1. Nov/2022/Paper_41/No.3

   Data should be selected from Table 3.1 in order to answer some parts of this question.

   **Table 3.1**

electrode reaction	$E^{\ominus}$ / V
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$2HOCl + 2H^+ + 2e^- \rightleftharpoons Cl_2 + 2H_2O$	+1.64
$ClO^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.15
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	−0.14
$V^{2+} + 2e^- \rightleftharpoons V$	−1.20
$V^{3+} + e^- \rightleftharpoons V^{2+}$	−0.26
$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	+0.34
$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$	+1.00

   (a) Standard electrode potentials are measured under standard conditions.

   (i) Describe the standard conditions used in the Sn^{4+}/Sn^{2+} half-cell.

   ....

   .... [1]

   (ii) Complete the diagram below to show how $E^{\ominus}$ (Sn^{4+}/Sn^{2+}) can be measured experimentally. Your diagram should be fully labelled to identify all apparatus and substances.
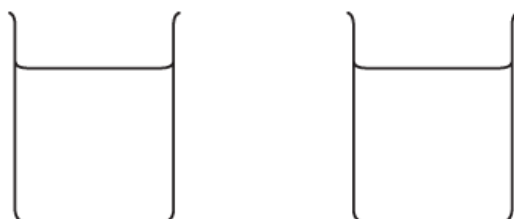
   [3]

(iii) Equal volumes of $1.0\,mol\,dm^{-3}$ $Sn^{2+}(aq)$ and $1.0\,mol\,dm^{-3}$ $Cl^-(aq)$ are mixed.

Use relevant $E^{\ominus}$ values to explain whether a reaction occurs between these two ions.

....

....

....

.... [2]

(iv) Equal volumes of $1.0\,mol\,dm^{-3}$ of $Sn^{2+}(aq)$ and acidified $1.0\,mol\,dm^{-3}$ $VO^{2+}(aq)$ are mixed.

Write an equation for the reaction that takes place in the resulting mixture.

.... [2]
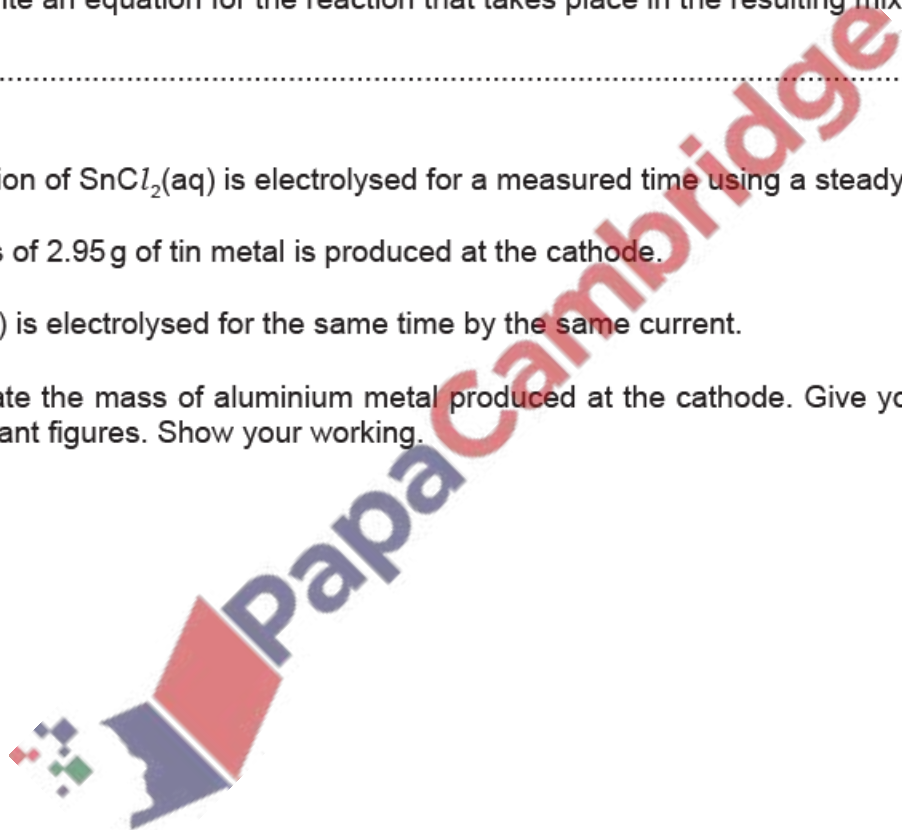
(b) A solution of $SnCl_2(aq)$ is electrolysed for a measured time using a steady current.

A mass of 2.95 g of tin metal is produced at the cathode.

$Al_2O_3(l)$ is electrolysed for the same time by the same current.

Calculate the mass of aluminium metal produced at the cathode. Give your answer to **three** significant figures. Show your working.

mass of aluminium metal = ... g [2]

[Total: 10]

2. Nov/2022/Paper_42/No.3

Data should be selected from Table 3.1 in order to answer some parts of this question.

Table 3.1

electrode reaction	$E^\ominus / V$
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2.38
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	-1.18
$Mn^{3+} + e^- \rightleftharpoons Mn^{2+}$	$+1.49$
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	$+1.23$
$MnO_4^- + e^- \rightleftharpoons MnO_4^{2-}$	$+0.56$
$MnO_4^- + 4H^+ + 3e^- \rightleftharpoons MnO_2 + 2H_2O$	$+1.67$
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	$+1.52$

(a) An electrochemical cell can be constructed from a Mg^{2+}/Mg half-cell and a MnO_4^-/Mn^{2+} half-cell. The standard cell potential of this cell can be calculated using the standard electrode potentials of the two half-cells.

(i) Define standard electrode potential. Include details of the standard conditions used.
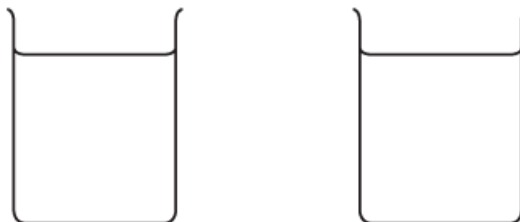
....

....

....

.... [2]

(ii) Complete the diagram below to show an electrochemical cell constructed from a Mg^{2+}/Mg half-cell and a MnO_4^-/Mn^{2+} half-cell.
Label your diagram.

[3]

(iii) Use a positive (+) sign and a negative (−) sign to identify the polarity of each of the two electrodes in your diagram.
Use an arrow and the symbol 'e' to show the direction of electron flow in the external circuit. [1]

(iv) Calculate the standard cell potential, $E^{\ominus}_{cell}$, of this cell.

$E^{\ominus}_{cell}$ = ... V [1]

(v) Construct an equation for the cell reaction.

.... [1]

(vi) Predict how the cell reaction will change, if at all, when the solution in the Mg^{2+}/Mg half-cell is diluted by the addition of a large volume of water. Explain your answer.

....

....

.... [1]

(b) A molten magnesium salt is electrolysed for 15.0 minutes by a constant current.

4.75×10^{22} magnesium atoms are produced at the cathode.

Calculate the value of the current used.

current = ... A [2]

[Total: 11]