

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL AS PHYSICS

Unit 2 Electricity, waves and particles

Tuesday 12 May 2026

08:00 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 question 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	
7	
8	
9	
10	
11	
12–25	
TOTAL	



Section AAnswer **all** questions in this section.**0 1**

State the unit for potential difference in fundamental (base) units.

[1 mark]

unit = _____

1**0 2**

Progressive transverse waves are present on the surface of the ocean.

A particular ocean wave has a wavelength of 72 m, an amplitude of 3.0 m and a time period of 8.7 s.

0 2 . 1

Calculate the speed of the wave.

[1 mark]speed = _____ m s⁻¹**0 2 . 2**

A floating piece of wood moves vertically up and down as the wave travels.

Calculate the distance travelled by the wood in a time of 8.7 s.

[1 mark]

distance = _____ m

2

0	3	.	1
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Describe how the resistance of a negative temperature coefficient (ntc) thermistor varies with temperature.

[1 mark]

0	3	.	2
---	---	---	---

Lead is a metal superconductor with a critical temperature of $-266\text{ }^{\circ}\text{C}$.

Describe how the resistivity of lead varies with temperature from $-273\text{ }^{\circ}\text{C}$ to room temperature.

You may sketch a graph as part of your answer.

[3 marks]

4

Turn over ►



0 4

Monochromatic light of wavelength 4.8×10^{-7} m is incident normally on a diffraction grating.

A screen is at a perpendicular distance of 0.62 m from the diffraction grating. The distance between the central maximum and the first-order maximum on the screen is 88.2 mm.

Calculate the angle between the third-order maximum and the central maximum.

[3 marks]

angle = _____ °

3

0 5 . 1

State Ohm's law.

[2 marks]



0 5 . 2

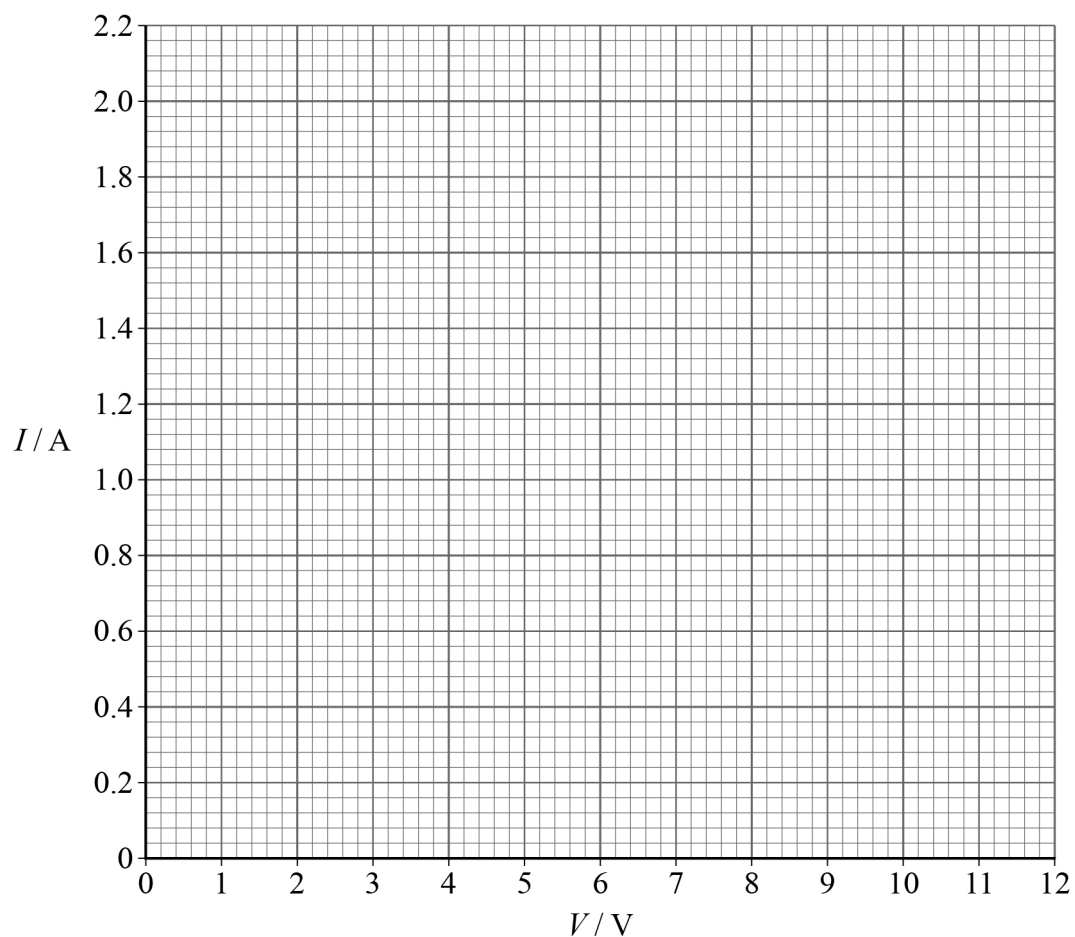
A filament lamp operates at a power of 24 W when there is a potential difference of 12 V across it.

When there is a current of 1.0 A in the lamp, it has a resistance of $2.0\ \Omega$.

Draw, on **Figure 1**, the I - V characteristic of the lamp between 0 and 12 V. Show clearly any points you have calculated.

[3 marks]

Figure 1



0 6

Monochromatic light of frequency f_A is incident on a metal plate. Electrons with a maximum kinetic energy of 2.8×10^{-19} J are emitted from the plate.

The metal has a work function of 2.3 eV.

0 6 . 1

Calculate f_A .

[2 marks]

$f_A =$ _____ Hz

0 6 . 2

Calculate the minimum de Broglie wavelength of the emitted electrons.

[2 marks]

minimum de Broglie wavelength = _____ m

0 6 . 3

When monochromatic light of frequency f_B is incident on the plate, electrons are **not** emitted.

Explain why electrons are **not** emitted.

[3 marks]



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ANSWER IN THE SPACES PROVIDED**

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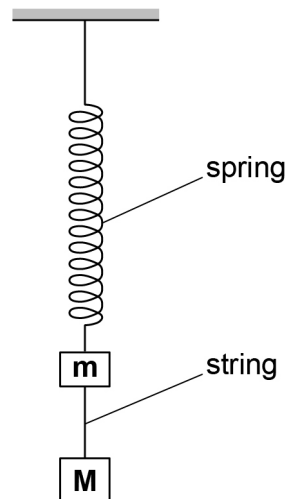


0 7

Figure 2 shows a spring suspended vertically with two masses **m** and **M** suspended from it. The masses are connected by a string that does not stretch.

Throughout this question the spring does not exceed its elastic limit.

Figure 2



The masses of the spring and the string are negligible.

The system is initially at rest. The extension of the spring is 0.055 m.

mass of **m** = 0.12 kg
spring constant = 57 N m⁻¹

0 7 . 1

Calculate the mass of **M**.

[1 mark]

mass = _____ kg



The string is cut so that **M** is removed. This causes **m** to oscillate vertically.

0 7 . 2 Calculate the initial amplitude of the oscillation.

[2 marks]

amplitude = _____ m

0 7 . 3 Calculate the frequency of the oscillation.

[2 marks]

frequency = _____ Hz

0 7 . 4 The experiment is repeated with the same spring and **m**, but **M** is replaced with a greater mass.

Explain the effect of this change on the amplitude and the frequency of the oscillation of **m**.

[3 marks]

effect on amplitude _____

effect on frequency _____



0 8 . 1 The emf of a cell is 1.5 V.

Explain what is meant by this statement.

[1 mark]

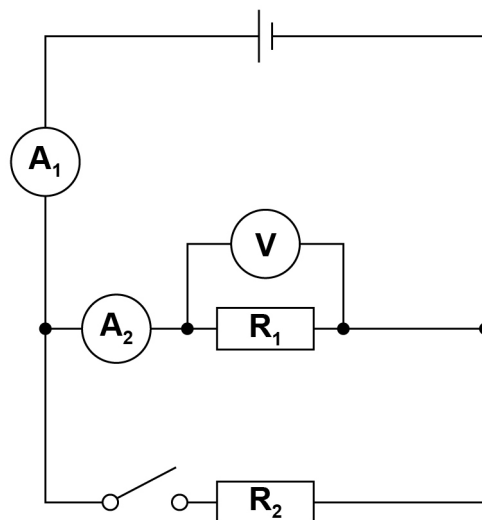
0 8 . 2 A cell with internal resistance is in a circuit.

Describe how to determine an accurate value of the emf of the cell using a single measurement.

[2 marks]

0 8 . 3 **Figure 3** shows a circuit containing a cell that has significant internal resistance.

Figure 3



Then the switch is closed.

[6 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

0	9
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A signal is sent along an optical fibre made of glass.
The signal is made up of a series of pulses of monochromatic light.

Figure 4 shows the signal as it enters the fibre.

Figure 5 shows the signal as it leaves the fibre.

The fibre does **not** have cladding.

Figure 4

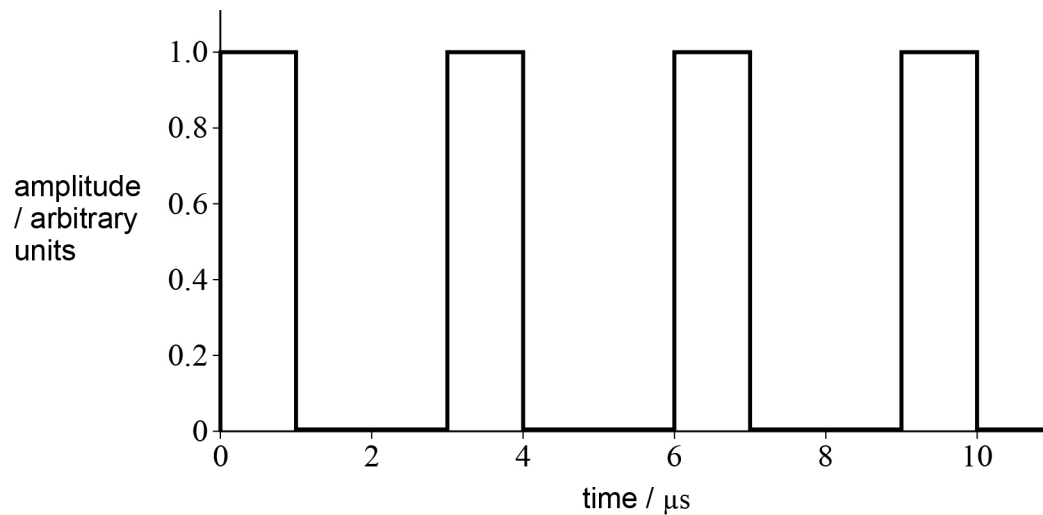
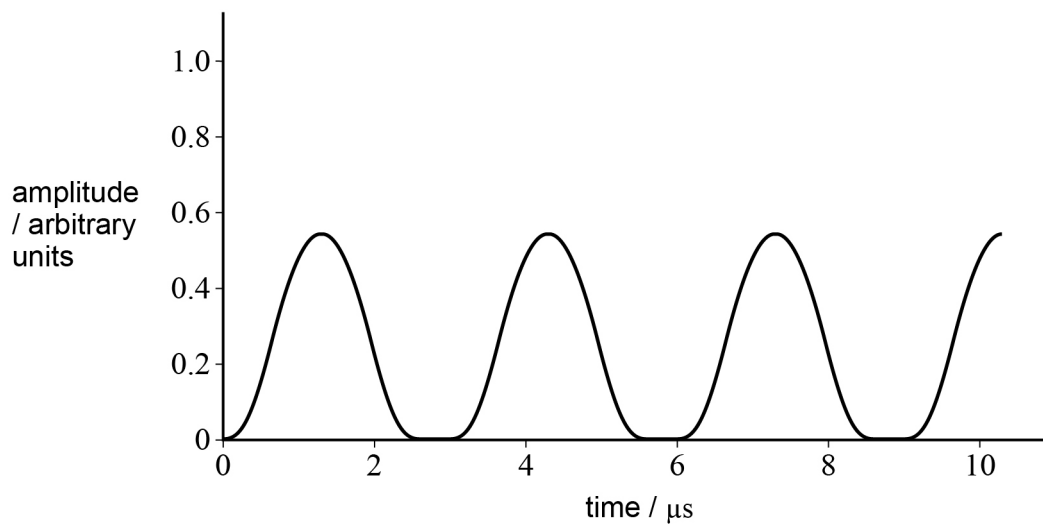


Figure 5



The time difference Δt between the times taken for light to travel along the longest path and the shortest path in the fibre is $1.6 \mu\text{s}$.

The pulses are broadened and reduced in amplitude due to modal dispersion and other effects.

0 9 . 1

Suggest **one** other effect that contributes to the reduction in amplitude.

[1 mark]

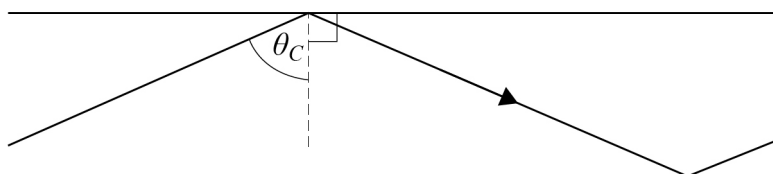
Question 9 continues on the next page

Turn over ►



Figure 6 shows part of the longest path taken by the light. In this path, light is incident on the glass–air boundary at the critical angle θ_C .

Figure 6



The shortest path is parallel to the fibre.

The length of the fibre is D .

The speed of light in the fibre is v .

0 9 . 2 Show that Δt is given by

$$\Delta t = \frac{D}{v} \left(\frac{1}{\sin \theta_C} - 1 \right)$$

[2 marks]

0 9 . 3 The refractive index of the glass in the fibre is 1.46

Calculate D .

$$\Delta t = 1.6 \mu\text{s}$$

[3 marks]

$$D = \text{_____ m}$$



The fibre is replaced with a new fibre of the same length.

The new fibre has cladding.

The glass core of the new fibre has the same thickness and refractive index as the original fibre.

0 9 . 4

Explain how the cladding improves the transmission of data in the optical fibre.

[3 marks]

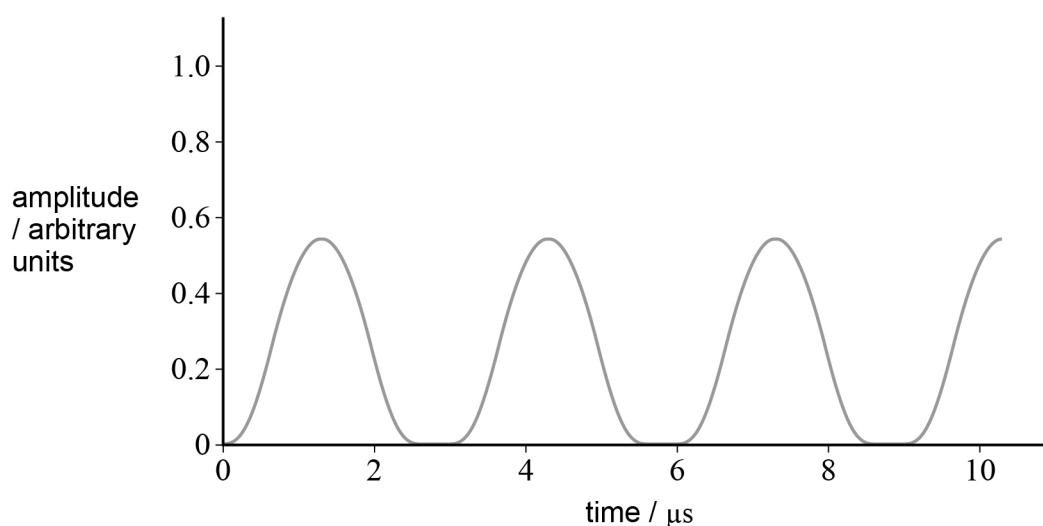
0 9 . 5

Figure 7 shows the signal as it leaves the original fibre, as shown in **Figure 5** on page 12.

Sketch, on **Figure 7**, the signal as it leaves the new fibre.
Calculations are not required.

[2 marks]

Figure 7



11

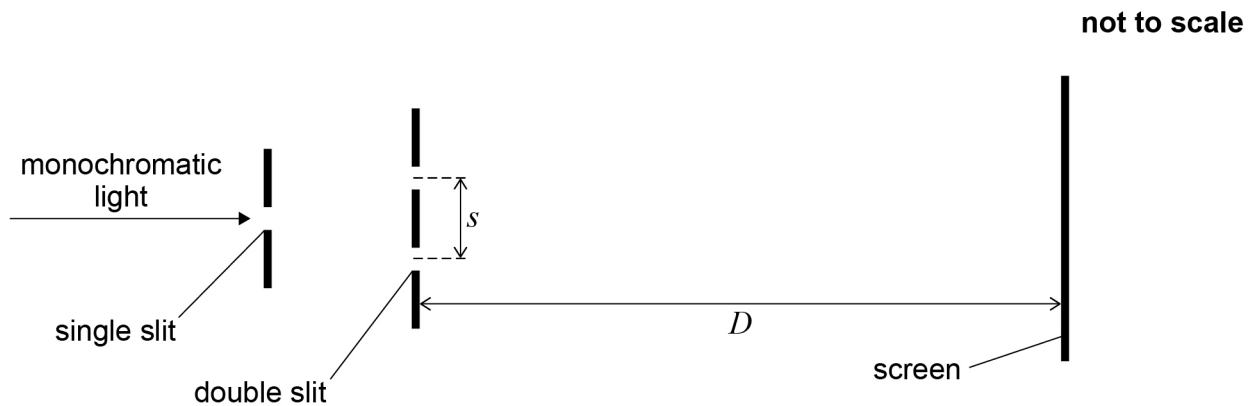
END OF SECTION A

Turn over ►



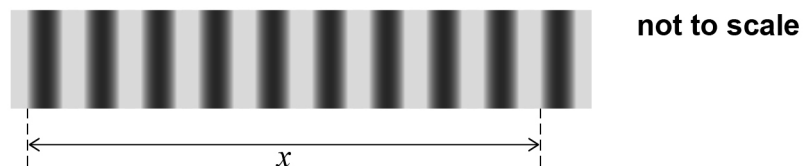
Section BAnswer **all** questions in this section.**1 0**

Some students use a Young's double slit experiment to determine the wavelength of a monochromatic light. A diagram of their experiment is shown in **Figure 8**.

Figure 8

D is the perpendicular distance between the double slit and the screen.

Figure 9 shows the fringe pattern seen on the screen.

Figure 9

Each student measures the distance x shown in **Figure 9**.

Table 1 shows the students' data.

Table 1

x / mm	39.1	38.4	38.7	43.2	38.6	39.6
-----------------	------	------	------	------	------	------

1 0 . 1

Determine the fringe separation w .**[2 marks]** $w =$ _____ mm

1 0 . 2

Determine the percentage uncertainty in w .**[2 marks]**

percentage uncertainty = _____

The students determine D to be 315 ± 1 cm.The slit spacing s is 0.40 mm $\pm 5\%$.

1 0 . 3

Determine, in nm, the wavelength λ .**[1 mark]** $\lambda =$ _____ nm

1 0 . 4

Determine the percentage uncertainty in λ .**[2 marks]**

percentage uncertainty = _____

7

Turn over ►

1 1

A student is investigating polarisation.

Unpolarised light passes through two polarising filters into a light sensor along a line **XY**.

The first filter is fixed. The second filter is rotated about **XY** as shown in **Figure 10**.

Figure 10

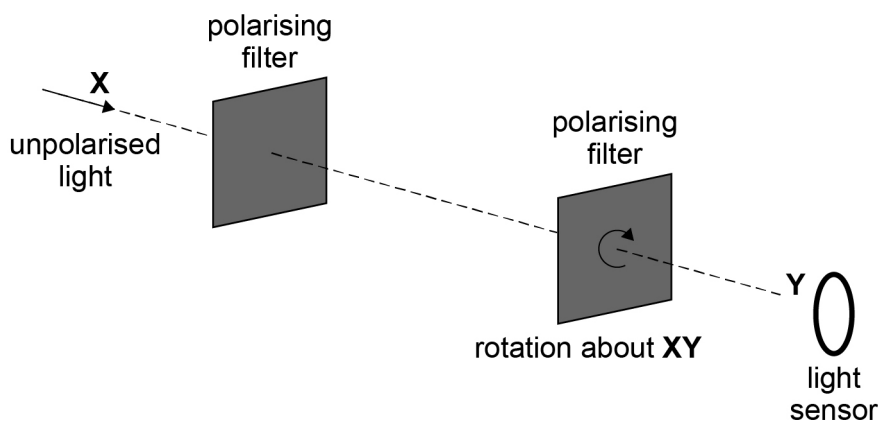
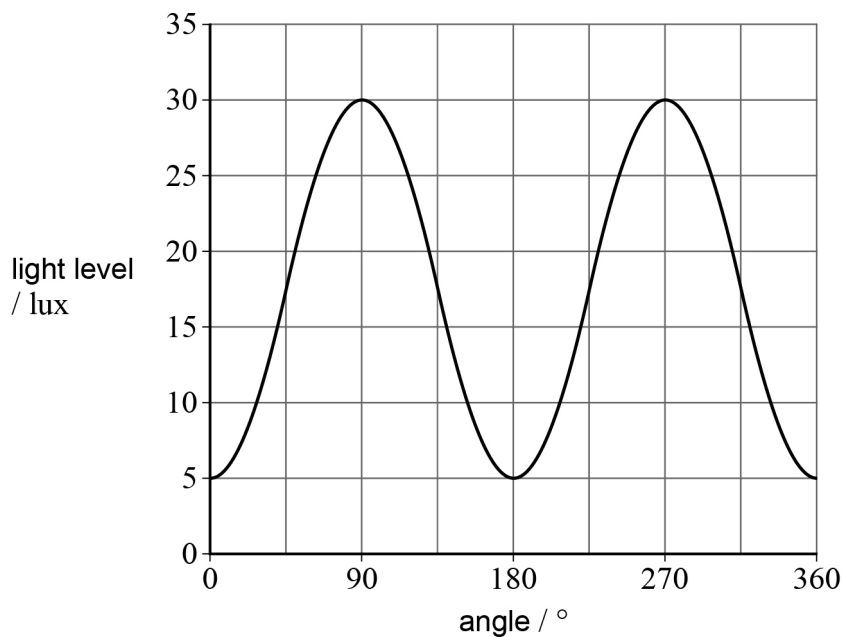


Figure 11 shows the variation of light level incident on the sensor with the angle of the second filter. The light level is measured in units called lux.

Figure 11



1 1 . 1

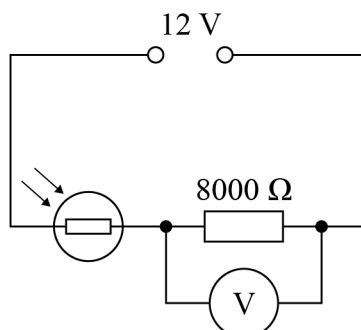
Explain the variation of light level shown in **Figure 11**.

[1 mark]

The light sensor was made by the student using a light dependent resistor (LDR) in the circuit shown in **Figure 12**.

The sensor uses a fixed-voltage power supply with negligible internal resistance.

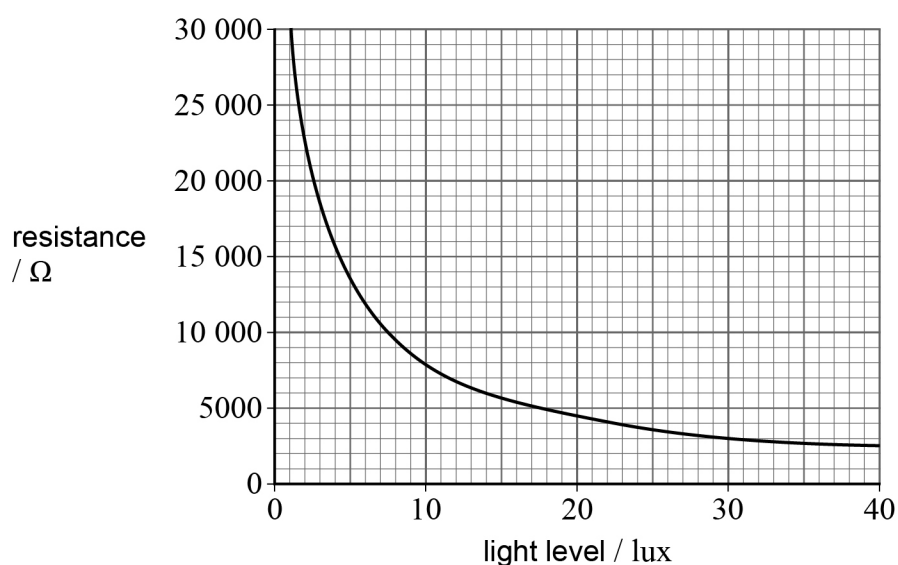
Figure 12



The student observes the reading on the voltmeter in order to determine the light level.

Figure 13 shows the variation of the resistance of the LDR with incident light level.

Figure 13



1 1 . 2 Explain why the reading on the voltmeter increases as the light level increases.

[2 marks]

Question 11 continues on the next page

Turn over ►



1	1	.	3
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Calculate the maximum voltage shown by the voltmeter during the rotation of the second filter.

Use data from **Figures 11, 12 and 13**, on pages 18 and 19.

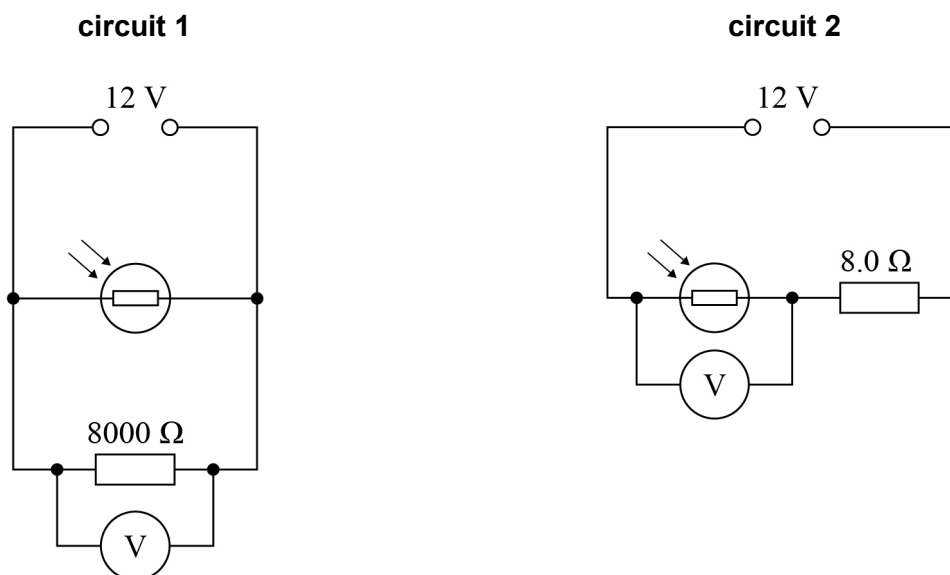
[3 marks]

maximum voltage = _____ V



1 1 . 4

Figure 14 shows two different circuits **1** and **2** that are **not** suitable for use in the light sensor. Each circuit uses the same voltage supply and the same LDR as in **Figure 12**.

Figure 14

Explain why the two circuits shown in **Figure 14** are **not** suitable for the light sensor. Calculations are not required.

[3 marks]

circuit 1 _____

circuit 2 _____

END OF SECTION B**Turn over ►**

Section C

Each of the questions in this section is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.

For each question, completely fill in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked.
Do **not** use additional pages for this working.

1 2 A metal wire of diameter d and length L has resistance R .

A second wire of the same metal has length $4L$ and resistance $2R$.

What is the diameter of the second wire?

[1 mark]

A $\frac{d}{2}$ ☐

B $\frac{d}{\sqrt{2}}$ ☐

C $\sqrt{2}d$ ☐

D $2d$ ☐



1 3

The voltage across a variable resistor is 250 V and the power dissipated is measured.

The voltage is reduced to 200 V and the resistance is adjusted so that the power dissipated is the same as before.

What is the percentage change in the resistance?

[1 mark]

A 20% ☐

B 36% ☐

C 56% ☐

D 64% ☐

Turn over for the next question

Turn over ►

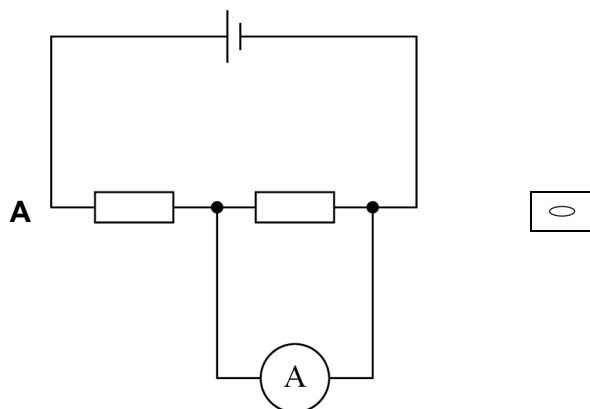
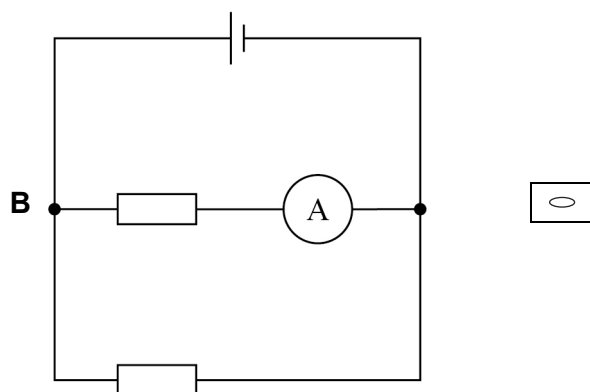
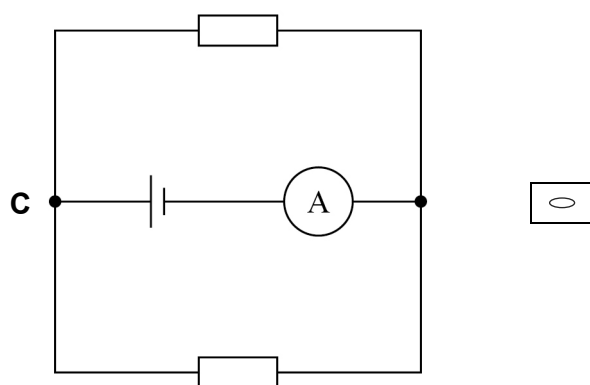
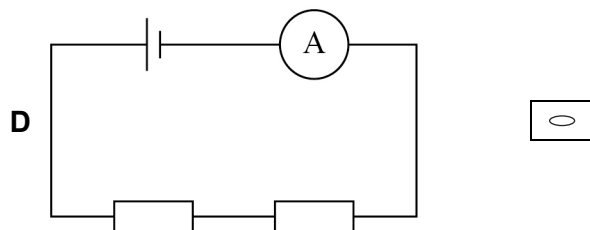


1 4

Two identical resistors, a cell and an ammeter are arranged into four different circuits. The internal resistance of the cell and the resistance of the ammeter are negligible.

In which circuit does the ammeter show the largest current?

[1 mark]



1 5

When a periodic driving force is applied to an object, the object resonates with a constant amplitude. There is a small damping force on the motion.

The frequency of the driving force is increased.

Which statement is correct?

[1 mark]

A The amplitude does not change.

☐

B The amplitude increases to a larger value.

☐

C The amplitude decreases to a smaller non-zero value.

☐

D The amplitude decreases to zero.

☐
1 6

Which statement about the damping force acting on an oscillating system is **not** correct?

[1 mark]

A It does work on the oscillator.

☐

B It removes energy from the system.

☐

C It is in the same direction as the velocity.

☐

D It reduces the amplitude.

☐
1 7

A string has a mass per unit length μ and a first-harmonic frequency f .

A second string has the same length and the same tension as the first string but has a first-harmonic frequency $\frac{f}{4}$.

What is the mass per unit length of the second string?

[1 mark]

A 16μ

☐

B 4μ

☐

C $\frac{\mu}{4}$

☐

D $\frac{\mu}{16}$

☐
Turn over ►

1 8

A string is fixed at both ends. It vibrates at its fifth harmonic.

What is the phase difference between the displacement of a particle at the centre of the string and at a quarter of the way along the string?

[1 mark]

A 0 ☐

B $\frac{\pi}{2}$ rad ☐

C $\frac{5\pi}{4}$ rad ☐

D π rad ☐

1 9

A stationary wave forms when a wave travelling in one direction on a string superposes with its reflected wave.

Energy is lost during reflection at the end of the string.

Which statement describes the effect of the energy loss on the stationary wave?

[1 mark]

A The antinodes no longer form. ☐

B There is non-zero amplitude at the nodes. ☐

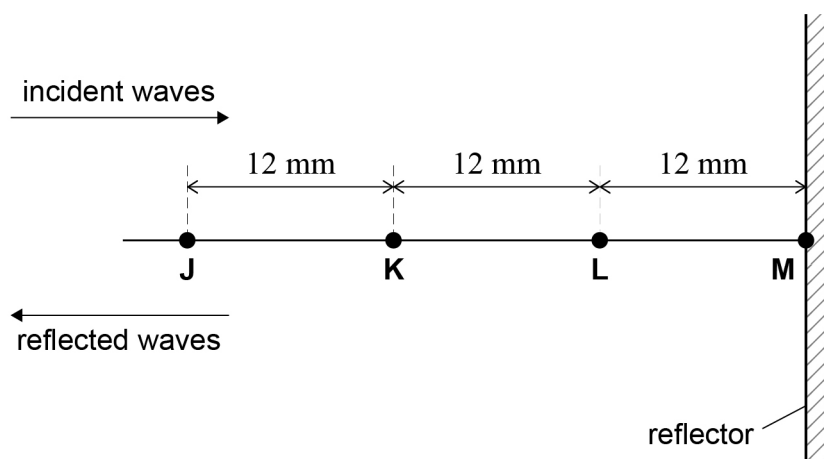
C The distance between nodes decreases. ☐

D The speed of the wave on the string decreases. ☐



2 0

Plane waves from a microwave transmitter are incident normally on a reflector, as shown.



Adjacent minima of microwave intensity are detected at positions **J**, **K**, **L** and **M**.

What is the frequency, in GHz, of the microwaves?

[1 mark]

- A** 4.0 ☐
- B** 6.0 ☐
- C** 13 ☐
- D** 25 ☐

2 1

Which statement is correct for electromagnetic waves in a vacuum?

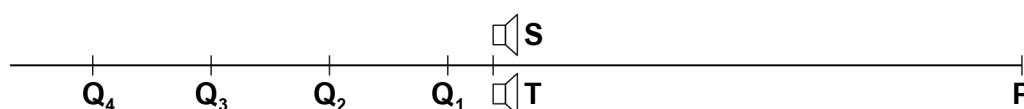
[1 mark]

- A** The wave speed is inversely proportional to the wavelength. ☐
- B** The wave speed is directly proportional to the frequency. ☐
- C** The frequency is directly proportional to the wavelength. ☐
- D** The frequency is inversely proportional to the wavelength. ☐



2 2

Two loudspeakers **S** and **T** each emit a note of frequency 500 Hz.



S is moved. **T** is not moved.

An observer at **P** hears maxima when **S** is at **Q₁** and at **Q₃**.

The observer at **P** hears minima when **S** is at **Q₂** and at **Q₄**.

The speed of sound is 330 m s^{-1} .

What is the distance between **Q₁** and **Q₄**?

[1 mark]

A 0.66 m ☐

B 0.99 m ☐

C 1.8 m ☐

D 2.8 m ☐

2 3

High-energy electrons are incident on a metal and an X-ray spectrum is emitted.

Why does a characteristic X-ray photon emission occur?

[1 mark]

A An incident electron replaces an orbital electron. ☐

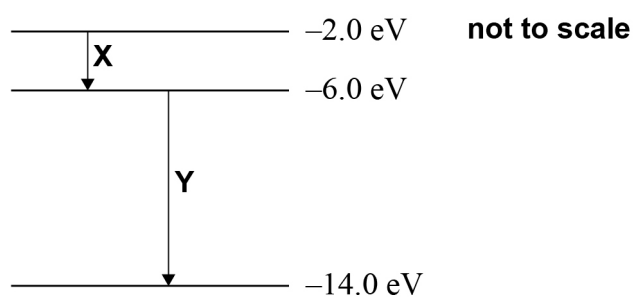
B An incident electron is deflected by the nucleus of the metal. ☐

C An orbital electron falls to a lower energy level to replace an emitted electron. ☐

D An orbital electron is raised to a higher energy level. ☐

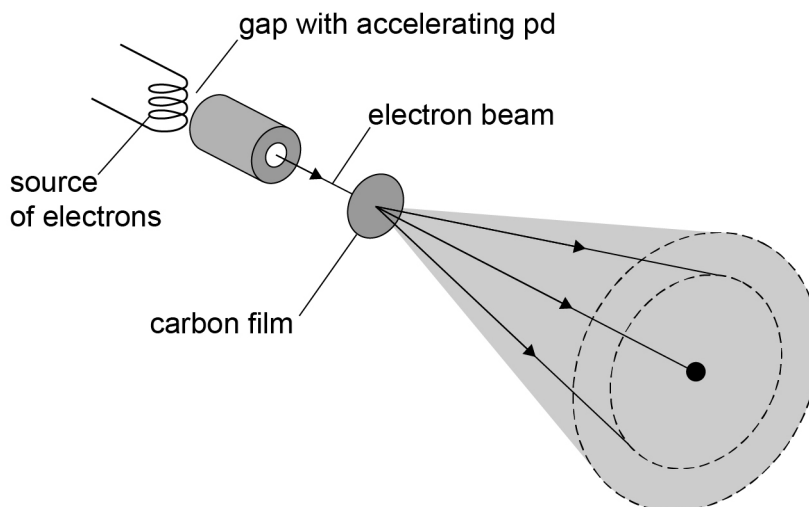
2 4

Three of the energy levels for an atom are shown.

Energy change **X** leads to the emission of a photon of frequency f_X .Energy change **Y** leads to the emission of a photon of frequency f_Y .What is $\frac{f_X}{f_Y}$?**[1 mark]****A** $\frac{1}{3}$ ☐**B** $\frac{1}{2}$ ☐**C** 2 ☐**D** 3 ☐**Turn over for the next question****Turn over ►**

2 5

In a demonstration of the wave properties of an electron beam, electrons in a vacuum are accelerated by a potential difference (pd). The electrons are then diffracted by a carbon film.



A diffraction pattern of rings is seen on a screen. The diameters of the diffraction rings are measured.

Which change reduces the percentage uncertainty in the diameters of the rings?

[1 mark]

- | | |
|---|-----------------------|
| A increasing the accelerating pd | ☐ |
| B decreasing the accelerating pd | ☐ |
| C increasing the current of the beam | ☐ |
| D decreasing the current of the beam | ☐ |

14

END OF QUESTIONS



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