InkChemistry

ANSWER BOOK

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 EDITION

Every question in this book has a code beside its number.
Type inklearning.co.uk/q/ followed by the code to open that question online.
© 2026 Ink Learning Ltd. All rights reserved.
inklearning.co.uk/chemistry/

SECTION B · Standard, 3 to 5 marks

B1 CCR-Q1

B1 discharge, negative electrode: $Li \rightarrow Li^+ + e^-$. **B1** discharge, positive electrode: $Li^+ + CoO_2 + e^- \rightarrow Li^+[CoO_2]^-$ (allow $LiCoO_2$). **B1** charging, positive electrode: $Li^+[CoO_2]^- \rightarrow Li^+ + CoO_2 + e^-$. **B1** charging, negative electrode: $Li^+ + e^- \rightarrow Li$; ignore state symbols. [4]

B2 CCR-Q2

B1 $Li(s) + FePO_4(s) \rightarrow LiFePO_4(s)$, the lithium half-equation reversed and the two added. **B1** iron goes from +3 in $FePO_4$ to +2 in $LiFePO_4$, so it is reduced at the positive electrode. **M1** the iron phosphate electrode is more positive and on the right: EMF = (+0.41) - (-3.04). **A1** EMF = +3.45 V. [4]

B3 CCR-Q4

B1 $H_2(g) \rightarrow 2H^+(aq) + 2e^-$ at the negative electrode. **B1** $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ at the positive electrode. **B1** both cells have the same overall reaction, $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. **B1** changing from acid to alkali lowers both electrode potentials by the same 0.83 V, so their difference, the EMF, is 1.23 V in both. [4]

B4 CCR-Q5

M1 the oxygen electrode has the more positive E°, so it is the positive electrode, on the right. **B1** the hydrazine half-equation is reversed and the two added; hydroxide ions and two waters cancel. **B1** $N_2H_4(aq) + O_2(g) \rightarrow N_2(g) + 2H_2O(l)$. **A1** EMF = (+0.40) - (-1.16) = +1.56 V. [4]

B5 CCR-Q6

M1 t = 40.0 × 60 = 2400 s, so Q = It = 0.250 × 2400 = 600 C. **M1** moles of electrons = Q/F = 600 ÷ 96 500 = 6.22×10^{-3} mol. **M1** $Ag^+(aq) + e^- \rightarrow Ag(s)$, so n = 1 and moles of silver = 6.22×10^{-3} mol. **A1** mass = $6.22 \times 10^{-3} \times 107.9$ = 0.671 g, to three significant figures; allow error carried forward. [4]

B6 CCR-Q7

B1 both half-equations carry two electrons, so they add directly. **B1** $Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$. **B1** sulfate ions and hydrogen ions leave the solution, the sulfate as solid lead(II) sulfate on both plates. **B1** water is formed, so the sulfuric acid becomes more dilute and its density falls. [4]

B7 CCR-Q8

M1 the silver oxide electrode is more positive, so it is the positive electrode, on the right. **M1** EMF = (+0.34) - (-1.26). **B1** the zinc half-equation is reversed and the two added, giving $Zn(s) + Ag_2O(s) \rightarrow ZnO(s) + 2Ag(s)$. **A1** EMF = +1.60 V. [4]

B8 CCR-Q12

B1 chloride ions and water molecules compete to be oxidised at the anode. **B1** in concentrated solution $[Cl^-]$ is high and chloride is oxidised: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$. **B1** in dilute solution $[Cl^-]$ is low, so $Cl_2 + 2e^- \rightleftharpoons 2Cl^-$ shifts right and chloride is harder to oxidise, while water is always present in large amount. **B1** water is oxidised instead: $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$; allow $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$. [4]

© 2026 Ink Learning Ltd. All rights reserved.

B9 CCR-Q16 **B1** a high energy for its mass, which makes phones, laptops and electric cars practical. **B1** recharged hundreds of times, giving less waste than non-rechargeable cells. **B1** the electrolyte contains a flammable organic solvent, so a damaged or overcharged cell can overheat and catch fire. **B1** mining lithium and cobalt causes environmental damage and can involve unsafe working conditions, and spent cells are hard to recycle. [4]

B10 CCR-Q17 **B1** both produce an electric current from a feasible redox reaction at two electrodes. **B1** a rechargeable cell holds its reactants inside and regenerates them when an external supply drives the reaction in reverse. **B1** in a fuel cell the reactants, a fuel and oxygen, are supplied continuously from outside the cell. **B1** the products leave and the electrodes and electrolyte are not used up, so it is refuelled and never recharged. [4]

B11 CCR-Q19 **B1** $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$, with the oxygen half-equation tripled. **B1** carbon averages -2 in ethanol and is +4 in CO_2, a rise of 6 for each of two carbons, which is twelve electrons. **M1** the oxygen electrode is more positive and on the right: EMF = (+1.23) - (+0.09). **A1** EMF = +1.14 V. [4]

B12 CCR-Q3 **B1** negative electrode: $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$; reject $H_2 \rightarrow 2H^+ + 2e^-$. **B1** positive electrode: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$. **B1** overall: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. [3]

B13 CCR-Q10 **B1** in a lithium-ion cell the products of discharge stay on the electrodes as solids, $Li^+[CoO_2]^-$ at the positive electrode. **B1** an external supply with a voltage greater than the EMF drives both electrode reactions in reverse and regenerates the reactants. **B1** in a zinc–carbon cell the zinc case is used up and the products spread away from the electrodes, so the reactants cannot be regenerated. [3]

B14 CCR-Q13 **B1** negative electrode: $CH_3OH(l) + H_2O(l) \rightarrow CO_2(g) + 6H^+(aq) + 6e^-$. **B1** positive electrode: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$. **B1** overall: $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$. [3]

B15 CCR-Q14 **B1** lithium is a very strong reducing agent and reacts with water, releasing hydrogen. **B1** an aqueous electrolyte would react with the negative electrode, and a cell EMF of about 3.6 V would also decompose the water. **B1** the ions are dissolved in an organic solvent, not water, so (aq) would be wrong. [3]

B16 CCR-Q15 **B1** cobalt is +4 in CoO_2 and +3 in $Li^+[CoO_2]^-$. **B1** cobalt is reduced at the positive electrode during discharge, $Li^+ + CoO_2 + e^- \rightarrow Li^+[CoO_2]^-$. **B1** cobalt is oxidised at the same electrode during charging, $Li^+[CoO_2]^- \rightarrow Li^+ + CoO_2 + e^-$. [3]

© 2026 Ink Learning Ltd. All rights reserved.

B17 CCR-Q20 **B1** methanol is a liquid at room temperature, so it is stored and carried in an ordinary tank without high pressure or very low temperature. **B1** the cell releases carbon dioxide at the point of use, and most methanol is made from natural gas. **B1** carbon monoxide formed during the oxidation poisons the platinum catalyst, or methanol crossing the membrane lowers the voltage, or methanol is toxic. [3]

SECTION C · Long, 6 marks or more

C1 CCR-Q18 **Indicative content** [6]

B1 the only product at the point of use is water, so the car emits no carbon dioxide, carbon monoxide or nitrogen oxides. **B1** a fuel cell converts a larger fraction of the fuel's energy into useful work than combustion in an engine, because it does not go through heat. **B1** the cell is refuelled in minutes, like a petrol car, and needs no electrical recharging from a supply. **B1** hydrogen is flammable and has a low density, so it must be stored at high pressure or as a liquid at very low temperature. **B1** most hydrogen is made from methane by steam reforming, releasing carbon dioxide, and electrodes need an expensive platinum catalyst. **B1** a judgement: the overall benefit depends on how the hydrogen is made, and is large only if it comes from electrolysis using renewable electricity.

Levels

Level 3 (5–6 marks) advantages and disadvantages are both covered with the chemistry behind each: water as the only product at the point of use, the efficiency and quick refuelling, the storage problem, the carbon dioxide from steam reforming and the platinum cost, with a judgement that depends on how the hydrogen is made.

Level 2 (3–4 marks) two advantages and a drawback are given with some chemistry, and a conclusion; where the hydrogen comes from, or how it is stored, is not raised, or the judgement does not follow.

Level 1 (1–2 marks) fuel cells are called pollution-free because they make only water, with no thought for how the hydrogen is made or stored.

© 2026 Ink Learning Ltd. All rights reserved.

THIS BOOK ONLINE



Scan the code, or type the address, to open the questions in this book online:

inklearning.co.uk/chemistry/practise/questions/cells-and-fuel-cells/

© 2026 Ink Learning Ltd. All rights reserved.