

**Q1.**

This question is about chemical cells and batteries.

- (a) Three different types of battery can be used to power a TV remote control.

The table below gives information about these batteries.

	Zinc-carbon battery	Alkaline battery	Nickel-metal hydride battery
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give **one** advantage of each type of battery.

Zinc-carbon \_\_\_\_\_

\_\_\_\_\_

Alkaline \_\_\_\_\_

\_\_\_\_\_

Nickel-metal hydride \_\_\_\_\_

\_\_\_\_\_

(3)

- (b) **Figure 1** shows a symbol printed on batteries.

**Figure 1**



This symbol shows that batteries should not be put in household waste.

Suggest why batteries should **not** be put in household waste.

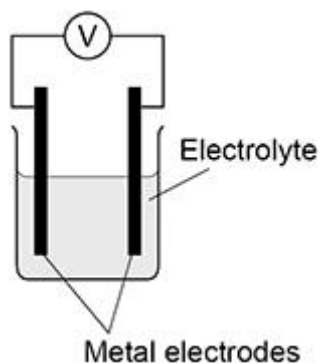
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(1)

**Figure 2** shows a chemical cell.

Figure 2



- (c) The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in **Figure 2**?

Tick (✓) **one** box.

Copper and iron

Iron and tin

Tin and copper

(1)

- (d) The voltage produced by the cell in **Figure 2** depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

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(1)

- (e) Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.



(2)  
(Total 8 marks)

**Q2.**

This question is about chemical reactions and energy.

Hydrogen reacts with oxygen to produce water.

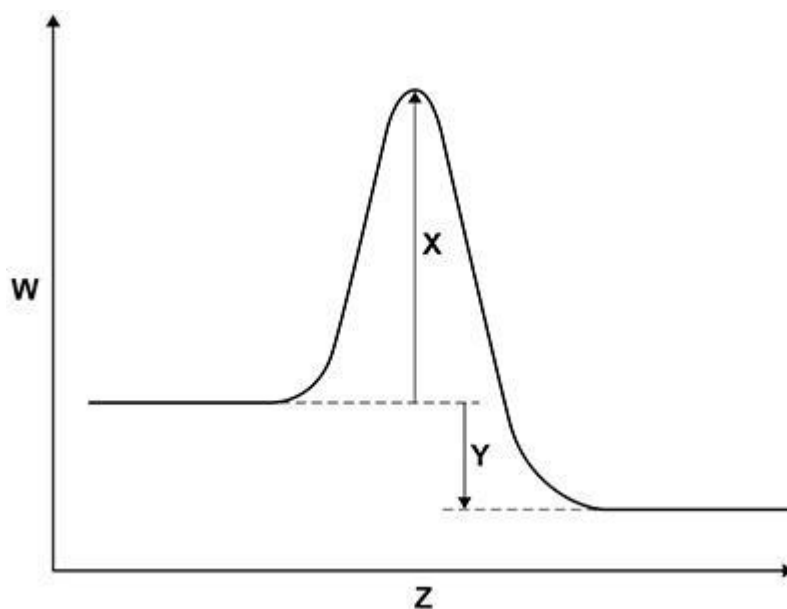
This reaction releases energy.

- (a) Complete the word equation for the reaction.

hydrogen + oxygen  $\rightarrow$  \_\_\_\_\_

(1)

- (b) The graph below shows a reaction profile for the reaction between hydrogen and oxygen.



What do the labels **W**, **X**, **Y** and **Z** represent?

Choose answers from the box.

activation energy	energy	overall energy change
products	progress of reaction	reactants

**W** \_\_\_\_\_

**X** \_\_\_\_\_

**Y** \_\_\_\_\_

**Z** \_\_\_\_\_

(4)

- (c) The reaction between hydrogen and oxygen is used in a hydrogen fuel cell.

What is the reason for using this reaction in a fuel cell?

Tick (✓) **one** box.

To produce a change of state

To produce a potential difference

To produce a temperature change

(1)

- (d) A student investigated the voltage produced by a chemical cell.

The student used different metals as the electrodes in the cell.

The metals used were:

- copper
- iron
- magnesium.

Which **two** metal electrodes would produce the greatest voltage when used in the chemical cell?

Give **one** reason for your answer.

Metals \_\_\_\_\_ and \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

(2)

(Total 8 marks)

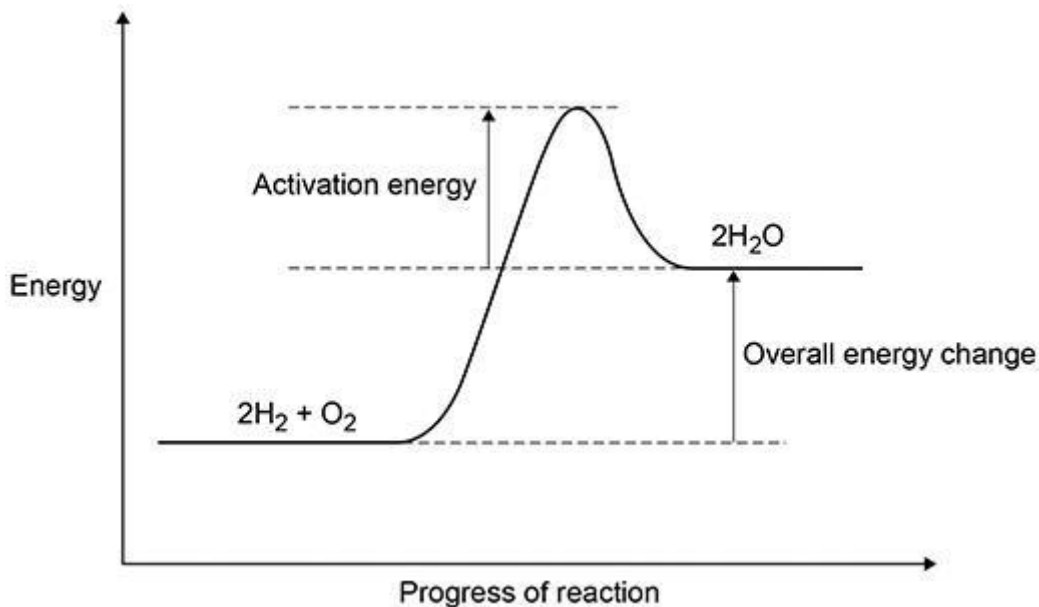
### Q3.

The reaction between hydrogen and oxygen releases energy.

- (a) A student drew a reaction profile for the reaction between hydrogen and oxygen.

**Figure 1** shows the student's reaction profile.

**Figure 1**



The student made **two** errors when drawing the reaction profile.

Describe the **two** errors.

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

(2)

- (b) The reaction between hydrogen and oxygen in a hydrogen fuel cell is used to produce electricity.

Hydrogen fuel cells and rechargeable cells are used to power some cars.

Give **two** advantages of using hydrogen fuel cells instead of using rechargeable cells to power cars.

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

(2)

- (c) Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell.

Write a half equation for **one** of these reactions.

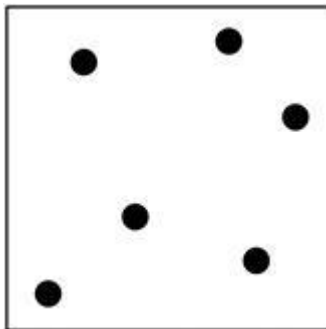
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(1)

- (d) The three states of matter can be represented by a simple particle model.

**Figure 2** shows a simple particle model for hydrogen gas.

**Figure 2**



Give **two** limitations of this simple particle model for hydrogen gas.

1 \_\_\_\_\_

2 \_\_\_\_\_

(2)

- (e) The hydrogen gas needed to power a car for 400 km would occupy a large volume.

Suggest **one** way that this volume can be reduced.

\_\_\_\_\_

\_\_\_\_\_

(1)

- (f) The energy needed for a car powered by a hydrogen fuel cell to travel 100 km is 58 megajoules (MJ).

The energy released when 1 mole of hydrogen gas reacts with oxygen is 290 kJ

The volume of 1 mole of a gas at room temperature and pressure is 24 dm<sup>3</sup>

Calculate the volume of hydrogen gas at room temperature and pressure needed for the car to travel 100 km

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\_\_\_\_\_

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Volume of hydrogen gas = \_\_\_\_\_ dm<sup>3</sup>

(4)

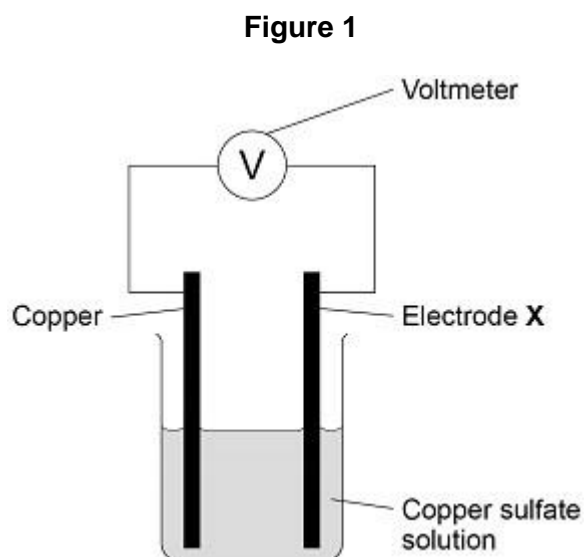
(Total 12 marks)

**Q4.**

This question is about chemical cells and batteries.

A student investigated the voltage produced by different chemical cells.

**Figure 1** shows the apparatus.



This is the method used.

1. Use cobalt metal as electrode **X**.
  2. Record the cell voltage.
  3. Repeat steps 1 and 2 using different metals as electrode **X**.
- (a) Suggest **two** variables the student should keep the same to make the investigation valid.

1 \_\_\_\_\_

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2 \_\_\_\_\_  
\_\_\_\_\_

(2)

The following table shows the student's results.

Electrode X	Voltage of the cell in volts
cobalt	0.62
magnesium	2.71
zinc	1.10

(b) Write the three metals used for electrode X in order of reactivity.

Use the table above.

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

\_\_\_\_\_

Least reactive \_\_\_\_\_

(1)

(c) Copper is used as electrode X in **Figure 1**.

Predict the voltage of this cell.

Give **one** reason for your answer.

Voltage = \_\_\_\_\_ volts

Reason \_\_\_\_\_

\_\_\_\_\_

(2)

(d) Describe how to make a 12 V battery using 1.5 V cells.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(2)

(e) Which is the most suitable use for a non-rechargeable cell?



Tick (✓) **one** box.

Electric toy

Laptop computer

Mobile phone

(1)

- (f) Hydrogen fuel cells or rechargeable cells can be used to power electric vehicles.

Suggest **one** advantage and **one** disadvantage of using a hydrogen fuel cell compared with a rechargeable cell.

Advantage of hydrogen fuel cell \_\_\_\_\_

\_\_\_\_\_

Disadvantage of hydrogen fuel cell \_\_\_\_\_

\_\_\_\_\_

(2)

(Total 10 marks)

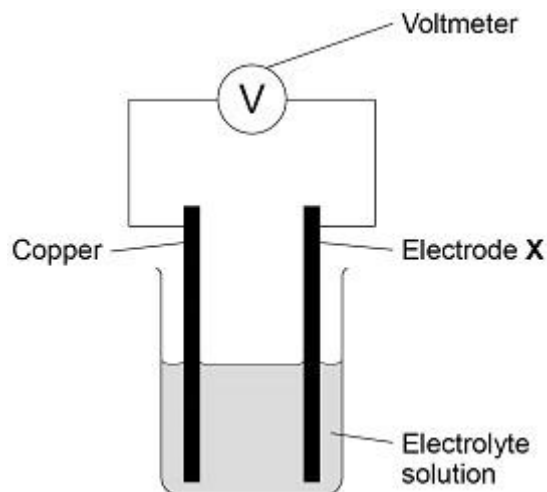
### Q5.

This question is about chemical cells.

A student investigated the voltage produced by different chemical cells.

**Figure 1** shows the apparatus.

**Figure 1**



This is the method used.

1. Use cobalt as electrode **X**.
2. Record the cell voltage.
3. Repeat steps 1 and 2 using different metals as electrode **X**.

(a) Suggest **two** control variables used in this investigation.

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

(2)

The following table shows the student's results.

Electrode X	Voltage of cell in volts
cobalt	+0.62
copper	0.00
magnesium	+2.71
nickel	+0.59
silver	-0.46
tin	+0.48

(b) Write the six metals used for electrode **X** in order of reactivity.

Use the table above.

Justify your order of reactivity.

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

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Least reactive \_\_\_\_\_

Justification

\_\_\_\_\_

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**(4)**

- (c) Which of the following pairs of metals would produce the greatest voltage when used as the electrodes in the cell?

Use the table above.

Tick (✓) **one** box.

Magnesium and cobalt

Magnesium and tin

Nickel and cobalt

Nickel and tin

**(1)**

- (d) Hydrogen fuel cells can be used to power different forms of transport.

Some diesel trains are being converted to run on hydrogen fuel cells.

A newspaper article referred to the converted trains as the new 'steam trains'.

Suggest why.

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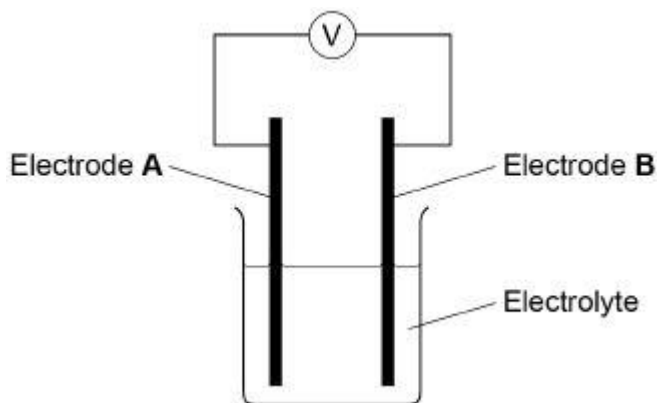
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**(2)****(Total 9 marks)****Q6.**

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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(1)

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

- (d) Complete the balanced equation for the overall reaction in a hydrogen fuel cell.



(2)

- (e) The table below shows data about different ways to power electric cars.

	<b>Hydrogen fuel cell</b>	<b>Rechargeable lithium-ion battery</b>
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use the table above and your own knowledge.

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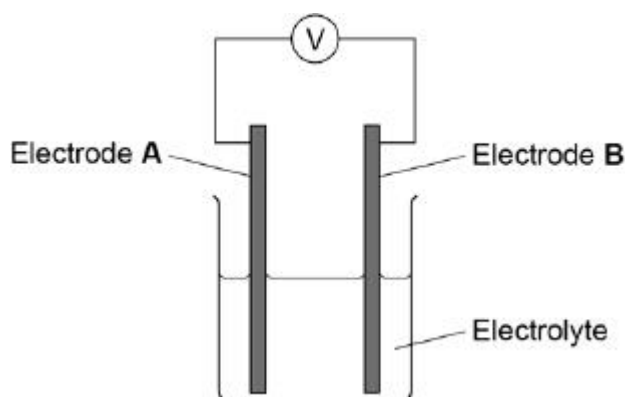
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(6)  
(Total 11 marks)

**Q7.**

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

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(2)

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

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(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. \_\_\_\_\_

\_\_\_\_\_

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

\_\_\_\_\_

(2)

(Total 9 marks)

**Q8.**

Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

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(1)

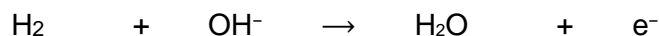
(b) Give **two** factors that affect the voltage produced by a cell.

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?

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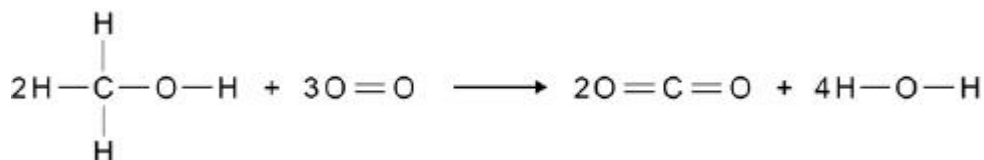


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(1)

(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.

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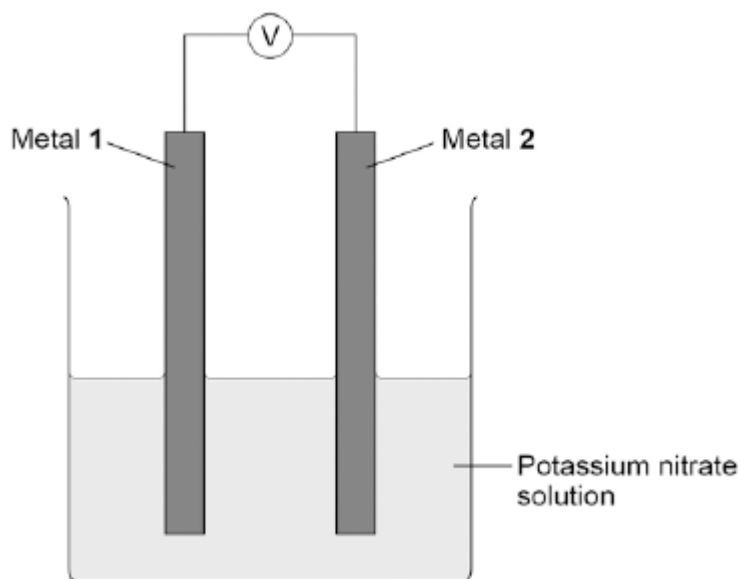
Overall energy change = \_\_\_\_\_ kJ / mol

(3)

(Total 8 marks)

**Q9.**

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

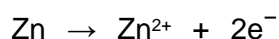


- If metal 2 is more reactive than metal 1 then the voltage measured is positive.
- If metal 1 is more reactive than metal 2 then the voltage measured is negative.
- The bigger the difference in reactivity of the two metals, the larger the voltage produced.

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

Metal 1 \ Metal 2	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

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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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**(2)****(Total 9 marks)**