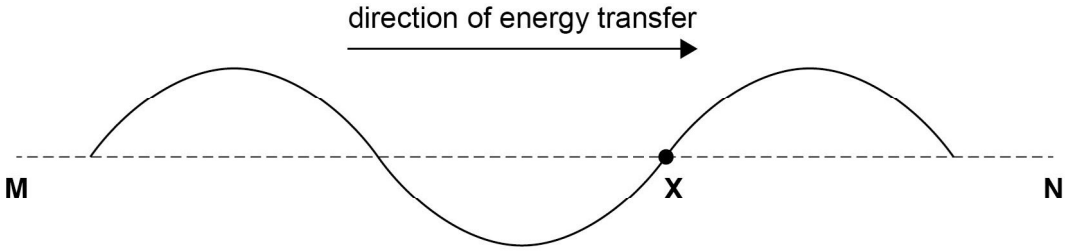
Do not write outside the box

1 5 A progressive wave travels along a rope in the direction **M** to **N**.

X marks a point on the rope.



The wave has a frequency of $5.0\ \text{Hz}$, a wavelength of $1.0\ \text{m}$ and an amplitude of $0.20\ \text{m}$.

Where will **X** be after $0.15\ \text{s}$?

[1 mark]

A below **MN** by $0.20\ \text{m}$ ⬭

B above **MN** by $0.20\ \text{m}$ ⬭

C nearer **N** by $0.15\ \text{m}$ ⬭

D nearer **N** by $0.75\ \text{m}$ ⬭

1 6 What is true for an inelastic collision between two isolated objects?

[1 mark]

A Both total momentum and total kinetic energy are conserved. ⬭

B Neither total momentum nor total kinetic energy is conserved. ⬭

C Only total kinetic energy is conserved. ⬭

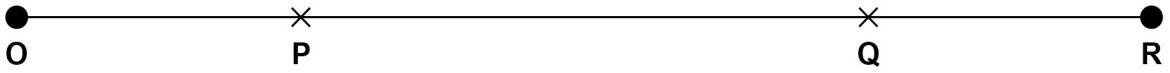
D Only total momentum is conserved. ⬭

Do not write outside the box

1 7 The diagram shows a string stretched between two fixed points **O** and **R** which are 120 cm apart.

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

OP = 30 cm
OQ = 90 cm



At a certain frequency the string vibrates at its first harmonic.

P and **Q** oscillate in phase.

The frequency is gradually increased.

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

[1 mark]

A second ⬭

B third ⬭

C fourth ⬭

D fifth ⬭

Turn over for the next question

Do not write outside the box

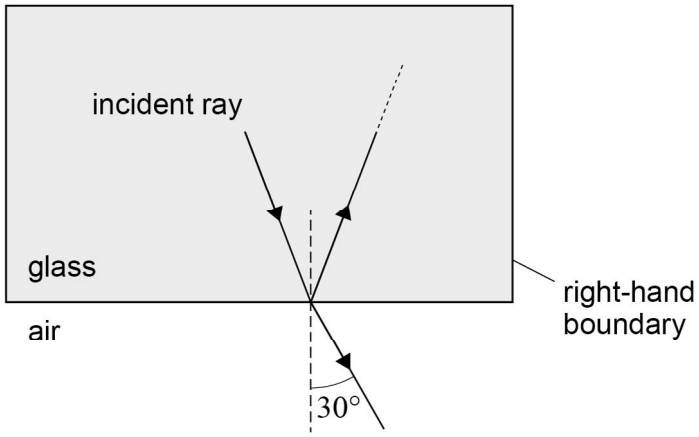
1 8 A ray of light is incident on the internal boundary of a rectangular glass block in air.

Part of the light refracts out of the block at an angle of 30°.

Some of the remaining light reflects within the block to become incident on the right-hand boundary.

refractive index of glass = 1.48

not to scale



What is the angle of incidence of the ray at the right-hand boundary?

[1 mark]

A 20° ⬭

B 42° ⬭

C 48° ⬭

D 70° ⬭

Do not write outside the box

1 9 In a Young's double-slit experiment, monochromatic light is incident on two narrow slits and the resulting interference pattern is observed on a screen.

Which change **decreases** the fringe separation?

[1 mark]

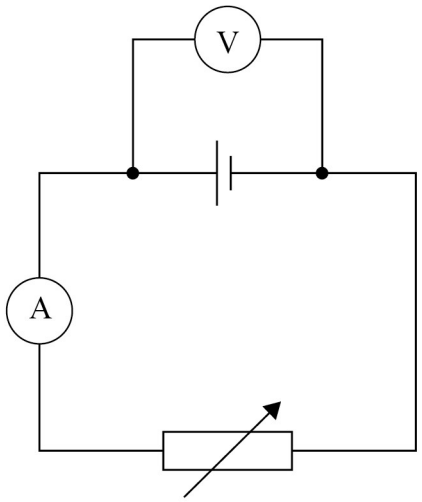
A decreasing the separation between the two slits ⬭

B increasing the distance between the slits and the screen ⬭

C using monochromatic light of higher frequency ⬭

D using monochromatic light of longer wavelength ⬭

2 0 In the circuit shown, the cell has an emf of $12\ \text{V}$ and an internal resistance which is not negligible.



When the resistance of the variable resistor is $10\ \Omega$ the voltmeter reads $10\ \text{V}$ and the ammeter reads $1.0\ \text{A}$.

The resistance of the variable resistor is changed to $5\ \Omega$.

What is the new reading on the ammeter?

[1 mark]

A $1.4\ \text{A}$ ⬭

B $1.7\ \text{A}$ ⬭

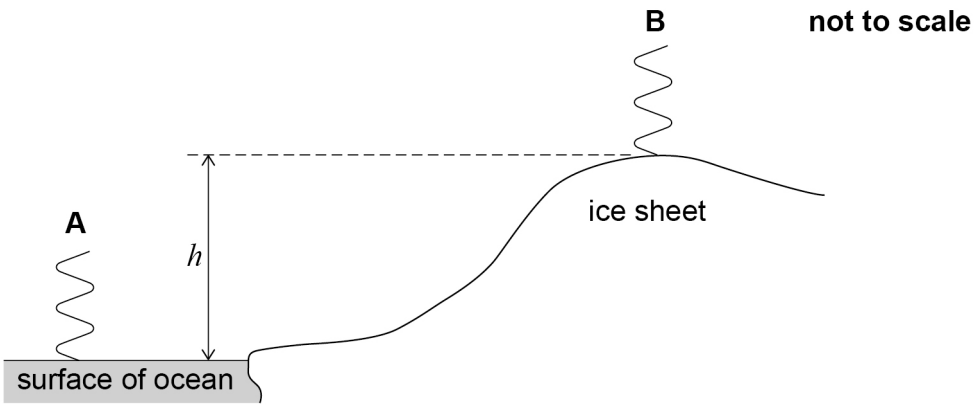
C $2.0\ \text{A}$ ⬭

D $2.4\ \text{A}$ ⬭

Do not write outside the box

0 3 A satellite system is used to measure the height h of the top of an ice sheet above the surface of the ocean.
The satellite emits two pulses **A** and **B** of infrared radiation. **A** is incident on the surface of the ocean and **B** is incident on the top of the ice sheet as shown in **Figure 2**.

Figure 2



0 3 . 1 The frequency of the infrared radiation is 3.8×10^{14} Hz.
Each pulse has a duration of 6.0 ns.

Calculate the number of cycles in each pulse.

[2 marks]

number of cycles = _____

0 3 . 2 **A** and **B** reflect and return to the satellite. The travel time is the time between the emission of a pulse and its return to the satellite.

The difference in the travel times of **A** and **B** is 10.7 μs.

Calculate h.

[2 marks]

h = _____ m

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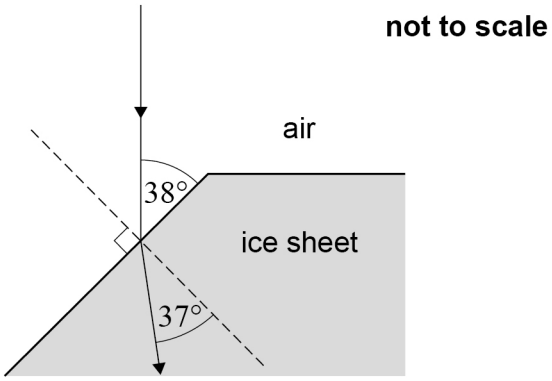
Some of the infrared radiation enters the ice sheet.

Figure 3 shows the path of infrared radiation that refracts at a sloping part of the ice sheet.

Figure 3



0 3 . 3 Calculate the refractive index of the ice.

[2 marks]

refractive index = _____

0 3 . 4 Calculate the wavelength of the infrared radiation when it is inside the ice sheet.

[2 marks]

wavelength = _____ m

8

Turn over ►

Do not write outside the box

Section B

Answer **all** questions in this section.

0 3 A student buys a portable loudspeaker that is powered by its own internal battery. The battery in the loudspeaker is initially uncharged.

0 3 . 1 The battery is connected to a charger that maintains a constant potential difference of 5.0 V across the battery. It takes 2.6 hours for the battery to become fully charged. The average current in the battery during this time is 2.0 A.

The battery is disconnected from the charger.
The fully-charged battery operates the loudspeaker for 12 hours before it is completely discharged.

Calculate the average output power of the battery during these 12 hours.

[2 marks]

average output power = _____ W

0 3 . 2 A mobile phone transmits data to the loudspeaker using microwaves. The data are processed at the loudspeaker to produce sound waves.

Microwaves and sound waves travel at different speeds.

Describe **two** other differences between microwaves and sound waves.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

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0 3 . 3 A second loudspeaker receives the same data from the mobile phone. The two loudspeakers act as coherent sources of sound waves.

State the **two** conditions required for the sources to be coherent.

[2 marks]

1 _____

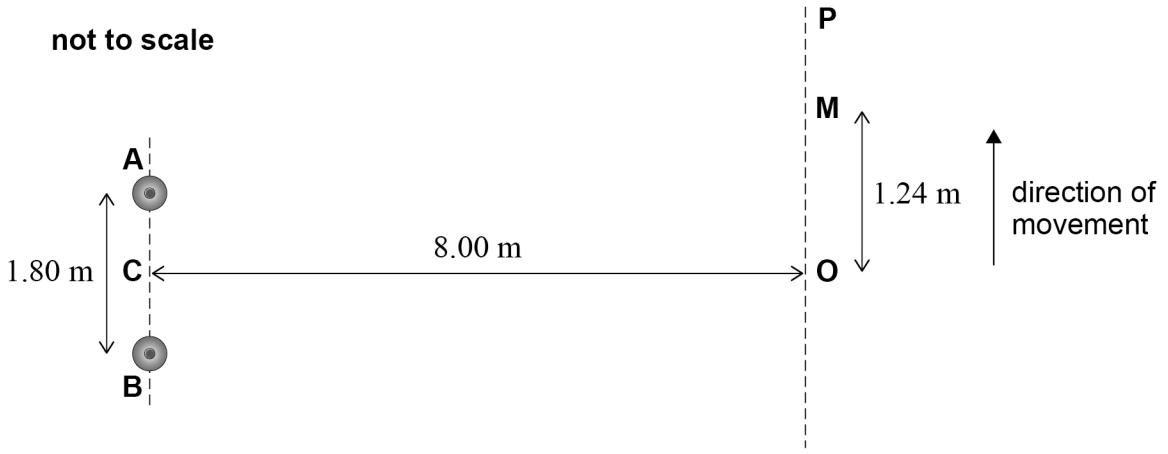
_____

2 _____

_____

Figure 5 shows two loudspeakers **A** and **B** that act as coherent point sources of sound of a single frequency.

Figure 5



C is the midpoint between **A** and **B**.
Distances **OA** and **OB** are equal.
OP is perpendicular to **CO**.

The student uses a sound-level meter to measure the intensity of the sound. The meter detects a maximum intensity at **O**.
The student moves the meter along **OP**. The intensity decreases and reaches a first minimum at **M**. The intensity then increases as the meter moves towards **P**.

The student records the following distances:

AB = 1.80 m
CO = 8.00 m
OM = 1.24 m.

Do not write outside the box

0 3 . 4 Show that the difference between the path lengths **AM** and **BM** is approximately $0.3\ \text{m}$.

[2 marks]

0 3 . 5 The speed of sound is $340\ \text{m s}^{-1}$.

Determine the frequency of the sound waves.

[2 marks]

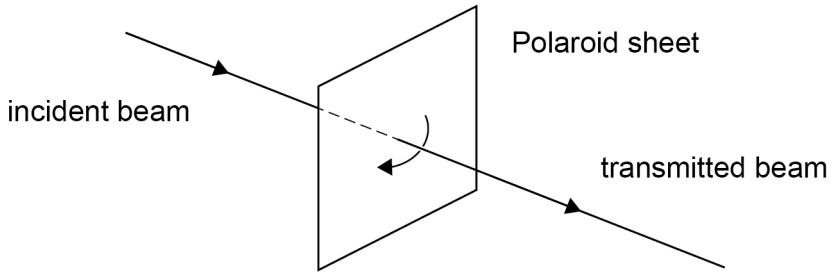
frequency = _____ Hz

10

Turn over for the next question

Do not write outside the box

1 1 A narrow beam of light is incident on a sheet of Polaroid material. The intensity of the transmitted beam is a maximum.



The Polaroid sheet is rotated about the beam by $90°$ and the intensity of the transmitted beam decreases to zero.

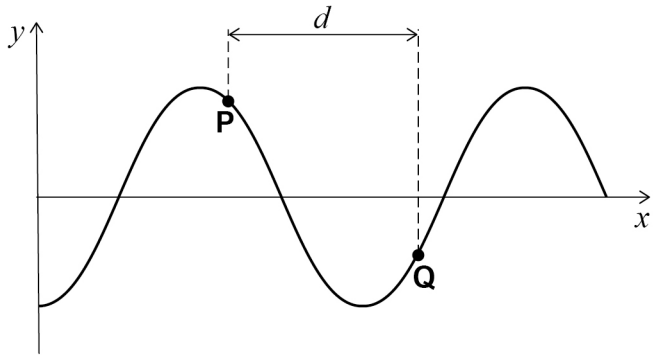
Which row explains this observation?

[1 mark]

	Nature of incident beam	**Action of Polaroid material as it is rotated**	
A	unpolarised	polarises the incident beam	⬭
B	unpolarised	absorbs the incident beam	⬭
C	polarised	absorbs the incident beam	⬭
D	polarised	changes the plane of polarisation of the incident beam	⬭

Do not write outside the box

1 5 Two points **P** and **Q** on a progressive wave are separated by distance d.



The phase difference between **P** and **Q** is θ rad.

What is the wavelength?

[1 mark]

A $\frac{\theta d}{2\pi}$ ⬭

B θd ⬭

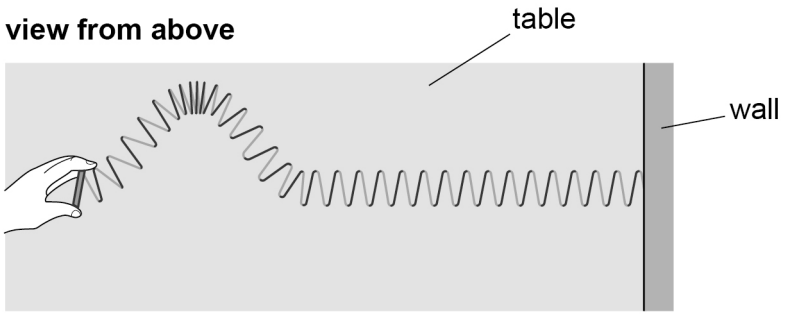
C $\frac{2\pi d}{\theta}$ ⬭

D $\frac{d}{\theta}$ ⬭

Turn over for the next question

Do not write outside the box

1 6 A long spring is used to demonstrate wave motion. The spring lies horizontally on a table. One end of the spring is attached to a wall.



The free end of the spring is quickly moved to one side and then back to the centre, creating a pulse.
This movement takes 0.40 s.
The pulse travels 4.0 m along the spring in a time of 2.0 s.

What is the length of the pulse?

[1 mark]

A 0.8 m ⬭

B 1.6 m ⬭

C 2.0 m ⬭

D 10.0 m ⬭

1 7 A stretched wire vibrates between two fixed points.
The frequency of the first harmonic of the vibrating wire is 300 Hz.
Without making any other change, the tension in the wire is doubled.

What is the frequency of the new first harmonic of the wire?

[1 mark]

A 150 Hz ⬭

B 420 Hz ⬭

C 600 Hz ⬭

D 1200 Hz ⬭

Do not write outside the box

1 8 A stationary wave forms on a uniform string.

Which statement is correct?

[1 mark]

A The amplitude of oscillations is a maximum at the nodes. ⬭

B The distance between two adjacent nodes equals one wavelength. ⬭

C The oscillations at two adjacent antinodes are in antiphase. ⬭

D The time period of oscillating sections varies along the string. ⬭

1 9 Monochromatic visible light is incident normally on a plane transmission diffraction grating that has 4.8×10^5 lines m^{-1}.
First-order maxima are observed at angles of $16°$ to the central maximum.

How many maxima in total can be observed?

[1 mark]

A 3 ⬭

B 4 ⬭

C 5 ⬭

D 7 ⬭

2 0 Which combination produces the smallest modal dispersion in an optical fibre?

[1 mark]

	Refractive index of core	Refractive index of cladding	
A	1.5	1.4	⬭
B	1.4	1.5	⬭
C	1.5	1.3	⬭
D	1.3	1.5	⬭