

GCSE Chemistry (9 – 1)

Chemical Cells and Fuel Cells

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/5
2	/5
3	/10
4	/19
5	/9
Total	/48
%	
Grade	

Information

- The maximum mark for this paper is 48 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Chemical cells and fuel cells are devices that harness chemical reactions to directly produce electrical energy. Circle the letter of the correct answer for each of the following questions.

a. A simple chemical cell is made by placing a zinc electrode and a copper electrode into a solution of an electrolyte. Zinc is more reactive than copper.

Which statement is correct?

- A The copper electrode is the negative terminal.
- B Electrons flow from the copper electrode to the zinc electrode.
- C The zinc electrode is the negative terminal.
- D The reaction is an example of electrolysis.

(1 mark)

b. In a hydrogen-oxygen fuel cell, hydrogen and oxygen are supplied to the electrodes.

What is the only waste product formed in this type of fuel cell?

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|----------------|----------|----------|-----------------|
| A | B | C | D |
| Carbon dioxide | Water | Hydrogen | Carbon monoxide |

(1 mark)

c. Fuel cells and rechargeable batteries can both be used to power electric vehicles.

What is a major advantage of a hydrogen fuel cell compared to a rechargeable battery?

- A A fuel cell can be refuelled much faster than a battery can be recharged.
- B Fuel cells are less expensive to manufacture than rechargeable batteries.
- C It is safer and easier to store hydrogen than to store the chemicals in a battery.
- D A fuel cell does not use an electrolyte.

(1 mark)

d. Which row about a hydrogen–oxygen fuel cell is correct?

	Energy transfer	Equation for the reaction
A	electrical to chemical	$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
B	electrical to chemical	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
C	chemical to electrical	$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
D	chemical to electrical	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

(1 mark)

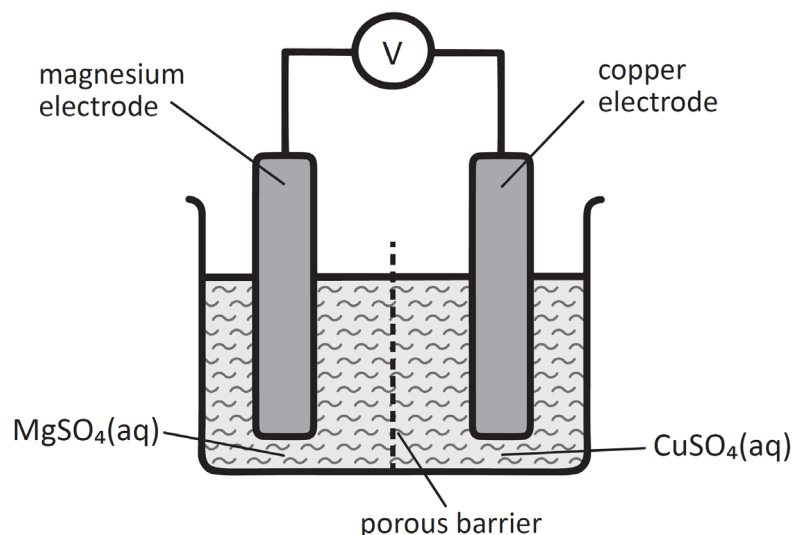
e. What is the primary function of the electrolyte in a simple chemical cell?

- A It allows electrons to flow through the solution to the positive electrode.
- B It reacts with both metals to generate a current.
- C It keeps the two metal electrodes from touching each other.
- D It completes the circuit by allowing ions to move between the electrodes.

(1 mark)

(Total for Question 1 is 5 marks)

2. The figure below shows a chemical cell.



- a. State which electrode, magnesium or copper, is the negative terminal.
Give a reason for your answer.

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(2 marks)

- b. What would be observed on the voltmeter? Explain the observation.

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(2 marks)

- c. State the function of the porous barrier.

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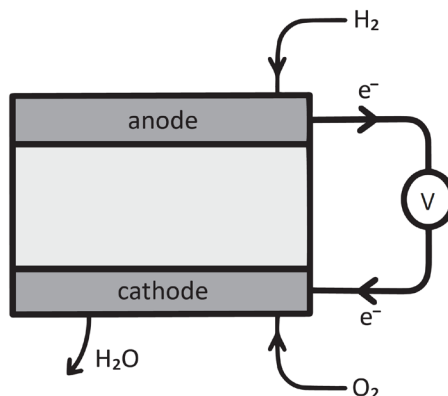
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(1 mark)

(Total for Question 2 is 5 marks)

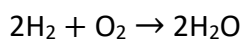
3. A fuel cell generates electricity from a chemical reaction between a fuel and oxygen. The figure below shows a fuel cell that uses hydrogen, which is the most common fuel. Other fuels, such as methane and methanol, can also be used.



- a. Methane (CH_4) can also be used as a fuel in this type of cell. Name the product, other than water, that is formed.
- (1 mark)
- b. Write a balanced chemical equation for the overall reaction that occurs in the hydrogen fuel cell shown.
- (2 marks)
- c. State whether oxidation or reduction happens at the anode. Explain your answer using information from the diagram.
- (1 mark)
- d. Write the half-equation for the reaction occurring at the anode.
- (2 marks)
- e. What chemical process happens at the cathode?
- (1 mark)
- f. Describe **two advantages** and **one disadvantage** of using a hydrogen fuel cell to power a car compared to using a petrol engine.
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- (3 marks)

(Total for Question 3 is 10 marks)

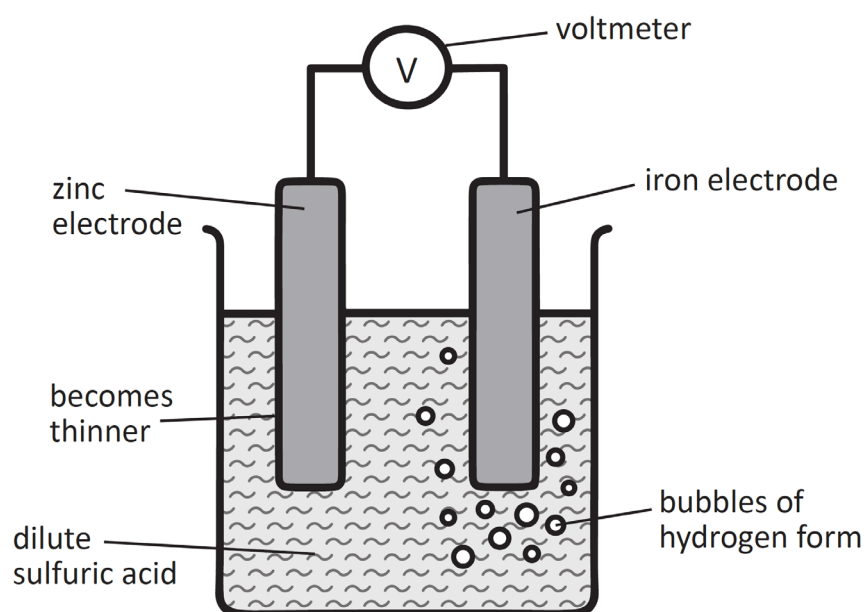
4. A space mission needs a reliable source of electrical energy. Engineers are considering either hydrogen-oxygen fuel cells or traditional chemical cells (batteries). The overall reaction in the fuel cell is:



- a. Compare the use of hydrogen-oxygen fuel cells with chemical cells for this purpose. You should include both the benefits and drawbacks of using fuel cells in your answer.

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b. The figure below shows a simple cell.



i. State what type of cell is shown in the figure above.

(1 mark)

ii. Identify the positive electrode and the negative electrode in this cell.
Explain your answer using observations from the figure of the cell and your knowledge of reactivity.

(4 marks)

- c. Write half-equations for the reactions occurring at each electrode.

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(2 marks)

- d. Explain why the voltmeter shows a reading and describe the direction of electron flow in the external circuit.

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(3 marks)

- e. If the iron electrode was replaced with a copper electrode, predict how the voltage reading would change, if at all.

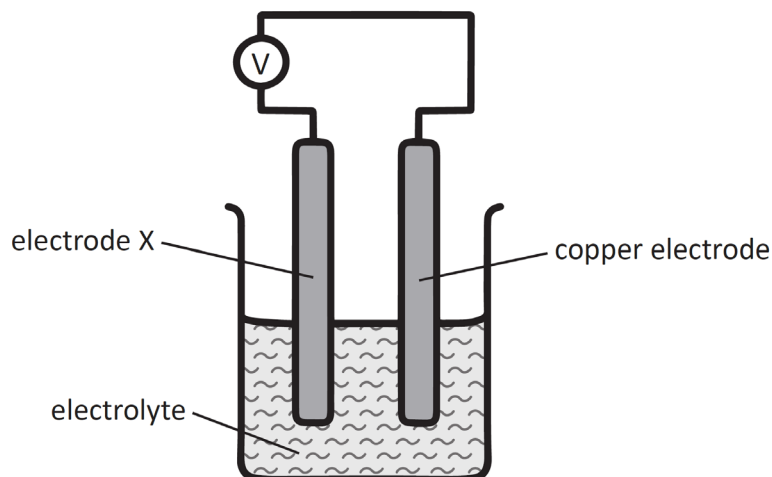
Justify your answer in terms of the reactivity series.

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(3 marks)

(Total for Question 4 is 19 marks)

5. The figure below shows a chemical cell.



The electrolyte is a solution that completes the electrical circuit inside the cell.

a. State what type of compound must be present in the electrolyte to complete the circuit?

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(1 mark)

To produce a voltage, electrode X must have a different reactivity to copper. The student knows that the greater the difference in reactivity between the two metals, the larger the voltage produced. The reactivity series is shown below.

Metal	
Magnesium	(most reactive) ↓ (least reactive)
Zinc	
Iron	
Copper	
Gold	

b. Using the reactivity series, predict which metal (magnesium, zinc, or gold) would produce the largest voltage when used as electrode X.
Explain your choice.

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(2 marks)

c. Oxidation occurs at the zinc electrode.
Write the half-equation for the reaction taking place at the zinc electrode. Include state symbols.

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(2 marks)

- d. Zinc is more reactive than copper.

State which electrode (zinc or copper) will be the negative terminal. Give a reason for your answer.

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(2 marks)

- e. Describe **one** change you would expect to see to the zinc electrode if the cell were left running for 24 hours.

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(1 mark)

- f. Hydrogen-oxygen fuel cells can be used as a source of electrical energy on spacecraft. Suggest **one** advantage of using fuel cells rather than chemical cells in spacecraft.

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(1 mark)

(Total for Question 5 is 9 marks)