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5182616127

COMBINED SCIENCE **0653/63**

Paper 6 Alternative to Practical **October/November 2025**

1 hour

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 40.
- 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 **20** pages. Any blank pages are indicated.

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[Turn over

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1 A student investigates the effect of exercise on heart rate.

The student exercises by lifting a metal block up and down 50 times. The student uses five different blocks, **A**, **B**, **C**, **D** and **E**, each with a different mass.

The student measures heart rate by counting the number of heart beats in three minutes.

(a) Procedure

The student:

step 1 measures the mass of block **A**
step 2 measures heart rate at rest
step 3 exercises by lifting block **A** up and down 50 times
step 4 measures heart rate after exercise
step 5 waits for 15 minutes
step 6 repeats **step 1** to **step 5** for blocks **B**, **C**, **D** and **E**.

The student calculates the heart rates in beats per minute.

Table 1.1 shows some of the student's data.

Table 1.1

block	mass of block / kg	heart rate at rest / beats per minute	heart rate after exercise / beats per minute
A		66	99
B	0.91	67	105
C	1.36	65	112
D	1.81	66	121
E		68	

(i) The student counts 403 heart beats in **three** minutes after exercise by lifting block **E**.

Calculate the heart rate after exercise in beats per minute.

Record in Table 1.1 this value to **three** significant figures.

[2]

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(ii) Suggest why it is more accurate to count the number of heart beats for three minutes rather than just one minute.

.....

..... [1]

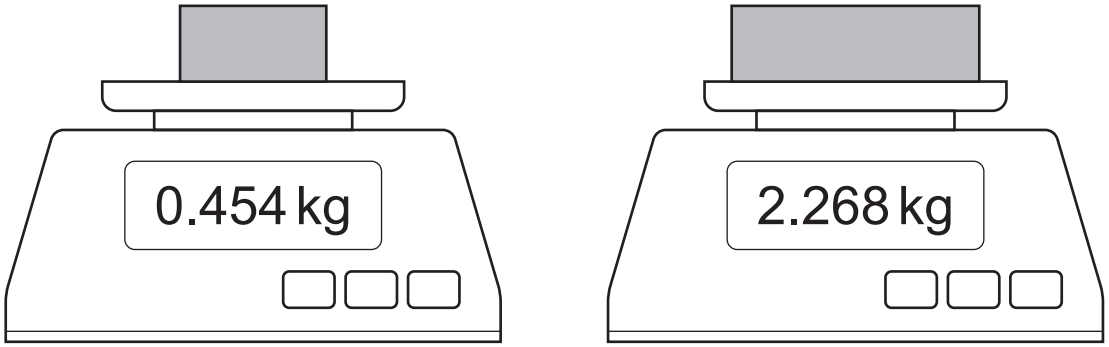
(iii) Suggest why in **step 5** the student waits for 15 minutes between lifting different blocks.

.....

..... [1]

(b) The student measures the mass of each block at **step 1**.

(i) Fig. 1.1 shows the balance readings for block **A** and block **E**.



block A **block E**

Fig. 1.1

Record in Table 1.1 these values to **two** decimal places. [2]

(ii) Describe the relationship between mass of the block lifted and heart rate after exercise shown in Table 1.1.

.....

..... [1]

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(c) The student calculates the percentage increase in heart rate for lifting each block.

Table 1.2 shows some of the data.

Table 1.2

block	percentage increase in heart rate
A	
B	57
C	72
D	83
E	97

(i) Complete Table 1.2 by calculating the percentage increase in heart rate for lifting block **A**.

Use information in Table 1.1 and the equation shown.

$$\text{percentage increase in heart rate} = \frac{\text{heart rate after exercise} - \text{heart rate at rest}}{\text{heart rate at rest}} \times 100$$

[1]

(ii) Explain why the student calculates the **percentage** increase in heart rate rather than the increase in heart rate.

.....

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..... [2]

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(d) During exercise, cells in the body produce carbon dioxide gas which is breathed out.

After exercising, the student uses the apparatus shown in Fig. 1.2 to test the composition of the air breathed in and the gases breathed out.

The student breathes in and out for 10 seconds.

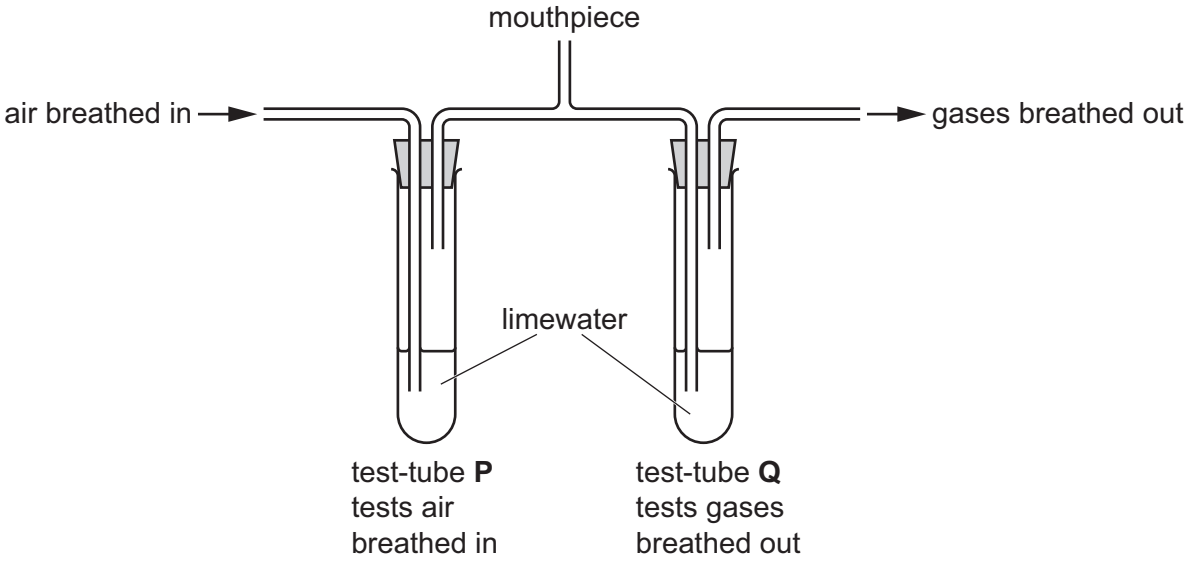


Fig. 1.2

Describe the appearance of the limewater in test-tube **P** and in test-tube **Q**.

Explain your answer.

test-tube **P** .....

test-tube **Q** .....

explanation .....

.....

.....

[3]

[Total: 13]

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2 A student investigates the effect on the boiling point of water of dissolving solid **H** in the water.

Procedure

The student:

step 1 half fills a beaker with water
step 2 heats the water until it boils using the assembled apparatus shown in Fig. 2.1

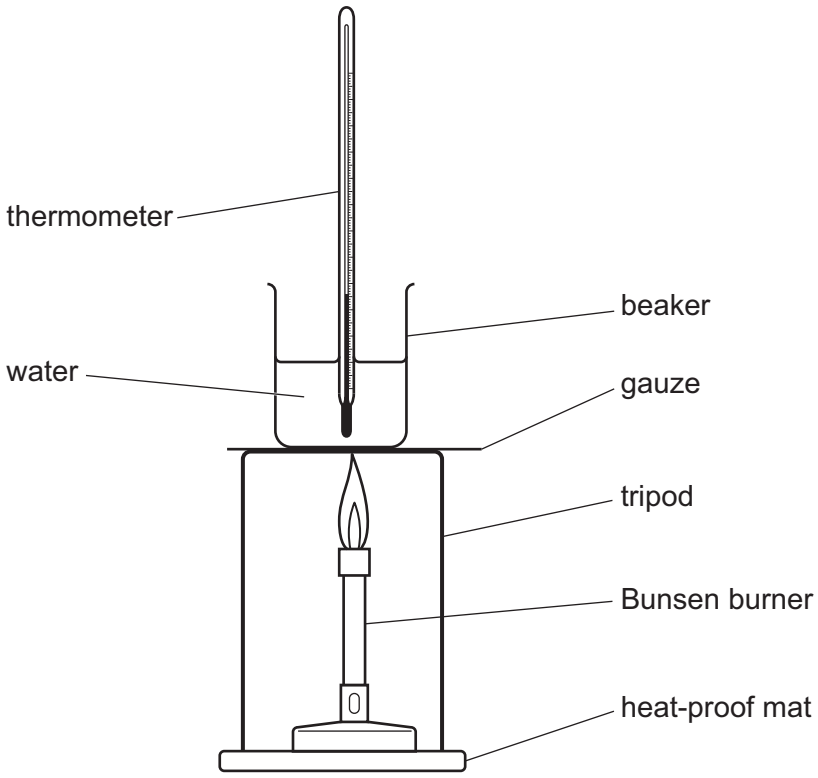


Fig. 2.1

step 3 records the temperature of the water at boiling point
step 4 turns off the Bunsen burner and allows the water to cool slightly
step 5 adds 1 spatula of solid **H** to the water and stirs until dissolved
step 6 turns on the Bunsen burner
step 7 heats the water until it boils again
step 8 records the temperature of the water at boiling point
step 9 repeats **step 4** to **step 8** until a total of 7 spatulas of solid **H** are dissolved in the water.

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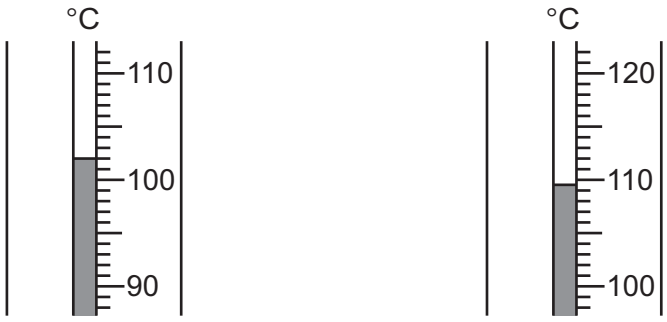
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Table 2.1 shows some of the student's data.

Table 2.1

number of spatulas of solid **H** dissolved in the water	boiling point / °C
0	100.0
1	101.0
2	
3	103.5
4	105.5
5	104.0
6	108.0
7	

(a) Fig. 2.2 shows the temperature reading on the thermometer at **step 8** for 2 spatulas and 7 spatulas of solid **H** dissolved in the water.



2 spatulas **7 spatulas**

Fig. 2.2

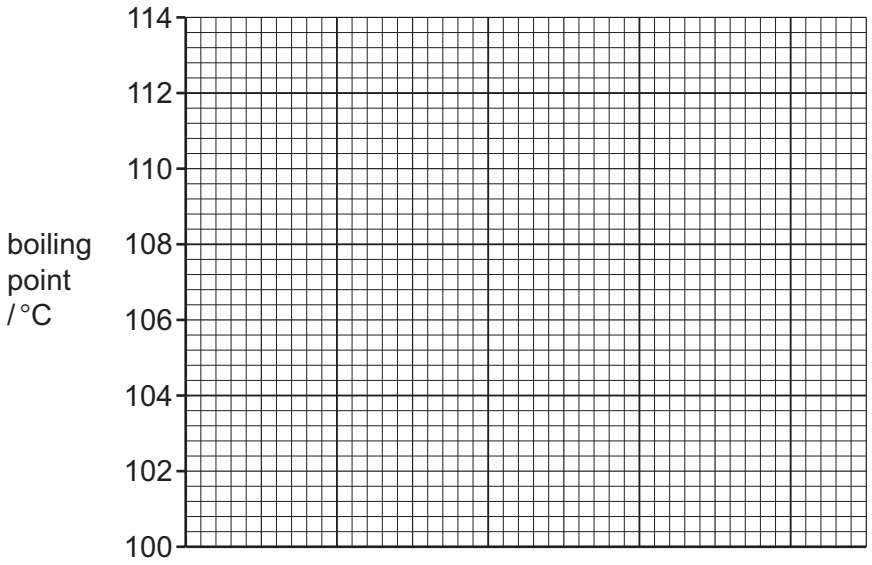
Record in Table 2.1 these temperatures to the nearest 0.5 °C. [2]

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(b) (i) On the grid, plot boiling point (vertical axis) against number of spatulas of solid **H** dissolved in the water.

The horizontal axis **must** include 8 spatulas of solid **H** dissolved in the water.



[2]

(ii) One of the results is anomalous.

Circle on the grid this anomalous result. [1]

(iii) Draw the best-fit line. [1]

(iv) Describe the relationship between the boiling point of the water and the number of spatulas of solid **H** dissolved in the water.

.....

.....

..... [1]

(v) Estimate the boiling point of water containing 8 spatulas of solid **H**.

Show your working on the graph.

boiling point = ... °C [2]

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(c) The student wants to improve the procedure.

Describe an improvement the student makes to:

step 1 .....

step 5. .....

[2]

(d) The teacher tells the student there is an experimental error in the overall procedure for the investigation.

The teacher says the error affects the results even after improvements are made to **step 1** and **step 5**.

Describe the error in the overall procedure.

Suggest a change to the procedure to minimise the error.

error .....

change .....

.....

[2]

[Total: 13]

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3 A student investigates the resistance *X* of a fixed resistor using:

- a cell of voltage *V*
- a switch
- a digital ammeter
- a variable resistor with resistance *R*, where *R* varies from 12 Ω to 39 Ω.

The student assembles the circuit shown in Fig. 3.1.

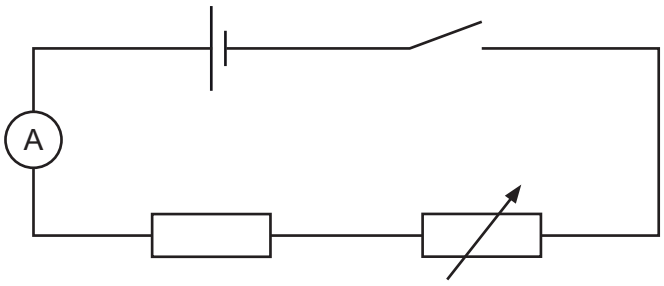
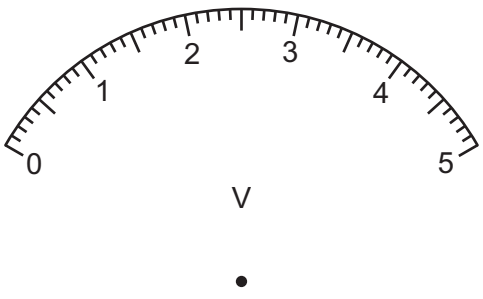
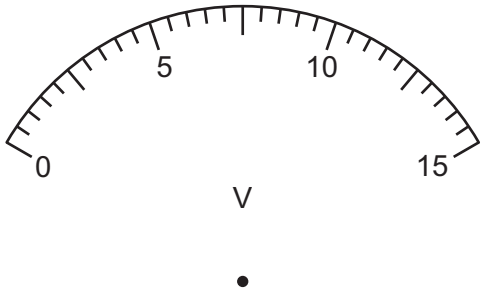


Fig. 3.1

(a) The student has two analogue voltmeters, **P** and **Q**. Fig. 3.2 shows the scale on each voltmeter.



voltmeter P



voltmeter Q

Fig. 3.2

The student uses **one** voltmeter to measure voltage *V* of the cell as 1.6 V.

State which voltmeter the student uses.

Explain your answer.

voltmeter .....

explanation .....

.....

[1]

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(b) Procedure

The student:

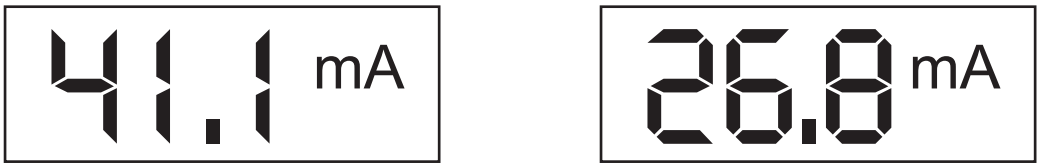
- sets resistance R of the variable resistor to $R = 12\,\Omega$
- closes the switch
- uses the ammeter to measure current I in the circuit
- opens the switch.

The student repeats the procedure for the values of R shown in Table 3.1.

Table 3.1

R/Ω	I/mA
12	44
15	
18	38
22	35
27	31
33	
39	25

Fig. 3.3 shows the readings on the ammeter for $R = 15\,\Omega$ and $R = 33\,\Omega$.



***R* = 15 Ω** ***R* = 33 Ω**

Fig. 3.3

Record in Table 3.1 these values of I to the nearest mA. [2]

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(c) The student plots the graph of $\frac{1}{I}$ against R shown in Fig. 3.4.

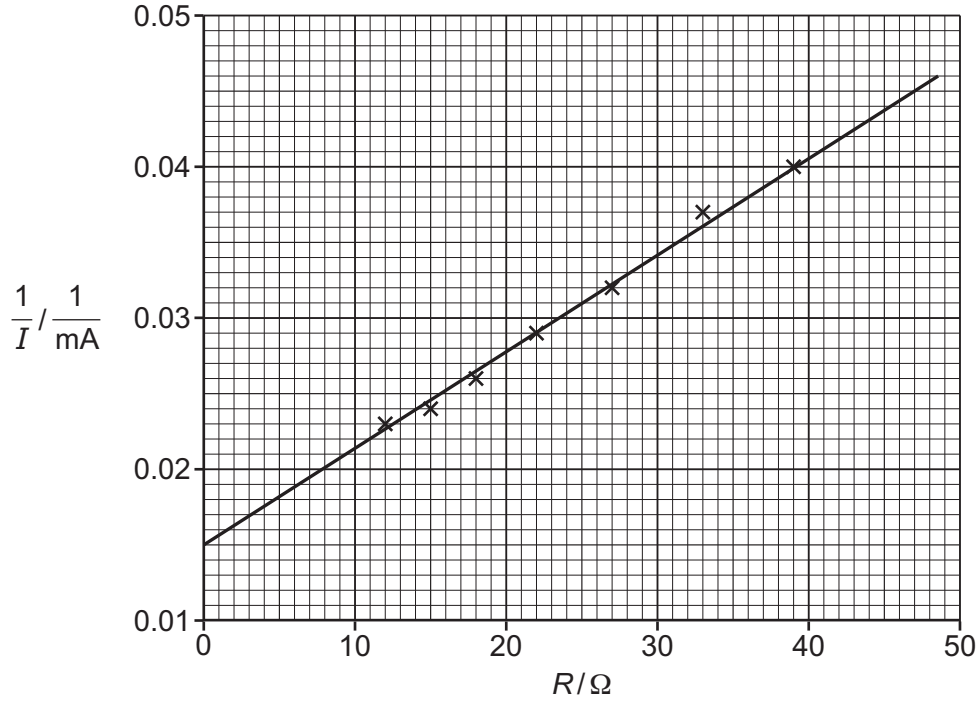


Fig. 3.4

(i) The intercept is the value of $\frac{1}{I}$ when $R = 0$.

Use Fig. 3.4 to determine the intercept.

intercept = ... [1]

(ii) The resistance X of the fixed resistor is given by the equation:

$$X = V \times 1000 \times \text{intercept}$$

where $V = 1.6\,\text{V}$.

Calculate X.

Use your answer to **(c)(i)** and the equation shown.

X = ... Ω [1]

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(d) When the switch is **open**, the student observes a reading on the ammeter, as shown in Fig. 3.5.



Fig. 3.5

The student realises the ammeter has an error.

The values of I in Table 3.1 are incorrect.

(i) Name the type of error shown in Fig. 3.5.

..... [1]

(ii) State how the student corrects the values of I in Table 3.1.

.....

..... [1]

[Total: 7]

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4 Fig. 4.1 shows a wooden beam of length l and width w.

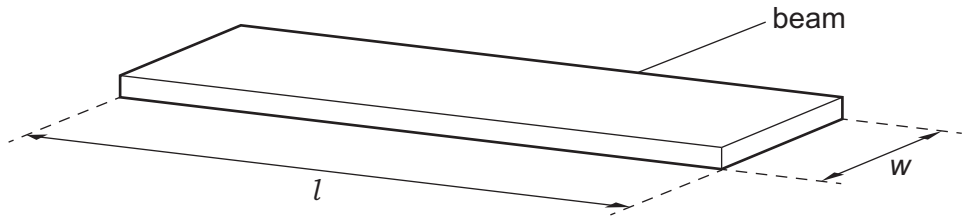


Fig. 4.1

One end of the beam is attached to a bench.

A mass is attached to the other end of the beam.

The beam moves downwards through a distance h, as shown in Fig. 4.2.

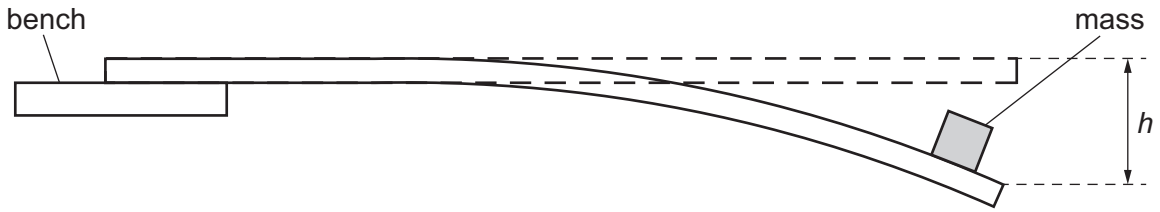


Fig. 4.2

A student states:

Distance *h* is inversely proportional to width *w* of the beam.

Plan an investigation to test the student's statement.

You are provided with beams of different widths made from the same wood.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- the apparatus you will use
- a brief description of the method
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a results table (you are **not** required to enter any data into the table).

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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.
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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