SPECIMEN MATERIAL v1.1

Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Candidate signature _____

AS PHYSICS

Paper 2

Specimen materials (set 2) Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a pencil
- a ruler
- a calculator
- a data and formulae booklet.

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.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.

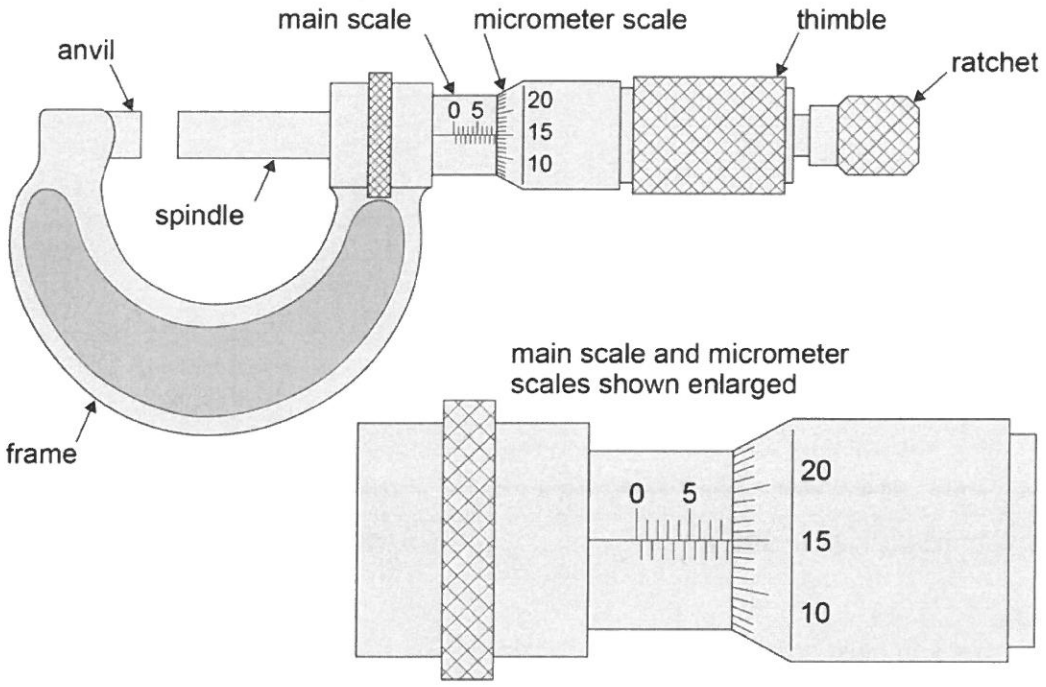
Section A

Answer **all** questions in this section.

0 1 This question is about the determination of the resistivity of a wire.

Figure 1 shows a micrometer screw gauge that is used to measure the diameter of the wire.

Figure 1



0 1 . 1 State the resolution of the **main scale** on the micrometer in **Figure 1**.

[1 mark]

resolution = _____ mm

0 1 . 2 Determine the distance between the anvil and the spindle of the micrometer in **Figure 1**. State any assumption you make.

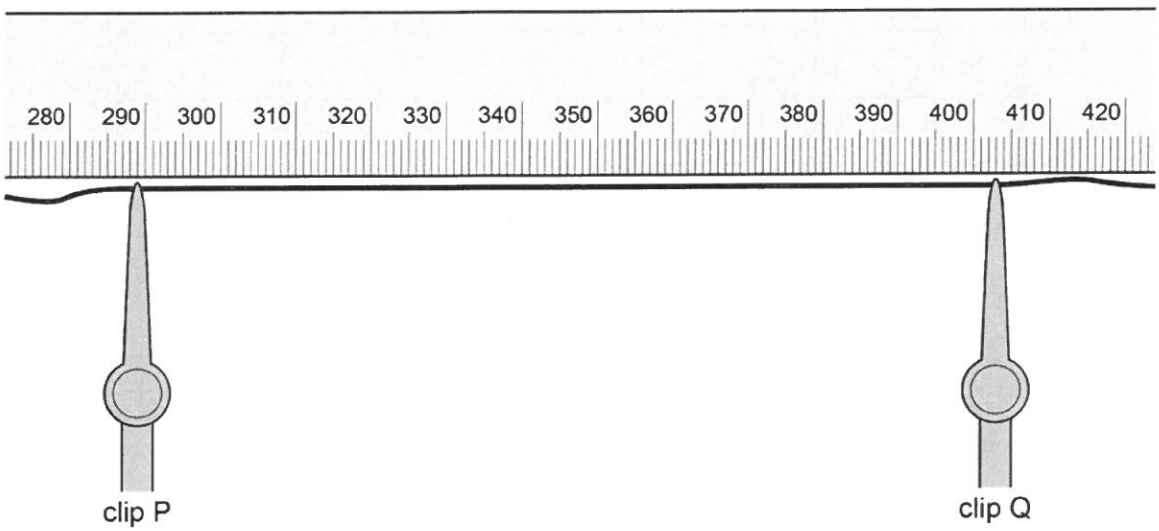
[2 marks]

distance = _____ mm

0 1 . 3 A student must also determine the length L of the wire between clips P and Q that will be connected into a circuit.

Figure 2 shows the metre ruler being used to measure L.

Figure 2



Determine L.

[1 mark]

L = _____ mm

0 1 . 4 Calculate the percentage uncertainty in your result for L.

[2 marks]

percentage uncertainty = _____ %

0 1 . 5 State and explain what the student could have done to reduce uncertainty in the reading for L.

[1 mark]

_____

_____

_____

0 1 . 6 The student intends to make measurements that will allow her to determine the resistance of one metre of the wire. She uses an ohm-meter to measure the resistance R for different lengths L of the wire. The student's measurements are shown in **Table 1**.

Table 1

L/cm	R/Ω	
81.6	8.1	
72.3	7.2	
63.6	6.3	
57.2	5.7	
44.1	4.7	

Determine the value that the student should record for the resistance per metre of the wire.

Use the additional column in **Table 1** to show how you arrived at your answer.

[2 marks]

resistance of one metre of wire = _____ Ω

0 1 . 7 Determine the resistivity of the wire. Give a suitable unit for your answer.

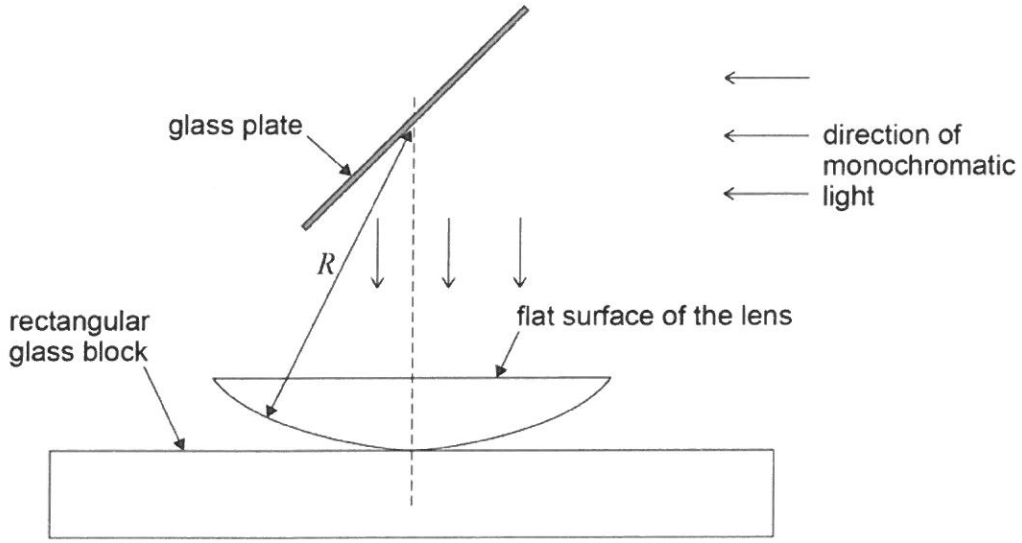
[4 marks]

mean diameter of the wire = 0.376 mm

resistivity = _____ unit = _____

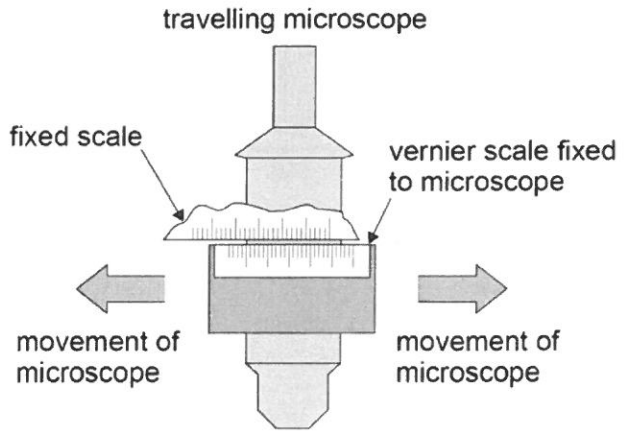
0 2 A lens has a flat surface and a curved surface. An experiment is carried out to determine the radius R of the curved surface of the lens. The lens is placed on a rectangular glass block with its flat surface upwards. The lens is illuminated with monochromatic light reflected from a glass plate as shown in **Figure 3**.

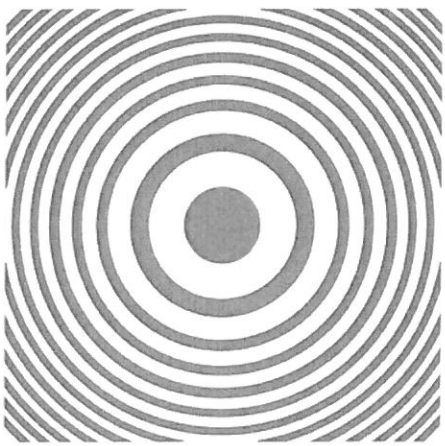
Figure 3



When the apparatus is viewed from above an interference pattern consisting of concentric dark and bright rings is seen. A travelling microscope positioned as shown in **Figure 4** is used to measure the diameter of the **bright** rings.

Figure 4





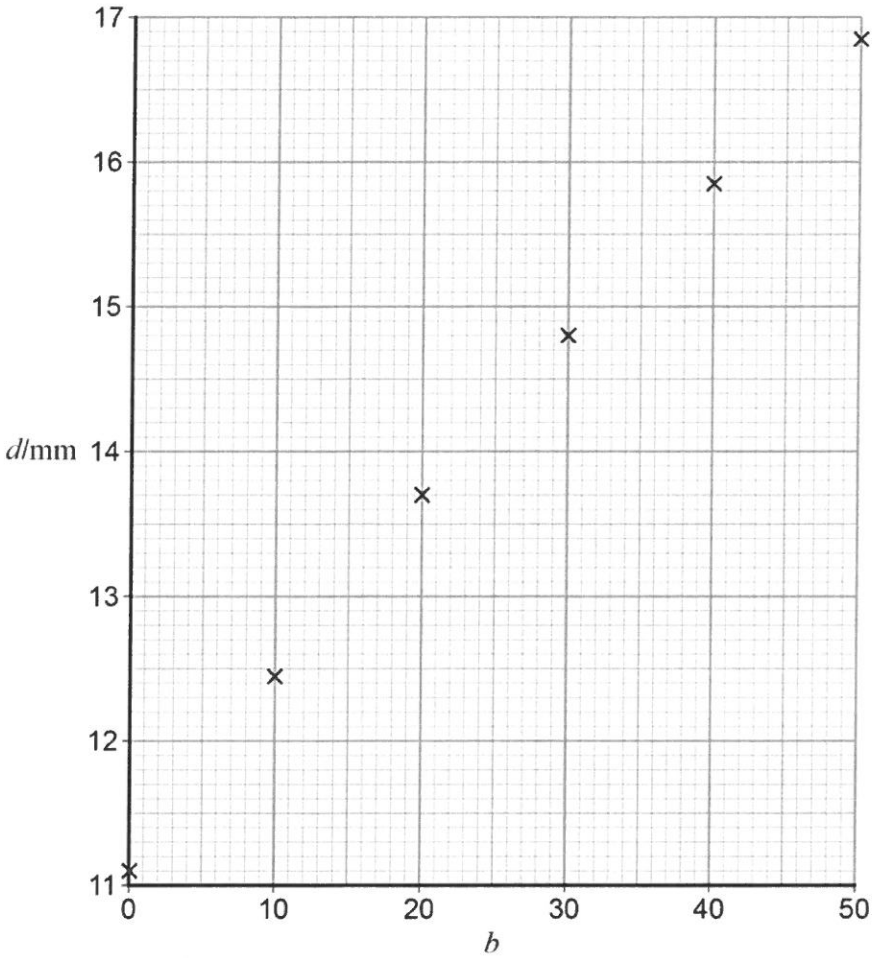
enlarged view of pattern of concentric dark and bright rings seen through the microscope

Question 2 continues on the next page

0 2 . 1 A student chose a particular bright ring (not at the centre of the pattern) and measured its diameter. He called this ring number 0. Counting outwards from the centre, he measured the diameter of every tenth ring.

Figure 5 shows the graph of ring number b against ring diameter d.

Figure 5



Draw a line of best fit on **Figure 5**.

[1 mark]

0 2 . 2 Determine the gradient G corresponding to $b = 25$.

[3 marks]

$G =$ _____

0 2 . 3 The radius of curvature R of the lens can be calculated using any point on the graph together with the formula

$$R = \frac{Gd}{2\lambda}$$

where $\lambda = 589.3$ nm.

Determine R.

[3 marks]

$R =$ _____ m

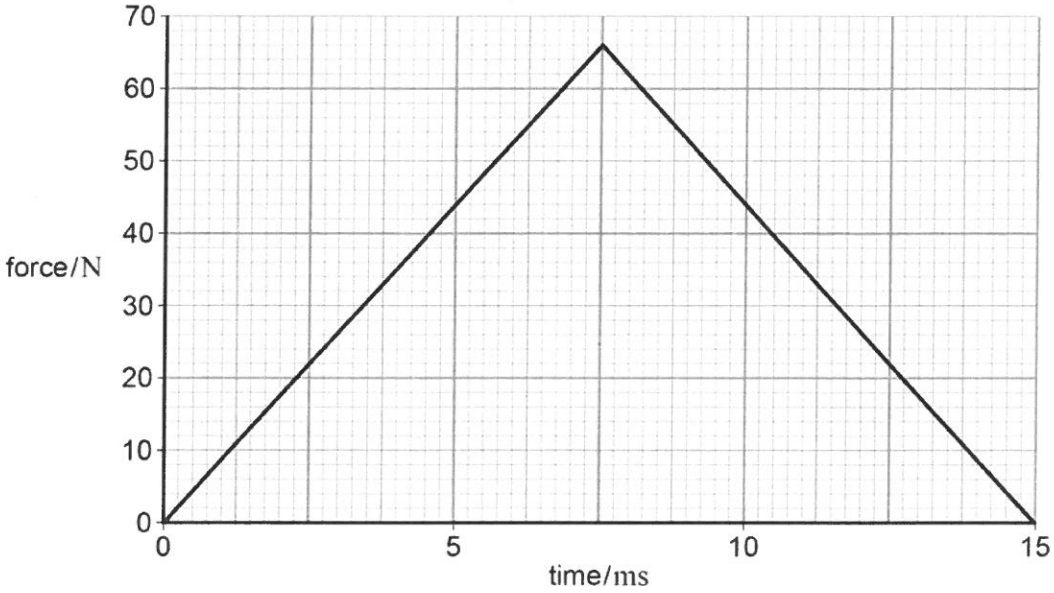
END OF SECTION A

Section B

Answer **all** questions in this section.

0 3 A golf ball is raised from the ground and dropped onto a hard plate to test the properties of the ball. A sensor measures the force exerted by the plate on the ball during its collision with the plate. **Figure 6** shows the variation of force exerted on the golf ball with time.

Figure 6



0 3 . 1 Show that the change in momentum of the golf ball during the collision is about 0.5 N s.

[2 marks]

0 3 . 2 The ball strikes the plate with a speed of 7.1 m s^{-1} and has a mass of 45 g. It leaves the plate with a speed of 3.9 m s^{-1}.

Show that this is consistent with a change in momentum of about 0.5 N s.

[3 marks]

0 3 . 3 The ball continues to bounce, each time losing the same fraction of its energy when it strikes the plate. Air resistance is negligible.

Determine the percentage of the original gravitational potential energy of the ball that remains when it reaches its maximum height after bouncing three times.

[4 marks]

gravitational potential energy remaining = _____ %

0 3 . 4 Explain, with reference to the conservation of momentum, the effect that the motion of the golf ball has on the motion of the Earth from the instant it is released until it bounces at the plate.

[3 marks]

0 4 . 1 Describe what occurs in the photoelectric effect.

[2 marks]

0 4 . 2 Violet light of wavelength 380 nm is incident on a potassium surface.

Deduce whether light of this wavelength can cause the photoelectric effect when incident on the potassium surface.

work function of potassium = 2.3 eV

[4 marks]

0 4 . 3 The photoelectric effect provides evidence for light possessing particle properties.

State and explain **one** piece of evidence that suggests that light also possesses wave properties.

[2 marks]

END OF SECTION B

Section C

Each of Questions **5** to **34** 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 answer 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.

0 5 The units of physical quantities can be expressed in terms of the fundamental (base) units of the SI system. In which line in the table are the fundamental units correctly matched to the physical quantity?

[1 mark]

	Physical quantity	Fundamental units	
A	charge	$A\ s^{-1}$	○
B	power	$kg\ m^2\ s^{-3}$	○
C	potential difference	$kg\ m^2\ s\ A^{-1}$	○
D	energy	$kg\ m^2\ s^{-1}$	○

0 6 Which of the following nuclei has the smallest specific charge?

[1 mark]

A $^{1}_{1}H$ ○

B $^{12}_{6}C$ ○

C $^{14}_{6}C$ ○

D $^{235}_{92}U$ ○

0 7 $^{232}_{90}\mathrm{Th}$ is an unstable nuclide in a radioactive decay series. It decays by emitting an α particle. The next two nuclides in the series emit β^- particles.

What nuclide is formed after these three decays have taken place?

[1 mark]

A $^{230}_{90}\mathrm{Th}$ ⬭

B $^{228}_{92}\mathrm{U}$ ⬭

C $^{228}_{88}\mathrm{Ra}$ ⬭

D $^{228}_{90}\mathrm{Th}$ ⬭

0 8 Which line does **not** give the correct exchange particle for the process?

[1 mark]

	Process	Exchange particle	
A	gravitational attraction	W boson	⬭
B	electrostatic repulsion of electrons	virtual photon	⬭
C	strong interaction	pion	⬭
D	β^- decay	W boson	⬭

0 9 Which line correctly classifies the particle shown?

[1 mark]

	Particle	Category	Quark combination	
A	neutron	baryon	$\bar{u}d$	⬭
B	neutron	meson	udd	⬭
C	proton	baryon	uud	⬭
D	positive pion	meson	$\bar{u}d$	⬭

1 0 Which of the following statements about muons is **incorrect**?

[1 mark]

A A muon is a lepton. ⬭

B A muon has a greater mass than an electron. ⬭

C If a muon and an electron each have the same de Broglie wavelength then they each have the same momentum. ⬭

D A muon with the same momentum as an electron has a larger kinetic energy than the electron. ⬭

1 1 In an experiment to demonstrate the photoelectric effect, a charged metal plate is illuminated with light from different sources. The plate loses its charge when an ultraviolet light source is used but not when a red light source is used.

What is the reason for this?

[1 mark]

A The intensity of the red light is too low. ⬭

B The wavelength of the red light is too short. ⬭

C The frequency of the red light is too high. ⬭

D The energy of red light photons is too small. ⬭

1 2 Which of the following classes of electromagnetic waves will **not** ionise neutral atoms?

[1 mark]

A ultraviolet ⬭

B X radiation ⬭

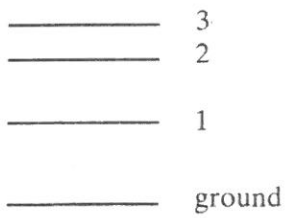
C gamma radiation ⬭

D microwave ⬭

1 3 The values of the lowest three energy levels in a particular atom are shown in the table.

The diagram shows these levels together with the ground state of the atom.

Level	Energy/eV
3	−0.85
2	−1.51
1	−3.39



When an electron moves from level 3 to level 1, radiation of frequency 6.2×10^{14} Hz is emitted.

What is the frequency of the radiation emitted when an electron moves from level 2 to level 1?

[1 mark]

A 2.3×10^{14} Hz ○

B 3.5×10^{14} Hz ○

C 4.6×10^{14} Hz ○

D 8.3×10^{14} Hz ○

1 4 Experiments on which of the following suggested the wave nature of electrons?

[1 mark]

A electron diffraction by a crystalline material ○

B β^- decay ○

C line spectra of atoms ○

D the photoelectric effect ○

1 5 A progressive wave of frequency 150 Hz travels along a stretched string at a speed of 30 m s^{-1}.

What is the phase difference between two points that are 50 mm apart on the string?

[1 mark]

A zero ○
B 90° ○
C 180° ○
D 360° ○

1 6 Which of the following statements about the behaviour of waves is **incorrect**?

[1 mark]

A All waves can be diffracted. ○
B All waves can be made to undergo superposition. ○
C All waves can be refracted. ○
D All waves can be polarised. ○

1 7 Two radio transmitters emit waves at a frequency of 1.4 MHz. A stationary wave is set up between the two transmitters due to the superposition of the radio waves.

What is the minimum distance between two nodes in the stationary wave?

[1 mark]

A 107 m ○
B 214 m ○
C 428 m ○
D 857 m ○

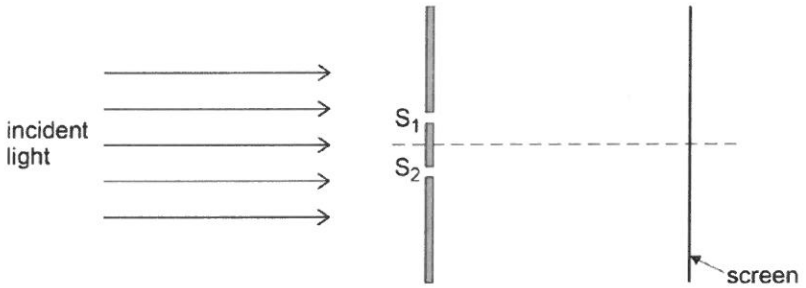
1 8 Two loudspeakers emit sound waves.

Which line in the table gives the correct frequency condition and the correct phase condition for the waves from the loudspeakers to be coherent?

[1 mark]

	Frequency condition	Phase condition	
A	same frequency	variable phase difference	⬭
B	constant frequency difference	constant phase difference	⬭
C	constant frequency difference	in phase	⬭
D	same frequency	constant phase difference	⬭

1 9 When a parallel beam of monochromatic light is directed at two narrow slits, S_1 and S_2, interference fringes are observed on a screen.

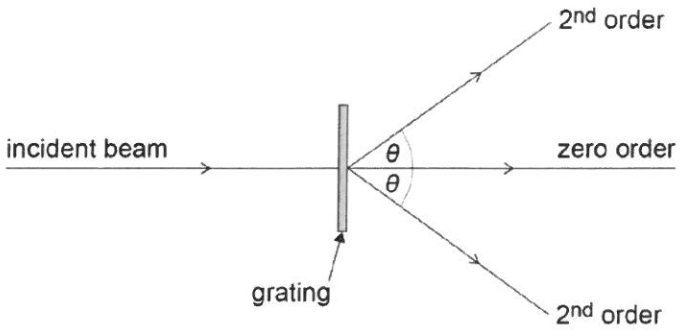


Which line in the table gives the changes that will increase the spacing of the fringes?

[1 mark]

	Slit spacing	Distance from slits to screen	
A	halved	halved	⬭
B	halved	doubled	⬭
C	doubled	halved	⬭
D	doubled	doubled	⬭

2 0 A parallel beam of monochromatic light is directed normally at a plane transmission grating which has N slits per metre. The second order diffracted beam is at angle θ to the zero order transmitted beam.



The grating is then replaced by a plane transmission grating which has $2N$ slits per metre.

Which one of the following statements is correct?

[1 mark]

A With the first grating, the first order beam is at angle 0.5θ to the zero order transmitted beam. ⬭

B With the second grating, the first order beam is at angle 0.5θ to the zero order transmitted beam. ⬭

C With the second grating, the first order beam is at angle θ to the zero order transmitted beam. ⬭

D With the second grating, the second order beam is at angle θ to the zero order transmitted beam. ⬭

2 1 A layer of liquid of refractive index 1.6 covers the horizontal flat surface of a glass block of refractive index 1.5. A ray of light strikes the boundary between them at an angle such that it travels along the boundary afterwards.

How does the ray strike the boundary?

[1 mark]

A it travels in glass at an angle of $70°$ to the boundary ⬭

B it travels in glass at an angle of $20°$ to the boundary ⬭

C it travels in the liquid at an angle of $70°$ to the boundary ⬭

D it travels in the liquid at an angle of $20°$ to the boundary ⬭

2 2 Which of the following is a scalar quantity?

[1 mark]

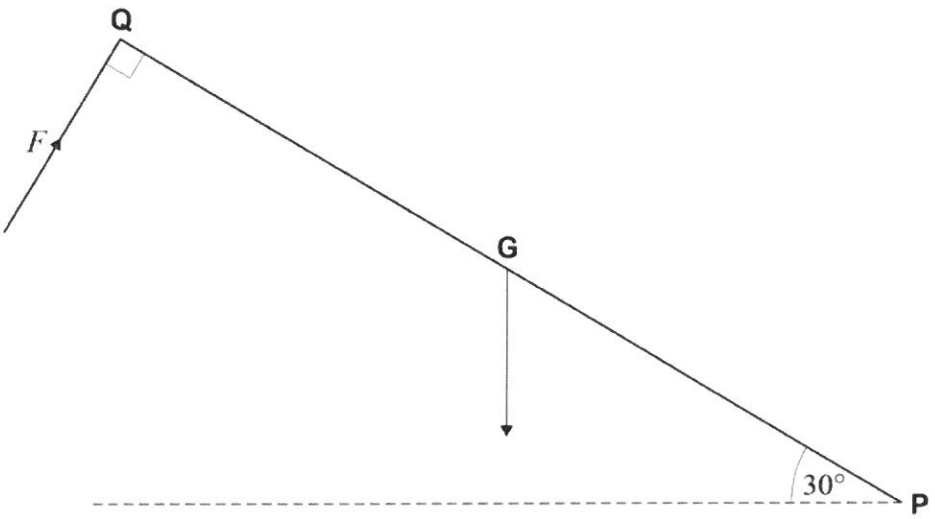
A kinetic energy ⬭

B momentum ⬭

C force ⬭

D acceleration ⬭

2 3 A car bonnet, represented by **QP**, of mass 12 kg is pivoted at **P**. Its weight acts at **G** where **QG** = **GP** = 1.0 m.



What force, F, acting perpendicular to **QP** as shown, is required to hold the bonnet at 30° to the horizontal?

[1 mark]

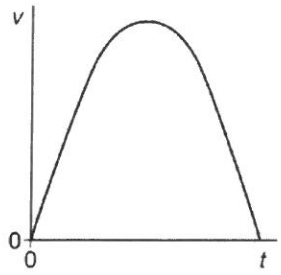
A 29 N ⬭

B 51 N ⬭

C 59 N ⬭

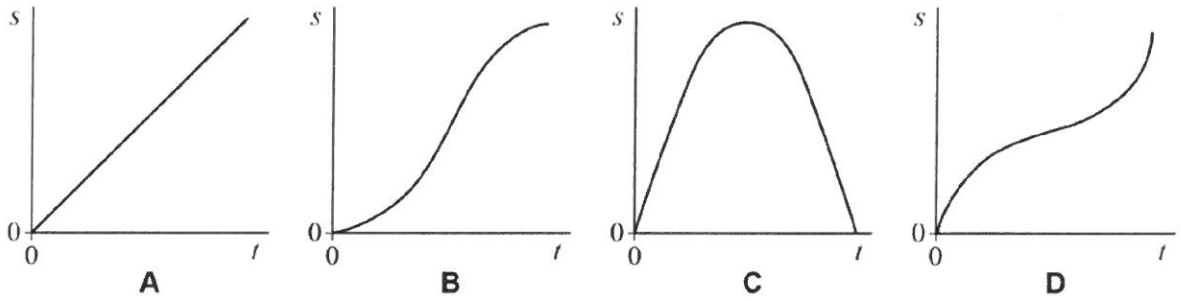
D 136 N ⬭

2 4 A body travels with speed v, which varies with time t as shown in the graph.



Which one of the graphs, **A** to **D**, shows how the distance s covered by the body varies with time t?

[1 mark]



A ○

B ○

C ○

D ○

2 5 A body of mass 4 kg falls vertically through the air.

What is the acceleration of the body when the magnitude of the air resistance is 30 N?

[1 mark]

A $17.3\ \text{m s}^{-2}$ ○

B $7.7\ \text{m s}^{-2}$ ○

C $2.3\ \text{m s}^{-2}$ ○

D $0.4\ \text{m s}^{-2}$ ○

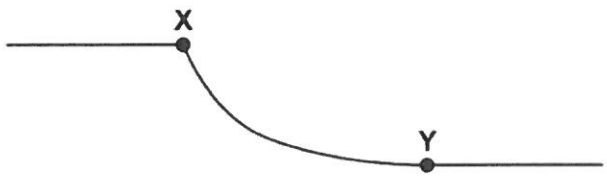
2 6 A stone of mass $0.4\ \text{kg}$ is projected horizontally at a speed of $6.0\ \text{m s}^{-1}$ from the top of a wall, $5.0\ \text{m}$ above the surrounding ground. When it arrives at the ground its speed is $10\ \text{m s}^{-1}$.

How much energy is lost by the stone in falling through the air?

[1 mark]

A 2.4 J ○
B 6.8 J ○
C 12.8 J ○
D 14.4 J ○

2 7 Two unpowered toy cars, **P** and **Q**, are released from rest from **X** and travel down the track to **Y**. Car **P** has twice the mass of car **Q**. There is negligible friction.



What quantity is the same for car **P** and car **Q**?

[1 mark]

A The gravitational potential energy at **X**. ○
B The accelerating force at **X**. ○
C The velocity when they arrive at **Y**. ○
D The momentum when they arrive at **Y**. ○

Turn over for the next question

2 8 A wire of length L and cross-sectional area A is stretched a distance e by a tensile force. The Young modulus of the material of the wire is E.

Which expression gives the elastic energy stored in the stretched wire?

[1 mark]

A $\frac{1}{2}\frac{EAe^2}{L}$ ⬭

B $\frac{1}{2}\frac{L}{Ae}$ ⬭

C $\frac{1}{2}\frac{Ae^2}{EL}$ ⬭

D $\frac{1}{2}\frac{EAL}{e}$ ⬭

2 9 When the temperature of a copper wire increases, its ability to conduct electricity

[1 mark]

A remains the same. ⬭

B increases. ⬭

C decreases. ⬭

D remains the same at first and then increases. ⬭

3 0 What is the best estimate for the order of magnitude for the diameter of an atom?

[1 mark]

A 10^{-14} m ⬭

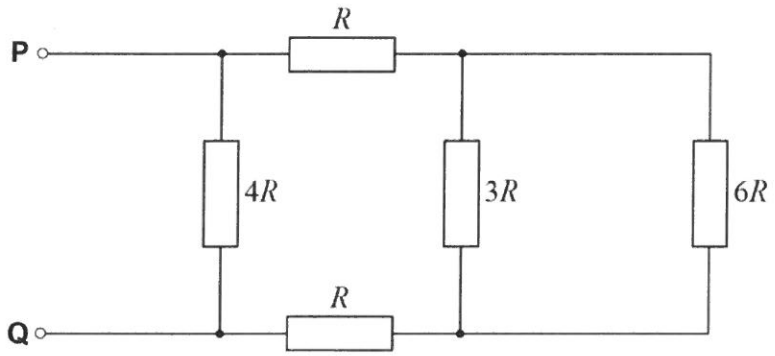
B 10^{-12} m ⬭

C 10^{-11} m ⬭

D 10^{-8} m ⬭

3 1 The diagram shows a network of resistors connected between the terminals **P** and **Q**.

The resistance of each resistor is shown.



What is the effective resistance between **P** and **Q**?

[1 mark]

A R ⬭

B $2R$ ⬭

C $3R$ ⬭

D $4R$ ⬭

3 2 A metal wire has a length l and a cross-sectional area A. When a potential difference V is applied to the wire, there is a current I in the wire.

What is the resistivity of the wire?

[1 mark]

A $\frac{IA}{Vl}$ ⬭

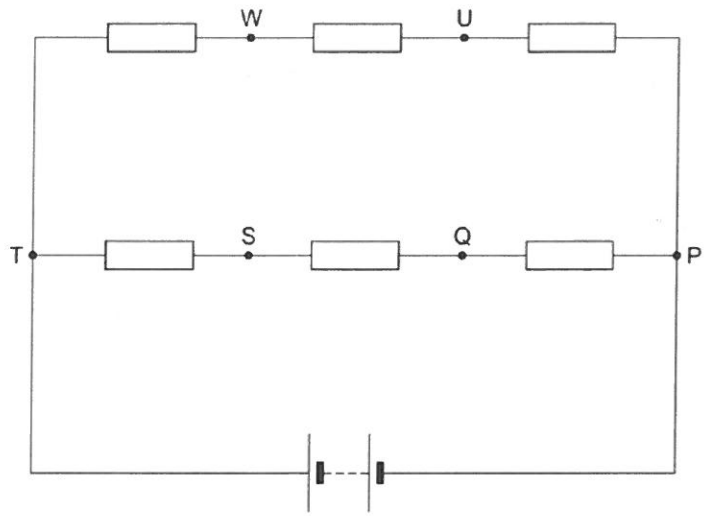
B $\frac{VA}{Il}$ ⬭

C $\frac{Il}{VA}$ ⬭

D $\frac{Vl}{IA}$ ⬭

Turn over for the next question

3 3 In the circuit shown below, each of the resistors has the same resistance.



A voltmeter with very high resistance is connected between two points in the circuit.

Between which two points of connection would the voltmeter read zero?

[1 mark]

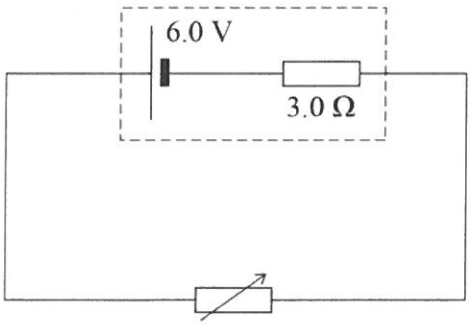
A Q and U ⬭

B P and T ⬭

C Q and W ⬭

D S and U ⬭

3 4 The cell in the following circuit has an emf (electromotive force) of 6.0 V and an internal resistance of 3.0 Ω. The resistance of the variable resistor is set to 12 Ω.



How much electrical energy is converted into thermal energy **within the cell** in 1 minute?

[1 mark]

A 0.48 J ⬭

B 29 J ⬭

C 45 J ⬭

D 144 J ⬭

END OF QUESTIONS