

5.1 Energetics of a reaction

01. 0620_s12_qp_62 Q: 5

A student investigated the temperature changes when two different solids, **C** and **D**, dissolved in water.

Two experiments were carried out.

Experiment 1

Using a measuring cylinder, 25 cm³ of distilled water was poured into a polystyrene cup. The initial temperature of the water was measured.

Solid **C** was added to the water, the timer started and the mixture stirred with a thermometer. The temperature of the solution was measured every 30 seconds for three minutes.

(a) Use the thermometer diagrams in the table to record the temperatures.

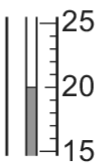
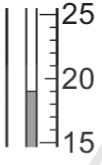
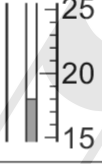
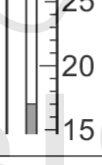
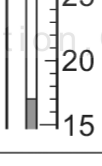
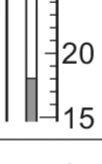
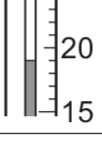
| time / s | thermometer diagram | temperature / °C |
|----------|---------------------|------------------|
| 0 | | |
| 30 | | |
| 60 | | |
| 90 | | |
| 120 | | |
| 150 | | |
| 180 | | |

5.1. ENERGETICS OF A REACTION

Experiment 2

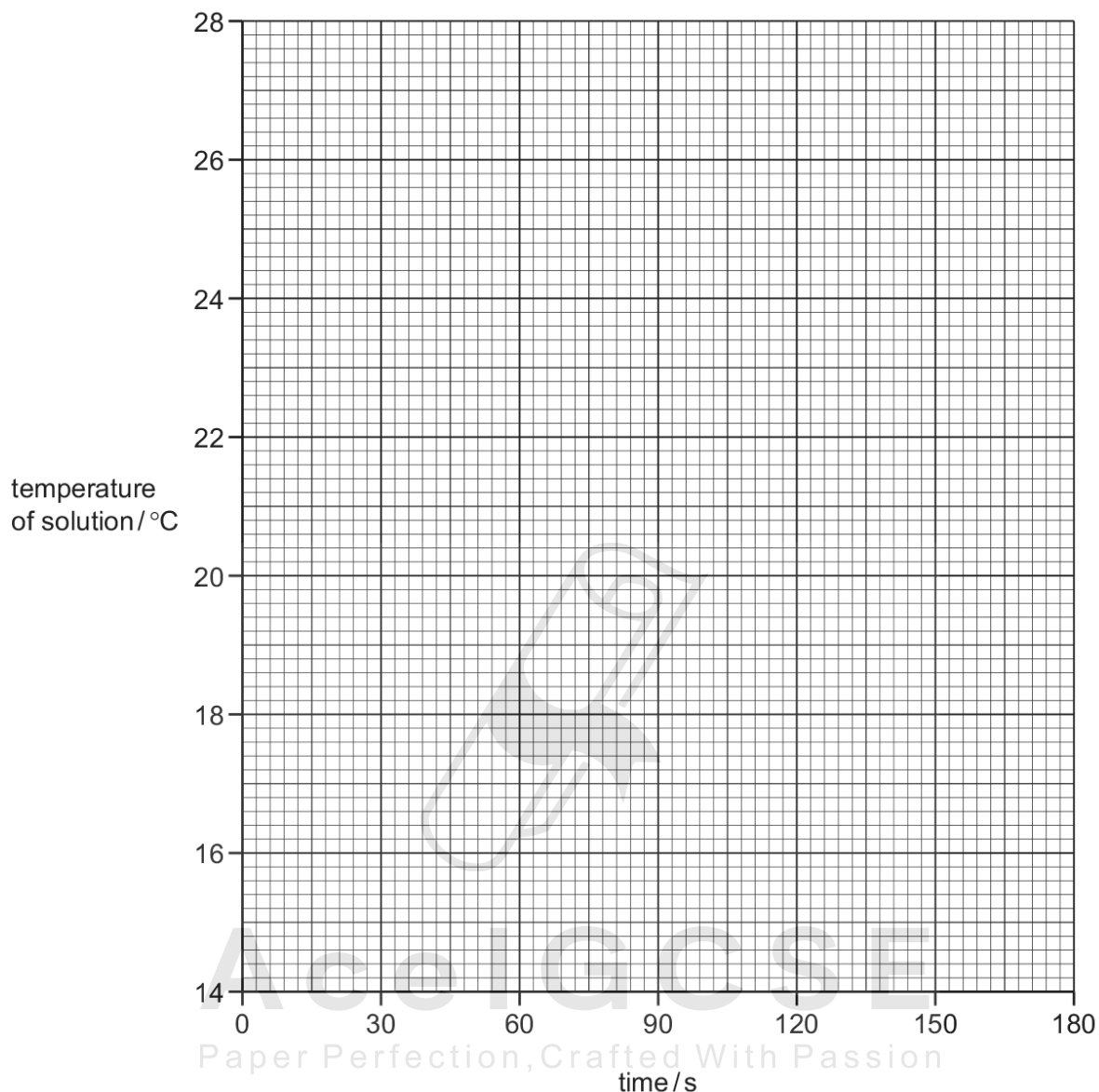
The polystyrene cup was emptied and rinsed with water. Experiment 1 was repeated using solid **D** instead of solid **C**. The temperature of the solution was measured every 30 seconds for three minutes as before.

(b) Use the thermometer diagrams in the table to record the temperatures.

| time/s | thermometer diagram | temperature/°C |
|--------|---|----------------|
| 0 |  | |
| 30 |  | |
| 60 |  | |
| 90 |  | |
| 120 |  | |
| 150 |  | |
| 180 |  | |

[2]

- (c) Plot the results for Experiments 1 and 2 on the grid and draw two smooth line graphs. Clearly label your graphs.



[6]

- (d) (i) From your graph, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly on the graph how you worked out your answer.

.....°C

[2]

- (ii) From your graph, deduce how long it takes for the initial temperature of the solution in Experiment 2 to change by 1.5°C. Show clearly on the graph how you worked out your answer.

.....s

[2]

5.1. *ENERGETICS OF A REACTION*

(e) What type of change occurs when substance **D** dissolves in water?

..... [1]

(f) Suggest the effect on the results if Experiment 1 was repeated using 50 cm³ of distilled water.

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

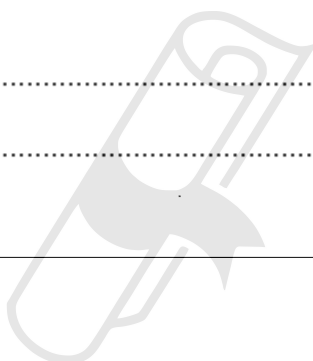
(g) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

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

(h) When carrying out the experiments what would be the advantage of taking the temperature readings every 15 seconds?

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

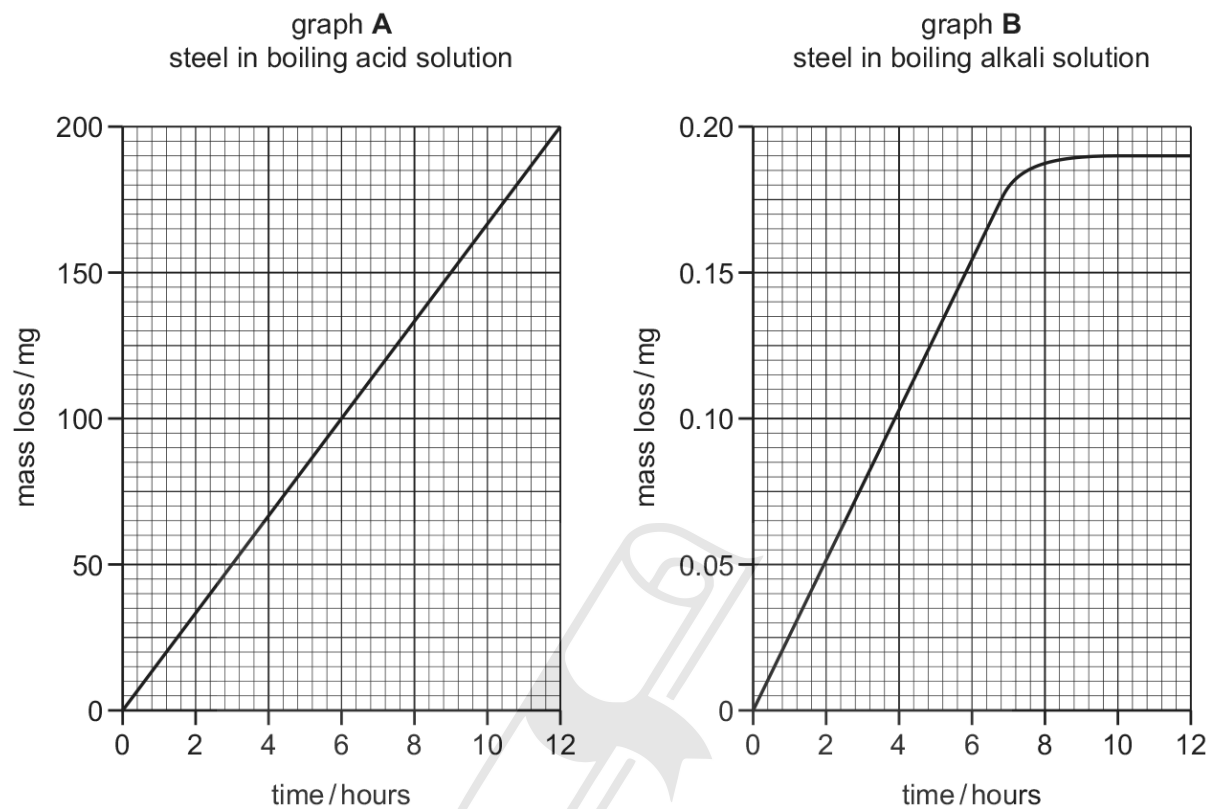
[Total: 20]



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02. 0620_s13_qp_61 Q: 5

Identical pieces of steel were placed in two different boiling liquids for 12 hours. The graphs show how the mass of each piece of steel changed.



(a) Give **one** similarity in the change in mass of the steel in both liquids.

..... [1]

(b) Describe **two** ways in which the mass loss shown in graph A is different from that shown in graph B.

1.

2.

..... [3]

(c) State **two** different safety precautions that would need to be taken when carrying out this investigation.

1.

2. [2]

[Total: 6]

04. 0620_s13_qp_62 Q: 5

A student investigated the temperature changes when dilute nitric acid neutralised aqueous potassium hydroxide. The instructions followed are listed below.

Step 1 The solutions were left at room temperature for one hour.

Step 2 Using a measuring cylinder, 20 cm^3 of aqueous potassium hydroxide solution was poured into a polystyrene cup and its temperature measured.

Step 3 From a burette, 5.0 cm^3 of nitric acid was added to the cup. The highest temperature reached by the mixture was measured. A further 5.0 cm^3 of nitric acid was added to the mixture and the highest temperature measured. Further 5.0 cm^3 additions were made until a total of 30.0 cm^3 of nitric acid had been added.

(a) Use the thermometer diagrams to complete the temperatures in the table.

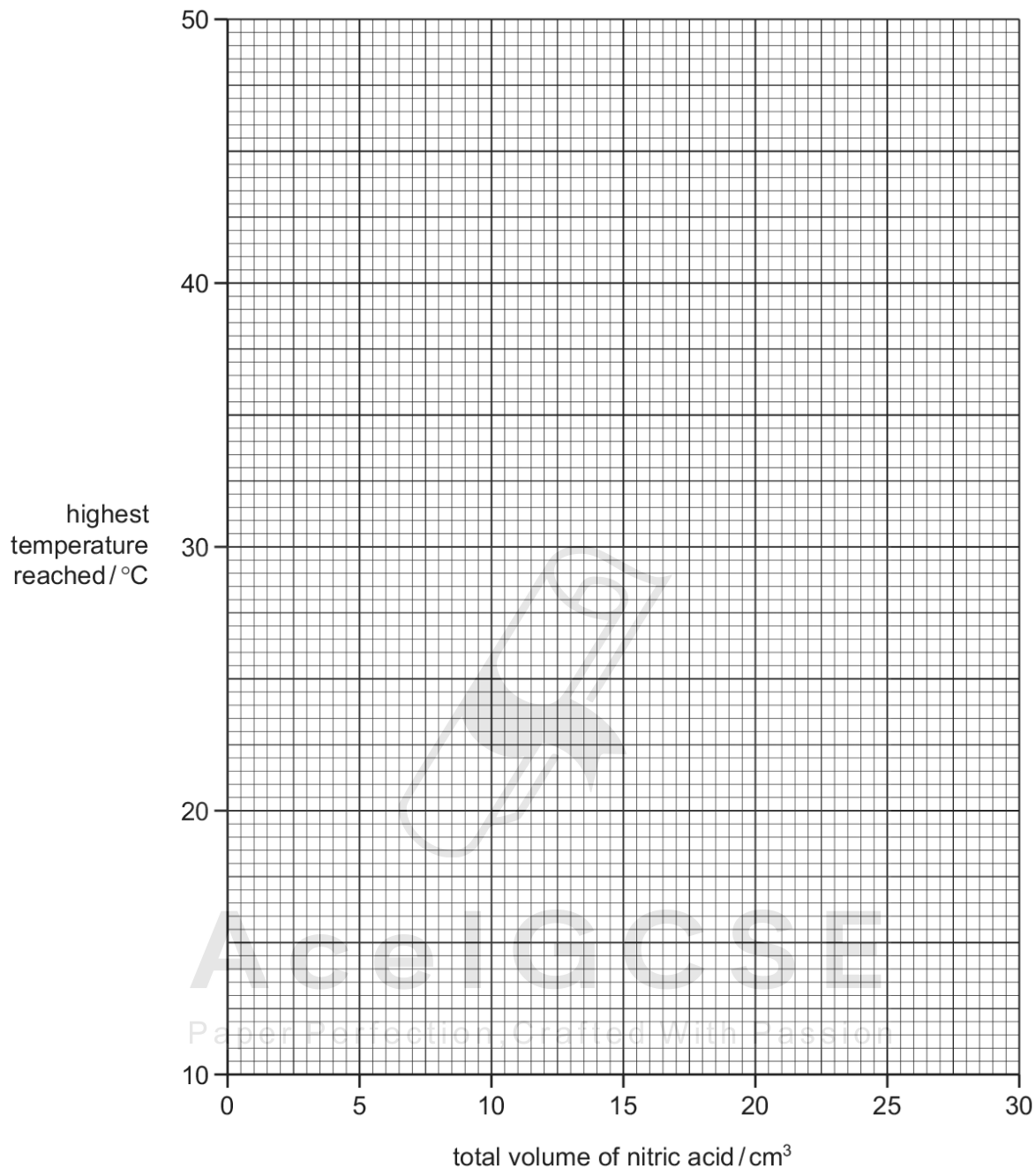
| volume of nitric acid added / cm^3 | thermometer diagram | highest temperature reached / $^{\circ}\text{C}$ |
|---|---------------------|--|
| 0.0 | | |
| 5.0 | | |
| 10.0 | | |
| 15.0 | | |
| 20.0 | | |
| 25.0 | | |
| 30.0 | | |



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(b) Plot the results on the grid. Draw two intersecting straight lines through the points.



[4]

(c) From your graph, work out the volume of nitric acid needed to completely neutralise the 20 cm³ of aqueous potassium hydroxide. Using an arrow, show clearly on the grid this neutralisation point.

..... [2]

(d) What was the room temperature?

..... [1]

(e) Why was a polystyrene cup used instead of a glass beaker?

..... [1]

5.1. *ENERGETICS OF A REACTION*

(f) Why does the temperature:

increase

.....

then decrease?

..... [2]

(g) What type of chemical reaction is this neutralisation?

..... [1]

[Total: 14]



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05. 0620_s18_qp_62 Q: 2

A student investigated the temperature changes when two different solids, solid **C** and solid **D**, dissolved in water.

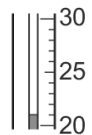
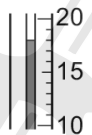
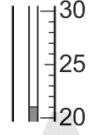
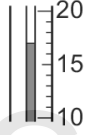


Two experiments were done.

Experiment 1

- Using a measuring cylinder, 40 cm³ of distilled water was poured into a polystyrene cup. The initial temperature of the distilled water was measured.
- 3 g of solid **C** was added to the polystyrene cup and the mixture was stirred with a thermometer. The temperature of the solution was measured after 1 minute.
- The procedure was repeated using 4 g of solid **C**.
- The procedure was repeated using 6 g of solid **C**.

(a) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

| mass of solid C / g | thermometer diagram | initial temperature of the distilled water / °C | thermometer diagram | temperature of the solution after 1 min / °C | temperature change / °C |
|----------------------------|---|---|---|--|-------------------------|
| 3 |  | |  | | |
| 4 |  | |  | | |
| 6 |  | |  | | |

[2]

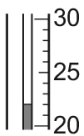
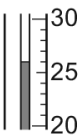
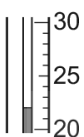
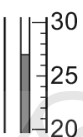

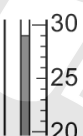

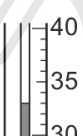
5.1. ENERGETICS OF A REACTION

Experiment 2

- Experiment 1 was repeated but using 3g, 4g, 6g and 8g of solid D .

(b) Use the thermometer diagrams to record the results in the table.

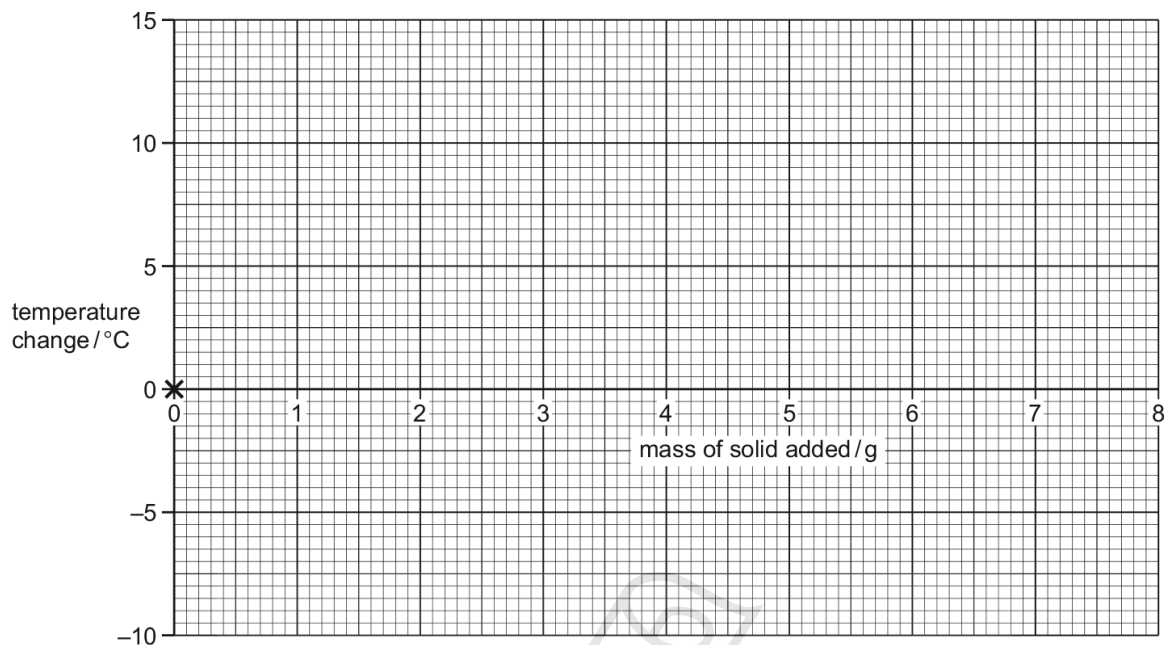
Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (-).

| mass of solid D/g | thermometer diagram | initial temperature of the distilled water/°C | thermometer diagram | temperature of the solution after 1 min/°C | temperature change/°C |
|-------------------|---|---|---|--|-----------------------|
| 3 |  | |  | | |
| 4 |  | |  | | |
| 6 |  | |  | | |
| 8 |  | |  | | |

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[2]

- (c) Plot the results for Experiments 1 and 2 on the grid. The (0,0) point has been plotted for you. Draw **two** straight lines of best fit. Clearly label your graphs.



[4]

- (d) Use your graph to estimate the temperature change after 1 minute if 8 g of solid **C** were added to 40 cm³ of distilled water.

Show clearly on the grid how you worked out your answer.

..... °C [2]

- (e) What type of energy change occurs when solid **D** dissolves in water?

..... [1]

- (f) Suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.

Explain your answer.

.....

..... [2]

5.1. ENERGETICS OF A REACTION

(g) How would the temperature changes measured after 1 minute differ if the experiments were repeated using 80 cm³ instead of 40 cm³ of distilled water in each case?

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

(h) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change

explanation

..... [2]

(i) Suggest how the reliability of the results could be checked.

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

[Total: 19]

06. 0620_s18_qp_63 Q: 2

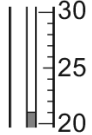
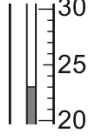
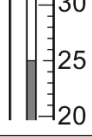
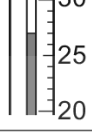
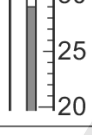
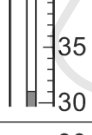
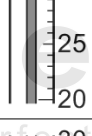


A student investigated how the temperature changed when aqueous sodium hydroxide reacted with solutions of two different acids, acid **R** and acid **S**.

Two experiments were done.

Experiment 1

- A measuring cylinder was used to pour 50 cm³ of aqueous sodium hydroxide into a polystyrene cup. The temperature of the solution was measured.
- A burette was filled up to the 0.0 cm³ mark with acid **R**.
- 5.0 cm³ of acid **R** was added to the aqueous sodium hydroxide in the polystyrene cup and the solution stirred.
- The highest temperature of the solution was measured.
- A further 5.0 cm³ of acid **R** was added to the polystyrene cup and the solution was stirred.
- The highest temperature of the solution was measured.
- Further 5.0 cm³ portions of acid **R** were added to the polystyrene cup until a total volume of 40.0 cm³ of acid **R** had been added. The highest temperature of the solution was measured after each addition.

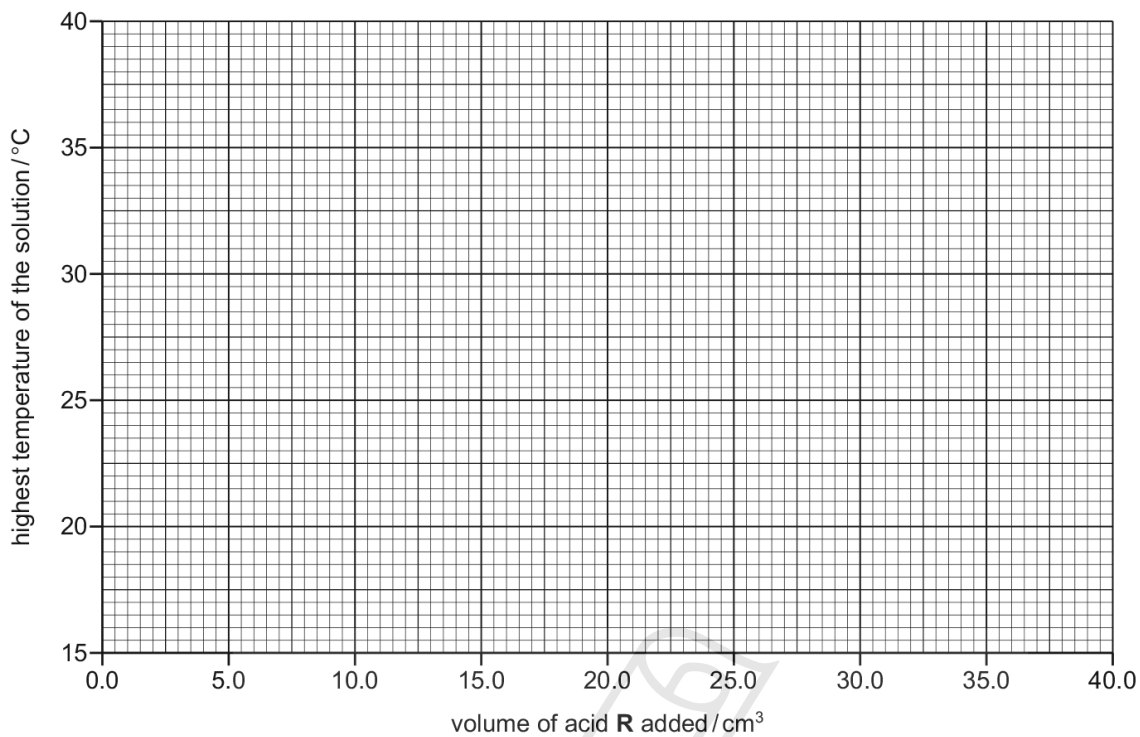
(a) Use the thermometer diagrams to record the results in the table.

| volume of acid added / cm ³ | thermometer diagram | highest temperature of the solution / °C |
|--|---|--|
| 0.0 |  | |
| 5.0 |  | |
| 10.0 |  | |
| 15.0 |  | |
| 20.0 |  | |
| 25.0 |  | |
| 30.0 |  | |
| 35.0 |  | |
| 40.0 |  | |

[2]

5.1. *ENERGETICS OF A REACTION*

(b) Plot the results for Experiment 1 on the grid and draw **two** intersecting straight line graphs.



[2]

Experiment 2

- The burette was rinsed with distilled water and then with acid **S**.
- Experiment 1 was repeated but using acid **S** instead of acid **R**.

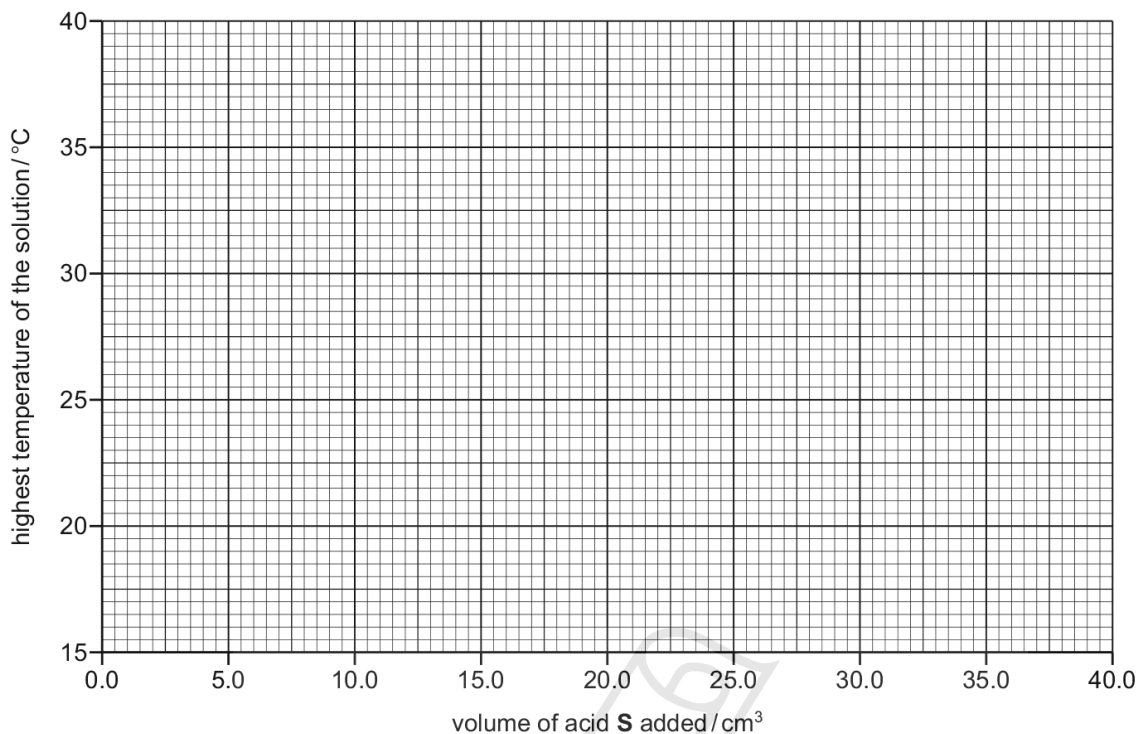
(c) Use the thermometer diagrams to record the results in the table.

| volume of acid S added / cm ³ | thermometer diagram | highest temperature of the solution / °C |
|---|---------------------|--|
| 0.0 | | |
| 5.0 | | |
| 10.0 | | |
| 15.0 | | |
| 20.0 | | |
| 25.0 | | |
| 30.0 | | |
| 35.0 | | |
| 40.0 | | |

[2]

5.1. ENERGETICS OF A REACTION

(d) Plot the results for Experiment 2 on the grid and draw **two** intersecting straight line graphs.



[2]

(e) (i) Use your graph to estimate the volume of acid **S** which must be added to neutralise 50 cm³ of aqueous sodium hydroxide.

Show clearly on the grid how you worked out your answer.

..... cm³ [2]

(ii) Suggest how the volume in (e)(i) would differ if the experiment were repeated using 25 cm³ instead of 50 cm³ of aqueous sodium hydroxide. Explain your answer.

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

(f) What type of energy change occurs when acid **S** reacts with aqueous sodium hydroxide?

..... [1]

(g) (i) In Experiment 2, why was the burette rinsed with distilled water?

..... [1]

(ii) Why was the burette then rinsed with acid **S**?

..... [1]

(h) Describe **one** source of error in Experiment 2. Suggest an improvement to reduce this source of error.

source of error

improvement

[2]

[Total: 17]

07. 0620_w12_qp_62 Q: 4

A student investigated the reaction of aqueous sodium hydroxide with two different acids, **G** and **H**.

Two experiments were carried out.

Experiment 1

Using a measuring cylinder, 20 cm³ of the solution of acid **G** was poured into a polystyrene cup. The initial temperature of the solution was measured.

A burette was filled with aqueous sodium hydroxide to the 0.0 cm³ mark.

5.0 cm³ of aqueous sodium hydroxide was added to the solution of **G** in the cup and the mixture stirred. The maximum temperature of the solution was measured.

A further 5.0 cm³ of aqueous sodium hydroxide was added to the cup and the mixture stirred. The maximum temperature of the mixture was measured.

Further 5.0 cm³ portions of aqueous sodium hydroxide were added to the cup, until a total volume of 40.0 cm³ of sodium hydroxide had been added. After each addition, the mixture was stirred and the maximum temperatures measured.

5.1. ENERGETICS OF A REACTION

(a) Use the thermometer diagrams in the table to record the temperatures.

| volume of aqueous sodium hydroxide added / cm ³ | thermometer diagram | maximum temperature of solution in polystyrene cup / °C |
|--|---------------------|---|
| 0.0 | | |
| 5.0 | | |
| 10.0 | | |
| 15.0 | | |
| 20.0 | | |
| 25.0 | | |
| 30.0 | | |
| 35.0 | | |
| 40.0 | | |

[3]

Experiment 2

Experiment 1 was repeated using 20 cm³ of the solution of acid H instead of the solution of acid G.

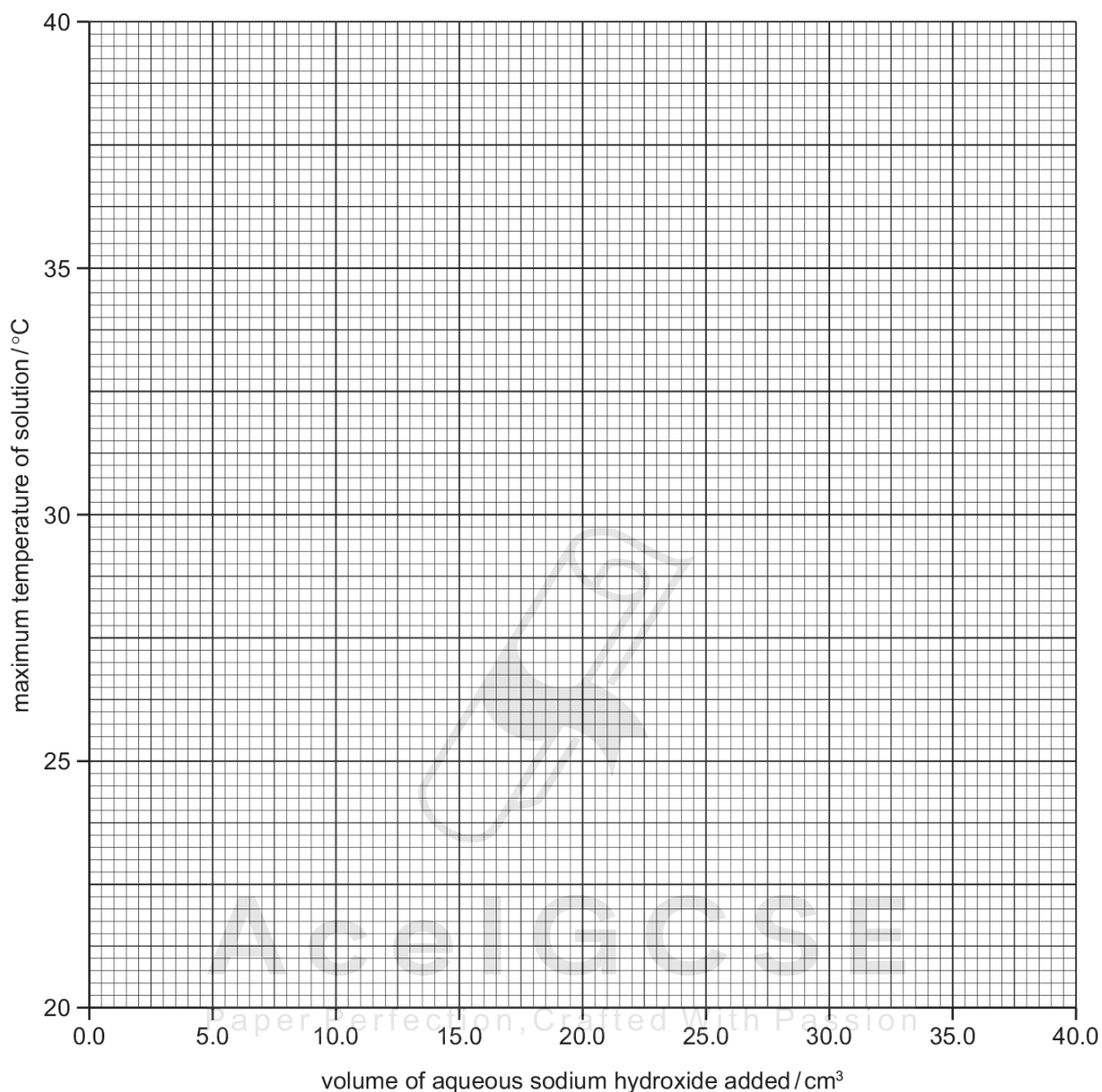
(b) Use the thermometer diagrams in the table to record the temperatures.

| volume of aqueous sodium hydroxide added / cm ³ | thermometer diagram | maximum temperature of solution in polystyrene cup / °C |
|--|---------------------|---|
| 0.0 | | |
| 5.0 | | |
| 10.0 | | |
| 15.0 | | |
| 20.0 | | |
| 25.0 | | |
| 30.0 | | |
| 35.0 | | |
| 40.0 | | |

[3]

5.1. ENERGETICS OF A REACTION

- (c) Plot the results for Experiments 1 and 2 on the grid and draw two smooth line graphs. Clearly label your graphs.



[6]

- (d) Use your graph to estimate the maximum temperature of the reaction mixture when 8.0 cm³ of aqueous sodium hydroxide was added to 20 cm³ of the solution of acid G. Show clearly on the graph how you worked out your answer.

..... [2]

- (e) What type of chemical reaction, other than neutralisation, occurs when acid H reacts with aqueous sodium hydroxide?

..... [1]

(f) (i) In which experiment was the temperature change greater?

..... [1]

(ii) Suggest why the temperature change was greater in this experiment.

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

(g) Predict the temperature of the mixture in Experiment 2 after two hours.
Explain your answer.

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

[Total: 19]



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5.1. ENERGETICS OF A REACTION

08. 0620_w14_qp_62 Q: 4

A student carried out an experiment to measure the temperature changes when aqueous sodium hydroxide reacted with dilute hydrochloric acid.

One experiment was carried out.

Using a measuring cylinder, 25 cm³ of the aqueous solution of sodium hydroxide was poured into a polystyrene cup. The initial temperature of the solution was measured.

A burette was filled with dilute hydrochloric acid to the 0.0 cm³ mark.

10.0 cm³ of dilute hydrochloric acid was added to the aqueous sodium hydroxide in the cup and the mixture stirred. The maximum temperature of the solution was measured. A further 10.0 cm³ of dilute hydrochloric acid was added to the cup and the mixture stirred. The highest temperature of the mixture was measured.

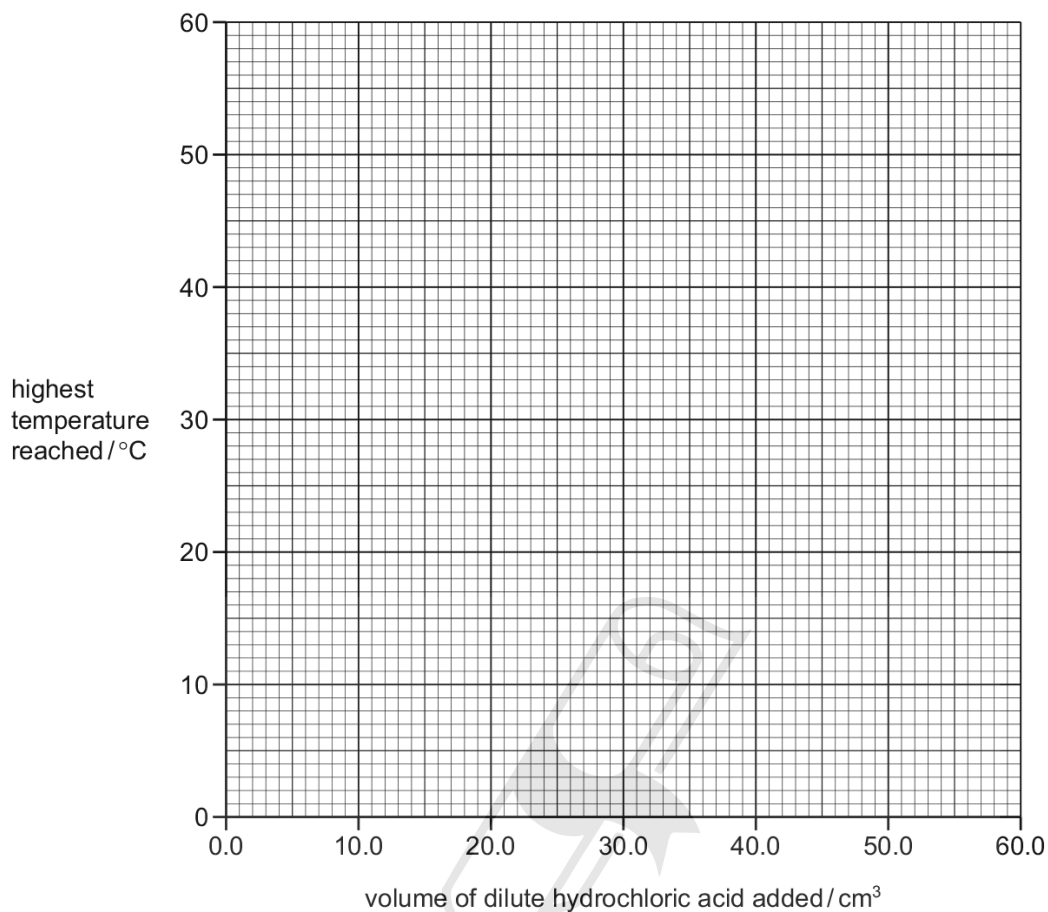
Further 10.0 cm³ portions of dilute hydrochloric acid were added to the cup, until a total volume of 60 cm³ of hydrochloric acid had been added. After each addition the mixture was stirred and the highest temperature measured.

(a) Use the thermometer diagrams to record the temperatures measured in the table.

| volume of dilute hydrochloric acid added / cm ³ | thermometer diagrams | temperature of solution in polystyrene cup / °C |
|--|----------------------|---|
| 0.0 | | |
| 10.0 | | |
| 20.0 | | |
| 30.0 | | |
| 40.0 | | |
| 50.0 | | |
| 60.0 | | |

[3]

- (b) Plot the results for the experiment on the grid. Draw two straight lines through the points and extend them until they cross.



[4]

- (c) (i) Use your graph to estimate the temperature of the reaction mixture when 25.0 cm³ of dilute hydrochloric acid were added to 25 cm³ of aqueous sodium hydroxide. Show clearly on the grid how you worked out your answer.

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- (ii) What volume of dilute hydrochloric acid was needed to completely neutralise 25 cm³ of aqueous sodium hydroxide? Show clearly on the grid how you worked out your answer.

..... [3]

5.1. *ENERGETICS OF A REACTION*

(d) Which reactant had the highest concentration? Explain your answer.

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

(e) What type of chemical reaction, other than neutralisation, occurs when dilute hydrochloric acid reacts with aqueous sodium hydroxide?

..... [1]

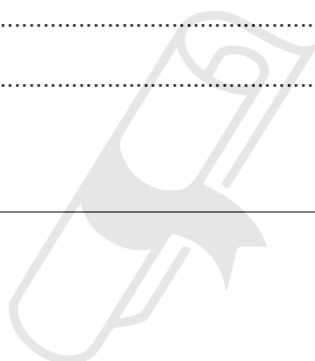
(f) Predict the temperature of the mixture after two hours. Explain your answer.

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

(g) Suggest how the reliability of the results could be checked.

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

[Total: 19]



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09. 0620_w15_qp_63 Q: 3

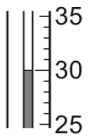
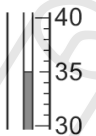
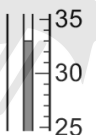

A student investigated the temperature changes when dilute nitric acid reacted with aqueous potassium hydroxide.

Solution **C** was nitric acid and solution **D** was aqueous potassium hydroxide.

She mixed together different volumes of **C** and **D** in four experiments. The maximum temperature reached was measured in each experiment.

The initial temperature of the solutions was 25 °C.

(a) Use the thermometer diagrams in the table to record the maximum temperatures. Work out the rise in temperature in each experiment.

| experiment | volume of C /cm ³ | volume of D /cm ³ | thermometer diagram | maximum temperature / °C | temperature rise / °C |
|------------|-------------------------------------|-------------------------------------|---|--------------------------|-----------------------|
| 1 | 40 | 10 |  | | |
| 2 | 30 | 20 |  | | |
| 3 | 20 | 30 |  | | |
| 4 | 10 | 40 |  | | |

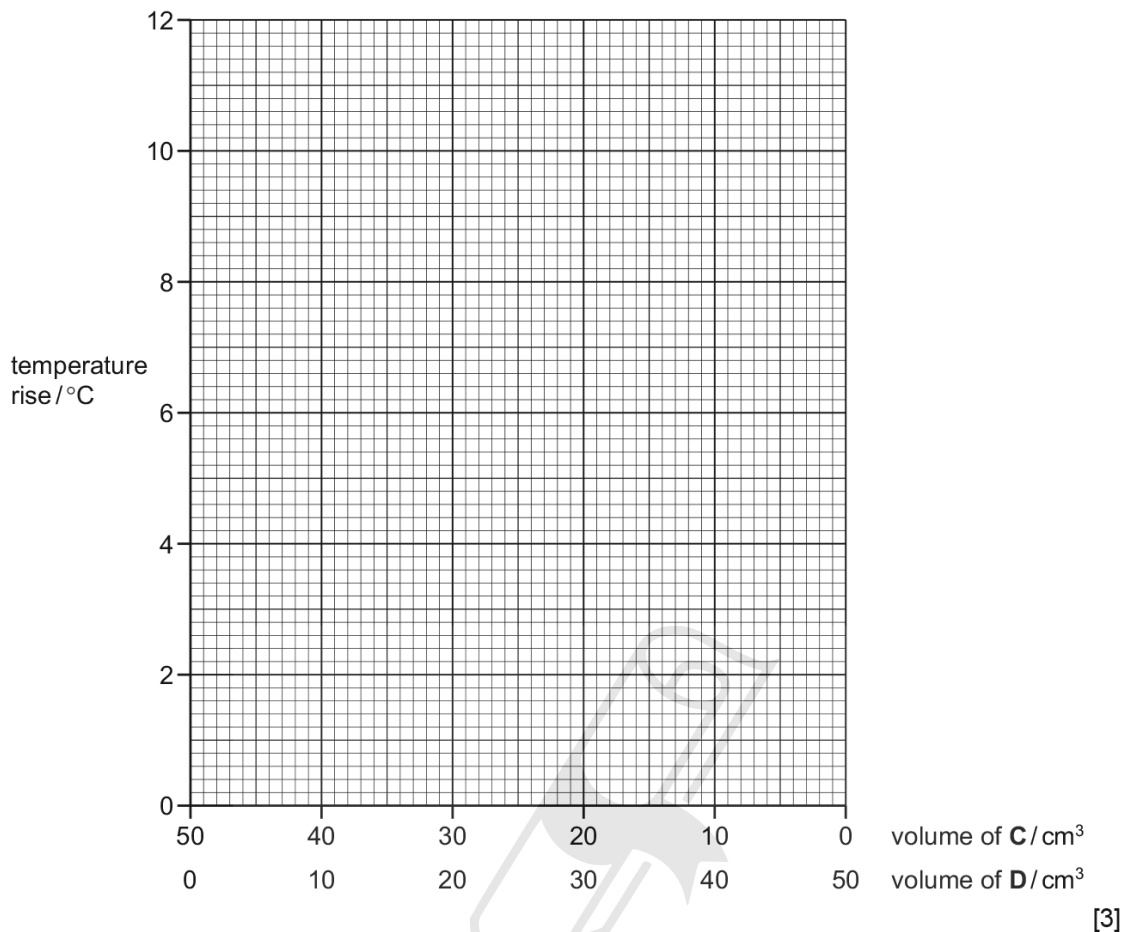
[3]

(b) Why was the total volume of solution always 50 cm³?

..... [1]

5.1. ENERGETICS OF A REACTION

(c) Plot the results on the grid and draw two intersecting straight line graphs.



(d) (i) From your graph, deduce the greatest temperature rise that could occur. Show this point clearly on the grid, with an arrow.

..... °C [1]

(ii) From your graph, deduce the volumes of C and D that would produce this temperature rise.

C

D

[2]

(e) The experiment was repeated using solutions of C and D that were twice as concentrated as used in the original experiment. The initial temperature of the solutions was still 25 °C.

Suggest the greatest temperature rise that could occur.

..... [1]

[Total: 11]

10. 0620_w16_qp_63 Q: 2

A student investigated what happened when two different metals, iron and magnesium, reacted with aqueous copper(II) sulfate.
Two experiments were carried out.

(a) Experiment 1

A measuring cylinder was used to pour 25 cm³ of aqueous copper(II) sulfate into a polystyrene cup. The initial temperature of the solution was measured, then again at 30 seconds and at 60 seconds.

At 60 seconds, the iron was added to the aqueous copper(II) sulfate and the mixture stirred continuously with a thermometer.

The temperature of the mixture was measured every 30 seconds for 300 seconds (5 minutes).
Use the thermometer diagrams to record the results in the table.

| time/s | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 |
|---------------------|---|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| thermometer diagram | | | | | | | | | | | |
| temperature /°C | | | | | | | | | | | |

[2]

(b) Experiment 2

Experiment 1 was repeated using magnesium instead of iron.

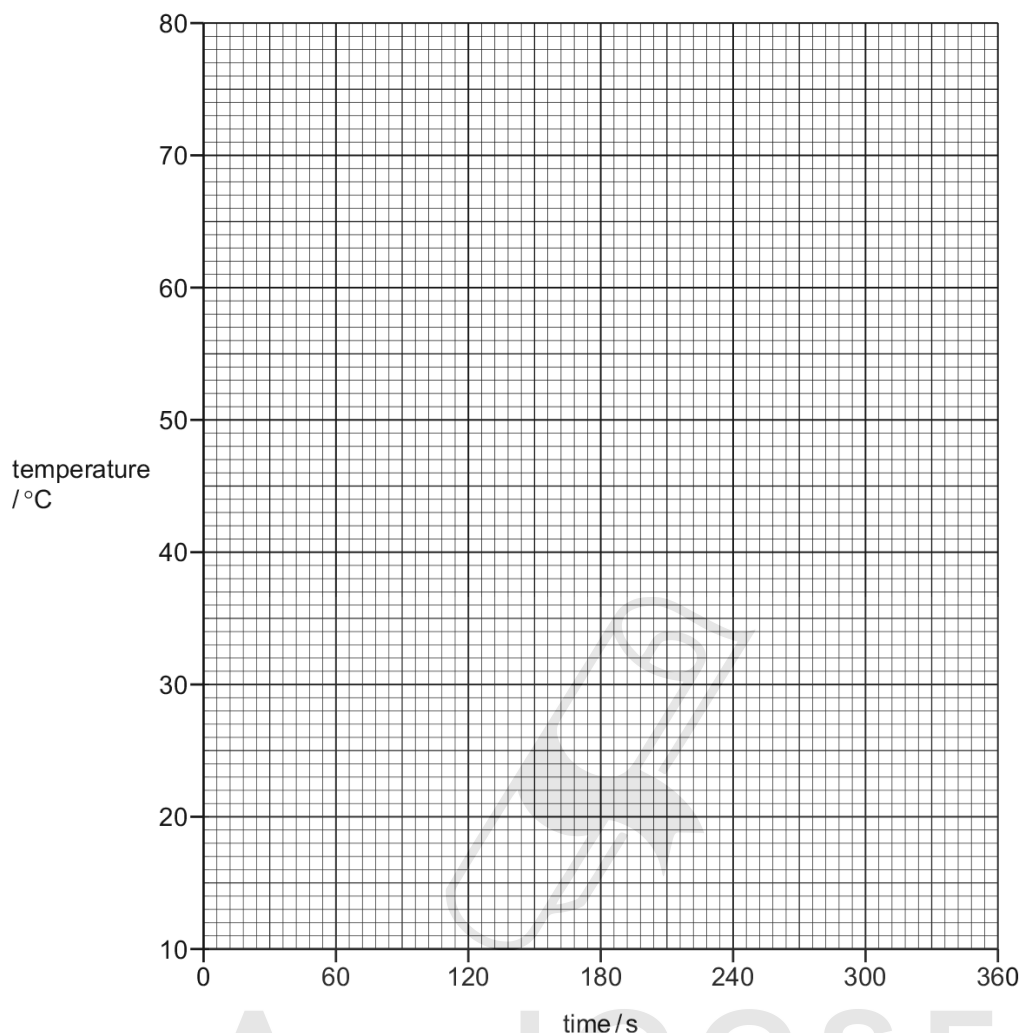
Use the thermometer diagrams to record the results in the table.

| time/s | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 |
|---------------------|---|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| thermometer diagram | | | | | | | | | | | |
| temperature /°C | | | | | | | | | | | |

[2]

5.1. ENERGETICS OF A REACTION

(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label the graphs.



[4]

(d) (i) **From your graph**, deduce the temperature of the mixture in Experiment 1 after 135 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the mixture in Experiment 2 to change by 30 °C **after the magnesium was added**. Show clearly **on the grid** how you worked out your answer.

..... s [2]

(e) Predict the temperature of the mixture in Experiment 2 after one hour. Explain your answer.

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

(f) Suggest an advantage of taking the temperature readings every 15 seconds.

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

(g) Explain why a polystyrene cup is used in the experiments and **not** a copper can.

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

[Total: 18]



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5.1. *ENERGETICS OF A REACTION*

11. 0620_w17_qp_62 Q: 2

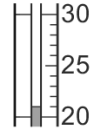
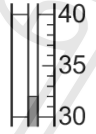
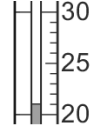
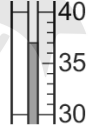

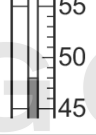
A student investigated what happened when two different solids, **S** and **T**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm³ of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured.
- 2.0g of solid **S** were added to the polystyrene cup and the solution was stirred with a thermometer.
- The **maximum** temperature of the solution was measured.
- The solution was poured away and the polystyrene cup was rinsed out with distilled water.
- The procedure was repeated using 3.0g of solid **S**.
- The procedure was repeated using 5.0g of solid **S**.

(a) Use the thermometer diagrams to record the temperatures in the table.

| mass of solid S / g | thermometer diagram | initial temperature of the water / °C | thermometer diagram | maximum temperature of the solution / °C |
|----------------------------|---|---------------------------------------|---|--|
| 2.0 |  | |  | |
| 3.0 |  | |  | |
| 5.0 |  | |  | |

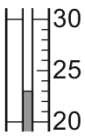
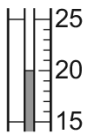
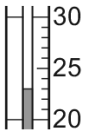
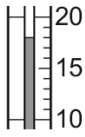
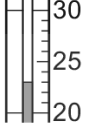
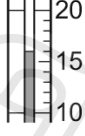

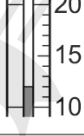
[2]

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Experiment 2

- Experiment 1 was repeated using 2.0g, 3.0g, 4.0g and 6.0g of solid T. The **minimum** temperature of the solution was measured in each case.

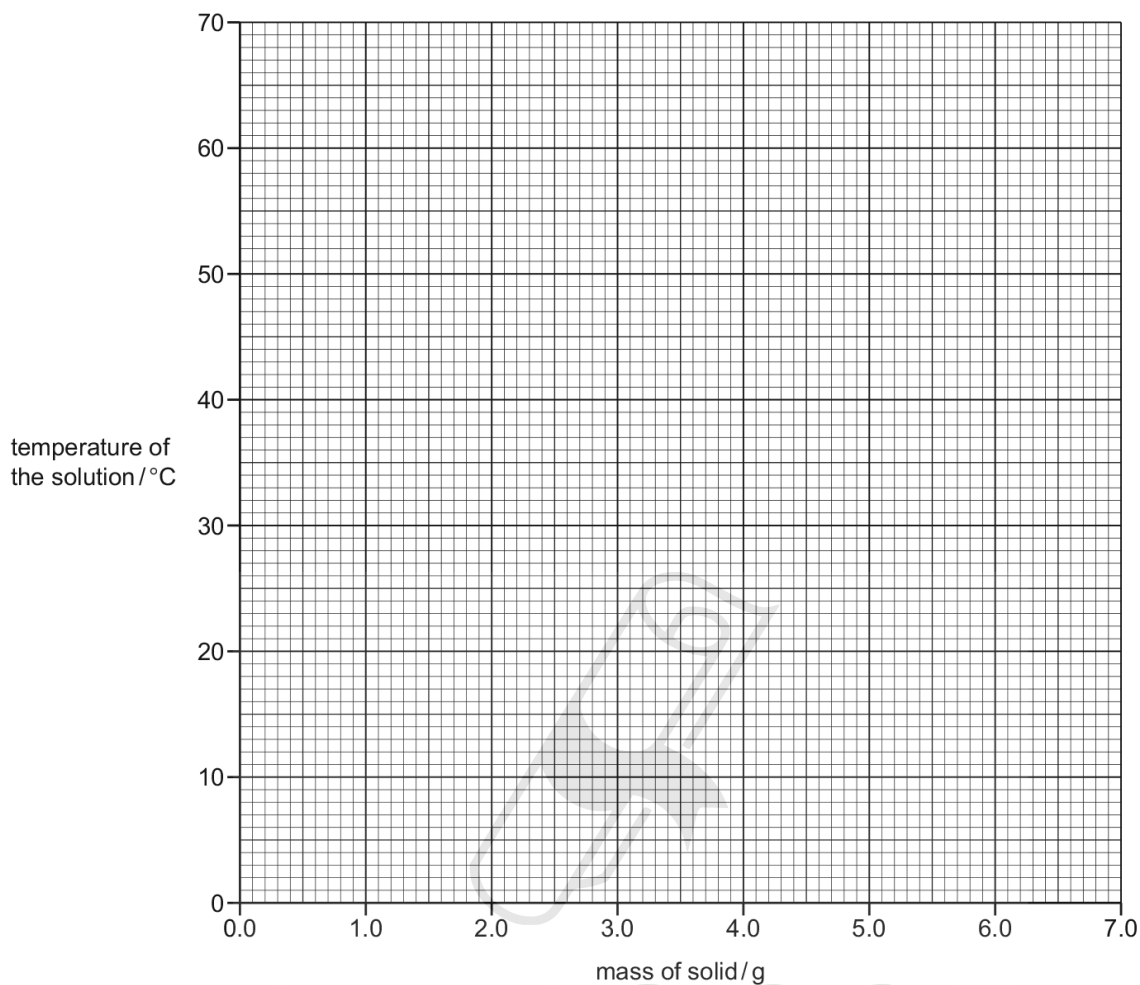
(b) Use the thermometer diagrams to record the temperatures in the table.

| mass of solid T/g | thermometer diagram | initial temperature of the water / °C | thermometer diagram | minimum temperature of the solution / °C |
|-------------------|--|---------------------------------------|--|--|
| 2.0 |  | |  | |
| 3.0 |  | |  | |
| 4.0 |  | |  | |
| 6.0 |  | |  | |

[2]

5.1. ENERGETICS OF A REACTION

- (c) Plot the results of Experiment 1 (maximum temperature) and Experiment 2 (minimum temperature) on the grid. Draw **two** straight lines of best fit. Clearly label your lines.



[4]

- (d) (i) **From your graph**, deduce the maximum temperature of the solution if 6.0g of solid **S** were added to 30 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

- (ii) **From your graph**, deduce the minimum temperature of the solution if 4.5g of solid **T** were added to 30 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) Use the results to identify the type of energy change that occurs when solid **S** dissolves in water.

..... [1]

(f) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change

explanation

..... [2]

(g) Suggest how the reliability of the results could be checked.

..... [1]

(h) Explain how the temperatures measured would be different if Experiment 1 were repeated using 60 cm³ of distilled water in each case.

.....

..... [2]

[Total: 18]

5.1. *ENERGETICS OF A REACTION*

12. 0620_w17_qp_63 Q: 2

A student investigated what happened to the temperature when two different solids, **W** and **X**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm³ of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured at time = 0 seconds.
- Solid **W** was added to the water, a timer was started and the solution was stirred with a thermometer.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(a) Use the thermometer diagrams to record the temperatures in the table.

| time / s | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|----------------------------------|---|----|----|----|----|----|----|----|----|----|
| thermometer diagram | | | | | | | | | | |
| temperature of the solution / °C | | | | | | | | | | |

[2]

Experiment 2

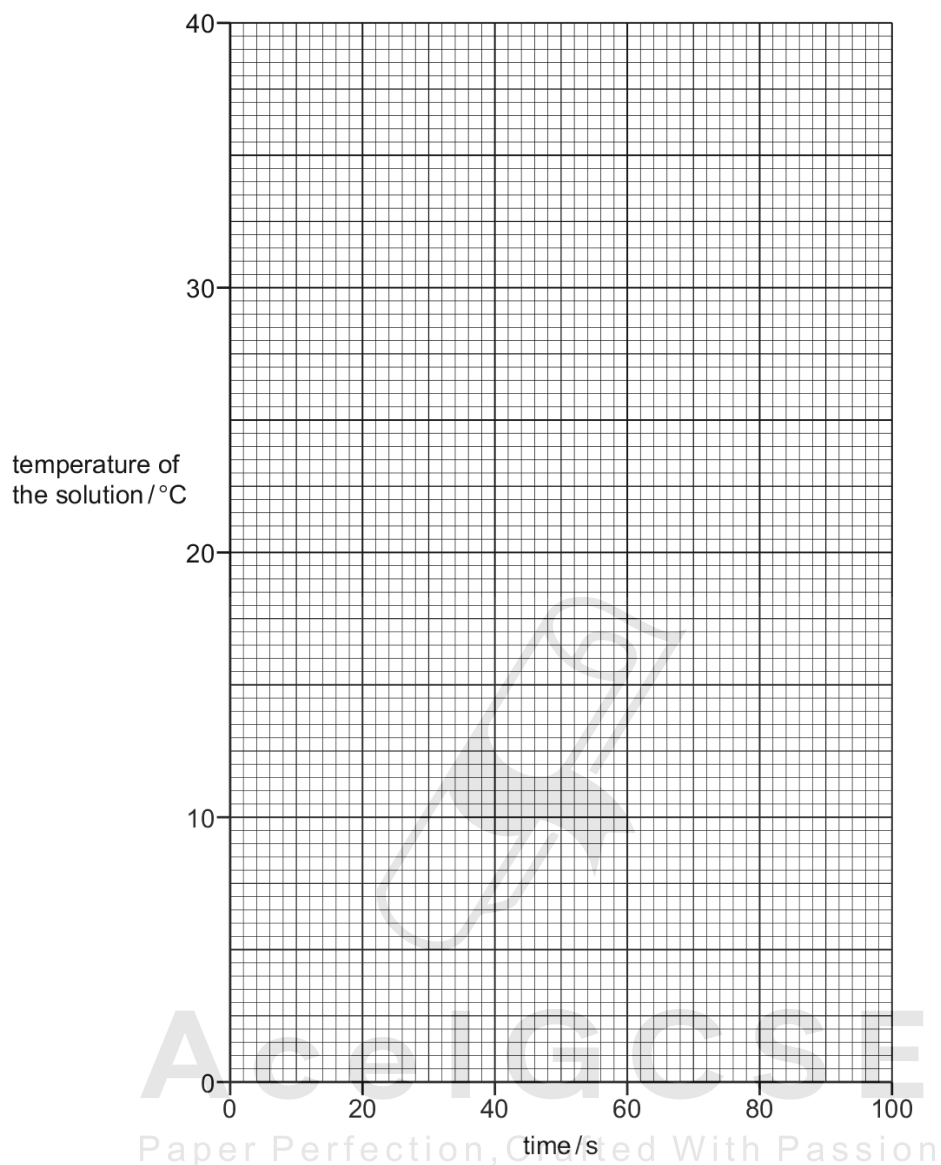
- The polystyrene cup was emptied and rinsed with water.
- Experiment 1 was repeated using solid **X**.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(b) Use the thermometer diagrams to record the temperatures in the table.

| time / s | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|----------------------------------|---|----|----|----|----|----|----|----|----|----|
| thermometer diagram | | | | | | | | | | |
| temperature of the solution / °C | | | | | | | | | | |

[2]

- (c) Plot the results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.



[4]

- (d) (i) **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

- (ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature. Show clearly **on the grid** how you worked out your answer.

..... s [2]

5.1. ENERGETICS OF A REACTION

(e) Use the results to identify the type of energy change that occurs when solid X dissolves in water.

..... [1]

(f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

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

(g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1

improvement 1

source of error 2

improvement 2

[4]

(h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

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

[Total: 19]

5.1. ENERGETICS OF A REACTION

14. 0620_w19_qp_62 Q: 2

A student investigated the temperature changes when two different solids, **N** and **O**, dissolve in water.

Two experiments were done.

Experiment 1

- Using a measuring cylinder, 30 cm³ of distilled water was poured into a polystyrene cup.
- The initial temperature of the distilled water was measured.
- Solid **N** was added to the distilled water, a timer started and the mixture was stirred with a stirring thermometer.
- The temperature of the mixture was measured every 30 seconds for three minutes (180 seconds).

(a) Use the thermometer diagrams to record the temperatures in the table.

| time / s | 0 | 30 | 60 | 90 | 120 | 150 | 180 |
|-----------------------------|---|----|----|----|-----|-----|-----|
| thermometer diagram | | | | | | | |
| temperature of mixture / °C | | | | | | | |

[2]

Experiment 2

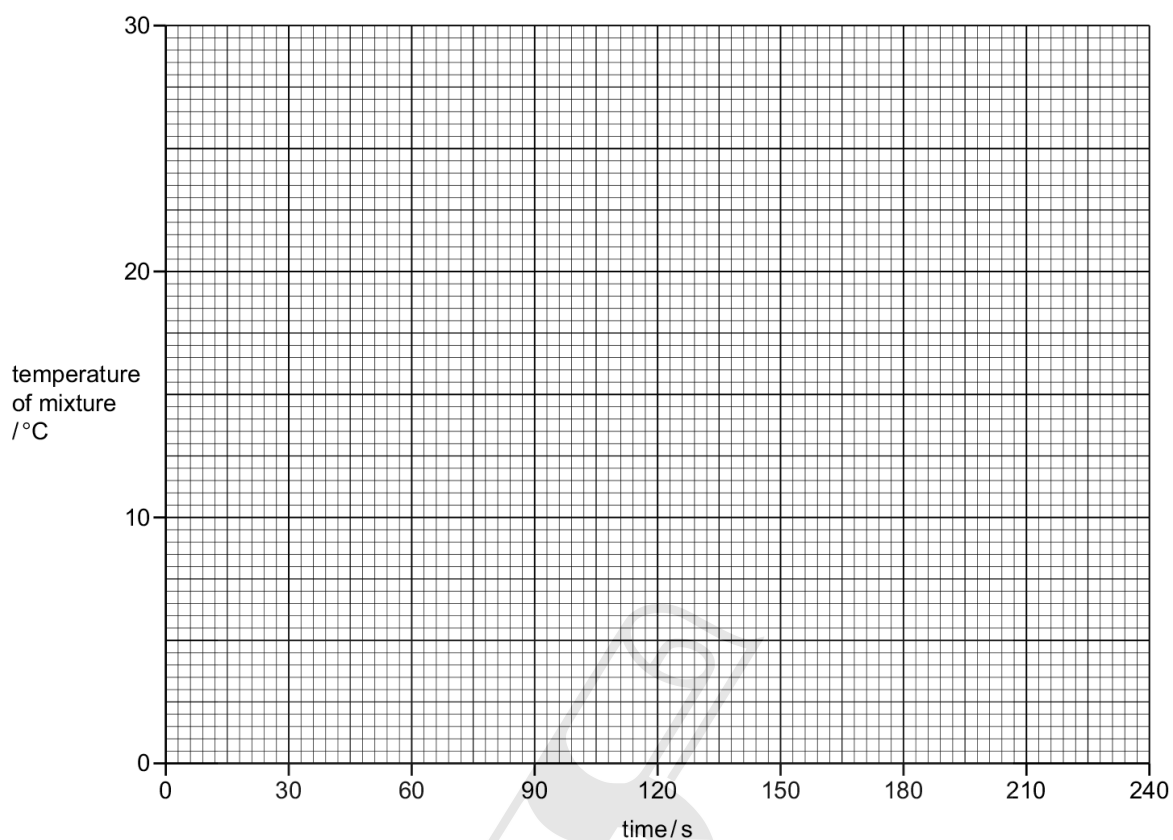
Experiment 1 was repeated using a new polystyrene cup and solid **O** instead of solid **N**.

(b) Use the thermometer diagrams to record the temperatures in the table.

| time / s | 0 | 30 | 60 | 90 | 120 | 150 | 180 |
|-----------------------------|---|----|----|----|-----|-----|-----|
| thermometer diagram | | | | | | | |
| temperature of mixture / °C | | | | | | | |

[2]

- (c) Plot the results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your graphs.



[3]

- (d) (i) From your graph, deduce the time taken for the initial temperature of the solution in Experiment 2 to change by 3 °C.

Show clearly **on the grid** how you worked out your answer.

..... s [3]

- (ii) Extend your graph for Experiment 1 to give the expected temperature of the mixture after 240 seconds.

..... °C [2]

- (e) Is the energy change in Experiment 2 exothermic or endothermic? Explain your answer.

.....
 [1]

16. 0620_w21_qp_63 Q: 2

A student investigated the temperature change when zinc reacted with two different aqueous solutions of copper(II) sulfate, solution **Q** and solution **R**.

Two experiments were done.

(a) *Experiment 1*

- A polystyrene cup was placed in a 250 cm³ beaker for support.
- Using a measuring cylinder, 25 cm³ of solution **Q** was poured into the polystyrene cup.
- Using a thermometer, the initial temperature of solution **Q** was measured.
- 3 g of zinc powder was added to the polystyrene cup. At the same time a stop-clock was started.
- Using the thermometer, the mixture in the polystyrene cup was continually stirred and the temperature measured every 30 seconds.

| | |
|-------------------------------------|-------|
| initial temperature in Experiment 1 | 23 °C |
|-------------------------------------|-------|

Use the thermometer diagrams and the initial temperature to complete the table.
Calculate the temperature changes using the equation:

$$\text{temperature change} = \text{temperature} - \text{initial temperature}$$

| time / s | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 |
|-------------------------|----|----|----|-----|-----|-----|-----|-----|
| thermometer diagram | | | | | | | | |
| temperature / °C | | | | | | | | |
| temperature change / °C | | | | | | | | |

[3]

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5.1. ENERGETICS OF A REACTION

(b) Experiment 2

- The polystyrene cup was washed out with distilled water.
- Experiment 1 was repeated using solution R instead of solution Q.

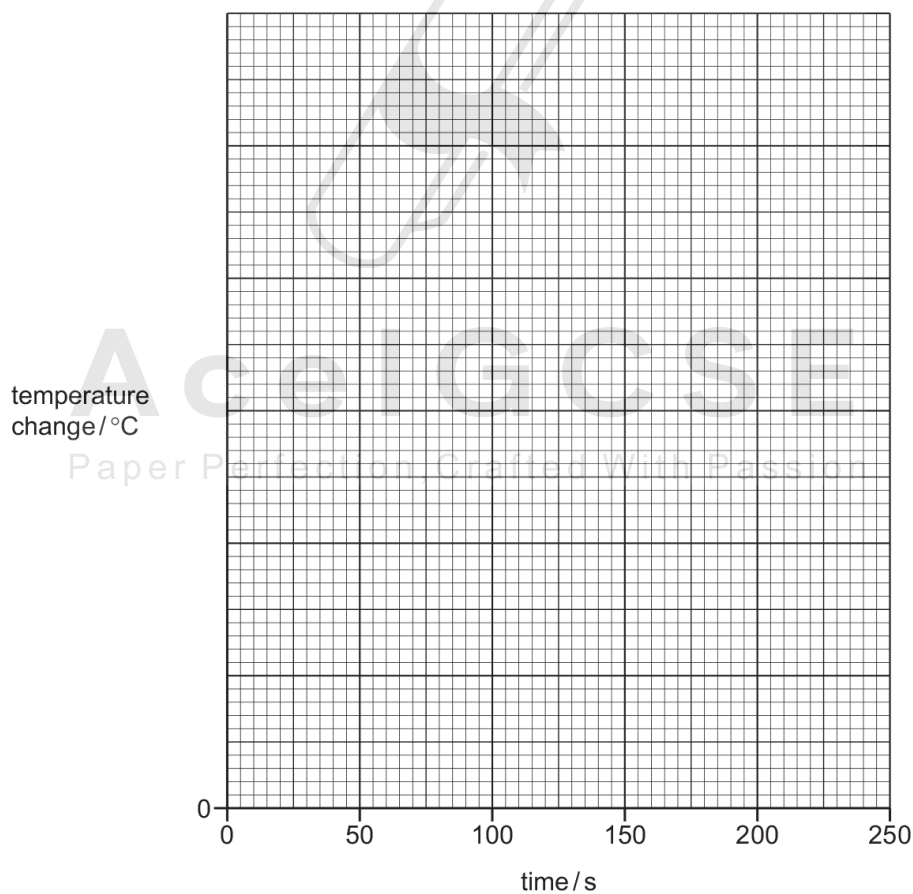
| | |
|-------------------------------------|-------|
| initial temperature in Experiment 2 | 24 °C |
|-------------------------------------|-------|

Use the thermometer diagrams and the initial temperature to complete the table.

| time / s | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 |
|-------------------------|----|----|----|-----|-----|-----|-----|-----|
| thermometer diagram | | | | | | | | |
| temperature / °C | | | | | | | | |
| temperature change / °C | | | | | | | | |

[3]

- (c) Complete a suitable scale on the y-axis and plot the results from Experiment 1 and Experiment 2 on the grid. Draw two curves of best fit. Both curves must start at (0,0). Label your curves.



[5]

(d) From your graph, deduce the temperature change at 110 seconds in Experiment 1.

Show clearly on the grid how you worked out your answer.

..... °C
[2]

(e) Predict the temperature of the solution in Experiment 2 after 5 hours. Explain your answer.

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

(f) (i) Suggest why the experiments were done in a polystyrene cup rather than a glass beaker.

..... [1]

(ii) Describe how the results would be different if a glass beaker is used in place of the polystyrene cup.

..... [1]

(g) Suggest one change that could be made to the apparatus that would improve the accuracy of the results. Explain why this change would improve the accuracy of the results.

change

explanation

..... [2]

[Total: 19]

01. 0620_s12_ms_62 Q: 5

- (a) temperature boxes correctly completed (2) 21, 25, 26, 27, 27, 26, 25 [2]
- (b) temperature boxes completed correctly (2) 20, 19, 18, 17, 17, 18, 19 [2]
- (c) all points correctly plotted (3), -1 for any incorrect
smooth line graphs (2)
labels (1) [6]
- (d) (i) value from graph (1) allow: $\pm 1/2$ small square shown clearly (1) [2]
(ii) value from graph (1) allow: $\pm 1/2$ small square shown clearly (1) [2]
- (e) endothermic (1) **ignore**: temperature decreases [1]
- (f) lower temperature (change)/halved (1) **ignore**: reference to rate/time [1]
- (g) room temperature/initial temperature from table/20°C/21°C (1) **ignore**: 25°C
reaction finished/owtte (1) [2]
- (h) more readings/more points (1)
more reliable/more accurate (1) **ignore**: precise
can spot anomalous points or errors (1)
smoother graph/owtte (1) any [2]

[Total: 20]

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02. 0620_s13_ms_61 Q: 5

- (a) both lose mass (1) [1]
not: change mass
- (b) mass loss increases constantly in graph **A** (1)
becomes constant in graph **B** (after about 7–9 hours) (1)
mass loss or change is greater in acid/less in alkali (1) [3]
- (c) goggles / lab coat / tongs / fume cupboard / well ventilated area any two [2]
ignore: reference to hair

03. 0620_s13_ms_61 Q: 6

weigh mixture (1)

add excess (1) sulfuric acid (1)

heat / stir (1)

filter (1) wash (1) dry (1) the carbon / residue

reweigh(1) calculate percentage (1) max 6

[6]

will not work = 0

ignore: details of evaporation of copper sulfate solution**note:** must have at least one weighing for 6 marks

04. 0620_s13_ms_62 Q: 5

(a) thermometer diagrams completed correctly (3) –1 each incorrect23, 29, 35, 41, 39, 35, 31 **ignore:** decimal places

[3]

(b) points plotted correctly (3), –1 each incorrect

two intersecting straight lines (1)

allow: lines extending beyond intercept but must be just two lines and no curves

[4]

(c) 16 (cm³) ±0.5 (1) any indication (1)

[2]

(d) 23 (°C) (1)

[1]

(e) good insulator or reference to minimising heat losses (1)

[1]

(f) reaction produced heat or energy (1) **accept:** reaction is exothermic

reaction finished / reactant(s) used up / KOH used up / neutralised (1)

not: acid used up/ neutralised

[2]

(g) exothermic (1)

[1]

05. 0620_s18_ms_62 Q: 2

| | | |
|-----|--|---|
| (a) | initial temperatures all 21 AND final temperatures 18, 17, 15 | 1 |
| | temperature changes -3, -4, -6 | 1 |
| (b) | initial temperatures 22, 22, 21, 22 AND final temperatures 26, 27, 29, 33 | 1 |
| | temperature changes +4, +5, +8, +11 | 1 |
| (c) | all points plotted correctly (□ half a small square) | 2 |
| | best-fit straight-line graphs | 1 |
| | labels D (upper) and C (lower) or (expt.) 2 and 1 | 1 |
| (d) | value from graph, -8 °C | 1 |
| | extrapolation | 1 |
| (e) | exothermic | 1 |
| (f) | room temperature / 21 °C / 22 °C | 1 |
| | heat lost to surroundings | 1 |
| (g) | half as much | 2 |
| (h) | change in apparatus or method e.g. use a pipette / burette or use insulation / lid | 1 |
| | explanation e.g. as more accurate / precise, than a <u>measuring cylinder</u> / reduce heat losses | 1 |
| (i) | repeat experiments | 1 |
| | compare / average | 1 |

06. 0620_s18_ms_63 Q: 2

| | | |
|--------|--|---|
| (a) | all temperature boxes completed correctly: 21, 23, 25, 27, 29, 31, 30, 29, 28 | 2 |
| | | |
| (b) | all points plotted correctly (□ half a small square) | 1 |
| | best-fit intersecting straight-line graphs | 1 |
| (c) | temperature boxes completed correctly: 21, 26, 31, 32, 31, 30, 29, 28, 27 | 2 |
| | | |
| (d) | all points plotted correctly | 1 |
| | best-fit intersecting straight-line graphs | 1 |
| (e)(i) | value from graph where lines cross: 12 cm ³ | 1 |
| | shown clearly at intersection | 1 |

| | | |
|---------|---|---|
| (e)(ii) | half volume of acid | 1 |
| | less / half as many moles of sodium hydroxide present | 1 |
| (f) | exothermic / heat given out | 1 |
| (g)(i) | to remove traces of acid / clean / remove impurities | 1 |
| (g)(ii) | to remove traces of water | 1 |
| (h) | sources of error using a measuring cylinder or heat losses | 1 |
| | improvement use a pipette / use a burette / lag / insulation / lid | 1 |

07. 0620_w12_ms_62 Q: 4

- (a) Table of results for Experiment 1
temperature boxes completed correctly (3), -1 any incorrect
- 23 27 31 34 36 35 34 33 32 [3]
- (b) Table of results for Experiment 2
temperature boxes completed correctly (3), -1 for each incorrect
- 23 28 32 35 37 38 39 38 36 [3]
- (c) all points correctly plotted $\pm 1/2$ small space(3) -1 for any incorrect
best fit smooth line graphs (2)
labels (1) [6]
- (d) value from graph ,29–30 °C (1)
shown clearly (1) [2]
- (e) exothermic (1) [1]
- (f) (i) experiment 2/acid H (1) [1]
(ii) acid (H) is more concentrated/stronger (1) [1]
- (g) room/initial temperature from table/23 °C (1)
reaction finished/owtte (1) [2]

(a) Table of results

temperature boxes completed correctly (3)

all 7 correct (3)

6 correct (2)

5 correct (1)

4 or fewer correct (0)

26 35 45 54 56 52 48

[3]

(b) all points correctly plotted (3)

all 7 correct (3)

6 correct (2)

5 correct (1)

4 or fewer correct (0)

two intersecting straight line graphs drawn with a ruler (1)

[4]

(c) (i) value from graph, $50(^{\circ}\text{C}) (1) \pm 1$

shown clearly (1)

[2]

(ii) value from graph, $34 \pm 1 (1)$

unit $\text{cm}^3 (1)$

shown clearly (1)

note: if tie-line not to peak of graph, max 1, for unit.

[3]

(d) sodium hydroxide (1)

less volume used than acid / volume of acid used was greater (1)

[2]

- (e) exothermic (1) [1]
- (f) room / initial temperature / 26 °C (1)
ignore: 20 °C
 reaction finished owtte (1) [2]
- (g) repeat (1)
 compare results (1) [2]
allow: take mean / average (1)
ignore: references to insulation

09. 0620_w15_ms_63 Q: 3

| | | | |
|---------|--|--|--|
| (a) | all temperatures correctly recorded: 30, 35, 33, 29 4 correct = 2 3 correct = 1 2 or fewer correct = 0 temperature rises: 5, 10, 8, 4; | 2 1 | I: trailing zeros I: trailing zeros |
| (b) | idea of fair test / comparability of results / only one variable / control (variable); | 1 | |
| (c) | 4 points plotted correctly, \pm half a small square; two intersecting <u>straight</u> lines drawn with a ruler; through points 1 and 2 and 3 and 4, extrapolated to intersect; | 1 1 1 | I: origins |
| (d)(i) | 11 °C; | 1 | ecf from the graph, ± 0.1 °C I: absence of arrow |
| (d)(ii) | C = 28 and D = 22; cm ³ ; | 1 1 | ecf from the graph, C + D = 50 |
| (e) | 22(°C)/2 \times value from (d)(i); | 1 | answer must be a number I: units / lack of units |

10. 0620_w16_ms_63 Q: 2

| | | |
|---------|--|-------------|
| (a) | table of results for Experiment 1 temperature boxes completed correctly 20, 20, 20, 25, 28, 31, 33, 34, 35, 36, 36 | 2 |
| (b) | table of results for Experiment 2 temperature boxes completed correctly 22, 22, 22, 71, 76, 75, 72, 70, 67, 65, 64 | 2 |
| (c) | all points correctly plotted \pm half a small square smooth line graphs labelled | 2 1 1 |
| (d)(i) | working shown clearly as construction lines or cross value from graph (29–30 °C \pm 0.5 °C) | 1 1 |
| (d)(ii) | value from graph (72 s) –60 s | 1 1 |
| (e) | room temperature or initial temperature from table (20–22 °C) reaction has finished / stopped | 1 1 |
| (f) | more readings / points / data smoother curve / better or more accurate graph | 1 1 |
| (g) | polystyrene is an insulator / copper is a (good) conductor reduced heat losses | 1 1 |

11. 0620_w17_ms_62 Q: 2

| | | |
|--------|--|---|
| (a) | initial and final temperature boxes completed: 21, 21, 21, 32, 37, 48 all readings correct = [2] 4 or 5 readings correct = [1] | 2 |
| (b) | initial and final temperature boxes completed: 23, 23, 23, 23, 20, 18, 16, 12 all readings correct = [2] 6 or 7 readings correct = [1] | 2 |
| (c) | all points plotted | 2 |
| | two straight lines of best fit drawn with a ruler | 1 |
| | both graphs appropriately labelled | 1 |
| (d)(i) | value from graph | 1 |
| | shown clearly | 1 |

| | | |
|---------|---|---|
| (d)(ii) | value from graph | 1 |
| | shown clearly | 1 |
| (e) | exothermic | 1 |
| (f) | <i>change to the experiments</i> use burette / pipette use insulation / lid use a new cup / dry the cup | 1 |
| | <i>explanation (to match change)</i> more accurate (than measuring cylinder) reduce heat losses remove water left from the previous experiment | 1 |
| (g) | repeat experiments | 1 |
| (h) | lower temperatures measured / smaller temperature changes | 1 |
| | changed is halved / more water (to heat) | 1 |

12. 0620_w17_ms_63 Q: 2

| | | |
|--------|--|---|
| (a) | temperature boxes completed: 23, 16, 14, 13, 12, 11, 11, 11, 11, 11 all readings correct = [2] 8 or 9 readings correct = [1] | 2 |
| (b) | temperature boxes completed correctly: 22, 26, 29, 31, 32, 33, 34, 35, 35, 35 all readings correct = [2] 8 or 9 readings correct = [1] | 2 |
| (c) | all points plotted | 1 |
| | two smooth line graphs (one line graph correct = [1]) | 2 |
| | both graphs appropriately labelled | 1 |
| (d)(i) | value from graph | 1 |
| | shown clearly | 1 |

| (d)(ii) | value from graph | 1 | | | | | | | | | | | | | | |
|---|---|-----------------|-------------|-------------|-------------------------------|-----------------------------|-----------------------|----------------------------------|---|--------------------------------------|---|----------------|---------------------------|---|---|---|
| | shown clearly | 1 | | | | | | | | | | | | | | |
| (e) | exothermic | 1 | | | | | | | | | | | | | | |
| (f) | room temperature / 22 °C AND reaction has finished / all the solid has dissolved | 1 | | | | | | | | | | | | | | |
| (g) | <table border="1"> <thead> <tr> <th>source of error</th> <th>improvement</th> </tr> </thead> <tbody> <tr> <td>heat losses</td> <td>use a lid / lag the apparatus</td> </tr> <tr> <td>use of a measuring cylinder</td> <td>use a pipette/burette</td> </tr> <tr> <td>wet cup in the second experiment</td> <td>use new/another cup OR dry the cup</td> </tr> <tr> <td>the solid absorbs water from the air</td> <td>store in a sealed container / airtight container / desiccator</td> </tr> <tr> <td>only done once</td> <td>repeat and average</td> </tr> <tr> <td>different masses of solids used / masses of solids not measured</td> <td>use same mass of solid / weigh the solids</td> </tr> </tbody> </table> | source of error | improvement | heat losses | use a lid / lag the apparatus | use of a measuring cylinder | use a pipette/burette | wet cup in the second experiment | use new/another cup OR dry the cup | the solid absorbs water from the air | store in a sealed container / airtight container / desiccator | only done once | repeat and average | different masses of solids used / masses of solids not measured | use same mass of solid / weigh the solids | 4 |
| source of error | improvement | | | | | | | | | | | | | | | |
| heat losses | use a lid / lag the apparatus | | | | | | | | | | | | | | | |
| use of a measuring cylinder | use a pipette/burette | | | | | | | | | | | | | | | |
| wet cup in the second experiment | use new/another cup OR dry the cup | | | | | | | | | | | | | | | |
| the solid absorbs water from the air | store in a sealed container / airtight container / desiccator | | | | | | | | | | | | | | | |
| only done once | repeat and average | | | | | | | | | | | | | | | |
| different masses of solids used / masses of solids not measured | use same mass of solid / weigh the solids | | | | | | | | | | | | | | | |
| (h) | fewer data / less detail / fewer readings / graph not as good / not enough readings whilst the solid is reacting | 1 | | | | | | | | | | | | | | |

13. 0620_w18_ms_62 Q: 4

| | |
|---|--------------|
| <p>Any 4 from</p> <ul style="list-style-type: none"> <input type="checkbox"/> Measured volume of dilute hydrochloric acid <input type="checkbox"/> Use of suitable container (e.g. test tube / beaker / flask / plastic cup) <input type="checkbox"/> Initial temperature of acid <input type="checkbox"/> Add known mass of solid C <input type="checkbox"/> Final temperature of mixture / Calculate temperature change <input type="checkbox"/> Repeat with (same mass / moles of) solid D <p>And</p> <ul style="list-style-type: none"> <input type="checkbox"/> Bigger temperature change is bigger energy change <input type="checkbox"/> Temperature increase is exothermic / temperature decrease is endothermic process | Max 6 |
|---|--------------|

14. 0620_w19_ms_62 Q: 2

| | | |
|-----|--|---|
| (a) | table of results for Experiment 1 temperature boxes completed correctly 22, 24, 25, 26, 27, 27, 26 | 2 |
| (b) | table of results for Experiment 2 temperature boxes completed correctly 21, 15, 12, 11, 10, 10, 11 | 2 |

| | | |
|---------|---|---|
| (c) | all points plotted correctly | 1 |
| | two smooth line graphs | 1 |
| | both labelled | 1 |
| (d)(i) | initial temperature minus 3 °C, 18 °C | 1 |
| | value from graph | 1 |
| | with clear indication | 1 |
| (d)(ii) | graph for Experiment 1 extended downwards | 1 |
| | correct temperature value | 1 |
| (e) | endothermic, temperature decreases | 1 |
| (f) | two sources of error: e.g. heat losses / use of a measuring cylinder / imprecise thermometer / temperature not accurate / experiment only done once / readings taken every 30 s | 2 |
| | two improvements: e.g. use a lid / lag the apparatus / use a pipette / burette / use more accurate / precise thermometer / repeat and average / compare / take readings at shorter intervals to get smoother graph | 2 |

15. 0620_w19_ms_63 Q: 4

| | |
|---|--------------|
| <p>any six from:</p> <ul style="list-style-type: none"> <input type="checkbox"/> known volume / amount of (distilled) water <input type="checkbox"/> initial temperature (of water before solid is added) <input type="checkbox"/> add measured mass / stated mass of potassium nitrate or ammonium chloride <input type="checkbox"/> stir / mix / dissolve / swirl / shake <input type="checkbox"/> final temperature of solution / temperature every 30 s <input type="checkbox"/> repeat with (same mass of) other solid (and volume / amount of water) OR measured mass of other solid <input type="checkbox"/> greater temperature change / decrease OR lowest final temperature is larger energy change / calculate energy change per gram | Max 6 |
|---|--------------|

16. 0620_w21_ms_63 Q: 2

| Question | Answer | Marks |
|----------|---|-------|
| (a) | M1 and M2 all temperature recorded correctly (43.0, 49.0, 51.0, 52.0, 51.0, 49.5, 48.0, 46.5). If seven correct score 1 mark | 2 |
| | M3 all temperature changes calculated correctly (20.0, 26.0, 28.0, 29.0, 28.0, 26.5, 25.0, 23.5) | 1 |
| (b) | M1 all temperature recorded correctly (33.0, 38.0, 41.5, 42.0, 41.0, 40.0, 39.0, 38.0) | 1 |
| | M2 all temperature changes calculated correctly (9.0, 14.0, 17.5, 18.0, 17.0, 16.0, 15.0, 14.0) | 1 |
| | M3 all temperatures and changes in experiment 2 recorded to 1 dp | 1 |
| (c) | M1 suitable scale for y-axis | 1 |
| | M2 M3 plotting – all 16 correct scores 2, 14 or 15 correct scores 1 | 2 |
| | M4 best fit curves for both experiments | 1 |
| | M5 correct labels | 1 |
| (d) | M1 correct working shown | 1 |
| | M2 Value read correctly from graph (correct line gives 28.5-29.0) | 1 |
| (e) | M1 room temperature / 24 | 1 |
| | M2 reaction over | 1 |
| (f)(i) | insulator | 1 |
| (f)(ii) | temperature changes lower / temperatures lower | 1 |
| (g) | change: use a pipette / burette | 1 |
| | explanation: more accurate than a measuring cylinder OR change: use a lid explanation: reduces heat loss | 1 |