13.5 Polymers

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A student investigated the reaction between two different solids, **C** and **D**, and excess dilute hydrochloric acid.

Five experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 30 cm^3 of dilute hydrochloric acid into a polystyrene cup. The temperature of the dilute hydrochloric acid was measured. 1 g of solid **C** was added to the dilute hydrochloric acid and the mixture stirred with a thermometer.
The maximum temperature reached by the liquid mixture was measured.

(b) *Experiment 2*

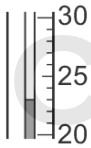
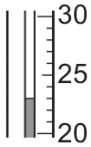
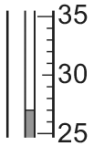
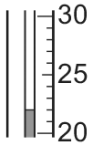
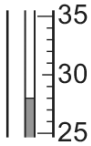
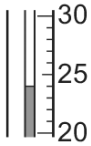
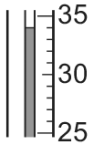
The polystyrene cup was emptied and rinsed with water.
Experiment 1 was repeated using 2 g of solid **C**.

(c) *Experiments 3 and 4*

Experiment 2 was repeated using 3 g and then 5 g of solid **C**.

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

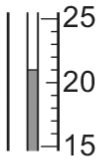
Complete the final column in the table.

experiment	mass of solid **C** / g	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature difference / °C
1						
2						
3						
4						

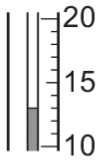
[3]

(d) *Experiment 5*

Experiment 1 was repeated using solid **D**. Use the thermometer diagrams to record the results in the spaces below.



initial temperature of acid



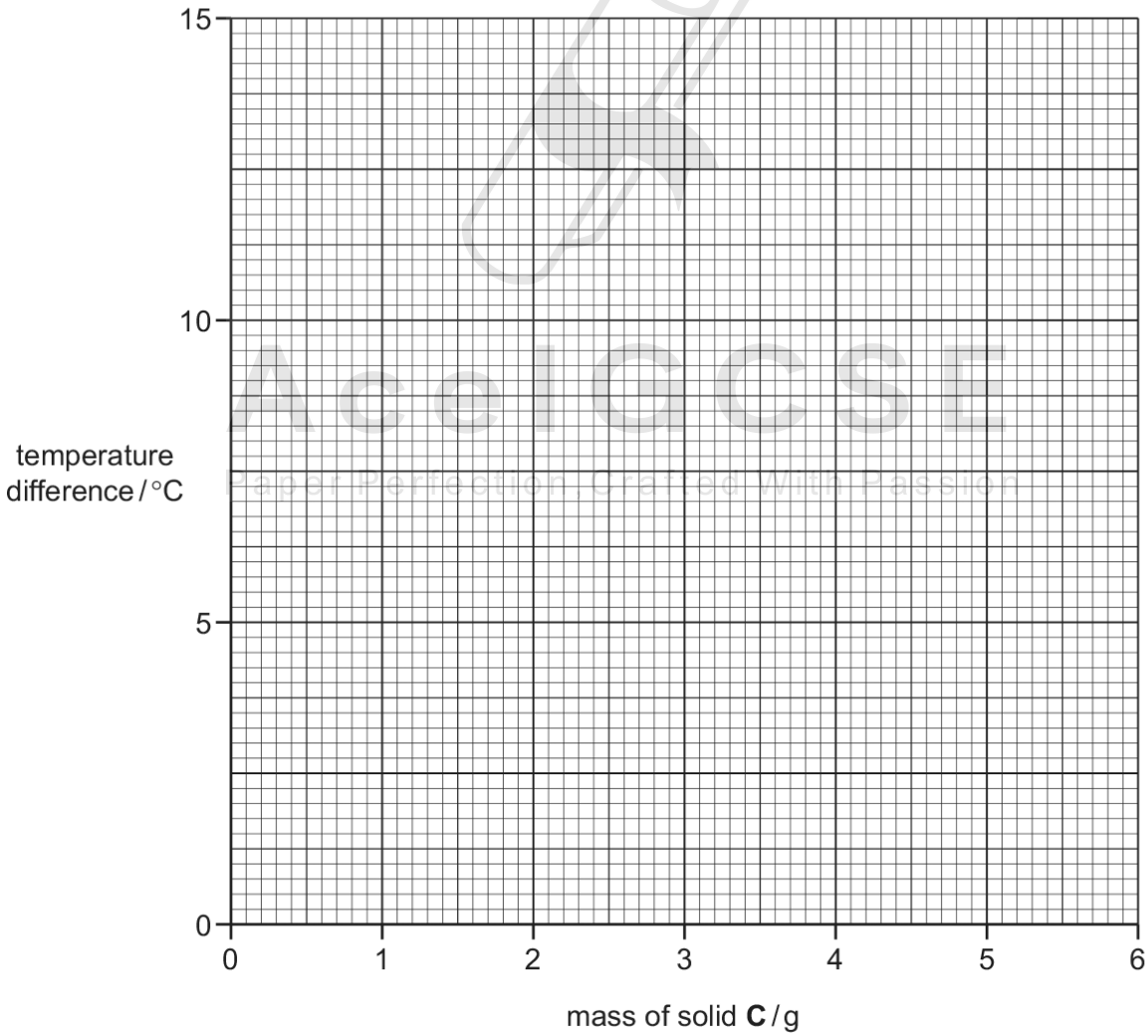
final temperature of liquid mixture

initial temperature of dilute hydrochloric acid = ... °C

final temperature of liquid mixture = ... °C

temperature change = ... °C [2]

(e) Plot the results for Experiments 1, 2, 3 and 4 on the grid and draw a straight line graph.



[4]

(f) **(i)** **From your graph**, deduce the temperature of the solution when 6 g of solid **C** is added to 30 cm^3 of dilute hydrochloric acid.
Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the mass of solid **C** that would give a temperature rise of 9 °C when added to 30 cm^3 of dilute hydrochloric acid.

.....

..... [2]

(g) What type of chemical process occurs when solid **D** reacts with dilute hydrochloric acid?

..... [1]

(h) Suggest the effect on the results if Experiment 3 was repeated using 60 cm^3 of dilute hydrochloric acid.

.....

..... [2]

(i) Predict the temperature of the solution in Experiment 4 after 1 hour. Explain your answer.

.....

..... [2]

(j) When carrying out the experiments, what would be **one** advantage and **one** disadvantage of taking the temperature readings after exactly one minute?

advantage .....

.....

disadvantage .....

..... [2]

[Total: 20]

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A mixture of two solids, **E** and **F**, was analysed.
Solid **E** was the water-soluble salt aluminium chloride, $AlCl_3$, and solid **F** was an insoluble salt.
The tests on the mixture and some of the observations are in the following table.
Complete the observations in the table.

tests	observations
Distilled water was added to the mixture in a boiling tube. The contents of the boiling tube were shaken and filtered, keeping the filtrate and residue for the following tests.	
<u>tests on the filtrate</u> The filtrate was divided into five portions in five test-tubes. **(a)** The first portion was used to describe the appearance of the filtrate.	appearance ..... [1]
(b) Several drops of aqueous sodium hydroxide were added to the second portion of the solution. Excess aqueous sodium hydroxide was then added to the test-tube.	.... [3]
(c) Aqueous ammonia was added to the third portion, dropwise and then in excess.	.... [2]
(d) To the fourth portion of the solution, dilute nitric acid and aqueous silver nitrate were added.	..... [2]
(e) To the fifth portion of the solution, about 1 cm^3 of dilute nitric acid and barium nitrate solution were added.	..... [1]

tests	observations
<u>tests on the residue</u>	
(f) (i) To a little of the residue, dilute hydrochloric acid was added. The gas given off was tested.	rapid effervescence gas turned limewater milky
(ii) The residue was heated, gently then strongly.	solid changed colour from green to black

(g) What conclusions can you draw about solid **F**?

.....

..... [2]

[Total: 11]

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(c) Table of results for Experiments 1–4

mass of solids correctly recorded (1) 1, 2, 3, 5 g

initial and maximum temperature boxes correctly completed (1)

initial 21, 23, 22, 24

maximum 23, 27, 28, 34

temperature differences correct (1) 2, 4, 6, 10 [3]

(d) results for Experiment 5

initial and final temperatures completed 21 and 13 (1)

temperature change completed correctly and shown as negative –8 (1) [2]

(e) all points correctly plotted 3–1 for any incorrect

straight line graph drawn with a ruler (1) [4]

(f) **(i)** value from graph 12 °C ± half small square (1)

extrapolation shown clearly (1) **allow:** ecf [2]

(ii) value from graph 4.5 g ± half small square (1)

indication shown clearly (1) **allow:** ecf [2]

(g) endothermic (1) [1]

(h) lower temperature change (1)

3 °C (1)

greater volume/more acid (1) any 2 for [2]

(i) room temperature or initial temperature from table 24 °C (1)

reaction finished / owtte (1) [2]

(j) advantage, e.g. comparability of results / fair test (1)
ignore: reference to reliability / accuracy

disadvantage, e.g. reaction not finished / temperature still changing / may not reach maximum temperature (1) [2]

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tests on filtrate

(a) colourless (1) [1]
ignore: clear, **not:** white

(b) white (1) precipitate (1)

soluble in excess / dissolves (1) [3]

(c) white precipitate (1)
Insoluble / does not dissolve (1) [2]

(d) white (1) precipitate (1) [2]

(e) no reaction / no change / no precipitate (1) [1]

(g) transition metal / copper (1) carbonate (1) [2]