Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

0768462310

PHYSICS **5054/42**

Paper 4 Alternative to Practical **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.

© UCLES 2023

1 A student measures the spring constant k of a spring using two different methods.

The spring constant k of a spring is a measure of the stiffness of the spring. The larger the spring constant k, the more difficult the spring is to stretch.

(a) Method 1

The student:

- measures the unstretched length of the spring to the nearest 0.1 cm.

A full-size diagram of the spring is shown in Fig. 1.1.

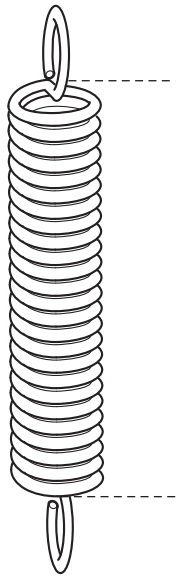


Fig. 1.1

(i) Measure the unstretched length l_0 of the spring to the nearest 0.1 cm.

Do **not** include the loops at the end of the spring in your measurement.

l_0 = ... cm [1]

(ii) The student:

- attaches the spring to a clamp on a stand
- suspends a 300 g mass from the spring.

The arrangement of apparatus is shown in Fig. 1.2.

© UCLES 2023

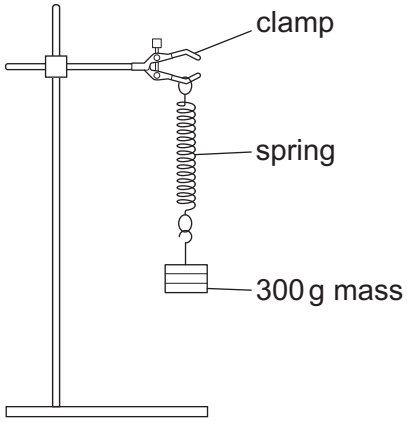


Fig. 1.2

- The student measures the new length l_1 of the spring.

$$l_1 = 17.6\,\text{cm}$$

Calculate the extension e of the spring produced by the mass.

Use the equation:

$$e = l_1 - l_0$$

e = ... cm [1]

(iii) Calculate the spring constant k_1 of the spring.

Use the equation:

$$k_1 = \frac{300}{e}$$

k_1 = ... N/m [1]

(iv) It is important to avoid line-of-sight (parallax) errors when determining the extension of the spring.

Explain what is meant by parallax errors and how to avoid parallax errors.

explanation .....

.....

how to avoid parallax errors .....

.....

[2]

(b) Method 2

The student:

- pulls the 300 g mass down by a small distance and releases it so that the mass oscillates up and down
- measures the time t_1 taken for 20 oscillations.

(i) The reading on the stop-watch is shown in Fig. 1.3.



Fig. 1.3

Record this time t_1 in Table 1.1 to one decimal place. [1]

Table 1.1

mass m/g	time t_1 for 20 oscillations/s	time t_2 for 20 oscillations/s	mean time t for 20 oscillations/s	period T/s	T^2/s^2
300		13.8			

(ii) • The student measures the time for 20 oscillations once more and records the time t_2 in Table 1.1.

Calculate the mean time t for 20 oscillations and record your answer in Table 1.1.

[1]

(iii) The mean period T of the oscillation is the mean time taken for one oscillation.

Calculate the mean period T.

Calculate the value of T^2.

Record all your values in Table 1.1.

[1]

© UCLES 2023

(iv) Use your value of T^2 from Table 1.1 to calculate the spring constant k_2 of the spring.

Use the equation:

$$k_2 = \frac{11.8}{T^2}$$

k_2 = ... N/m [1]

(c) Explain why the value for the mean period T obtained by measuring 20 oscillations twice is more accurate than the value obtained by measuring 1 oscillation twice.

.....

..... [1]

[Total: 10]

2 A student investigates the rate of cooling of water at the top and at the bottom of a beaker of hot water.

(a) The student:

- measures the room temperature θ_R as θ_R = 22.5 °C
- pours 200 cm^3 of hot water into a beaker
- lowers a thermometer into the beaker until its bulb is just covered by the hot water, as shown in Fig. 2.1

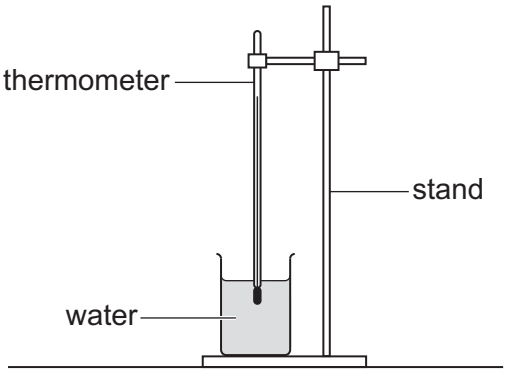


Fig. 2.1

- waits for approximately 30 s
- starts a stop-watch and reads the thermometer.

(i) The temperature on the thermometer at time t = 0 is shown in Fig. 2.2.

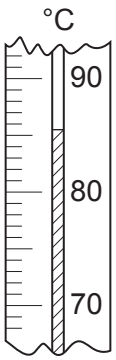


Fig. 2.2

Record the temperature reading at time t = 0 to the nearest 0.5 °C in Table 2.1. [1]

© UCLES 2023

Table 2.1

time t / min	bulb just below surface temperature / °C	bulb just above bottom temperature / °C
0		86.0
3	78.0	77.0

(ii) Explain why the student waits for 30 s before reading the initial temperature of the hot water.

.....

..... [1]

(b) The student waits for 3 minutes, reads the thermometer and records the new temperature reading in Table 2.1.

The student then:

- removes the thermometer from the beaker and pours the water away
- repeats the procedure in **(a)**, but lowers the thermometer into the beaker, so that the bulb is just above, but not touching the bottom of the beaker, as shown in Fig. 2.3.

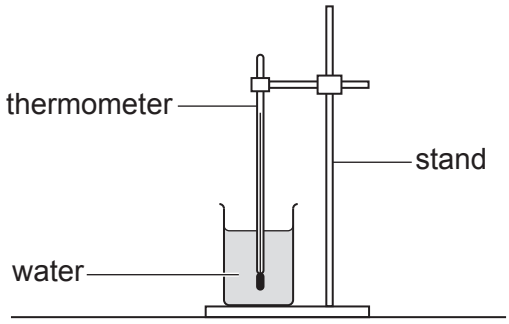


Fig. 2.3

- records the initial and final temperatures of the water as shown in Table 2.1.

(i) Calculate the average rate of cooling P_T of the hot water at the top of the beaker.

Use the equation:

$$\text{average rate of cooling} = \frac{\text{decrease in temperature of the water}}{\text{time taken}}$$

Give your answer to 2 significant figures and state the unit.

P_T = ... unit ..... [3]

(ii) Use the data in Table 2.1 on page 7 to calculate the average rate of cooling P_B of the hot water at the bottom of the beaker.

P_B = ... [1]

(c) **(i)** Use your answers to **(b)(i)** and **(b)(ii)** to suggest why a hot liquid should be stirred before measuring its temperature.

.....

..... [1]

(ii) State **one** way in which the apparatus in this experiment is arranged to make it easy to read the thermometer accurately.

.....

..... [1]

(d) The experiment is repeated to check the results.

Suggest **one** variable that must be kept constant.

..... [1]

(e) The student leaves the thermometer in the hot water and waits for 30 minutes before reading the thermometer again.

Predict a value for the temperature of the water in the beaker.

temperature of water = ... °C [1]

[Total: 10]

© UCLES 2023

3 A student investigates how the potential difference V across the terminals of a power supply changes as the current I in a circuit changes.

The student assembles the circuit shown in Fig. 3.1.

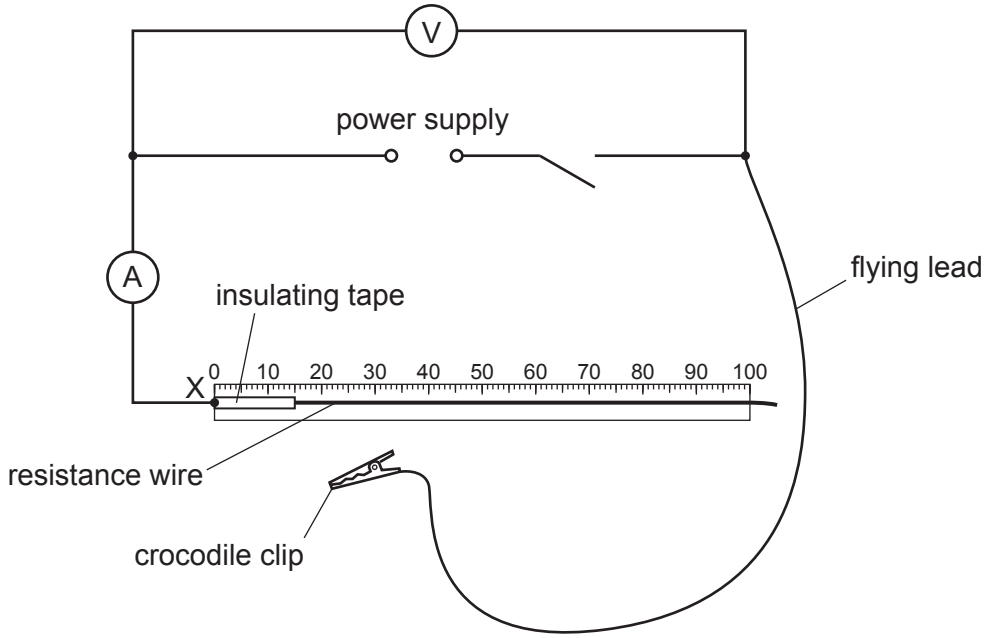


Fig. 3.1

(a) The student closes the switch and observes the reading V_0 on the voltmeter.

The reading is shown in Fig. 3.2.

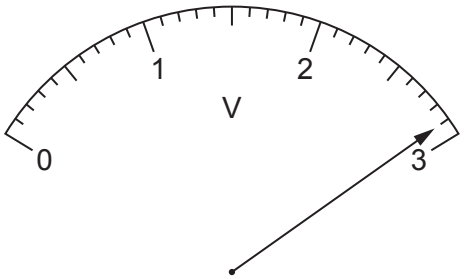


Fig. 3.2

Record the voltmeter reading V_0.

V_0 = ... V [1]

(b) The student then:

- connects the crocodile clip to the resistance wire at a distance d = 100.0 cm from end X
- records the potential difference V across the wire as V = 2.3 V
- records the current I in the wire
- opens the switch.

The reading on the ammeter is shown in Fig. 3.3.

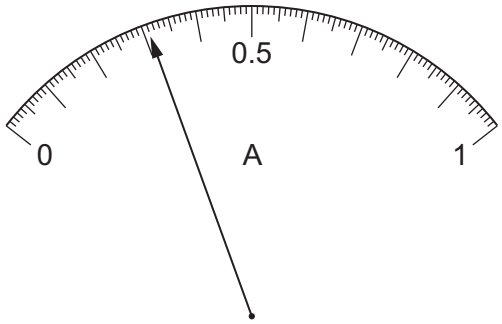


Fig. 3.3

Record the ammeter reading I.

I = ... A [1]

(c) The student:

- closes the switch
- repeats **(b)** for values of d = 80.0 cm, 60.0 cm, 40.0 cm and 20.0 cm.

The student's results are shown in Table 3.1.

Complete the header of each column.

Include the value of I from **(b)**.

Table 3.1

d	*V*	*I* .....
100.0	2.3	
80.0	2.2	0.37
60.0	2.0	0.45
40.0	1.7	0.60
20.0	1.2	0.88

[1]

(d) On the grid provided in Fig. 3.4, plot a graph of V on the y-axis against I on the x-axis, using the data in Table 3.1.

Start both axes from the origin (0, 0).

Draw the best-fit straight line. [3]

© UCLES 2023



Fig. 3.4

(e) **(i)** The gradient m of your line is numerically equal to the resistance r of the power supply.

Calculate the gradient of your line.

Show clearly on the graph the values you chose and show your working.

m = ... [2]

(ii) The intercept between the y-axis and your line is the electromotive force V_0 of the power supply.

Extend your best-fit line to meet the y-axis and write down the value of V_0.

V_0 = ... V [1]

(f) Compare the value of V_0 in **(a)** with the value of V_0 you obtained from the graph in **(e)(ii)**.

Two quantities can be considered to be equal within the limits of experimental accuracy if their values are within 10% of each other.

State whether your results show that the two values obtained for the electromotive force are the same.

Support your statement with a calculation.

calculation

statement .....

..... [2]

© UCLES 2023

(g) Another student decides to connect the crocodile clip in Fig. 3.1 so that there is only a very small length of the resistance wire included in the circuit. The teacher tells the student **not** to do this.

Suggest **one** practical reason why values of *d* less than 20.0 cm should **not** be used.

.....

.....

..... [1]

(h) It is possible to change the potential difference *V* by using a variable resistor rather than using different lengths of resistance wire.

Complete the circuit diagram in Fig. 3.5 to show how the variable resistor is connected.

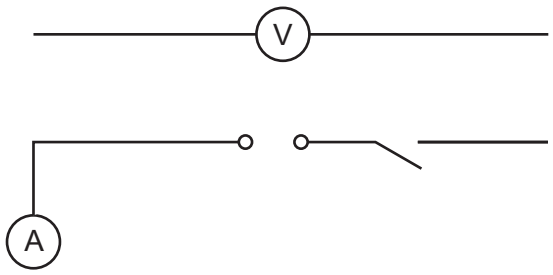


Fig. 3.5

[2]

[Total: 14]

4 A student investigates the average speed of a trolley moving along a horizontal bench.

The trolley is placed on a ramp and released from rest. Some of the apparatus used is shown in Fig. 4.1.

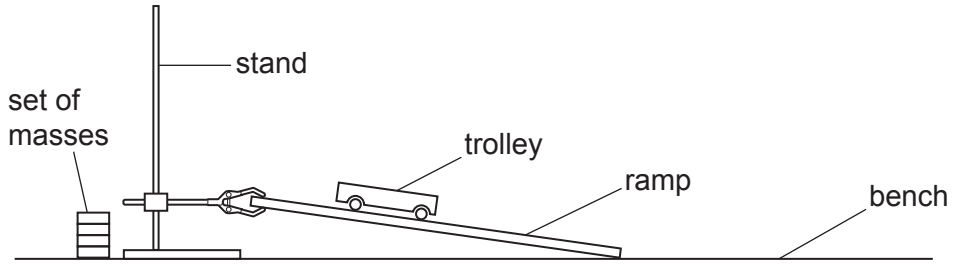


Fig. 4.1

The stopping distance of the trolley is the distance moved by the trolley from the bottom of the ramp until it comes to rest.

Plan an experiment to investigate how the average speed of the trolley **along the bench** until it comes to rest depends upon its mass.

The average speed of the trolley can be calculated using the equation shown.

$$\text{average speed} = \frac{\text{stopping distance}}{\text{time}}$$

In your plan you should:

- explain briefly how to carry out the investigation, stating any other apparatus needed
- state the key variables to keep constant
- draw a table with column headings to show how to display the readings (you are **not** required to enter any readings into the table)
- explain how to use your readings to reach a conclusion.

© UCLES 2023

[6]

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 Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

© UCLES 2023