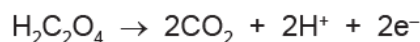


**Electrochemistry – 2016**

1. 9701/22/M/J/16/No.3

Acidified potassium dichromate(VI) can oxidise ethanedioic acid,  $\text{H}_2\text{C}_2\text{O}_4$ .  
The relevant half-equations are shown.



(a) State the overall equation for the reaction between acidified dichromate(VI) ions and ethanedioic acid.

..... [2]

(b) In an experiment a 0.242 g sample of hydrated ethanedioic acid,  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ , was reacted with a  $0.0200 \text{ mol dm}^{-3}$  solution of acidified potassium dichromate(VI).

$32.0 \text{ cm}^3$  of the acidified potassium dichromate(VI) solution was required for complete oxidation of the ethanedioic acid.

(i) Calculate the amount, in moles, of dichromate(VI) ions used to react with the sample of ethanedioic acid.

amount = ..... mol [1]

(ii) Calculate the amount, in moles, of ethanedioic acid in the sample.

amount = ..... mol [1]

(iii) Calculate the relative molecular mass,  $M_r$ , of the hydrated ethanedioic acid.

$M_r = \dots\dots\dots$  [1]

(iv) Calculate the value of  $x$  in  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ .

$x = \dots\dots\dots$  [1]

[Total: 6]

2. 9701/23/M/J/16/No.1

An experiment was carried out to determine the percentage of iron in a sample of iron wire.

(a) A 3.35 g piece of the wire was reacted with dilute sulfuric acid, in the absence of air, so that all of the iron atoms were converted to iron(II) ions. The resulting solution was made up to 250 cm<sup>3</sup>.

(i) Write a balanced equation for the reaction between the iron in the wire and the sulfuric acid.

..... [1]

A 25.0 cm<sup>3</sup> sample of this solution was acidified and titrated with 0.0250 mol dm<sup>-3</sup> potassium dichromate(VI). 32.0 cm<sup>3</sup> of the potassium dichromate(VI) solution was required for complete reaction with the iron(II) ions in the sample.

The relevant half-equations are shown.



(ii) Use the half-equations to write an equation for the reaction between the iron(II) ions and the acidified dichromate(VI) ions.

..... [1]

(iii) Calculate the amount, in moles, of dichromate(VI) ions used in the titration.

amount = ..... mol [1]

(iv) Calculate the amount, in moles, of iron(II) ions in the 25.0 cm<sup>3</sup> sample of solution.

amount = ..... mol [1]

(v) Calculate the amount, in moles, of iron in the 3.35 g piece of wire.

amount = ..... mol [1]

(vi) Calculate the mass of iron in the 3.35 g piece of wire.

mass = ..... g [1]

(vii) Calculate the percentage of iron in the iron wire.

percentage = ..... % [1]

(b) Some electronegativity values are shown.

element	electronegativity
aluminium	1.5
chlorine	3.0
iron	1.8

(i) Use the data to suggest the nature of the bonding in iron(III) chloride. Explain your answer.

.....  
.....  
..... [2]

(ii) Suggest an equation for the reaction between iron(III) chloride and water.

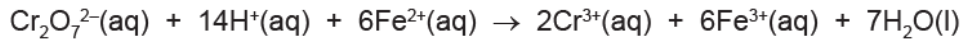
..... [1]

[Total: 10]

3. 9701/22/F/M/16/No.2

Spathose is an iron ore that contains iron(II) carbonate,  $\text{FeCO}_3$ . The percentage of iron(II) carbonate in spathose can be determined by titration with acidified potassium dichromate(VI) solution using a suitable indicator.

The ionic equation is shown below.



(a) A 5.00 g sample of spathose was reacted with excess concentrated hydrochloric acid and then filtered.

The filtrate was made up to 250 cm<sup>3</sup> in a volumetric flask with distilled water.

A 25.0 cm<sup>3</sup> sample of the standard solution required 27.30 cm<sup>3</sup> of 0.0200 mol dm<sup>-3</sup> dichromate(VI) solution for complete reaction.

(i) Calculate the amount, in moles, of dichromate(VI) ions used in the titration.

amount = ..... mol [1]

(ii) Use your answer to (i) to calculate the amount, in moles, of  $\text{Fe}^{2+}$  present in the 25.0 cm<sup>3</sup> sample.

amount = ..... mol [1]

(iii) Use your answer to (ii) to calculate the amount, in moles, of  $\text{Fe}^{2+}$  present in the 250 cm<sup>3</sup> volumetric flask.

amount = ..... mol [1]

(iv) Use your answer to (iii) to calculate the mass of iron(II) carbonate present in the sample of spathose.

mass = ..... g [2]

(v) Calculate the percentage of iron(II) carbonate in the sample of spathose.

percentage of iron(II) carbonate = ..... % [1]

(b) Iron ores containing iron(III) compounds can be analysed using a similar method.

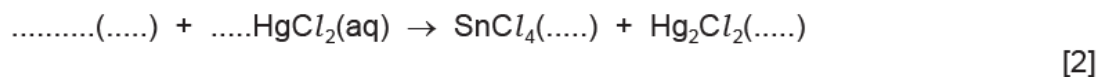
A standard solution of an aqueous iron(III) compound is reacted with aqueous tin(II) chloride. Aqueous tin(IV) chloride and aqueous iron(II) chloride are the products of this reaction.

(i) Write an ionic equation for this reaction. Do not include state symbols.

..... [2]

(ii) Any excess tin(II) chloride can be removed by reaction with  $\text{HgCl}_2(\text{aq})$ . A white precipitate of  $\text{Hg}_2\text{Cl}_2$  is produced.

Complete the equation for this reaction.



[Total: 10]