Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3080325200

PHYSICS **5054/42**

Paper 4 Alternative to Practical **May/June 2020**

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 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

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[Turn over

1 A student investigates the refraction of light by a glass block.

- She places the glass block on a sheet of paper and draws around the outline of the block.
- She uses a ray box to shine an incident ray on to the side AB, as shown in Fig. 1.1. The ray is incident at point E.

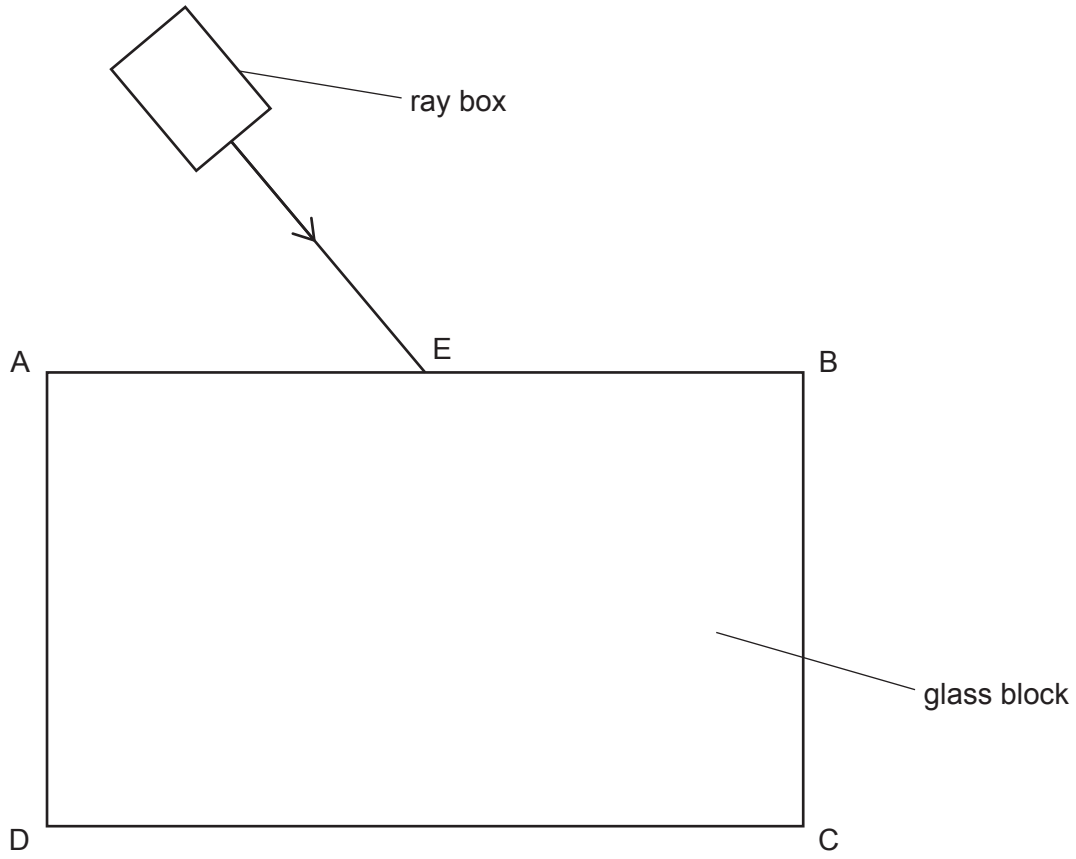


Fig. 1.1

(a) **(i)** On Fig. 1.1, draw the normal at point E. [1]

(ii) Measure and record the angle of incidence *i*. *i* = ... [1]

(b) The ray is refracted into the block at an angle of refraction of 25°.

On Fig. 1.1 draw the refracted ray. Continue the ray until it meets the side CD of the block. Label the point where the refracted ray meets the side CD with the letter F. [1]

(c) Describe how the student accurately traces the path of the light emerging from the block through side CD.

.....

.....

..... [2]

[Total: 5]

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2 A student investigates the terminal velocities v of small steel spheres of different diameters d falling through oil.

A steel sphere falling through oil reaches terminal velocity when the weight of the sphere is balanced by the drag force of the oil acting upon the sphere.

- The student measures the diameter d of a steel sphere. The diameter of the sphere is 7.82 mm.
- He fills a large glass cylinder with oil.
- He places two rubber bands around the cylinder, one above the other, at a distance of 10.0 cm apart, as shown in Fig. 2.1.

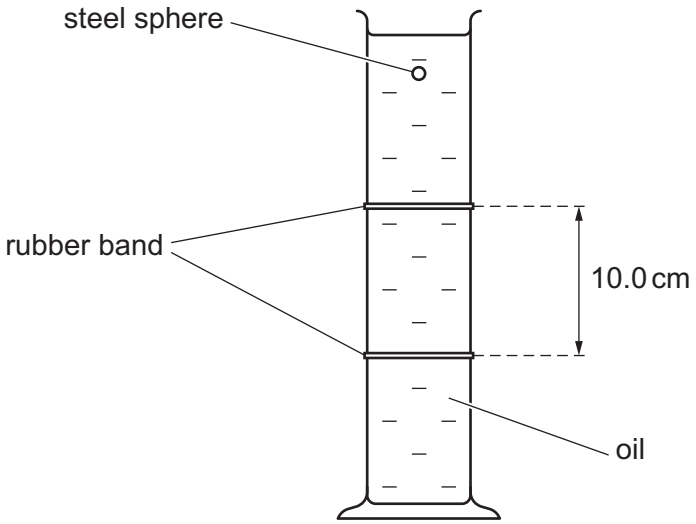


Fig. 2.1

- He drops the steel sphere into the oil and as it passes the first rubber band, he starts a stop-watch.
- He stops the stop-watch as the sphere passes the second rubber band.
- He removes the steel sphere from the oil in the bottom of the cylinder.
- He repeats this measurement for the same sphere two times.

(a) He obtains the following values of the time t for the sphere to fall a distance of 10.0 cm.

0.83 s 0.69 s 0.60 s

(i) Calculate t_{AV}, the average value of t. Give your answer to 2 decimal places.

Record your answer on the answer line and in Table 2.1 on page 4.

t_{AV} = ... s [2]

(ii) Suggest why t_{AV} is not recorded to more than 2 decimal places.

.....

..... [1]

(b) Calculate the average velocity v of this sphere as it falls between the rubber bands.

Use the equation shown.

Record your answer on the answer line and in Table 2.1.

$$v = \frac{10.0}{t_{AV}}$$

v = ... cm / s [1]

(c) **(i)** Calculate d^2 for this sphere.

Record your answer to the nearest whole number on the answer line and in Table 2.1.

d^2 = ... mm^2 [1]

(ii) Name a measuring instrument suitable for measuring the diameter d of the steel sphere to a precision of 0.01 mm.

..... [1]

(d) Suggest why the top rubber band is **not** placed close to the surface of the oil.

.....

..... [1]

(e) The student repeats the procedure using steel spheres of different diameters. His results are shown in Table 2.1.

Table 2.1

d / mm	t_{AV} / s	$\frac{v}{cm/s}$	d^2 / mm^2
7.82			
6.92	0.91	11	48
5.13	1.65	6.1	26
4.41	2.24	4.5	19
3.18	4.24	2.4	10

Using the data in Table 2.1, plot on Fig. 2.2 a graph of v on the y-axis against d^2 on the x-axis. Start both axes from the origin.

Draw the straight line of best fit. [4]

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Fig. 2.2

(f) Describe the relationship between v and d^2 shown by your graph.

.....

..... [1]

(g) (i) Human reaction time errors occur when using a stop-watch.

Use Table 2.1 on page 4 to suggest why the average time t_{AV} for a smaller sphere is more accurate than for a larger sphere.

.....

..... [1]

(ii) Suggest **one** modification to the apparatus that produces more accurate timings.

.....

..... [1]

(h) The student removes the steel spheres from the oil at the bottom of the cylinder by dipping a magnet attached to a length of string into the oil.

State why this procedure does **not** work if the spheres are made of copper.

..... [1]

[Total: 15]

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3 A student investigates the effective resistance of different combinations of three identical resistors.

She sets up circuit 1, shown in Fig. 3.1.

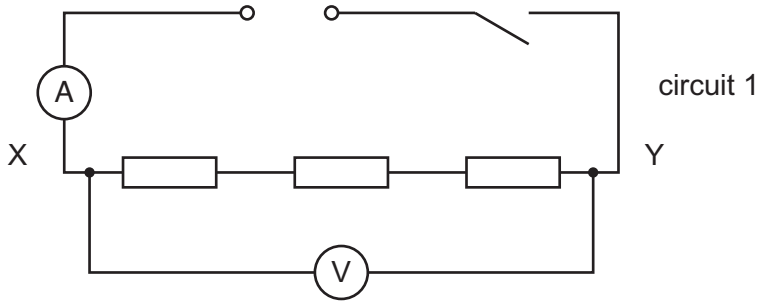


Fig. 3.1

She measures and records the current I in the circuit and the potential difference V across the resistor combination.

Fig. 3.2 shows part of the scale of the voltmeter.

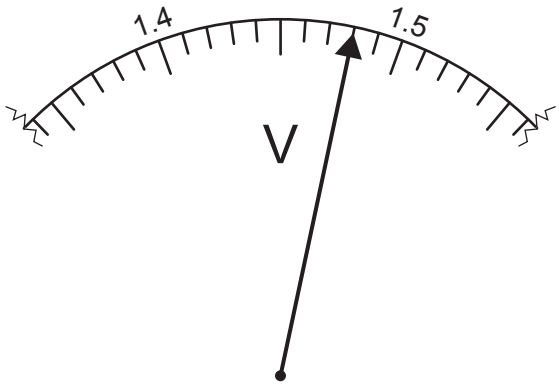


Fig. 3.2

(a) Read the voltmeter scale shown in Fig. 3.2. Record your answer on the answer line and in Table 3.1 on page 8.

voltmeter reading = ... V [1]

(b) The student uses two more combinations of the three resistors. The combinations are shown in Fig. 3.3.



Fig. 3.3

She replaces the resistor combination shown between X and Y in circuit 1 with that of circuit 2 and then that of circuit 3, in turn.

Each time she records the current I in the circuit and the potential difference V across the resistor combination.

Her results are shown in Table 3.1.

Table 3.1

circuit	V /	I /	R / .....
1		0.13	
2	1.46	0.25	
3	1.46	0.58	

The resistance R of each combination of resistors is given by

$$R = V / I$$

(i) Complete the column headings in Table 3.1. [1]

(ii) Calculate the resistance R of each combination of resistors.

Record the values of R in Table 3.1. [1]

(c) Theory suggests that for identical resistors, the resistance of the resistor combination in circuit 1 is double the resistance of the resistor combination in circuit 2.

State whether your results support this theory, within the limits of experimental accuracy. Give a reason for your answer.

.....

..... [1]

(d) Give **one** precaution that the student takes so that her readings of current and voltage are as accurate as possible.

.....

..... [1]

[Total: 5]

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4 A student investigates the rate of cooling of thermometer bulbs under different conditions.

- The student takes two identical thermometers P and Q.
- He leaves the bulb of thermometer P exposed to the air, but wraps and secures a small piece of cloth around the bulb of thermometer Q.
- He places thermometer P into a beaker of hot water.

Fig. 4.1 shows the reading on thermometer P at time $t = 0$.

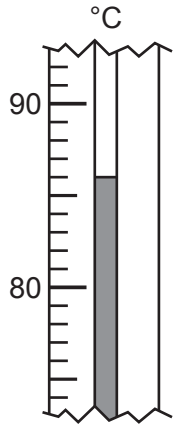


Fig. 4.1

(a) Record on the answer line, and in Table 4.1, the temperature shown at time $t = 0$.

temperature = ... °C [1]

(b)
- The student removes thermometer P from the hot water and starts the stop-watch.
- He takes the reading of the temperature of the thermometer bulb at 30 s intervals for 3 minutes.
- He repeats the experiment using thermometer Q.

His results are shown in Table 4.1.

Table 4.1

time t / s	reading of thermometer P / °C	reading of thermometer Q / °C
0		89
30	52	77
60	37	60
90	33	49
120	30	41
150	28	38
180	27	35

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State which thermometer cooled more quickly at the start of the investigation.

Justify your answer by referring to readings in Table 4.1 on page 9.

.....

.....

..... [2]

(c) Suggest **two** conditions that must be kept the same to ensure that a fair comparison is made between the rates of cooling of the two thermometers.

condition 1 .....

condition 2 .....
[2]

[Total: 5]

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