{excess moles H}^+ = 0.01209\text{ mol} - 0.01081\text{ mol} = 0.00128\text{ mol H}^+\text{ remaining}$$

$$\text{total volume} = 37.2\text{ ml} + 47.0\text{ ml} = 84.2\text{ ml}$$

$$[\text{H}^+] = \frac{0.00128\text{ mol H}^+}{0.0842\text{ L}} = 0.0152\text{ M H}^+$$

c. The pH is given by:

$$\text{pH=-log}[\text{H}^+] = -\log(0.0152) = 1.8$$

d. At the equivalence point, moles of H^+ and OH^- added are equal. Since we have 0.00128 moles of H^+ remaining, we must add this many moles of OH^- to neutralize:

$$0.00128\text{ mol OH}^- \times \frac{1\text{ mol Ba(OH)}_2}{2\text{ mol OH}^-} = 0.000640\text{ mol Ba(OH)}_2$$

$$0.000640\text{ mol Ba(OH)}_2 \times \frac{1000\text{ ml}}{0.115\text{ mol Ba(OH)}_2} = 5.57\text{ ml Ba(OH)}_2$$

Oxidation Numbers - Solutions

1. The elements are listed here in the order of decreasing priority in which the oxidation numbers are determined. In other words, the oxidation number of the first element is set by the rules outlined in the handout and in Zumdahl, and the oxidation numbers of the other element are dependent on the oxidation number of that first element such that the correct overall charge is obtained.

   a. Li^{+1} N^{-3}

   b. H^{+1} N^{-3}

   c. H^{+1} N^{-2}

   d. O^{-2} N^{+4}

   e. O^{-2} K^{+1} N^{+5}

   f. F^{-1} Br^{+3}

   g. H^{+1} O^{-2} Br^{+1}

   h. Na^{+1} H^{-1}

2. a. C_2H_6 reactant: H^{+1} C^{-3}

   O_2 reactant O^{0}

   CO_2 product O^{-2} C^{+4}

   H_2O product O^{-2} H^{+1}

   C is oxidized from –3 to +4 and O is reduced from 0 to –2 during the reaction, so this is an oxidation–reduction (redox) reaction.

   b. $CuSO_4$ reactant (recall SO_4^{2-} polyatomic ion) O^{-2} S^{+6} Cu^{+2}

   Na_2CO_3 reactant (recall CO_3^{2-} polyatomic ion) O^{-2} C^{+4} Na^{+1}

   $CuCO_3$ product (recall CO_3^{2-} polyatomic ion) O^{-2} C^{+4} Cu^{+2}

   Na_2SO_4 product (recall SO_4^{2-} polyatomic ion) O^{-2} S^{+6} Cu^{+2}

   No element changes its oxidation number during the reaction, so this is not an oxidation–reduction (redox) reaction.

   c. CuCl reactant: Cl^{-1} Cu^{+1}

   $CuCl_2$ product Cl^{-1} Cu^{+2}

   Cu product Cu^{0}

   One Cu atom is oxidized from +1 to +2 and one Cu atom is reduced from –1 to 0 during the reaction, so this is an oxidation–reduction (redox) reaction.