

AQA A-Level Chemistry

Electrode potentials

Questions only

The newest questions, about an hour. All 14 are in the exam generator.

Questions

9

Total marks

44

Time allowed

57 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 AQA Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2023 A-level P1 Q8	5	
2	2023 A-level P1 Q2	5	
3	2024 A-level P3 Q17	1	
4	2022 A-level P3 Q11	1	
5	2022 A-level P3 Q12	1	
6	2024 A-level P1 Q6	10	
7	2019 A-level P3 Q13	1	
8	2025 A-level P1 Q6	9	
9	2025 A-level P3 Q3	11	

Total _____ / 44 Percentage _____ %

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

whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions?topics=electrode-potentials-cells&len=0

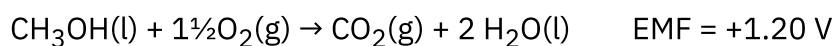
Questions

Electrode potentials · 9 questions · 44 marks · time allowed 57 min

Q1 · June 2023 · Paper 1 · Q8 · [5 marks]

This question is about fuel cells.

In a methanol–oxygen fuel cell, the overall reaction is



(a) At the positive electrode, oxygen reacts with hydrogen ions to form water.

Give a half-equation for this reaction.

[1 mark]

(b) At the negative electrode, methanol reacts with water to produce carbon dioxide and hydrogen ions.

Give a half-equation for this reaction.

[1 mark]

(c) The standard electrode potential for the $\text{CO}_2 / \text{CH}_3\text{OH}$ electrode is +0.03 V

Calculate the standard electrode potential for the $\text{O}_2 / \text{H}_2\text{O}$ electrode.

[1 mark]

(d) State why a fuel cell does not need to be electrically recharged.

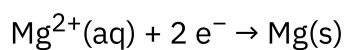
[1 mark]

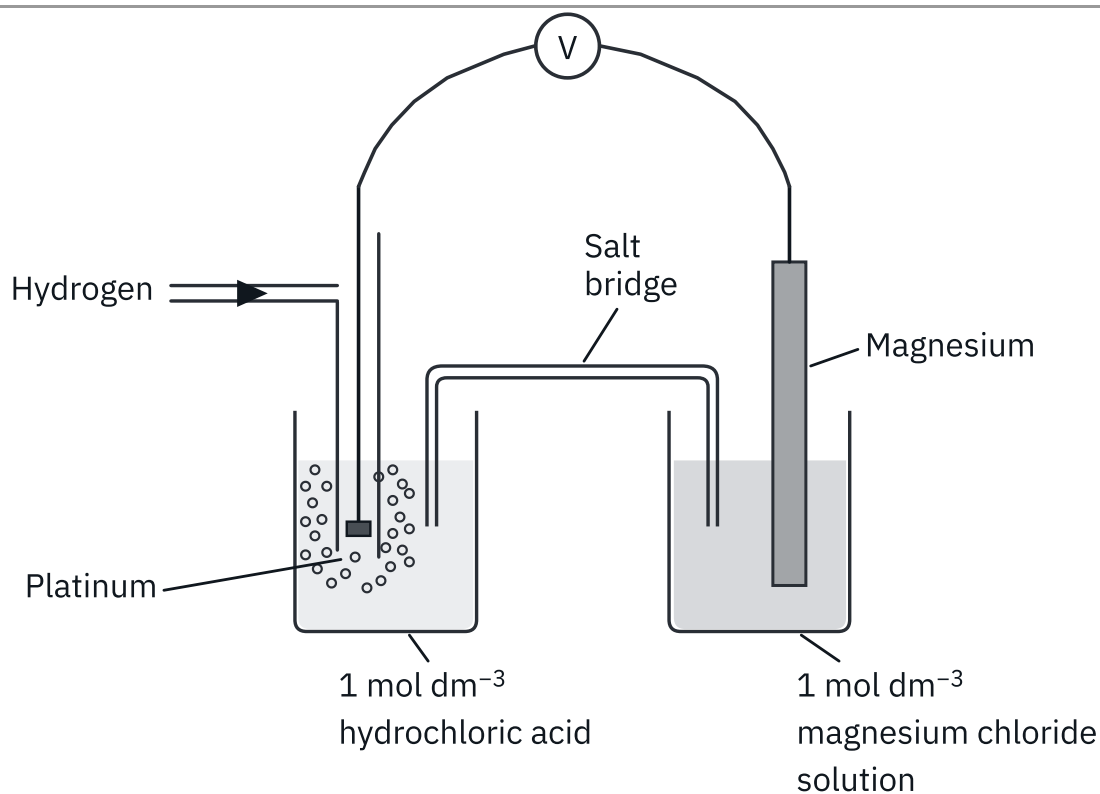
(e) Suggest one advantage of using methanol, rather than hydrogen, in a fuel cell for use in cars.

[1 mark]

Q2 · June 2023 · Paper 1 · Q2 · [5 marks]

The figure below shows a cell used to measure the standard electrode potential for the half-cell





(a) State the purpose of the salt bridge.

Identify an ionic compound that could be used in the salt bridge.

[2 marks]

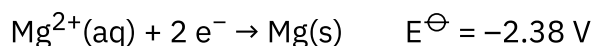
Purpose

Identity

(b) State how, if at all, the EMF of this cell will change if the surface area of the platinum electrode is increased.

[1 mark]

The standard electrode potential, $E^\ominus$ for the half-cell is shown.



(c) Water is added to the beaker containing the magnesium chloride solution.

What is the effect on the magnitude of the EMF of the cell?

Tick ✓ one box.

EMF increases	☐
EMF stays the same	☐
EMF decreases	☐

[1 mark]

(d) The voltmeter V shown in the diagram above is replaced by a bulb.

Give an equation for the overall reaction that occurs when the cell is operating.

[1 mark]

Q3 • June 2024 • Paper 3 • Q17 • [1 mark]

A cell with EMF = +2.15 V is made from two electrodes. The half-equations for the two electrodes are shown. Positive electrode: $\text{PbO}_2(\text{s}) + 3 \text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq}) + 2 \text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2 \text{H}_2\text{O}(\text{l})$

Negative electrode: $\text{PbSO}_4(\text{s}) + \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{Pb}(\text{s}) + \text{HSO}_4^-(\text{aq})$ $E^\ominus = -0.46 \text{ V}$ What is the standard electrode potential of the $\text{PbO}_2 / \text{PbSO}_4$ electrode?

Tick (✓) one box.

- ☐ **A** -2.61 V
- ☐ **B** -1.69 V
- ☐ **C** +1.69 V
- ☐ **D** +2.61 V

Q4 • June 2022 • Paper 3 • Q11 • [1 mark]

Which change to a hydrogen electrode has no effect on the electrode potential?

Tick (✓) one box.

- ☐ **A** the concentration of the hydrogen ions
- ☐ **B** the pressure of the hydrogen
- ☐ **C** the surface area of the platinum electrode
- ☐ **D** the temperature of the acid

Q5 • June 2022 • Paper 3 • Q12 • [1 mark]

Some electrode potential data are shown.

$\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^{-} \rightarrow \text{Zn}(\text{s})$	$E^{\ominus} = -0.76 \text{ V}$
$\text{Pb}^{2+}(\text{aq}) + 2 \text{e}^{-} \rightarrow \text{Pb}(\text{s})$	$E^{\ominus} = -0.13 \text{ V}$

Which is a correct statement about this cell? $\text{Zn}(\text{s})|\text{Zn}^{2+}(\text{aq})||\text{Pb}^{2+}(\text{aq})|\text{Pb}(\text{s})$

Tick (✓) one box.

- ☐ **A** Electrons travel in the external circuit from zinc to lead.
- ☐ **B** The concentration of lead(II) ions increases.
- ☐ **C** The maximum EMF of the cell is 0.89 V
- ☐ **D** Zinc is deposited.

Q6 • June 2024 • Paper 1 • Q6 • [10 marks]

This question also needs Amount of substance.

This question is about vanadium ions.

The table below shows some standard electrode potential values.

	$E^\ominus / \text{V}$
$\text{O}_2(\text{g}) + 4 \text{H}^+(\text{aq}) + 4 \text{e}^- \rightarrow 2 \text{H}_2\text{O}(\text{l})$	+1.23
$\text{VO}_2^+(\text{aq}) + 2 \text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
$\text{VO}^{2+}(\text{aq}) + 2 \text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{V}^{2+}(\text{aq})$	-0.26
$\text{Fe}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76
$\text{V}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{V}(\text{s})$	-1.20
$\text{Mg}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Mg}(\text{s})$	-2.38

(a) Use the data in the table above to explain why Zn reduces an aqueous solution of VO_2^+ ions to V^{2+} ions, but does not reduce it any further.

[2 marks]

(b) Identify the species in the table above that can reduce an aqueous solution of VO_2^+ to V

[1 mark]

(c) Two half-cells $\text{Fe}^{2+}(\text{aq}) / \text{Fe}(\text{s})$ and $\text{VO}^{2+}(\text{aq}) / \text{V}^{3+}(\text{aq})$ are connected.

Calculate the EMF of this cell.

Give the conventional representation for this cell.

Give a half-equation for the reaction that occurs at the negative electrode.

[3 marks]

EMF

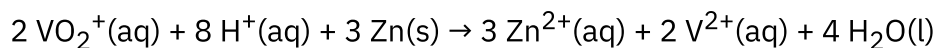
Cell representation

Half-equation

(d) 0.151 g of impure NH_4VO_3 is added to dilute sulfuric acid to form a solution containing aqueous VO_2^+ ions.

All the VO_3^- ions are converted to VO_2^+ ions.

These VO_2^+ ions are reduced to aqueous V^{2+} ions by reaction with an excess of zinc.

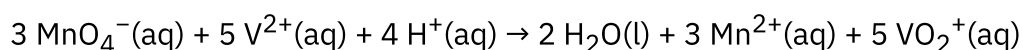


The excess of zinc is removed by filtration and washed.

The filtrate, containing the V^{2+} ions, is titrated with a $0.0200 \text{ mol dm}^{-3}$ solution of acidified KMnO_4

29.43 cm^3 of KMnO_4 solution are needed to oxidise all the V^{2+} ions to VO_2^+ ions.

The ionic equation for the reaction of MnO_4^- ions with V^{2+} ions is



Calculate the percentage purity of the NH_4VO_3

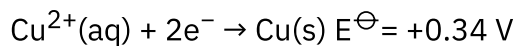
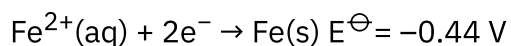
Give your answer to 3 significant figures.

Percentage purity

[4 marks]

Q7 • June 2019 • Paper 3 • Q13 • [1 mark]

The $E^\ominus$ values for two electrodes are shown.



What is the EMF of the cell $\text{Fe}(\text{s})|\text{Fe}^{2+}(\text{aq})||\text{Cu}^{2+}(\text{aq})|\text{Cu}(\text{s})$?

Tick (✓) one box.

☐ **A** +0.78 V

☐ **B** +0.10 V

☐ **C** -0.10 V

☐ **D** -0.78 V

Q8 • June 2025 • Paper 1 • Q6 • [9 marks]

An alkaline hydrogen-oxygen fuel cell uses hydrogen and oxygen to produce electricity.

The overall equation for the reaction is

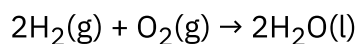
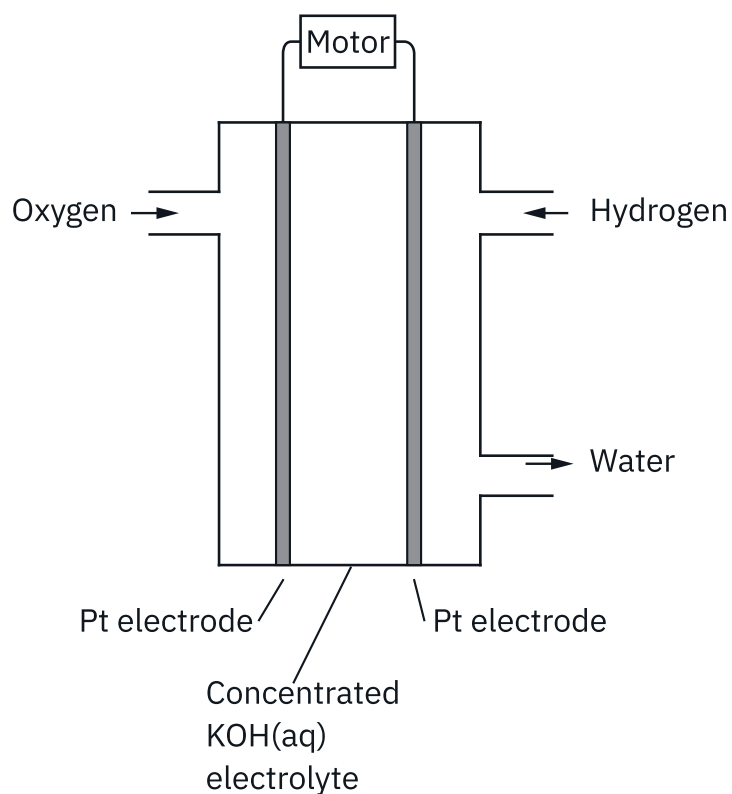


Figure 2 represents an alkaline hydrogen-oxygen fuel cell in use to power a motor.

Figure 2



06.1 Give a half-equation for the reaction occurring, in alkaline conditions, at each electrode.

[2 marks]

At negative electrode

At positive electrode

06.2 Suggest why it is not necessary to replace the KOH electrolyte during the operation of this fuel cell.

[1 mark]

06.3 Describe how the reactions at the electrodes generate an electric current that can power the motor in the external circuit.

[2 marks]

06.4 This fuel cell uses pure oxygen, rather than air, as an oxidising agent.

Suggest the identity of the gas in air that would react with the KOH and affect the efficient operation of the cell.

[1 mark]

06.5 When an alkaline hydrogen-oxygen fuel cell is used to power the motor in a car, the hydrogen can be stored as a liquid.

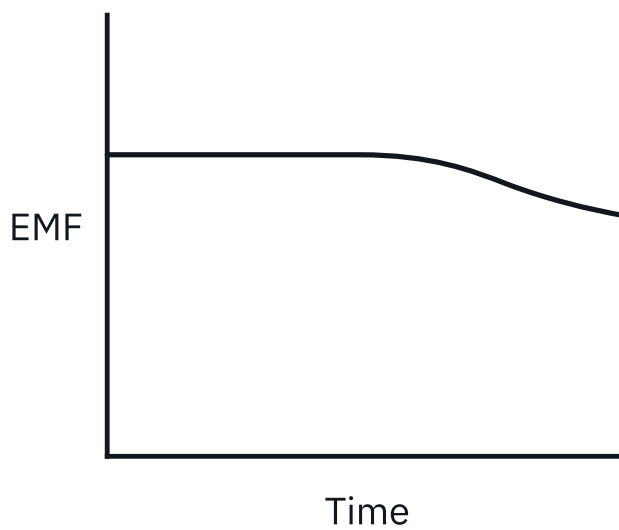
Suggest an advantage of storing hydrogen as a liquid.

[1 mark]

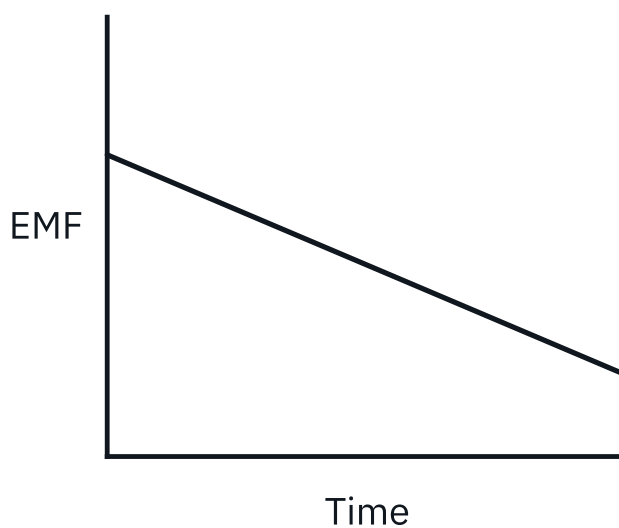
06.6 Which graph shows the change in EMF, with time, for an alkaline hydrogen-oxygen fuel cell?

Tick (✓) one box.

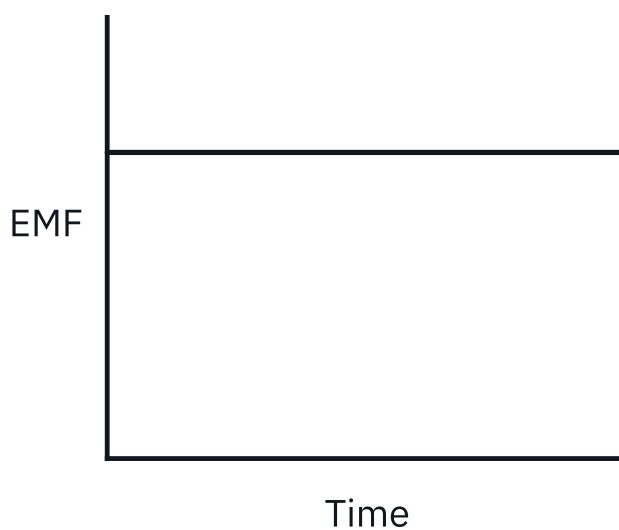
A



B



C



[1 mark]

A

B

C

06.7 An acidic hydrogen-oxygen fuel cell has different reactions at the electrodes.

Suggest why the EMF of the acidic hydrogen-oxygen fuel cell is the same as that of the alkaline hydrogen-oxygen fuel cell.

[1 mark]

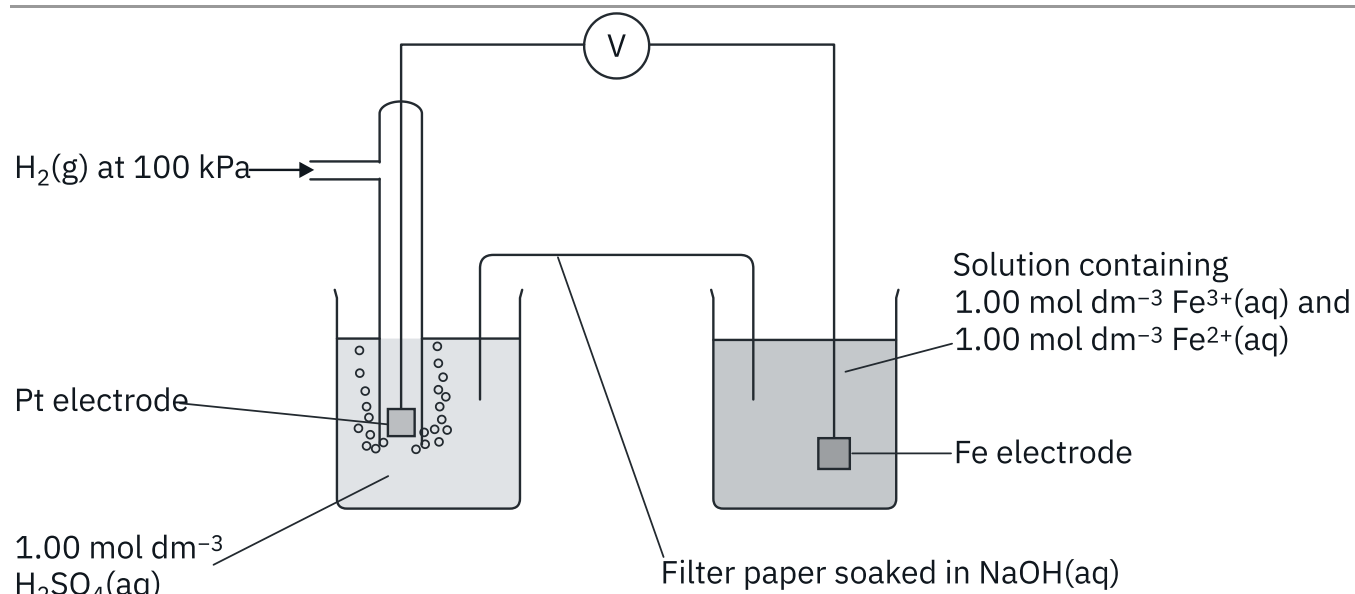
Q9 • June 2025 • Paper 3 • Q3 • [11 marks]

A student does an experiment to measure the standard electrode potential of an

$\text{Fe}^{3+}/\text{Fe}^{2+}$ electrode at 298 K

Figure 1 shows the apparatus the student uses.

Figure 1



03.1 Figure 1 shows three mistakes made by the student.

Identify each mistake and the change needed to correct it.

[3 marks]

Mistake 1

Change 1

Mistake 2

Change 2

Mistake 3

Change 3

03.2 What feature of the voltmeter ensures that the voltmeter measures the cell EMF?

Tick (✓) one box.

[1 mark]

Low resistance

Variable resistance

High resistance

03.3 The $\text{Fe}^{3+}/\text{Fe}^{2+}$ electrode is the positive electrode when the cell is set up correctly at 298 K

Give the redox equation for the overall reaction that occurs in the cell when the voltmeter is replaced with a lamp.

[1 mark]

03.4 Table 4 shows some standard electrode potentials.

Table 4

Half-equation	$E^\ominus / \text{V}$
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \rightarrow \text{Cu}^+(\text{aq})$	+0.15
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77

Finely powdered iron filings are added to a solution of copper(II) sulfate and the mixture is stirred.

The solution gradually changes from blue to pale green and a brown solid forms.

Use the data in Table 4 to explain these observations.

Give an ionic equation for the reaction that occurs.

Give the conventional representation of the cell that has the same overall reaction as in your equation.

Calculate the EMF, in volts, of this cell.

[6 marks]

Explanation

Equation

Conventional representation

EMF V

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