HL Paper 3

Discuss the production of chlorine and sodium hydroxide from brine using a membrane cell. Include in your answer the materials used for the electrodes, the equations taking place at each electrode and why this method has replaced the mercury cell.

A fuel cell is an energy conversion device that generates electricity from a spontaneous redox reaction.

a. The *Geobacter* species of bacteria can be used in microbial fuel cells to oxidise aqueous ethanoate ions, [2]

$CH_3COO^-(aq)$, to carbon dioxide gas.

State the half-equations for the reactions at both electrodes.

Negative electrode (anode):

. . . . . .

Positive electrode (cathode):

. . . . . .

b. A concentration cell is an example of an electrochemical cell. [3]

(i) State the difference between a concentration cell and a standard voltaic cell.

(ii) The overall redox equation and the standard cell potential for a voltaic cell are:

$$Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Zn^{2+}\ (aq) + Cu\ (s) \quad E^{\theta}_{cell} = +1.10\ V$$

Determine the cell potential E at 298 K to three significant figures given the following concentrations in mol dm^{-3}:

$$[Zn^{2+}] = 1.00 \times 10^{-4} \qquad [Cu^{2+}] = 1.00 \times 10^{-1}$$

Use sections 1 and 2 of the data booklet.

(iii) Deduce, giving your reason, whether the reaction in (b) (ii) is more or less spontaneous than in the standard cell.

c. Dye-sensitized solar cells (DSSC) convert solar energy into electrical energy. [4]

(i) Describe how a DSSC converts sunlight into electrical energy.

(ii) Explain the role of the electrolyte solution containing iodide ions, I^-, and triiodide ions, I_3^-, in the DSSC.