



## Cambridge O Level

CANDIDATE  
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**PHYSICS**

**5054/41**

Paper 4 Alternative to Practical

**October/November 2022**

**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.

1 A student measures the refractive index of oil.

- Oil is poured into a semi-circular transparent plastic container as shown in Fig. 1.1.
- The container is placed on top of a 360° protractor as shown in Fig. 1.2.

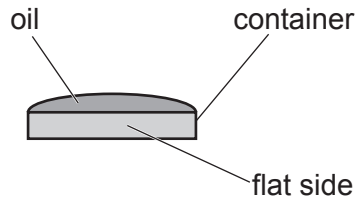


Fig. 1.1

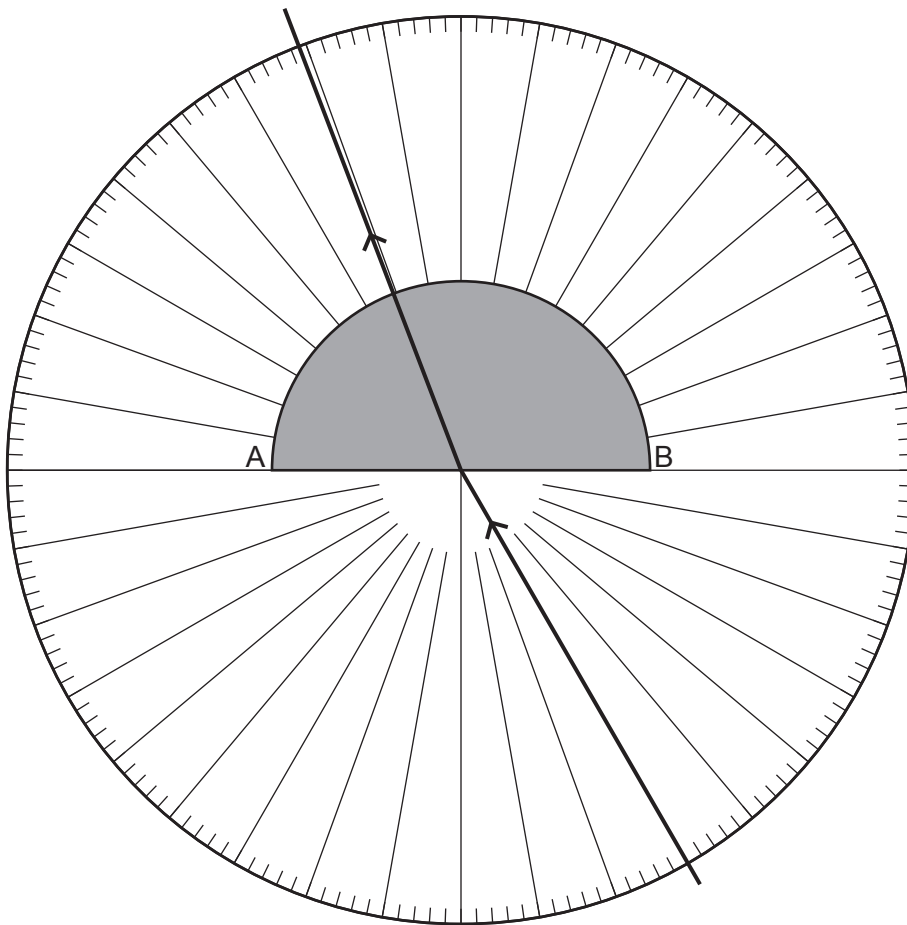


Fig. 1.2  
(viewed from above)

(a) The line AB shows the position of the flat side of the plastic container.

A ray of light is incident at the midpoint of AB with an angle of incidence  $i = 30^\circ$  as shown in Fig. 1.2.

(i) State **one** property of the oil that is needed to ensure that the experiment works.

..... [1]

(ii) On Fig. 1.2, measure the angle of refraction  $r$  of the light in the oil.

$r =$  ..... ° [1]

- (b) The student repeats the procedure described in (a) and measures the angle of refraction  $r$  for angles of incidence  $i = 15^\circ, 45^\circ, 60^\circ$ , and  $75^\circ$ . The results are shown in Table 1.1.

**Table 1.1**

$i/^\circ$	15	30	45	60	75
$r/^\circ$	11		31	39	45

- (i) Complete Table 1.1 with your value of  $r$  from (a)(ii).

On the grid provided in Fig. 1.3, plot a graph of  $r$  on the  $y$ -axis against  $i$  on the  $x$ -axis. Start your axes from (0,0). Draw a smooth curve of best fit.



**Fig. 1.3**

[4]

- (ii) Describe the relationship between  $i$  and  $r$  shown by the graph.

.....  
 ..... [1]

- (iii) Use your graph to find the value of  $r$  when  $i = 50^\circ$ .

Show on the graph how you determine your answer.

$r = \dots\dots\dots^\circ$  [2]

(iv) Theory suggests that the refractive index  $n$  of the oil is given by:

$$n = \frac{\sin i}{\sin r}$$

Using  $i$  and your value of  $r$  from (b)(iii), calculate a value for  $n$ . Give your answer to an appropriate number of significant figures.

$n =$  ..... [2]

(v) On Fig. 1.4, sketch the graph when  $\sin r$  is plotted against  $\sin i$ . No calculations are required.

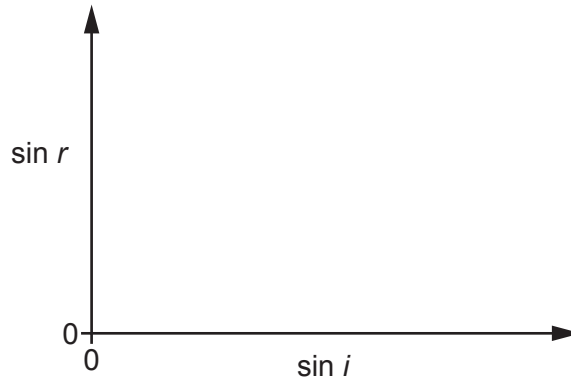


Fig. 1.4

[1]

(c) Suggest **one** reason why the practical method used in this investigation might not give an accurate value for  $n$ .

.....  
 .....  
 ..... [1]

[Total: 13]

**Question 2 starts over the page.**

2 A student investigates the cooling of water. The apparatus used is shown in Fig. 2.1.

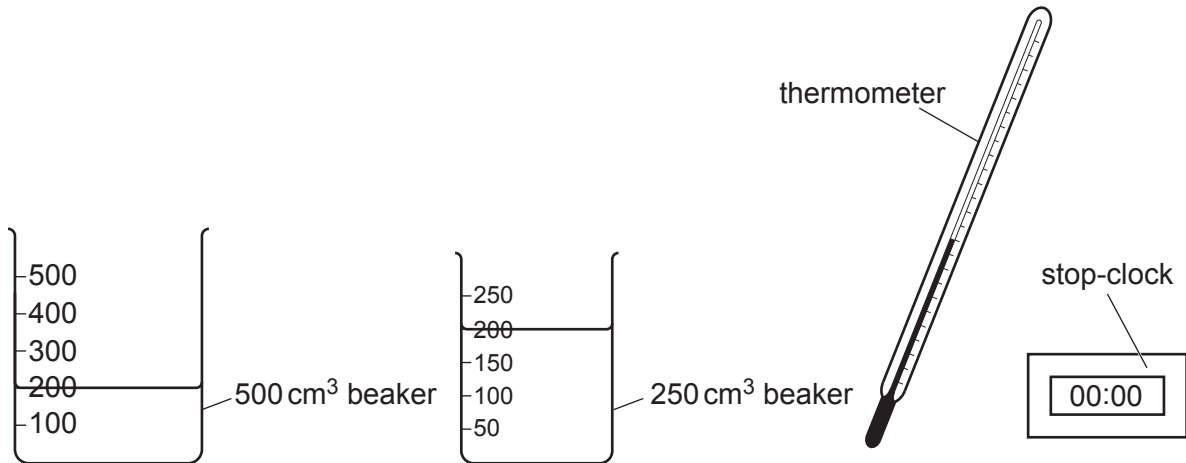


Fig. 2.1

(a) The student:

- pours 200 cm<sup>3</sup> of hot water into the 500 cm<sup>3</sup> beaker
- places the thermometer in the water
- stirs the water
- measures the initial temperature of the water
- uses the clock to find the time taken for the water to cool by 5.0 °C and by 10.0 °C
- repeats the experiment three times.

(i) Explain why the water is stirred before taking a temperature reading.

.....  
 ..... [1]

(ii) The student uses 200 cm<sup>3</sup> of hot water in the same beaker in each test.

State **one** other experimental variable that the student keeps constant to make a fair comparison of the three sets of results.

..... [1]

(b) Table 2.1 shows the results obtained by the student.

Table 2.1

temperature decrease/°C	time/s			average time/s
	trial 1	trial 2	trial 3	
5.0	82	84	82	
10.0	173	184	185	181

- (i) Complete Table 2.1 by calculating the average time taken for the water to cool by  $5.0^{\circ}\text{C}$ .  
Give your answer to an appropriate number of significant figures.

[2]

- (ii) Suggest **one** reason why the time taken for the water to cool by  $10.0^{\circ}\text{C}$  is **not** double the time taken for the water to cool by  $5.0^{\circ}\text{C}$ .

.....  
 .....  
 ..... [1]

- (c) The student repeats the experiment using the  $250\text{ cm}^3$  beaker. All other experimental variables remain the same.

Table 2.2 shows the average times taken for the  $250\text{ cm}^3$  beaker to cool by  $5.0^{\circ}\text{C}$  and by  $10.0^{\circ}\text{C}$ .

**Table 2.2**

temperature decrease/ $^{\circ}\text{C}$	average time/s
5.0	110
10.0	250

- (i) Describe the difference in the cooling of the water in the two beakers.

Refer to the results recorded in Table 2.1 and Table 2.2 in your answer.

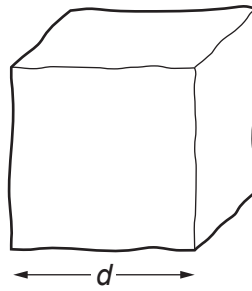
.....  
 .....  
 ..... [1]

- (ii) Suggest a reason for the difference.

.....  
 ..... [1]

[Total: 7]

- 3 A student measures the density of a sample of modelling clay. The clay is moulded into a cube as shown in Fig. 3.1.



**Fig. 3.1**

- (a) Suggest **one** difficulty the student finds when moulding the clay into a cube.

..... [1]

- (b) (i) On Fig. 3.1, measure the length  $d$  of one side of the cube.

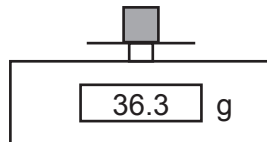
$d =$  ..... cm [1]

- (ii) Calculate the volume  $V$  of the modelling clay using the equation:

$$V = d^3$$

$V =$  ..... cm<sup>3</sup> [1]

- (iii) The student uses a balance to find the mass  $m$  of the modelling clay as shown in Fig. 3.2.



**Fig. 3.2**

Calculate the density  $\rho$  of the modelling clay using the equation:

$$\rho = \frac{m}{V}$$

Give the unit of your answer.

$\rho =$  ..... unit ..... [2]

[Total: 5]



4 A student investigates the current in a resistor of fixed resistance.

The following apparatus is available:

- ammeter
- electrical connecting leads
- a resistor of fixed resistance
- lamp
- switch
- variable resistor
- 6V battery
- LED
- voltmeter.

(a) State which piece of apparatus is used to measure current.

..... [1]

(b) (i) The student measures the current  $I$  for a range of potential differences.

Draw a circuit diagram to show the circuit the student uses.

You may use some or all of the apparatus available.

[3]

(ii) Describe how the student obtains different values of the potential difference across the fixed resistor.

.....  
.....  
..... [1]

[Total: 5]





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