

Exothermic and Endothermic Reactions

Question Paper 1

| | |
|-------------------------|---------------------------------------|
| Level | GCSE (9-1) |
| Subject | Combined Science: Trilogy - Chemistry |
| Exam Board | AQA |
| Topic | 5.5 Energy Changes |
| Sub-Topic | Exothermic and Endothermic Reactions |
| Difficulty Level | Bronze Level |
| Booklet | Question Paper 1 |

Time Allowed: 56 minutes

Score: /54

Percentage: /100

Grade Boundaries:

Q1. Some students investigated the reactivity of four unknown metals, **W**, **X**, **Y** and **Z**.

The letters are not the symbols of these elements.

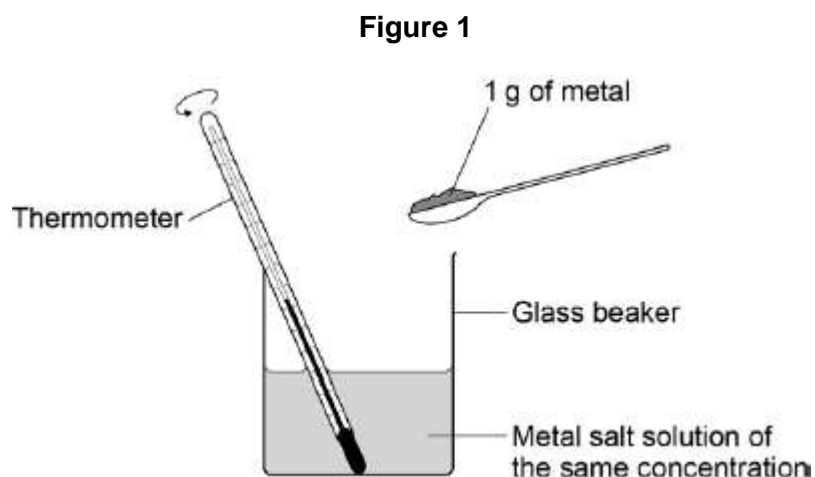
The students used metal salt solutions of copper nitrate, magnesium sulfate and zinc chloride.

This is the method used.

1. Pour a solution of a metal salt into a glass beaker.
2. Measure the temperature of the solution.
3. Add 1 g of metal to the solution.
4. Measure the temperature of the solution.
5. Calculate the temperature increase.

The students did the experiment using each salt solution with each metal.

Figure 1 shows the apparatus the students used.



The table below shows the students' results.

| Solution | Temperature increase in °C | | | |
|-------------------|----------------------------|-----------|-----------|-----------|
| | Metal W | Metal X | Metal Y | Metal Z |
| Copper nitrate | 46 | 10 | 29 | No change |
| Magnesium sulfate | No change | No change | No change | No change |
| Zinc chloride | 15 | No change | No change | No change |

(a) Which metal is **least** reactive?

Tick **one** box.

| | |
|---------|--------------------------|
| Metal W | <input type="checkbox"/> |
| Metal X | <input type="checkbox"/> |
| Metal Y | <input type="checkbox"/> |
| Metal Z | <input type="checkbox"/> |

(1)

- (b) How do the results show that magnesium is **more** reactive than the metals **W**, **X**, **Y** and **Z**?

.....
.....

(1)

- (c) How do the results show that the reaction between metal **Y** and copper nitrate solution is exothermic?

.....
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(1)

- (d) One student said that the investigation was not valid (a fair test).

Write a plan for the investigation that includes improvements to the method and apparatus.

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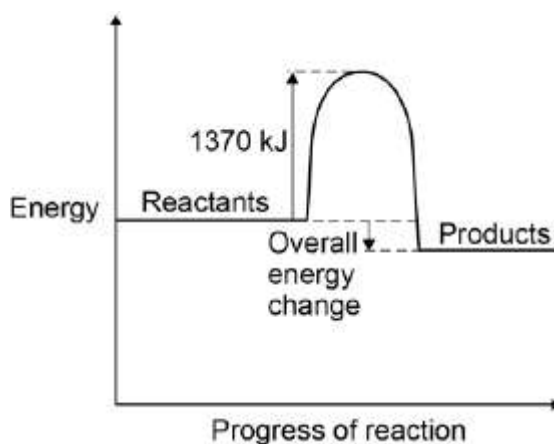
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(4)

(e) **Figure 2** shows the reaction profile of an exothermic reaction.

Figure 2



What does the energy value of 1370 kJ represent?

Tick **one** box.

- Activation energy
- Products energy
- Reactants energy
- Released energy

(1)

(f) The overall energy change is 386 kJ.

What percentage of 1370 kJ is this?

Give your answer to two significant figures.

.....

Percentage = %

(2)
(Total 10 marks)

Q2. This question is about the reactions of acids.

- (a) When dilute hydrochloric acid is reacted with sodium hydroxide solution there is a temperature change.

Explain how the temperature changes.

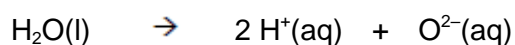
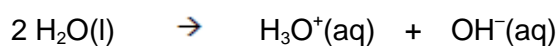
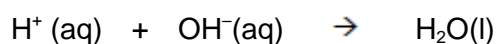
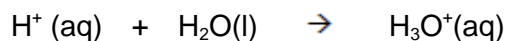
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(2)

- (b) Acids produce hydrogen ions in aqueous solutions.

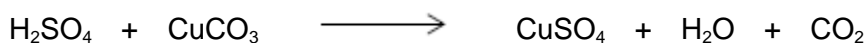
What is the ionic equation for neutralisation reactions?

Tick **one** box.



(1)

- (c) Sulfuric acid reacts with copper carbonate to produce a salt, water and carbon dioxide.



What is the name of the salt produced?

.....

(1)

- (d) A student reacted four metals with water and with a dilute acid to work out the order of reactivity of the metals.

The table below shows some of the observations.

| Metal | Reaction with water | Reaction with dilute acid |
|-----------|---------------------|---------------------------|
| Calcium | Bubbles of gas | X |
| Copper | Y | No bubbles of gas |
| Magnesium | Few bubbles of gas | Bubbles of gas |
| Zinc | No bubbles of gas | Bubbles of gas |

Write the observations for **X** and **Y**.

Observation at **X**

Observation at **Y**

(2)

- (e) Write the four metals, calcium, copper, magnesium and zinc, in order of reactivity.

Start with the **most** reactive metal.

.....

(2)

- (f) Some gases given off in reactions can be identified by chemical tests.

Draw **one** line from each chemical test to the name of the gas.

Chemical test

Gas

| | |
|--|----------------|
| Put in a lighted splint. The gas burns with a pop sound. | Carbon dioxide |
| Put in a glowing splint. The gas relights the splint. | Chlorine |
| Put into limewater. The gas turns limewater cloudy. | Hydrogen |
| | Nitrogen |
| | Oxygen |

(3)

- (g) Acids react with bases to produce salts and water (H_2O).

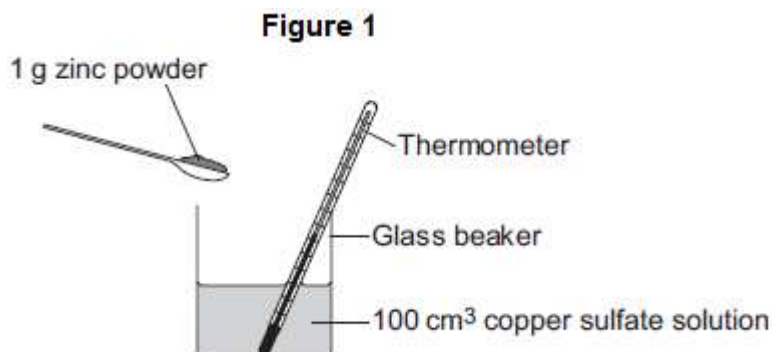
The electronic structure of a hydrogen atom is 2,1

The electronic structure of an oxygen atom is 2,6

Draw a diagram to show the arrangement of the outer shell electrons in a molecule of water.

(2)
(Total 13 marks)

Q3. A student investigates the energy released when zinc powder reacts with copper sulfate solution. The student uses the apparatus shown in **Figure 1**.



The student:

- measures 100 cm³ copper sulfate solution into a beaker
- measures the temperature of the copper sulfate solution
- puts 1 g zinc powder into the beaker
- stirs the mixture with a thermometer
- measures the highest temperature.

The student's results were:

Starting temperature = 21 °C

Highest temperature = 32 °C

- (a) (i) Calculate the change in temperature.

.....

Change in temperature = °C

(1)

- (ii) Calculate the energy released in the reaction.

Use the equation

$$\begin{array}{ccccccc} \text{energy} & = & \text{volume of} & & & & \\ \text{released} & & \text{solution} & \times & 4.2 & \times & \text{temperature change} \\ \text{in J} & & \text{in cm}^3 & & & & \text{in } ^\circ\text{C} \end{array}$$

.....

.....

Energy released = J

(2)

- (b) The reaction of zinc with copper sulfate is exothermic.

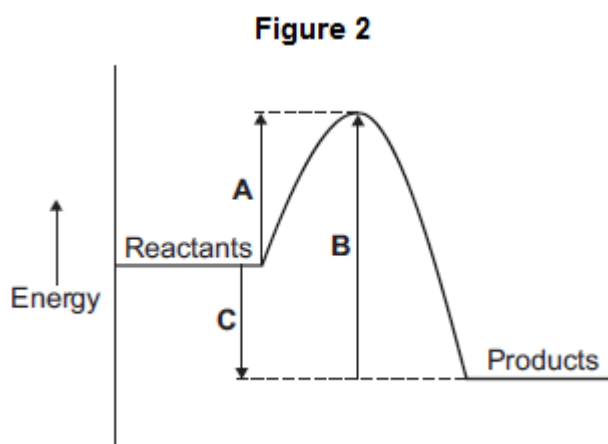
How can you tell from the student's results that the reaction is exothermic?

.....

.....

(1)

- (c) The energy diagram for the reaction is shown in **Figure 2**.



(i) How can you tell from the energy diagram that the reaction is exothermic?

.....
.....

(1)

(ii) Which arrow shows the activation energy in **Figure 2**?

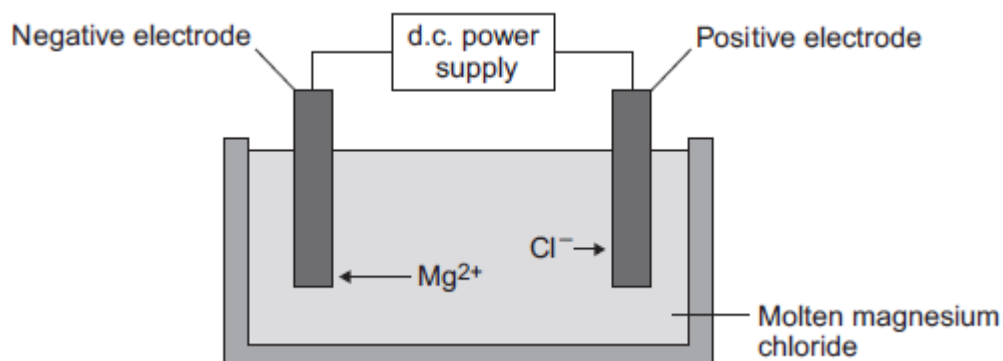
Tick (✓) **one** box.

| | |
|----------|--------------------------|
| A | <input type="checkbox"/> |
| B | <input type="checkbox"/> |
| C | <input type="checkbox"/> |

(1)
(Total 6 marks)

Q4. Some students investigated reactions to produce magnesium.

(a) The students used electrolysis to produce magnesium from magnesium chloride, as shown in the figure below.



- (i) Magnesium chloride contains magnesium ions and chloride ions.

Why does solid magnesium chloride **not** conduct electricity?

.....
.....

(1)

- (ii) One of the products of the electrolysis of molten magnesium chloride is magnesium.

Name the other product.

.....

(1)

- (iii) Why do magnesium ions (Mg^{2+}) move to the negative electrode?

.....
.....

(1)

- (iv) At the negative electrode, the magnesium ions (Mg^{2+}) gain electrons to become magnesium atoms.

How many electrons does each magnesium ion gain?

.....

(1)

- (b) The students did the experiment four times and weighed the magnesium produced.

The table below shows their results.

| Experiment | Mass of magnesium produced in grams |
|------------|-------------------------------------|
| 1 | 1.13 |
| 2 | 0.63 |
| 3 | 1.11 |
| 4 | 1.09 |

- (i) There is an anomalous result.

Suggest **one** possible reason for the anomalous result.

.....
.....

(1)

- (ii) Calculate the mean mass of magnesium produced, taking account of the anomalous result.

.....
.....
.....

Mean mass = g

(2)

- (c) The formula of magnesium chloride is $MgCl_2$

The relative formula mass of magnesium chloride is 95.

The relative atomic mass of magnesium is 24.

- (i) Use the equation to calculate the percentage mass of magnesium in magnesium chloride.

$$\text{Percentage mass of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium chloride}} \times 100\%$$

.....
.....
.....

Percentage mass of magnesium in magnesium chloride = %

(2)

(ii) Draw a ring around the relative mass of chlorine in MgCl_2

71 95 119

(1)

(d) Magnesium is also produced from the reaction of magnesium oxide with silicon.

(i) The equation for the reaction is:



What is the meaning of this symbol \rightleftharpoons ?

Draw a ring around the correct answer.

**neutralisation
reaction**

precipitation reaction

reversible reaction

(1)

(ii) The forward reaction is endothermic.

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

In an endothermic reaction the temperature of the surroundings

| |
|-----------------|
| decreases. |
| increases. |
| stays the same. |

(1)

(Total 12 marks)

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?

Draw a ring around the correct answer.

chemical

electrical

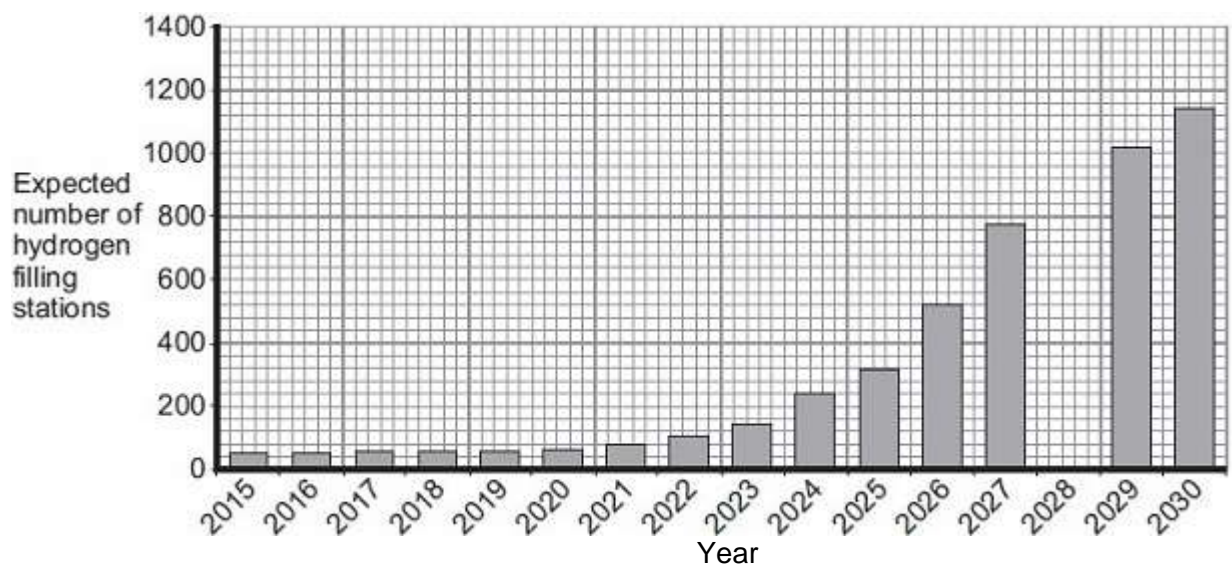
light

(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



- (i) Suggest the total number of hydrogen filling stations expected in 2028.

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(1)

- (ii) The number of hydrogen filling stations will still be very low compared with the number of petrol filling stations.

Suggest **one** reason why.

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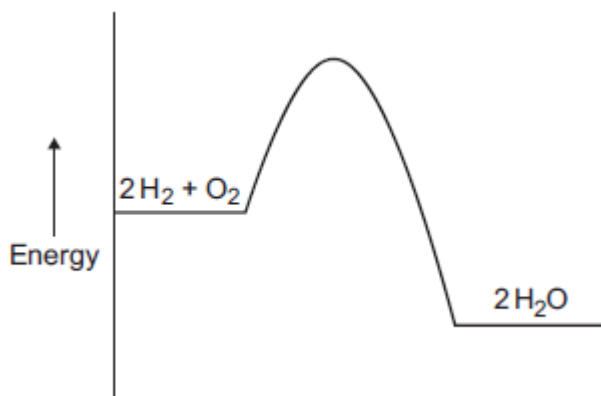
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(1)

- (c) Hydrogen reacts with oxygen to produce water.

The energy level diagram for this reaction is shown in **Figure 3**.

Figure 3



Mark clearly with a cross (x) on **Figure 3** where bond breaking happens.

(1)

(Total 4 marks)

Q6. Kelp is a seaweed.

Kelp can be burned to give out energy.



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

Reactions which give out energy are

endothermic

exothermic.

reversible.

(1)

- (b) Which **two** of the following questions **cannot** be answered by scientific experiments alone?

Tick (✓) **two** boxes.

| Question | Tick (✓) |
|---|----------|
| How much carbon dioxide is produced when 100 g of kelp is burned? | |
| Does kelp give out more heat energy than coal when burned? | |
| Should people use kelp instead of oil as an energy source? | |
| Will kelp be more popular than coal in the next 10 years? | |

(2)

- (c) Potassium iodide can be produced from kelp.

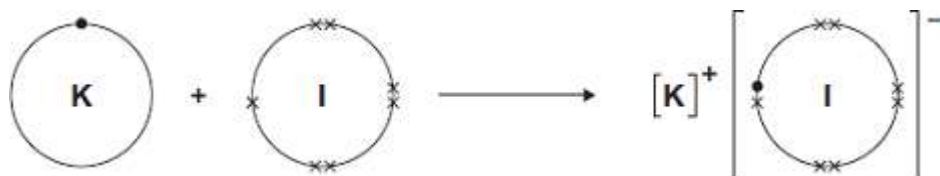
- (i) Potassium can be reacted with iodine to produce potassium iodide.



The diagram shows how this happens.

Only the outer electrons are shown.

The dots (●) and crosses (x) are used to represent electrons



Use the diagram to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with iodine to produce potassium iodide.

To get full marks you should use the words atom, electron and ion in your answer.

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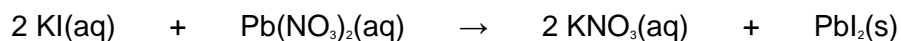
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(4)

- (ii) Potassium iodide reacts with lead nitrate.



Why is this reaction a precipitation?

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(1)

(iii) How can the precipitate be removed from the reaction mixture?

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(1)

(Total 9 marks)