Experiment 8: Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.

Significance of experiment : In potentiometry we measure the potential of an electrochemical cell under static conditions.[1,2] Because no current or only a negligible current flows through the electrochemical cell, its composition remains unchanged. For this reason, potentiometry is a useful quantitative method. The first quantitative potentiometric applications appeared soon after the formulation, in 1889, of the Nernst equation, which relates an electrochemical cell's potential to the concentration of electroactive species in the cell. Turbid, fluorescent, opaque or coloured solutions can be titrated. Mixture of solutions or very dilute solutions can be titrated. The results are more accurate because the actual end point is determined graphically.

Aim : To estimate FAS potentiometrically using standard potassium dichromate solution.

Theory : The estimation of concentration of substances in solution by the measurement of emf is known as potentiometric titration. Here, emphasis is laid on the changes in emf of an electrolytic cell as a titrant of known concentration is added.

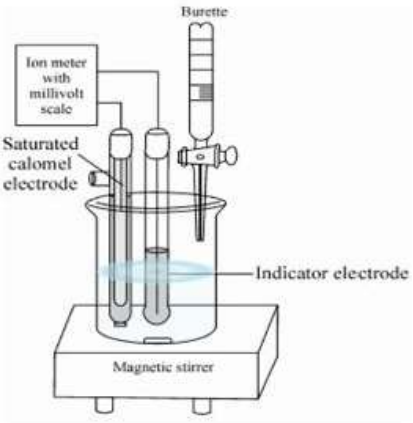
When a metal M is immersed in a solution containing its own ions M^{n+}, the electrode potential is given by Nernst equation.

$$E = E^0 + \frac{0.0591}{n} \log\left[M^{n+}\right]$$

Thus, the concentration can be calculated, provided E^o of the electrode is known.If an electrode of the metal reversible with respect to the corresponding ions is placed in the solution, the potential will vary throughout the titration. Initially the change in potential will be small. At the equivalence point, there will be a steep rise in the potential. The equivalence point can be determined by plotting the change in potential against volume of titrant added.

Instrumentation:

A potentiometer consists of: (i) Calomel electrode as a reference electrode, (ii) Platinum electrode as an indicator electrode, (iii) a device for measuring the potential and (iv) magnetic stirrer.



Application: Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution

Procedure: Pipette out 25ml of the given FAS solution into a clean beaker and add 1 test tube of dil H_2SO_4. Immerse a bright platinum electrode and saturated calomel electrode and connect it to a pH meter in the millivolts (mV) position. Fill a clean burette with the given standard $K_2Cr_2O_7$ solution.Add 0.5ml of $K_2Cr_2O_7$ from the burette, mix the solution well. Measure the emf of the solution. Continue measuring the emf after addition of 0.5ml of $K_2Cr_2O_7$everytime, till there is a rise in the emf. Take few more readings. Plot a graph of $\Delta E/\Delta V$ (ordinate) against volume of $K_2Cr_2O_7$ (bascissa). From this graph volume of $K_2Cr_2O_7$ at equivalent point is found out. Following reaction takes place during titration.

$$6FeSO_4 + 7H_2SO_4 + K_2Cr_2O_7 \rightarrow 3Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O$$

Advantages of potentiometric titrations are:

(i) They give results more reliable than those obtained from titrations using indicators
(ii) The method is applicable to both coloured and turbid solutions also

Result:(i) Normality of FAS (N_{FAS}) = …….

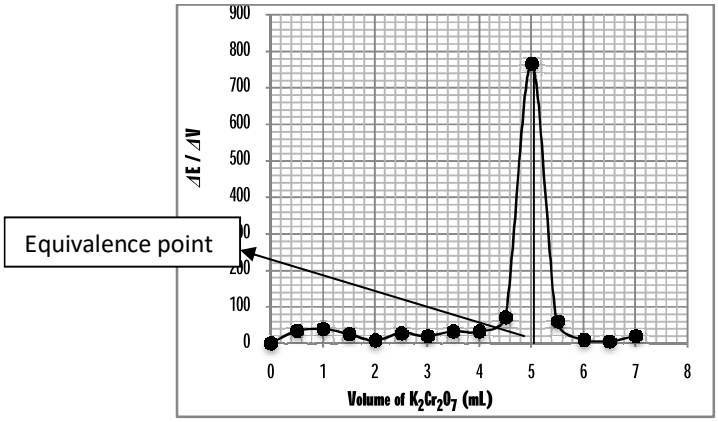
(ii) Weight of FAS present in given solution = …… g

Links to the external sources of information about the topic:

1. http://en.wikipedia.org/wiki/Potentiometric_titration
2. www.sciencedirect.com/science/article/pii/S0022072868801743

Experiment 8: Observation and calculations

Volume of $K_2Cr_2O_7$added (VmL)	E (mV)	ΔE	ΔV	$\frac{\Delta E}{\Delta V}$
0.0		---	--	--



From the graph, volume of $K_2Cr_2O_7$at the equivalence point = …… (x) mL

Normality of $K_2Cr_2O_7$ = …… (a) (will be provided to you)

Normality of FAS (N_{FAS})=$\frac{Normality\ X\ VolumeofK2Cr2O7}{VolumeofFAS}$= $\frac{a\times x}{25}$= ……(say b)

Weight of FAS / L = N x equivalent weight of FAS = b x 392 = …….g (say c)

Weight of FAS / 25 mL =$\frac{c}{40}$=..……..g

Result: (i) Normality of FAS (N_{FAS}) = …….

(ii) Weight of FAS present in given solution = …… g