<u>Year 12 Chemistry Titrations Worksheet 2 Answers</u>

1. To determine the concentration of a sodium hydroxide solution it is titrated against a solution of hydrochloric acid of known concentration. In this example:
    a. What is the analyte?

        Sodium hydroxide solution

    b. What is the standard solution?

        Hydrochloric acid

    c. What is the titre?

        The measured volume (of acid or base) added from the burette to reach the endpoint.

2. State two characteristics of sodium hydrogen carbonate that make it suitable for use in a primary standard solution.

    It has a relatively high molar mass.
    It is stable in air. **(Many other answers possible)**

3. A titration is being performed where hydrochloric acid is placed in the burette and sodium hydroxide (the primary standard solution) is in the conical flask.
    a. What would be used for the final rinse of each of these?
        i. The burette.

            Hydrochloric acid

        ii. The conical flask.

            Distilled or deionised water

        iii. The volumetric pipette that is used to transfer sodium hydroxide solution to the conical flask.

            Sodium hydroxide solution

    b. What is used to rinse the tip of the burette after each drop of acid is added to the conical flask as you approach the end point?

        Distilled or deionised water

c. Explain how to identify concordant titres.

   Concordant titres are within 0.2 mL of each other.

4. It is not possible to directly determine the purity of a sample of copper(II) oxide by titration because copper(II) oxide is insoluble. Explain how the purity of such a sample could be determined indirectly. Name this method.

   A <u>back titration</u> would be used. For instance the CuO could be reacted with an excess of hydrochloric acid. After this reaction is complete the resulting solution is titrated, for instance against a sodium hydroxide standard solution, to determine the number of moles of hydrochloric acid remaining after the reaction with CuO. From here the number of moles of HCl that reacted with CuO can be determined, the number of moles and mass of CuO determined and finally the percentage purity of the CuO determined.

5. Select an appropriate indicator for each of the following titrations. Choose from bromothymol blue, methyl orange and phenolphthalein.
   a. Hydrochloric acid and potassium hydroxide

      Bromothymol blue

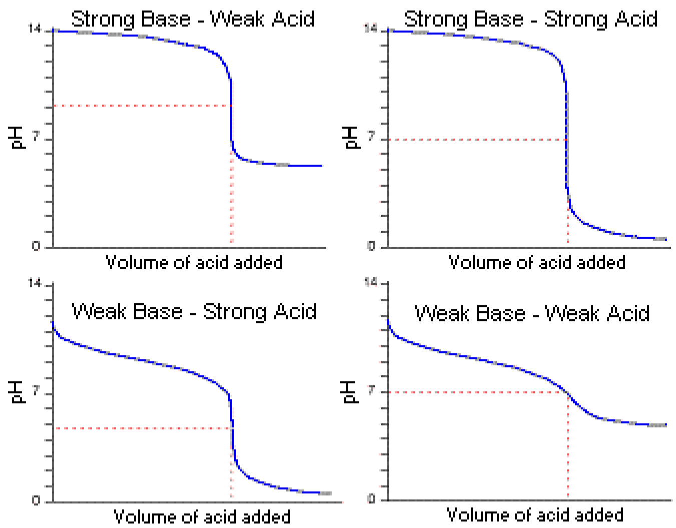
   b. Ethanoic acid and potassium hydroxide

      Phenolphthalein

   c. Hydrochloric acid and sodium carbonate.

      Methyl orange

6. Sketch titration curves for each of the following titrations acid-base titrations, where the acid is in the burette and the base is in the conical flask. Indicate with dashed lines the volume of acid added and the pH at the equivalence points.
    a. Strong base and weak acid
    b. Strong base and strong acid
    c. Weak base and strong acid
    d. Weak base and weak acid



7. A student added 50.00 mL of 0.1000 mol L^{-1} HCl to 25.00 mL of a commercial ammonia-based cleaner. It took 21.50 mL of 0.1000 mol L^{-1} NaOH to neutralise the excess HCl. What was the concentration of ammonia in the cleaner, in mol L^{-1} and in g L^{-1}?

Titration

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$
n(NaOH) = cV = 0.1000 x 0.02150 = 0.002150 mol
SR = 1/1 = 1
n(HCl, excess remaining after reaction with NH_3) = 0.002150 mol

Reaction between HCl and NH_3

n(HCl before reaction with NH_3) = cV = 0.1000 x 0.05000
= 0.005000 mol
n(HCl used in reaction with NH_3) = 0.005000 – 0.002150 = 0.00285 mol
$HCl_{(aq)} + NH_{3(aq)} \rightarrow NH_4Cl_{(aq)}$
SR = 1/1 = 1
n(NH_3) = 0.00285 mol
c(NH_3 in cleaner) = n / V = 0.00285 / 0.02500 = 0.1140 mol L^{-1} (4 sf)
m (in 1 L) =nM = 0.1140 x (14.01 + (3 x 1.008)) = 1.942 g
i.e. c = m / V = 1.942 / 1 = 1.942 g L^{-1} (4 sf)

8. A sample of chalk weighing 0.135 g was reacted with 40.00 cm^3 of 1.00 mol/l hydrochloric acid (an excess). After the reaction was complete the solution was transferred to a 250 cm^3 volumetric flask and made up to the mark with distilled water. 25.00 cm^3 portions of this solution were then titrated against 0.15 mol/l sodium hydroxide using methyl orange as the indicator. An average titre of 25 cm^3 of the sodium hydroxide was required.

   Calculate the percentage purity of the chalk.

   <u>Titration</u>
   $HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$
   n(NaOH) = cV = 0.15 x 0.025 = 0.00375 mol
   SR = 1/1 = 1
   n(HCl in 25 cm^3 aliquot of diluted HCl) = 0.00375 mol
   c(HCl in 25 cm^3 aliquot of diluted HCl) = n / V = 0.00375 / 0.025
   = 0.15 mol L^{-1}

   <u>Dilution</u>
   c(HCl in 250 cm^3 volumetric flask) = 0.15 mol L^{-1} = c_2
   c(HCl after reaction with chalk, before dilution) = c_1
   V_1 = 0.040 L. V_2 = 0.25
   $c_1V_1 = c_2V_2$
   c_1 = c(HCl after reaction with chalk, before dilution)
   = 0.15 x 0.25 / 0.04 = 0.9375 mol L^{-1}
   n(HCl in 40.00 cm^3, after reaction with chalk) = cV
   = 0.9375 x 0.040 = 0.0375 mol
   n(HCl before reaction with chalk) = cV = 1.00 x 0.0400 = 0.0400 mol
   n(HCl) used in reaction with chalk) = 0.0400 – 0.0375 = 0.0025 mol

   <u>Reaction with chalk</u>
   $CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$
   SR = ½
   n($CaCO_3$) = ½ x 0.0025 = 0.00125 mol
   m($CaCO_3$) = nM = 0.00125 x (40.08 + 12.01 + 48.00) = 0.1251125 g
   % purity = (0.1251125 / 0.135) x 100 = 93 % (2 sf)

   Other methods are possible.