* 0000800000001 *

Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 4 5 5 4 4 1 6 3 3 0 *

CO-ORDINATED SCIENCES **0973/61**

Paper 6 Alternative to Practical **May/June 2025**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **24** pages. Any blank pages are indicated.

DC (IP) 354638

1 A student investigates diffusion in animals.

The student uses agar jelly cubes to represent different sized animals.

Each cube contains a green coloured indicator that turns red in acid.

The acid moves into the cubes by diffusion.

(a) Procedure

The student:

- places a cube of agar jelly with sides of 1 cm into a clean beaker
- pours acid into this beaker until the cube is completely covered with acid
- starts a stop-watch
- records in Table 1.1 for trial 1 the time it takes for the cube to turn from green to completely red
- does another trial and records this time in Table 1.1 as trial 2.

Repeats the procedure with a cube of side 2 cm.

(i) Fig. 1.1 shows the stop-watch reading for trial 1 for the cube of side 2 cm.

Record in Table 1.1 this time in seconds to the nearest second.

trial 1

Fig. 1.1

Table 1.1

cube side / cm	surface area of cube / cm^2	volume of cube / cm^3	ratio of surface area to unit volume	time taken to turn completely red / s		
				trial 1	trial 2	average
1			6.0	24	34	29
2			3.0		65	

[1]

(ii) Calculate the average time for the cubes of side 2 cm.

Record this value in Table 1.1 to the nearest whole second. [1]

(iii) Use the value of the cube side given in Table 1.1 to calculate the surface area of each cube.

Use the equation shown.

$$\text{surface area} = \text{length} \times \text{height} \times 6$$

Record these values in Table 1.1. [1]

(iv) Use the value of the cube side given in Table 1.1 to calculate the volume of each cube.

Use the equation shown.

$$\text{volume} = \text{length} \times \text{height} \times \text{depth}$$

Record these values in Table 1.1. [1]

(v) Calculate the rate of diffusion for the cube of side 1 cm in Table 1.1.

Use the equation shown.

$$\text{rate of diffusion} = \frac{1000}{\text{average time taken to turn completely red}}$$

rate of diffusion = ... per 1000 seconds [1]

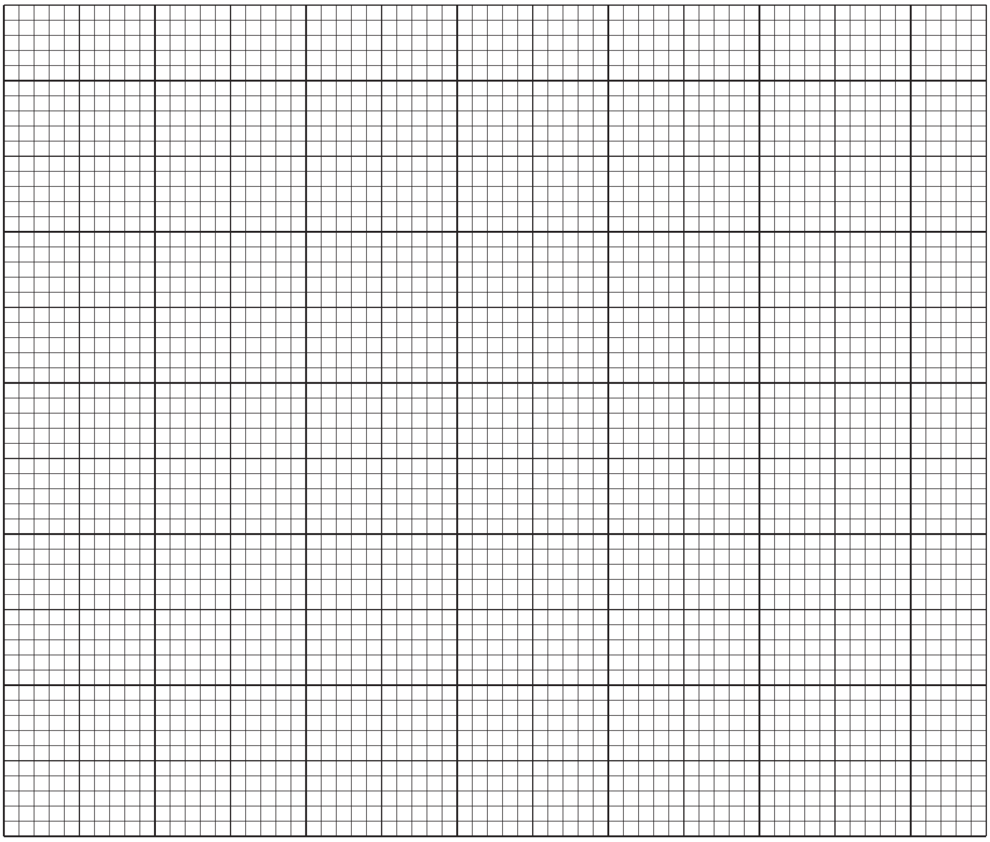
(b) A teacher repeats the procedure in **(a)** with increasing sizes of cube.

They calculate the rate of diffusion for each cube as shown in Table 1.2.

Table 1.2

cube side / cm	ratio of surface area to unit volume	time / s	rate of diffusion per 1000 seconds
2	3.0	59	16.9
3	2.0	165	6.1
4	1.5	240	4.2
5	1.2	298	3.4
6	1.0	368	2.7

(i) On the grid, plot rate of diffusion (vertical axis) against ratio of surface area to unit volume.



[3]

(ii) Draw the curve of best fit. [1]

(iii) Estimate the rate of diffusion for a cube with ratio of surface area to unit volume of 2.5.

Show your working on the graph.

rate of diffusion = ... per 1000 seconds [2]

(c) The teacher obtains a rate of diffusion for a cube of side 1 cm.

This rate of diffusion is 25.0 per 1000 seconds.

Compare this rate of diffusion with the rate you calculated in **(a)(v)**.

Suggest **one** reason why the values are different.

....

.... [1]

(d) The cubes represent different sized animals.

The acid moves into the cubes by diffusion.

Some small animals rely on diffusion from their body surface to supply all their oxygen.

Larger animals use a transport system such as blood to supply oxygen.

Use the data in Table 1.2 and your graph to suggest why large animals **cannot** use diffusion from their body surface to supply oxygen.

....

.... [1]

[Total: 13]

2 A student investigates an enzyme-controlled reaction.

Yeast and some plants contain the enzyme catalase.

Catalase speeds up the breakdown of hydrogen peroxide, releasing oxygen gas.

The oxygen gas released forms a foam.

(a) Procedure

The student:

- stirs a suspension of yeast cells
- places approximately 1 cm depth of the suspension of yeast cells in a test-tube
- adds 1 cm^3 of aqueous hydrogen peroxide to the test-tube and starts a stop-watch
- records in Table 2.1 the total height of the suspension of yeast cells and foam after 60 seconds.

The student repeats the procedure using liquidised apple instead of the suspension of yeast cells.

Fig. 2.1 shows the test-tube of the suspension of yeast cells actual size.

(i) Record in Table 2.1 the total height in mm of the suspension of yeast cells and foam.

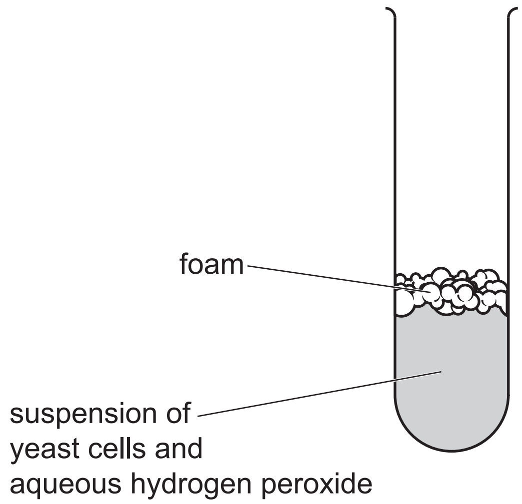


Fig. 2.1

Table 2.1

sample	total height / mm
suspension of yeast cells	
liquidised apple	11

[1]

(ii) Use Table 2.1 to compare how much catalase is present in the samples of yeast cells **and** liquidised apple.

Explain your answer.

....

.... [1]

(b) **(i)** Liquidising the apple breaks open the cells.

Suggest why the cells need to be broken open.

....

.... [1]

(ii) Suggest why it is important to stir to mix the suspension of yeast cells in the procedure.

....

.... [1]

(c) Name **one** piece of apparatus suitable for measuring 1 cm^3 of aqueous hydrogen peroxide.

.... [1]

(d) Suggest **one** difficulty of measuring the total height of the suspension of yeast cells and foam in the test-tube.

....

.... [1]

(e) Explain why repeating the procedure increases confidence in the results.

....

.... [1]

[Total: 7]

3 A student investigates the neutralisation of dilute hydrochloric acid by aqueous sodium hydroxide.

The student does two experiments, one with aqueous sodium hydroxide **J**, and the other with aqueous sodium hydroxide **K**.

The titration method is used.

Bromothymol blue is an indicator. It turns yellow in acid solutions, blue in alkali solutions and green in neutral solutions.

(a) Procedure

The student:

- fills a burette with dilute hydrochloric acid
- records in Table 3.1 the initial burette reading to the nearest $0.05\,cm^3$
- uses a measuring cylinder to add $25\,cm^3$ of aqueous sodium hydroxide **J** to a conical flask
- adds three drops of bromothymol blue indicator to the conical flask; the indicator turns blue
- adds dilute hydrochloric acid to the conical flask until the indicator turns green
- swirls the flask to mix while the dilute hydrochloric acid is added
- records in Table 3.1 the final burette reading to the nearest $0.05\,cm^3$.

Fig. 3.1 shows a diagram of the apparatus.

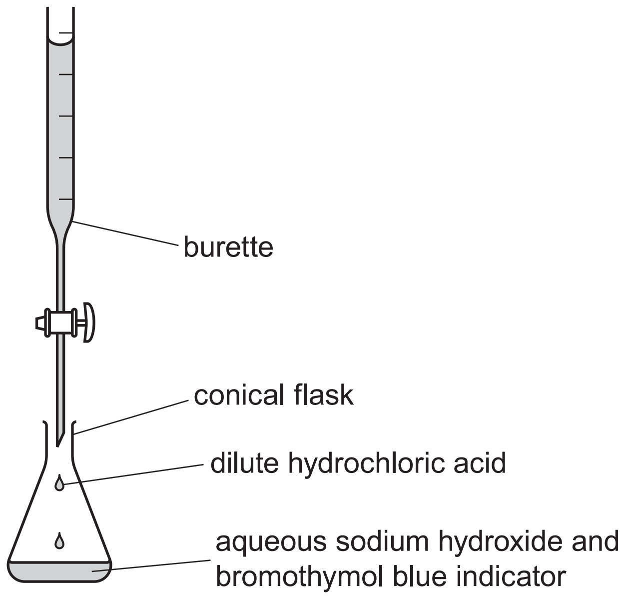


Fig. 3.1

The student repeats the procedure for aqueous sodium hydroxide **K** instead of **J**.

Fig. 3.2 shows the final burette reading for **J**.

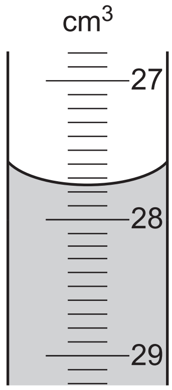


Fig. 3.2

Record in Table 3.1 this volume to the nearest 0.05 cm^3.

Table 3.1

	J	K
initial burette reading / cm^3	1.20	12.60
final burette reading / cm^3		25.65
volume of dilute hydrochloric acid added / cm^3		

[1]

(b) **(i)** Suggest why the conical flask is swirled to mix the solutions as the dilute hydrochloric acid is added to the aqueous sodium hydroxide.

....

.... [1]

(ii) Suggest **one** piece of apparatus suitable for measuring the 25 cm^3 of aqueous sodium hydroxide more accurately than a measuring cylinder.

.... [1]

(iii) Suggest what the student does to have more confidence in the volumes of dilute hydrochloric acid used.

....

.... [1]

(c) Calculate the volume of dilute hydrochloric acid added for aqueous **J** and aqueous **K**.

Record your values in Table 3.1. [1]

(d) The concentrations of aqueous **J** and **K** are different.

Suggest the relationship between the concentrations of aqueous **J** and aqueous **K**.

Include a calculation in your answer.

....

....

.... [2]

(e) A student repeats the procedure but does **not** notice the indicator turning green.

The student continues adding dilute hydrochloric acid to the flask.

Suggest the final colour of the mixture in the flask.

.... [1]

(f) Aqueous sodium chloride is the product in the conical flask.

The aqueous sodium chloride is coloured green with the indicator.

Suggest how the procedure in **(a)** is changed to make colourless aqueous sodium chloride.

....

.... [1]

(g) **(i)** The student heats the aqueous sodium chloride to make solid sodium chloride using a Bunsen burner.

Draw a labelled diagram of the assembled apparatus the student uses.

[2]

(ii) The student uses a balance to measure the mass of the solid sodium chloride.

The mass is larger than expected. The balance is used correctly.

Describe what the student does to confirm they have measured **only** the mass of solid sodium chloride.

....

.... [1]

(h) A student has two colourless liquids.

One of the liquids is dilute hydrochloric acid, HCl.

The other liquid is dilute sulfuric acid, H_2SO_4.

Describe tests to confirm the identity of each acid.

Include the observations for the positive result in your answer.

hydrochloric acid

test ....

observation ....

sulfuric acid

test ....

observation ....

[1]

[Total: 13]

4 An iron key is electroplated with copper metal using the apparatus shown in Fig. 4.1.

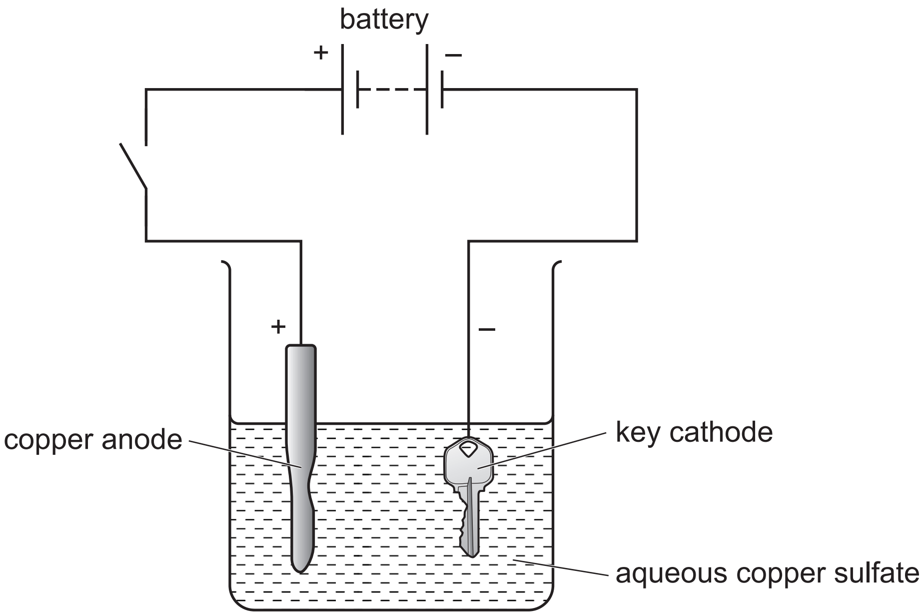


Fig. 4.1

When the switch is closed, the copper dissolves from the anode, moves through the aqueous copper sulfate and coats (plates) onto the key at the cathode.

Plan an investigation to find the relationship between the number of volts supplied by the batteries and the mass of copper coated onto the key.

You are provided with:

- several 1.5 V batteries
- the apparatus and chemicals shown in Fig. 4.1.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any other apparatus you will need
- a brief description of the method
- the measurements you will make and how you make them as valid as possible
- the variables you will control
- how you will process your results to reach a conclusion.

[7]

5 A student does an experiment to find the density of glass using solid glass marbles.

(a) Procedure

The student:

- uses a balance to find the mass *m* of 6 glass marbles
- pours water into a 50 cm^3 measuring cylinder and measures the volume
- carefully drops the 6 glass marbles into the water and measures the volume again.

(i) Fig. 5.1 shows the balance with the 6 glass marbles.

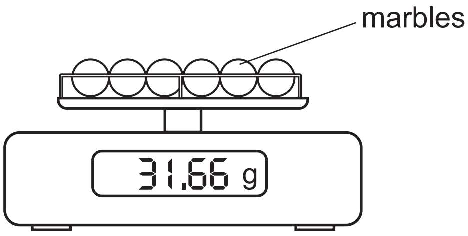


Fig. 5.1

Record the mass *m* of the 6 glass marbles to the nearest 0.1 g.

m = ... g [1]

(ii) The student measures the volume V_1 of water before adding the glass marbles.

Fig. 5.2 shows the measuring cylinder.

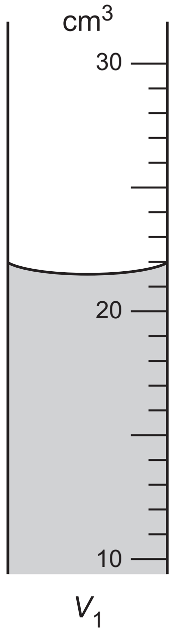


Fig. 5.2

Record the volume V_1 of water in cm^3 to the nearest $0.5\,cm^3$.

V_1 = ... cm^3 [1]

(iii) The reading on the measuring cylinder after adding the glass marbles is $39.0\,cm^3$.

Calculate the volume V_m of the 6 glass marbles.

Use the equation shown.

$$V_m = 39.0 - V_1$$

V_m = ... cm^3 [1]

(iv) Calculate the density ρ of the glass marbles.

Use the equation shown.

$$\rho = \frac{m}{V_m}$$

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

ρ = ... g/cm^3 [2]

(v) A teacher does the same experiment and calculates the density of the glass marbles as $2.80\,g/cm^3$.

Two values are considered to be equal within the limits of experimental error if the difference between them is less than 10%.

Explain if the value in **(a)(iv)** and the teacher's value are equal within the limits of experimental error.

Justify your answer with a calculation.

....

.... [2]

(b) Describe how the student measures the volume of water accurately using the measuring cylinder.

You may draw a diagram to help.

....

.... [1]

(c) **(i)** Another student does the experiment and uses a balance to measure the mass of the glass marbles.

Fig. 5.3 shows the balance before any glass marbles are added.

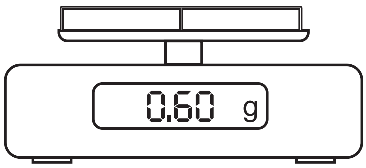


Fig. 5.3

State why this balance does **not** give the correct reading for the mass of the glass marbles.

Suggest what the student does to obtain an accurate mass of the glass marbles.

statement ....

....

suggestion ....

....
[1]

(ii) The student calculates the volume of one glass marble using its diameter.

The student measures the diameter of one glass marble using a 30 cm ruler.

The student uses two wooden blocks to make the measurement of the diameter more accurate.

Describe how the student uses the blocks.

You may draw a diagram to help.

....

.... [1]

(iii) The student repeats the procedure in **(a)** but uses different marbles.

The 6 marbles used have the same diameter and are made of the same glass as those used in the procedure in **(a)**.

These marbles have a large air bubble in the centre as shown in Fig. 5.4.

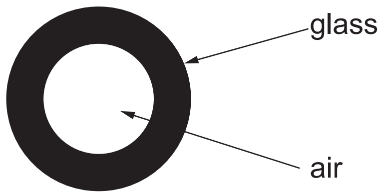


Fig. 5.4

State the effect the air bubble has on the density of the marbles and on the density of the glass.

Explain your answers.

effect on density of the marbles ....

explanation ....

....

effect on density of the glass ....

explanation ....

....

[2]

[Total: 12]

6 A student does an experiment to find a value for the acceleration of free fall *g* using a pendulum.

(a) Procedure

The student:

- sets up a pendulum as shown in Fig. 6.1

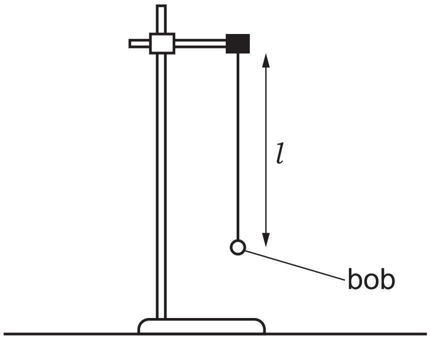


Fig. 6.1

- uses a stop-watch to measure the time *t* for the pendulum to complete **20** swings.

(i) The length l is the distance from the bottom of the clamp to the centre of the pendulum bob.

The student uses a ruler to measure the length l. Fig. 6.2 shows the reading of l on the ruler.

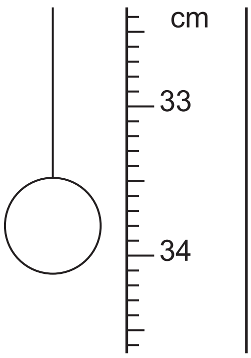


Fig. 6.2

Record this reading of length l in cm to the nearest 0.1 cm.

l = ... cm [1]

(ii) The stop-watch in Fig. 6.3 shows the time t for 20 swings.

Fig. 6.3

Record t in seconds to the nearest 0.1 s.

t = ... s [1]

(iii) Calculate the time T for **one** swing.

T = ... s [1]

(iv) Calculate T^2.

T^2 = ... s^2 [1]

(v) Calculate the acceleration of free fall g.

Use your answers from **(a)(i)** and **(a)(iv)** and the equation shown.

$$g = \frac{0.395 \times l}{T^2}$$

g = ... m/s^2 [1]

(b) **(i)** A student is given ruler **A** and ruler **B** to measure the length of the pendulum.

Parts of the rulers are shown in Fig. 6.4.

Fig. 6.4

State which ruler the student uses.

Explain your answer.

ruler ....

explanation ....

.... [1]

(ii) The student does the experiment and uses a fan to keep the room cool.

The wind from the fan changes the time taken for one swing of the pendulum.

Suggest what the student does to minimise the effect of the wind on the pendulum.

The student does **not** adjust the fan.

....

.... [1]

(c) Explain why it is more accurate to time 20 swings of the pendulum instead of just one swing.

....

.... [1]

[Total: 8]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	*test*	*test result*
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint

Flame tests for metal ions

metal ion	*flame colour*
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
copper(II), Cu^{2+}	blue-green

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