

A Level Chemistry B (Salters)
H433/02 Scientific literacy in chemistry

Question Set 13

1

Chlorine is made by electrolysis of sodium chloride solution.

Sodium chlorate(V) is made by letting the chlorine react with the hydroxide ions that are also produced.

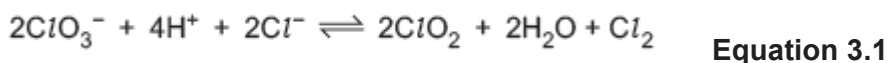
- (a) When chlorine reacts with hot hydroxide ions, part of the chlorine is oxidised to chlorate(V) and the rest of the chlorine is reduced to chloride.

Use oxidation states to balance the equation for the reaction.



[2]

- (b) (i) ClO_2 can be made by reacting ClO_3^- with concentrated hydrochloric acid.



ClO_2 is used for water purification and for bleaching the pulp used to make paper.

Table 3.1 shows some electrode potential data.

Half-reaction	E^\ominus/V
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$ClO_3^-(aq) + 2H^+(aq) + e^- \rightleftharpoons ClO_2(aq) + H_2O(l)$	+1.15
$Cl_2(aq) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36

Table 3.1

The forward reaction in **equation 3.1** does **not** occur under standard conditions.

Use data from **Table 3.1** to explain why.

[2]

- (ii) Suggest why the forward reaction in **equation 3.1** **does** occur in the presence of concentrated hydrochloric acid.
- (c) (i) A student investigates the reactions of some halogen compounds using the data in **Table 3.1**.

[2]

Half-reaction	E^\ominus/V
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$ClO_3^-(aq) + 2H^+(aq) + e^- \rightleftharpoons ClO_2(aq) + H_2O(l)$	+1.15
$Cl_2(aq) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36

Table 3.1

The student uses a $Cu^{2+}(aq)/Cu(s)$ half-cell to confirm the E^\ominus of a $Cl_2(aq)/Cl^-(aq)$ half-cell.

Complete and label the diagram of the apparatus the student would set up.
 Show state symbols.
 Indicate how standard conditions are achieved.



[4]

(ii) Give the value of E°_{cell} for the cell in (c)(i).

$E^{\circ}_{\text{cell}} = \dots\dots\dots \text{V}$

[1]

(iii) State where the electrons move and which way they are moving when the cell delivers a current.

[1]

(iv) A standard hydrogen electrode is used to measure E° values, such as those in **Table 3.1**.

Give the half-cell reaction that occurs at a hydrogen electrode.

Show state symbols.

[1]

(v) The E value for the copper electrode at 298K varies with the concentration of copper ions. The equation for this is shown below.

$$E = E^{\circ} + 0.0128 \ln [\text{Cu}^{2+}]$$

Calculate the E value for a copper electrode where $[\text{Cu}^{2+}] = 0.010 \text{ mol dm}^{-3}$.

$E = \dots\dots\dots \text{V}$ [2]

(d) (i) From data in **Table 3.1**, the student knows that chlorine reacts with iodide ions in aqueous solution.

Write an equation for the reaction that occurs.

[1]

(ii) **Name** the reducing agent in your reaction in (d)(i).

[1]

(iii) What will be **seen** when the reaction in (d)(i) occurs?

[1]

(iv) Explain, in terms of electrons, why chlorine is more reactive than iodine.

[1]

- (e) The student uses a simple apparatus to prepare a test-tube full of hydrogen chloride gas in the laboratory.

Draw a diagram of an apparatus the student could use, labelling the reactants.

[2]

Total Marks for Question Set 13: 21

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