InkChemistry

QUESTION WORKBOOK

Commercial cells, rechargeable cells and fuel cells

Electrochemistry · Unit C10

AQA 3.1.11.2 · OCR A 5.2.3

18 questions · 68 marks

NAVY SCREEN EDITION

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SECTION B · Standard, 3 to 5 marks

B1 CCR-Q1

Give the half-equation at each electrode of a lithium-ion cell during discharge, and at each electrode while it is being charged. [4]

B2 CCR-Q2

Calculate the EMF of a lithium iron phosphate cell, write the overall equation for its discharge, and deduce the change in the oxidation state of iron. $FePO_4(s) + Li^+ + e^- \rightarrow LiFePO_4(s)$, E = +0.41 V; $Li^+ + e^- \rightarrow Li(s)$, E = -3.04 V. [4]

B3 CCR-Q4

Complete the half-equations for the hydrogen–oxygen fuel cell with an acidic electrolyte, $H_2(g) \rightarrow$ … and $O_2(g)$ + … $\rightarrow 2H_2O(l)$, and explain why this cell has the same EMF as the alkaline cell. [4]

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B4 CCR-Q5 Calculate the EMF of a hydrazine fuel cell with an alkaline electrolyte, and write the overall equation for its reaction. $N_2(g) + 4H_2O(l) + 4e^- \rightarrow N_2H_4(aq) + 4OH^-(aq)$, $E^\circ = -1.16$ V; $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$, $E^\circ = +0.40$ V. [4]

B5 CCR-Q6 Calculate the mass of silver deposited at the cathode when a current of 0.250 A is passed through silver nitrate solution for 40.0 minutes. $F = 96\,500$ C mol^{-1}; $Ar(Ag) = 107.9$. [4]

B6 CCR-Q7 Deduce the overall equation for the discharge of a lead–acid cell from its electrode half-equations, $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$ and $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$, and explain why the density of the acid falls as the cell discharges. [4]

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B7 CCR-Q8 Calculate the EMF of a silver oxide–zinc button cell, and write the overall equation for its discharge. $Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$, $E^\circ = +0.34$ V; $ZnO(s) + H_2O(l) + 2e^- \rightarrow Zn(s) + 2OH^-(aq)$, $E^\circ = -1.26$ V. [4]

B8 CCR-Q12 Explain why electrolysis of concentrated sodium chloride solution with inert electrodes gives chlorine at the anode, whereas very dilute sodium chloride solution gives mostly oxygen. Include an equation for each anode reaction. [4]

B9 CCR-Q16 Describe two benefits and two risks to society of the use of lithium-ion cells. [4]

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B10 CCR-Q17 Compare a rechargeable cell with a fuel cell, and explain why a fuel cell does not need to be electrically recharged. [4]

B11 CCR-Q19 Calculate the EMF of a direct ethanol fuel cell with an acidic electrolyte, write its overall equation, and show that the twelve electrons match the change in the oxidation state of carbon. $2CO_2(g) + 12H^+(aq) + 12e^- \rightarrow C_2H_5OH(l) + 3H_2O(l)$, $E^\circ = +0.09$ V; $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$, $E^\circ = +1.23$ V. [4]

B12 CCR-Q3 Give the half-equations for the hydrogen–oxygen fuel cell with an alkaline electrolyte, and the overall equation. [3]

B13 CCR-Q10 Explain why a lithium-ion cell can be recharged but a zinc–carbon cell cannot. [3]

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B14 CCR-Q13 Suggest the half-equation at each electrode, and the overall equation, for a methanol fuel cell with an acidic electrolyte, in which methanol is oxidised to carbon dioxide and oxygen is reduced to water. [3]

B15 CCR-Q14 Suggest why the electrolyte in a lithium-ion cell is a lithium salt dissolved in an organic solvent and not an aqueous solution, and why its Li^+ ions are written without a state symbol. [3]

B16 CCR-Q15 Identify the oxidation state of cobalt in CoO_2 and in $Li^+[CoO_2]^-$, and identify the electrode reaction in which cobalt is reduced and the one in which it is oxidised. [3]

B17 CCR-Q20 Explain one advantage and two disadvantages of methanol compared with hydrogen as the fuel for a fuel cell. [3]

SECTION C · Long, 6 marks or more

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C1 Evaluate the use of hydrogen fuel cells in place of petrol engines to power cars. [6]
CCR-Q18

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