Oxford Cambridge and RSA

Wednesday 19 June 2019 – Morning

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Practical Insert

Time allowed: 1 hour 30 minutes

INSTRUCTIONS

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INFORMATION

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Iron in spinach

Spinach has often been regarded as an excellent source of dietary iron.

Below a student describes an investigation to determine the mass of iron contained in a typical portion of spinach used in a meal.

Introduction

The amount of iron, as Fe^{2+}, in spinach can be found by titration with potassium manganate(VII) solution.

Manganate(VII), MnO_4^-, is a strong oxidising agent. It accepts electrons easily, and is reduced to colourless manganese(II) ions according to the half-equation below:

$$\underset{\text{(purple)}}{MnO_4^-(aq)} + 8H^+(aq) + 5e^- \rightarrow \underset{\text{(colourless)}}{Mn^{2+}(aq)} + 4H_2O(l)$$

The electrons are provided by reducing agents such as iron(II) salts:

$$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$$

As a result, manganate(VII) can be used in acidic solution to determine the number of moles of reducing agent, e.g. Fe^{2+}, present.

Manganate(VII) is added from a burette to a solution of Fe^{2+} ions and is decolourised immediately. As soon as the Fe^{2+} ions are used up, the next drop of manganate(VII) is not decolourised, and so the solution in the conical flask goes pale pink. The end-point of the titration is the first permanent appearance of this pale pink colour. Manganate(VII) is therefore self-indicating and no other indicator is needed.

The acid used to provide $H^+(aq)$ is dilute sulfuric acid; this should always be in excess or else insoluble brown MnO_2 will form.

Getting the Fe^{2+} ions into solution

Approximately 5 g portions of spinach were immersed in dilute sulfuric acid for various amounts of time. The solutions were filtered and 25 cm^3 portions were titrated with the standard potassium manganate(VII) solution.

Method

1. Four samples of approximately 5 g of the spinach leaves provided were weighed by difference, accurately, using a 2 decimal place balance. All the weighings were recorded.

2. Each weighed sample of spinach was added to about 100 cm^3 of sulfuric acid in a beaker and allowed to stand for various amounts of time.
After standing each sample was filtered into a 250 cm^3 volumetric flask. The original beakers were washed several times with de-ionised water and the washings transferred to the flask. The solution was made up to the mark with de-ionised water.

3. 25 cm^3 of one of the solutions was pipetted into a conical flask.

4. The above solution was titrated against a 5.0×10^{-6} mol dm^{-3} solution of $KMnO_4$ from a burette until at least two concordant results were obtained.

5. Steps 3, 4 and 5 were repeated with each of the sample solutions.

Results and Analysis

Weighings

	Mass of weighing boat / g	Mass of spinach + weighing boat / g	Mass of spinach / g
Sample 1	1.43	6.75	5.32
Sample 2	1.43	6.98	5.55
Sample 3	1.43	6.40	4.97
Sample 4	1.43	6.53	5.10

Table 1

Titrations

		Sample 1	Sample 2	Sample 3	Sample 4
	Time / mins	**30**	**60**	**90**	**120**
Rough titre	**Initial vol / cm^3**	0.00	0.00	0.00	0.00
	Final vol / cm^3	6.80	7.25	7.70	8.20
	Titre / cm^3	6.80	7.25	7.70	8.20
Titre 1	**Initial vol / cm^3**	7.00	8.00	8.00	10.00
	Final vol / cm^3	13.80	15.10	15.55	18.05
	Titre / cm^3	6.80	7.10	7.55	8.05
Titre 2	**Initial vol / cm^3**	15.00	16.00	16.00	20.00
	Final vol / cm^3	21.75	23.15	23.50	27.95
	Titre / cm^3	6.75	7.15	7.50	7.95

Table 2

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