

GCSE Chemistry (9 – 1)

Heat Energy Changes

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	/4
2	/12
3	/6
4	/8
5	/7
6	/9
Total	/46
%	
Grade	

Information

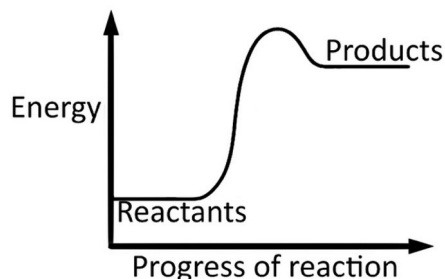
- The maximum mark for this paper is 46 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. All chemical reactions involve an energy change, which we most commonly observe as heat being either released to or absorbed from the surroundings.

Circle the letter of the correct answer for each of the following questions.

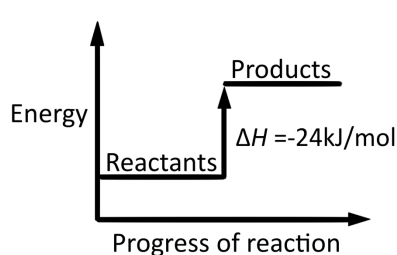
- a. A reaction pathway diagram is shown below.
Which statement about this reaction is correct?



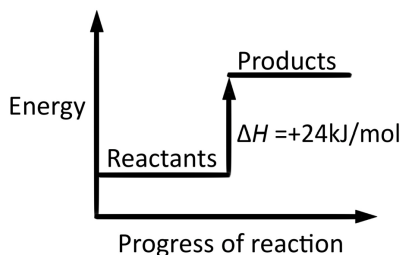
- A** The reaction rate increases during the reaction.
B The reaction is endothermic.
C The reaction transfers thermal energy to the surroundings.
D The temperature of the surroundings increases.

(1 mark)

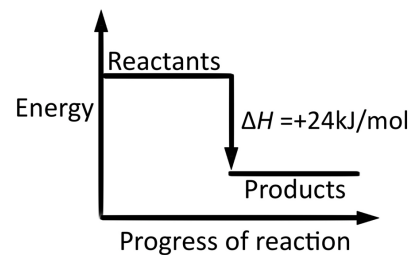
- b. Which reaction pathway diagram below shows an endothermic reaction?



A



B



C

(1 mark)

- c. Which of the following changes of state releases heat energy into the surroundings?

A
Condensation

B
Evaporation

C
Melting

D
Sublimation

(1 mark)

- d. Which of the following processes does **not** require an input of energy from the surroundings to occur?

A
Condensation

B
Evaporation

C
Melting

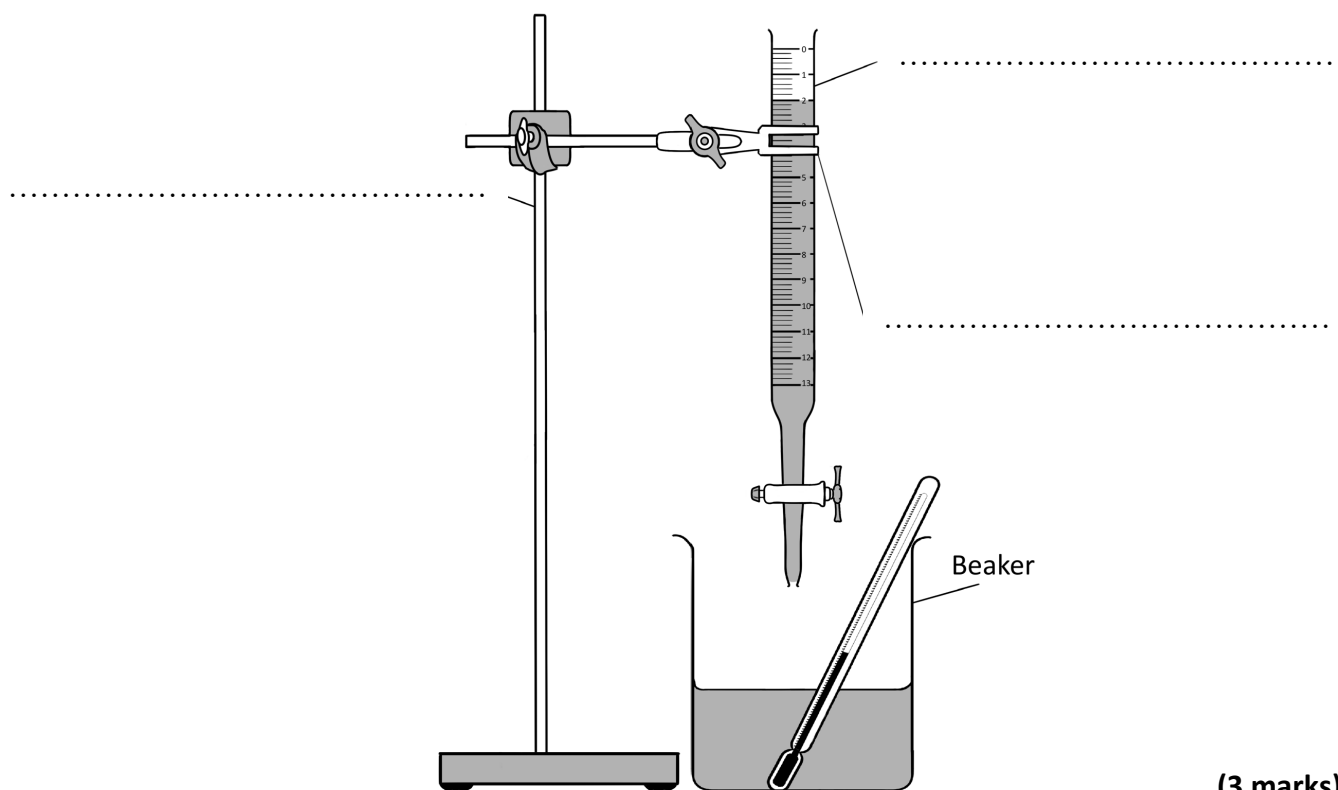
D
Sublimation

(1 mark)

(Total for Question 1 is 4 marks)

2. A student wants to investigate the heat energy released when an acid neutralises an alkali. They assemble the apparatus shown in the diagram.

a. Name the items of equipment they are using for their experiment.



b. Suggest **one** change to the experimental setup that would improve the accuracy of the final temperature reading.

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(1 mark)

c. Explain why the improvement you suggested in part (b) would lead to a more accurate value for the temperature change.

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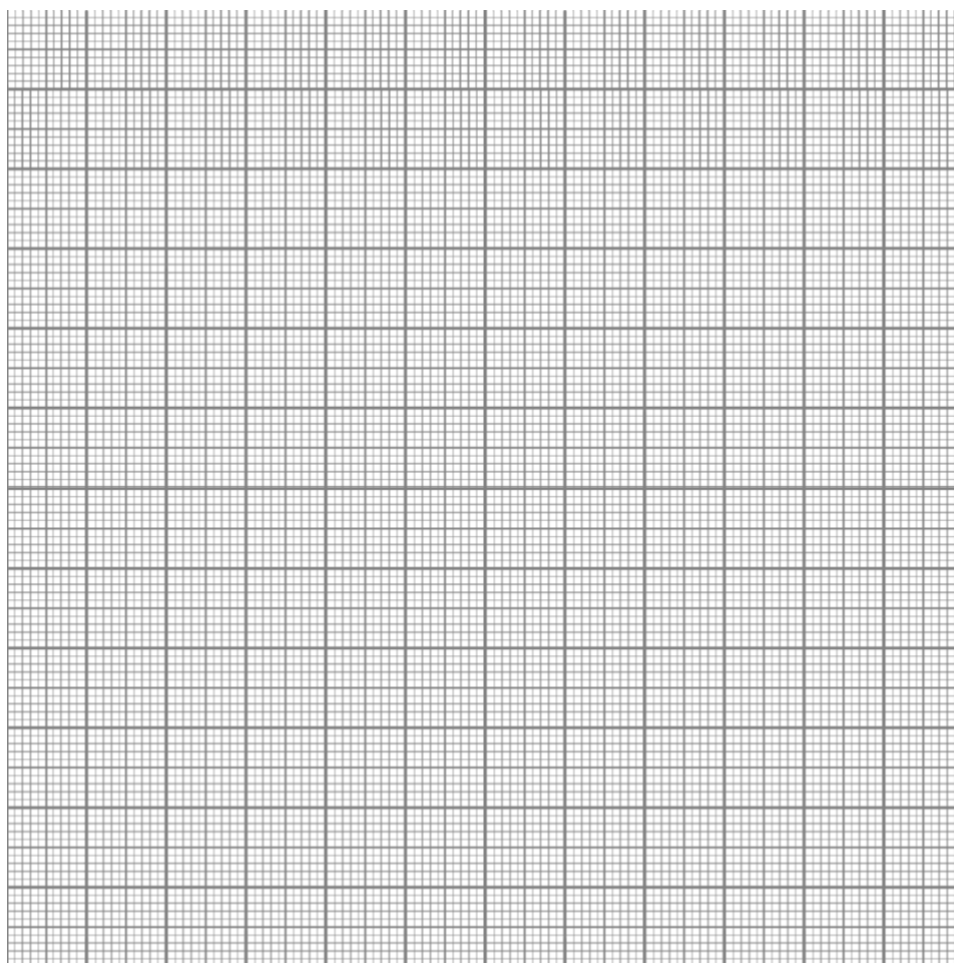
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(2 marks)

- d. In the experiment, the student adds the acid to the alkali in 5 cm³ portions. After each portion was added, the mixture was stirred and the temperature was recorded. The results are shown in the table below.

Volume of acid (cm ³)	Temperature (°C)
5	20
10	22
15	25
20	28
25	24

Plot the results from the table on the graph paper below.



(4 marks)

- e. Describe the relationship between the volume of acid added and the temperature of the mixture.

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(2 marks)

(Total for Question 2 is 12 marks)

3. A student is investigating chemical reactions that give out heat to their surroundings.

a. The student adds magnesium to a solution of sulfuric acid, H_2SO_4 .
Magnesium sulfate, MgSO_4 , and hydrogen gas are made.

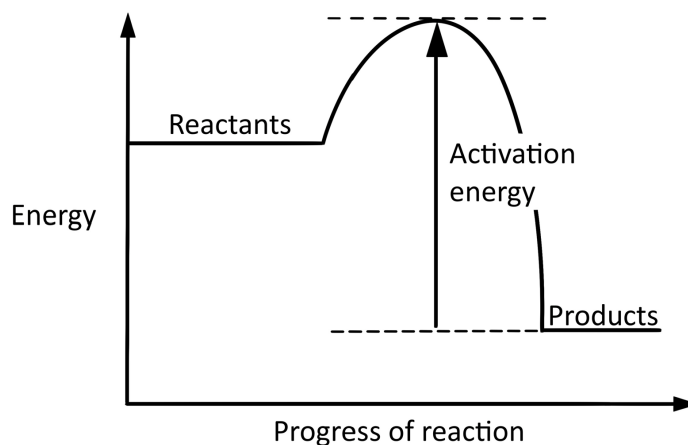
i. Write the **balanced** symbol equation for this reaction.

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(2 marks)

ii. What term is used to describe a reaction that gives out heat to its surroundings?

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(1 mark)

b. The student draws the reaction profile for this reaction.
The figure below shows the student's reaction profile.



i. Identify an error that the student made on their reaction profile.

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(1 mark)

ii. The activation energy is mentioned in the reaction profile above.
Explain what is meant by the term **activation energy**.

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(2 marks)

(Total for Question 3 is 6 marks)

4. The thermal decomposition of calcium carbonate is an important industrial process that is endothermic.

It requires a large input of heat energy to break down the calcium carbonate into calcium oxide and carbon dioxide. A reaction profile diagram can show the energy pathway for this reaction.

- a. In the space below draw a fully labelled reaction profile diagram for an **endothermic** reaction.

Your diagram must show and label:

- The reactants and products
- The activation energy (E_a)
- The overall enthalpy change (ΔH)
- Labels for both axes

(6 marks)

- b. Explain, in terms of bond breaking and bond making, why the reaction is endothermic.

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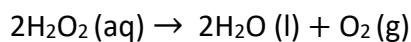
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(2 marks)

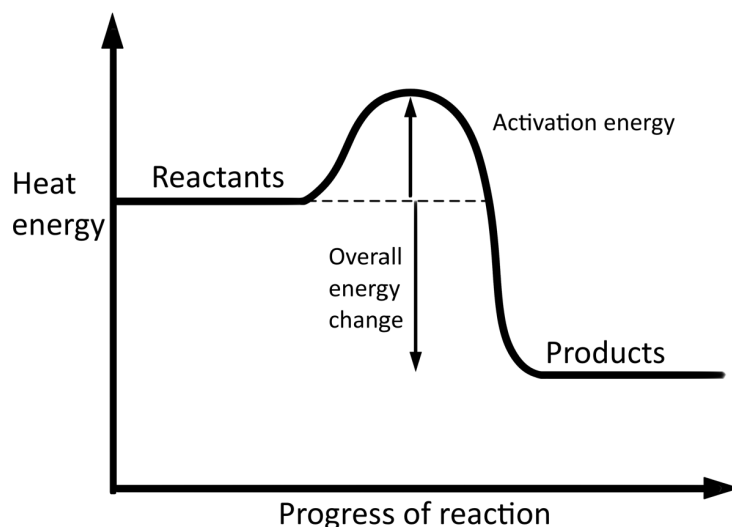
(Total for Question 4 is 8 marks)

5. A student investigates the decomposition of hydrogen peroxide solution into water and oxygen.



The reaction is slow at room temperature.

The reaction profile for this uncatalysed reaction is shown below.



The student adds a small amount of manganese(IV) oxide powder, which acts as a catalyst.

- a. On the reaction profile diagram, **draw a second line** to show the pathway for the reaction when a **catalyst is added**.

(3 marks)

- b. Describe, in terms of activation energy, how the catalyst increases the rate of reaction.

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(2 marks)

- c. What would be the mass of the manganese(IV) oxide at the end of the reaction?
Explain your answer.

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(2 marks)

(Total for Question 5 is 8 marks)

6. Ammonia is manufactured from nitrogen and hydrogen in the Haber process.

The process involves a reversible reaction which is often run at high temperatures and pressures.

Step 1: Nitrogen and hydrogen gases react to form ammonia.

Step 2: The ammonia is then cooled, liquefied, and removed.

The forward reaction in step 1 is an exothermic reaction.

a. Draw a labelled reaction profile diagram for an exothermic reaction.

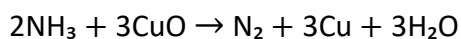
Label the following in your diagram:

- **Reactants.**
- **Activation energy.**
- The **energy change** (enthalpy change, ΔH).
- **Products.**



(4 marks)

In a different reaction, ammonia can be used to reduce copper(II) oxide to copper.



b. Explain, in terms of electron transfer, why ammonia (NH_3) is called a reducing agent in this reaction.

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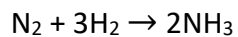
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(2 marks)

- c. A chemical engineer reacts hydrogen with an excess of nitrogen to produce ammonia.
The balanced equation for the reaction is:



Calculate the number of moles of ammonia (NH_3) that would be produced from 12.0 g of hydrogen.
(Relative atomic masses: H = 1, N = 14)

Give your answer to 2 significant figures.

Moles of ammonia = ...

(3 marks)

(Total for Question 6 is 9 marks)