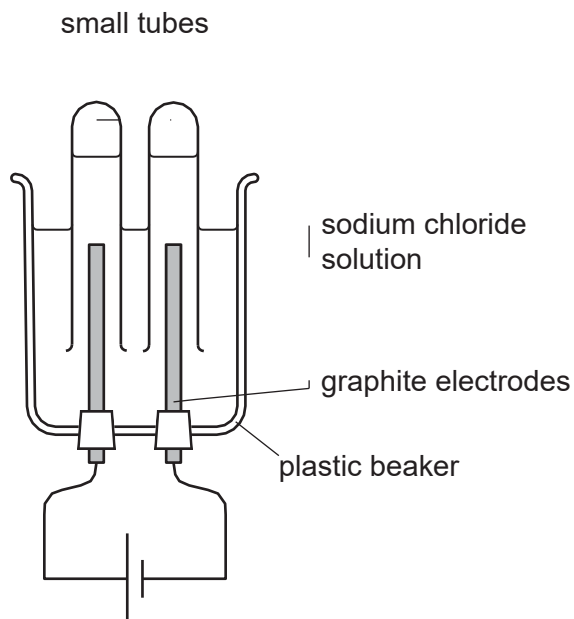# AS Level Chemistry B

H033/02 Chemistry in depth

Question Set 10

1 Chlorine is obtained by the electrolysis of aqueous sodium chloride.

(a) A student investigates the electrolysis of aqueous sodium chloride in the laboratory using the apparatus shown below.

small tubes

sodium chloride solution

graphite electrodes

plastic beaker

The student observes bubbles of gas at both the anode (+) and the cathode (−).

Write half-equations for the reactions occurring at each electrode.
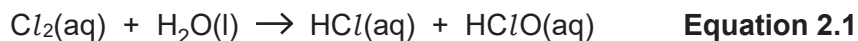
Anode (+)

Cathode (−)

[2]

(b) One use of chlorine is in water treatment.

Chlorine reacts with water to form chloric(I) acid, HCl O, as in **equation 2.1**.

The HClO kills the bacteria that can cause diseases like cholera.

$Cl_2(aq) + H_2O(l) \rightarrow HCl(aq) + HClO(aq)$ **Equation 2.1**

(i) Explain what is meant by the (I) in chloric(I) acid.

.... [1]

**(ii)** Chloric(I) acid can also be produced by adding solid calcium chlorate(I) to water.

Suggest a reason why it may be preferable to use calcium chlorate(I) rather than chlorine for treating drinking water.

.... **[2]**

(c) (i) Chlorine is also used to sterilise swimming pool water.

An analytical chemist uses a titration to find out the amount of chlorine in a sample of swimming pool water.

The chemist takes a 25.0 cm^3 sample of water and treats it with an excess of potassium iodide solution. The equation for this reaction is shown in **equation 2.2**.

$$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq) \qquad \textbf{Equation 2.2}$$
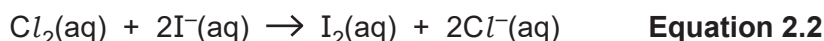
The chemist then titrates the treated sample with 0.000100 mol dm^{-3} sodium thiosulfate solution to find out how much iodine has formed. The equation for this reaction is shown in **equation 2.3**.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq) \qquad \textbf{Equation 2.3}$$
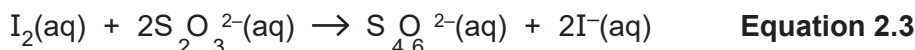
The chemist obtains a mean titre of 12.4 cm^3.

Use this information to calculate the concentration of Cl_2, in mol dm^{-3}, in the sample of swimming pool water.

Give your answer to an **appropriate** number of significant figures.

Assume Cl_2 is the only substance in the water that oxidises iodide ions.

concentration of Cl_2 = ... mol dm^{-3} **[4]**

**(ii)** A student is asked to write a detailed plan for the titration carried out by the chemist. The student writes:

1 Use a measuring cylinder to transfer 25 cm^3 of swimming pool water to a 250 cm^3 conical flask.
2 Rinse out a burette with de-ionised water and fill it with the 0.000100 mol dm^{-3} solution of sodium thiosulfate, and ensure that the space below the tap is filled.
3 Record the initial burette reading to the nearest 0.1 cm^3.
4 Add excess potassium iodide solution to the solution in the conical flask.
5 Add a few drops of starch indicator.
6 Titrate until the blue-black colour of the starch indicator just disappears.
7 Repeat until titres agree within 0.1 cm^3.

Identify and correct the mistakes that the student has made.

.... **[3]**

(d) Bromine can be extracted from seawater. One method of making bromine involves reactingchlorine gas with acidified seawater that contains bromide ions.

$$Cl_2(aq) + 2Br^-(aq) \rightarrow Br_2(aq) + 2Cl^-(aq) \qquad \textbf{Equation 2.4}$$
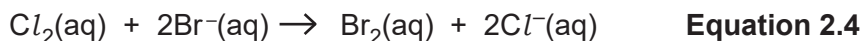
The bromine that is produced is then reacted with sulfur dioxide and water.
The reaction that occurs is a redox process.

$$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4{}^{2-} + 4H^+ \qquad \textbf{Equation 2.5}$$
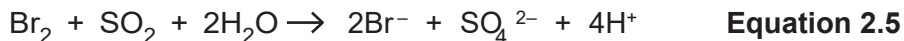
Give the formula of the reducing agent in the reaction shown in **equation**

**2.5**.Explain your answer in terms of oxidation states.

Reducing agent ....

Explanation ....
[1]

(e) The solution containing bromide ions is then treated with chlorine and steam before thebromine produced is separated by fractional distillation.

Describe the state and appearance at room temperature of the bromine that is collected at the end of this process. **[1]**

(f) **(i)** A student is given a solution of bromide ions.

The student adds acidified silver nitrate to the solution of bromide

ions.

$$Ag^+ + Br^- \rightarrow AgBr$$
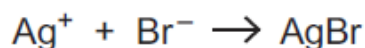
Describe what the student sees.

.... **[1]**

(ii) A solution of sodium bromide has a concentration of $0.0260\,mol\,dm^{-3}$.
$25.0\,cm^3$ of this solution are mixed with an excess of silver nitrate solution.
$0.118\,g$ of silver bromide is obtained.

Calculate the percentage yield of silver bromide.

percentage yield of AgBr = ... % **[3]**

Total Marks for Question Set 10: 18