Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5957424371

COMBINED SCIENCE **5129/31**

Paper 3 Experimental Skills and Investigations **October/November 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 **16** pages. Any blank pages are indicated.

1 A student investigates the effect of exercise on the breathing of two friends, **A** and **B**.

(a) The student:

- counts the number of breaths that each friend takes in one minute while resting
- times the friends for 5 minutes as they exercise
- counts the number of breaths that each friend takes in the first minute after exercise.

The results are shown in Fig. 1.1.

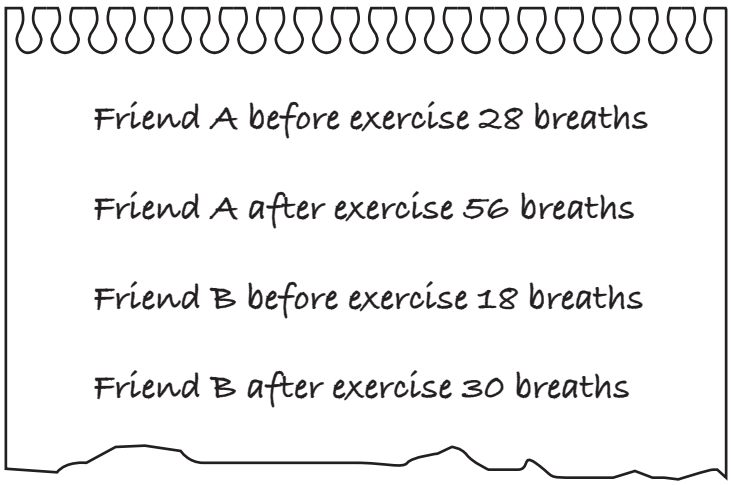


Fig. 1.1

(i) In Table 1.1, record the results from Fig. 1.1.

Table 1.1

friend	breaths in one minute before exercise	breaths in one minute after exercise	difference in number of breaths in one minute before and one minute after exercise
A			
B			

[2]

(ii) Calculate the difference in number of breaths in one minute before and one minute after exercise for each friend and record your answers in Table 1.1. [1]

(iii) State the name of the apparatus the student uses to measure the time.

..... [1]

(iv) State **two** variables that the student needs to keep constant to make the investigation a fair test.

variable 1 .....

.....

variable 2 .....

.....
[2]

(b) The student measures the volume of air exhaled by one friend using the apparatus shown in Fig. 1.2.

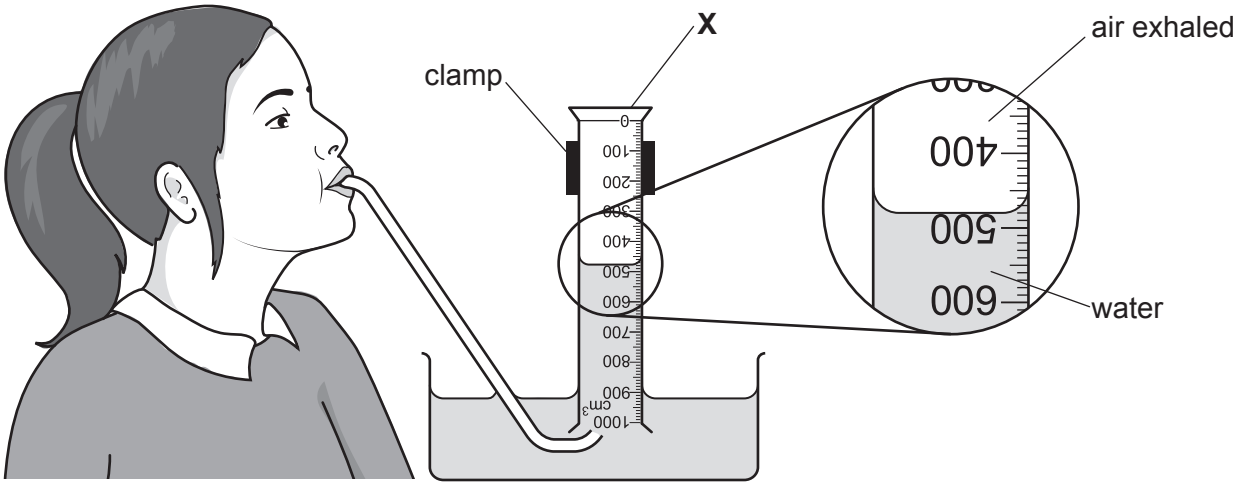


Fig. 1.2

(i) State the name of the piece of apparatus labelled **X**.

..... [1]

(ii) Record the volume of air exhaled by the friend.

volume of air = ... cm^3 [1]

(iii) In another investigation, the student uses the test for carbon dioxide to show that the amount of carbon dioxide in exhaled air is greater than the amount of carbon dioxide in atmospheric air.

The student collects a sample of exhaled air from friend **A** and a sample of atmospheric air and then bubbles each sample through limewater.

Describe what the student observes when each sample is bubbled through limewater.

exhaled air .....

.....

atmospheric air .....

.....

[2]

(iv) The student repeats the test for carbon dioxide using a sample of exhaled air from student **B**.

State how this improves the investigation.

.....

..... [1]

[Total: 11]

2 A student investigates the force needed to push air into a bicycle tyre.

The student uses a pump as shown in Fig. 2.1.

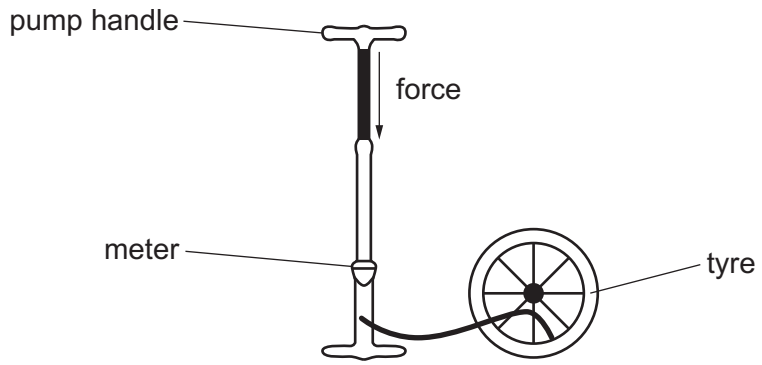
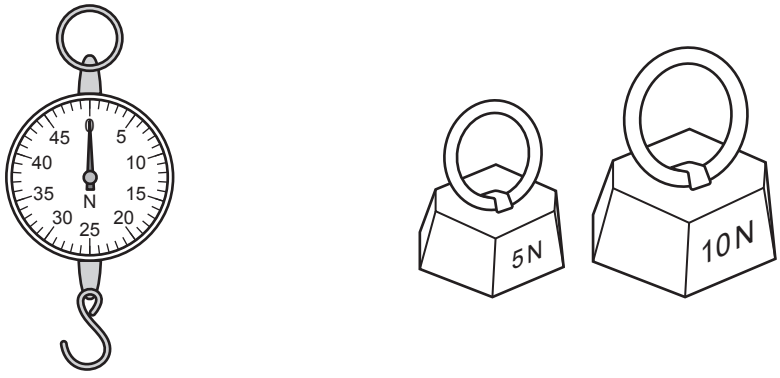


Fig. 2.1

When force is applied at the pump handle, the handle moves down and pushes air into the tyre.

(a) The student wants to find the smallest force needed to push air into the tyre.

Fig. 2.2 shows apparatus **A** or **B** that can be used.



A **B**

Fig. 2.2

(i) State the name of apparatus **A**.

..... [1]

(ii) Describe how apparatus **B** is used in this experiment.

.....

..... [1]

(iii) Explain why apparatus **A** is more appropriate for finding the smallest force in this investigation.

.....

..... [1]

(b) In another experiment, the student investigates how the pressure inside the tyre changes when the pump handle is pushed downwards.

A meter on the pump displays the pressure of the air inside the tyre.

Fig. 2.3 shows the pressure reading on the meter after 12 pushes on the handle.

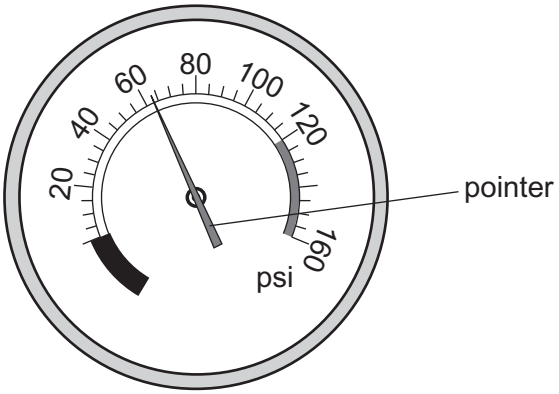


Fig. 2.3

(i) The meter in Fig. 2.3 measures the pressure in pounds per square inch (psi).

Record the pressure reading of the meter shown in Fig. 2.3 in Table 2.1.

Table 2.1

number of pushes on the handle	pressure reading on the meter / psi
2	20
4	30
6	38
8	41
10	56
12	.....

[1]

(ii) On the grid provided in Fig. 2.4, plot a graph of the pressure reading on the *y*-axis against the number of pushes on the handle on the *x*-axis.

Draw the straight line of best fit through your points.

Extend your line to intercept the *y*-axis.

Draw a circle around **one** anomalous reading.

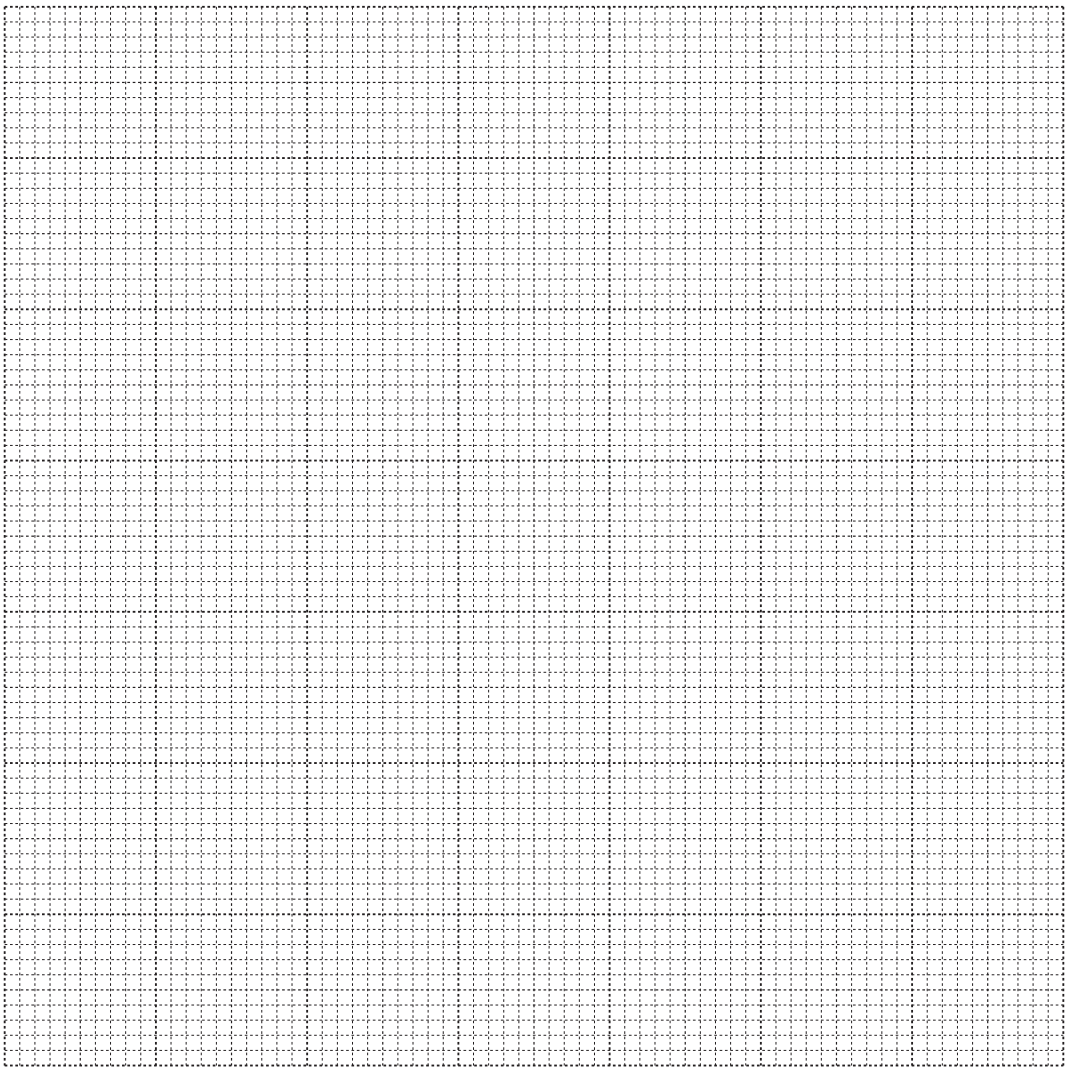


Fig. 2.4

[5]

(iii) Determine the value of the *y*-intercept of your graph.

y-intercept = ... psi [1]

(iv) The value of the *y*-intercept shows that there is a systematic error in all of the readings.

Suggest a cause of this systematic error.

.....

..... [1]

[Total: 11]

3 A student investigates the effect of manganese(IV) oxide on hydrogen peroxide.

Hydrogen peroxide is a colourless solution and manganese(IV) oxide is a powdered black solid.

procedure

The student:

- places a dilute solution of hydrogen peroxide, H_2O_2, in a flask
- adds 0.50 g of manganese(IV) oxide into the flask
- quickly attaches a bung connected to a gas syringe to the flask.

Bubbles of gas are seen (effervescence).

Manganese(IV) oxide and a colourless liquid remain in the flask at the end of the experiment.

The apparatus is shown in Fig. 3.1.

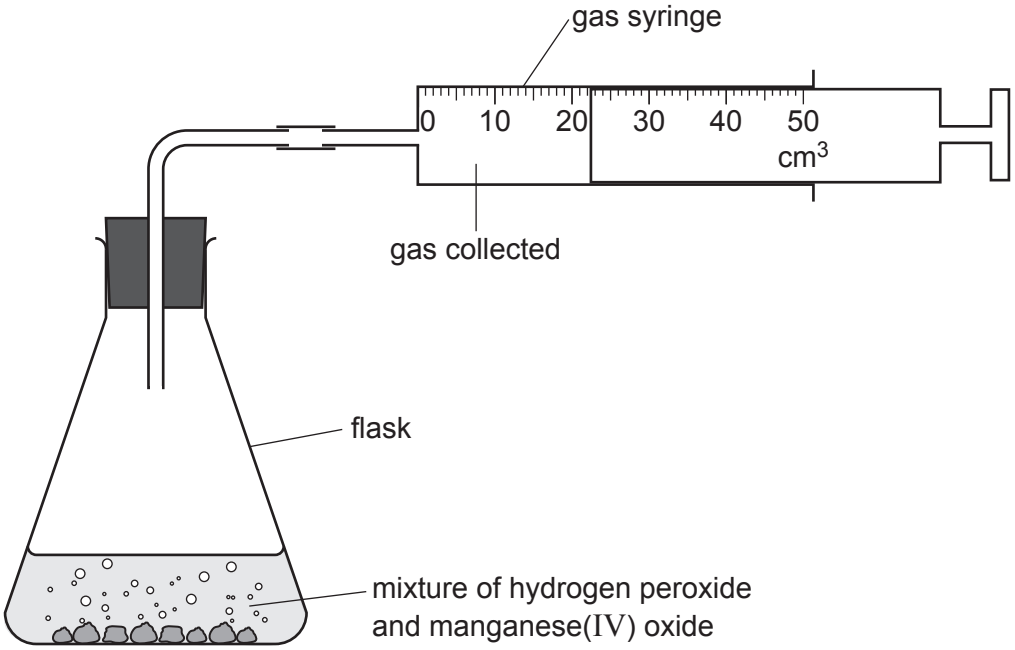


Fig. 3.1

(a) (i) State the name of the type of flask shown in Fig. 3.1.

..... [1]

(ii) State the volume of the gas collected.

volume of gas collected = ... cm^3 [1]

(iii) The volume of the gas collected is less than the volume of the gas given off by the reaction.

By referring to the procedure and Fig. 3.1, explain why.

.....

..... [1]

(b) The student:

- puts the gas collected into two test-tubes
- tests the gas in the first test-tube with a lighted splint
- tests the gas in the second test-tube with a glowing splint.

The splint in the first test-tube continues to burn brightly.

The splint in the second test-tube relights.

Name the gas produced.

..... [1]

(c) At the end of the experiment, the student:

- separates the manganese(IV) oxide from the liquid in the flask
- washes and dries the manganese(IV) oxide
- measures its mass.

(i) State the method used to separate the manganese(IV) oxide solid from the liquid.

..... [1]

(ii) The manganese(IV) oxide is a catalyst in the reaction.

Predict the mass for the manganese(IV) oxide that is obtained.

Explain the reason for your suggestion.

mass of solid = ... g

explanation .....

.....

.....

[1]

(d) The student then investigates the effect of changing the concentration of hydrogen peroxide on the volume of gas produced in 60 seconds.

Table 3.1 shows the results.

Table 3.1

concentration of hydrogen peroxide / g/dm^3	volume of gas produced in 60 seconds / cm^3
3.4	11
5.1	15
6.8	12
8.5	25
10.2	
11.9	34
13.6	40

(i) One volume of gas is **not** recorded in the table.

Suggest the volume of gas produced when the concentration of hydrogen peroxide is $10.2\,g/dm^3$.

Explain your answer.

suggested volume = ... cm^3

explanation: .....

.....

.....

[2]

(ii) The student thinks that the volume of gas produced when the concentration of hydrogen peroxide is $6.8\,g/dm^3$ is an anomaly.

Explain how the data shows that this value may be an anomaly.

Suggest how the student can check whether it is an anomaly.

explanation .....

.....

suggestion .....

.....

[2]

(iii) Describe the relationship between the concentration of hydrogen peroxide and the **rate** at which the gas is produced.

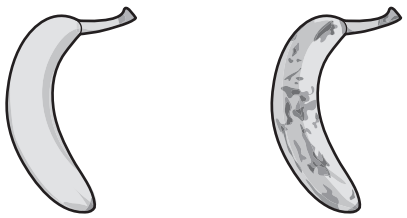
.....

.....

..... [1]

[Total: 11]

4 Fig. 4.1 shows an unripe banana, A, and a ripe banana, B.



unripe banana **A**

ripe banana **B**

Fig. 4.1

Unripe bananas contain mainly starch and no reducing sugars.

A student states: “As bananas ripen the stored starch is converted to reducing sugars”.

Plan an investigation to show how the starch and reducing sugar content is different between banana A and banana B.

You are provided with the two bananas, all the food testing reagents found in a school laboratory, and common laboratory equipment.

Include in your answer:

- the reagents that you will use
- a brief description of the methods you use to test for starch and to test for reducing sugar
- variables that you keep constant
- the table you will use to record the results
- the results from the tests that you will expect from each banana if the student’s statement is correct.

[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