Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

0664150163

COMBINED SCIENCE **5129/31**

Paper 3 Experimental Skills and Investigations **May/June 2024**

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 **16** pages. Any blank pages are indicated.

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1 **(a)** When grass is cut, it begins to decompose. This process releases gases and water.

A student investigates the decomposition of grass.

The student:

- places one sample of grass in a clear plastic bag which has small holes cut into it to allow gases to pass through
- places a second sample of grass in a different clear plastic bag without holes
- squeezes all the air out of the bag without holes and seals it so that no air can enter the bag
- measures the mass of each sample of grass and the bag it is in
- leaves both bags side by side in the same environment for 40 days
- measures the mass of each sample of grass and the bag it is in every 10 days for 40 days.

The student's results are shown in Table 1.1.

Table 1.1

time from start of experiment / days	mass of grass and bag with no holes	mass of grass and bag with small holes
0	30 g	30 g
10	30 g	25 g
20	30 g	20 g
30	30 g	14 g
40	30 g	8 g

(i) State **one** error in the presentation of the results shown in Table 1.1.

.... [1]

(ii) At the start of the experiment, the student places the same mass of grass in each bag.

State **two** other variables that the student needs to control.

variable 1 ....

variable 2 ....
[2]

(iii) Calculate the percentage change in mass at the end of the experiment for the grass and bag with small holes.

percentage change in mass = ... % [1]

(iv) Suggest a reason for the loss of mass from the grass and bag with small holes.

....

.... [1]

(b) The student measures the temperature of the grass in each bag at the end of the experiment.

The thermometers are shown in Fig. 1.1.

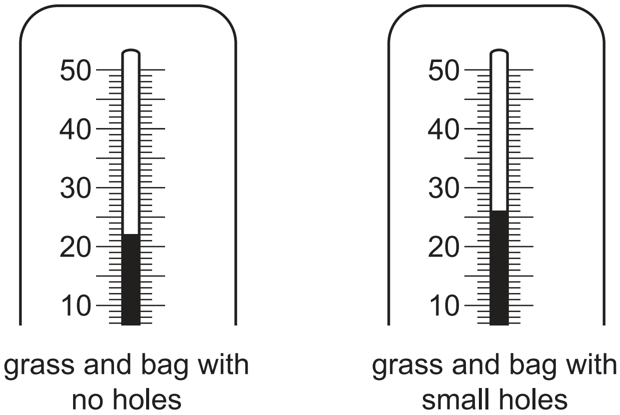


Fig. 1.1

(i) Determine the difference in the temperatures measured by the two thermometers shown in Fig. 1.1.

State the unit.

difference in temperature = ... unit .... [2]

(ii) The temperature of the grass in the bag with small holes is higher than room temperature. Suggest why.

....

.... [1]

(c) Fig. 1.2 shows a photograph of a leaf from a clover plant the student finds in a different grass sample.

Make a **large** drawing of the clover leaf shown in Fig. 1.2 in the box provided.

Fig. 1.2

[3]

[Total: 11]

2 Magnesium sulfate is a salt.

A student prepares pure crystals of magnesium sulfate.

The student:

- measures 25 cm^3 of dilute sulfuric acid into a flask
- adds insoluble solid magnesium carbonate to the mixture until in excess
- separates the excess solid magnesium carbonate from the liquid
- heats the separated liquid.

(a) (i) Name a piece of apparatus suitable for measuring 25 cm^3 of sulfuric acid.

.... [1]

(ii) State **two** observations that show that the magnesium carbonate has been added in excess.

observation 1 ....

....

observation 2 ....

....
[2]

(iii) Name the process that the student uses to separate the excess magnesium carbonate from the mixture.

.... [1]

(iv) Explain how the student knows that the mixture has been heated for long enough.

....

.... [1]

(v) Describe what the student needs to do after heating the separated mixture in order to obtain pure crystals.

....

.... [2]

(b) Another student prepares lead sulfate.

Lead sulfate is insoluble in water.

(i) The student has:

- insoluble lead carbonate solid
- insoluble barium oxide solid
- lead metal
- aqueous lead nitrate
- dilute sulfuric acid
- aqueous sodium sulfate
- insoluble barium sulfate.

Select **two** chemicals from the list which are suitable for the student to use to make lead sulfate.

1 ....

2 ....
[1]

(ii) State **two** reasons why the method used for making magnesium sulfate is not suitable for making lead sulfate.

reason 1 ....

....

reason 2 ....

....
[2]

(iii) Name the method used for making lead sulfate.

.... [1]

[Total: 11]

3 Fig. 3.1 is a full-sized diagram of a spring.

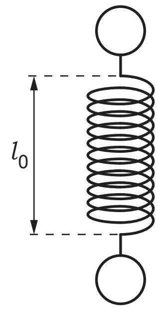


Fig. 3.1

(a) Measure and record the unstretched length l_0 of the spring shown in Fig. 3.1.

l_0 = ... mm [1]

(b) A student hangs the spring from a clamp attached to a stand and attaches a load of 1 N as shown in Fig. 3.2.

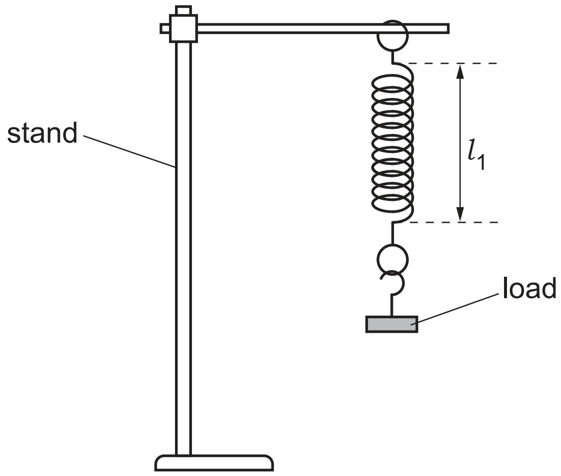


Fig. 3.2 (not to scale)

The new length l_1 of the spring is 53 mm.

Calculate the extension x of the spring using the equation $x = l_1 - l_0$.

x = ... mm [1]

(c) The student investigates the oscillation of the load on the spring.

The student:

- pulls down on the load to extend the spring by another 5 mm
- releases the load so that it moves up and down (oscillates) on the spring
- measures the time t_{20} for 20 complete oscillations
- calculates the period T for 1 oscillation
- calculates T^2
- repeats the experiment using different loads
- records his measurements and calculations as shown in Table 3.1.

Table 3.1

load / N	x / mm	t_{20} / s	T / s	T^2 ……..
1	………....	8.38	………....	………....
2	78	12.19	0.61	0.37
3	123	14.72	0.74	0.54
4	166	16.94	0.85	0.72
5	214	18.78	0.94	0.88

Complete Table 3.1 by:

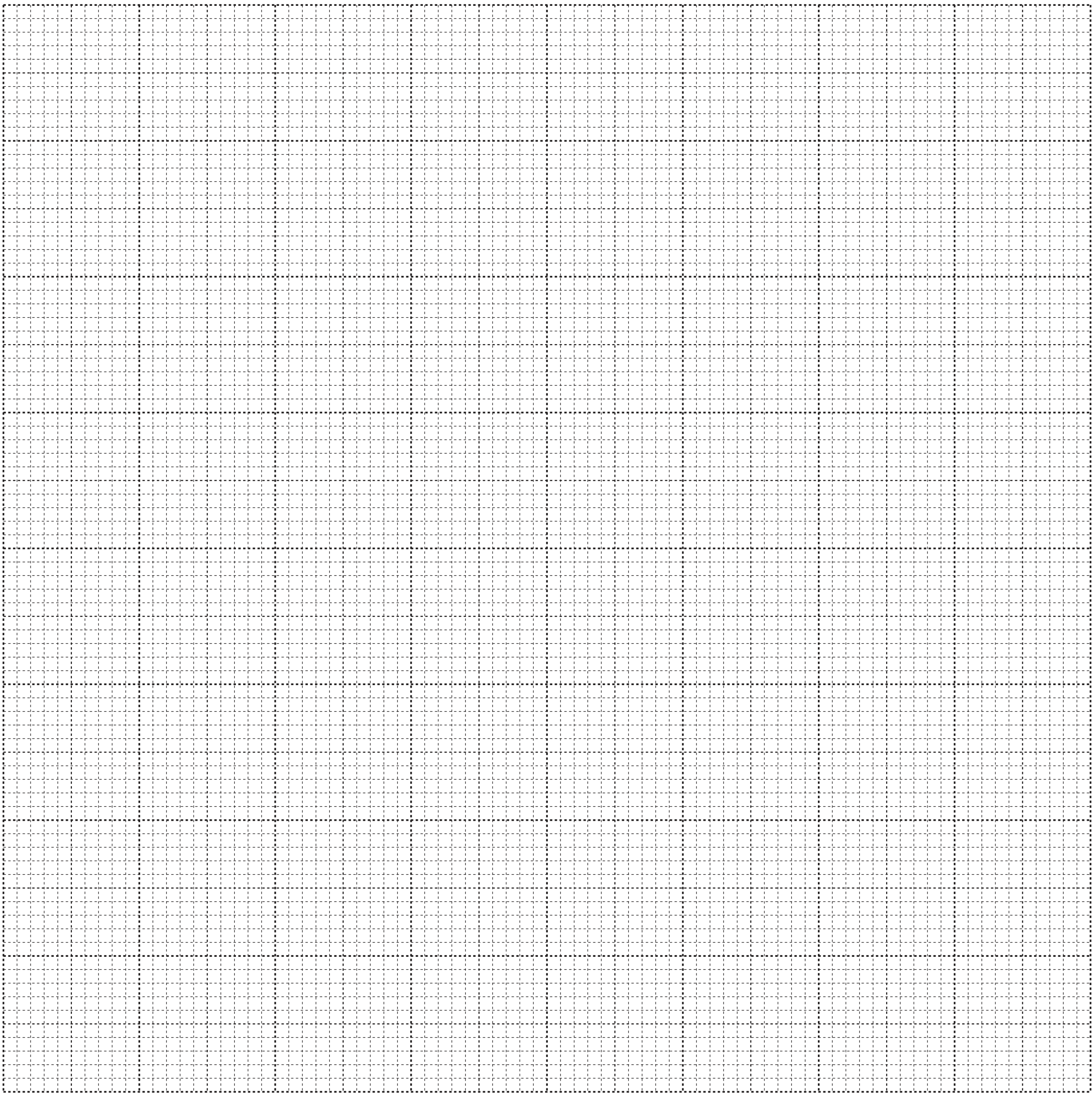
1 entering your value of x from **(b)**
2 calculating and entering the missing values of T and T^2
3 entering a unit for T^2 in the header of Table 3.1.

[3]

(d) On the grid provided in Fig. 3.3, plot a graph of the load on the *x*-axis against T^2 on the *y*-axis.

Start your graph at (0,0). Draw the straight line of best fit through your points.

T^2



load / N

Fig. 3.3

[3]

(e) Suggest **one** practical reason why the student must not put more than a 5 N load on the spring.

....

....

.... [1]

(f) The student determines the period T for 1 oscillation by measuring the time t_{20} for 20 complete oscillations.

Complete the sentence to explain why this method is used.

Measuring the time t_{20} for 20 complete oscillations rather than the period T for 1 oscillation reduces the effect of .... when starting and stopping the stop-watch. [1]

(g) The ratio of load to extension is the spring constant k of the spring.

State **one** source of error that produces slightly different values of k for each load.

....

.... [1]

[Total: 11]

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4 A student has three bottles of aqueous solutions, labelled **A**, **B** and **C**.

The student knows that the solutions are:

- aqueous aluminium chloride
- aqueous zinc chloride
- aqueous potassium chloride

but does not know which solution is in which bottle.

Plan a set of tests to determine the chemical names of solutions **A**, **B** and **C**.

You must plan tests which positively identify each chemical not just two out of the three.

Include in your plan:

- a description of the methods for all of the tests
- a description of the observations expected in each test
- how the observations identify the unknown solutions.

You are provided with:

- any chemical mentioned in the notes for qualitative analysis at the end of the paper
- normal laboratory equipment.

[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