

## Chemical Cells and Fuel Cells

**These practice questions can be used by students and teachers and is suitable for GCSE AQA Chemistry topic Questions 8462**

**Level: GCSE AQA Chemistry 8462**

**Subject: Chemistry**

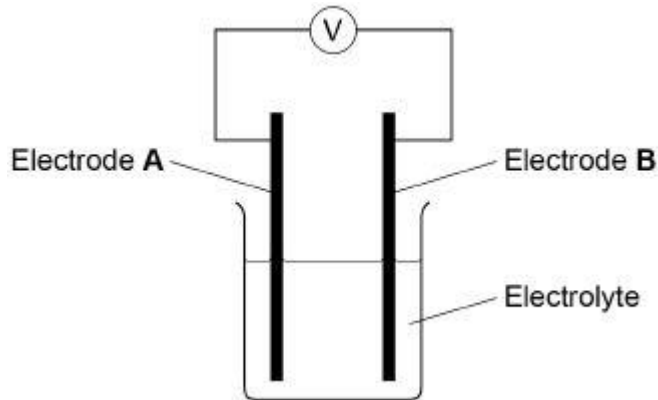
**Exam board: GCSE AQA**

**Topic: Chemical Cells and Fuel Cells**

**Q1.**

Chemical reactions can produce electricity.

(a) The diagram below shows a simple cell.



Which of these combinations would not give a zero reading on the voltmeter in the diagram above?

Tick **one** box.

Electrode A	Electrode B	Electrolyte	<input type="checkbox"/>
Copper	Copper	Sodium chloride solution	<input type="checkbox"/>
Zinc	Zinc	Water	<input type="checkbox"/>
Copper	Zinc	Sodium chloride solution	<input type="checkbox"/>
Copper	Zinc	Water	<input type="checkbox"/>

(1)

Alkaline batteries are non-rechargeable.

(b) Why do alkaline batteries eventually stop working?

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(1)

(c) Why can alkaline batteries **not** be recharged?

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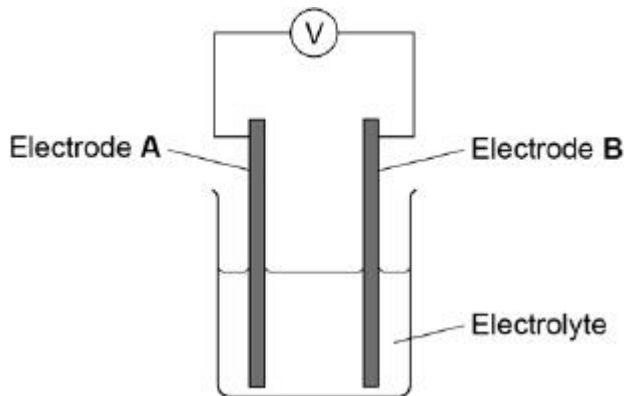
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(6)  
(Total 11 marks)

**Q2.**

A student investigated the voltage produced by simple cells.

The diagram shows the apparatus used.



The table shows the voltage produced with different metal electrodes.

Electrode A	Electrode B	Voltage in V
Copper	Copper	0.00
Copper	Iron	0.78
Copper	Magnesium	2.71
Copper	Tin	0.48
Copper	Zinc	1.10

(a) List the metals in the table in order of reactivity.

Most reactive \_\_\_\_\_  
\_\_\_\_\_

Least reactive      Copper

(2)

(b) Batteries consist of cells.

Describe how a 6.0 V battery can be made from cells of voltage 1.5 V

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(2)

(c) Why do non-rechargeable cells stop producing electricity?

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(2)

(d) Complete the word equation for the reaction in a hydrogen fuel cell.

hydrogen    +    \_\_\_\_\_    →    water

(1)

(e) Give **two** reasons why using a hydrogen fuel cell is seen as non-polluting.

Use the equation in part (d).

1. \_\_\_\_\_

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2. \_\_\_\_\_

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(2)

(Total 9 marks)

### Q3.

Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

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\_\_\_\_\_ (1)

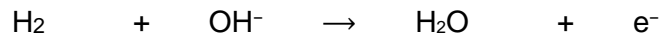
(b) Give **two** factors that affect the voltage produced by a cell.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

(c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.



(1)

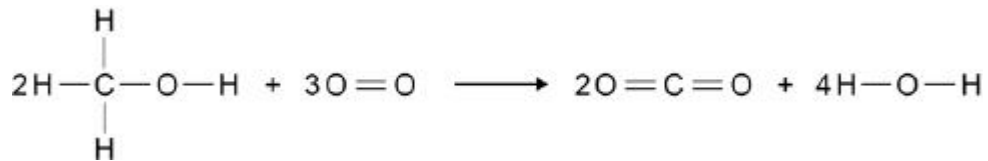
(d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

\_\_\_\_\_  
 \_\_\_\_\_

(1)

(e) Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

	C-H	C-O	O-H	O=O	C=O
Bond energy in kJ / mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

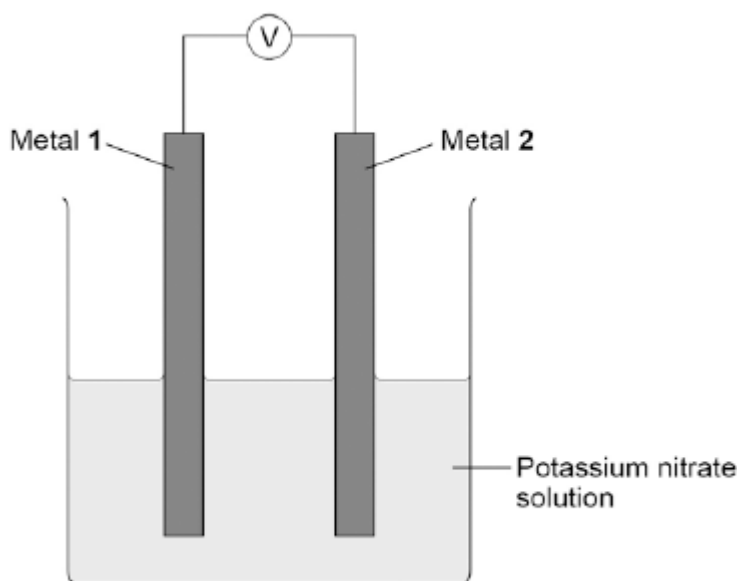
\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Overall energy change = \_\_\_\_\_ kJ / mol

(3)

**Q4.**

A student investigated simple cells using the apparatus shown in the figure below.

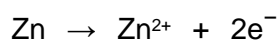


- If metal 2 is more reactive than metal 1 then the voltage measured is positive.
- If metal 1 is more reactive than metal 2 then the voltage measured is negative.
- The bigger the difference in reactivity of the two metals, the larger the voltage produced.

The student's results are shown in the table below.

Metal 2 Metal 1	Chromium	Copper	Iron	Tin	Zinc
Chromium	0.0 V				
Copper	1.2 V	0.0 V			
Iron	0.5 V	not measured	0.0 V		
Tin	0.8 V	-0.4 V	0.3 V	0.0 V	
Zinc	0.2 V	-1.0 V	-0.3 V	-0.6 V	0.0 V

- (a) The ionic equation for the reaction occurring at the zinc electrode in the simple cell made using copper and zinc electrodes is:



Zinc is oxidised in this reaction.

Give a reason why this is oxidation.

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(1)

(b) Look at the table above.

Which **one** of the metals used was the least reactive?

Give a reason for your answer.

Metal \_\_\_\_\_

Reason \_\_\_\_\_

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(2)

(c) Predict the voltage that would be obtained for a simple cell that has iron as metal **1** and copper as metal **2**.

Explain your answer.

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(3)

(d) Hydrogen fuel cells have been developed for cars.

Write a word equation for the overall reaction that takes place in a hydrogen fuel cell.

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(1)

(e) Write the **two** half equations for the reactions that occur at the electrodes in a hydrogen fuel cell.

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**Q5.**

Some cars are powered by hydrogen fuel cells.

**Figure 1**



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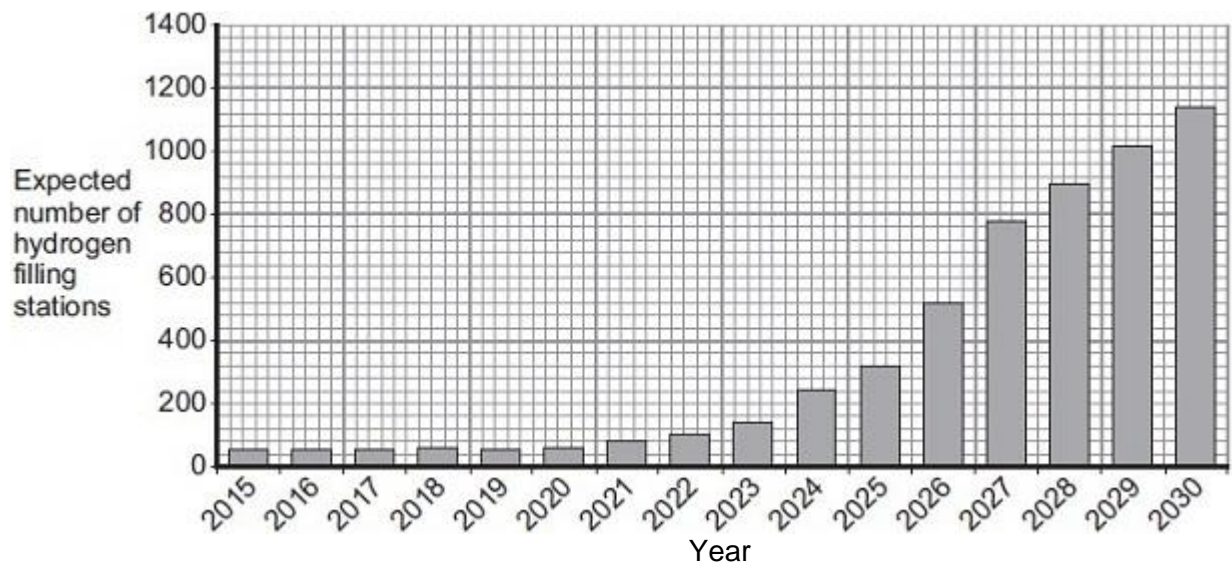
- (a) What type of energy is released by hydrogen fuel cells?

(1)

- (b) Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

**Figure 2** shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

**Figure 2**



Use the information in **Figure 2** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

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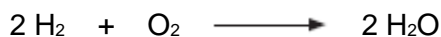
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(2)

(c) The equation for the reaction of hydrogen with oxygen is:



During the reaction, energy is used to break the bonds of the reactants.

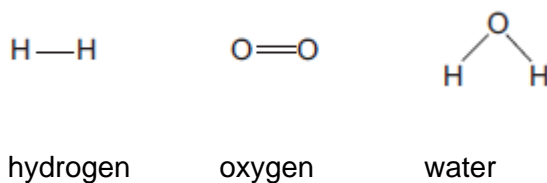
Energy is released when new bonds are made to form the product.

Bond energies for the reaction are given in the table below.

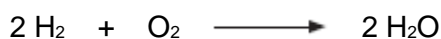
Bond	Bond energy in kJ
H—H	436
O=O	498
O—H	464

The structures of the reactants and product are shown in **Figure 3**.

**Figure 3**



(i) Calculate the energy change for the reaction:




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Energy change = \_\_\_\_\_ kJ

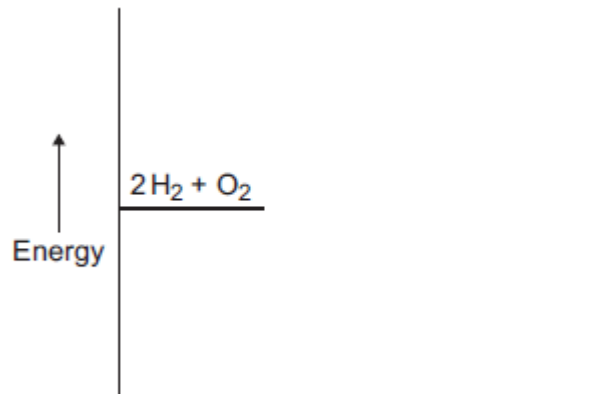
(3)

(ii) The reaction of hydrogen with oxygen is exothermic.

Complete the energy level diagram for this reaction on **Figure 4**.

Clearly label the activation energy.

**Figure 4**



(3)  
(Total 9 marks)

**Q6.**

The picture shows two different cars.



(a) Some properties of aluminium are given below.

Tick (✓) **two** reasons why aluminium is better than steel for car bodies.

Reason	Tick (✓)
Aluminium is not a transition metal.	<input type="checkbox"/>
Aluminium has a low density.	<input type="checkbox"/>
Aluminium is expensive to extract.	<input type="checkbox"/>
aluminium is resistant to corrosion.	<input type="checkbox"/>

(2)

(b) Each car body is made from an *alloy*.

(i) What is an *alloy*?

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\_\_\_\_\_ (1)

- (ii) An alloy is used to make a car body. A pure metal is **not** used to make a car body.

Suggest why.

\_\_\_\_\_  
\_\_\_\_\_ (1)

- (c) The car with a steel body uses petrol for fuel.

Draw a ring around the correct answer to complete each sentence.

- (i) Petrol is made from 

air.
crude oil.
metal ores.

 (1)

- (ii) Petrol is a mixture of 

carbonates
hydrocarbons
polymers

 including C<sub>8</sub>H<sub>18</sub> (1)

- (iii) In the car engine petrol reacts with 

argon
nitrogen
oxygen

 to produce carbon dioxide and water. (1)

- (d) Look at the substances coming out of each car's exhaust.

- (i) Suggest the name of the fuel used in the car with the aluminium alloy body.

Name of fuel \_\_\_\_\_ (1)

- (ii) Why is the fuel burned in the car with the aluminium alloy body better for the environment than petrol?

\_\_\_\_\_  
\_\_\_\_\_ (1)

(1)  
**(Total 9 marks)**

## Mark schemes

### Q1.

- (a) copper, zinc, sodium chloride solution 1
- (b) a reactant is used up  
*allow the reaction stops*  
*allow electrolyte / electrode / ions / metal / metal hydroxide / alkali for reactant* 1
- (c) the reaction is not reversible 1
- (d)  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$   
*allow fractions / multiples*  
*allow 1 mark for O<sub>2</sub>* 2
- (e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. 5-6
- Level 2:** Some logically linked reasons are given. There may also be a simple judgement. 3-4
- Level 1:** Relevant points are made. This is not logically linked. 1-2
- No relevant content** 0

#### Indicative content

#### reasons why fuel cells could be judged as better

from the table	from other knowledge
<ul style="list-style-type: none"> <li>• time for refuelling a fuel cell is faster than recharging</li> <li><b>or</b></li> <li>• a fuel cell does not need to be recharged</li> <li>• a fuel cell has a greater range</li> </ul>	<ul style="list-style-type: none"> <li>• hydrogen can be renewable if made by electrolysis using renewable energy</li> <li>• lithium-ion batteries can catch fire</li> <li>• produces only water</li> <li><b>or</b></li> <li>• no pollutants produced</li> <li>• lithium-ion batteries may release toxic chemicals on disposal</li> <li>• lithium-ion batteries</li> </ul>

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	(eventually cannot be recharged so) have a finite life
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**reasons why the lithium-ion battery could be judged as better**

from the table	from other knowledge
<ul style="list-style-type: none"> <li>lithium-ion uses energy more efficiently</li> <li>cost of lithium-ion car much less</li> <li>cost of recharging much less than refuelling with hydrogen</li> </ul>	<ul style="list-style-type: none"> <li>hydrogen is often made from fossil fuels so is not renewable</li> <li>charging points are more widely available than hydrogen filling stations</li> <li>hydrogen takes up a lot of space</li> </ul> <p><b>or</b></p> <ul style="list-style-type: none"> <li>is difficult to store</li> <li>hydrogen can be highly flammable / explosive</li> <li>no emissions produced</li> <li>(catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life</li> </ul>

[11]

**Q2.**

- (a) magnesium  
zinc  
iron  
tin  
(copper)

*three in the correct order scores 1 mark  
all correct scores 2 marks*

2

- (b) use 4 cells (each of voltage 1.5 V)

1

connect in series

1

- (c) reaction stops

1

(because) one of the reactants is used up

1

- (d) (hydrogen +) oxygen ( → water)

1

- (e) any **two** from:

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- produces water
- water is not harmful / polluting
- does not produce carbon dioxide
- does not produce other named pollutant

*allow an answer of **only** produces water for 2 marks*

2

[9]

### Q3.

- (a) the chemical reaction is reversible

1

- (b) any **two** from:

- type of electrode
- electrolyte
- concentration of electrolyte
- temperature

2

- (c)  $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$

*allow multiples*

1

- (d) contains  $\text{OH}^-$  ions

1

- (e) (bonds broken)

$$((6 \times 412) + (2 \times 360) + (2 \times 464) + (3 \times 498)) = 5614$$

1

(bonds made)

$$((4 \times 805) + (8 \times 464)) = 6932$$

1

(overall energy change)

$$(6932 - 5614) = -1318 \text{ (kJ / mol)}$$

*allow ecf from marking point 1 and / or marking point 2*

1

*an answer of 1318 (kJ / mol) scores 3 marks*

[8]

### Q4.

- (a) (zinc has) lost electron(s)

*accept loss of electrons*

1

- (b) copper is the least reactive

1

because it gave the most negative voltage when it was metal 2  
or

it gave the biggest voltage with chromium

**or**

it gave the most positive voltage when it was metal 1

1

(c) -0.7 V

1

The voltage with chromium and copper is 1.2

*accept use of other cell pairings such as tin with copper and tin with iron*

1

The voltage with chromium and iron is 0.5 and copper is less reactive (than iron)

1

(d) hydrogen + oxygen = water

1

(e)  $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$

1

$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$

1

[9]

### Q5.

(a) electrical

1

(b) using hydrogen saves petrol / diesel / crude oil

*allow crude oil is non-renewable*

*ignore hydrogen is renewable*

1

*using hydrogen (in fuel cells) does not cause pollution*

*accept no carbon dioxide produced*

*allow less carbon dioxide produced*

*allow hydrogen produces only water*

1

(c) (i) (-)486

*correct answer with or without working gains 3 marks*

*if answer is incorrect:*

*(2 × 436) + 498 or 1370 gains 1 mark*

*4 × 464 or 1856 gains 1 mark*

*correct subtraction of ecf gains 1 mark*

3

(ii) products lower than reactants

1

*reaction curve correctly drawn*

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activation energy labelled

1

1

[9]

**Q6.**

- (a) Aluminium has a low density

1

Aluminium is resistant to corrosion

1

- (b) (i) (an alloy) is a mixture of metals  
*accept (an alloy) can be a metal mixed with another metal **or**  
iron mixed with carbon / a non-metal*

1

- (ii) pure metals are soft  
*allow weak*

**or**

alloys are hard  
*allow strong / keep their shape  
ignore rust / corrosion*

1

- (c) (i) crude oil

1

- (ii) hydrocarbons

1

- (iii) oxygen

1

- (d) (i) hydrogen

*allow H<sub>2</sub> or H*

1

- (ii) only water is produced (from the fuel)

**or**

no carbon dioxide is produced (from the fuel)

*allow less carbon dioxide produced **or** less global warming  
allow carbon dioxide causes global warming*

1

[9]