Lesson 4 -Volumetric

Volumetric analysis involves finding the concentration of an unknown sample by reacting it with an accurately known volume of a solution whose concentration is known accurately. This solution is known as the standard solution.

So what do we need to perform a volumetric analysis.

1- A balanced chemical equation of the reaction between the two solutions
2- The volume and concentration of the standard solution.

Let's do the first example.

An unknown sample of brick cleaner is to be analysed for its concentration of HCl.

5 conical flasks with exactly 20.00 mL of the unknown brick cleaner solution are prepared and titrated against a 0.100 M $NaHCO_3$ solution. The average titre is calculate at 25.26 mL. Find the concentration, in %m/v of HCl in the brick cleaner.

Step 1 Write a balanced chemical equation for the reaction between HCl and $NaHCO_3$.

$HCl(aq) + NaHCO_3(aq) \rightarrow CO_2(g) + NaCl(aq) + H_2O(l)$

Step 2 Find the mol of $NaHCO_3$ that reacted.

mol of $NaHCO_3$ = C X V = 0.2526 X 0.100 = 0.02526 mol

Step 3 Now find the mol of HCl that reacted with the $NaHCO_3$ in the conical flask. Use the balanced equation to get the mol ratios

=> Mol of $NaHCO_3$ = mol of HCl = 0.02526 mol

Step 4 Find the mass of HCl represented by 0.02526 mol

=> 0.02526 X 36.5 = 0.922g

Step 5 Find the %m/v = (0.922/20.00 mL) X 100 = 4.61%m/v

Let's do a second example

An unknown sample of acid wash is to be analysed for its concentration of H_2SO_4.

Five conical flasks with exactly 20.00 mL of the unknown acid wash solution are prepared and titrated against a 0.100 M $NaHCO_3$ solution. The five titres were, 25.62 mL, 23.29 mL, 23.20 mL, 23.25, 23.19. Find the concentration, in %m/v of H_2SO_4 in the acid wash.

Step 1 Write a balanced chemical equation for the reaction between H_2SO_4 and $NaHCO_3$.

$H_2SO_4(aq) + 2NaHCO_3(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$

Step 2 Find the average titre. Only include the concordant results.

(23.29 mL + 23.20 mL + 23.25 + 23.19) / 4 = 23.23 mL

Step 3 Find the mol of $NaHCO_3$ that reacted.

mol of $NaHCO_3$ = C X V = 0.100 X 0.02323 = 0.002323 mol

Step 3 Now find the mol of H_2SO_4 that reacted with the $NaHCO_3$ in the conical flask. Use the balanced equation to get the mol ratios

mol of H_2SO_4 = ½ of $NaHCO_3$ = ½ X 0.002323 = 1.162 X 10^{-3}mol

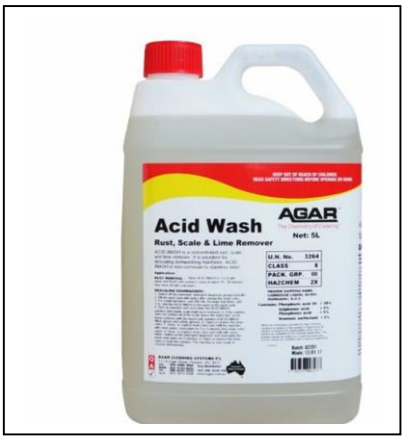
Step 4 Find the mass of H_2SO_4 represented by 0.001162 mol

mass = n X F_m = 1.162 X 10^{-3} X 98.0 = 0.114g

Step 5 Find the %m/v

=> (0.114g/20.00mL) X 100 = 0.57%m/v

1. An unknown sample of acid wash is to be analysed for its concentration of H_2SO_4.
   A 20.00 mL aliquot is taken from the original sample and placed in a 200 mL volumetric flask and made to the mark with distilled water. A 20.00 mL aliquot is placed in a 100mL conical flask and titrated against a 0.114 M Na_2CO_3 solution. This was repeated several times unitl concordant titres were recorded and an average titre of 18.98 mL was calculated.



   a. Write a balanced chemical equation for the reaction between H_2SO_4 and Na_2CO_3.

      $H_2SO_4\,(aq) + Na_2CO_3\,(aq) \rightarrow Na_2SO_4\,(aq) + H_2O(l) + CO_2(g)$

   b. Find the mol of Na_2CO_3 present in an average titre.
      mol of Na_2CO_3 = C X V = 0.114 X 0.01898 = 2.164 X 10^{-3} mol
   c. Find the mol of H_2SO_4 present in the conical flask.
      According to the equation in a. above mol of H_2SO_4 = mol of Na_2CO_3 = 2.164 X 10^{-3} mol
   d. Find the mol of H_2SO_4 in the volumetric flask
      Since an amount of 2.164 X 10^{-3} mol of H_2SO_4 is present in the 20 mL aliquot taken from the 200 mL volumetric flask the amount in mol of H_2SO_4 in the volumetric flask is calculated by the expression below
      => (200/20) X 2.164 X 10^{-3} mol = 2.164 X 10^{-2} mol
   e. Find the concentration, in mol/L, of H_2SO_4 in the original solution of acid wash.
      since 2.164 X 10^{-2} mol of H_2SO_4 in the volumetric flask came from 20.00 mL of original sample, the concentration in mol/L therefore is
      => 2.164 X 10^{-2} mol / 0.0200 = 1.08M