OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL AS

PHYSICS

Unit 2 Electricity, waves and particles

Wednesday 30 May 2018 07:00 GMT 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.
- 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	

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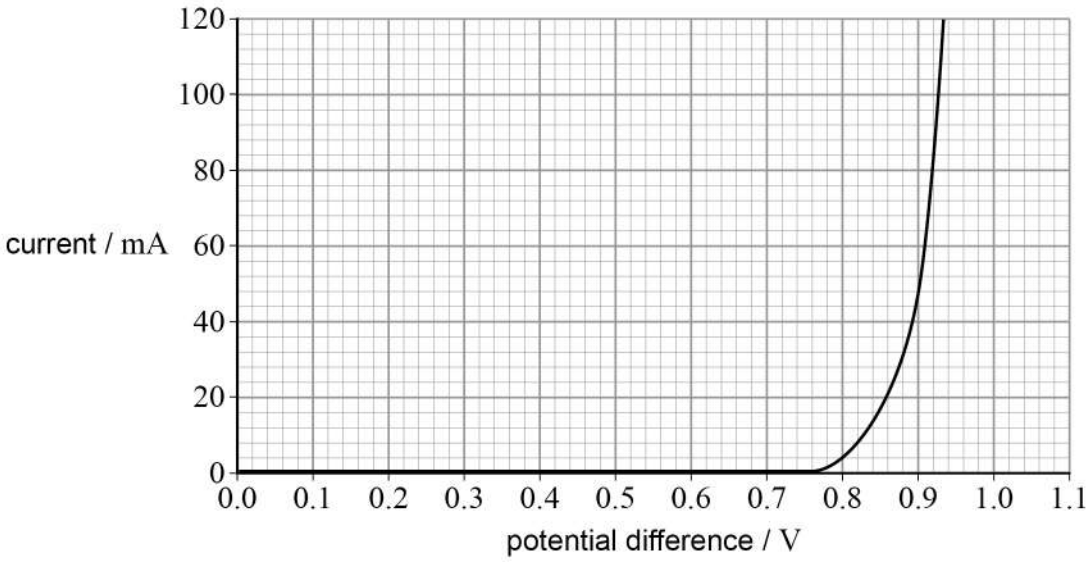
Section A

Answer **all** questions in this section.

0 1 **Figure 1** shows the variation of current with potential difference for an electrical component.

Figure 1



0 1 . 1 Identify the component.

[1 mark]

0 1 . 2 Calculate the resistance of the component when there is a potential difference of 0.90 V across it.

[2 marks]

resistance = _____ Ω

3

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0 2 . 1 The work function of copper is 4.65 eV.

Explain the meaning of the term work function.

[1 mark]

0 2 . 2 Determine the threshold frequency for copper.

[3 marks]

threshold frequency = _____ Hz

0 2 . 3 Electromagnetic radiation of frequency 850 THz is incident on a sheet of clean copper.

Explain whether photoelectrons will be emitted from the surface of the copper.

[2 marks]

6

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0 3 A $0.20\ \text{kg}$ mass suspended from a vertical spring makes 10 oscillations in a time of $5.1\ \text{s}$.

Calculate the spring constant.

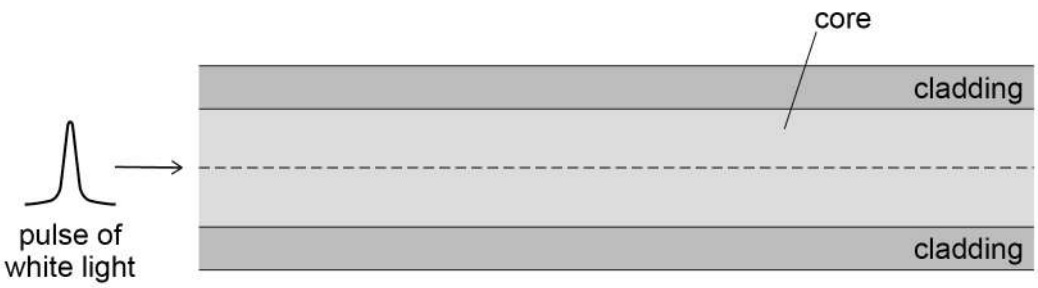
[3 marks]

spring constant = _____ N m^{-1}

3

0 4 **Figure 2** shows a pulse of white light entering an optical fibre along the central axis of the core.

Figure 2



The pulse of white light broadens as it travels through this optical fibre.

State the name of this effect and explain its cause.

[2 marks]

Name _____

Cause _____

_____

_____

_____

2

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0 5 A stretched string of mass 3.3×10^{-3} kg and length 0.75 m vibrates at the first harmonic when the tension in the string is 20 N.

Calculate the frequency of the first harmonic.

[3 marks]

frequency = _____ Hz

3

Turn over for the next question

0 6 **Figure 3** shows a circuit used to determine the emf and internal resistance of a cell.

Figure 3

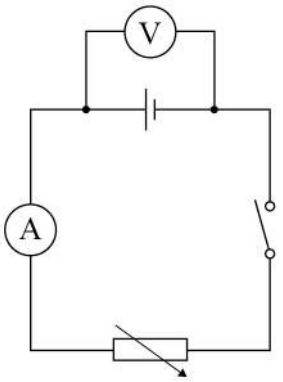
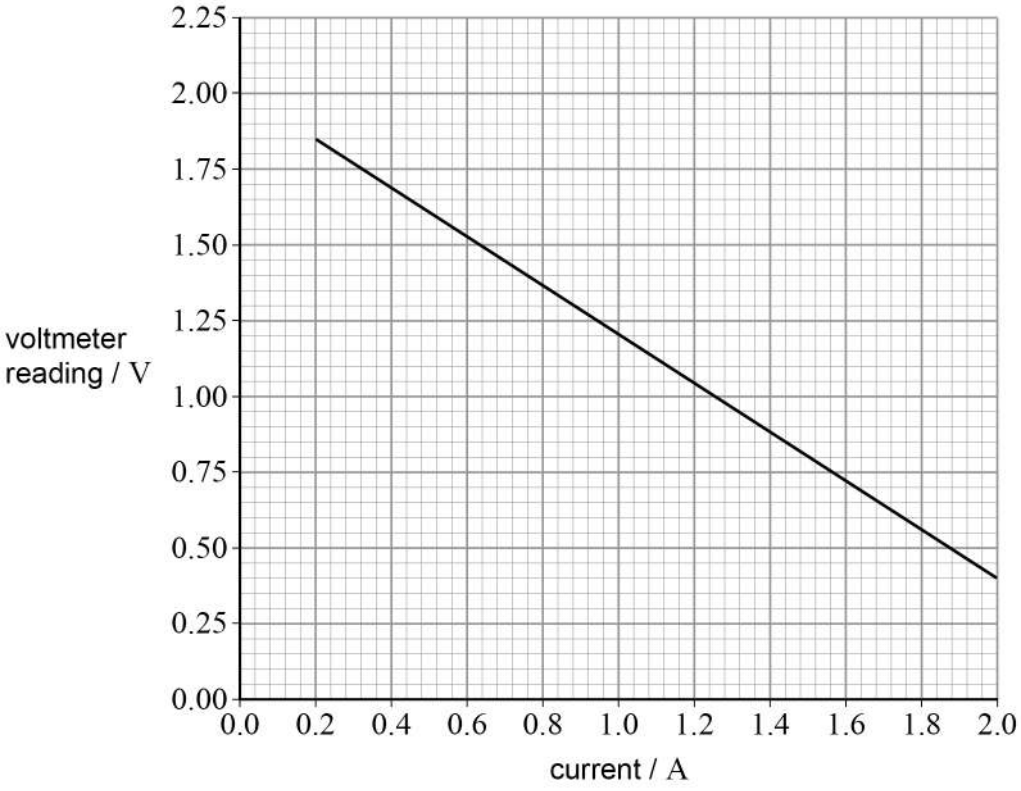


Figure 4 shows the variation of the voltmeter reading with current in the circuit as the variable resistor is adjusted.

Figure 4



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0 6 . 1 The circuit contains an ideal voltmeter and an ideal ammeter.

State the resistance of an ideal voltmeter.

[1 mark]

0 6 . 2 Show that the internal resistance of the cell is approximately $0.8\ \Omega$.

[1 mark]

0 6 . 3 The variable resistor is adjusted until the current in the circuit is $2.10\ \text{A}$.

Calculate the resistance of the variable resistor.

[3 marks]

resistance = _____ Ω

5

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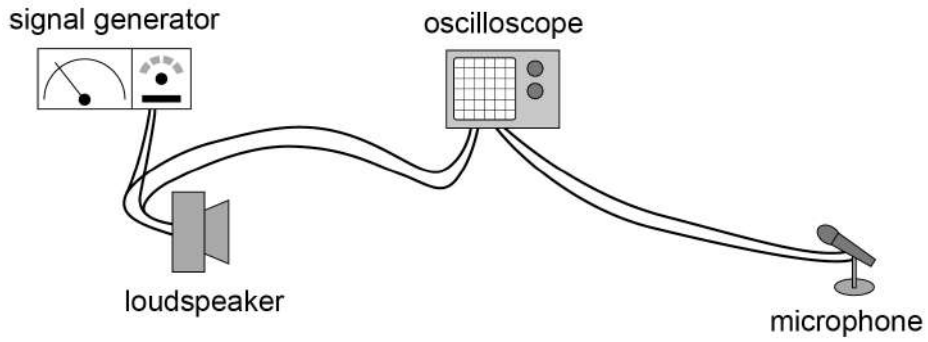
0 7 A signal generator causes a loudspeaker to emit continuous sound waves of constant frequency f. A microphone placed $5.0\ \text{m}$ away from the loudspeaker detects the sound waves. A dual-trace oscilloscope displays the output from the signal generator and the output from the microphone at the same time.

The speed of sound in air is $340\ \text{m s}^{-1}$.

Figure 5



0 7 . 1 Describe the motion of an air particle during one cycle of a sound wave.

[2 marks]

0 7 . 2 A sound wave completes 12.8 cycles while travelling between the loudspeaker and the microphone.

Show that f is approximately $870\ \text{Hz}$.

[3 marks]

Do not write outside the box

0 7 . 3 The oscilloscope shows a phase difference between the sound waves emitted by the loudspeaker and the sound waves arriving at the microphone.

Calculate in degrees the phase difference.

[1 mark]

phase difference = _____ degrees

0 7 . 4 The phase difference can be reduced to zero by increasing the frequency of the signal generator.

Determine the minimum increase required in the frequency of the signal generator to make the phase difference zero.

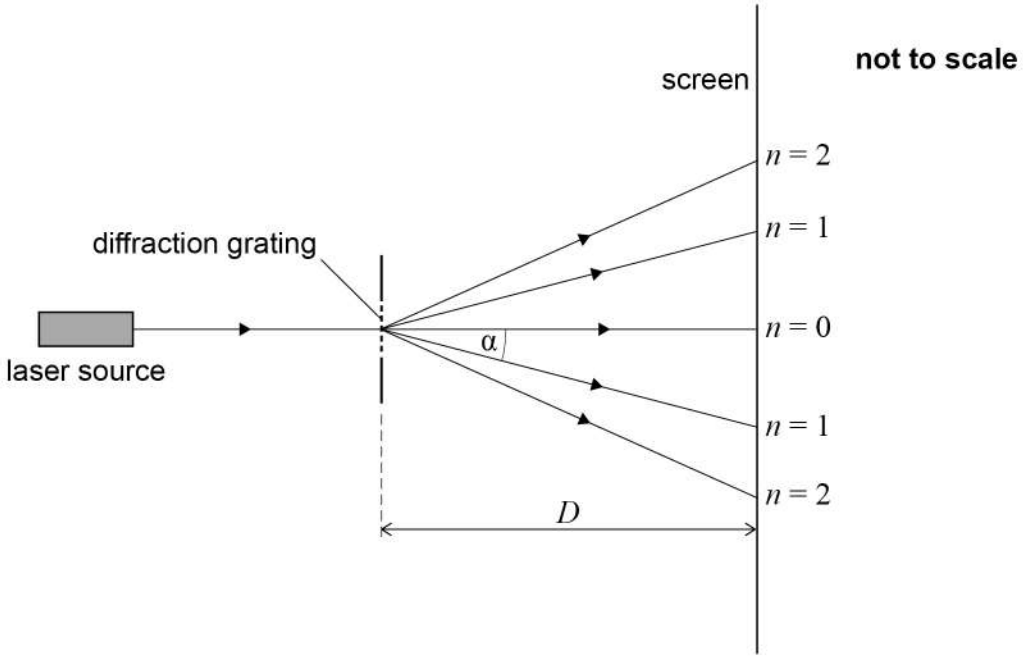
[4 marks]

minimum increase in frequency = _____ Hz

10

0 8 A student wants to determine the wavelength of laser light using a diffraction grating. She sets up the experiment as shown in **Figure 6**.

Figure 6



The student observes five maxima of light on the screen. To determine the angle between each maximum and the zero-order maximum, she measures:

- the distance D between the screen and the diffraction grating
- the separation y of each maximum from the zero-order maximum.

Table 1 shows the results.

Table 1

n	***D* / m**	***y* / m**
1	2.000	0.878
2	2.000	2.704

Do not write outside the box

0 8 . 1 **Figure 6** has an angle marked α.

Show that α is approximately $24°$

[1 mark]

0 8 . 2 The diffraction grating has 600 lines per millimetre.

Calculate the wavelength of the light.

[3 marks]

wavelength = _____ m

Question 8 continues on the next page

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0 8 . 3 Explain how a second-order maximum occurs on the screen.

[3 marks]

0 8 . 4 The student repeats the experiment with a laser source that emits light of wavelength 532 nm.

Show that seven maxima may be observed.

[3 marks]

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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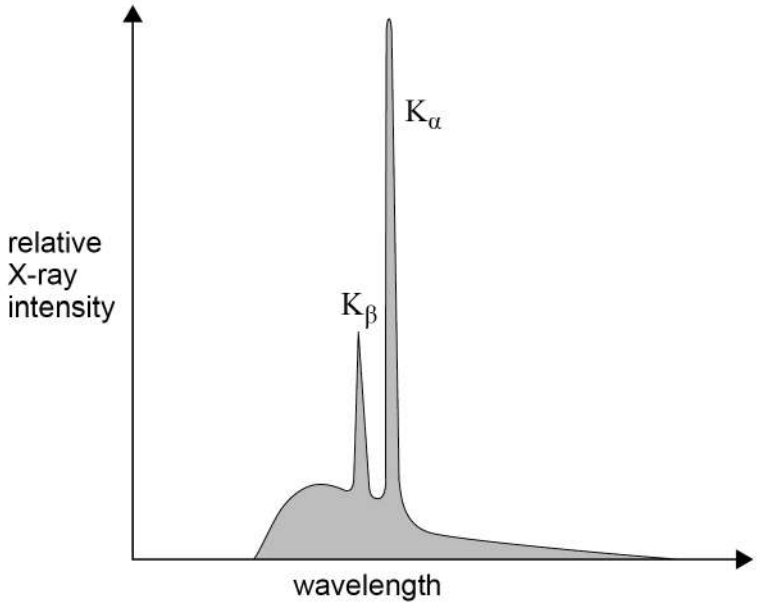
0 9 **Figure 7** shows the spectrum from an X-ray tube. The two peaks, labelled K_α and K_β, correspond to the production of characteristic X-rays.

Figure 7



0 9 . 1 Explain how characteristic X-rays are produced in an X-ray tube.

[3 marks]

Do not write outside the box

0 9 . 2 The X-ray tube transfers $60\ \text{keV}$ of kinetic energy to each accelerated electron.

Calculate the minimum wavelength emitted by the X-ray tube.

[3 marks]

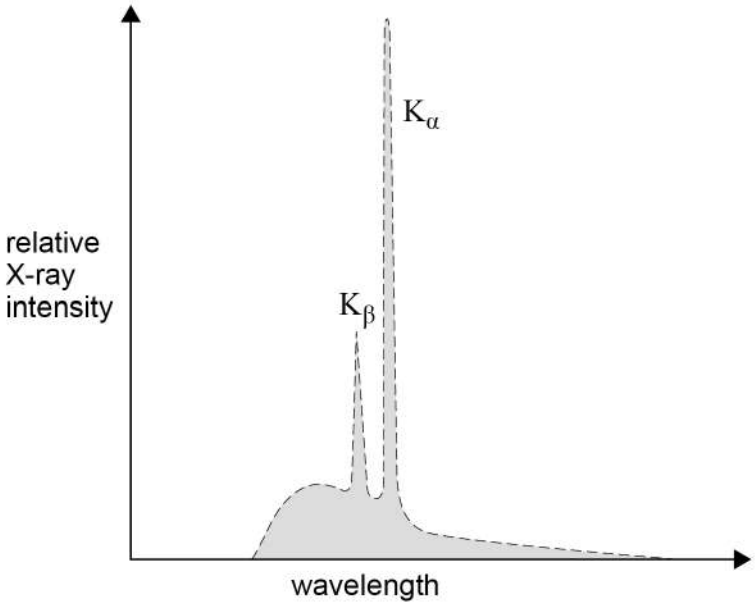
minimum wavelength = _____ m

0 9 . 3 The X-ray tube is now operated at a higher voltage, transferring $120\ \text{keV}$ of kinetic energy to each electron.

Sketch on **Figure 8** the new X-ray spectrum.
Figure 8 shows the spectrum from **Figure 7** to help you.

[2 marks]

Figure 8



8

END OF SECTION A

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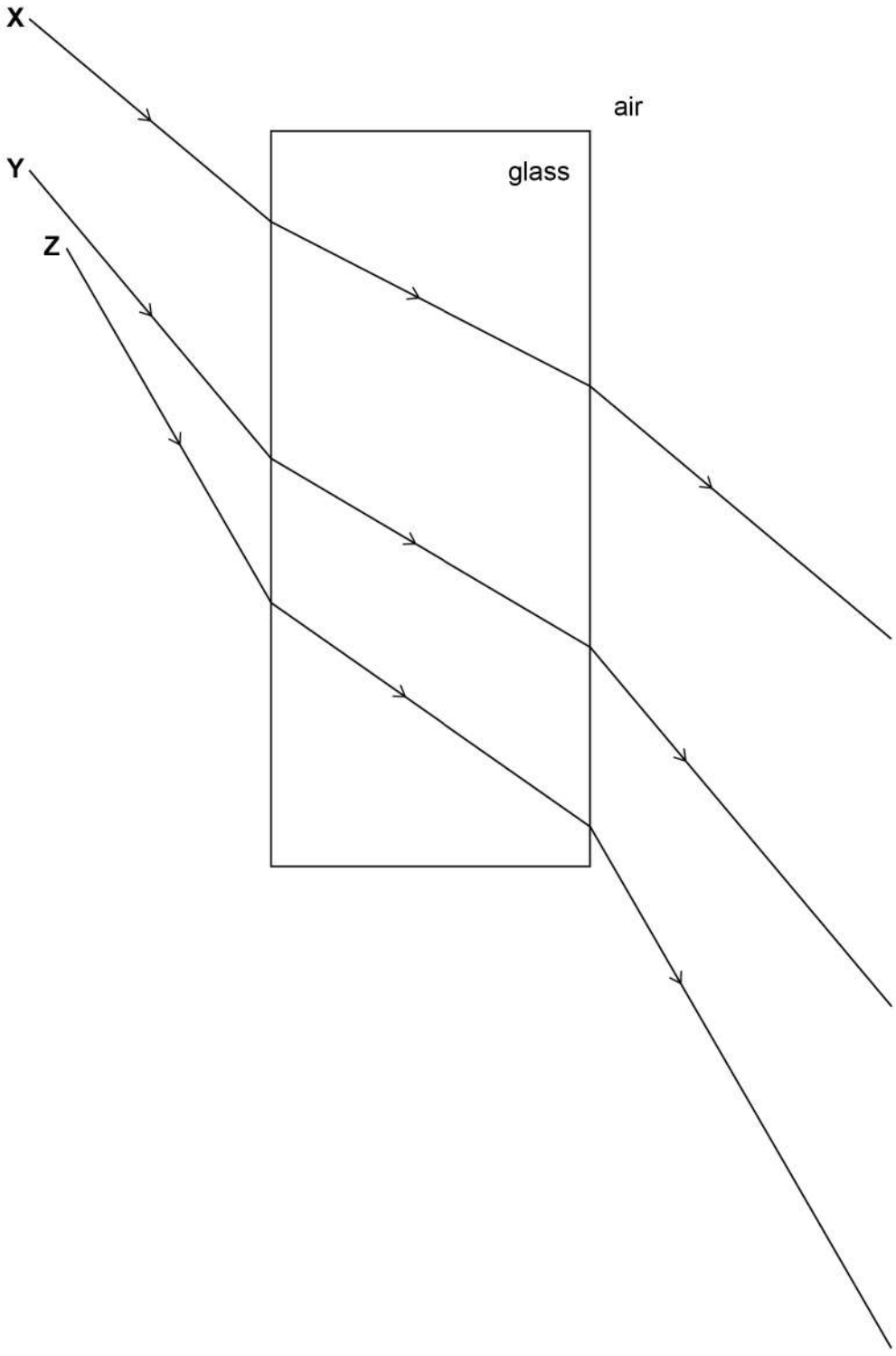
Section B

Answer **all** questions in this section.

1 0 **Figure 9** shows the paths of three light rays **X**, **Y** and **Z** as they pass through a rectangular glass block.

Figure 9



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1 0 . 1 Determine the refractive index of the glass for ray **X**.

Use a protractor to take suitable measurements from **Figure 9**.

[3 marks]

refractive index = _____

1 0 . 2 Assume that the percentage uncertainty in the sine of an angle is equal to the percentage uncertainty in the measurement of that angle.

Take the absolute uncertainty of measurement of all angles in this question to be ±1°

Calculate the absolute uncertainty in your answer to question **10.1**.

[3 marks]

absolute uncertainty = ± _____

1 0 . 3 State and explain which of the three rays is most likely to provide a value for refractive index with the smallest **percentage** uncertainty.

[2 marks]

_____

_____

_____

_____

8

Turn over ►

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1 1 A device uses the gravitational potential energy stored by a mass of $12.5\ \text{kg}$ that is connected by a chain to a gear system. The mass is released from rest and falls through a height of $1.8\ \text{m}$.

The mass falls at a constant speed of $1.5\ \text{mm s}^{-1}$ pulling the chain through the gear system. The gear system spins a generator that provides an electric light with a potential difference of $2.7\ \text{V}$ and $80\ \text{mW}$ of power.

1 1 . 1 Show that the power available when the mass is falling is approximately $0.18\ \text{W}$.

Ignore the weight of the chain in your calculation.

[3 marks]

1 1 . 2 Suggest **one** change to this device that would increase the maximum power available.

[1 mark]

1 1 . 3 Inefficiencies occur in both the gear system and the generator.
The efficiency of the gear system is 0.60

Calculate the efficiency of the generator when producing an output of $80\ \text{mW}$.

[2 marks]

efficiency = _____

Do not write outside the box

1 1 . 4 Calculate the resistance of the electric light when the potential difference across it is 2.7 V.

[2 marks]

resistance = _____ Ω

8

END OF SECTION B

Turn over ►

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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 

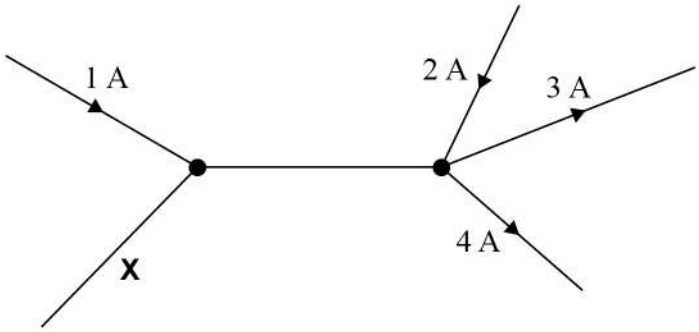
WRONG METHODS 

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 sheets for this working.

1 2 The diagram shows the currents in a set of wires.



What is the current in wire **X**?

[1 mark]

A 0 A 

B 2 A 

C 4 A 

D 8 A 

Do not write outside the box

1 3 A lamp with a power rating of $24\ \text{W}$ and a resistance of $12\ \Omega$ is operated for $2\ \text{minutes}$.

What charge flows through the lamp in this time?

[1 mark]

A $15\ \text{C}$ ⬭

B $89\ \text{C}$ ⬭

C $170\ \text{C}$ ⬭

D $240\ \text{C}$ ⬭

1 4 A metal wire of length $1.3\ \text{m}$ has a resistance of $0.70\ \Omega$.
The wire has a diameter of $0.50\ \text{mm}$.

What is the resistivity of the metal?

[1 mark]

A $1.1 \times 10^{-5}\ \Omega\ \text{m}$ ⬭

B $1.1 \times 10^{-7}\ \Omega\ \text{m}$ ⬭

C $2.1 \times 10^{-7}\ \Omega\ \text{m}$ ⬭

D $4.2 \times 10^{-7}\ \Omega\ \text{m}$ ⬭

1 5 Which is a unit of power?

[1 mark]

A $\text{C}^2\ \Omega\ \text{s}^{-1}$ ⬭

B $\text{J}\ \text{C}^{-1}\ \text{s}^{-1}$ ⬭

C $\text{V}\ \text{C}\ \text{s}^{-1}$ ⬭

D $\text{V}^2\ \Omega$ ⬭

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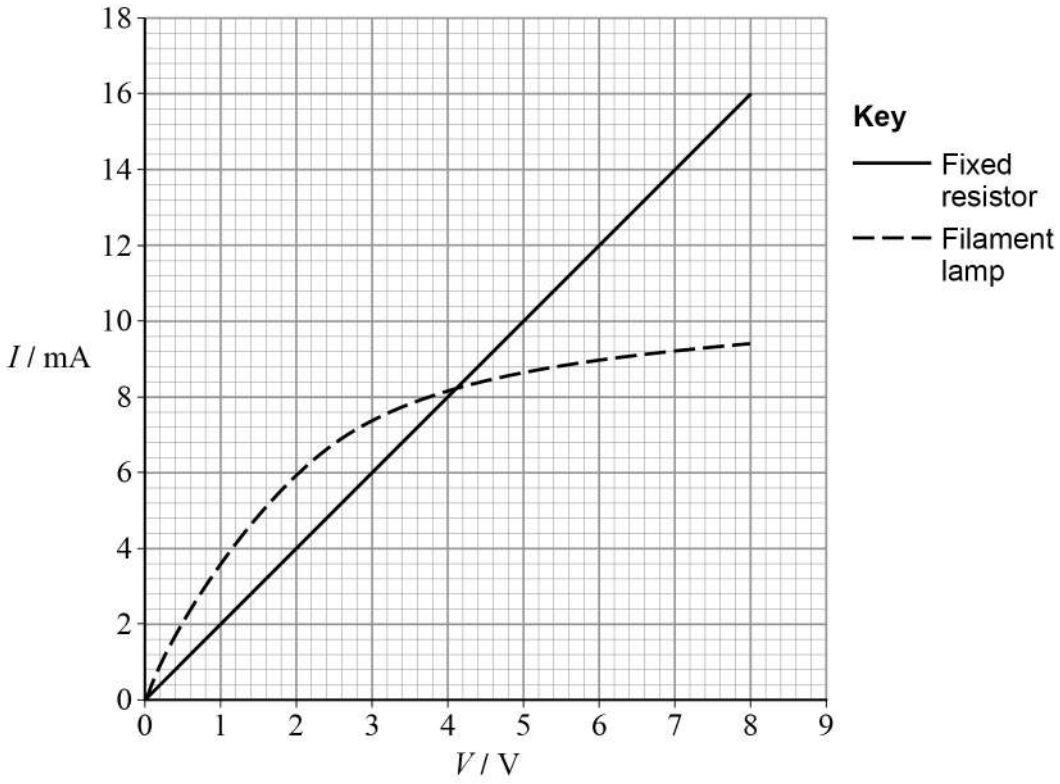
1 6 The graph shows the current–voltage (I–V) characteristics for a filament lamp and a fixed resistor.



The two components are connected in parallel with a 6 V battery that has negligible internal resistance.

What is the current in the battery?

[1 mark]

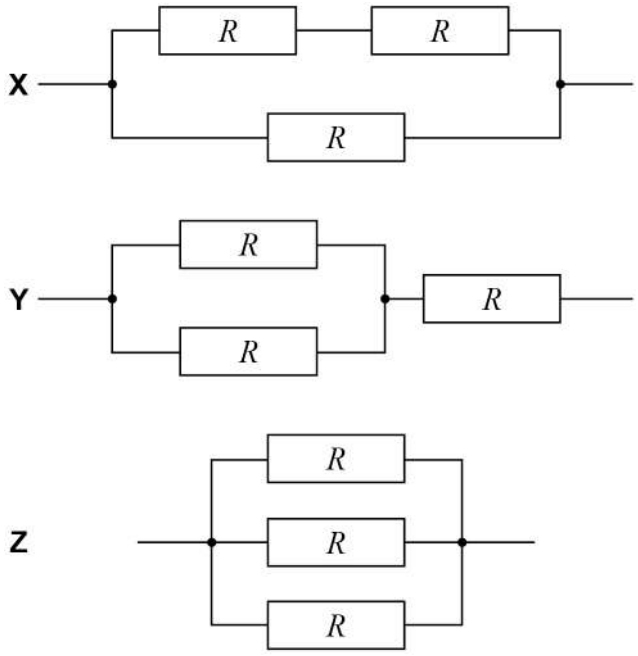
A 8 mA ⬭

B 13 mA ⬭

C 16 mA ⬭

D 21 mA ⬭

1 7 The diagrams show three networks of resistors. Each resistor has resistance R.



Which list gives the networks in order of largest total resistance to smallest total resistance?

[1 mark]

A X, Y, Z ⬭

B Y, X, Z ⬭

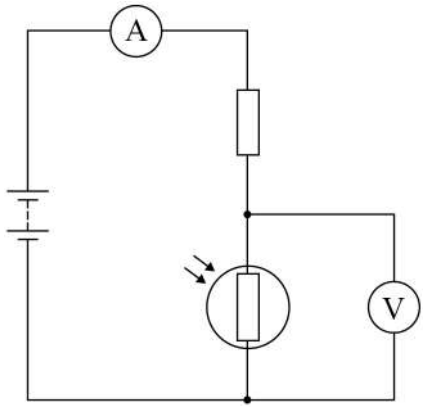
C Z, X, Y ⬭

D Z, Y, X ⬭

Turn over for the next question

Do not write outside the box

1 8 The diagram shows a potential-divider circuit.



Which row shows the changes in the ammeter and voltmeter readings when the intensity of the light incident on the LDR increases?

[1 mark]

	Ammeter reading	**Voltmeter reading**	
A	Increases	Increases	⬭
B	Increases	Decreases	⬭
C	Decreases	Increases	⬭
D	Decreases	Decreases	⬭

Do not write outside the box

1 9 The diagram shows a string stretched between two fixed points, **O** and **R**, which are 100 cm apart.

P and **Q** are points on the string.

OP = 20 cm
OQ = 60 cm

P and **Q** oscillate in phase when the string vibrates at the first harmonic.

What is the next harmonic at which **P** and **Q** will oscillate in phase?

[1 mark]

A Second ⬭

B Third ⬭

C Fourth ⬭

D Fifth ⬭

2 0 The speed of light decreases by 60% when light passes from air into a transparent substance.

What is the refractive index of the substance?

[1 mark]

A 0.40 ⬭

B 0.60 ⬭

C 1.67 ⬭

D 2.50 ⬭

Turn over ►

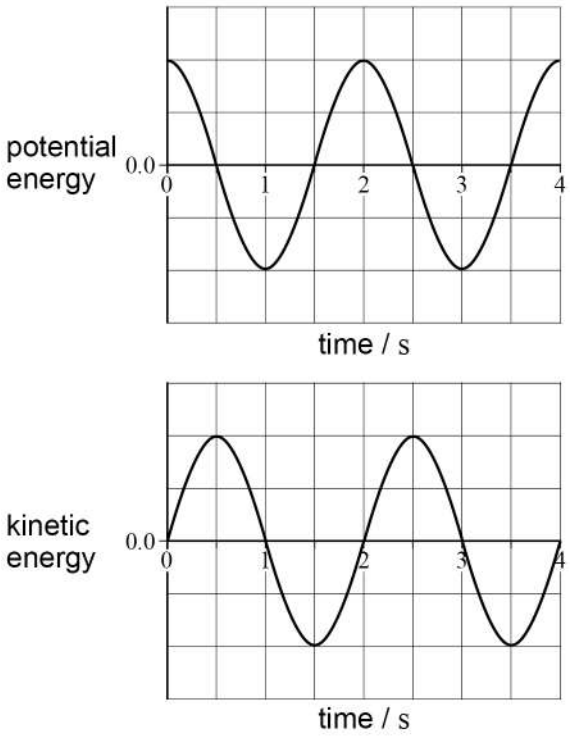
Do not write outside the box

2 1 A simple pendulum oscillates with a frequency of 0.5 Hz.

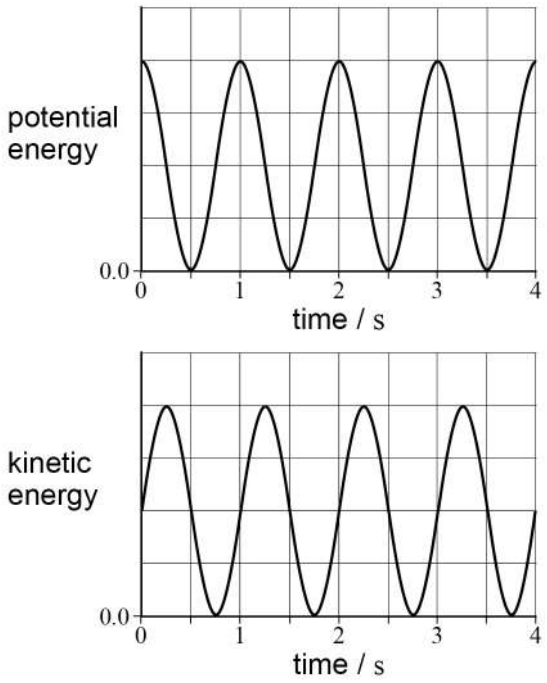
Which pair of graphs shows the variation with time of its potential energy and its kinetic energy?
The y-axis has the same scale on each graph.

[1 mark]

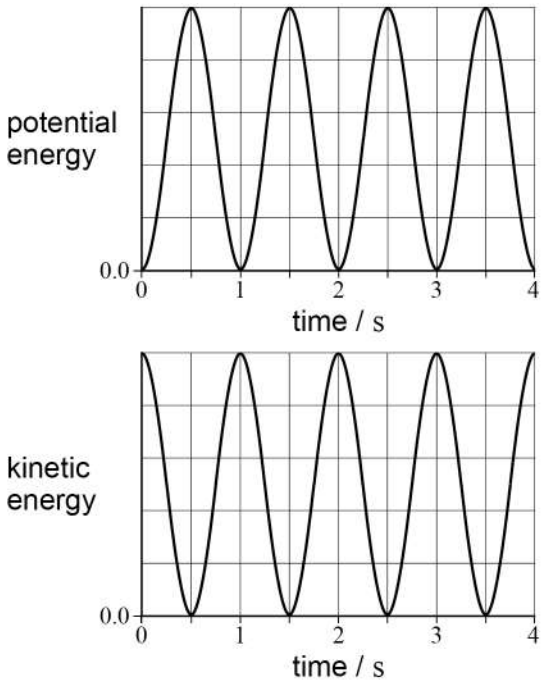
A



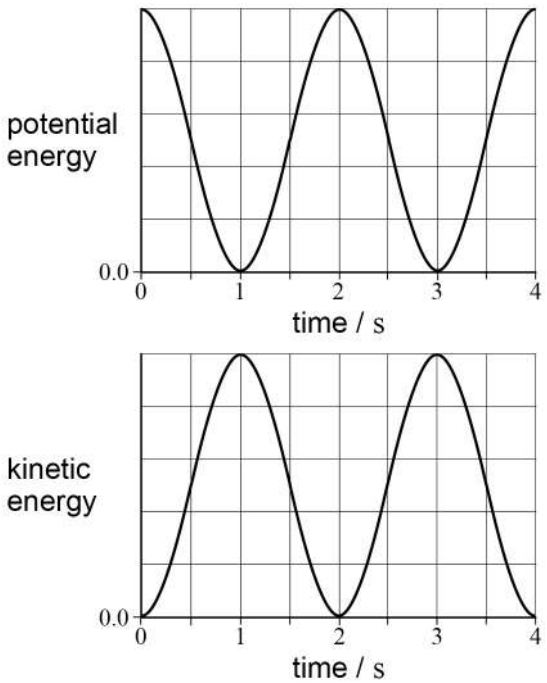
B



C



D



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A ⬭

B ⬭

C ⬭

D ⬭

Turn over for the next question

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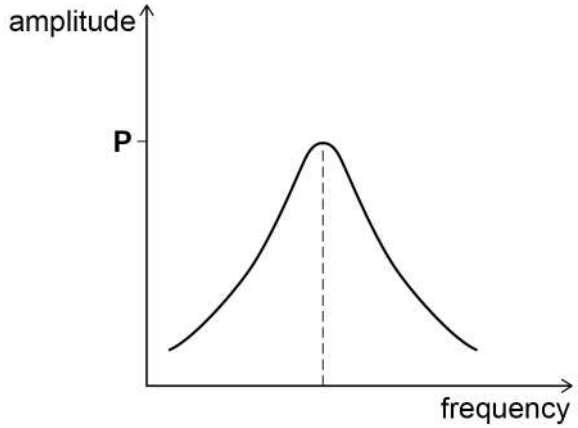
2 2 The graph shows the variation of amplitude with frequency for the forced oscillation of a lightly damped system. **P** marks the maximum amplitude of the system.

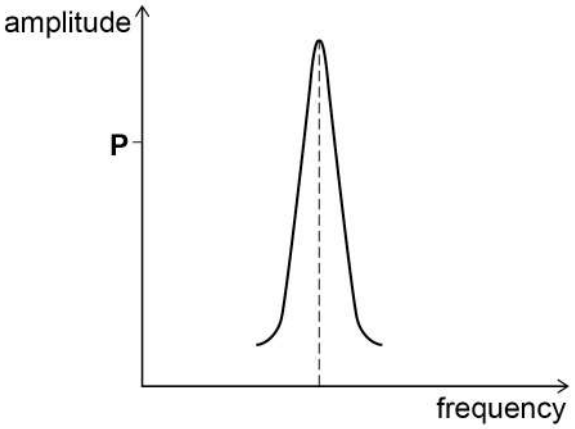


The damping on the oscillator is decreased. Each of the following graphs is drawn to the same scales as the scales on the graph above.

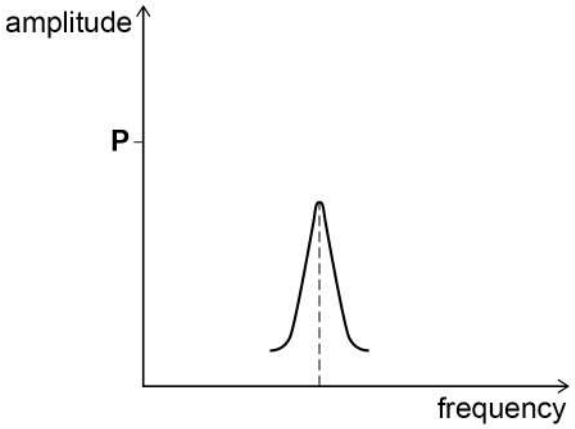
Which graph shows the new variation of amplitude with frequency?

[1 mark]

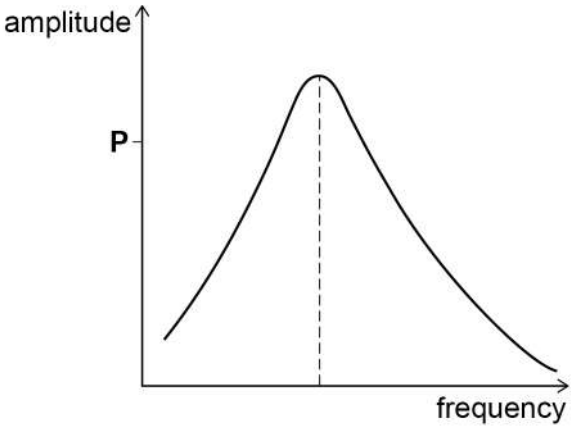
A



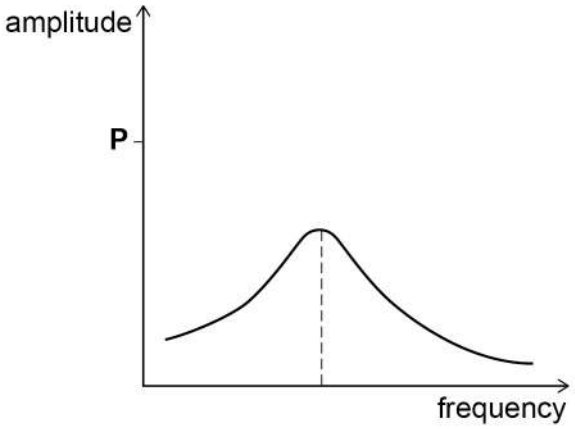
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

2 3 A simple pendulum oscillates with the same time period as a mass on a spring.

Which row gives a combination of pendulum length, mass and spring constant that produce the same time period in each system?

Assume $g = 10\ \text{N kg}^{-1}$

[1 mark]

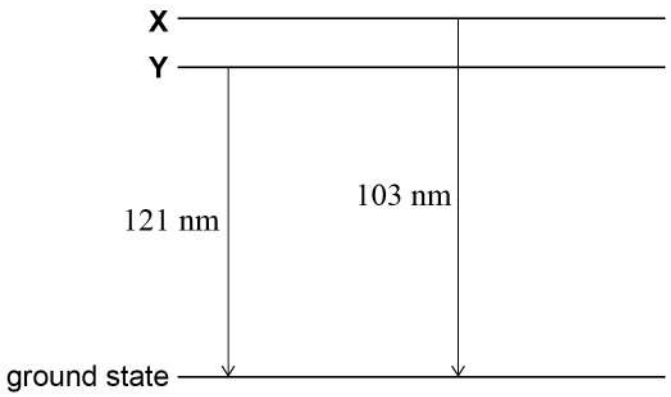
	Pendulum length / m	**Mass / kg**	**Spring constant / N m^{-1}**	
A	0.4	0.1	40	⬭
B	0.1	0.1	50	⬭
C	0.4	0.5	40	⬭
D	0.1	0.5	50	⬭

Turn over for the next question

Do not write outside the box

2 4 The diagram shows the ground state and two excited energy levels, **X** and **Y**, of an atom.

The wavelength corresponding to each transition is shown.



What is the energy difference between levels **X** and **Y**?

[1 mark]

A 2.9×10^{-19} J ⬭

B 1.6×10^{-18} J ⬭

C 1.9×10^{-18} J ⬭

D 1.1×10^{-17} J ⬭

2 5 A proton has a kinetic energy of 5.0×10^{-12} J.

What is the de Broglie wavelength of the proton?

[1 mark]

A 1.3×10^{-19} m ⬭

B 5.1×10^{-15} m ⬭

C 1.0×10^{-14} m ⬭

D 4.4×10^{-13} m ⬭

14

END OF QUESTIONS

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