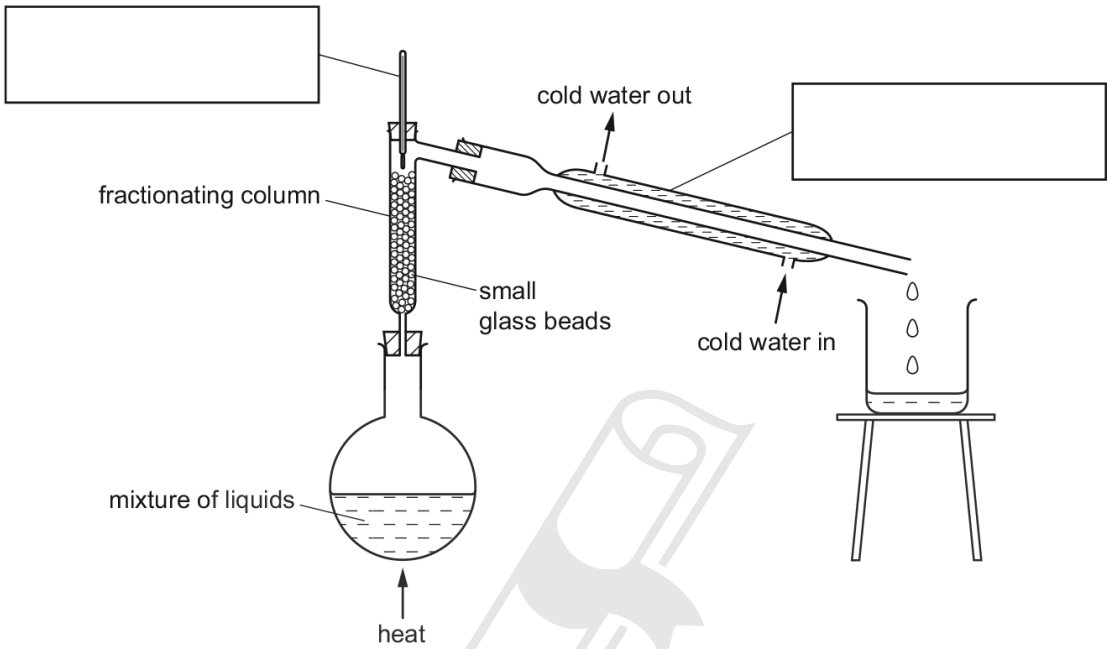
7.1 The characteristic properties of acidsand bases

01. 0620_m15_qp_62 Q: 1

A teacher separated a mixture of two liquids using the apparatus shown. The liquids were:

- ethanoic acid, boiling point 118 °C,
- chloroethanoic acid, boiling point 190 °C.



(a) Complete the boxes to label the pieces of apparatus used. [2]

(b) **(i)** Which liquid would be collected first? Explain why.

.....

..... [2]

(ii) How would the teacher know when all of this liquid had been collected?

..... [1]

(c) Suggest why small glass beads are used in the fractionating column instead of large glass beads.

.....

..... [1]

(d) Give a test to show that the liquids are acidic.

test .....

result ..... [2]

[Total: 8]

02. 0620_m17_qp_62 Q: 2

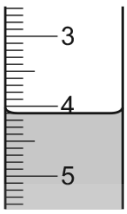
A student investigated the reaction between dilute hydrochloric acid and two different aqueous solutions of sodium hydroxide labelled solution **O** and solution **P**.

Two experiments were carried out.

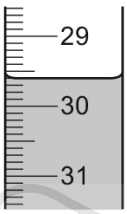
Experiment 1

- A burette was filled with dilute hydrochloric acid. The initial burette reading was recorded.
- Using a measuring cylinder, 20 cm^3 of solution **O** were poured into a conical flask.
- Thymolphthalein indicator was added to the conical flask.
- The dilute hydrochloric acid was added from the burette, while swirling the flask, until the solution just changed colour. The final burette reading was recorded.

(a) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

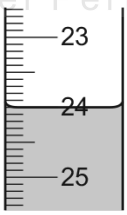
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

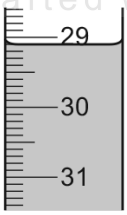
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution **P** instead of solution **O**.

(b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) What type of chemical reaction occurs when dilute hydrochloric acid reacts with sodium hydroxide solution?

..... [1]

(d) **(i)** Which solution of sodium hydroxide, solution **O** or solution **P**, is the more concentrated? Explain your answer.

.....

..... [2]

(ii) How many times more concentrated is this solution of sodium hydroxide than the other solution of sodium hydroxide?

..... [1]

(e) If Experiment 2 were repeated using 10 cm^3 of solution **P**, what volume of dilute hydrochloric acid would be needed?

..... [2]

(f) What would be the effect, if any, on the volume of dilute hydrochloric acid used in Experiment 1 if the solution of sodium hydroxide were **warmed** before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on volume .....

reason .....

[2]

(g) **(i)** What would be a more accurate method of measuring the volume of the aqueous sodium hydroxide solution?

..... [1]

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

..... [1]

(h) Aqueous sodium hydroxide reacts with aqueous calcium chloride to form a precipitate of calcium hydroxide.

Use this information to suggest a **different** method of finding out which of the solutions of sodium hydroxide is the more concentrated.

.....

.....

.....

..... [3]

[Total: 17]

03. 0620_m18_qp_62 Q: 2

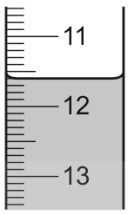
A student investigated the reaction between dilute hydrochloric acid and an aqueous solution of sodium carbonate labelled solution **L**.

Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm^3 of solution **L** into a conical flask.
- Ten drops of thymolphthalein indicator were added to the conical flask.
- A burette was filled up to the 0.0 cm^3 mark with dilute hydrochloric acid.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed to colourless at the end-point of the titration.

(a) Use the burette diagram to record the final burette reading in the table and complete the table.



final burette reading

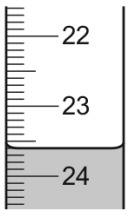
	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	0.0
difference / cm^3	

[1]

Experiment 2

- Ten drops of methyl orange indicator were added to the solution in the conical flask from Experiment 1.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed colour.

(b) Use the burette diagram to record the final burette reading in the table and complete the table.



final burette reading

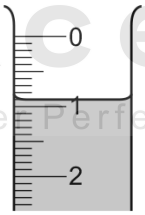
	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	12.0
difference / cm^3	

[1]

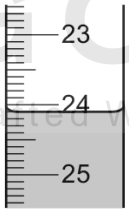
Experiment 3

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein indicator and adding dilute hydrochloric acid from the burette to the conical flask until the solution just changed colour.

(c) Use the burette diagrams to record the burette readings in the table and complete the table.



initial burette reading



final burette reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[3]

(d) What colour change was observed in the conical flask in Experiment 3?

from ..... to .....
[1]

(e) Why was the conical flask emptied and rinsed with distilled water at the start of Experiment 3?

..... [1]

(f) Complete the sentence.

Experiment ..... needed the largest volume of dilute hydrochloric acid to change the colour of the indicator. [1]

(g) Give the name of a more accurate piece of apparatus for measuring the volume of solution **L**.

..... [1]

(h) What would be the effect on the results if solution **L** were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on the results .....

reason .....
[2]

(i) **(i)** Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 3.

..... [1]

(ii) Suggest why the volumes of dilute hydrochloric acid used in Experiments 1 and 3 are different.

..... [1]

(j) Suggest why Universal Indicator **cannot** be used in these experiments.

.....

..... [1]

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

.....

..... [2]

[Total: 16]

04. 0620_m21_qp_62 Q: 2

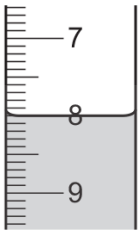
A student investigated the reaction between aqueous potassium hydroxide and two different aqueous solutions of hydrochloric acid labelled solution **A** and solution **B**.

Two experiments were done.

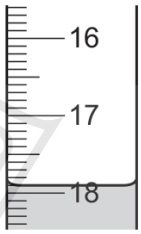
(a) *Experiment 1*

- A burette was filled with solution **A**. Some of solution **A** was run out of the burette so that the level of solution **A** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **A** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.



initial reading



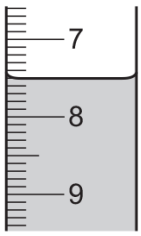
final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **A** added / cm^3	

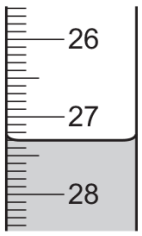
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was emptied and rinsed with distilled water.
- The burette was rinsed with solution **B**.
- The burette was filled with solution **B**. Some of solution **B** was run out of the burette so that the level of solution **B** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **B** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 2.



initial reading



final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **B** added / cm^3	

[4]

(b) State the colour change observed in the conical flask at the end-point in Experiment 2.

from ..... to ..... [1]

(c) Before starting the titration in Experiment 2 the conical flask was rinsed with water.

(i) Explain why the conical flask was rinsed with water.

..... [1]

(ii) The conical flask was **not** then rinsed with aqueous potassium hydroxide.

State how rinsing the conical flask with aqueous potassium hydroxide would change the volume of solution **B** needed. Explain your answer.

.....

..... [2]

(d) (i) Deduce which aqueous solution of hydrochloric acid, **A** or **B**, was more concentrated. Explain your answer.

.....

..... [1]

(ii) Deduce how many times more concentrated this solution of hydrochloric acid was than the other solution of hydrochloric acid.

..... [1]

(e) Explain why Experiment 1 and Experiment 2 should be repeated.

.....

..... [1]

(f) Deduce the volume of solution **B** required if Experiment 2 is carried out with 50 cm^3 of aqueous potassium hydroxide.

.....

..... [2]

(g) Describe **one** change that could be made to the apparatus to improve the accuracy of the results.

.....

..... [1]

(h) Describe what effect using a larger conical flask would have on the results obtained.

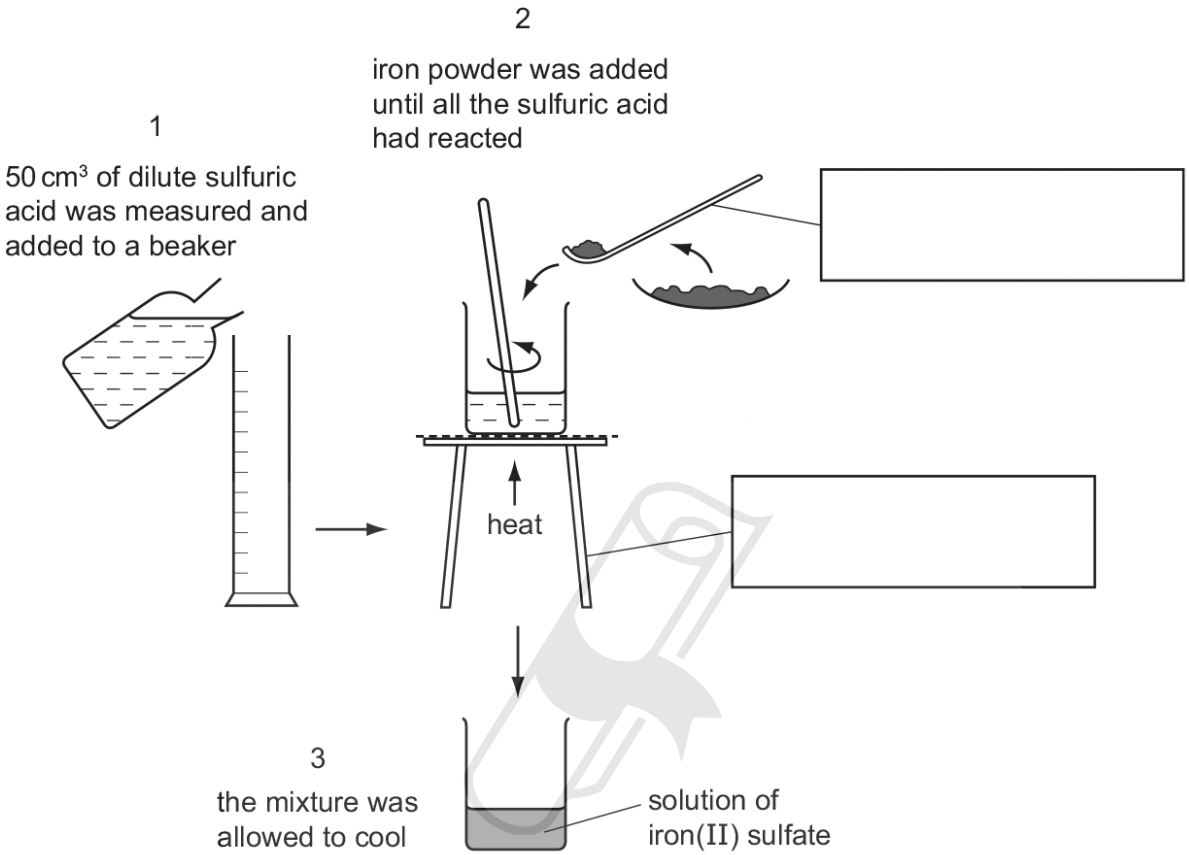
..... [1]

[Total: 15]

05. 0620_s12_qp_61 Q: 1

A student reacted excess iron powder with sulfuric acid to prepare a solution of iron(II) sulfate.

The diagram shows the procedure followed in three stages.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) How would the student know when all of the sulfuric acid had reacted? Give **two** reasons.

1 .....

2 ..... [2]

(c) Describe the effect of boiling the solution of iron(II) sulfate for several minutes.

.....

.....

..... [3]

[Total: 7]

06. 0620_s12_qp_62 Q: 7

Fizzy drinks

The bubbles in fizzy drinks are bubbles of carbon dioxide. The carbon dioxide is dissolved in the drink under pressure.
When a bottle of fizzy drink is opened the gas escapes and eventually the drink goes flat.
The gas is lost more quickly if the fizzy drink is heated.

(a) How could the acidity of the fizzy drink be checked?

..... [1]

(b) Plan an experiment to find the volume of gas in a bottle of fizzy drink.
You may use common laboratory apparatus.

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 7]

07. 0620_s13_qp_63 Q: 3

A student investigated the reaction between potassium hydrogen carbonate, $KHCO_3$, and two aqueous solutions of dilute hydrochloric acid of different concentrations, labelled **F** and **G**.

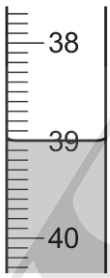
Two experiments were carried out.

(a) *Experiment 1*

Using a measuring cylinder, 20 cm^3 of distilled water was poured into a conical flask. A 0.3 g sample of potassium hydrogen carbonate was added to the flask and shaken to dissolve the solid.
Methyl orange indicator was added to the alkaline solution in the conical flask.

A burette was filled up to the 0.0 cm^3 mark with the solution **F** of dilute hydrochloric acid. Acid **F** was added from the burette until the solution in the flask just changed colour.

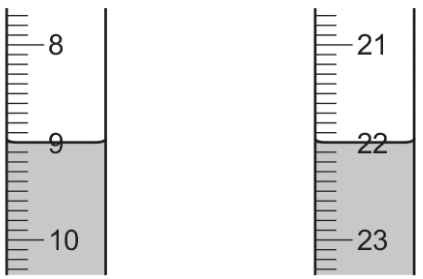
Use the burette diagram to record the final reading in the table below and complete the table for this experiment.



final reading

(b) *Experiment 2*

The conical flask was emptied and rinsed with distilled water.
The contents of the burette were poured away and the burette rinsed with distilled water and then the solution **G** of dilute hydrochloric acid. Experiment 1 was repeated using solution **G** instead of solution **F**.
Use the burette diagrams to record the readings in the table below and complete the table.



initial reading final reading

	burette readings / cm^3	
	Experiment 1	Experiment 2
final reading		
initial reading		
difference		

[4]

(c) What colour change was observed in the contents of the flask after the hydrochloric acid was added to the flask?

from ..... to ..... [2]

(d) What type of chemical reaction occurred when hydrochloric acid reacted with potassium hydrogen carbonate?

..... [1]

(e) Complete the sentence below.

Experiment ..... needed the smallest volume of hydrochloric acid to change the colour of the methyl orange. [1]

(f) **(i)** Compare the volumes of hydrochloric acid used in Experiments 1 and 2.

..... [1]

(ii) The most concentrated solution of hydrochloric acid was solution ..... . [1]

(g) If Experiment 2 was repeated using 0.6 g of potassium hydrogen carbonate, what volume of hydrochloric acid would be needed?

..... [2]

(h) What would be a more accurate method of measuring the volume of the distilled water?

..... [1]

(i) Why was the burette rinsed with distilled water and then the solution **G** of dilute hydrochloric acid before starting Experiment 2?

.....

..... [2]

(j) What would be the effect on the results if the solutions of potassium hydrogen carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results .....

reason ..... [2]

(k) Describe a **different** method of finding out which of the solutions of hydrochloric acid, **F** or **G**, is the more concentrated.

.....

.....

.....

.....

..... [3]

[Total: 20]

08. 0620_s14_qp_61 Q: 4

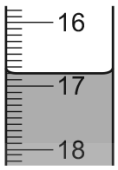
A student investigated the reaction between dilute hydrochloric acid and an aqueous alkaline solution **R**, containing two different substances, **S** and **T**.

Three experiments were carried out.

Experiment 1

Using a measuring cylinder, 25 cm^3 of solution **R** was poured into a conical flask and five drops of phenolphthalein were added to the flask.
A burette was filled with hydrochloric acid up to the 0.0 cm^3 mark. Hydrochloric acid was added to the solution **R** and the flask shaken. Addition of hydrochloric acid was continued until the colour just disappeared.
The mixture in the flask was kept for Experiment 2.

(a) Use the burette diagram to record the final volume in the table of results and complete the table.



final burette reading

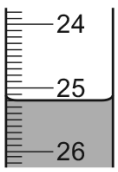
	burette readings
final volume / cm^3	
initial volume / cm^3	
difference / cm^3	

[3]

Experiment 2

Five drops of methyl orange indicator were added to the mixture in the flask from Experiment 1. The mixture turned yellow. The initial volume reading of the burette was the same as the final reading in Experiment 1. Hydrochloric acid was added from the burette to the mixture in the flask and the mixture shaken.
The volume of hydrochloric acid added was recorded when the indicator just changed colour.

(b) Use the burette diagram to record the final volume in the table of results and complete the table.



final burette reading

	burette readings
final volume / cm^3	
initial volume / cm^3	
difference / cm^3	

[3]

(c) *Experiment 3*

Hydrochloric acid was added to about 5 cm^3 of solution **R** in a test-tube.

Rapid effervescence was observed.

(d) When phenolphthalein indicator was used in Experiment 1 the colour changed

from pink to ..... [1]

(e) In a similar experiment, methyl orange indicator was used in Experiment 1 followed by phenolphthalein in Experiment 2.
Suggest why this experiment would not work.

.....

..... [1]

(f) What conclusion can you draw from Experiment 3?

..... [1]

(g) The volume of hydrochloric acid added in Experiment 1 reacted with all of substance **S** and half of substance **T**.
The volume of hydrochloric acid in Experiment 2 reacted with half of substance **T**.

(i) Work out the volume of hydrochloric acid which reacted with substance **S**.

..... [2]

(ii) Work out the volume of hydrochloric acid which reacted with substance **T**.

..... [1]

(iii) Compare the volumes of hydrochloric acid which reacted with substances **S** and **T**.

..... [1]

(h) (i) The experiments were repeated using 100 cm^3 of solution **R**.
Predict the volume of hydrochloric acid which would be added in Experiments 1 and 2.
Explain your answer.

Experiment 1 .....

Experiment 2 .....

Explanation ..... [3]

(ii) Suggest a practical problem that would occur when carrying out these repeat experiments and how you could solve this problem.

.....

..... [2]

[Total: 18]

09. 0620_s14_qp_63 Q: 6

Vinegar contains ethanoic acid. Different brands of vinegar contain different concentrations of ethanoic acid. The concentration of ethanoic acid in the vinegar can be determined by reaction with aqueous sodium hydroxide.

Plan an experiment to show which of two different brands of colourless vinegar, **C** and **D**, contain the highest concentration of ethanoic acid.
You are provided with common laboratory apparatus.
You may use the space below to draw a diagram.

.....

.....

.....

.....

.....

.....

.....

..... [7]

[Total: 7]

10. 0620_s15_qp_61 Q: 4

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

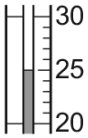
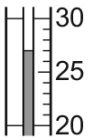
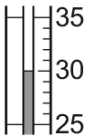
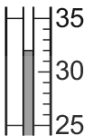
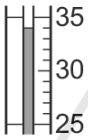
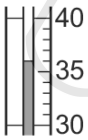
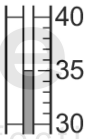
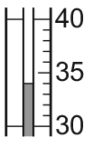
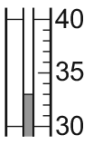
Two experiments were done.

(a) *Experiment 1*

Using a measuring cylinder, 50 cm^3 of aqueous sodium hydroxide solution was poured into a polystyrene cup. The initial temperature of the solution was measured.

A burette was filled with the solution of acid **A** to the 0.0 cm^3 mark.
5.0 cm^3 of acid **A** was added to the aqueous sodium hydroxide in the cup and the mixture stirred.
The temperature of the solution was measured. Another 5.0 cm^3 of acid **A** was added to the cup and the mixture stirred. The temperature of the mixture was measured.
More 5.0 cm^3 portions of acid **A** were added to the cup until a total volume of 40.0 cm^3 of acid had been added. After each addition, the mixture was stirred and the temperature measured.

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

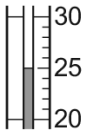
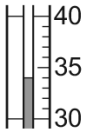
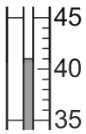
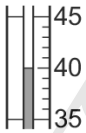
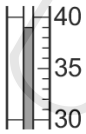
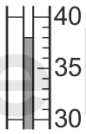
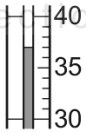
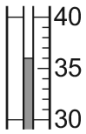
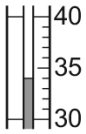
volume of acid **A** added / cm^3	thermometer diagram	temperature of solution in polystyrene cup / °C
0.0		
5.0		
10.0		
15.0		
20.0		
25.0		
30.0		
35.0		
40.0		

[3]

The burette was emptied and rinsed with distilled water, and then with acid **B**. This acid was discarded. The burette was then filled up to the 0.0 cm^3 mark with acid **B**.

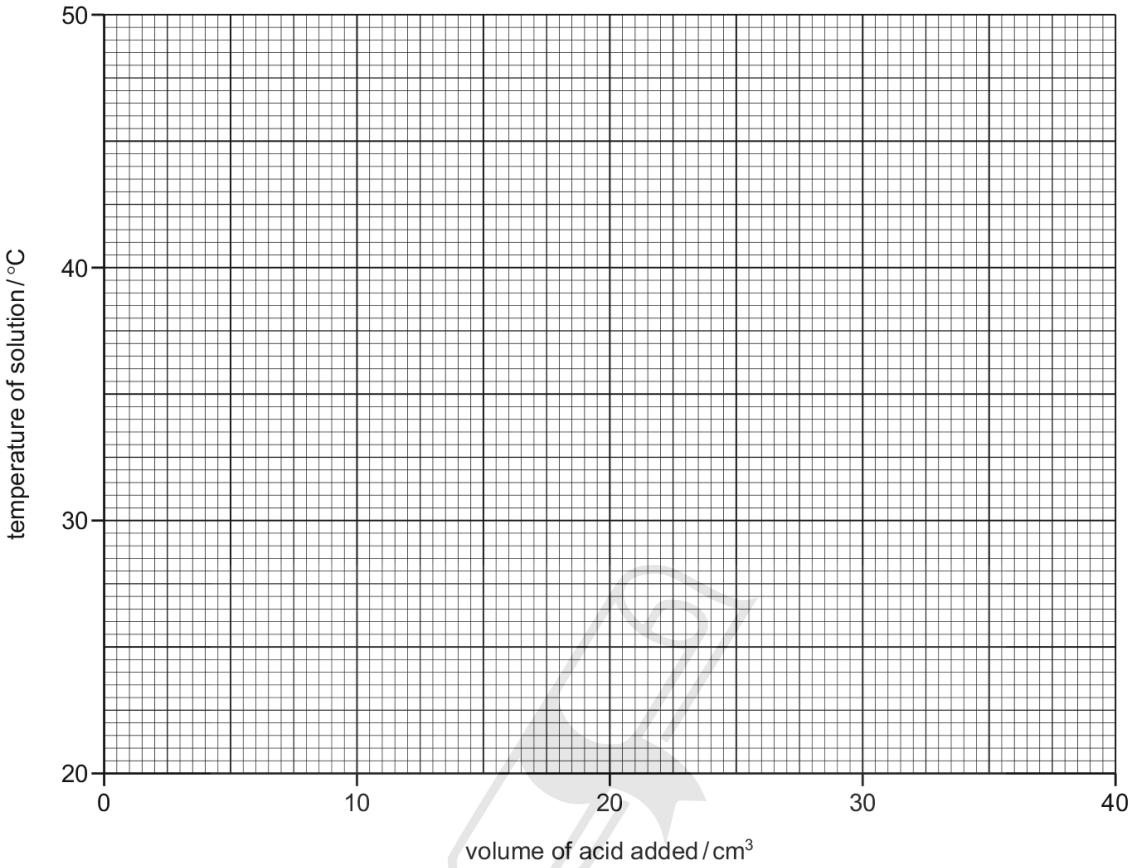
(b) *Experiment 2*

Experiment 1 was repeated using acid **B** instead of acid **A**.
Use the thermometer diagrams in the table to record the temperatures.

volume of acid **B** added / cm^3	thermometer diagram	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]

(c) Plot the results for Experiments 1 and 2 on the grid and draw a smooth line graph for each experiment.
Clearly label your graphs.



[5]

(d) **Use your graph** to estimate the temperature of the reaction mixture when 8.0 cm^3 of acid **B** were added to 50 cm^3 of aqueous sodium hydroxide.

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

..... [2]

(e) What type of chemical reaction, other than neutralisation, occurred when acid **A** reacted with sodium hydroxide?

..... [1]

(f) Why was the burette rinsed firstly with distilled water and then with acid **B** before starting Experiment 2?

.....

..... [2]

(g) The solutions of acids **A** and **B** are the same concentration.

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

..... [1]

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

.....

..... [1]

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

source of error .....

improvement .....

[2]

[Total: 20]

11. 0620_s15_qp_62 Q: 7

Tonic water is a solution containing citric acid. The concentration of the acid can be determined by reaction with aqueous potassium hydroxide solution.
Plan an investigation to show which of two different brands of colourless tonic water, Tastyton and Slimton, contains the highest concentration of citric acid.
You can use common laboratory apparatus and chemicals.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

12. 0620_s15_qp_63 Q: 4

A student investigated the temperature changes when four different solids, **D**, **E**, **F** and **G**, reacted with excess dilute hydrochloric acid. The solids were all calcium compounds.

Four experiments were carried out.

(a) *Experiment 1*

Using a measuring cylinder, 30 cm^3 of hydrochloric acid was poured into a polystyrene cup.
The temperature of the hydrochloric acid was measured.
2 g of solid **D** was added to the hydrochloric acid and the mixture stirred with a thermometer.
The temperature reached by the liquid mixture was measured.
Observations were recorded.

Observation: Rapid effervescence.

The polystyrene cup was emptied and rinsed with distilled water.

(b) *Experiment 2*

Experiment 1 was repeated using solid **E**.

(c) *Experiment 3*

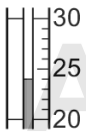
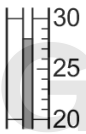
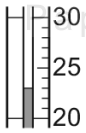
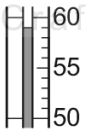
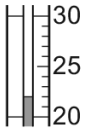
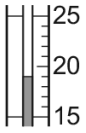
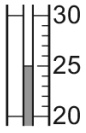
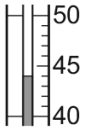
Experiment 1 was repeated using solid **F**.

(d) *Experiment 4*

Experiment 1 was repeated using solid **G** but Universal Indicator solution was added to the hydrochloric acid before adding the solid. Observations were recorded.

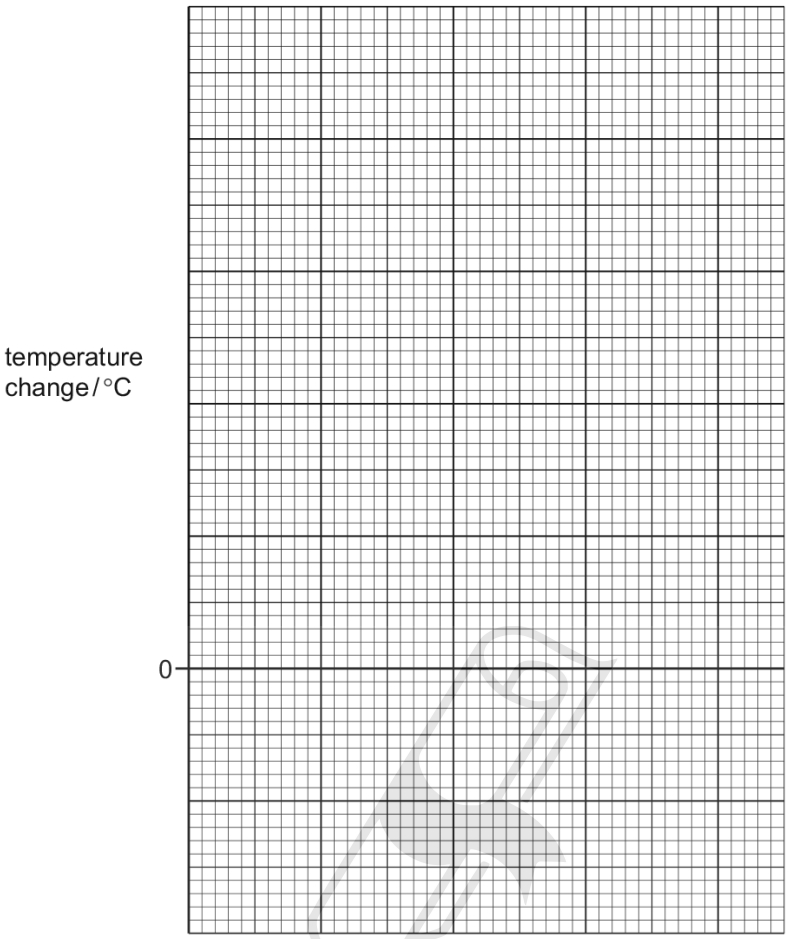
Observation: The red colour of the liquid, pH 1, changed colour to orange then yellow, pH 6.

(e) Use the thermometer diagrams to record all of the temperatures in the table. Complete the final column in the table.

Experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	temperature reached / °C	temperature change / °C
1					
2					
3					
4					

[3]

(f) Draw a labelled bar chart to show the results of the Experiments 1, 2, 3 and 4.



[4]

(g) Use the results and observations to answer the following questions.

(i) What type of chemical process occurred when solid **D** reacted with hydrochloric acid?

..... [1]

(ii) What conclusion can you draw about solid **D** from the observations in Experiment 1?

..... [1]

(h) Which experiment produced the largest temperature change?

..... [1]

(i) Explain the observations in Experiment 4.

.....

..... [2]

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

.....

..... [2]

(k) Suggest and explain the effect on the results if Experiment 2 was repeated using 60 cm^3 of hydrochloric acid.

.....

..... [2]

(l) Suggest a possible source of error in this experiment. Identify a change in apparatus which would reduce this error.

source of error .....

change to apparatus .....
[2]

[Total: 18]

13. 0620_s16_qp_61 Q: 2

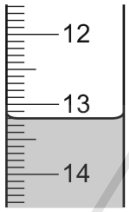
A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

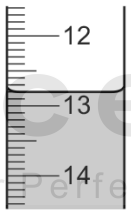
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



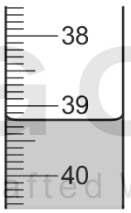
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3		
initial burette reading / cm^3		
difference / cm^3		

[4]

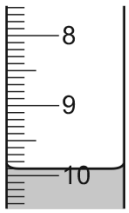
(b) What colour change was observed in the flask in experiment 2?

from ..... to ..... [1]

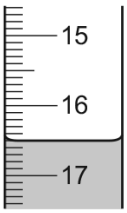
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..... [1]

(e) Complete the sentence below.

Experiment ..... needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..... [1]

(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results .....

reason .....

[2]

(h) (i) Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3.

..... [1]

(ii) Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**.

..... [1]

(i) Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated.

.....

.....

.....

.....

..... [3]

[Total: 17]

14. 0620_s17_qp_62 Q: 2

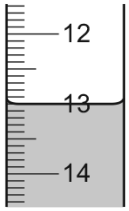
A student investigated the reaction between aqueous potassium manganate(VII), solution **A**, and two solutions of iron(II) sulfate, solution **B** and solution **C**, of different concentrations.

Two experiments were carried out.

Experiment 1

- A burette was filled with solution **A** to the 0.0 cm^3 mark.
- A measuring cylinder was used to pour 25 cm^3 of solution **B** into a conical flask.
- Solution **A** was added to the flask, while the flask was swirled, until the mixture just turned permanently pink. The burette reading was recorded.

(a) Use the burette diagram to record the reading in the table and complete the table.



final reading

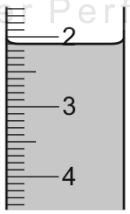
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

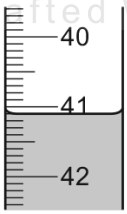
Experiment 2

- Experiment 1 was repeated using 25 cm^3 of solution **C** instead of solution **B**. In Experiment 2 the burette was not filled to the 0.0 cm^3 mark.

(b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) Why is an indicator **not** added to the conical flask?

..... [1]

(d) (i) Which solution of iron(II) sulfate, solution **B** or solution **C**, is the more concentrated? Explain your answer.

.....

..... [2]

(ii) How many times more concentrated is this solution of iron(II) sulfate?

..... [1]

(e) (i) If Experiment 2 were repeated using 50 cm^3 of solution **C**, what volume of solution **A** would be needed? Explain your answer.

.....

..... [2]

(ii) Suggest a practical problem that using 50 cm^3 of solution **C** in this investigation would cause. Suggest a practical solution to the problem.

problem .....

solution .....
[2]

(f) Give **one** advantage and **one** disadvantage of using a measuring cylinder instead of a 25 cm^3 pipette for solution **B**.

advantage .....

disadvantage .....
[2]

(g) How would the results be improved by taking repeated measurements?

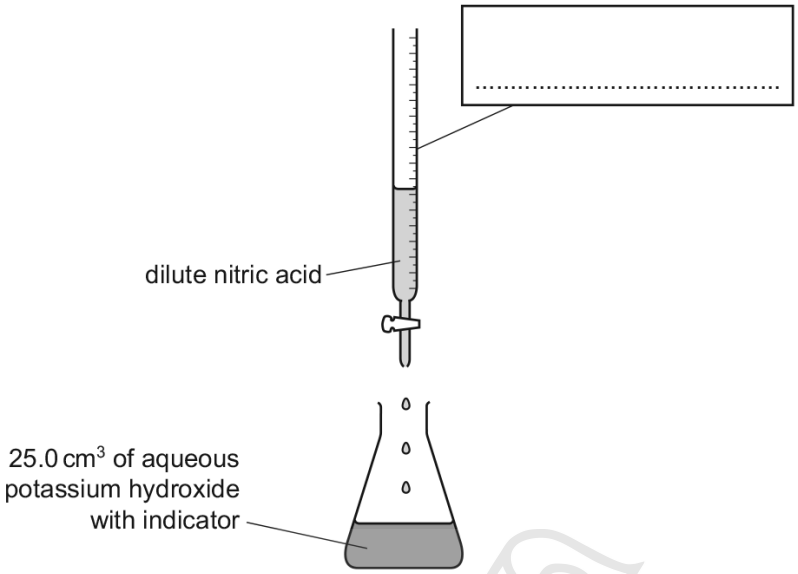
.....

..... [1]

[Total: 15]

15. 0620_s18_qp_61 Q: 1

The volume of dilute nitric acid that reacts with 25.0 cm^3 of aqueous potassium hydroxide can be found by titration using the apparatus shown.



(a) Complete the box to name the apparatus. [1]

(b) Name a suitable indicator that could be used.

..... [1]

A student did the titration four times and recorded the following results.

titration number	volume of dilute nitric acid / cm^3
1	18.1
2	18.9
3	18.3
4	18.2

(c) (i) Which **one** of the results is anomalous?

..... [1]

(ii) Suggest what might have caused this result to be anomalous.

..... [1]

(iii) Use the **other** results to calculate the average volume of dilute nitric acid that reacted with the aqueous potassium hydroxide.

..... [2]

(d) The equation for the reaction taking place in the titration is shown.

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

The student concluded that the aqueous potassium hydroxide was more concentrated than the dilute nitric acid.

Explain whether or not the student's conclusion was correct.

.....

.....

..... [2]

[Total: 8]

---

16. 0620_s18_qp_62 Q: 4

Aqueous solutions of barium hydroxide are alkaline.
Plan an investigation to find the concentration of an aqueous solution of barium hydroxide.

You are provided with an aqueous solution of barium hydroxide, dilute hydrochloric acid of known concentration and common laboratory apparatus.

.....

.....

.....

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.....

.....

.....

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.....

.....

..... [6]

[Total: 6]

---

17. 0620_s20_qp_61 Q: 2

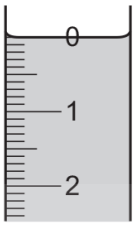
A student investigated the reaction between dilute hydrochloric acid and two different aqueous solutions of sodium carbonate, solution **E** and solution **F**.

Three experiments were done.

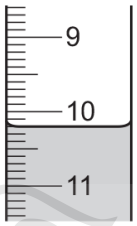
(a) *Experiment 1*

- A burette was filled up to the 0.0 cm^3 mark with dilute hydrochloric acid.
- Using a measuring cylinder, 25 cm^3 of solution **E** was poured into a conical flask.
- Five drops of thymolphthalein indicator were added to the conical flask.
- Dilute hydrochloric acid was slowly added from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.



initial reading



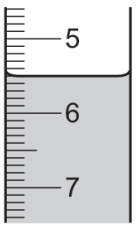
final reading

final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid added / cm^3	

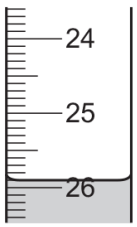
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was refilled with dilute hydrochloric acid.
- Experiment 1 was repeated using five drops of methyl orange indicator instead of thymolphthalein indicator.

Use the burette diagrams to complete the table for Experiment 2.



initial reading



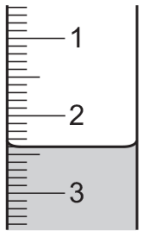
final reading

final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid added / cm^3	

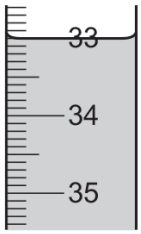
Experiment 3

- The conical flask was emptied and rinsed with distilled water.
- The burette was refilled with dilute hydrochloric acid.
- Using a measuring cylinder, 25 cm^3 of solution **F** was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Dilute hydrochloric acid was slowly added from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 3.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid added / cm^3	

[5]

(b) What colour change was observed in the conical flask in Experiment 2?

from ..... to .....

[2]

(c) Compare the volumes of dilute hydrochloric acid added in Experiment 2 and Experiment 3. Explain any difference.

.....

..... [2]

(d) Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 2.

ratio Experiment 1 : Experiment 2 = ... [1]

(e) What volume of dilute hydrochloric acid would be required if Experiment 3 was repeated using thymolphthalein indicator instead of methyl orange indicator?

volume = ... [2]

(f) The conical flask was rinsed with distilled water between each experiment.

(i) Why was the conical flask rinsed?

.....

..... [1]

(ii) Why does it **not** matter if a little distilled water is left in the flask after it has been rinsed?

.....

..... [1]

(g) State **two** sources of error in the experiments. For each error suggest an improvement that would reduce the error.

source of error 1 .....

improvement 1 .....

.....

source of error 2 .....

improvement 2 .....

.....

[4]

[Total: 18]

18. 0620_s20_qp_62 Q: 4

Many window-cleaning products contain aqueous ammonia. Aqueous ammonia is an alkali that reacts with dilute acids.

Plan an investigation to find which of two window-cleaning products contains the most concentrated aqueous ammonia. Include in your plan:

- the method you will use
- how your results will be used to determine which window-cleaning product contains the most concentrated aqueous ammonia.

You are provided with an aqueous solution of the two window-cleaning products, dilute hydrochloric acid of known concentration and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

19. 0620_s21_qp_61 Q: 2

A student investigated the temperature decrease when sodium hydrogencarbonate reacts with dilute hydrochloric acid.

The student did six experiments.

Experiment 1

- Using a measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a conical flask.
- The initial temperature of the acid was measured using a thermometer.
- 1 g of sodium hydrogencarbonate was added to the conical flask. At the same time a stop-clock was started.
- The acid and sodium hydrogencarbonate mixture in the conical flask was stirred continuously using the thermometer.
- The temperature of the mixture after 1 minute was measured.
- The conical flask was rinsed with distilled water.

Experiment 2

- Experiment 1 was repeated using 2 g of sodium hydrogencarbonate instead of 1 g.

Experiment 3

- Experiment 1 was repeated using 3 g of sodium hydrogencarbonate instead of 1 g.

Experiment 4

- Experiment 1 was repeated using 5 g of sodium hydrogencarbonate instead of 1 g.

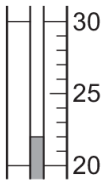
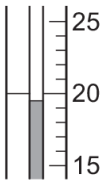
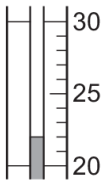
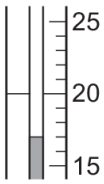
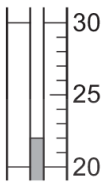
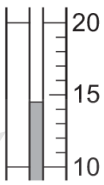
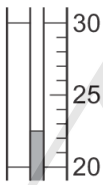
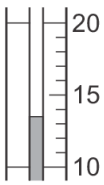
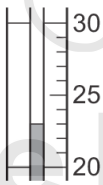
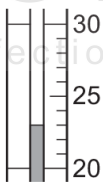
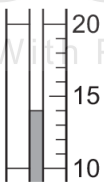
Experiment 5

- Experiment 1 was repeated using 6 g of sodium hydrogencarbonate instead of 1 g.

Experiment 6

- Experiment 1 was repeated using 7 g of sodium hydrogencarbonate instead of 1 g.

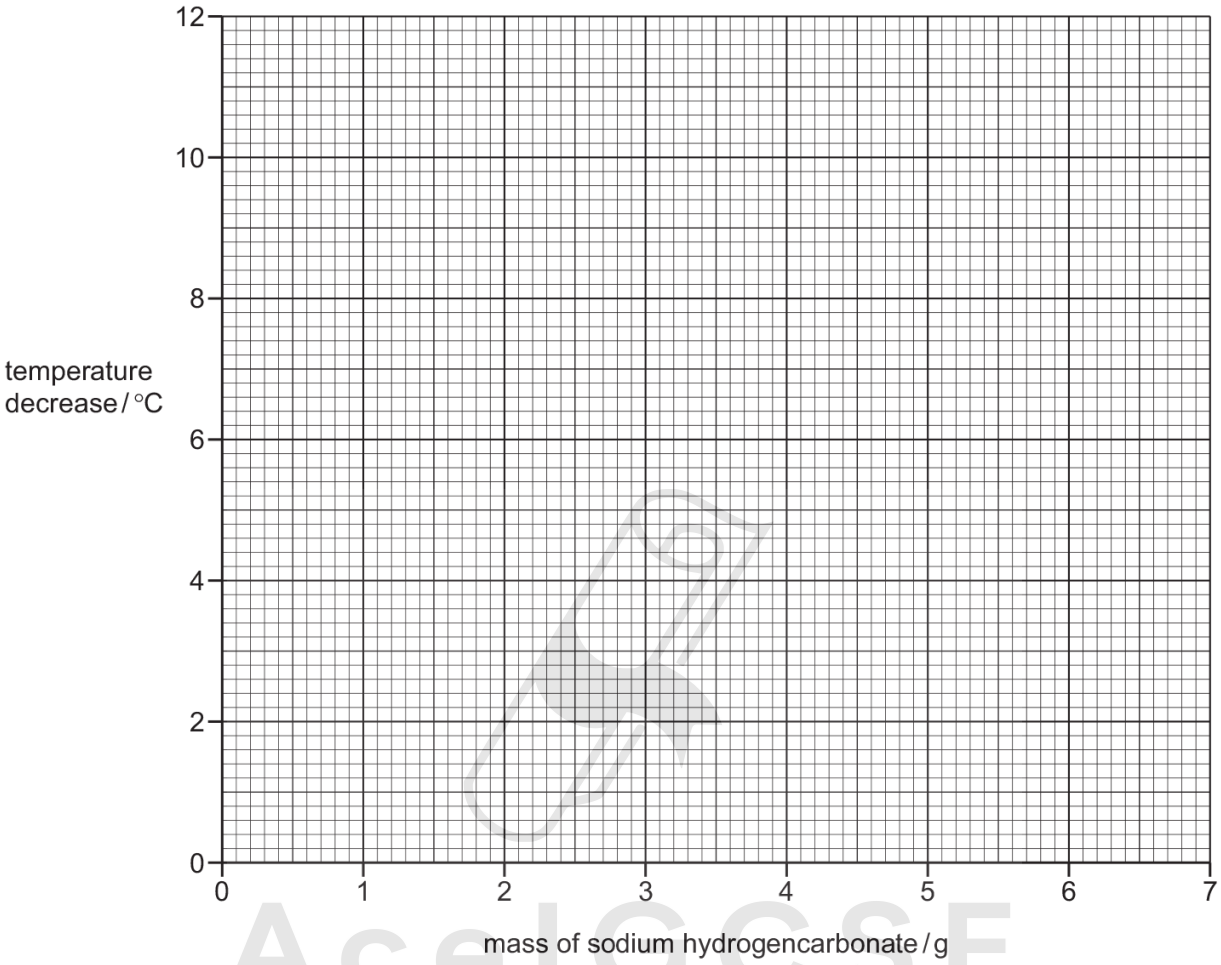
(a) Use the thermometer diagrams to complete the table and calculate the temperature decreases.

experiment	mass of sodium hydrogencarbonate /g	thermometer diagram	initial temperature of acid /°C	thermometer diagram	temperature after 1 minute /°C	temperature decrease /°C
1	1					
2	2					
3	3					
4	5					
5	6					
6	7					

[4]

(b) Plot the results from Experiments 1 to 6 on the grid.

Draw **two** best-fit straight lines through your points. The first straight line should be for the first three points and must pass through (0,0). The second straight line should be for the last three points and must be horizontal. Extend your straight lines so that they meet each other.



[4]

(c) (i) **From your graph**, determine the temperature decrease and mass of sodium hydrogencarbonate where your two straight lines meet. Include appropriate units in your answer.

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

temperature decrease = ...

mass of sodium hydrogencarbonate = ...

[3]

(ii) Explain why the temperature decrease becomes constant for high masses of sodium hydrogencarbonate.

.....

..... [1]

(d) The investigation was repeated with dilute hydrochloric acid of half the concentration, but the same volume.

Sketch **on the grid** the graph you would expect to obtain.

Label your line **D**. [2]

(e) Suggest **two** changes that could be made to the apparatus that would improve the accuracy of the results. For each change explain why it would improve the accuracy of the results.

change 1 .....

explanation 1 .....

.....

change 2 .....

explanation 2 .....

.....

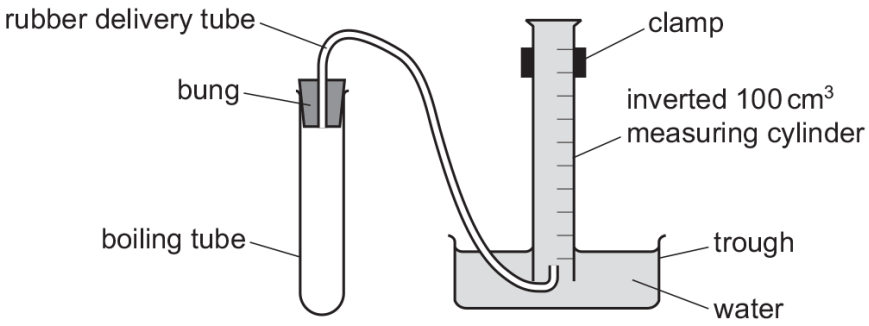
[4]

[Total: 18]

20. 0620_s21_qp_62 Q: 2

A student investigated the volume of gas made when sodium carbonate reacts with dilute hydrochloric acid.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 16 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The apparatus was set up as shown in the diagram.
- The bung was removed from the boiling tube.
- 2.5 g of sodium carbonate was added to the boiling tube and the bung was immediately replaced.
- When no more gas was being collected, the volume of gas in the measuring cylinder was measured.

Experiment 2

- Experiment 1 was repeated using 14 cm^3 of dilute hydrochloric acid instead of 16 cm^3.

Experiment 3

- Experiment 2 was repeated using 12 cm^3 of dilute hydrochloric acid instead of 14 cm^3.

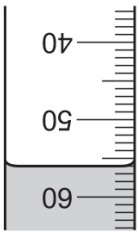
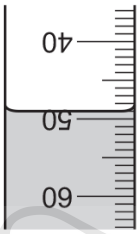
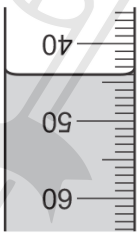
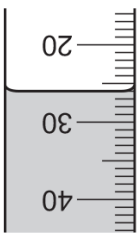
Experiment 4

- Experiment 3 was repeated using 10 cm^3 of dilute hydrochloric acid instead of 12 cm^3.

Experiment 5

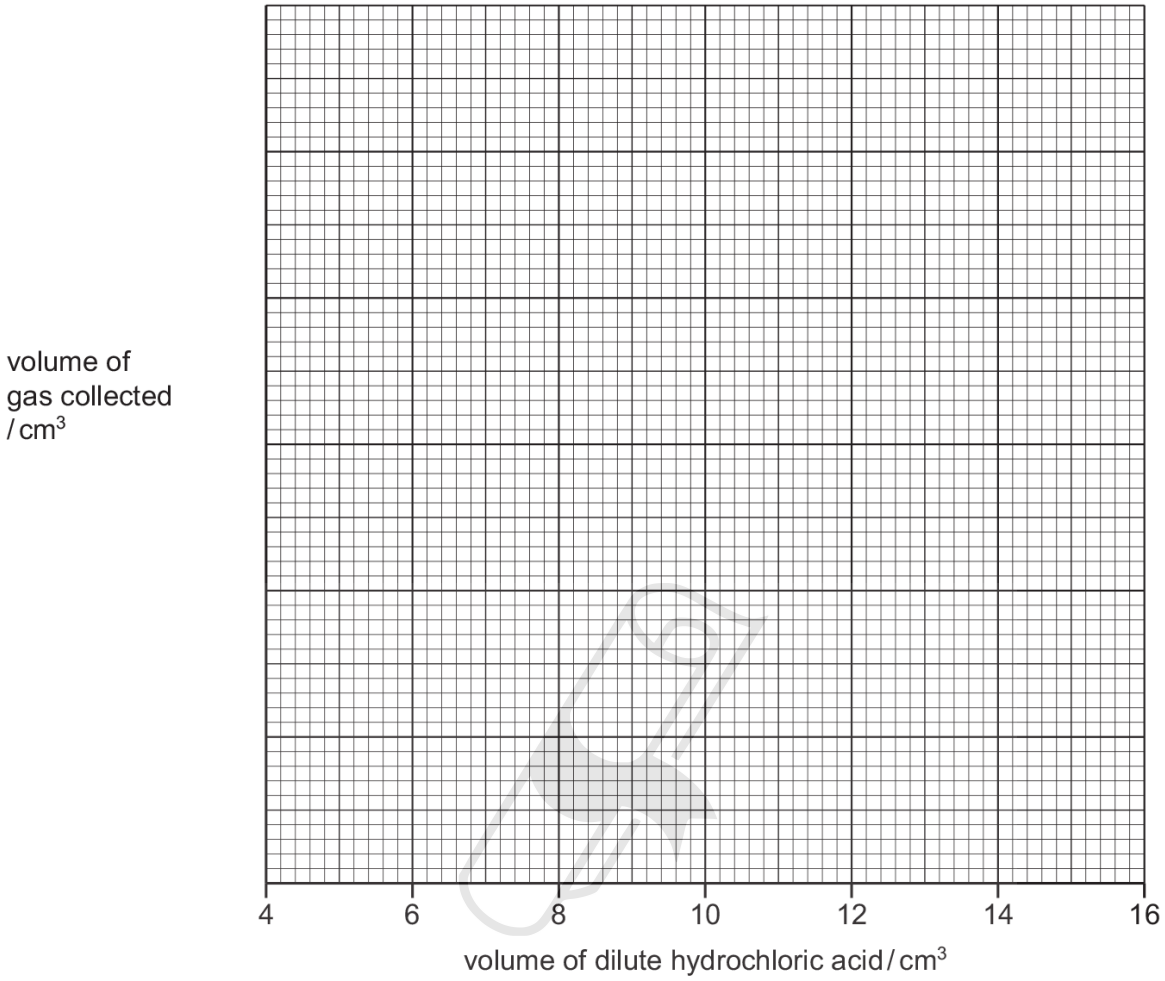
- Experiment 4 was repeated using 6 cm^3 of dilute hydrochloric acid instead of 10 cm^3.

(a) Use the information in the description of the experiments and the inverted measuring cylinder diagrams to complete the table.

experiment	volume of dilute hydrochloric acid / cm^3	inverted measuring cylinder diagram	volume of gas collected / cm^3
1			
2			
3			
4			
5			

[3]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on the grid. Draw a straight line of best fit.



[4]

(c) (i) **From your graph**, deduce the volume of gas that would be collected if 7 cm^3 of dilute hydrochloric acid was used.

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

..... cm^3
[2]

(ii) The volume of gas made per cm^3 of dilute hydrochloric acid can be calculated using the equation shown.

$$\text{volume of gas per cm}^3\text{ of acid} = \frac{\text{volume of gas collected in cm}^3}{\text{volume of acid in cm}^3}$$

Use this equation and your answer to **(c)(i)** to calculate the volume of gas made per cm^3 of dilute hydrochloric acid.

..... [1]

(d) The bung was removed and then replaced immediately after the sodium carbonate was added to the boiling tube.

(i) Explain why the bung must be replaced immediately after the sodium carbonate is added to the boiling tube.

.....

..... [1]

(ii) Explain how the apparatus could be altered so that the bung does **not** have to be removed. You may draw a diagram to explain your answer.

.....

..... [2]

(e) State **one** advantage of using a burette rather than a measuring cylinder to measure the volume of the dilute hydrochloric acid.

..... [1]

(f) In Experiments 1 to 5, the sodium carbonate was in excess.

Sketch **on the grid** the graph you would expect if all of the experiments were repeated using dilute hydrochloric acid of half the concentration.

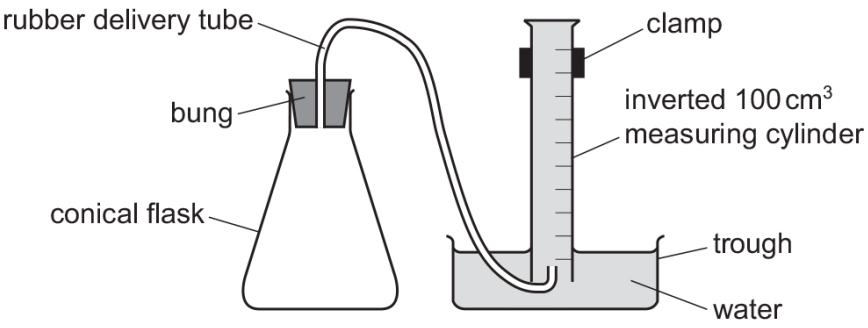
Label your line **F**. [2]

[Total: 16]

21. 0620_s21_qp_63 Q: 2

A student investigated the rate at which hydrogen gas was made when magnesium reacted with dilute sulfuric acid.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 25 cm^3 of dilute sulfuric acid was poured into a conical flask.
- Using a different measuring cylinder, 30 cm^3 of distilled water was poured into the conical flask.
- The apparatus was set up as shown in the diagram.
- The bung was removed from the conical flask.
- A coiled length of magnesium ribbon was added to the conical flask, the bung was replaced immediately and a timer started.
- The volume of gas collected in the inverted measuring cylinder after 30 seconds was measured.

Experiment 2

- Experiment 1 was repeated using 20 cm^3 of distilled water instead of 30 cm^3.

Experiment 3

- Experiment 1 was repeated using 10 cm^3 of distilled water instead of 30 cm^3.

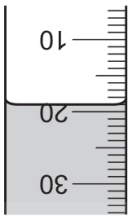
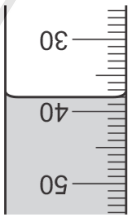
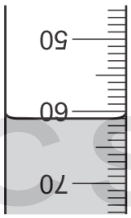
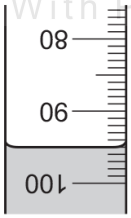
Experiment 4

- Experiment 1 was repeated using 5 cm^3 of distilled water instead of 30 cm^3.

Experiment 5

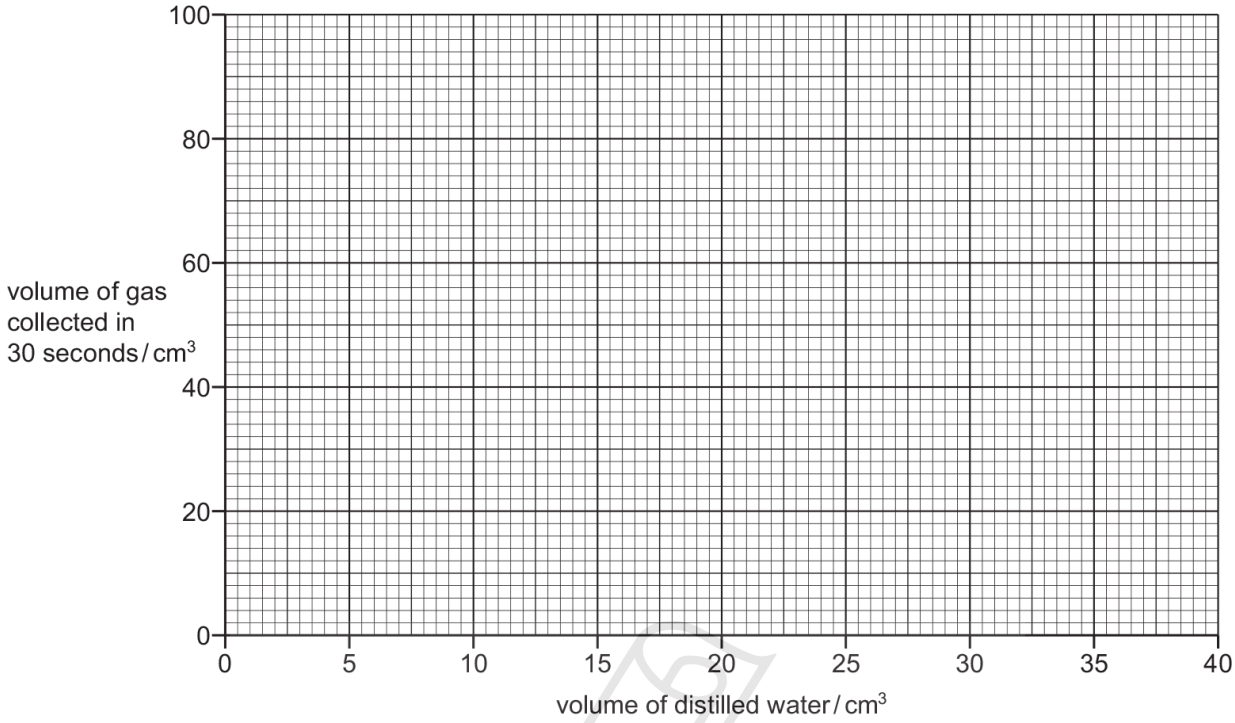
- Experiment 1 was repeated without adding any distilled water to the dilute sulfuric acid.

(a) Use the information in the description of the experiments and the inverted measuring cylinder diagrams to complete the table.

experiment	volume of dilute sulfuric acid / cm^3	volume of distilled water / cm^3	inverted measuring cylinder diagram	volume of gas collected in 30 seconds / cm^3
1				
2				
3				
4				
5				

[4]

(b) Plot the results from Experiments 1 to 5 on the grid. Draw a smooth curve of best fit.



[3]

(c) Extrapolate (extend) the line on your graph and deduce the volume of gas that would be collected in 30 seconds if 35 cm^3 of distilled water was added to the dilute sulfuric acid.

..... cm^3

[2]

(d) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the rate of reaction in Experiment 3. Give the units for the rate you have calculated.

rate = ...

units = ...
[2]

(ii) State which Experiment, 1, 2, 3, 4 or 5, had the highest rate of reaction.

..... [1]

(e) The volume of the dilute sulfuric acid was measured using a measuring cylinder. A 25 cm^3 pipette could have been used instead of a measuring cylinder.

(i) State **one** advantage of using a 25 cm^3 pipette instead of a measuring cylinder.

..... [1]

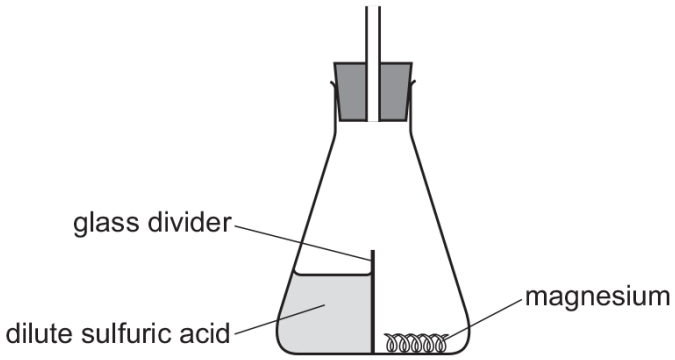
(ii) State **one** disadvantage of using a 25 cm^3 pipette instead of a measuring cylinder.

..... [1]

(f) Name another item of apparatus, which can be used instead of an inverted measuring cylinder, to collect and measure the volume of gas made in the reaction.

..... [1]

(g) The diagram shows a modified conical flask that could be used in this investigation.



Explain the advantage of using this type of conical flask instead of the type used in the investigation.

.....

.....

..... [2]

[Total: 17]

22. 0620_w12_qp_63 Q: 3

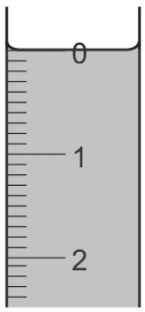
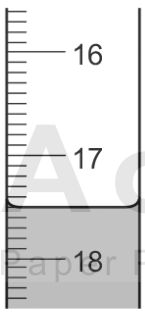
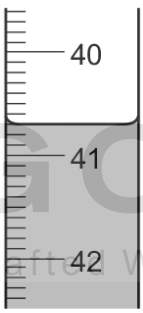
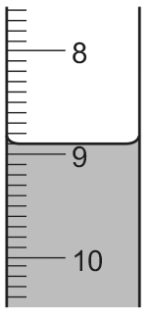
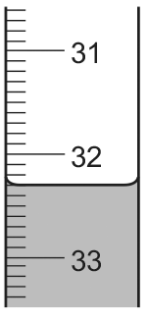
The formula of any acid can be written as H_yA.

A student investigated an acid, **S**, by titrating its aqueous solution with aqueous sodium hydroxide.

A burette was filled with a solution of acid **S** up to the 0.0 cm^3 mark. A 25.0 cm^3 portion of aqueous sodium hydroxide was added to a conical flask. A few drops of litmus indicator were added to the flask. The acid was added from the burette until the colour of the indicator changed. Three titrations were carried out.

The burette diagrams in the table below show the initial and final readings in the three titrations.

(a) Use the burette diagrams to record the volumes in the table. Complete the table.

titration	burette diagram	initial reading / cm^3	burette diagram	final reading / cm^3	difference / cm^3
1					
2					
3					

[3]

(b) Which of these are the best **two** titration results? Use these results to work out the average volume of solution **S** added.

best results .....

average volume = ...cm^3 [2]

(c) Which piece of apparatus was used to measure the sodium hydroxide solution?

..... [1]

(d) The litmus indicator changed colour

from ..... to ..... [1]

The experiment was repeated using hydrochloric acid of the same concentration as acid **S**. 46.6 cm^3 of hydrochloric acid was needed to neutralise 25.0 cm^3 of the aqueous sodium hydroxide.

(e) **(i)** Compare the volume of acid **S** used to neutralise 25.0 cm^3 of the aqueous sodium hydroxide with the volume of hydrochloric acid used.

..... [1]

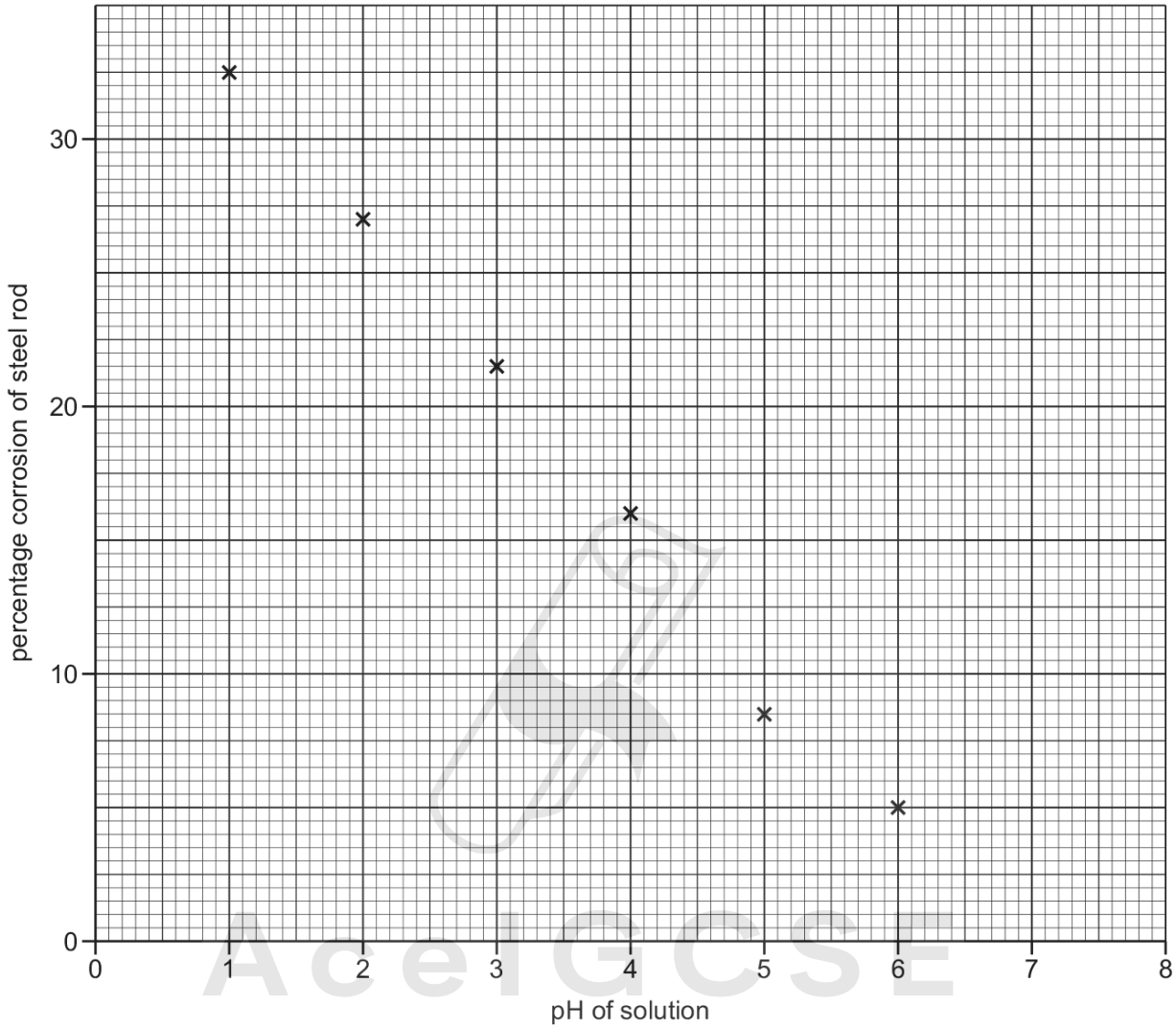
(ii) Suggest the value of y in the formula H_yA for acid **S**.

..... [1]

[Total: 9]

23. 0620_w13_qp_61 Q: 2

Eight steel rods of the same size were placed in solutions of different pH for one week.
The percentage corrosion of the rods was measured and the results plotted on the grid below.



(a) Draw a best fit straight line through the points. [1]

(b) Why were the steel rods the same size?

..... [1]

(c) State **one** other variable which should have been kept constant.

..... [1]

(d) State one conclusion that could be drawn from the results.

..... [1]

(e) Determine the percentage corrosion of a steel rod in a solution of pH 6.5.

..... [1]

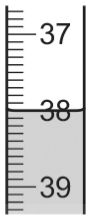
[Total: 5]

24. 0620_w13_qp_61 Q: 3

A student investigated the reaction between aqueous sodium hydroxide and acid **K**.
Two experiments were carried out.

(a) *Experiment 1*

Using a measuring cylinder, 25 cm^3 of acid **K** was poured into a conical flask. Phenolphthalein indicator was added to the flask. A burette was filled with aqueous sodium hydroxide to the 0.0 cm^3 mark. Aqueous sodium hydroxide was added from the burette to the flask and the mixture shaken until the solution showed a permanent colour change.
The final volume was measured. Use the burette diagram to record the final volume in the table and complete the table.



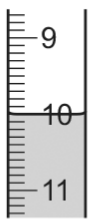
final volume

	burette reading
final volume / cm^3	
initial volume / cm^3	
difference / cm^3	

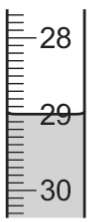
[2]

(b) *Experiment 2*

The solution was poured away and the conical flask rinsed.
Using a measuring cylinder, 50 cm^3 of acid **K** was poured into the conical flask. 0.3 g of powdered calcium carbonate was added to the flask and the flask shaken until no further reaction was observed.
Phenolphthalein was added to the mixture in the flask.
A burette was filled with the same aqueous sodium hydroxide and the initial volume measured. Aqueous sodium hydroxide was added from the burette to the flask and the mixture shaken until the solution showed a permanent colour change.
Use the burette diagrams to record the initial and final volumes in the table and complete the table.



initial volume



final volume

	burette reading
final volume / cm^3	
initial volume / cm^3	
difference / cm^3	

[2]

(c) What colour change was observed after the sodium hydroxide solution was added to the flask?

from ..... to ..... [2]

(d) What type of chemical reaction occurred when acid **K** reacted with sodium hydroxide?

..... [1]

(e) If Experiment 1 were repeated using 50 cm^3 of acid **K**, what volume of sodium hydroxide would be required to change the colour of the indicator?

..... [2]

(f) **(i)** What were the effects of adding 0.3 g of powdered calcium carbonate to acid **K**?

.....

..... [2]

(ii) Use your answer in **(e)** to work out the difference between the volume of sodium hydroxide needed to completely react with 50 cm^3 of acid **K** and the volume of sodium hydroxide used in Experiment 2.

.....

..... [2]

(iii) Estimate the mass of calcium carbonate that would be needed to be added to 50 cm^3 of acid **K** to require 0.0 cm^3 of sodium hydroxide.

..... [1]

(g) What would be the effect on the results if the solutions of acid **K** were warmed before adding the sodium hydroxide? Give a reason for your answer.

effect on results .....

reason ..... [2]

(h) Suggest the advantage, if any, of

(i) using a pipette to measure the volume of acid **K**.

.....

..... [2]

(ii) using a polystyrene cup instead of a flask.

.....

..... [2]

[Total: 20]

---

25. 0620_w13_qp_63 Q: 6

Indigestion tablets

Indigestion pain is caused by too much acid in your stomach. The acid is hydrochloric acid. Indigestion tablets contain a base which neutralises the acid.

You are provided with two different brands of indigestion tablets, Painremuve and Indcure.

Plan an investigation to compare which of these brands of tablet is the most effective. You are provided with dilute hydrochloric acid and common laboratory apparatus.

.....

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.....

.....

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.....

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.....

.....

..... [7]

[Total: 7]

26. 0620_w14_qp_61 Q: 4

A student investigated the reaction between two different solutions of dilute hydrochloric acid, **A** and **B**, and solution **C** which is alkaline.

Two experiments were carried out.

(a) *Experiment 1*

A burette was filled with solution **A** of dilute hydrochloric acid to the 0.0 cm^3 mark. Using a measuring cylinder, 20 cm^3 of solution **C** was poured into a conical flask. A few drops of methyl orange were added to the flask.

Solution **A** was added to the flask, with shaking, until the mixture just changed colour.
Use the burette diagram to record the burette reading in the table and complete the table.

initial reading

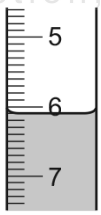
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(b) *Experiment 2*

The burette was emptied and rinsed, first with distilled water, and then with a little of solution **B**. The burette was filled with solution **B** of dilute hydrochloric acid to the 0.0 cm^3 mark.

Experiment 1 was repeated using solution **B**.
Use the burette diagram to record the burette reading in the table and complete the table.



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) **(i)** What type of chemical reaction takes place when hydrochloric acid reacts with alkaline solutions?

..... [1]

(ii) Why is methyl orange added to the flask?

..... [1]

(d) Why was the burette rinsed, first with distilled water and then with solution **B**, before starting Experiment 2?

.....

.....

..... [2]

(e) **(i)** In which experiment was the greater volume of dilute hydrochloric acid used?

..... [1]

(ii) Compare the volumes of dilute hydrochloric acid used in Experiments 1 and 2.

..... [1]

(iii) Suggest, in terms of the concentration of solutions **A** and **B**, an explanation for the difference in volumes used.

.....

.....

..... [2]

(f) If Experiment 2 was repeated using 10 cm^3 of solution **C**, what volume of dilute hydrochloric acid would be used? Explain your answer.

.....

..... [2]

(g) Give **one** advantage and **one** disadvantage of using a measuring cylinder for solution **C**.

advantage .....

disadvantage ..... [2]

(h) Describe a method other than titration, using a **different** reactant, that could be used to compare the concentrations of the two solutions of dilute hydrochloric acid, **A** and **B**.

.....

.....

.....

.....

.....

..... [4]

[Total: 20]

27. 0620_w14_qp_62 Q: 6

(a) Some liquid oven cleaners contain particles of an insoluble solid, bentonite, suspended in an aqueous solution.
Outline an experiment to obtain a **pure** sample of bentonite from the oven cleaner.

.....

.....

.....

.....

..... [3]

(b) Oven cleaners contain an aqueous solution of sodium hydroxide.
Plan an investigation to show which of two different oven cleaners, **C** and **D**, contains the more concentrated solution of sodium hydroxide.
You are provided with common laboratory apparatus and chemicals.

.....

.....

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.....

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.....

.....

..... [6]

[Total: 9]

28. 0620_w14_qp_63 Q: 6

Indicators turn different colours in acidic and alkaline solutions. Many plants contain substances which are indicators. These coloured substances can be extracted from the plant material using water and these substances can then be used to test whether a solution is an acid or an alkali.

You are provided with two plant materials, blueberries and red cabbage leaves, and common laboratory apparatus and chemicals.

(a) Plan an investigation to extract the coloured substances from these plant materials.

.....

.....

.....

.....

..... [4]

(b) Plan an experiment to show if the coloured substances obtained in **(a)** are suitable to use as indicators.

.....

.....

.....

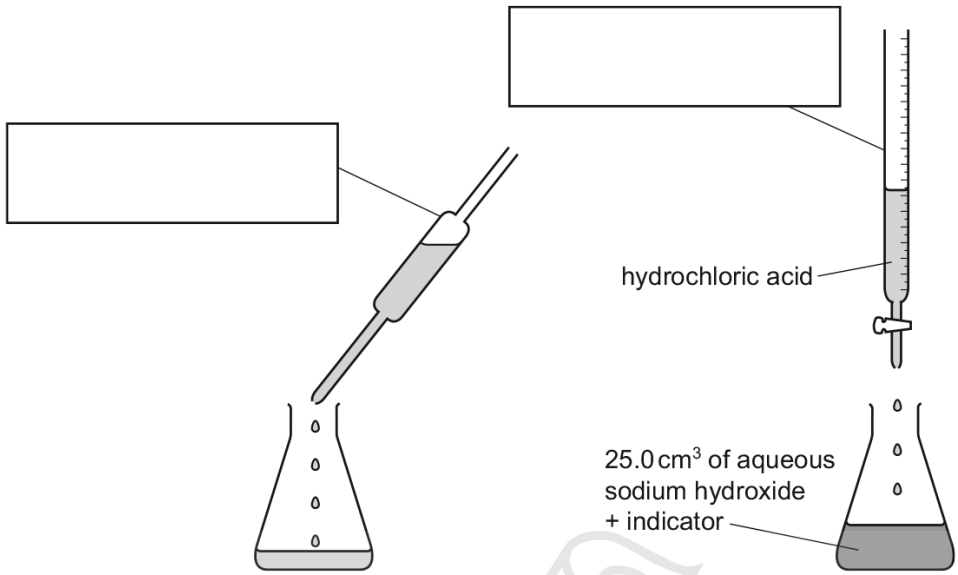
.....

..... [3]

[Total: 7]

29. 0620_w15_qp_62 Q: 1

The volume of hydrochloric acid that reacts with 25.0 cm^3 of aqueous sodium hydroxide can be found using the apparatus below.



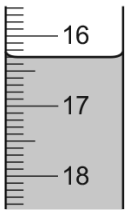
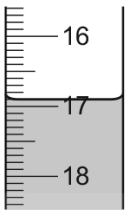
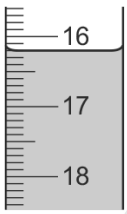
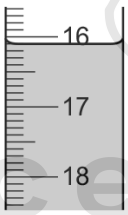
(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) Name a suitable indicator that could be used.

..... [1]

(c) A student did the experiment four times and the volume of hydrochloric acid added each time was measured.

Use the burette diagrams in the table to record the volumes of hydrochloric acid added.

experiment	burette diagram	volume of acid added / cm^3
1		
2		
3		
4		

[2]

(d) (i) What type of chemical reaction occurs when hydrochloric acid reacts with sodium hydroxide?

..... [1]

(ii) How did the student know when all of the sodium hydroxide had reacted?

..... [1]

(e) (i) Which **one** of the results is anomalous?

..... [1]

(ii) Suggest what may have caused this result to be anomalous.

..... [1]

(iii) Use the other results to calculate the average amount of hydrochloric acid that reacted with the sodium hydroxide solution.

.....

..... [2]

(f) Which of the solutions was more concentrated? Explain your answer.

.....

..... [2]

[Total: 13]

---

30. 0620_w16_qp_61 Q: 2

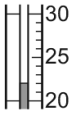
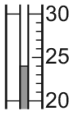
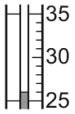
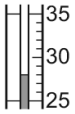
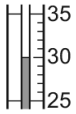
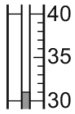
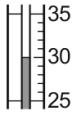
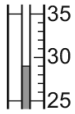
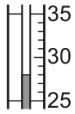
A student investigated what happened when dilute nitric acid reacted with aqueous solutions of two different alkalis, solution **N** and solution **O**.

Two experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 50 cm^3 of solution **N** into a polystyrene cup. The initial temperature of the solution was measured.
A burette was filled with nitric acid to the 0.0 cm^3 mark.
5.0 cm^3 of nitric acid were added to solution **N** in the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
A further 5.0 cm^3 of nitric acid were added to the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
The student continued to add 5.0 cm^3 portions of nitric acid to the polystyrene cup, until a total volume of 40 cm^3 of nitric acid had been added. After each addition, the solution was stirred and the maximum temperature measured.

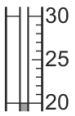
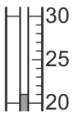
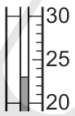
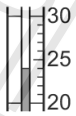
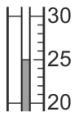
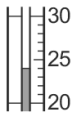
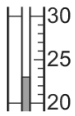
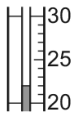
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram									
maximum temperature of the solution in the polystyrene cup / °C									

[2]

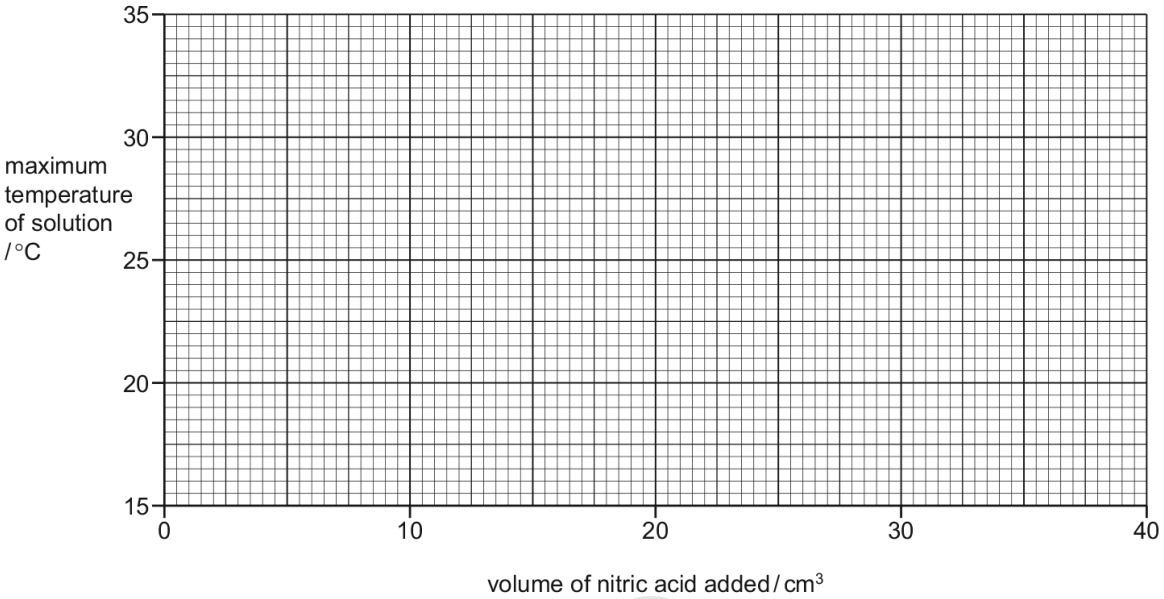
(b) *Experiment 2*

Experiment 1 was repeated using solution **O** instead of solution **N**.
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram									
maximum temperature of the solution in the polystyrene cup / °C									

[2]

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



[4]

(d) **Use your graph** to estimate the maximum temperature of the solution when 13 cm^3 of nitric acid were added to 50 cm^3 of solution **N** in Experiment 1.
Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) Name a suitable indicator that could be used in Experiment 1.

..... [1]

(f) Solution **N** and solution **O** were the same concentration.

In which experiment is the temperature change greater? Suggest why the temperature change is greater in this experiment.

.....

..... [2]

(g) How would the results differ in Experiment 1 if 100 cm^3 of solution **N** were used?

.....

..... [1]

(h) Suggest why a polystyrene cup was used in these experiments and **not** a copper can.

..... [1]

(i) State **one** source of error in the experiments. Suggest an improvement to reduce this source of error.

source of error .....

improvement .....
[2]

[Total: 17]

31. 0620_w16_qp_61 Q: 4

Agri Limes are mixtures of calcium carbonate and calcium oxide. Farmers use Agri Limes on fields to neutralise acidity.

Plan an investigation to find out which of **two** different Agri Limes, **Q** or **R**, will neutralise more acid. You are provided with common laboratory apparatus and chemicals, including dilute nitric acid.

.....

.....

.....

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.....

.....

.....

..... [6]

[Total: 6]

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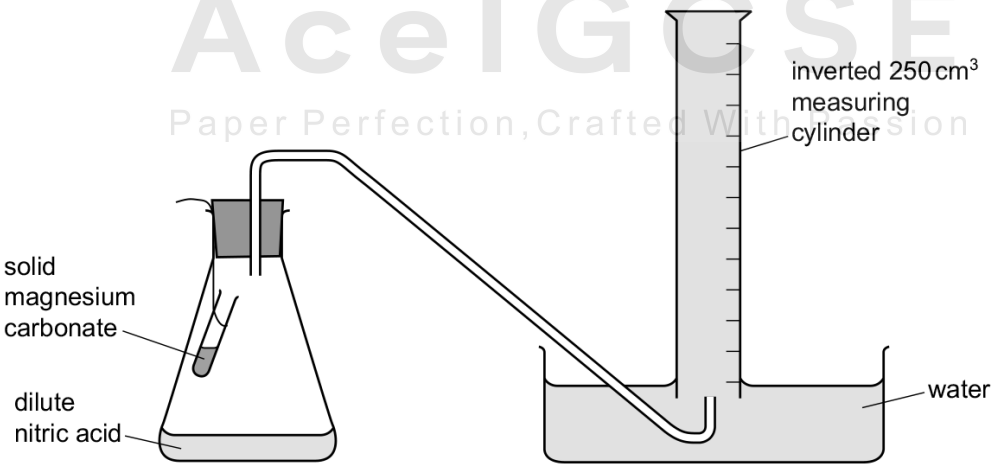
32. 0620_w19_qp_61 Q: 2

A student investigated the rate of reaction between dilute nitric acid and an excess of solid magnesium carbonate at room temperature.

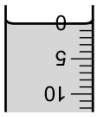
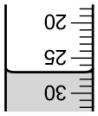
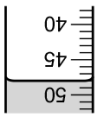
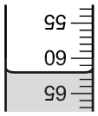
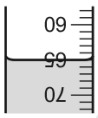
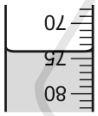
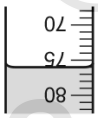
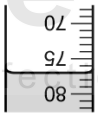
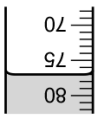
The apparatus was set up as shown in the diagram.

A small test-tube containing magnesium carbonate was suspended in the conical flask.



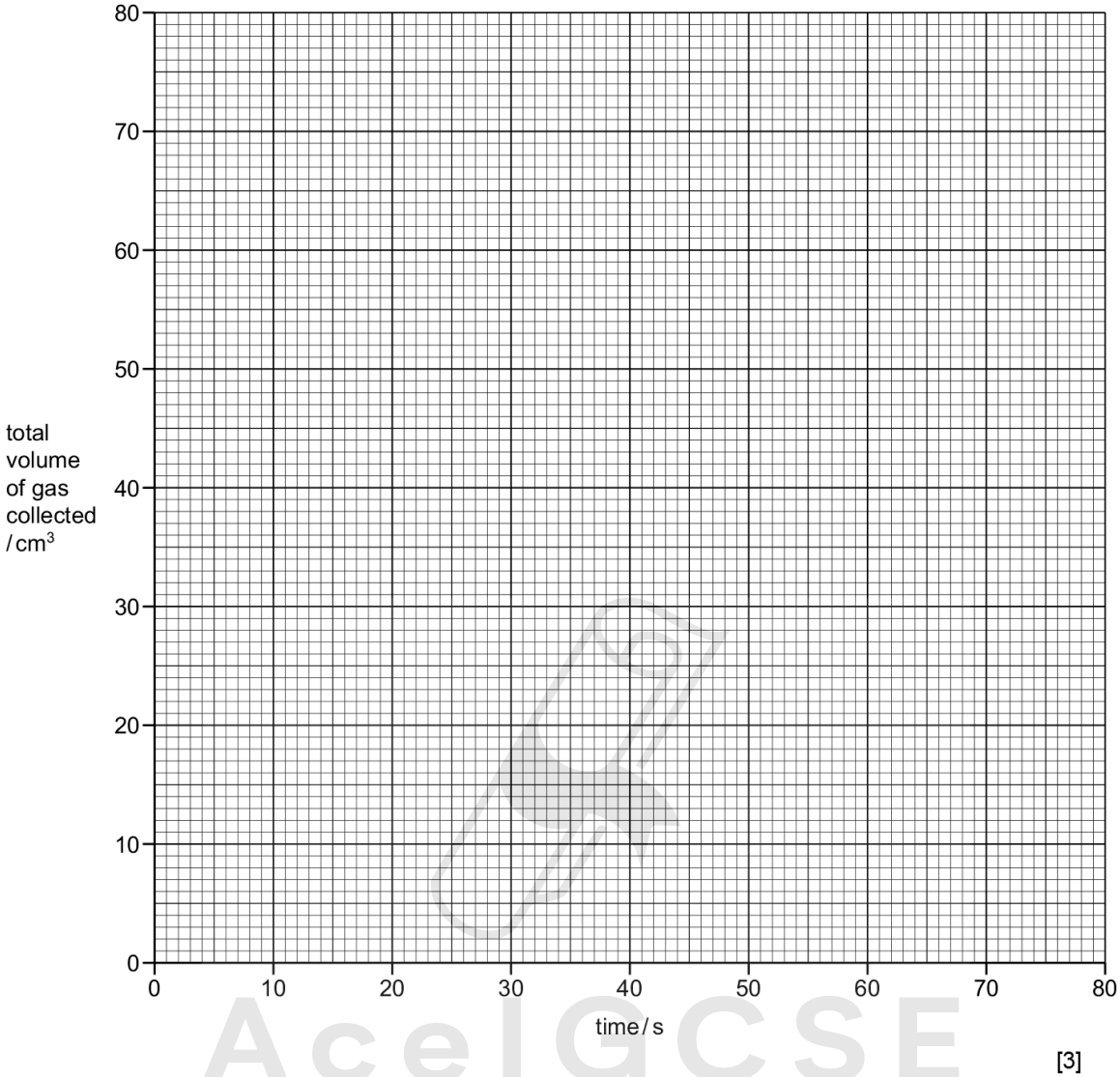
50 cm^3 of dilute nitric acid was added to the conical flask. The contents of the test-tube were released, allowing the solid magnesium carbonate to mix with the dilute nitric acid. A stop-clock was started and the volume of gas collected in the inverted measuring cylinder was measured every 10 seconds for 80 seconds.

(a) Use the inverted measuring cylinder diagrams to record the volume of gas collected in the table.

time / s	inverted measuring cylinder diagram	total volume of gas collected / cm^3
0		
10		
20		
30		
40		
50		
60		
70		
80		

[2]

(b) Plot the results on the grid. Draw a smooth line graph.



[3]

(c) (i) One of the points is anomalous.

Circle this point on your graph. [1]

(ii) **From your graph**, deduce the time taken to collect 40 cm^3 of gas.
Show clearly **on the grid** how you worked out your answer.

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

(d) State **one** possible source of error in this experiment. Suggest **one** improvement to reduce this source of error.

source of error .....

improvement .....
[2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time taken / s}}$$

(i) Calculate the volume of gas collected between 10 seconds and 30 seconds.

..... [1]

(ii) Calculate the average rate of reaction between 10 seconds and 30 seconds. Include the unit in your answer.

average rate of reaction = ...

unit = ...
[2]

(f) The student calculated that the total volume of gas collected in this reaction would be 85 cm^3.

Suggest and explain why the actual volume of gas collected was different from 85 cm^3.

.....

.....

..... [2]

(g) Sketch **on the grid** the graph you would expect if the experiment were repeated at a **lower** temperature. Label this graph as **L**. [2]

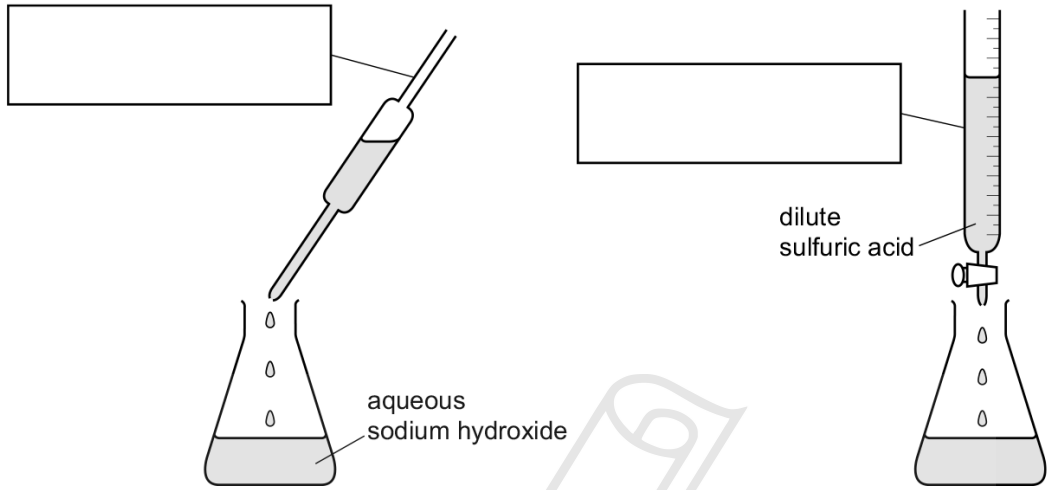
[Total: 17]

33. 0620_w19_qp_62 Q: 1

A student did a single titration to find the concentration of a solution of dilute sulfuric acid.

The student added 25.0 cm^3 of aqueous sodium hydroxide to a conical flask, followed by a few drops of indicator. Dilute sulfuric acid was then added to the aqueous sodium hydroxide until the solution was neutral.

The apparatus used is shown in the diagram.



(a) Complete the boxes to name the apparatus. [2]

(b) Name a suitable indicator to use in the titration and give the colour change.

indicator .....

colour change from ..... to .....
[2]

(c) What readings should the student take when doing this single titration?

..... [2]

(d) After the titration, the student discarded the contents of the conical flask and rinsed the conical flask with distilled water.

Suggest and explain what would be the effect, if any, on the titration values if the conical flask was not dried before repeating the titration.

.....

.....

..... [2]

[Total: 8]

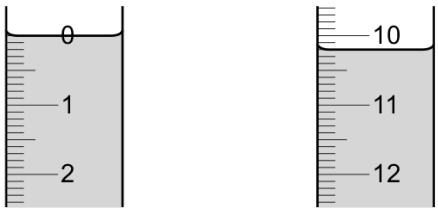
34. 0620_w19_qp_63 Q: 2

A student investigated the reaction between dilute hydrochloric acid and three different concentrations of aqueous sodium hydroxide, labelled **R**, **S** and **T**.

Three experiments were done.

Experiment 1

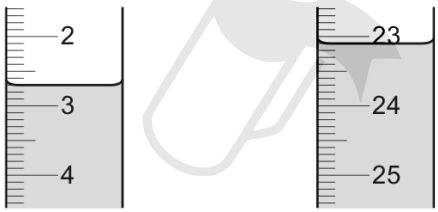
- A burette was filled with dilute hydrochloric acid. The initial burette reading was measured.
- Using a measuring cylinder, 20 cm^3 of solution **R** was poured into a conical flask.
- Six drops of methyl orange indicator were added to the conical flask.
- Dilute hydrochloric acid was added from the burette, until the solution just changed colour.
- The final burette reading was measured.



initial final

Experiment 2

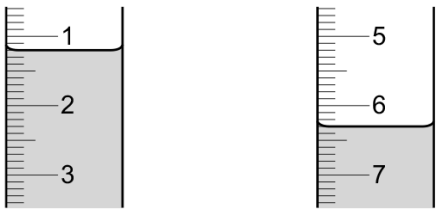
- Experiment 1 was repeated but using 20 cm^3 of solution **S** instead of solution **R**.



initial final

Experiment 3

- Experiment 1 was repeated but using 20 cm^3 of solution **T** instead of solution **R**.



initial final

(a) Use the burette diagrams to record all the burette readings in the table.

burette reading / cm^3	Experiment 1 using solution **R**	Experiment 2 using solution **S**	Experiment 3 using solution **T**
final burette reading			
initial burette reading			
volume used			

[4]

(b) What colour change is observed in the conical flask at the end-point?

from ..... to .....

[2]

(c) Suggest why Universal Indicator is **not** a suitable indicator in these experiments.

.....

..... [1]

(d) (i) Complete the sentences below.

Experiment ..... needed the smallest volume of dilute hydrochloric acid to change the colour of the indicator.

Experiment ..... needed the largest volume of dilute hydrochloric acid to change the colour of the indicator.

[1]

(ii) Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 2.

Experiment 1 ..... : ..... Experiment 2 [1]

(iii) Deduce the order of concentrations of the solutions of aqueous sodium hydroxide, **R**, **S** and **T**.

most concentrated .....

.....

least concentrated .....

[1]

(e) What would be the effect on the results, if any, if the solutions of aqueous sodium hydroxide were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on the results .....

reason .....

[2]

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

.....

.....

.....

..... [2]

(g) Suggest a different method, **not** involving an indicator, of finding the order of concentrations of the solutions of aqueous sodium hydroxide, **R**, **S** and **T**.

.....

.....

..... [3]

[Total: 17]

35. 0620_w20_qp_61 Q: 2

A student investigated the mass of lead(II) iodide precipitate formed when aqueous potassium iodide reacts with aqueous lead(II) nitrate.

The equation for the reaction is shown.

$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

The student did seven experiments.

Experiment 1

- Using a 50 cm^3 measuring cylinder, 25 cm^3 of aqueous potassium iodide was poured into a beaker.
- Using a clean 50 cm^3 measuring cylinder, 10 cm^3 of aqueous lead(II) nitrate was added to the aqueous potassium iodide in the beaker. The solutions were mixed together.
- The mass of the precipitate of lead(II) iodide formed was found.

Experiment 2

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 1.

Experiment 3

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 2.

Experiment 4

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 3.

Experiment 5

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 4.

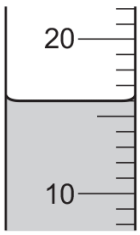
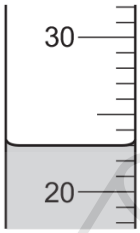
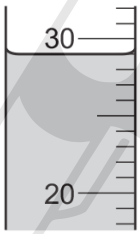
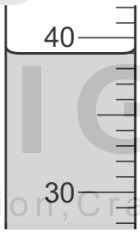
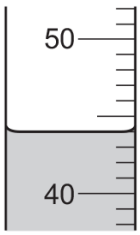
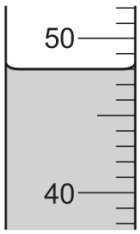
Experiment 6

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 5.

Experiment 7

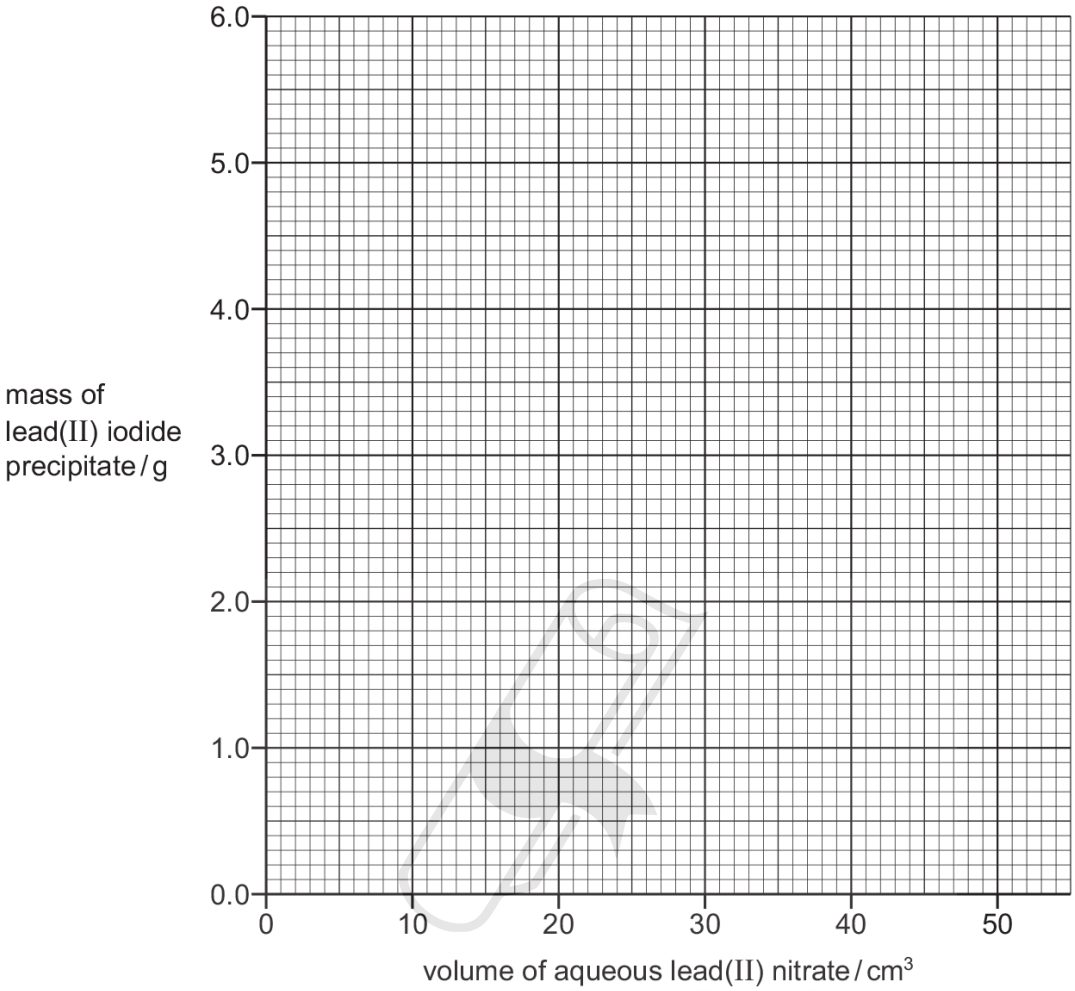
- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 6.

(a) Use the measuring cylinder diagrams to complete the table.

experiment	volume of aqueous potassium iodide / cm^3	measuring cylinder diagram for aqueous lead(II) nitrate	volume of aqueous lead(II) nitrate / cm^3	mass of lead(II) iodide precipitate / g
1	25		10	1.4
2	25			2.3
3	25			3.3
4	25			4.1
5	25			5.1
6	25			5.1
7	25			5.1

[2]

(b) Plot the results from Experiments 1 to 7 on the grid. Draw two straight lines through the points. Extend your straight lines so that they meet.



[5]

(c) **From your graph**, deduce the mass of lead(II) iodide precipitate that would be formed if Experiment 1 was repeated using 20 cm^3 of aqueous lead(II) nitrate.

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

mass = ... g [2]

(d) Explain why the same mass of precipitate is formed in Experiment 5, Experiment 6 and Experiment 7.

.....

..... [1]

(e) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using aqueous potassium iodide with half the concentration. [2]

(f) **(i)** State why using a 25.0 cm^3 pipette to measure the volume of aqueous potassium iodide would be an improvement.

.....

..... [1]

(ii) State why a 25.0 cm^3 pipette could **not** be used to measure the volume of aqueous lead(II) nitrate in each experiment.

.....

..... [1]

(g) Describe how the solid lead(II) iodide can be separated from the reaction mixture and its mass found.

.....

.....

.....

.....

.....

..... [3]

[Total: 17]

36. 0620_w20_qp_63 Q: 2

A student investigated the reaction between dilute ethanoic acid and two different solutions of sodium hydroxide labelled solution **A** and solution **B**.

Two experiments were done.

(a) *Experiment 1*

- A burette was rinsed with solution **A**.
- The burette was filled with solution **A**. Some of solution **A** was run out of the burette so that the level of solution **A** was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of dilute ethanoic acid was poured into a conical flask.
- Five drops of thymolphthalein indicator were added to the conical flask.
- Solution **A** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.

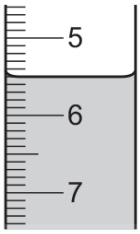
initial reading final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **A** added / cm^3	

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was emptied and rinsed with distilled water.
- The burette was rinsed with solution **B**.
- The burette was filled with solution **B**. Some of solution **B** was run out of the burette so that the level of solution **B** was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of dilute ethanoic acid was poured into a conical flask.
- Five drops of thymolphthalein indicator were added to the conical flask.
- Solution **B** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 2.



initial reading

final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **B** added / cm^3	

[4]

(b) Explain why universal indicator is **not** a suitable indicator to use in this titration.

.....

..... [1]

(c) (i) State which solution of sodium hydroxide, solution **A** or solution **B**, was the more concentrated.
Explain your answer.

.....

..... [1]

(ii) State how many times more concentrated this solution of sodium hydroxide was than the other solution of sodium hydroxide.

.....

..... [1]

Determine the volume of solution **B** that would be required if Experiment 2 was repeated with 10 cm^3 of dilute ethanoic acid.

.....

..... [2]

Describe how the reliability of the results could be checked.

.....

..... [1]

A 25 cm^3 pipette can be used to measure the volume of a solution.

(i) Describe an advantage of using a 25 cm^3 pipette to measure the volume of the dilute ethanoic acid.

.....

..... [1]

(ii) Explain why a 25 cm^3 pipette could **not** be used to measure the volume of solution **A**.

.....

..... [1]

(i) Explain why the burette was rinsed with distilled water in Experiment 2.

.....

..... [1]

(ii) Explain why the burette was then rinsed with solution **B**.

.....

..... [1]

(iii) State the effect that **not** rinsing the burette with solution **B** would have on the final burette reading.
Explain your answer.

effect .....

explanation .....

.....
[2]

[Total: 16]

37. 0620_w21_qp_62 Q: 2

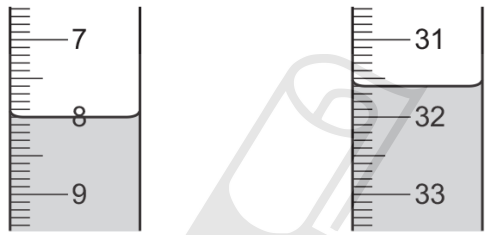
A student investigated the reaction between two different solutions of aqueous sodium carbonate, solution **K** and solution **L**, and two different solutions of dilute hydrochloric acid, acid **M** and acid **N**.

Three experiments were done.

(a) *Experiment 1*

- A burette was filled with solution **K**. Some of solution **K** was run out of the burette so that the level of solution **K** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **M** was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **K** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.



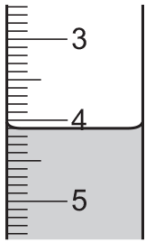
initial reading final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **K** added / cm^3	

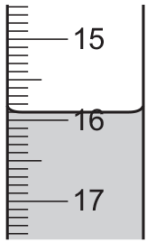
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was refilled with solution **K**. Some of solution **K** was run out of the burette so that the level of solution **K** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **N** was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **K** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 2.



initial reading



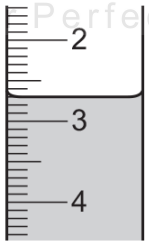
final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **K** added / cm^3	

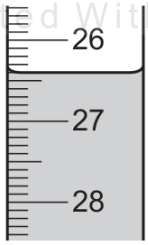
Experiment 3

- The burette was emptied and rinsed with distilled water.
- The conical flask was emptied and rinsed with distilled water.
- The burette was filled with solution **L**. Some of solution **L** was run out of the burette so that the level of solution **L** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **N** was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **L** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 3.



initial reading



final reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **L** added / cm^3	

[5]

(b) State the colour change observed at the end-point in the conical flask in Experiment 1.

from ..... to ..... [1]

(c) Describe one **other** observation made when solution **K** was added to acid **M** in Experiment 1.

..... [1]

(d) **(i)** Compare the volumes of solution **K** used in Experiment 1 and Experiment 2.

.....

..... [2]

(ii) Suggest why different volumes of solution **K** were needed in Experiment 1 and Experiment 2.

..... [1]

(e) Deduce the volume of solution **L** required to reach the end-point if Experiment 3 is repeated using acid **M** in place of acid **N**.

volume of solution **L** = ... cm^3 [1]

(f) Explain why the conical flask was rinsed with water at the start of Experiment 2 and Experiment 3.

..... [1]

(g) At the start of Experiment 3 the burette was rinsed with water.

Describe an additional step that should have been done after rinsing the burette with water but before filling the burette with solution **L**. Explain your answer.

.....

..... [2]

(h) Explain why the conical flask is placed on a white tile.

..... [1]

(i) Describe how the reliability of the results can be confirmed.

.....

..... [1]

(j) State **one** source of error in Experiment 1. Suggest an improvement to reduce this error.

source of error .....

improvement .....
[2]

[Total: 18]

---

01. 0620_m15_ms_62 Q: 1

(a) thermometer (1)

condenser (1) [2]

(b) **(i)** ethanoic acid (1)

lower boiling point / evaporates first (1) [2]

(ii) temperature reading will rise / gap in liquid coming over / no more collected at 118 °C (1) [1]

(c) larger surface area (1) [1]

(d) test: named indicator / pH meter / pH paper (1)

result: correct colour change / pH < 7 (1) [2]

---

02. 0620_m17_ms_62 Q: 2

(a)	initial and final readings completed correctly: 29.6; 4.1	**1**
	difference completed correctly: 25.5	**1**
(b)	initial and final readings and difference completed correctly: 29.1; 24.0; 5.1	**1**
	all readings to 1 d.p.	**1**
(c)	neutralisation	**1**
(d)(i)	solution **O**	**1**
	greater volume of acid was used in the titration	**1**

(d)(ii)	five times as concentrated	**1**
(e)	2.5–2.6	**1**
	unit: cm^3	**1**
(f)	effect on volume: no effect	**1**
	reason: temperature would only affect the rate	**1**
(g)(i)	use a pipette / burette	**1**
(g)(ii)	repeat experiments (and compare / average)	**1**
(h)	**M1** ***fair test*** to equal volumes of each sodium hydroxide solution / solutions **O** and **P** add an equal volume / measured volumes of aqueous calcium chloride	**1**
	M2 ***dependent variable measured*** measure mass / height of precipitate formed / volume of calcium chloride used	**1**
	M3 ***conclusion*** the more concentrated sodium hydroxide solution would form the most precipitate (mass / height) / would require a smaller volume of calcium chloride	**1**

03. 0620_m18_ms_62 Q: 2

(a)	*table of results final reading and difference completed correctly* 11.6		**1**
(b)	*table of results with final reading and difference completed* correctly 23.6 **and** 11.6		**1**
(c)	*final reading completed correctly*	24.1	**1**
	initial reading completed correctly	0.9	**1**
	difference correct	23.2	**1**
(d)	yellow to orange		**1**
(e)	to remove impurities / chemicals / residue / solution / owtte		**1**
(f)	3		**1**

(g)	pipette / burette	1
(h)	*effect* no effect	1
	reason no change in reactant concentrations / owtte	1
(i)(i)	1:2	1
(i)(ii)	different indicators used / owtte	1
(j)	more than one colour change / cannot find end point	1
(k)	repeat (experiments)	1
	compare / average / check spread of results	1

04. 0620_m21_ms_62 Q: 2

Question	Answer	Marks
(a)	final and initial burette reading for Experiment 1 correct (17.9 and 8.0)	1
	final and initial burette reading for Experiment 2 correct (27.3 and 7.5)	1
	both titres correct (9.9 and 19.8)	1
	all volumes recorded to 1 dp or better	1
(b)	(from) yellow (to) orange	1
(c)(i)	to remove any residue from Experiment 1	1
(c)(ii)	larger volume of solution B needed / it would increase	1
	(as there is) more potassium hydroxide / alkali	1
(d)(i)	solution A as lower volume (required).	1
(d)(ii)	2× / twice	1
(e)	can spot anomalous results OR can find a mean/average	1
(f)	39.6 / numerical answer which is twice titre in Experiment 2	1
	cm^3	1
(g)	use a (volumetric) pipette to measure the volume of potassium hydroxide	1
(h)	none	1

05. 0620_s12_ms_61 Q: 1

(a) tripod (1) **accept**: stand spatula (1) not: spoon [2]

(b) fizz/bubbles/effervescence stops (1)
solid/iron/powder visible / no more iron dissolves/reacts (1) [2]

(c) evaporation of water/steam (1) solid/residue/crystals formed (1)
colour change turns brown/darker green (1)
effect of heat on solid solid breaks down (1) max 3 [3]

[Total: 7]

06. 0620_s12_ms_62 Q: 7

(a) use Universal/pH indicator/pH meter (1) ignore: litmus/indicator [1]

(b) **note**: This can be marked via three routes.

If they use a full bottle:
use full bottle (1)
(air-tight) connections (1)
syringe/inverted measuring cylinder/graduated tube to collect gas (1)
heat/shake (1)
until no more gas given off (1)
measure volume of gas (1)
any 6

If they use a sample:
use measured volume (1)
(air-tight) connections (1)
syringe/inverted measuring cylinder/graduated tube to collect gas (1)
heat/shake (1)
until no more gas given off (1)
measure volume of gas (1)
multiply to get full bottle value (1)
max 6

If they do it by loss in mass:
weigh the bottle/sample (1)
heat/shake (1)
until no more gas given off (1)
reweigh bottle (1)
use density to calculate volume (1)
max 5 [6]

[Total: 7]

(b) table of results

initial readings completed correctly (1) 0.0, 9.0

final readings completed correctly (1) 39.0, 22.0

all readings to 1 decimal place (1)

differences completed correctly (1) 39.0, 13.0 [4]

(c) yellow (1) to orange / pink (1) [2]

(d) neutralisation (1) **allow:** endothermic [1]

(e) Experiment 2 (1) **allow:** ecf [1]

(f) **(i)** three times as much used in Experiment 1 (1) **not:** ecf [1]

(ii) solution / acid **G** / 2 (1) [1]

(g) twice value from table result for experiment 2 / 26 (1) cm^3 (1) [2]

(h) use a pipette/burette [1]

(i) to remove acid **F** / clean (1) water would dilute acid **G** / owtte (1) [2]

(j) effect none / owtte (1)

reason no change in concentration / owtte (1) [2]

(k) any correct method that would work- precise details not needed

using same method with different bases = 0

reagents (1) method (1) result (1) [3]
not: method using indicators

e.g. * to hydrochloric acid add named metal, e.g. Mg, Zn (1)

measure temperature change (1)

largest change = strongest / more concentrated solution (1)

* to hydrochloric acid add sodium hydroxide solution (1)

measure temperature change (1)

largest change = strongest solution (1)

* rate experiment

add acid to appropriate reagent (1)

method of rate measurement, e.g. volume of gas (1)

conclusion (1)

---

08. 0620_s14_ms_61 Q: 4

(a) table of results for Experiment 1

initial and final volume boxes completed correctly (1) 0.0 and 16.8

difference box correctly completed (1) 16.8

all readings to one decimal place (1) [3]

(b) table of results for Experiment 2

initial (1) and final volume (1) boxes completed correctly 16.8 (1) and 25.2 (1)

difference box correctly completed (1) 8.4 [3]

(d) to colourless (1) [1]
not: clear

(e) coloured reacting mixture masks colour of phenolphthalein / reaction is finished / solution is acidic (1) [1]

(f) carbonate / carbon dioxide present (1) [1]
allow: hydrogencarbonate

(g) (i) 8.4 (1)
ecf: titre 1 – titre 2

cm^3 (1) [2]

(ii) 16.8 (1) [1]
ecf: 2 × titre 2

(iii) twice volume of acid needed to react with T (1) [1]
ecf: if **(g)(i)** or / and **(g)(ii)** wrong need quantitative link.
not: more (unqualified)

(h) (i) 67.2 cm^3 (1)

33.6 cm^3 (1)

4 × volume of solution R (1) [3]

(ii) volume of acid used > 50 cm^3 / more than burette can hold (1)

set up more than two burettes / 100.8 won't fit into 2 (1) [2]
allow: impurities / contamination (1)

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09. 0620_s14_ms_63 Q: 6

x cm^3 of vinegar (1)

in named container e.g. beaker (1)

add named indicator (1)

add sodium hydroxide until colour change (1)

record volume sodium hydroxide added (1)

repeat with other vinegar (1)

compare results (1) [7]

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10. 0620_s15_ms_61 Q: 4

(a)	25, 27, 30, 32, 34, 36, 35, 34, 33 all 9 = 3 marks 8 = 2 marks 7 = 1 mark	**3**	please put an 'x' by any incorrectly plotted points
(b)	25, 34, 41, 40, 39, 38, 37, 36, 34 all 9 = 3 marks 8 = 2 marks 7 = 1 mark	**3**	
(c)	all 18 points plotted within half a small square = 3 marks 17 points plotted within half a small square = 2 marks 16 points plotted within half a small square = 1 mark; smooth line graph; labels;	**5**	
(d)	value read from graph, 38.5 °C; indication clearly shown;	**2**	
(e)	exothermic;	**1**	

(f)	to remove traces of acid A / clean; to remove water;	2	
(g)(i)	experiment 2 / acid B;	1	
(g)(ii)	acid B is stronger / dibasic / has a lower pH / more acidic;	1	**I** more reactive / more concentrated
(h)	heat losses / using a measuring cylinder / thermometer / cup not washed; insulate / use burette / digital thermom. / new cup;	2	**I** repeat and average

11. 0620_s15_ms_62 Q: 7

	Generic marking points can be applied to any method: mp1 (fair testing) known or stated volume of tonic water; mp2 (fair testing) repeat with other sample of tonic water; mp3 (reagent) add or react with KOH or Mg turnings etc.; mp4 (method) use of indicator / collect gas etc.; mp5 (endpoint) until colour changes / until no more gas evolved / for one minute etc.; mp6 (measurement) volume of KOH added / volume of gas evolved; mp7 (conclusion) the higher concentration is the one that needs the greater volume of KOH / gives off the most gas etc.;	**max 6**	There are many possible methods. The most common is titration by either adding tonic water to KOH or KOH to tonic water. However, reagents such as Mg or carbonates would also work. **A** a pH meter / probe could work. The volume of the tonic water does not matter, so mp1 should be replaced by constant temperature. **A** use of Universal Indicator with green as the endpoint **A** use of litmus

12. 0620_s15_ms_63 Q: 4

(e)	24, 23, 22, 25 initial temperature boxes completed correctly; 28, 59, 19, 44 maximum temperature boxes completed correctly; 4, 36, –3, 19 temperature changes completed correctly;	3	
(f)	appropriate scale for y axis; all temp differences correctly plotted = 2 marks three temp differences correctly plotted = 1 mark; clearly labelled;	4	highest temperature at least half-way
(g)(i)	exothermic;	1	**A** neutralisation
(g)(ii)	(D is a) carbonate / carbon dioxide formed;	1	
(h)	experiment 2 / solid E;	1	
(i)(i)	acid neutralised / pH increased; (so solid G is a) base / alkali;	2	
(j)	room temperature / initial temperature from table; reaction over;	2	

(k)	temperature change lower / halved; volume of acid larger / doubled;	**2**	
(l)	source: measuring cylinder / thermometer / heat losses; improvement: use burette / digital thermometer / insulate / lag;	**2**	

13. 0620_s16_ms_61 Q: 2

(a)	final readings completed correctly: 13.2, 39.2; initial readings completed correctly: 0.0, 12.8; differences completed correctly: 13.2, 26.4; all readings and differences to 1 decimal place;	**4** 1 1 1 1
(b)	yellow to orange / red / pink;	**1**
(c)	initial and final readings completed correctly: 9.9, 16.5; difference completed correctly: 6.6;	**2** 1 1
(d)	bubbles / fizzing / effervescence;	**1**
(e)	Experiment 2;	**1**
(f)	use a pipette / burette;	**1**
(g)	effect on results: none owtte; reason: no change in concentration owtte;	**2** 1 1
(h)(i)	2:1;	**1**
(h)(ii)	acid **B** is double the concentration of acid **A** ora / acid **B** is more concentrated ora;	**1**
(i)	any suitable correct and different method **M1** method; **M2** reagents; **M3** result;	**3** 1 1 1

14. 0620_s17_ms_62 Q: 2

(a)	initial volume completed correctly: 0.0 final volume completed correctly: 13.0	**1**
	difference: 13.0	**1**
(b)	final volume, initial volume and difference completed correctly: 41.1, 2.1 and 39.0	**1**
	all readings in **(a)** and **(b)** to 1 d.p.	**1**
(c)	there is a colour change at the end-point already	**1**
(d)(i)	solution **C**	**1**
	a greater volume of potassium manganate(VII) / solution **A** was needed	**1**

(d)(ii)	3 × as concentrated	1
(e)(i)	double the volume of solution **C** was used / double the volume of solution **A** was needed	1
	78 cm^3	1
(e)(ii)	problem: volume of potassium manganate(VII) solution added would be greater than 50 cm^3	1
	solution: use more than one burette / refill burette	1
(f)	advantage: easy (to use) / quick	1
	disadvantage: not accurate	1
(g)	can take average or mean / can spot anomalies / more reliable	1

15. 0620_s18_ms_61 Q: 1

(a)	burette	1
(b)	methyl orange / thymolphthalein / litmus	1
(c)(i)	number 2 / 18.9 cm^3	1
(c)(ii)	overshot end point / more than 25 cm^3 KOH in flask	1
(c)(iii)	18.2	1
	cm^3	1
(d)	(wrong conclusion) nitric acid more concentrated / stronger	1
	smaller volume of acid needed	1

16. 0620_s18_ms_62 Q: 4

	any **6** from: □ hydrochloric acid in burette / measuring cylinder (solutions can be reversed) □ measured volume of barium hydroxide solution (solutions can be reversed) □ in named container e.g. beaker / (conical) flask □ (named) indicator (ignore Universal Indicator) **OR** pH meter □ acid added gradually / slowly / dropwise / dripped □ until colour changes / endpoint / neutral / pH 7 □ note volume added / initial and final volumes □ calculation (using volumes and concentration of the acid)	**max 6**

17. 0620_s20_ms_61 Q: 2

Question	Answer	Marks
(a)	all six burette readings correct • 10.2 / 0.0 • 25.9 / 5.5 • 33.0 / 2.4	2
	all readings to 1 dp	1
	initial and final readings the correct way round	1
	all subtractions correct to calculate volume added • 10.2 • 20.4 • 30.6	1
(b)	(from) yellow	1
	(to) red / pink / orange	1
(c)	solution F more concentrated (than solution E)	1
	1.5 times	1
(d)	1:2	1

Question	Answer	Marks
(e)	15.3	1
	cm^3	1
(f)(i)	clean / remove residues from previous experiment	1
(f)(ii)	does not change amount of E / F or volumes / amounts already measured	1
(g)	errors any **two** from: • using measuring cylinder • missing endpoint / misjudging colour change • not repeating improvements any **two** from: • use pipette (in place of measuring cylinder) • add more slowly • repeat (and find mean)	4

18. 0620_s20_ms_62 Q: 4

Question	Answer	Marks
	Any six from: • stated / equal volumes of each cleaner • measured with pipette / measuring cylinder / burette into a beaker or flask • named indicator added • add hydrochloric acid • from a burette • until indicator changes colour • record / calculate volume acid added • biggest volume of acid is most concentrated	6

19. 0620_s21_ms_61 Q: 2

Question	Answer	Marks
(a)	all temperatures and temperature changes completed and all temperatures and temperature changes recorded to the same precision	1
	all temperatures recorded correctly (22.0, 22.0, 22.0, 22.5, 23.0, 23.0) and (19.5, 17.0, 14.5, 13.5, 14.0, 14.0)	2
	all temperature changes calculated correctly (2.5, 5.0, 7.5, 9.0, 9.0, 9.0)	1
(b)	all points plotted correctly	1
	ruler drawn straight line through first 4 points	1
	(ruler) drawn straight line through last three points	1
	straight lines have been extended so that they meet / cross	1
(c)(i)	values read correctly from graph (9.0 °C **and** 3.6 g)	1
	correct indication on graph	1
	units (°C **and** g)	1
(c)(ii)	(all) acid used up / sodium hydrogen carbonate in excess	1
(d)	correct line should be identical to plotted line up to 1.8 g and then becomes horizontal. temp change of between 4.0 and 5.0 where line becomes horizontal / levels off	1
	mass of between 1.0 and 2.5 where line becomes horizontal / levels off	1

Question	Answer	Marks
(e)	change: use a pipette	1
	explanation: more accurate than a measuring cylinder	1
	change: use a polystyrene / styrofoam cup	1
	explanation: insulator / reduces heat gain	1

20. 0620_s21_ms_62 Q: 2

Question	Answer	Marks
(a)	all volumes of dilute hydrochloric acid correct (16, 14, 12, 10, 6)	1
	all volumes recorded correctly, 4 correct scores 1 (56, 49, 44, 37, 26)	2
(b)	suitable scale for *y*-axis	1
	plotting – all 5 correct scores 2, 4 correct scores 1	2
	line drawn is a straight line of best fit	1
(c)(i)	correct reading from graph (usually 29 cm^3)	1
	working shown on graph	1
(c)(ii)	answer to **(c)(i)** ÷ 7	1
(d)(i)	gas escapes before bung is replaced /so that gas does not escape	1

Question	Answer	Marks
(d)(ii)	either • place one reagent in tube inside boiling tube / flask • tip / shake tube to start reaction **OR** • use a divided flask • tip flask to start reaction	2
(e)	more accurate	1
(f)	line drawn is below plotted line	1
	volumes are half of the values of plotted line	1

21. 0620_s21_ms_63 Q: 2

Question	Answer	Marks
(a)	all experiments have volume of sulfuric acid of 25 cm^3	1
	all volumes of water correct (30, 20, 10, 5, 0) and all volumes given to the same precision	1
	all volume of gas collected correct (10, 19, 38, 61, 95), four volumes correct scores 1	2
(b)	plotting – all 5 correct scores 2, 4 correct scores 1	2
	suitable best fit curve	1
(c)	appropriate extrapolation of line to 35	1
	correct reading from extrapolation	1
(d)(i)	correct calculation of volume for experiment 3; 38 / 30 = 1.27)	1
	cm^3 / s	1

Question	Answer	Marks
(d)(ii)	5	1
(e)(i)	more accurate	1
(e)(ii)	slower / takes more time	1
(f)	(gas) syringe	1
(g)	any 2 from: • The reaction can be started by tipping the flask • do not have to replace / remove the bung • so no gas escapes (while the bung is being removed / replaced)	2

22. 0620_w12_ms_63 Q: 3

(a) initial readings [3]

0.0 17.5 8.9

final readings

23.8 40.7 32.3 (2), –1 any incorrect

differences

23.8 23.2 23.4 (1)

(b) titration 2 and 3/23.2 and 23.4 (1) [2]

average = 23.3 (1)

allow: ecf for calculation of average

(c) pipette/burette (1) [1]

(d) blue to red/pink (1) [1]

(e) **(i)** half as much acid S/twice as much HC*l* (1) [1]

(ii) $y = 2$ (1) [1]

23. 0620_w13_ms_61 Q: 2

(a) straight line drawn with a ruler through all points missing point at pH 5 (1) [1]

(b) idea of fair test / comparability (1) [1]

(c) temperature (1) [1]

(d) the lower the pH the greater the % corrosion / or converse / pH 1 is most corrosive (1) [1]

(e) 2.5% (1) [1]

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24. 0620_w13_ms_61 Q: 3

(a) table of results for Experiment 1
initial, final and difference volume boxes completed correctly (1)
0.0, 38.0 difference 38.0
readings to 1dp (1) [2]

(b) table of results for Experiment 2
initial and final boxes completed correctly (1) 10.0, 29.0
difference (1) [2]

(c) colourless (1) pink (1) [2]

(d) neutralisation / exothermic (1) [1]

(e) 2 × volume for Experiment 1 from table / 76 (1) cm^3 (1) [2]

(f) **(i)** reacts with the acid / neutralised (1) less sodium hydroxide needed (1) [2]

(ii) volume in **(e)** – volume added in Experiment 2 (1) e.g. 76–19
correct value (2) e.g. 57 cm^3 [2]

(iii) estimate based on **(ii)** answer to **(ii)** / 3 divided into 19 × 0.1 + 0.3 = 0.4 g [1]

(g) no effect (1)
reason – reaction not affected by temperature (1) [2]

(h) **(i)** more accurate (1) than a measuring cylinder (1) [2]

(ii) no effect / advantage (1) not measuring temperature changes (1) [2]

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25. 0620_w13_ms_63 Q: 6

stated / known / same volume of hydrochloric acid (1)
use of named measuring apparatus (1)
addition of named indicator (1)
add tablets (1)
until the colour changes / pH =7 (1)
take measurement (1) e.g. number of tablets
repeat with other tablet (1)
compare / conclusion (1) e.g. brand that uses fewer tablets is most effective
allow: other correct methods including loss of mass and collection of gas

max [7]

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26. 0620_w14_ms_61 Q: 4

(a) table of results for Experiment 1
initial volume completed correctly (1)
0 or 24.4
all readings to 1 decimal place (1) [2]

(b) table of results for Experiment 2
final volume completed correctly (1)
6.1
difference correct (1) [2]

(c) **(i)** neutralisation (1) [1]
allow: acid-base

(ii) as an indicator / to show end point (1) [1]

(d) water to remove the solution A of acid (1)
acid B to remove traces of water (1) [2]

(e) **(i)** Experiment 1
ecf from readings (1) [1]

(ii) any correct comparison (1) [1]

(iii) solution B more concentrated / stronger (1) or converse
less volume was needed (1) [2]

(f) half value from table result for experiment 2 (1)
cm^3 (1) [2]

(g) advantage: easy to use / quick / convenient (1)
disadvantage: not accurate owtte (1) [2]

(h) same volume of each solution (1)
add suitable reactant (1)
expected observation (1)
comparison (1) [4]
note: e.g. 10 cm^3 of each acid (1), add strip of magnesium / named carbonate (1)
effervescence (1), more rapid bubbles means stronger acid (1)

27. 0620_w14_ms_62 Q: 6

(a) filter solution (1)
wash with water (1)
dry (1) [3]
do not allow: evaporate to dryness

(b) known volume of oven cleaner (1)
add named acid (1)
with named apparatus (1)
indicator (1)
observe colour change (1)
note volume added (1)
repeat with other sample (1)
valid comparison (1) max [6]

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28. 0620_w14_ms_63 Q: 6

(a) add water (1)
allow: named organic solvent
crush / grind stir / mix / heat plant material / description of (1)
filter (1)
extract each plant material separately / named apparatus (1) [4]

(b) add extract to acid (1)
add extract to alkali (1)
different colours shows suitable indicator (1) [3]
allow: named colours

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29. 0620_w15_ms_62 Q: 1

(a)	pipette; burette;	1 1	**I:** dropper **R:** teat pipette
(b)	named indicator;	1	**I:** references to indicator paper **R:** Universal Indicator
(c)	all volumes correct: 16.3, 16.9, 16.2, 16.1 4 correct = 2 3 correct = 1 2 or fewer correct = 0	2	
(d)(i)	neutralisation / acid-base reaction / exothermic;	1	
(d)(ii)	(indicator) changed colour;	1	**A:** incorrect colour changes
(e)(i)	Experiment 2 / the second one / 16.9;	1	ecf on **(c)**
(e)(ii)	measuring or recording error / overshot end-point / manual error with burette;	1	**A:** incorrect volume of sodium hydroxide used **I:** human error
(e)(iii)	16.2; cm^3;	1 1	ecf on **(c)**
(f)	hydrochloric acid; less volume used than sodium hydroxide;	1 1	

30. 0620_w16_ms_61 Q: 2

(a)	table of results for Experiment 1 all temperature boxes completed correctly 22, 24, 26, 28, 30, 31, 30, 29, 28	**2**
(b)	table of results for Experiment 2 initial and other temperature boxes completed correctly 20, 21, 22, 23, 24, 25, 24, 23, 22	**2**
(c)	all points correctly plotted best-fit smooth line graphs labels	**2** **1** **1**
(d)	value from graph (27 °C) shown clearly	**1** **1**
(e)	phenolphthalein / litmus / suitable named indicator	**1**
(f)	Experiment 1 / solution **N** solution **N** is a stronger acid / has a higher pH	**1** **1**
(g)	measured results / temperature changes / results would be smaller **OR** larger / double volume needed to reach same temperature changes	**1**
(h)	polystyrene is an insulator / copper is a (good) conductor	**1**
(i)	source of error: heat losses / using a measuring cylinder improvement: lag or insulate / use burette	**1** **1**

31. 0620_w16_ms_61 Q: 4

	method adding Agri Lime to acid add weighed amount / known mass of Agri Lime **Q** to a known volume of acid with a named indicator added to the acid until the indicator changes colour note the mass of Agri Lime **Q** added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the smaller amount of Agri Lime is better' **OR** **method adding acid to Agri Lime** use weighed amount / known mass of Agri Lime **Q** add acid to it gradually / from a burette with a named indicator added to the acid until the indicator changes colour note volume of acid added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the larger volume of acid is better'	**6**

32. 0620_w19_ms_61 Q: 2

(a)	table of results volume boxes completed 0, 27, 48, 62, 65, 74, 76, 77, 77	**2**
(b)	all points plotted correctly	**2**
	best fit smooth line graph omitting anomalous point at 40 s / 65 cm^3	**1**
(c)(i)	point at 40 s / 65 cm^3	**1**
(c)(ii)	value from graph	**1**
	shown clearly	**1**

(d)	use of a 250 cm^3 measuring cylinder / inaccurate measurements / readings	**1**
	use a gas syringe / 100 cm^3 measuring cylinder	**1**
(e)(i)	35 cm^3	**1**
(e)(ii)	35 / 20 = 1.75	**1**
	cm^3 / s	**1**
(f)	volume of gas less / lower	**1**
	gas / carbon dioxide dissolved in water	**1**
(g)	curve below original	**1**
	approaching same level	**1**

33. 0620_w19_ms_62 Q: 1

(a)	pipette	**1**
	burette	**1**
(b)	methyl orange **or** phenolphthalein	**1**
	yellow to orange / pink / red **or** pink to colourless	**1**
(c)	initial burette reading	**1**
	final burette reading	**1**
(d)	values should be same	**1**
	moles / amount of sodium hydroxide added still same	**1**

34. 0620_w19_ms_63 Q: 2

(a)	table of results for experiments initial and final reading boxes completed correctly 10.2 23.1 6.3 0.0 2.7 1.2	**2**
	differences completed correctly 10.2, 20.4, 5.1	**1**
	all values to 1 or 2 decimal places	**1**
(b)	yellow	**1**
	orange / pink / red	**1**
(c)	no sharp colour change / no (clear) end point	**1**
(d)(i)	(Experiment) 3 (needed smallest) **and** (Experiment) 2 (needed largest)	**1**
(d)(ii)	1 : 2	**1**
(d)(iii)	most concentrated S R least concentrated T	**1**
(e)	no effect / none	**1**
	concentration of reactants not affected / unchanged / same	**1**
(f)	repeat the experiment	**1**
	compare / to check for anomalous results / until concordant results owtte	**1**

(g)	measurement to be taken	1
	use of results to draw conclusion	1
	reactant / method	1
	thermometric • measure temperature (change) • highest temperature (change) is most concentrated • add (xs) hydrochloric acid precipitation of metallic hydroxide • measure mass / height of precipitate • most precipitate is most concentrated • add (xs aqueous) copper sulfate (for example) gas produced • measure volume of gas made • largest volume is most concentrated • add an ammonium salt or aluminium evaporation • mass of solid • most mass is most concentrated • evaporate solution pH meter • measure pH • highest pH is most concentrated • pH meter dissolving • measure time taken for solid to dissolve • shortest time is most concentrated • aluminium / aluminium oxide / zinc / zinc oxide	

35. 0620_w20_ms_61 Q: 2

Question	Answer	Marks
(a)	Measuring cylinder readings: 16; 23; 29; 39; 44; 48	2
(b)	**M1** and **M2** all points plotted correctly **M3** ruler drawn straight line through first 4 points **M4** ruler drawn straight line through last three points **M5** straight lines have been extended so that they meet / cross	5
(c)	working on graph	1
	correct reading from their working on graph	1
(d)	all potassium iodide reacted / used-up	1
(e)	maximum mass of precipitate is 2.55 g	1
	maximum mass reached at half volume of plotted graph	1
(f)(i)	(more) accurate / precise (than a measuring cylinder)	1
(f)(ii)	(pipette measures a) fixed volume / 25 cm^3	1
(g)	filter	1
	wash / rinse residue	1
	dry **and** weigh	1

36. 0620_w20_ms_63 Q: 2

Question	Answer	Marks
(a)	Experiment 1 readings correct and readings recorded correctly with final > initial (37.2; 0.0)	1
	Experiment 2 readings correct and readings recorded correctly with final > initial (17.9; 5.5)	1
	both subtractions to get volume added correct (37.2; 12.4)	1
	all results figures for both experiments recorded to 1 dp or better	1
(b)	many colour changes / keeps changing colour / hard to determine the end point	1
(c)(i)	B (Experiment 2) **and** volume (of B) was less (than volume of A)	1
(c)(ii)	3 (times more concentrated)	1
(d)	12.4 ÷ 2.5 = 4.96 or 5(.0)	1
	cm^3	1

Question	Answer	Marks
(e)	repeat **and** compare the results	1
(f)(i)	more accurate / more precise (than a measuring cylinder)	1
(f)(ii)	(pipette measures a) fixed volume / 25 cm^3	1
(g)(i)	to remove solution A	1
(g)(ii)	to remove (distilled) water	1
(g)(iii)	larger / higher / bigger	1
	the water dilutes solution B / makes solution B less concentrated	1

37. 0620_w21_ms_62 Q: 2

Question	Answer	Marks
(a)	**M1** Experiment 1 burette readings completed correctly (31.6 and 8.0)	1
	M2 Experiment 2 burette readings completed correctly (15.9 and 4.1)	1
	M3 Experiment 3 burette readings completed correctly (26.4 and 2.7)	1
	M4 All subtractions to give volume added correct (23.6, 11.8, 23.7)	1
	M5 All readings / volumes are given to 1 dp or better	1
(b)	(from) red (to) orange	1
(c)	effervescence / fizzing / bubbles	1

Question	Answer	Marks
(d)(i)	**M1** greater volume used in experiment 1 / smaller volume used in experiment 2	1
	M2 twice as much in experiment 1 / half as much in experiment 2	1
(d)(ii)	solution **M** is more concentrated than solution **N**	1
(e)	47.4	1
(f)	to clean / to remove residue from previous experiment	1
(g)	**M1** rinse with solution **L**	1
	M2 to remove water / avoid diluting solution **L** / avoid changing concentration (of L)	1
(h)	to see colour change clearly / easily / accurately / better	1
(i)	repeat the experiments **and** compare the results	1
(j)	**M1** source of error: measuring cylinder / error in volume of solution M	1
	M2 improvement: use a pipette	1