

OCR A-Level Chemistry A

Redox and electrode potentials

Questions only

The newest questions, about an hour. All 18 are in the exam generator.

Questions

9

Total marks

44

Time allowed

59 min

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the OCR Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2019 P1 Q15	1	
2	2022 P3 Q2	13	
3	2023 P1 Q12	1	
4	2025 P1 Q10	1	
5	2025 P1 Q11	1	
6	2025 P1 Q20	9	
7	2025 P3 Q5	16	
8	2020 P1 Q12	1	
9	2021 P1 Q12	1	

Total _____ / 44 Percentage _____ %

Questions from OCR past papers, 2019–2025, reproduced for revision. Practise these topics online, with instant marking:

whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/?topics=redox-and-electrode-potentials&len=0

Questions

Redox and electrode potentials · 9 questions · 44 marks · time allowed 59 min

Q1 · June 2019 · Paper 1 (Periodic table, elements and physical chemistry) · Q15 · [1 mark]

Four redox systems relevant to hydrogen–oxygen fuel cells are shown below.

		$E^\ominus/\text{V}$
$\text{H}_2\text{O}(\text{l}) + \text{e}^- \rightleftharpoons$	$\text{OH}^-(\text{aq}) + \frac{1}{2}\text{H}_2(\text{g})$	-0.83
$\text{H}^+(\text{aq}) + \text{e}^- \rightleftharpoons$	$\frac{1}{2}\text{H}_2(\text{g})$	0.00
$\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons$	$2\text{OH}^-(\text{aq})$	+0.40
$\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons$	$\text{H}_2\text{O}(\text{l})$	+1.23

Which statement(s) is/are correct for an alkaline hydrogen–oxygen fuel cell?

1 The reaction at the positive electrode is: $\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{O}(\text{l})$.

2 The overall cell reaction is: $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$.

3 The cell potential is 1.23 V.

Tick (✓) one box.

- ☐ **A** 1, 2 and 3
- ☐ **B** Only 1 and 2
- ☐ **C** Only 2 and 3
- ☐ **D** Only 1

Q2 · June 2022 · Paper 3 (Unified chemistry) · Q2 · [13 marks]

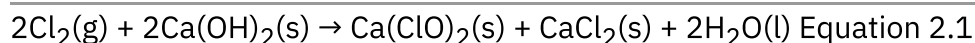
This question also needs Amount of substance.

This question is about redox reactions.

‘Calcium hypochlorite’, $\text{Ca}(\text{ClO})_2$, is an ionic compound used in ‘bleaching powder’.

The ClO^- ion in $\text{Ca}(\text{ClO})_2$ is the active ingredient that kills bacteria.

Calcium hypochlorite is prepared by reacting chlorine gas with calcium hydroxide.



2(a)(i) 420 dm³ of chlorine, measured at RTP, is reacted with an excess of Ca(OH)₂.

The solid products are dissolved in water to form 4.00 m³ of solution.

Calculate the concentration of Ca(ClO)₂(aq) in this solution, in mol dm⁻³.

Give your answer to an **appropriate** number of significant figures and in standard form.

concentration = mol dm⁻³

[3 marks]

2(a)(ii) Calcium hypochlorite, Ca(ClO)₂, is heated. The Ca(ClO)₂ decomposes to form CaCl₂ and Ca(ClO₃)₂. This is a disproportionation reaction.

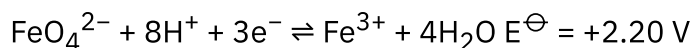
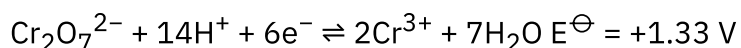
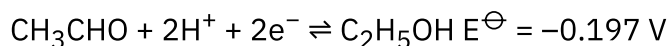
Write an equation for this decomposition and explain, using oxidation numbers, why this is a disproportionation reaction.

[3 marks]

equation

explanation

2(b) A student analyses the redox reactions shown below. State symbols have been omitted.



The student concludes that different ions containing chromium can act as oxidising or reducing agents.

Using the terms oxidising agent and reducing agent, and ideas about electrode potentials and equilibrium, explain how the student is correct.

Include overall equations.

[5 marks]

2(c) A student bubbles hydrogen sulfide gas, $\text{H}_2\text{S}(\text{g})$, through an acidified solution containing manganate(VII) ions, $\text{MnO}_4^-(\text{aq})$.

A redox reaction takes place, forming aqueous manganese(II) ions, a yellow precipitate and one other product.

Construct the equation for this reaction. State symbols are not required.

[2 marks]

Q3 · June 2023 · Paper 1 (Periodic table, elements and physical chemistry) · Q12 · [1 mark]

The equations show the electrode potentials of the half-cells used in a lithium-ion cell.

	$E^\ominus / \text{V}$
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3.04
$\text{Li}^+ + \text{CoO}_2 + \text{e}^- \rightleftharpoons \text{LiCoO}_2$	+1.16

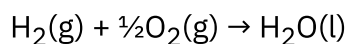
Which statement is correct in a lithium-ion cell?

Tick (✓) one box.

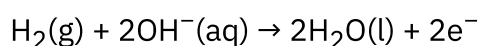
- ☐ **A** The cell potential is 2.88 V.
- ☐ **B** The reaction at the positive electrode is: $\text{LiCoO}_2 \rightarrow \text{Li}^+ + \text{CoO}_2 + \text{e}^-$
- ☐ **C** The overall cell reaction is: $\text{Li} + \text{CoO}_2 \rightarrow \text{LiCoO}_2$
- ☐ **D** The oxidation number of Co changes from +2 to +1.

Q4 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q10 · [1 mark]

The overall equation for a hydrogen–oxygen fuel cell is:



The half-equation at the negative electrode is:



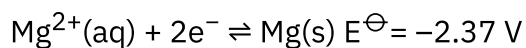
What is the half-equation at the positive electrode?

Tick (✓) one box.

- ☐ **A** $\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{e}^-$
- ☐ **B** $\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{OH}^-(\text{aq}) + 2\text{e}^-$
- ☐ **C** $\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow 2\text{OH}^-(\text{aq})$
- ☐ **D** $\text{O}_2(\text{g}) + 2\text{OH}^-(\text{aq}) + \text{H}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$

Q5 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q11 · [1 mark]

Two redox systems are shown below.



Which species is the strongest reducing agent?

Tick (✓) one box.

☐ **A** $\text{Mg}^{2+}(\text{aq})$

☐ **B** $\text{Mg}(\text{s})$

☐ **C** $\text{Pb}^{2+}(\text{aq})$

☐ **D** $\text{Pb}(\text{s})$

Q6 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q20 · [9 marks]

Standard electrode potentials for seven redox systems are shown in the table below.

Redox system	Half-equation	$E^\ominus / \text{V}$
1	$\text{V}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{V}(\text{s})$	-1.18
2	$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76
3	$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Co}(\text{s})$	-0.28
4	$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{V}^{2+}(\text{aq})$	-0.26
5	$2\text{H}^+(\text{aq}) + \text{VO}^{2+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
6	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80
7	$2\text{H}^+(\text{aq}) + \text{VO}_2^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00

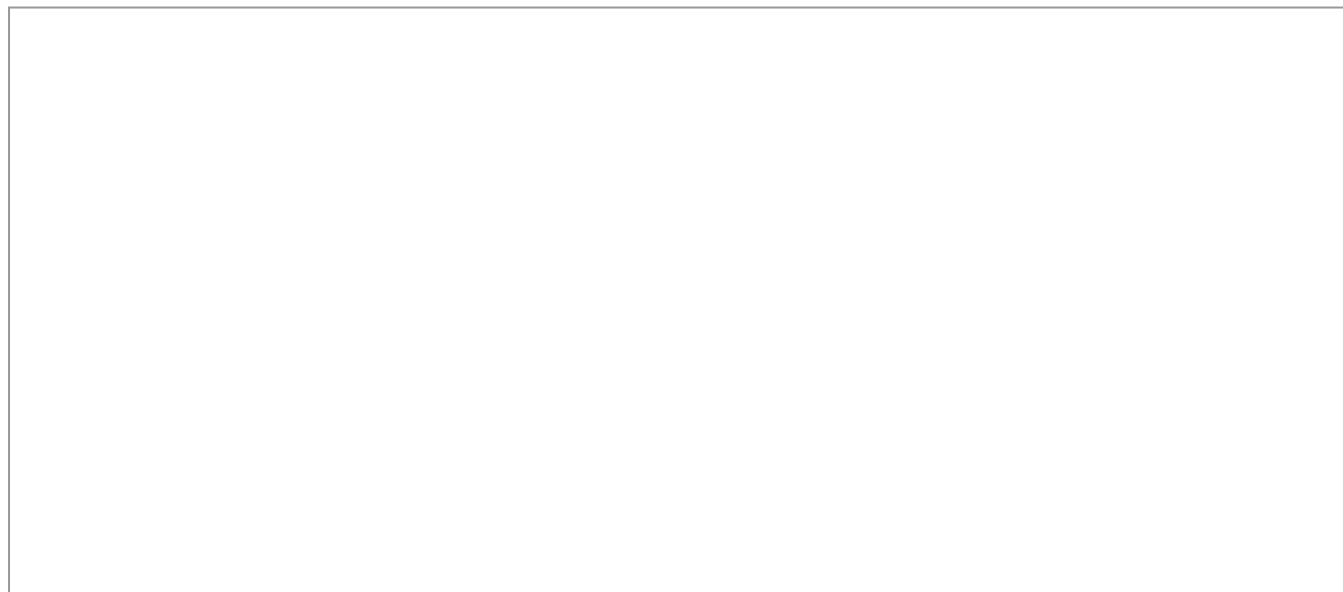
20(a)(i) A student sets up a standard cell based on redox systems **2** and **4**.

Draw a labelled diagram to show how this cell could be set up to measure its standard cell potential.

Include the conditions required to measure the standard cell potential.

standard conditions

[4 marks]



20(a)(ii) Calculate the standard cell potential of this cell.

standard cell potential = V

[1 mark]

20(b) A student predicts that cobalt metal will reduce acidified VO^{2+} ions to form V^{2+} ions in two stages.

Explain why this two-stage reduction should happen in terms of electrode potentials and equilibria shifts.

Include overall equations for the predicted reactions.

[4 marks]

Q7 · June 2025 · Paper 3 (Unified chemistry) · Q5 · [16 marks]

This question also needs Amount of substance and Carbonyls, carboxylic acids and esters.

This question is about two metal hydrides, lithium aluminium hydride, LiAlH_4 , and sodium borohydride, NaBH_4 . Both hydrides are used as reducing agents in organic chemistry.

LiAlH_4 , is a stronger reducing agent than NaBH_4 , and can reduce esters to alcohols.

A student plans to use LiAlH_4 to reduce the liquid ester, ethyl phenylmethanoate, $\text{C}_6\text{H}_5\text{COOC}_2\text{H}_5$ (density = 1.05 g cm^{-3}) to the alcohol, $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$ ($M_r = 108$).

The student uses $\text{C}_6\text{H}_5\text{COOC}_2\text{H}_5$ and LiAlH_4 (an excess) in a 1.0 : 2.5 molar ratio.

The student's method is outlined below.

Step 1	7.50 cm ³ of C ₆ H ₅ COOC ₂ H ₅ is dissolved in an organic solvent.
Step 2	LiAlH ₄ is added to the solution from Step 1. The reduction takes place.
Step 3	The mixture from Step 2 is heated with dilute aqueous acid.
Step 4	The impure C ₆ H ₅ CH ₂ OH is purified.

The student carries out this preparation and obtains 4.40 g of pure C₆H₅CH₂OH.

5(a)(i) What is the systematic name of the alcohol C₆H₅CH₂OH?

[1 mark]

5(a)(ii) Calculate the mass of LiAlH₄ that the student should use in Step 2 and the percentage yield of pure C₆H₅CH₂OH obtained in Step 4.

Give the mass of LiAlH₄ and the percentage yield of pure C₆H₅CH₂OH to **3** significant figures.

Mass of LiAlH₄ = g

Percentage yield of pure C₆H₅CH₂OH = %

[4 marks]

5(a)(iii) In the preparation, LiAlH_4 behaves as a nucleophile.

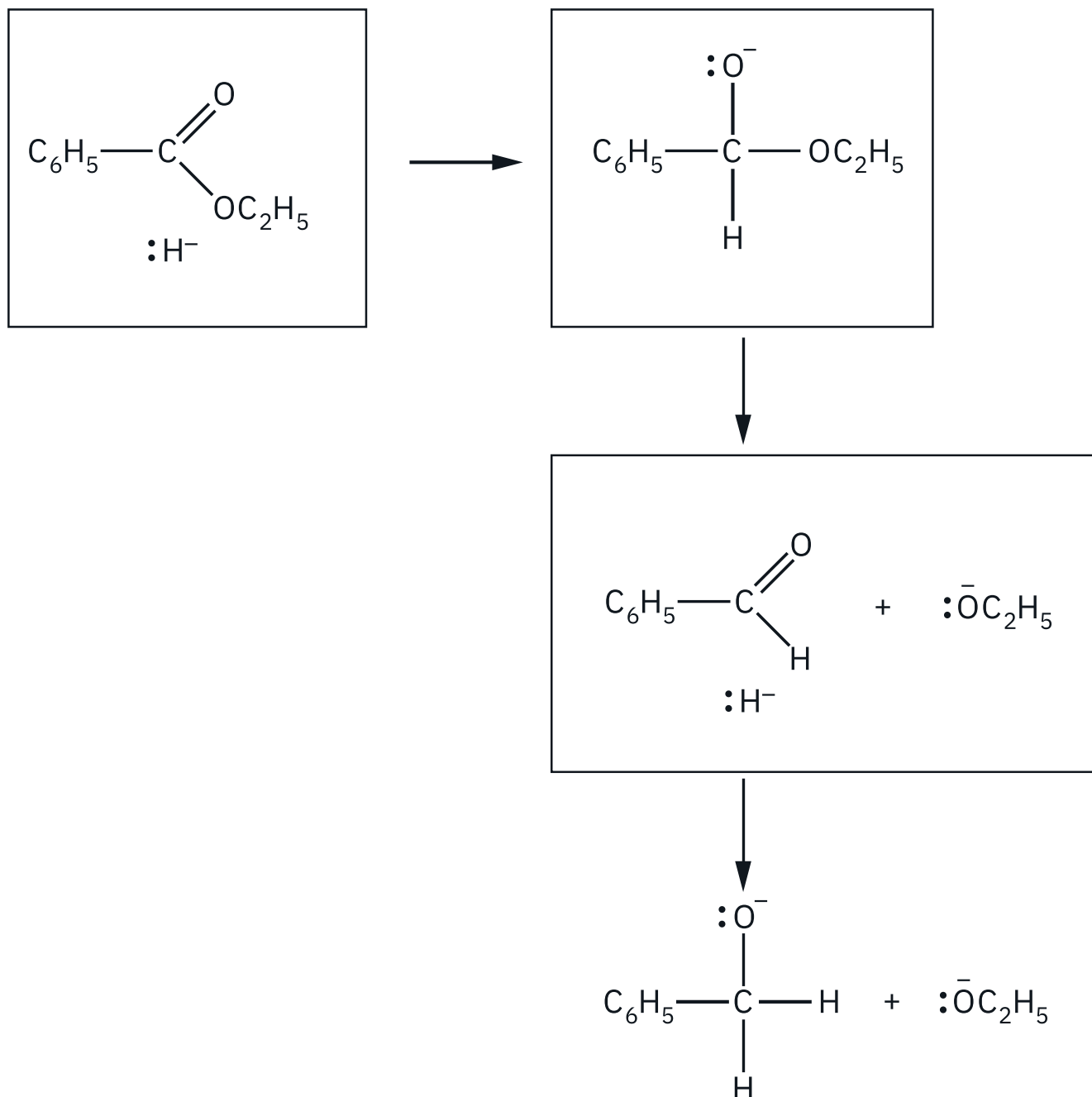
What is meant by the term **nucleophile**?

[1 mark]

5(a)(iv) The mechanism for Step 2 in the reduction of $\text{C}_6\text{H}_5\text{COOC}_2\text{H}_5$ is shown below.

In the mechanism, LiAlH_4 can be represented as H^- .

Complete the mechanism by adding curly arrows to the three boxes.



[4 marks]

Draw your answer on the figure above.

5(a)(v) Suggest why the student heated the mixture from Step 2 with dilute aqueous acid in Step 3.

[1 mark]

5(b) NaBH_4 contains Na^+ and BH_4^- ions.

Draw a 'dot-and-cross' diagram for NaBH_4 .

Use a different symbol for the electrons from each element.

Show outer electrons only.

[2 marks]

$\text{NaBH}_4 / \text{O}_2$ cells are being investigated as potential fuel cells.

- The positive electrode contains O_2 .
- The negative electrode contains NaBH_4 .

The reaction at the positive electrode and the overall cell reaction for a $\text{NaBH}_4 / \text{O}_2$ fuel cell are shown below.

Reaction at positive electrode: $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$ $E^\ominus = +0.40 \text{ V}$

Overall cell reaction: $\text{NaBH}_4 + 2\text{O}_2 \rightarrow \text{NaBO}_2 + 2\text{H}_2\text{O}$ $E^\ominus_{\text{cell}} = 1.64 \text{ V}$

5(c)(i) What is the standard electrode potential of the negative electrode in this cell?

Standard electrode potential = V

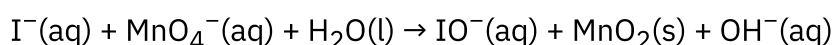
[1 mark]

5(c)(ii) Construct the equation for the reaction at the negative electrode of this cell.

[2 marks]

Q8 • November 2020 • Paper 1 (Periodic table, elements and physical chemistry) • Q12 • [1 mark]

Iodide ions, $\text{I}^-(\text{aq})$, react with $\text{MnO}_4^-(\text{aq})$. The unbalanced equation is shown below.



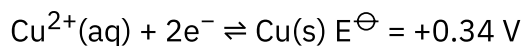
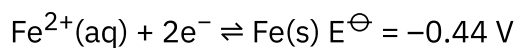
What is the ratio of $\text{MnO}_2(\text{s})$ to $\text{OH}^-(\text{aq})$ in the balanced equation?

Tick (✓) one box.

- ☐ **A** 1 : 3
- ☐ **B** 1 : 2
- ☐ **C** 1 : 1
- ☐ **D** 3 : 2

Q9 · November 2021 · Paper 1 (Periodic table, elements and physical chemistry) · Q12 · [1 mark]

Two redox systems are shown below.



Which species in the two redox systems is the strongest oxidising agent?

Tick (✓) one box.

☐ **A** $\text{Fe}^{2+}(\text{aq})$

☐ **B** $\text{Fe}(\text{s})$

☐ **C** $\text{Cu}^{2+}(\text{aq})$

☐ **D** $\text{Cu}(\text{s})$

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Mark scheme:

whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/pdf/redox-and-electrode-potentials-mark-scheme.pdf