Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7400226456

COMBINED SCIENCE **5129/31**

Paper 3 Experimental Skills and Investigations **May/June 2023**

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 [ ].

This document has **20** pages. Any blank pages are indicated.

[Turn over

1 A student investigates the magnetic force of attraction between a magnet and a steel spanner.

First, the student measures the mass of the spanner using an electronic balance.

Fig. 1.1 shows the electronic balance used to measure the mass of the spanner.

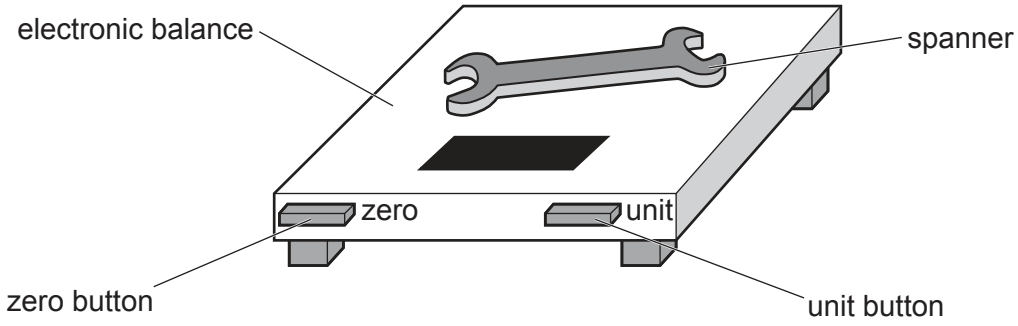


Fig. 1.1

(a) The student switches the balance on and then uses the zero button and the unit button before placing the spanner on the balance.

Explain why the student uses the zero button and the unit button **before** the spanner is placed on the balance.

zero button .....

.....

unit button .....

.....

[2]

(b) Fig. 1.2 shows the arrangement of apparatus the student uses to investigate the magnetic force between the magnet and the spanner.

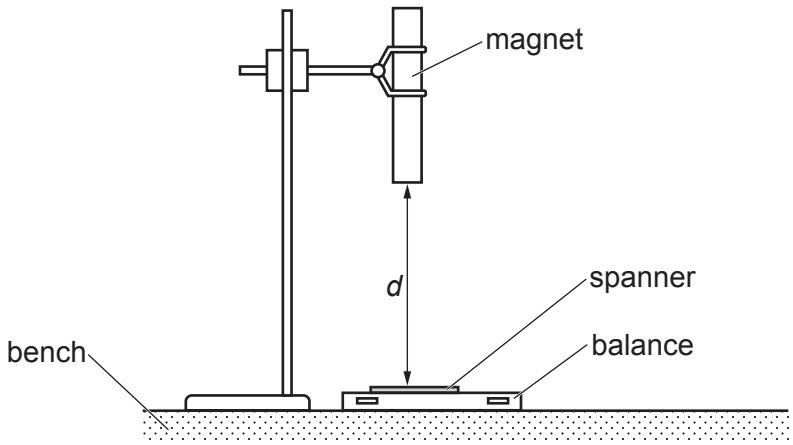


Fig. 1.2

The student:

- measures the distance *d* between the bottom of the magnet and the top of the spanner
- records the reading shown on the balance with the magnet at this position.

Fig. 1.3 shows the balance readings for three different positions of the magnet A, B and C.

On Fig. 1.3, use a ruler to measure each distance *d* to the nearest mm. Only the first distance *d* has been marked with an arrow.

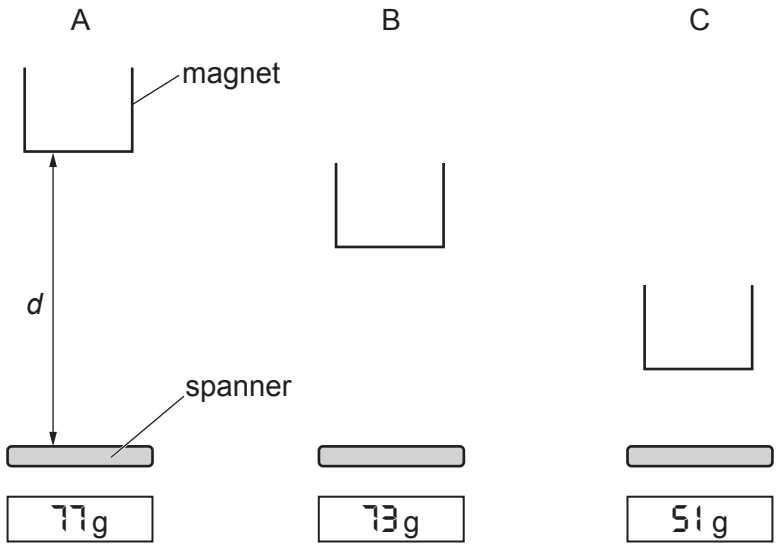


Fig. 1.3

In the space below, record your measurements of *d* and the readings from the balance in **a suitable table**. Include headings and units.

[4]

(c) Explain why an electronic balance is a suitable piece of apparatus for determining changes in the force of attraction between the magnet and spanner.

.....

.....

..... [2]

(d) **(i)** Describe the trend in the measurements shown in Fig. 1.3.

.....

.....

..... [1]

(ii) Suggest an explanation for the trend you described in **(d)(i)**.

.....

..... [1]

(e) The student repeats the experiment using the same magnet and the same values of *d* shown in Fig. 1.3.

Explain why repeating the readings improves the experiment.

.....

..... [1]

[Total: 11]

2 A student investigates the heating of water by different alkane fuels.

The apparatus used is shown in Fig. 2.1.

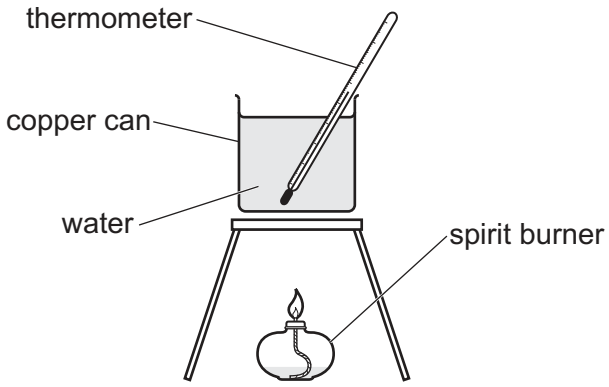


Fig. 2.1

Procedure

The student:

- measures 50 cm^3 of water and pours it into the copper can
- measures the initial temperature of the water
- adds some fuel to the spirit burner
- places the spirit burner under the copper can and lights the fuel
- records the final temperature of the water after 5 minutes
- repeats the experiment using different fuels.

(a) (i) To determine the energy released per gram of each fuel, additional measurements need to be made.

State the additional measurements that need to be made.

.....

..... [1]

(ii) Fig. 2.2 shows the thermometer used by the student.

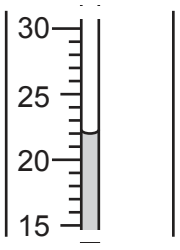


Fig. 2.2

The thermometer shows the temperature of the room.

Record the temperature shown on the thermometer.

temperature = ... °C [1]

(b) (i) Table 2.1 shows the results.

The initial temperature of the water is 20 °C for all fuels.

Table 2.1

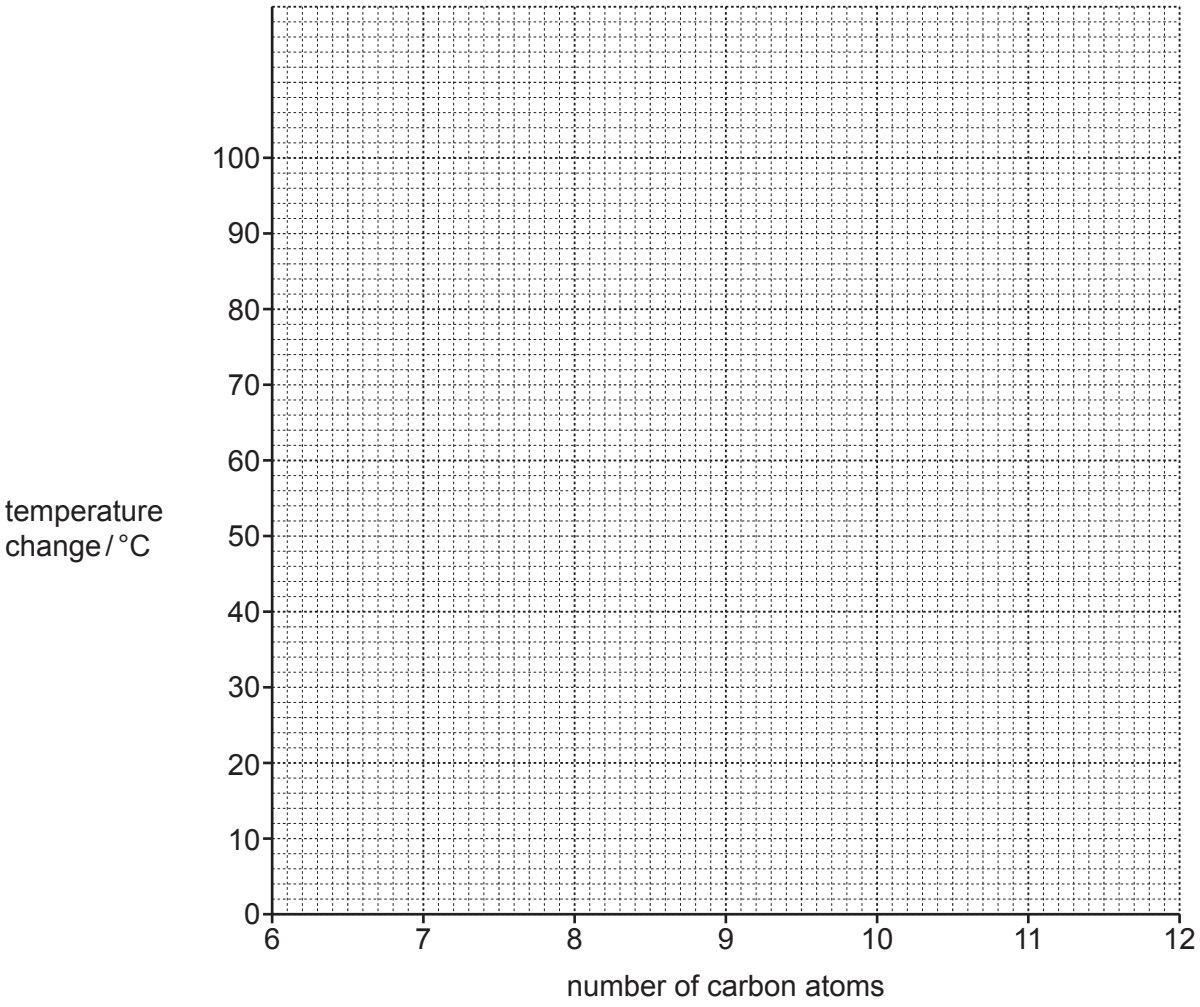
fuel	number of carbon atoms per molecule of fuel	final temperature / °C	temperature change / °C
hexane	6	35	15
heptane	7	48	.....
octane	8	47	27
nonane	9	70	50
decane	10	84	64

Complete the table by calculating the temperature change for heptane. [1]

(ii) On the grid provided, plot a graph of temperature change on the *y*-axis against number of carbon atoms on the *x*-axis.

Draw the straight line of best fit.

Draw a circle around the anomalous point on the graph.



[3]

(iii) Undecane is an alkane fuel that contains 11 carbon atoms.

Use the graph to suggest the temperature change for undecane.

Show your working on the graph.

temperature change for undecane = ... °C [2]

(iv) Duodecane is an alkane fuel that contains 12 carbon atoms.

The temperature change for duodecane cannot be measured using the procedure given on page 5 and water with an initial temperature of 20 °C.

Use the data in Table 2.1 to suggest the reason for this.

.....

..... [1]

(v) For each fuel shown in Table 2.1, the calculated energy released per gram is less than the true value.

Suggest a reason for this error and an improvement to the procedure to reduce this error.

reason .....

.....

.....

improvement .....

.....

.....

[2]

[Total: 11]

Question 3 begins over the page

3 A student investigates changes of mass due to osmosis in various foods.

(a) A student investigates the effect of concentrated sodium chloride solution on the mass change in eggs.

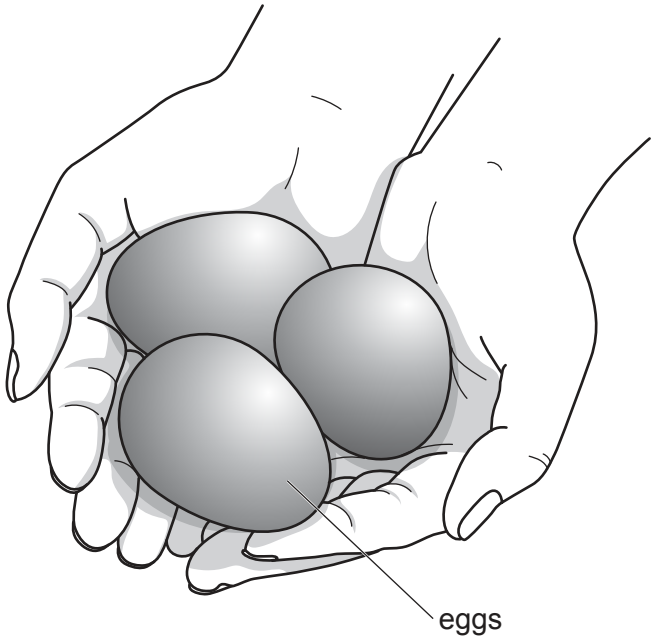


Fig. 3.1

Eggs have a hard shell to protect the contents.

The student:

- places 3 eggs in dilute hydrochloric acid to remove the hard shell
- dries the eggs and measures the starting mass of each egg
- places each egg into a separate beaker and labels the beakers 1, 2 and 3
- adds concentrated sodium chloride solution to each beaker to cover the eggs
- removes the eggs from the solution after 2 hours
- dries the eggs and measures the final mass of each egg.

The student's results are shown in Fig. 3.2. All of the eggs have lost mass.

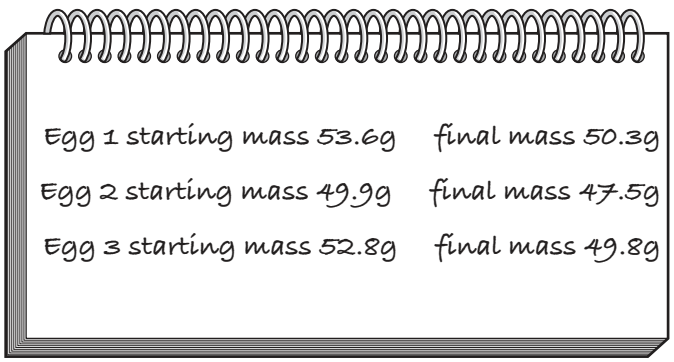


Fig. 3.2

(i) In Table 3.1, record the student's results from Fig. 3.2.

Calculate the change in mass for each egg.

Record your calculated values to a suitable number of significant figures.

Table 3.1

egg	starting mass / g	final mass / g	change in mass / g
1			
2			
3			

[3]

(ii) Calculate the average change in mass for the 3 eggs.

average change in mass = ... g [2]

(b) The student also investigates osmosis using carrots.

The student:

- cuts a carrot into 6 cylinders of the same length
- measures the starting mass of each carrot cylinder
- prepares 6 sodium chloride solutions of different concentration and places one carrot cylinder into each solution
- removes the carrot cylinders after 3 hours and dries them
- measures the final mass.

(i) State **two** variables that the student needs to control.

1 .....

.....

2 .....

..... [2]

(ii) The student's results for the carrot cylinders are shown in Table 3.2.

Table 3.2

$\frac{\text{concentration of sodium chloride solution}}{\text{g/dm}^3}$	percentage change in mass
0.0	+17
0.2	+1
0.4	–6
0.6	–12
0.8	–19
1.0	–25

Explain why the student calculates the **percentage** change in mass of each carrot cylinder.

.....

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..... [2]

(iii) The student plots a graph of their results from Table 3.2. This is shown in Fig. 3.3.

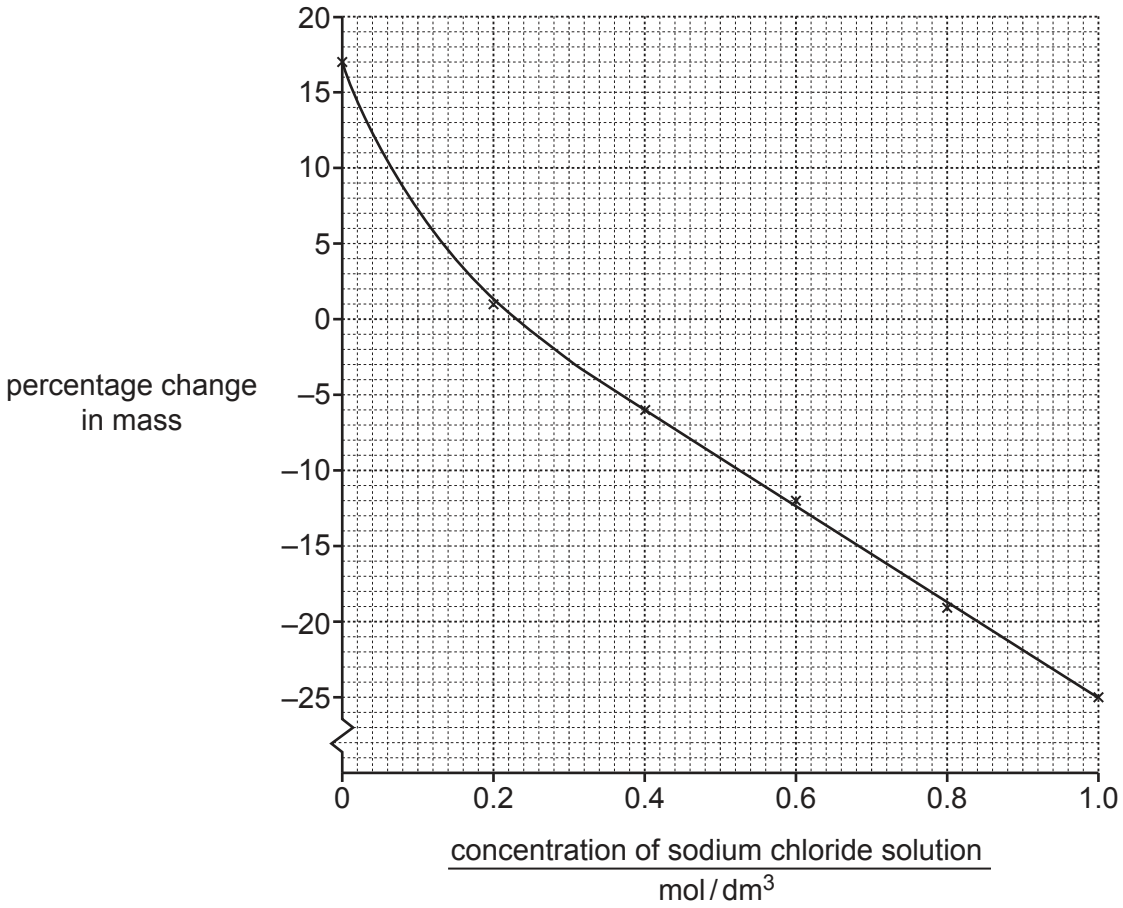

Fig. 3.3

The percentage change in mass is zero when the concentration of sodium chloride in the carrot is the same as the concentration of the sodium chloride solution.

Use the graph in Fig. 3.3 to determine the concentration of sodium chloride in the carrot.

Show your working on the graph.

concentration of sodium chloride in the carrot = ... mol / dm^3 [2]

[Total: 11]

4 Human ears detect sound waves in a narrow range of frequencies.

People wear ear defenders (Fig. 4.1) made from materials that are designed to absorb these sound waves.

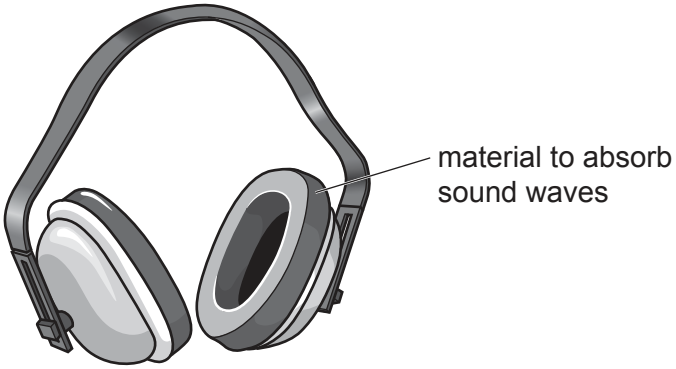

Fig. 4.1

A student investigates materials suitable for absorbing these sound waves and preventing them from reaching the ears. The apparatus used is shown in Fig. 4.2.

The sound wave generator produces sound waves with different loudnesses and different frequencies. The sound wave detector receives these sound waves and converts them to a voltage signal that is displayed on a meter. The material is placed between the generator and the detector.

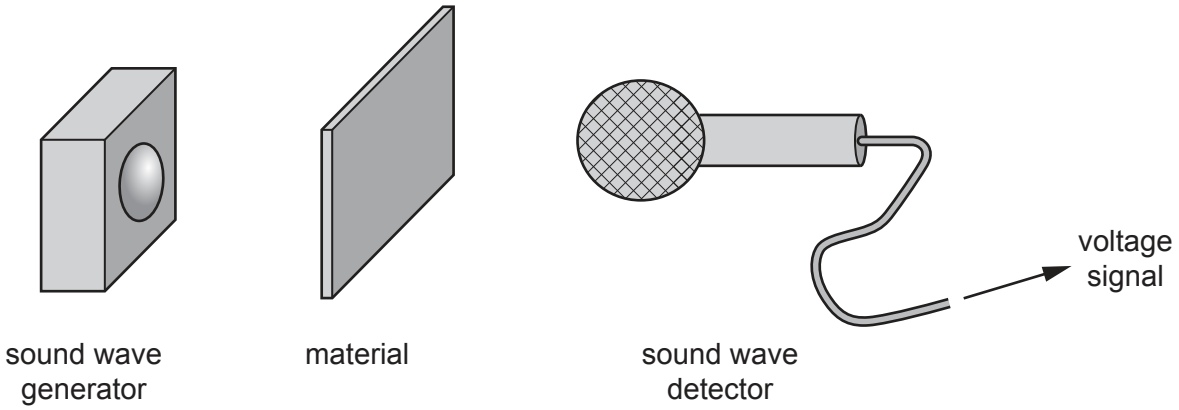

Fig. 4.2

Plan an investigation, using the apparatus in Fig. 4.2, to find if the material actually used in the ear defenders is the most suitable material.

Include in your answer:

- the apparatus needed to display the voltage
- a brief description of the method and any safety precautions
- what you will keep constant and what you will change
- how the measurements will be used to reach a conclusion.

A diagram of apparatus and a results table are **not** required but you may include them if it helps to explain your plan.

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..... [7]

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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
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
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