EXPERIMENT: DETERMINATION OF THE ALCOHOL CONTENT OF WINE

Aim:

To ascertain the alcohol content of wine, utilising a back titration.

Introduction:

$3C_2H_5OH\ (aq) + Cr_2O_7^{2-}(aq) + 8H^+\ (aq) \rightarrow 3CH_3CHO\ (aq) + 2Cr^{3+}\ (aq) + 7H_2O(l)$

Excess dichromate ions reacting with iodine-

$Cr_2O_7^{2-}(aq) + 8H^+\ (aq) + 14I^-\ (aq) \rightarrow 2Cr^{3+}\ (aq) + 7H_2O(l) + 3I_2\ (aq)$

Iodine being titrated against standard sodium thiosulfate solution.

$I_2\ (aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-\ (aq) + S_4O_6^{2-}(aq)$

Procedure:

The experiment has been divided into two parts, the oxidation of alcohol and the determination of excess dichromate.

Part (A) Oxidation of alcohol

1. Record the brand of wine to be analysed and the manufacturer's specification of the alcohol content.

2. Use a pipette to transfer 10.00 mL wine to a 250 mL volumetric flask. Make up the volume to 250 mL using de ionised water and mix thoroughly.

3. Place 20.00 mL aliquots of the diluted wine into each of three 250 mL conical flasks.

4. Record the concentration of the standard potassium dichromate solution supplied. Place a 20.00 mL aliquot of this solution in each flask. Wearing gloves and using a measuring cylinder, *slowly* add approximately 10mL 40% sulfuric acid solution into each flask.

5. Stopper each flask loosely and heat for 10 minutes in a water bath at 45-50°C. (*Do not allow the temperature to exceed 50°C*)

Part (B) Determination of excess dichromate

1. After heating for 10 minutes, add about 2 g of potassium iodide to each flask.

2. Fill a burette with standard sodium solution. Record the initial volume of solution in the burette and the concentration of the solution.

3. Titrate the contents of each conical flask with the sodium thiosulfate solution, adding 1-2 mL starch indicator when the brown colour of the solution develops a green tinge. The equivalence point of each titration is reached when the blue colour of the starch-iodine complex just disappears, leaving a clear, green colour. Record the final volume of liquid in the burette.

Results:

Manufacturer's specification of alcohol content: 9.5 % /4 L
Concentration of standard potassium dichromate:

	First titration			Second titration		Third titration			Average	
	Initial Reading	Final Reading	Overall	Initial Reading	Final Reading	Overall	Initial Reading	Final Reading	Overall	
Titration of iodine against sodium thiosulfate	0	25.1	25.1 mL	25.1 mL	50 mL	24.9 mL	20.1 mL	46.7 mL	26.6 mL	25.53 mL

Discussion:

1. Calculate the amount of $Cr_2O_7^{2-}$ ions, in mol, in each 20.00mL aliquot of potassium dichromate solution

   n = cv
   = 0.04 M x 0.02 L
   = 8 x 10^-4 mol

2. Calculate the average titre of standard sodium thiosulfate solution and the amount of thiosulfate ions in this titre.

   Average titre = 25.53 mL
   n = cv
   = 0.01 M x 0.02553
   = 0.002553 mol

3. Deduce the amount of iodine formed during the reaction with excess dichromate
   $n(I_2$ formed) = $n(I_2$ reacting with $S_2O_3^{2-})$

   Mole ratio between $I_2 : S_2O_3^{2-}$
   1 : 2
   $n(I_2) = ½\ n(S_2O_3^{2})$
   = ½ x 0.002553
   = 0.0012765 mol

4. Use the equation for the reaction between $Cr_2O_7^{2-}$ ions and I- ions to deduce the amount of $Cr_2O_7^{2-}$ ions in excess after oxidation of the ethanol

   Mole ratio between $Cr_2O_7^{2-}$ and I_2
   1 : 6
   $n(Cr_2O_7^{2-}$ in excess) = 1/6 $n(I_2)$
   = 1/6 x 0.0012765
   = 2.1275 x 10^-4mol

5. Calculate the amount of $Cr_2O_7^{2-}$ ions that reacted with ethanol

   $n(Cr_2O_7^{2-}$ reacted with ethanol) = $n(Cr_2O_7^{2-}$ initially) - $n(Cr_2O_7^{2-}$ in excess)
   = 8 x 10^-4 – 2.1275 x 10^-4
   = 5.8725 x 10^-4

6. Find the amount of ethanol in each 20 mL aliquot of diluted wine

   Mole ration between ethanol and dichromate ions

   3 : 1

   n (C_2H_5OH) = 3 n ($Cr_2O_7^{2-}$)

   = 3 x 5.8725 x 10^-4

   = 0.001761675

7. Calculate the amount of ethanol in the 250 mL conical flask

   $$n(C_2H_5OH) \text{ in } 250 \text{ mL} = \frac{n(C_2H_5OH) \times 0.25}{0.02}$$

   = (0.001761675 x 0.25) / 0.02

   = 0.02202 mol

8. Find the molar mass of ethanol and hence calculate the mass of ethanol in the initial 10mL sample of wine

   $M(C_2H_5OH)$ = 46 g/mol

   m (C_2H_5OH) = nM

   = 0.02202 x 46

   = 1.01292 g

9. Given that the density of ethanol is 0.785 g/mL calculate the volume of ethanol in the 10 mL sample

   In 10 mL, there is 1.01292 g of ethanol

   $$V = \frac{\text{mass}}{\text{density}}$$

   7= 1.01292 / (7.85 g / 10 mL)

   = 0.129034 mL in 10 mL

10. Determine the percentage of alcohol in the wine on a volume/volume basis
    %volume/volume -> mL / 100 mL

    0.129034mL/10 mL

    x 10 x 10

    = 1.29034mL/100 mL

11. Compare your result with the alcohol content of wine as specified by the label on the bottle. If there is a discrepancy between the two figures, suggest possible reasons for this.
    The amount of wine as advertised is- 9.5 % / 4 L

    2.37 % / L

    23.7 mL / L

    1.29034 mL / 100 mL

    x 10 x10

    12.9034 mL / L