CH10: titrations

ACTIVITY 3. ESTIMATION OF THE PERCENTAGE OF IRON IN TARDYFERON TABLETS

The purpose of this experiment is to determine the mass of iron in tablets of Tardyferon®. To do this we are going to do a redox titration.

Source: *wikimediacommons*

A. Introduction

Iron is a transition metal and shows typical properties of such elements. Iron is an essential element in the human body and a well-balanced diet usually provides all the iron needed for most people. However, in some cases (like pregnancy) a person may need additional iron and this can be supplied in the form of « iron tablets ». These are tablets containing iron(II) sulfate mixed with a base.

The purpose of this experiment is to determine the mass of iron in such iron tablets. To do this, we are going to make use of the ability of iron to exist in more than one oxidation state.

In the tablets iron is present as iron(II) or Fe^{2+}. Potassium manganate (VII) is a powerful oxidizing agent and is able to oxidize iron (II) to iron (III). The half equations for the oxidation and reduction reactions are:

(i) oxidation $Fe^{2+}_{(aq)} = Fe^{3+}_{(aq)} + e^-$

(ii) reduction $MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- = Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

These two equations can be combined to give the overall equation for the redox reaction:

$$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5Fe^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)}$$

Solutions containing $MnO^{-}_{4(aq)}$ have a deep purple color. Solutions containing $Mn^{2+}_{(aq)}$ ions are colorless.

Therefore, if a solution of $Fe^{2+}_{(aq)}$ ions is titrated against potassium manganate (VII), the point at which all the Fe^{2+} has been oxidized (i.e. the end point of the reaction) is when the titration mixture in the flask turns pale pink. At this point the addition of one more drop of purple potassium permanganate solution turns the solution a permanent pink color. At this point, all the Fe^{2+} ions have been oxidized to Fe^{3+} and this is the end point of the titration.

This titration forms the basis of the analytical technique used to estimate the amount of iron present.

B. Experimental

- Weigh **accurately** one iron tablet. Record the weighing in your notebook.
- Transfer the tablet to a pestle and mortar and grind it with a little 1M sulfuric acid, taking care not to lose any grains of the tablets. Transfer the paste to a 100 cm^3 volumetric flask, using a funnel.
- Rinse all the remaining particles of the tablet out of the mortar and off the pestle using small portions of sulfuric acid. Add all the rinsings to the volumetric flask. Make sure to rinse the funnel.
- Then add 1M sulfuric acid to the flask until the level just reaches the 100 cm^3 mark.
- Place a stopper on the flask and shake well to make sure the contents are thoroughly mixed. There will probably be some undissolved solid in the flask, but all the Fe^{2+} should now be in solution.
- Pipette out a 10 cm^3 portion of the solution using a pipette filler. Add 20 cm^3 of 1M sulfuric acid. Titrate the solution with 0,0020M potassium permanganate solution, shaking the flask well after each addition. The end point is the first permanent pink color. This indicates that there are no Fe^{2+} ions remaining to react with the $MnO^{-}_{4(aq)}$.
- Carry out one rough titration and then carry out further titrations until consistent results are obtained according to the International Standard ISO 5725-6.
- Write a report of your method including any observations.

C. Results (report all results in your notebook)

Mass of iron tablets used:

Volume of iron solution used:

Molarity of potassium permanganate solution =

Titration results:

	Rough	**1st Accurate**	**2nd Accurate**	**3rd Accurate**
Volume used / cm^3				

Find the mass of iron in the tablet and give your result by taking into account an accuracy of 1.2%.

Determine the percentage of iron present in the tablet.

DOCUMENT: Safety Information Sheet

This information must be read BEFORE the experiment is attempted.

You are then required to sign the declaration at the bottom of the sheet and have this countersigned by a demonstrator or member of staff BEFORE commencing the practical.

DO NOT SIGN this form until you are satisfied that you appreciate the hazards associated with all aspects of this experiment.

Potassium manganate (VII) solution (0,002M) is an oxidant, **but represents no serious hazard (at this concentration) however, avoid ingestion and skin and eye contact.**

→ See the Safety Data Sheet

Sulphuric acid (1.0 M) is corrosive – **avoid contact with skin and eyes.**

→ See the Safety Data Sheet of sulfuric acid 2.5 mol/l

→ See the Safety Data Sheet of sulfuric acid 0.5 mol/l

I have read the experimental procedure and the hazards assessments and will comply with these procedures.

Student: …………………………………………………….

Date: ……………………………

Declaration as part of COSHH regulations

Activity summary

What you must remember:

- endpoint
- titration
- oxidation, reduction reaction
- accuracy

Skills linked to the curriculum**:**

Compétences	Capacités à maitriser
APP	S'approprier un mode opératoire S'approprier l'ensemble des informations liées à la sécurité
ANA	Suivre un protocole de titrage direct d'espèces colorées avec réactions support de titrage d'oxydation-réduction
REA	Réaliser un protocole de titrage direct d'espèces colorées avec réactions support de titrage d'oxydation-réduction Définir l'équivalence d'un titrage avec réactions support de titrage d'oxydation-réduction Déterminer la concentration d'une solution inconnue à partir des conditions expérimentales d'un titrage Calculer et exprimer un résultat en tenant compte de l'incertitude de mesure, associée à un niveau de confiance, donnée
COM	Commenter le résultat de mesure obtenu en le comparant à une valeur de référence Formuler et argumenter des réponses structurées Formuler et présenter une conclusion Citer en anglais les formules chimiques de quelques espèces usuelles (acide

	sulfurique, ion permanganate) Utiliser des notions d'anglais scientifique à l'écrit et à l'oral