Cambridge Assessment International Education

# Cambridge O Level

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |

*2553730650*

**PHYSICS** **5054/41**

Paper 4 Alternative to Practical **May/June 2021**

**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. Any blank pages are indicated.


© UCLES 2021

**BLANK PAGE**

© UCLES 2021

**1** A student investigates the relationship between the resistance $R$ of different lengths of wire and their length $l$. Resistance can be found using the equation:

$$R = \frac{V}{I}$$

where $V$ is the voltage and $I$ is the current.

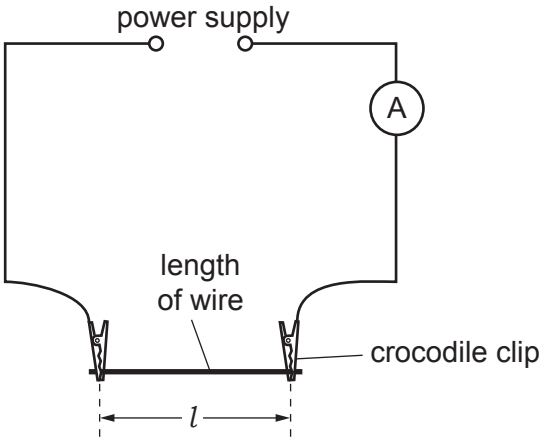



**Fig. 1.1**

The student is provided with different lengths of wire of the same material.
He uses the circuit shown in Fig. 1.1.

**(a)** State **one** property of the wire that must be the same for the student to make a fair comparison.

.....

..... [1]

**(b)** On Fig. 1.1, draw a voltmeter symbol connected to measure the voltage across the length of wire. [1]

**(c)**
- The student places a 40.0 cm length of wire between the crocodile clips shown in Fig. 1.1.
- He switches on the power supply.

**(i)** Name the piece of apparatus he uses to measure the length of the wire between the crocodile clips.

.....

..... [1]

**(ii)** Fig. 1.2 shows the ammeter and the voltmeter readings when length $l$ = 40.0 cm.

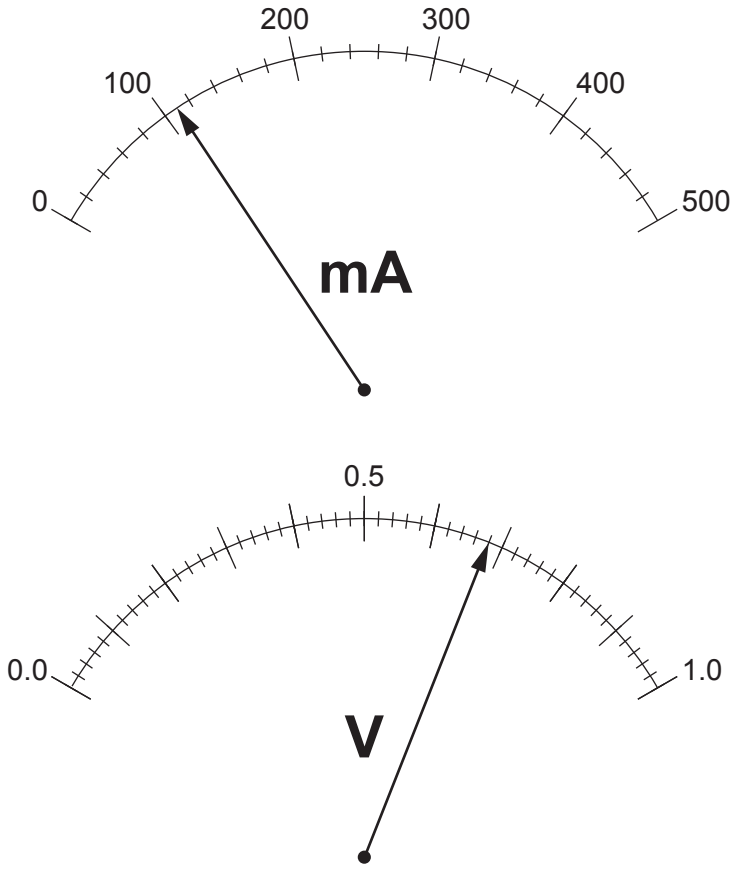



**Fig. 1.2**

Record the readings of current and voltage for this length of wire.

current = ..... mA

voltage = ..... V
[2]

**(d)**
- The student switches off the power supply.
- He removes the wire and replaces it with a different length of wire.
- He repeats the procedure for wires of length $l$ = 20.0 cm, 60.0 cm, 80.0 cm and 100.0 cm.
- The values of $I$, $V$ and $R$ that he obtains are shown in Table 1.1.

**Table 1.1**

| $l$/cm | $V$/V | $I$/A | $R$/Ω |
|---|---|---|---|
| 20.0 | 0.58 | 0.180 | 3.2 |
| 40.0 | | | |
| 60.0 | 0.75 | 0.076 | 9.9 |
| 80.0 | 0.82 | 0.066 | 12.4 |
| 100.0 | 0.86 | 0.056 | 15.4 |

© UCLES 2021

**(i)** Complete Table 1.1, using your recorded readings in **(c)(ii)**. [1]

**(ii)** On Fig. 1.3, plot the graph of $R/\Omega$ on the *y*-axis against $l$/cm on the *x*-axis. Start both axes from the origin (0,0).

Draw the straight line of best fit. [4]

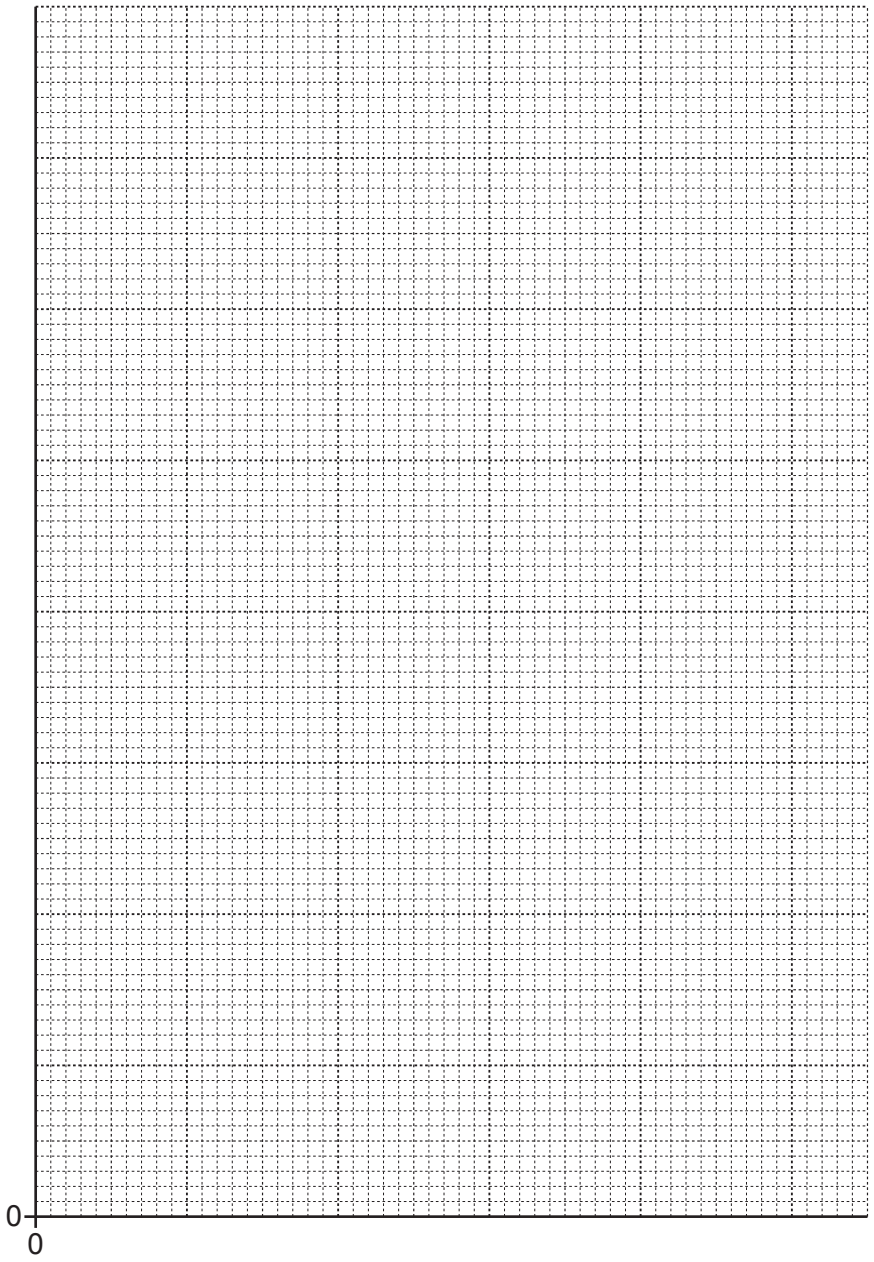



**Fig. 1.3**

**(iii)** State the relationship between *R* and $l$ shown by your graph.

.....

..... [1]

**(iv)** Use your graph to determine the length of wire that has a resistance of 14 Ω.

Show how you determine this value on your graph.

length of wire needed = ..... cm [1]

**(e)** A second student carries out the same experiment.

- He uses one single 120.0 cm length of wire.
- He connects two crocodile clips at different points along the 120.0 cm wire so that the required length of wire for each measurement is between them for each reading.

He switches off the power supply after each reading and waits a short time before taking the next reading.

Suggest a reason for waiting a short time.

.....

..... [1]

[Total: 13]

© UCLES 2021

**2** A student measures the focal length of a convex lens.
He sets up the apparatus as shown in Fig. 2.1.

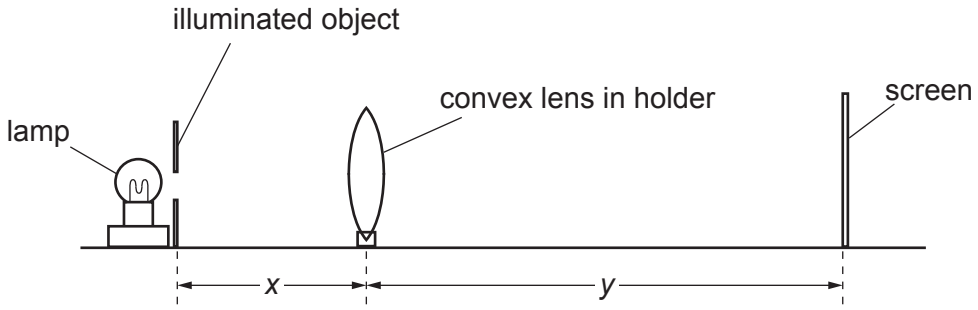



**Fig. 2.1**

- He places the lens a distance *x* from the illuminated object.
- He moves the screen until a sharp image of the object is formed on the screen. The lens is now a distance *y* from the screen.

**(a)** **(i)** On Fig. 2.1, measure, to the nearest millimetre, the length *x* and the length *y*.

*x* = ..... cm

*y* = ..... cm
[1]

**(ii)** Fig. 2.1 is drawn to one quarter full size.

Calculate the actual distance *u* between the lens and the object and calculate the actual distance *v* between the lens and the screen.

*u* = ..... cm

*v* = ..... cm
[1]

**(iii)** Calculate the focal length *f* of the lens using the equation:

$$f = \frac{uv}{u + v}$$

Give your answer to 2 significant figures.

*f* = ..... cm [2]

**(b)** The lens manufacturer states that the lens has a focal length *f* = 7.0 cm.

Explain, giving a reason, whether your results agree with the manufacturer's value within the limits of experimental accuracy.

.....

..... [1]

[Total: 5]

© UCLES 2021

**3** A student investigates the effect of insulation on the rate of cooling of hot water.

- She pours 200 $cm^3$ of hot water into a beaker, as shown in Fig. 3.1.
- She waits a short time.
- She then starts a stop-watch and records the temperature of the water. This is at time $t = 0$.

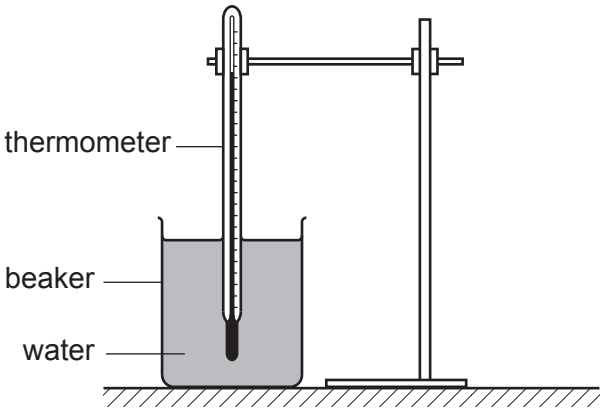



**Fig. 3.1**

**(a)** Suggest why the student waits a short time before recording the temperature at time $t = 0$.

.....

..... [1]

**(b)** Fig. 3.2 shows part of the thermometer at time $t = 0$.

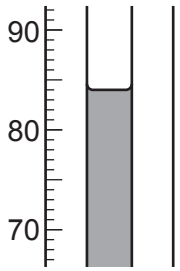



**Fig. 3.2**

Read the thermometer and record the temperature $\theta$ on the answer line and in Table 3.1.

$\theta$ = ..... °C [1]

**(c)** The student records the temperature of the water every minute for 5.0 minutes. Table 3.1 shows her results.

**Table 3.1**

| $t$/min | $\theta$/°C |
|---|---|
| 0 | |
| 1.0 | 76 |
| 2.0 | 70 |
| 3.0 | 65 |
| 4.0 | 62 |
| 5.0 | 61 |

**(i)** Using the results from Table 3.1, describe how the rate of cooling of the water changes over the 5.0 minutes.

.....

..... [1]

**(ii)** Calculate the average rate of cooling over the 5.0 minutes using the equation:

$$\text{average rate of cooling} = \frac{\text{temperature change in 5.0 minutes}}{5.0}$$

average rate of cooling = ..... unit ..... [2]

**(d)** The student now covers the sides of the beaker with a layer of cotton wool and repeats the procedure, ensuring that the starting temperature is the same as the temperature recorded in **(b)**.

Table 3.2 shows her new results.

**Table 3.2**

| $t$/min | $\theta$/°C |
|---|---|
| 0 | |
| 1.0 | 79 |
| 2.0 | 76 |
| 3.0 | 74 |
| 4.0 | 72 |
| 5.0 | 71 |

**(i)** Use the results in Table 3.1 on page 9 and Table 3.2 to suggest how the layer of cotton wool has changed the rate of cooling of the water.

.....

..... [1]

**(ii)** The student repeats the experiment again with the same starting temperature. Suggest how the student changes her apparatus to ensure that the temperature after 5.0 minutes is greater than 71 °C.

.....

..... [1]

[Total: 7]

© UCLES 2021

**4** A student investigates the magnetic field **between** two strong magnets.

She places the magnets as shown in Fig. 4.1.

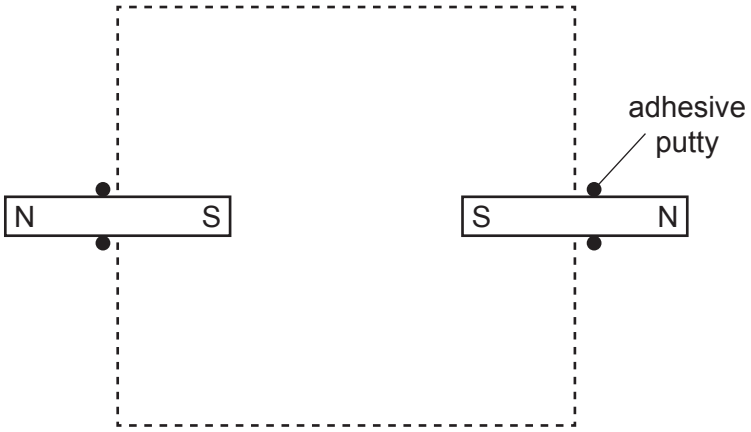



**Fig. 4.1**

**(a)** She places the magnets on a smooth surface using pieces of adhesive putty (e.g. Blu Tack or Patafix), as shown in Fig. 4.1. Suggest why the pieces of adhesive putty are needed.

.....

.....

..... [1]

**(b)** **(i)** Describe how she uses a plotting compass to plot the pattern of the magnetic field between the magnets.

.....

.....

.....

.....

.....

..... [3]

**(ii)** On Fig. 4.1, draw the shape of the magnetic field that she observes inside the box indicated by the dashed lines. [1]

[Total: 5]

© UCLES 2021

**BLANK PAGE**

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

© UCLES 2021