OXFORD AQA
INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________
I declare this is my own work.

INTERNATIONAL A-LEVEL
PHYSICS

Unit 5 Physics in practice

Tuesday 20 January 2026   07:00 UK Time   Time allowed: 2 hours

Materials
For this paper you must have:
- a Data and Formulae Booklet as a loose insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate
- a protractor.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

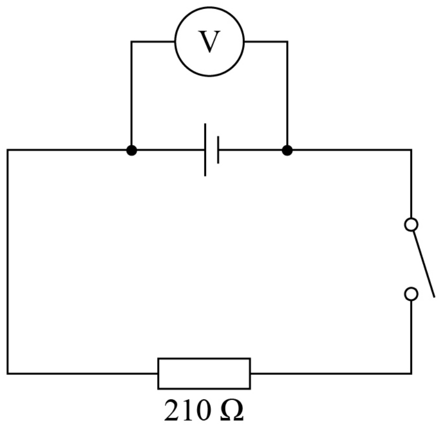
Do not write outside the box

Section A

Answer **all** questions in this section.

0 1 This question is about determining the internal resistance r of a cell of emf ε using three different methods.
Figure 1 shows a circuit that can be used to determine r.

Figure 1



The reading on the voltmeter is V.
The resistance of the fixed resistor in the circuit is $210\ \Omega$.

0 1 . 1 Describe how this circuit can be used to determine r.

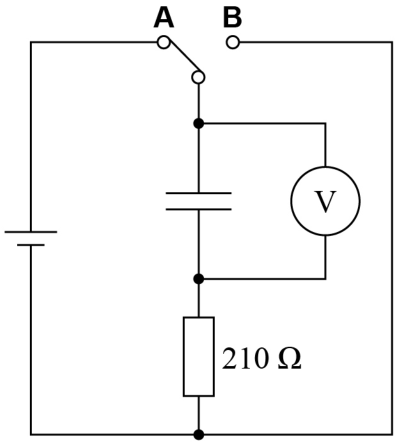
In your answer:
- state the measurements required
- explain how to calculate r.

You should not add any other components to the circuit.

[3 marks]

Figure 2 shows another circuit that uses the same cell, resistor and voltmeter.
A student uses the circuit to charge and discharge a capacitor to determine r.

Figure 2



When the switch is in position **A** the capacitor charges.

0 1 . 2 Explain why the value of r does not affect the voltage across the fully charged capacitor.

[2 marks]

____

____

____

____

____

____

____

____

Question 1 continues on the next page

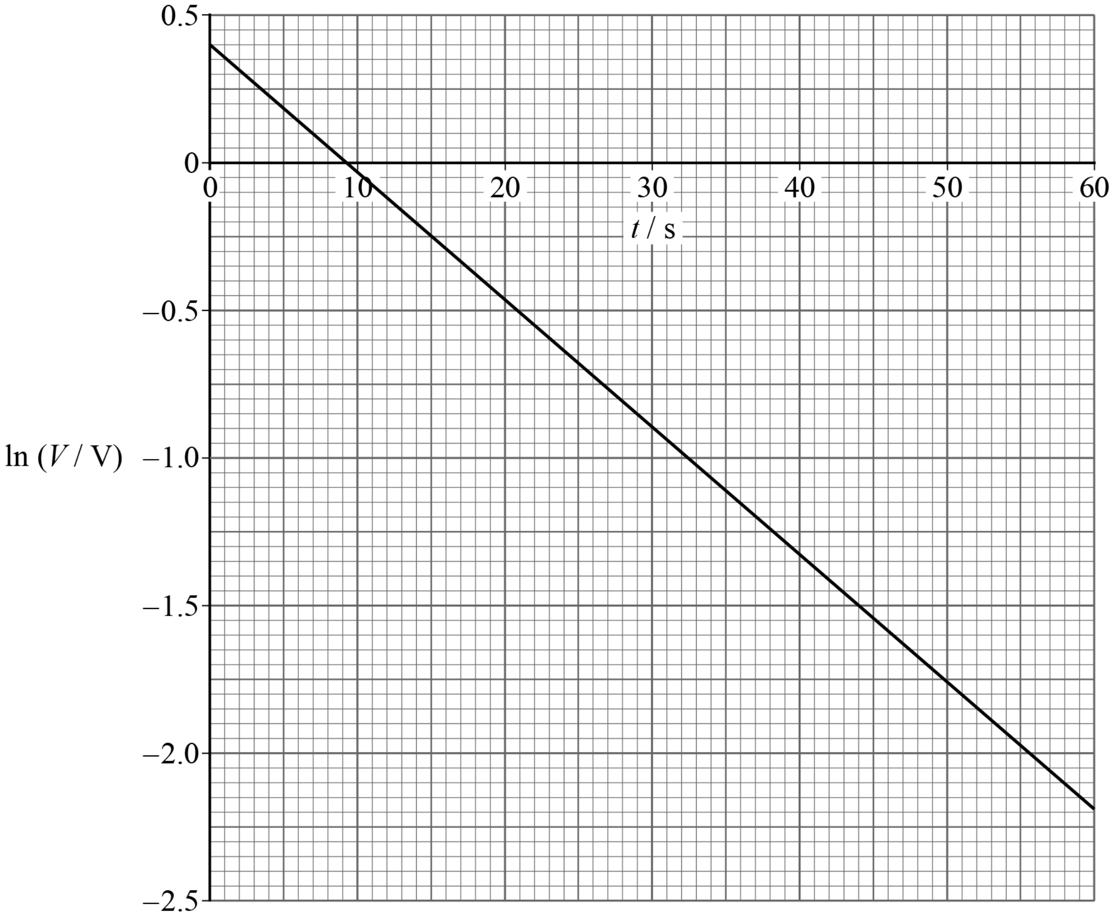
Do not write outside the box

The student moves the switch to position **B** and starts a stopwatch at time $t = 0$

The student measures the variation of V with time as the capacitor discharges.

Figure 3 shows the variation of $\ln (V / \mathrm{V})$ with t.

Figure 3



0 1 . 3 Determine the gradient of the line.

[2 marks]

gradient = ______________________

Do not write outside the box

0 1 . 4 Show that the capacitance of the capacitor is approximately $0.1\ \mathrm{F}$.

[1 mark]

Question 1 continues on the next page

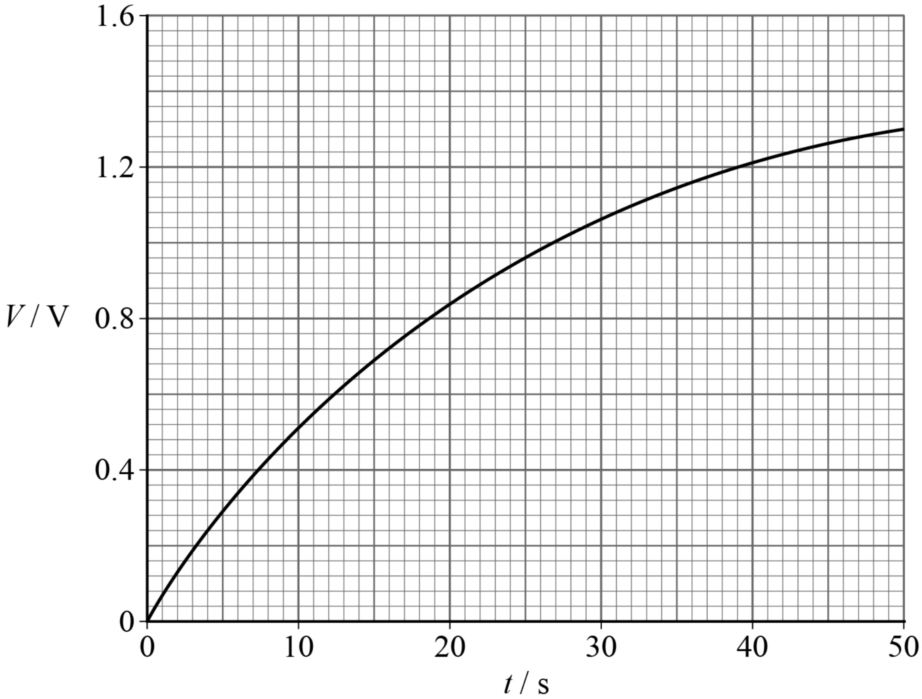
Do not write outside the box

0 1 . 5 The capacitor is fully discharged. The stopwatch is reset.

The student moves the switch back to position **A** in **Figure 2** and starts the stopwatch at time $t = 0$

Figure 4 shows the variation of V with t for the charging capacitor.

Figure 4



For a charging capacitor, the time constant is the time taken for the voltage to reach $\varepsilon(1 - e^{-1})$.

Determine r.

$\varepsilon = 1.5$ V

[3 marks]

$r =$ ____________________ Ω

Do not write outside the box

0 1 . 6 Another student uses the same capacitor and resistor to determine r.

The student uses the same method as in Question **01.5** but with a voltage sensor and datalogger instead of a voltmeter and stopwatch. The datalogger records the voltage at fixed time intervals.

The voltage sensor has a much lower resistance than the voltmeter.

Evaluate the use of the voltage sensor and datalogger, instead of the voltmeter and stopwatch, in the determination of r.

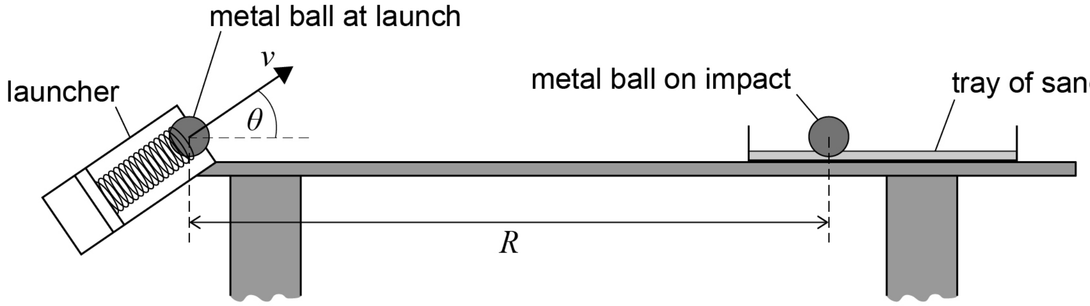
[3 marks]

14

Do not write outside the box

0 2 **Figure 5** shows an arrangement for measuring the horizontal distance R travelled by a metal ball launched into the air. The launch angle θ to the horizontal can be varied. The launch speed v of the ball is constant.

Figure 5



The ball lands in a tray of sand and leaves a mark in the sand. R is measured, with a metre ruler, from the end of the launcher to the middle of the mark in the sand.

Figure 6 shows part of the ruler and the marks left by the ball for five launches when $\theta = 20°$.

Figure 6

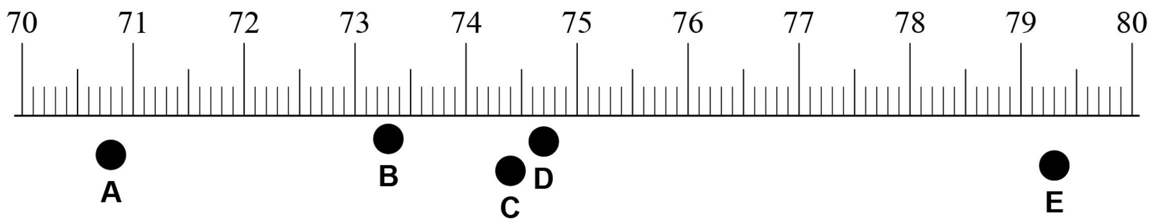


Table 1 shows the values of R for two of the marks.

Table 1

	A	B	C	D	E
***R* / m**			0.744	0.747	

0 2 . 1 Complete **Table 1**.

[1 mark]

Do not write outside the box

0 2 . 2 Determine the mean value of R and the uncertainty in R for $\theta = 20°$.
All the data are valid.

[2 marks]

mean value of $R =$ ____________________ m

uncertainty in $R = \pm$ ____________________ m

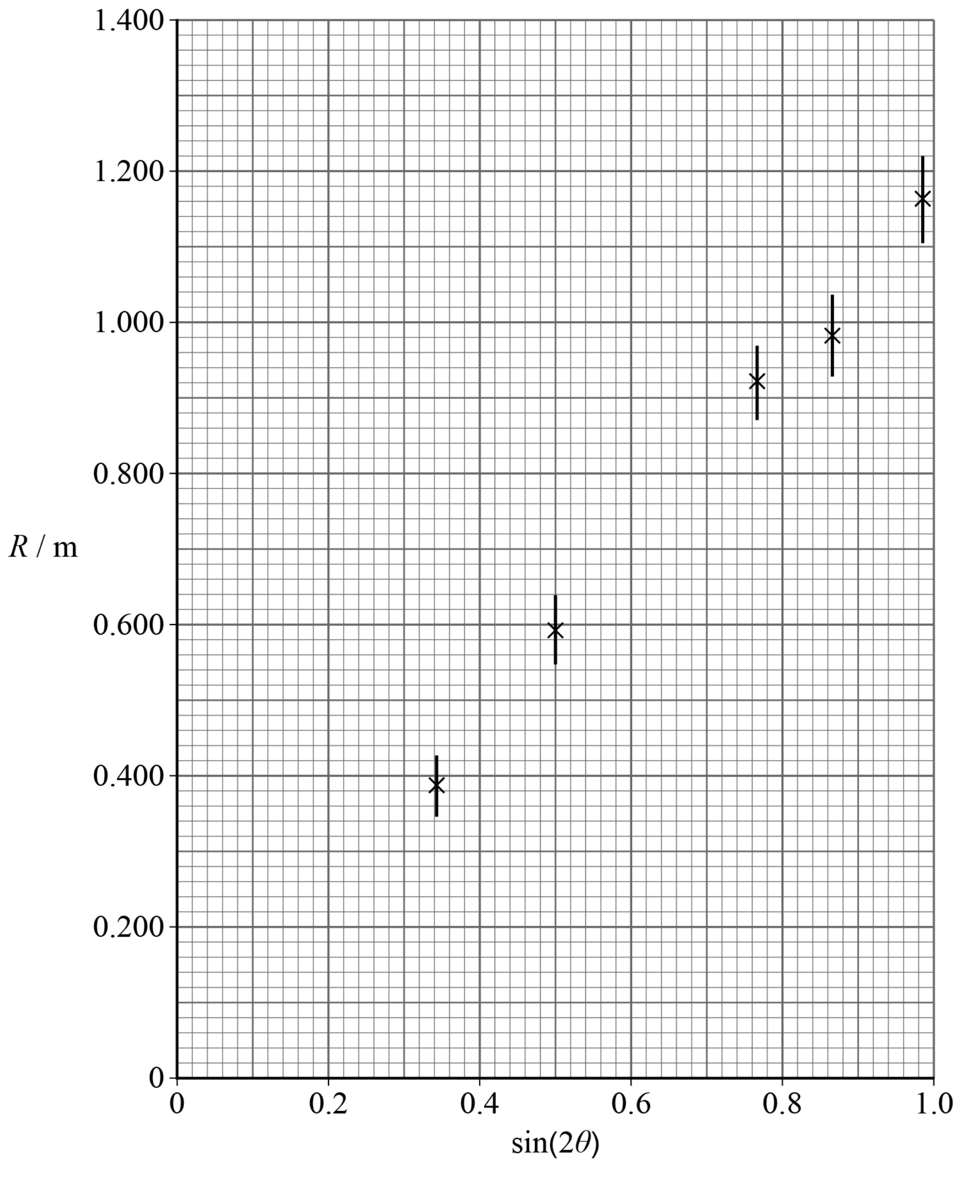
Question 2 continues on the next page

The ball is now launched at a range of values of θ. The mean value of R is determined for each value of θ.

Figure 7 shows the variation of R with $\sin(2\theta)$.

0 2 . 3 Draw a point and an error bar on **Figure 7** using the data in **Table 1** on page 8.
[2 marks]

Figure 7



Do not write outside the box

0 2 . 4 Determine the maximum and minimum gradients consistent with the error bars on **Figure 7**.

[3 marks]

maximum gradient = ______________________

minimum gradient = ______________________

R is given by

$$R = \frac{v^2 \sin(2\theta)}{g}$$

where v is the launch speed and g is the gravitational field strength.

0 2 . 5 Determine v using your answers to Question **02.4**.

[3 marks]

v = ______________________ $\mathrm{m\ s^{-1}}$

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 The percentage uncertainty in g is $\pm 0.4\%$.

Determine the percentage uncertainty in v.

[3 marks]

percentage uncertainty = ± ____________________ %

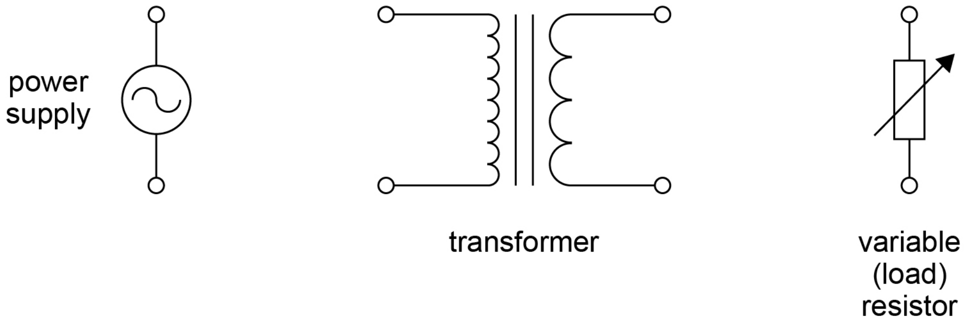
14

Do not write outside the box

0 3 This question is about an experiment to determine how the efficiency of a transformer varies with the load resistance.

Figure 8 shows an incomplete circuit diagram for this experiment that includes a variable ac power supply, a transformer and a variable (load) resistor.

Figure 8



0 3 . 1 Complete **Figure 8** to show the circuit that is used to take measurements in this experiment.

You should include the necessary measuring devices in the circuit.

[1 mark]

0 3 . 2 A student wants to plot a graph showing how the efficiency varies with the load resistance.

Describe how to use the equipment in your completed **Figure 8** to obtain the data for this graph.

[3 marks]

___

___

___

___

___

___

___

___

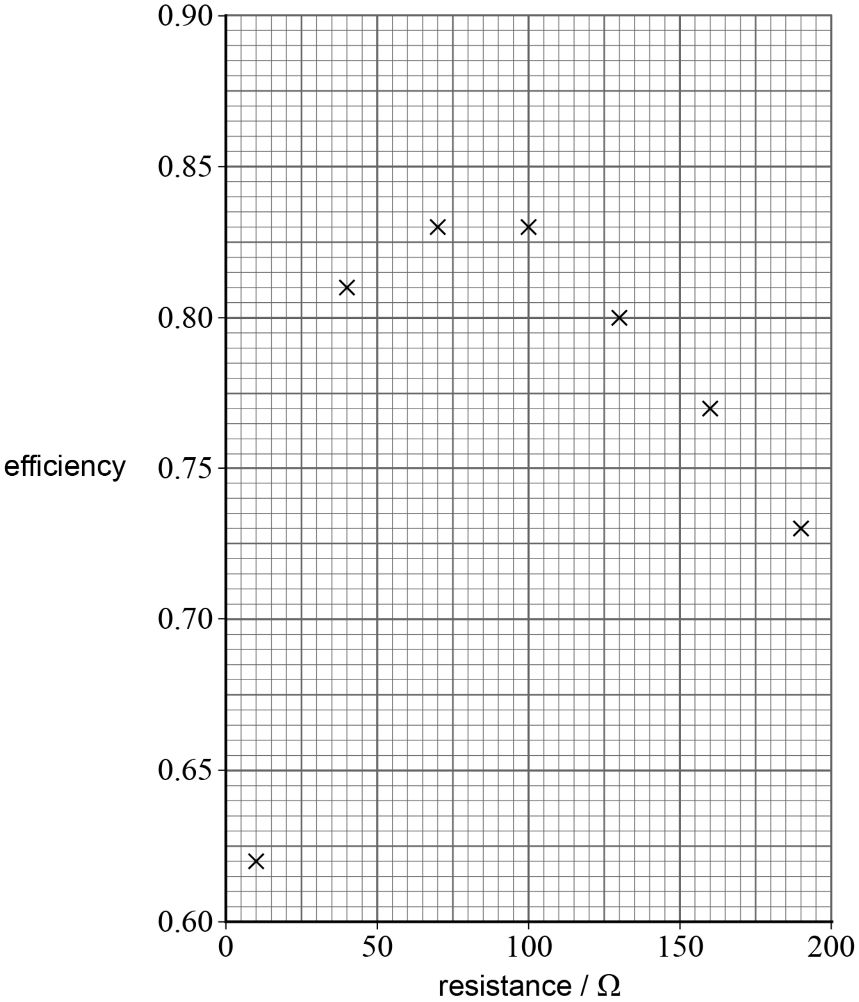
___

___

Question 3 continues on the next page

Figure 9 shows an incomplete graph of the variation of efficiency with load resistance.

Figure 9



0 3 . 3 Draw a line of best fit on **Figure 9**.

[1 mark]

R_M is the load resistance for which the transformer has maximum efficiency.

0 3 . 4 Determine R_M.

[1 mark]

R_M = ____________________ Ω

Do not write outside the box

0 3 . 5 Suggest how the data collection could be improved to find a more accurate value for R_{M}.

[2 marks]

8

END OF SECTION A

Turn over ►

Do not write outside the box

Section B

Answer **all** questions in this section.

0 4 When a filament lamp is operating normally, it has a power of 19 W and a voltage of 12 V across it.

The filament in the lamp is a thin metal wire made of tungsten. The wire has:

- a length of 16 mm
- a cross-sectional area of $1.66 \times 10^{-9} \text{ m}^2$.

0 4 . 1 Determine the resistivity of tungsten when the lamp is operating normally.

[2 marks]

resistivity = ____________________ $\Omega \text{ m}$

The temperature of the filament is $2700\ \mathrm{K}$ when the lamp is operating normally.

Before the lamp is connected across a battery, the filament is initially at a temperature of $300\ \mathrm{K}$.
The lamp is now connected across a battery of negligible internal resistance and emf $12\ \mathrm{V}$.
The temperature of the filament increases from $300\ \mathrm{K}$ to $2700\ \mathrm{K}$ in a time t.

0 4 . 2 The specific heat capacity of tungsten is $133\ \mathrm{J\ kg^{-1}\ K^{-1}}$.
The density of tungsten is $1.9 \times 10^{4}\ \mathrm{kg\ m^{-3}}$.

Estimate t.
Assume that while the temperature of the filament increases to $2700\ \mathrm{K}$:
- the resistance of the filament remains constant
- the energy transferred to the surroundings is negligible.

[4 marks]

$t =$ ______________________ s

0 4 . 3 The energy transferred to the surroundings is negligible due to the small value of t.
However, the resistance of the filament does **not** remain constant.

Discuss how the actual value of t will be different from your answer to Question **04.2**.
[2 marks]

____

____

____

____

____

____

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 The lamp is now connected across an ac voltage supply and is operating normally.

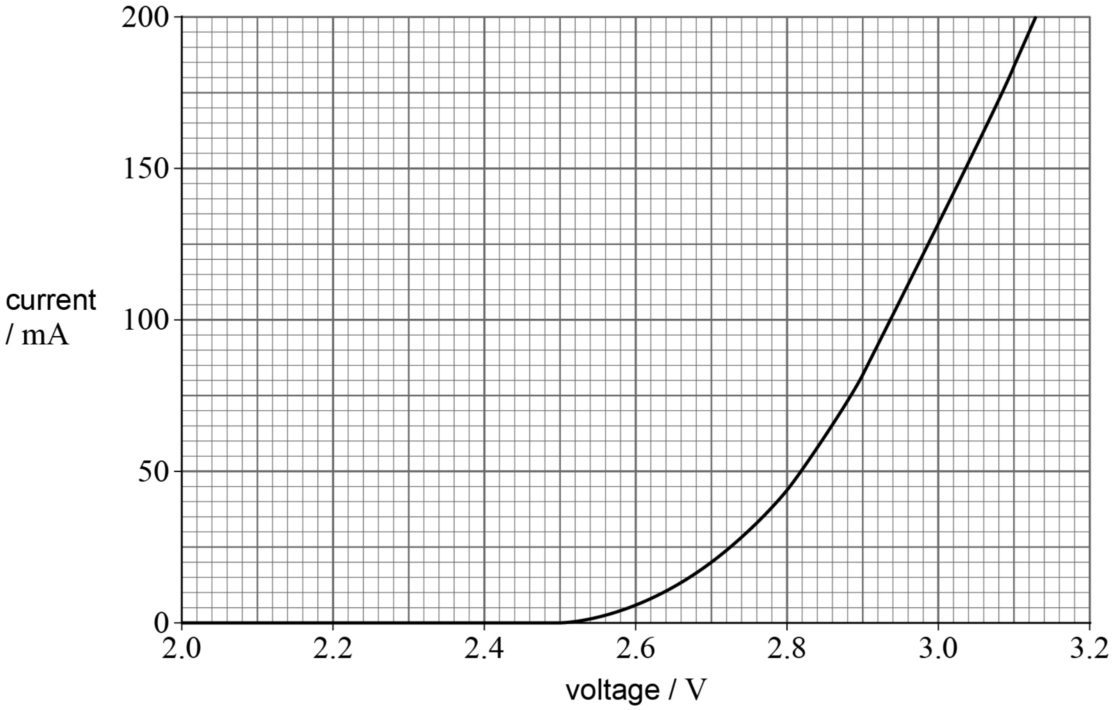
Calculate the peak voltage across the lamp.

[1 mark]

peak voltage = ____________________ V

Modern lamps often contain a light-emitting diode (LED) rather than a filament.
Figure 10 shows part of the current–voltage characteristic for an LED.

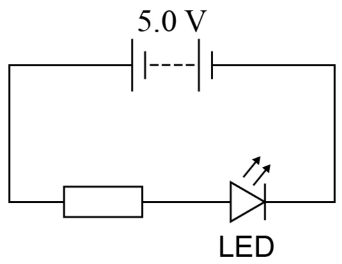
Figure 10



Do not write outside the box

Figure 11 shows the LED in a circuit. The battery has an emf of 5.0 V and negligible internal resistance.

Figure 11



0 4 . 5 The voltage across the LED in **Figure 11** is 2.8 V.

Determine the resistance of the resistor in **Figure 11**.

[2 marks]

resistance = ____________________ Ω

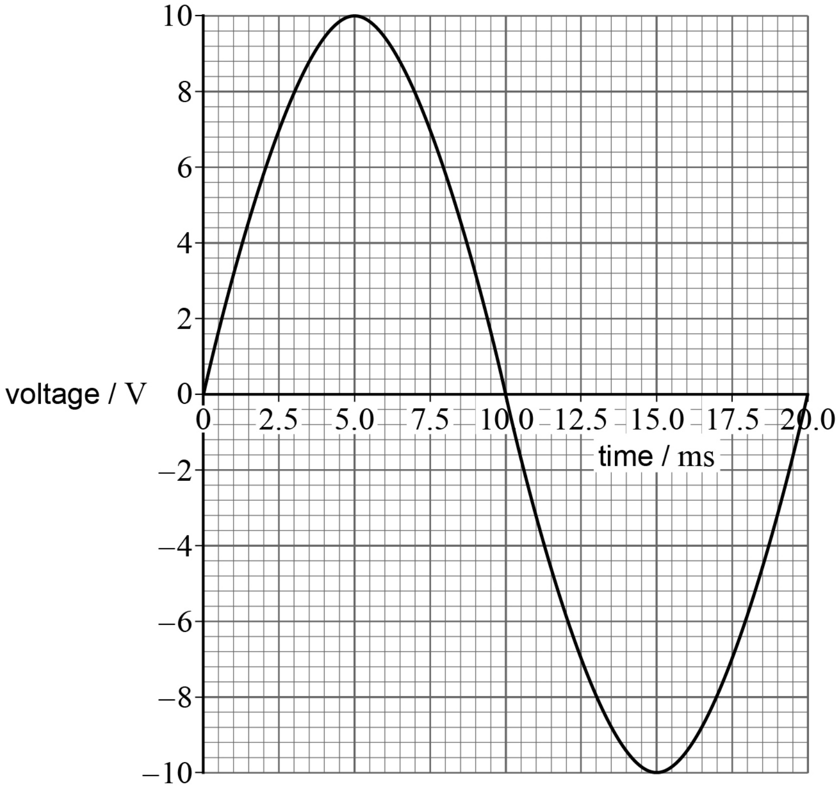
Question 4 continues on the next page

Do not write outside the box

0 4 . 6 The 5.0 V battery in **Figure 11** is replaced with an ac supply. The supply has negligible internal resistance.

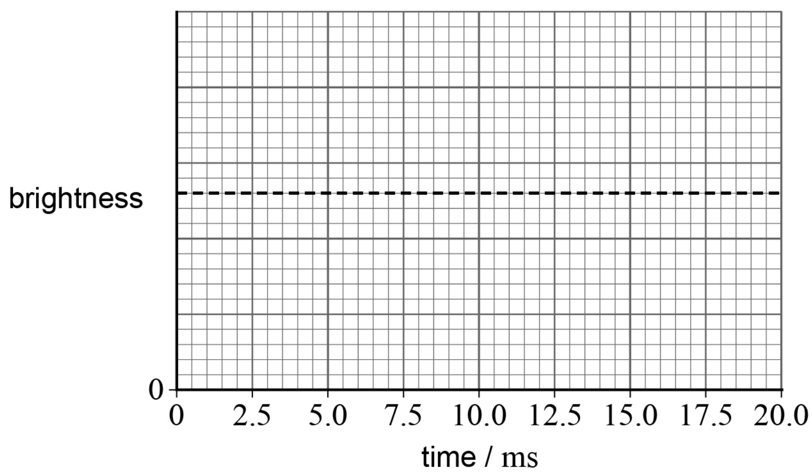
Figure 12 shows the variation of voltage with time for this ac supply.

Figure 12



The dashed line in **Figure 13** shows the variation of the brightness of the LED with time when connected to the 5.0 V battery and resistor as shown in **Figure 11**.

Figure 13



Sketch on **Figure 13** the variation of the brightness of the LED with time when connected to the ac power supply.

Do **not** add a scale to the brightness axis.

[4 marks]

Do not write outside the box

15

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

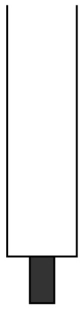
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 Air springs are used in some car suspension systems. A syringe consisting of a plunger inside a cylindrical barrel can be used to model an air spring.

Figure 14 shows the barrel of the syringe.

Figure 14



The internal diameter of the barrel is measured as $42.0\ \mathrm{mm}$.

0 5 . 1 Suggest a suitable measuring instrument to measure the internal diameter of the barrel.

[1 mark]

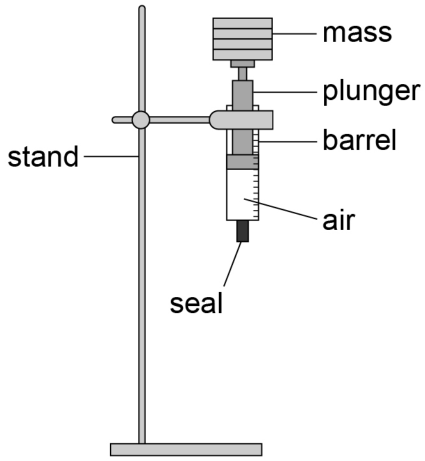
____

____

Question 5 continues on the next page

Figure 15 shows a model of an air spring using the syringe.

Figure 15



A pressure sensor is placed inside the syringe. The syringe is filled with air and sealed at the bottom.

Initially the mass on top of the plunger is $0.100\ \text{kg}$.

The absolute pressure inside the syringe is $1.007 \times 10^{5}\ \text{Pa}$.

The volume of air in the syringe is $8.94 \times 10^{-5}\ \text{m}^{3}$.

The mass is then increased to $0.200\ \text{kg}$ and the pressure increases to $1.014 \times 10^{5}\ \text{Pa}$.

For the masses used in this experiment,

$$W = k\Delta L$$

where:

W is the weight of the mass on top of the plunger
ΔL is the change in length of the column of air in the syringe due to W
k is the spring constant of the model air spring.

Do not write outside the box

0 5 . 2 Determine k.

State any assumptions that you make.

[4 marks]

$k =$ ____________________ $\mathrm{N\ m^{-1}}$

0 5 . 3 The experiment is repeated but with a smaller amount of air inside the syringe.

Atmospheric pressure remains the same.

Explain how this change affects the spring constant.

[2 marks]

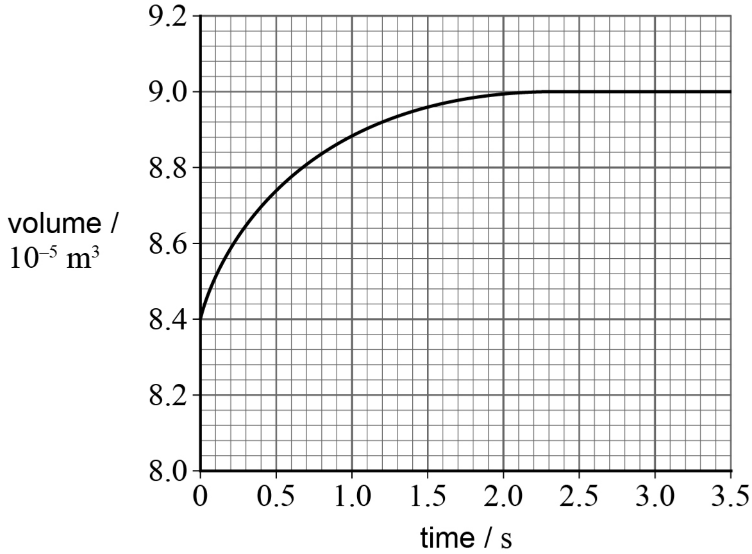
Question 5 continues on the next page

Do not write outside the box

0 5 . 4 The mass on the plunger is now increased to $1.000\ \mathrm{kg}$.

All of the mass is then removed quickly from the top of the plunger. **Figure 16** shows the variation of the volume of air with time after the mass is removed.

Figure 16



Explain why the plunger does not oscillate when the $1.000\ \mathrm{kg}$ mass is removed.

[2 marks]

____

____

____

____

____

____

A real air spring contains a fixed mass of trapped air.

When no force is applied to the air spring, the pressure of this air is 1.01×10^{5} Pa and its volume is 5.00×10^{-4} m^3.

The temperature of this air is 21 °C.

0 5 . 5 Determine, in mol, the amount of trapped air.

[2 marks]

amount of trapped air = ____________________ mol

Question 5 continues on the next page

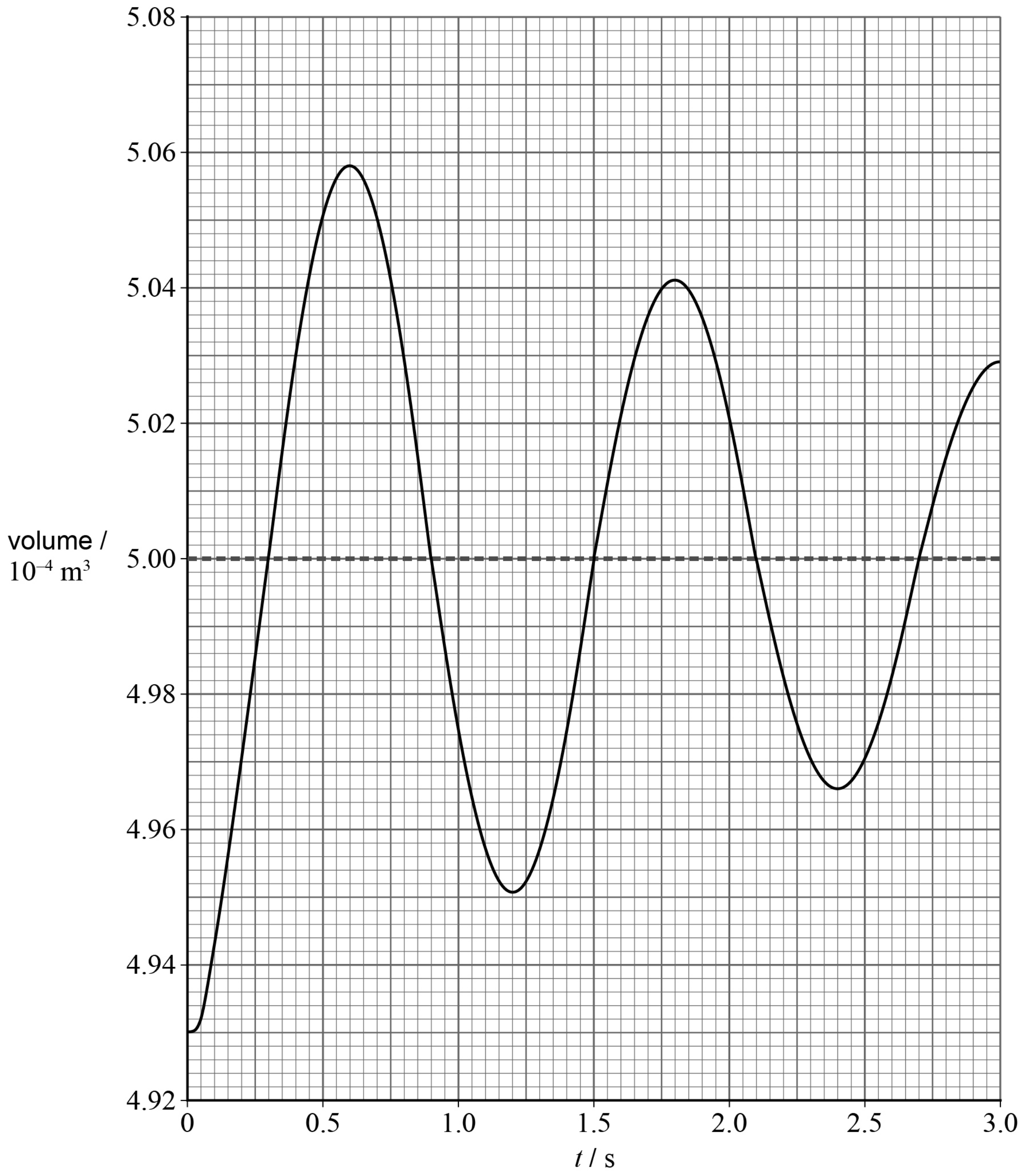
Do not write outside the box

0 5 . 6 The trapped air is compressed by applying a force. The force is then removed at time $t = 0$

The air spring oscillates about its equilibrium volume of 5.00×10^{-4} m^3.

Figure 17 shows the variation of the volume of air in the air spring with t as the air spring oscillates. The dashed line shows the equilibrium volume.

Figure 17



Determine whether this variation of amplitude with time is exponential.

[3 marks]

14

Turn over for the next question

0 6 **Figure 18** shows a system used to safely lower a lifeboat into the sea from the side of a ship. The brake in this system limits the speed at which the lifeboat can be lowered.

Figure 18

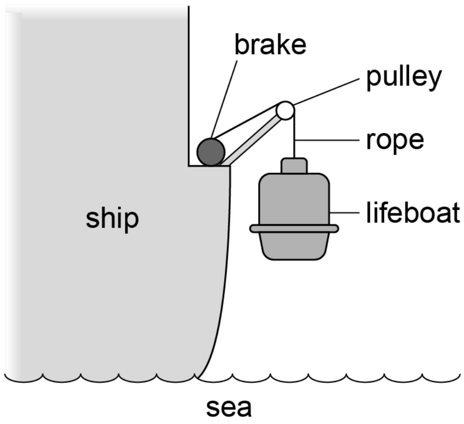
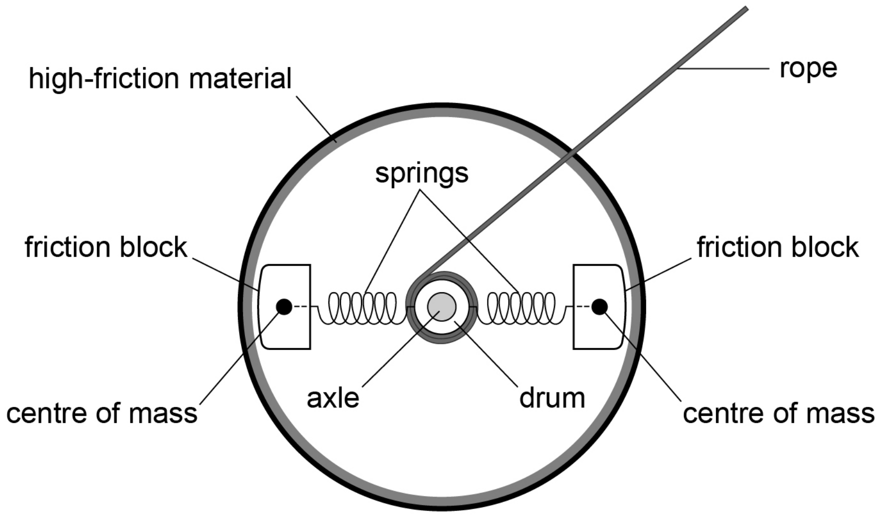


Figure 19 shows the design of the brake. A drum rotates freely around an axle. The rope is wrapped around the drum and does not slip.

Figure 19



A spring is attached to each friction block at its centre of mass. This pulls each friction block inwards towards the centre of the axle.

As the drum rotates, the friction blocks also rotate and move outwards.

When the drum reaches a certain angular speed, the friction blocks press against the high-friction material. This slows down the drum.

The high-friction material does not rotate.

0 6 . 1 Explain why the friction blocks move outwards as the drum increases in speed.

[3 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 Each friction block has a mass of $125\ \mathrm{g}$.

Each spring has a spring constant of $210\ \mathrm{N\ m^{-1}}$.

When the lifeboat is being lowered at its maximum speed, the friction blocks are just in contact with the high-friction material but there is negligible frictional force applied. The extension of each spring is $5.5\ \mathrm{cm}$.

The distance from the centre of mass of each friction block to the centre of the axle is $10.3\ \mathrm{cm}$.

The radius of the drum is $2.1\ \mathrm{cm}$ and the rope is of negligible thickness.

Determine the maximum speed of the rope.

[4 marks]

maximum speed = ____________________ $\mathrm{m\ s^{-1}}$

Do not write outside the box

0 6 . 3 The acceleration of the lifeboat is always less than $9.81\ \mathrm{m\ s^{-2}}$, even when the friction blocks are not in contact with the high-friction material.

Explain why.

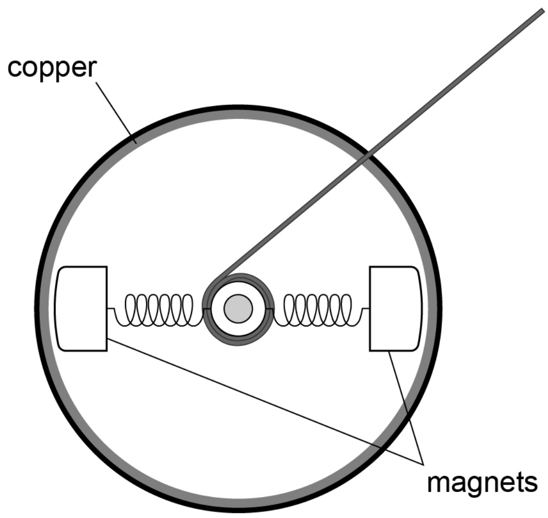
[3 marks]

Question 6 continues on the next page

0 6 . 4 **Figure 20** shows another design for the brake where:

- the friction blocks have been replaced by magnets
- the high-friction material has been replaced by a thick layer of copper.

Figure 20



Do not write outside the box

As the rope accelerates, the magnets move outwards so that they move close to the copper but do not touch it. There is no friction acting.

Explain how the magnets apply a braking force to the drum.

Refer to **two** laws of induction in your answer.

[5 marks]

15

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Do not write outside the box

There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**