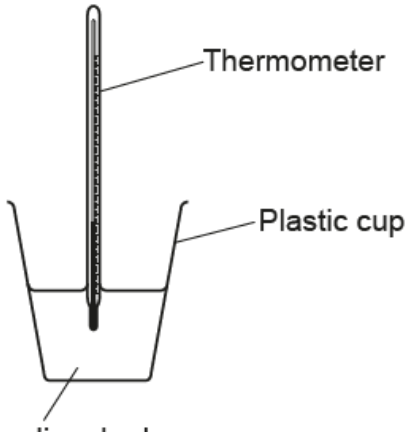
Energetics – 2021/20 GCSE Gateway Chemistry Combined Science A

1. Nov/2021/Paper_J250/03/No.17

The reaction between solid citric acid and sodium hydrogen carbonate solution is an endothermic reaction.

A student investigates the temperature change for the reaction.

The diagram shows the equipment the student uses.



The student adds 0.65 g of solid citric acid to an excess of sodium hydrogen carbonate solution.

The student measures the temperature change. The temperature change is 3.5 °C.

(a) (i) How does a temperature change show that a reaction is endothermic?

.....

..... **[1]**

(ii) How should the student have written the temperature change to show that this reaction is endothermic?

.....

..... **[1]**

(b) Describe how the student performed the experiment so that they could calculate the temperature change.

.....

.....

.....

..... **[2]**

(c) The student repeats the experiment using a different mass of citric acid. This time the student measures a larger temperature change.

The temperature change is 10.0 °C.

If 0.65 g of citric acid gives a temperature change of 3.5 °C, calculate the mass of citric acid, **in milligrams**, that gives a 10.0 °C temperature change.

1 g = 1000 mg

Give your answer to **3** significant figures.

Mass of citric acid = ... mg **[4]**

(d) When the student washed out the plastic cup at the end of the second experiment they saw some excess solid left.

Explain how this affected the student's result **and** describe how the student could have improved their experiment.

.....

.....

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.....

.....

..... **[3]**

(e) Citric acid and sodium hydrogen carbonate react to form sodium citrate.

Sodium citrate contains sodium ions, Na^+, and citrate ions, $C_6H_5O_7^{3-}$.

Write the **formula** of sodium citrate.

..... **[1]**

2. Nov/2020/Paper_J250/03/No.12

A student investigates the temperature change in an exothermic reaction.

Look at **Fig. 12.1**. It shows his experiment.

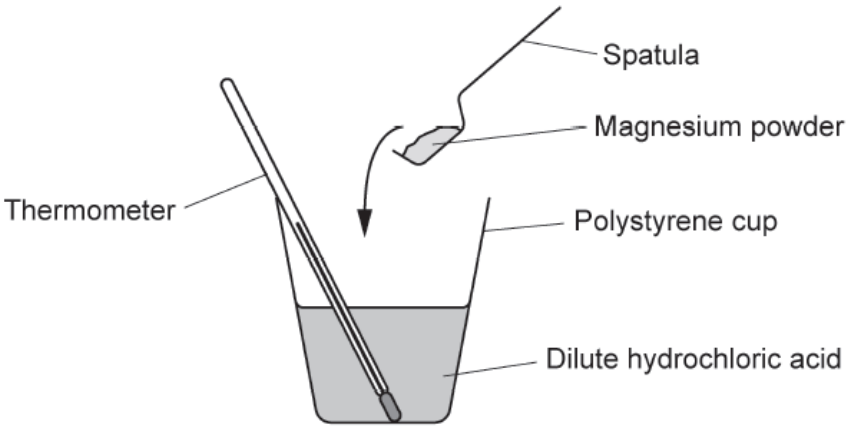


Fig. 12.1

This is the method the student follows:

- Measure 25 cm^3 of dilute hydrochloric acid into a polystyrene cup.
- Measure the temperature of the acid.
- Add 1 small spatula of magnesium powder and stir the mixture.

(a) What piece of equipment should the student use to measure an **accurate** volume of 25 cm^3 of dilute hydrochloric acid?

..... **[1]**

(b) Look at **Fig. 12.2**. It shows part of the thermometer used to measure the temperature of the dilute hydrochloric acid at the start of the experiment.

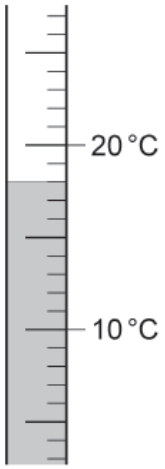


Fig. 12.2

What is the temperature shown on the thermometer?

..... **[1]**

(c) The student's method is incomplete.

(i) Describe what the student should do next to prove that the reaction is exothermic.

.....

..... **[1]**

(ii) Predict the result the student would obtain.

..... **[1]**

(d) Why was the temperature change measured by the student **less** than he expected?

Tick (✓) **one** box.

Some heat escaped from the top of the polystyrene cup. ☐

The thermometer was left in the dilute hydrochloric acid for too long. ☐

Too much magnesium powder was added to the dilute hydrochloric acid. ☐

[1]

(e) Look at **Fig. 12.3**. It shows the reaction profile for an exothermic reaction.

E_a is the activation energy.

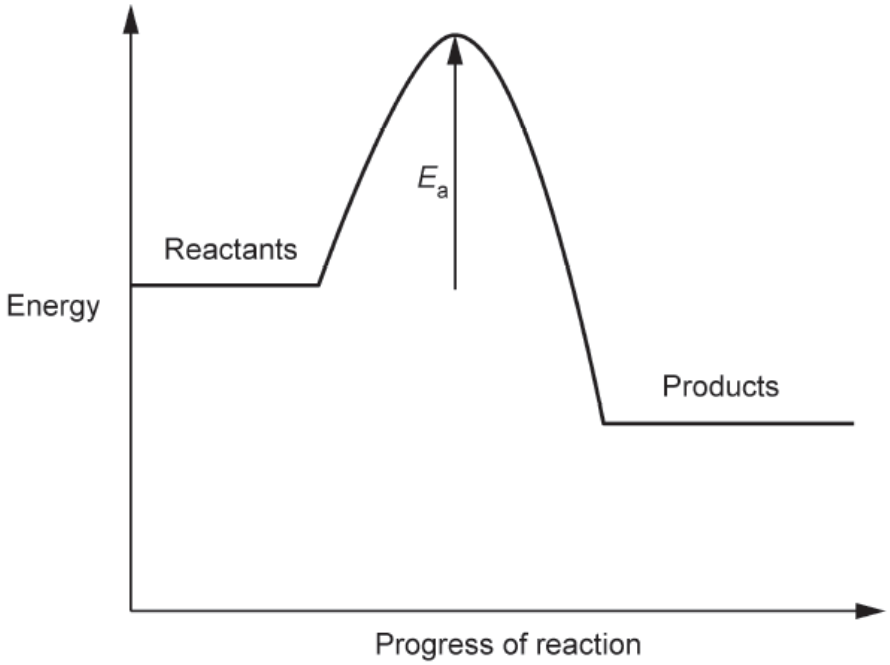


Fig. 12.3

(i) Describe how the reaction profile shows that this reaction is **exothermic**.

.....

..... **[1]**

(ii) What is meant by **activation energy**?

.....

..... **[1]**

(f) When magnesium reacts with dilute hydrochloric acid, a gas is produced.

(i) What is the name of the gas produced?

..... **[1]**

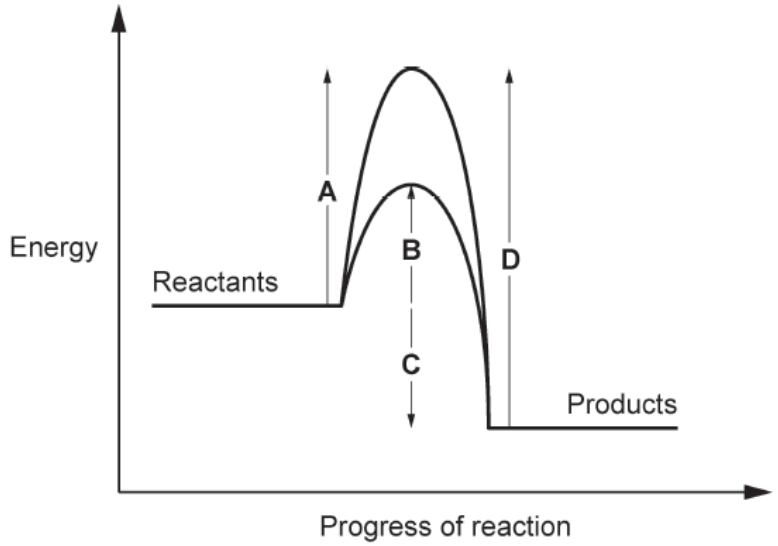
(ii) Describe the test and result for the gas named in **(f)(i)**.

Test .....

Result ..... **[2]**

3. Nov/2020/Paper_J250/04/No.6

Look at the energy profile for a reaction.



Which letter shows the activation energy of the reaction with a catalyst?

Your answer ☐ **[1]**

4. Nov/2020/Paper_J250/04/No.9

What is an example of a **biological** catalyst?

A A lipid

B An amino acid

C An enzyme

D A substrate

Your answer ☐ **[1]**

5. Nov/2021/Paper_J250/09/No.11

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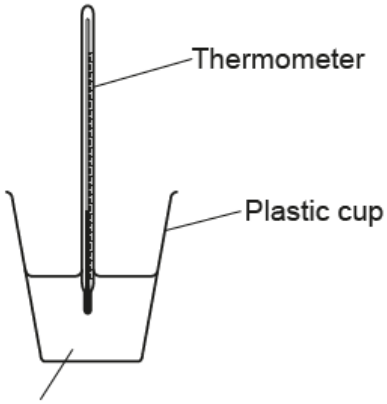

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..... **[1]**

(ii) How should the student have written the temperature change to show that this reaction is endothermic?

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(b) Describe how the student performed the experiment so that they could calculate the temperature change.

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(c) The student repeats the experiment using a different mass of citric acid. This time the student measures a larger temperature change.

The temperature change is 10.0 °C.

If 0.65 g of citric acid gives a temperature change of 3.5 °C, calculate the mass of citric acid, **in milligrams**, that gives a 10.0 °C temperature change.

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Mass of citric acid = ... mg **[4]**

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(e) Citric acid and sodium hydrogen carbonate react to form sodium citrate.

Sodium citrate contains sodium ions, Na^+, and citrate ions, $C_6H_5O_7^{3-}$.

Write the **formula** of sodium citrate.

..... **[1]**

6. Nov/2021/Paper_J250/09/No.15(c)

(c) The equation shows the formation of 1 mole of carbon dioxide from carbon monoxide and oxygen.

The table shows the bond energies of some bonds.

Bond	Bond energy (kJ/mol)
C≡O	1070
O=O	496
C=O	743

Calculate the energy change for the formation of 1 mole of carbon dioxide.

Energy change = ... kJ/mol **[3]**

7. Nov/2021/Paper_J250/09/No.13

Hydrogen peroxide solution decomposes slowly to form water and oxygen.

Look at the equation for the reaction.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

This reaction, shown in **Fig. 13.1**, is very slow.

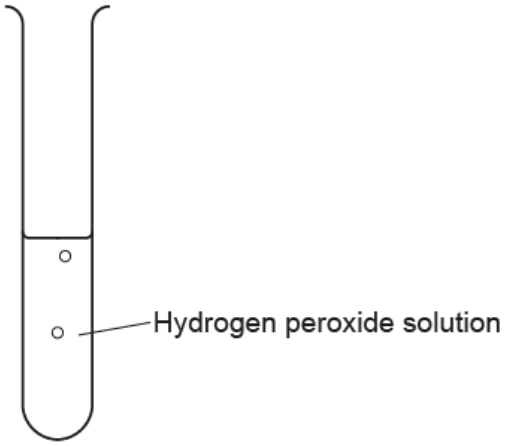

Fig. 13.1

A student thinks that adding manganese(IV) oxide, MnO_2, will catalyse the decomposition reaction.

Her experiment is shown in **Fig. 13.2**.

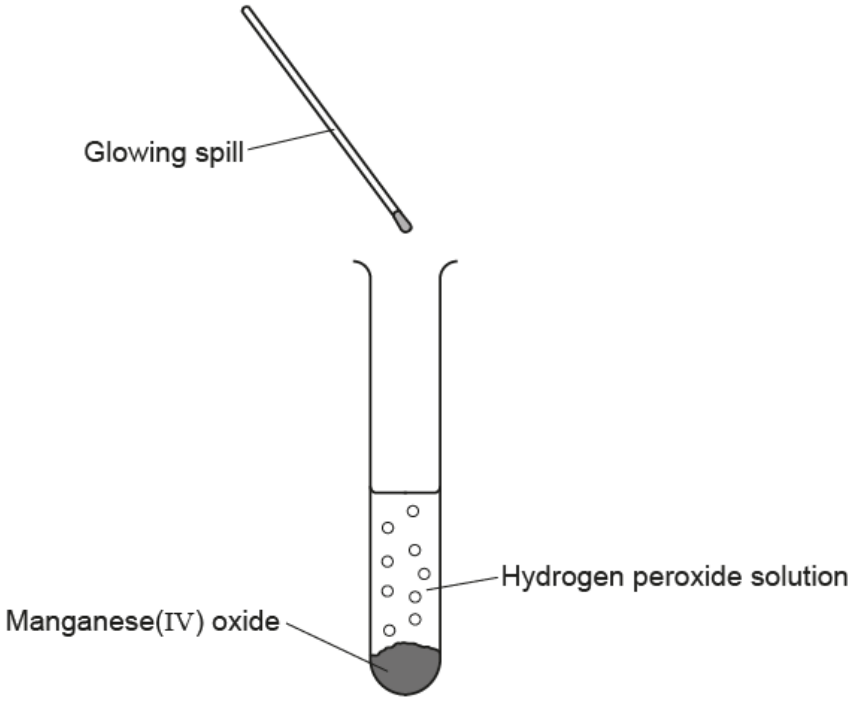

Fig. 13.2

When she puts the glowing spill into the test tube in **Fig. 13.2** the spill relights.

The student separates the manganese(IV) oxide from the reaction mixture.

She adds this manganese(IV) oxide to a new solution of hydrogen peroxide.

Predict the results of this experiment if manganese(IV) oxide **is** a catalyst.

Explain your answer.

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..... **[4]**