AQA – Electrode potentials and electrochemical cells – A2 Chemistry P1

1. June/ 2020/Paper_1/No.11

1 1 This question is about a glucose–oxygen fuel cell.

When the cell operates, the glucose ($C_6H_{12}O_6$) molecules react with water at the negative electrode to form carbon dioxide and hydrogen ions.

Oxygen gas reacts with hydrogen ions to form water at the positive electrode.

1 1 . 1 Deduce the half-equation for the reaction at the negative electrode.

[1 mark]

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1 1 . 2 Deduce the half-equation for the reaction at the positive electrode.

[1 mark]

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1 1 . 3 Give the equation for the overall reaction that occurs in the Glucose–oxygen fuel cell.

[1 mark]

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1 1 . 4 The negative electrode is made of carbon and the positive electrode is made of platinum.

Give the conventional representation for the glucose–oxygen fuel cell.

[2 marks]

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1 1 . 5 State what must be done to maintain the EMF of this fuel cell when in use.

[1 mark]

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2. June/ 2021/Paper_1/No.8

0 8 This question is about electrode potentials and electrochemical cells.

0 8 . 1 State the meaning of the term electrochemical series.

[1 mark]

Table 8 shows some electrode potentials.

Table 8

	$E^{\ominus}$ / V
$[Fe(H_2O)_6]^{2+}(aq) + 2e^- \rightarrow Fe(s) + 6\,H_2O(l)$	–0.44
$H^+(aq) + e^- \rightarrow \frac{1}{2}\,H_2(g)$	0.00
$[Co(NH_3)_6]^{3+}(aq) + e^- \rightarrow [Co(NH_3)_6]^{2+}(aq)$	+0.11
$[Fe(H_2O)_6]^{3+}(aq) + e^- \rightarrow [Fe(H_2O)_6]^{2+}(aq)$	+0.77
$VO_2^+(aq) + 2\,H^+(aq) + e^- \rightarrow VO^{2+}(aq) + H_2O(l)$	+1.00
$[Co(H_2O)_6]^{3+}(aq) + e^- \rightarrow [Co(H_2O)_6]^{2+}(aq)$	+1.81

0 8 . 2 State **two** conditions needed for the following half-cell to have $E^{\ominus} = 0.00$ V

$$H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$$

[1 mark]

0 8 . 3 Identify the weakest reducing agent in **Table 8**.

[1 mark]

0 8 . 4 Use half-equations from **Table 8** to deduce an equation for the reduction of VO_2^+ to form VO^{2+} in aqueous solution by iron.

[2 marks]

0 8 . 5 Use data from **Table 8** to explain why $[Co(H_2O)_6]^{3+}(aq)$ will undergo a redox reaction with $[Fe(H_2O)_6]^{2+}(aq)$

Give an equation for this reaction.

[2 marks]

Explanation

Equation

0 8 . 6 Suggest why the **two** cobalt(III) complex ions in **Table 8** have different electrode potentials.

[1 mark]

3. June/ 2021/Paper_1/No.9

0 9 This question is about the development of lithium cells.
The value of $E^{\ominus}$ for lithium suggests that a lithium cell could have a large EMF.

Table 9 shows some electrode potential data.

Table 9

	$E^{\ominus}$ / V
$Li^+(aq) + e^- \rightarrow Li(s)$	–3.04
$2\,H_2O(l) + 2\,e^- \rightarrow H_2(g) + 2\,OH^-(aq)$	–0.83
$\frac{1}{2}\,I_2(s) + e^- \rightarrow I^-(aq)$	+0.54

0 9 . 1 Use data in **Table 9** to explain why an aqueous electrolyte is **not** used for a lithium cell.

[2 marks]

0 9 . 2 In the 1970s lithium-iodine cells became a common power source for heart pacemakers. Lithium iodide is the final product of the cell reaction.

Use the data in **Table 9** to calculate the cell EMF of a standard lithium-iodine cell.

[1 mark]

0 9 . 3 An EMF value for a commercial lithium-iodine cell is 2.80 V

Suggest why this value is different from the value calculated in Question **09.2**.

[1 mark]

0 9 . 4 In some lithium cells, lithium perchlorate ($LiClO_4$) is used as the electrolyte.

Deduce the oxidation state of chlorine in $LiClO_4$

[1 mark]

In other lithium cells, lithium cobalt oxide electrodes **and** lithium electrodes are used.

0 9 . 5 Give an equation for the reaction that occurs at the positive lithium cobalt oxide electrode.

[1 mark]

0 9 . 6 Give an equation for the reaction that occurs at the negative lithium electrode.

[1 mark]