

Wednesday 13 May 2026 – Morning

AS Level Physics A

H156/01 Breadth in physics

Time allowed: 1 hour 30 minutes

You must have:

the Data, Formulae and Relationships Booklet

You can use:

- a scientific or graphical calculator
- a ruler (cm/mm)
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- This document has **28** pages.

ADVICE

- Read each question carefully before you start your answer.

Section A

You should spend a maximum of **25 minutes** on this section.

Write your answer to each question in the box provided.

1 Which unit is a **derived** SI unit?

- A** Coulomb
- B** Kilogram
- C** Metre
- D** Second

Your answer

[1]

2 What is a typical wavelength for X-rays?

- A** 10^0
- B** nm
- C** 10^3
- D** nm

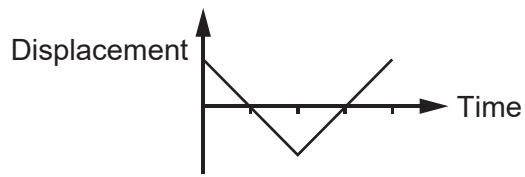
10^6
Your answer
nm

[1]

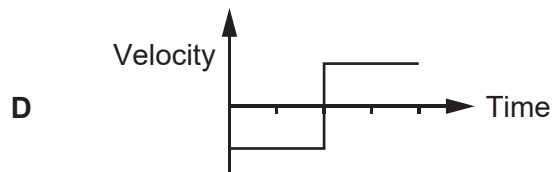
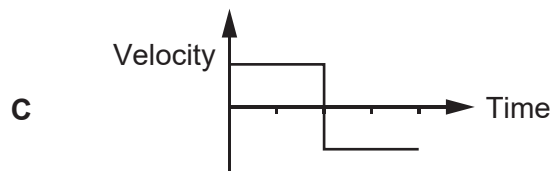
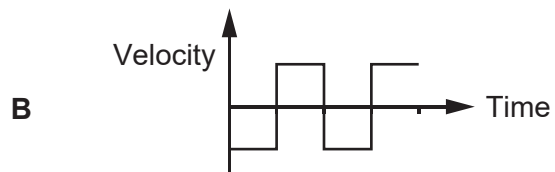
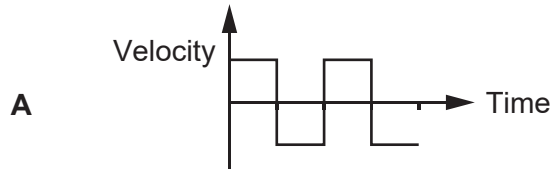
10^9

nm

- 3 A displacement–time graph for the motion of an object is shown.



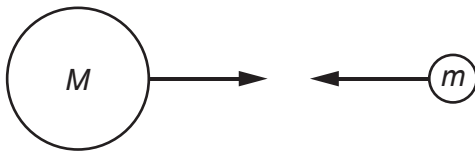
Which velocity–time graph shows this motion?



Your answer

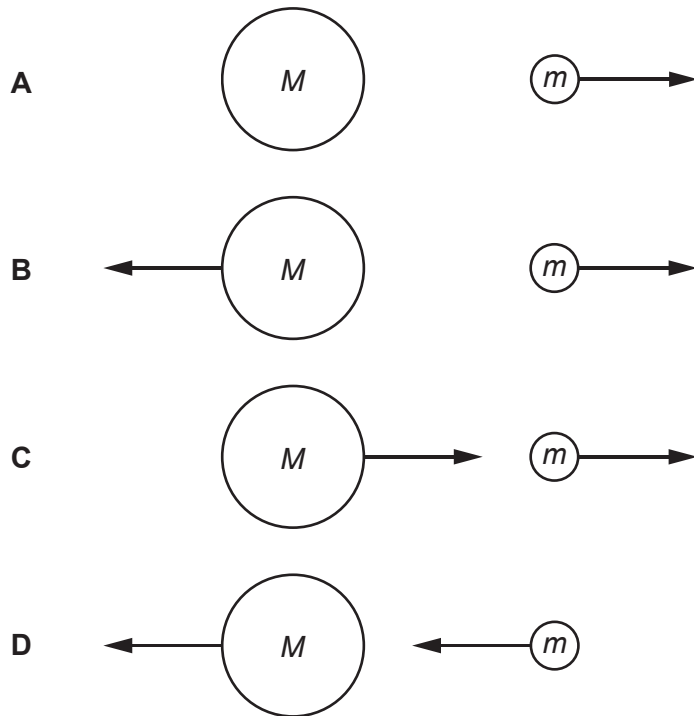
[1]

- 4 Two particles are travelling towards each other with the same speed. They collide elastically. The particles have masses M and m , where $M > m$.



Which diagram shows the motion of the particles after the collision?

The arrows show the **direction** of motion only. The diagrams are **not** to scale.

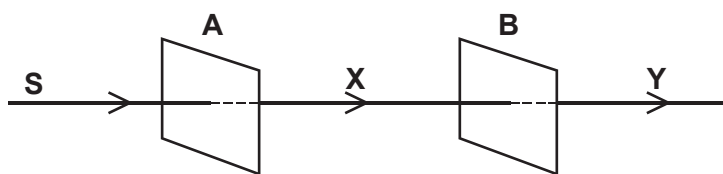


Your answer ☐

[1]

5

The diagram shows a ray of light from a source **S** passing through two polarising filters **A** and **B**.



Initially, the intensity of the rays at **X** and **Y** is the same.

Filter **B** is then rotated until the intensity at **Y** is a minimum.

What angle is filter **B** rotated through?

- A** 45°
- B** 90°
- C** 180°
- D** 360°

Your answer

[1]

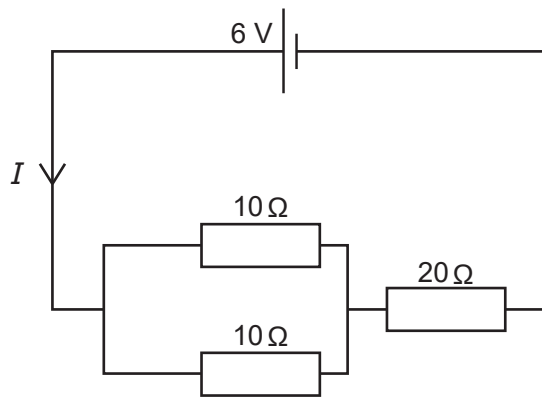
6 Which statement is true for all stationary waves?

- A** All points between adjacent nodes oscillate in phase.
- B** All points between adjacent nodes oscillate with the same amplitude.
- C** All points on a stationary wave oscillate in phase.
- D** All points on a stationary wave oscillate with the same amplitude.

Your answer

[1]

- 7 The diagram shows three resistors connected to a 6 V cell. The cell has negligible internal resistance.



What is the size of the current I ?

A 0.12

B A

C 0.15

D A

0.24
Your answer

A

0.60

A

[1]

- 8 A small bubble of air is released at the bottom of a beaker of water. It accelerates upwards.

A drag force acts on the bubble as it rises. The volume of the bubble is assumed to be constant.

Which row shows how the acceleration and drag force change while the bubble accelerates?

	Size of the acceleration Decreases	Size of the drag force Decreases
A		
B	Decreases	Increases
C	Increases	Decreases
D	Increases	Increases

Your answer

[1]

- 9 Beaker **A** contains mercury. The pressure at the bottom of **A** from the mercury is P .

Beaker **B** contains water. The depth of the water in **B** is **twice** the depth of the mercury in **A**.
What is the pressure at the bottom of **B** from the water?

Density of mercury = $14\,000\text{ kg m}^{-3}$

Density of water = 1000 kg m^{-3}

A $0.036 P$

B $0.14 P$

C $7 P$

D $28 P$

Your answer

[1]

- 10 Visible light has wavelengths between $4.0 \times 10^{-7} \text{ m}$ and $7.0 \times 10^{-7} \text{ m}$.

What is the maximum energy of a photon of visible light?

- A 1.8
B eV
C 2.8
D eV

3.1
Your answer
eV

[1]

- 11 A ball of mass 0.70 kg moves vertically downwards towards the ground. The ball hits the ground at a speed of 2.2 m s^{-1} .

The ball then rebounds with a speed of 1.8 m s^{-1} in the opposite direction.

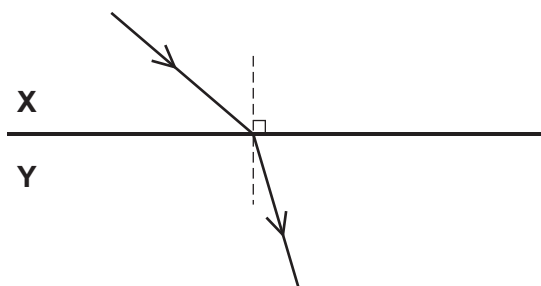
What is the impulse exerted on the ground?

	Magnitude of impulse / N s	Direction of impulse
A	0.28	Downwards
B	0.28	Upwards
C	2.8	Downwards
D	2.8	Upwards

Your answer

[1]

- 12 A ray of light refracts at the boundary between materials **X** and **Y**.



Which row of the table is correct?

	Material with larger refractive index	How the speed changes at the boundary
A	X	Slows down
B	X	Speeds up
C	Y	Slows down
D	Y	Speeds up

Your answer

☐

[1]

- 13 The potential difference across a filament lamp is increased at a constant rate.

Which statement is correct?

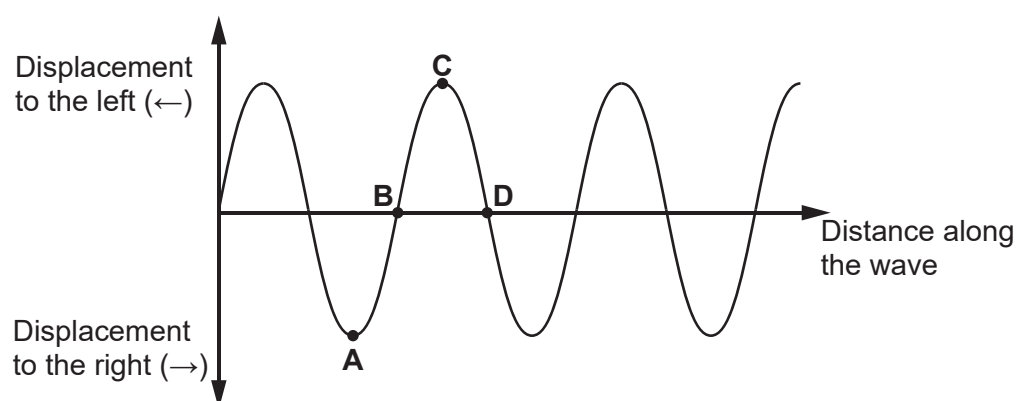
- A** The current gets smaller at a decreasing rate.
- B** The current gets smaller at an increasing rate.
- C** The current gets larger at a decreasing rate.
- D** The current gets larger at an increasing rate.

Your answer

☐

[1]

- 14 The graph shows displacement of particles in a longitudinal wave at one moment in time. Each point is a particle at a different position along the wave.



Which point, **A**, **B**, **C** or **D**, shows a **compression**?

Your answer

[1]

- 15 A ball is dropped from a height of 2.5 m.

What is its speed when it hits the ground?

Use $g = 9.81 \text{ m s}^{-2}$.

A 2.2 m s^{-1}

B 3.5 m s^{-1}

C 7.0 m s^{-1}

D 49 m s^{-1}

Your answer s^{-1}

[1]

- 16** Two equal and opposite forces of 15 N act on opposite edges of a wheel to form a couple.

The perpendicular distance between the forces is 0.80 m.

What is the torque of the couple?

- A** 3 N m
- B** 6 N m
- C** 12 N
- D** m 24

Your answer

[1]

- 17** Two identical waves meet in phase at a point and superpose. Each wave has intensity I .

What is the intensity of the resultant wave?

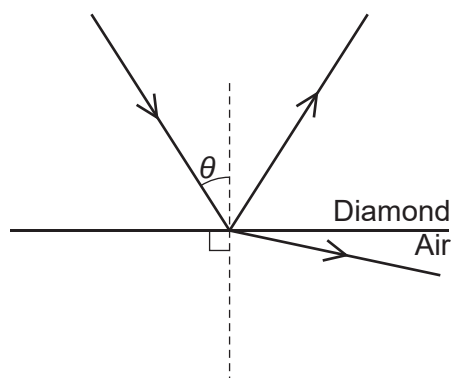
- A** I
- B** $\sqrt{2}I$
- C** $2I$
- D** $4I$

Your answer

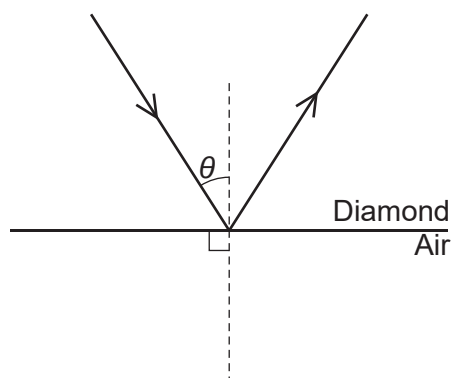
[1]

- 18 The diagrams show red and violet light meeting a boundary between diamond and air. Both colours hit the boundary at the **same** angle θ to the normal.

Red light



Violet light



Not to scale

Refractive index of red light in diamond = 2.41
 Refractive index of violet light in diamond = 2.46

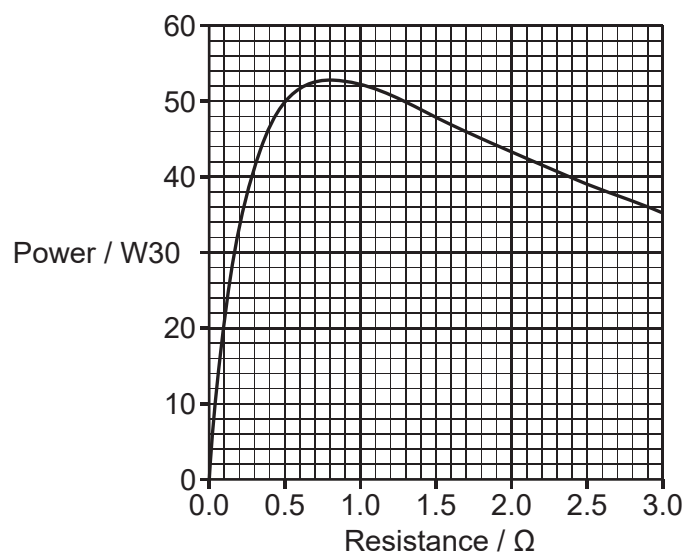
What is a possible angle for θ ?

- A 22°
- B 23°
- C 24°
- D 25°

Your answer

[1]

- 19 The graph shows power delivered to a load against resistance.



What is the current when maximum power is delivered to the load?

Use the equation: $P = I^2 R$

- A 6.5
B A
C 8.1
D A 42

A 66
Your answer
A

[1]

- 20 The table shows the properties of four metal wires.

	Resistivity / $\Omega \text{ m}$	Cross-sectional area / mm^2	Length / m
A	1.6×10^{-8}	0.75	2.00
B	1.6×10^{-8}	1.6	2.00
C	5.6×10^{-8}	0.75	2.00
D	5.6×10^{-8}	1.6	2.00

Which wire has the greatest resistance?

Your answer

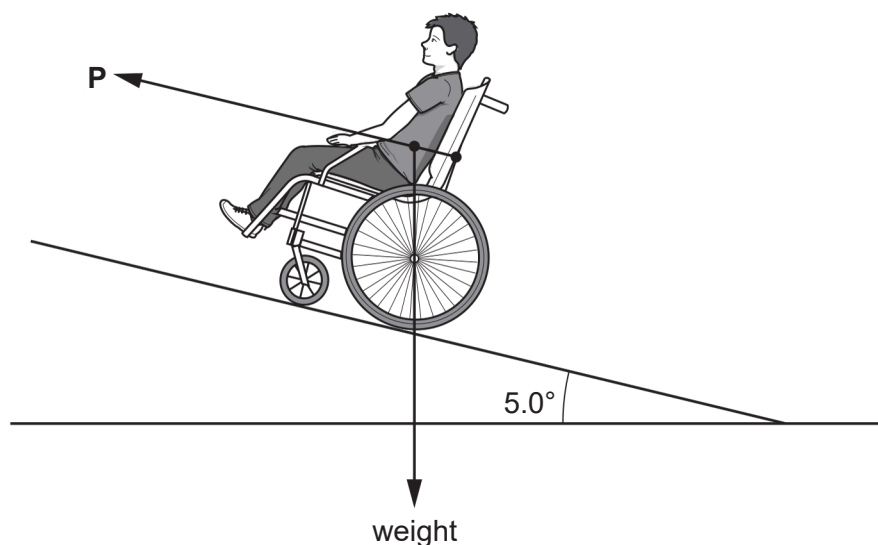
[1]

Section B

21 Ramps and lifts can be used to load wheelchairs into a vehicle.

- (a) The diagram shows a person in a wheelchair on a ramp at an angle of 5.0° to the horizontal. The wheelchair is in **equilibrium**.

A total forward force **P** acts on the wheelchair. The force **P** is parallel to the ramp.
Not to scale



- (i) Draw **one** arrow to show the **total** normal contact force **N** acting on the wheelchair.

Label the arrow **N**.

[2]

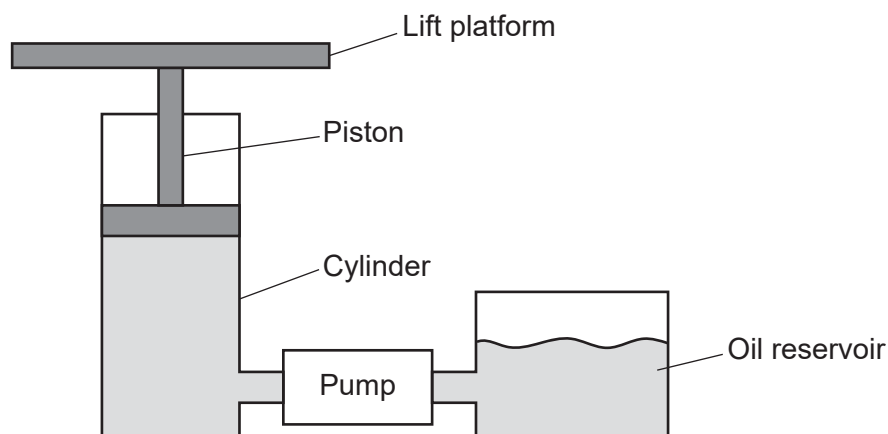
- (ii) The total mass of the wheelchair and person is 95 kg.

Calculate the size of the force **P**.

Give your answer to **an appropriate number of** significant figures.

Force **P** = ... N [3]

- (b) A simplified diagram of a hydraulic cylinder used in a wheelchair lift is shown.



To lift the platform, the pump pushes oil into the cylinder.

- (i) The oil pressure in the cylinder is 1.2×10^7 Pa. It exerts an upwards force of 500 N on the piston.

Calculate the cross-sectional area of the piston.

Cross-sectional area = ... m² [1]

- (ii) The oil in the cylinder exerts an upward force of 500 N on the piston. The lift platform rises at a constant speed of 420 cm min⁻¹.

Calculate the power provided by the oil.

Power = ... W [2]

22 An athlete uses gym equipment that contains springs. The springs obey Hooke's law up to their elastic limit.

(a) Explain why the springs must **not** exceed their elastic limit when the athlete uses the equipment.

.....

.....

.....

..... **[2]**

(b) The athlete exerts a force of 75 N on a spring.

The spring extends elastically by 110 cm.

(i) Calculate the force constant of the spring.

Force constant = ... N m^{-1} **[1]**

(ii) The athlete extends and releases the spring 22 times in 1 minute.

Each time they produce an extension of 110 cm.

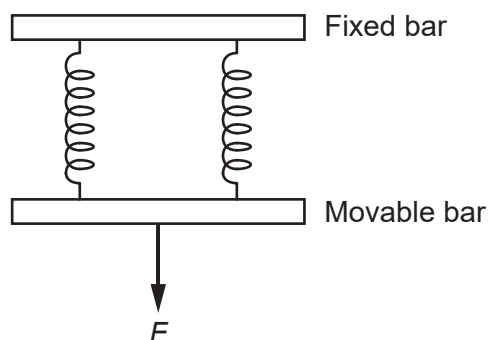
Calculate the power developed by the athlete.

Use your answer from **(b)(i)**.

Power = ... W **[3]**

- (c) Two identical springs are connected between two metal bars as shown.

Each spring has a force constant of 240 N m^{-1} .



The athlete pulls on the movable bar with a force F .

Both springs extend by 0.55 m .

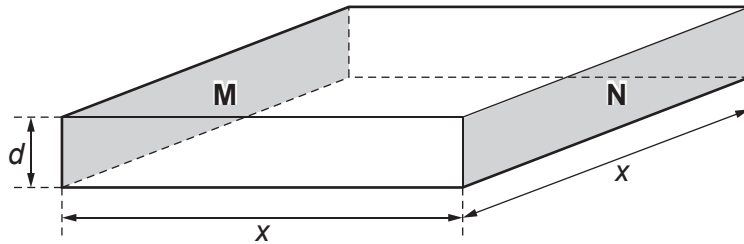
Calculate the magnitude of F .

Force $F = \dots\dots\dots \text{ N}$ [2]

23 Circuit boards in computers have copper tracks that conduct current.

(a) The diagram shows a square piece of copper track of side length x .

The thickness of the track is d .



(i) The resistance between the sides **M** and **N** is R .

Show that $R = \frac{\rho}{d}$, where ρ is the resistivity of copper.

[2]

(ii) A section of track is 28 times longer than its side length x .

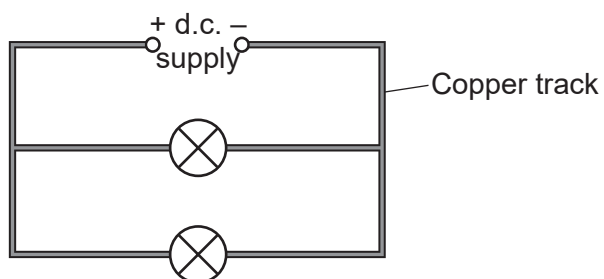
The thickness d of the track is $35 \mu\text{m}$.

Calculate the resistance of the section of track.

Resistivity of copper = $1.68 \times 10^{-8} \Omega \text{ m}$

Resistance = ... Ω [2]

- (b) An engineer uses copper tracks to connect lamps to a power supply as shown. The lamps are dim.



It is **not** possible to change the power supply or the lamps.

Suggest how the engineer can change the **copper track** so that the lamps are brighter.

.....

.....

.....

..... [2]

- (c) The engineer estimates the mean drift velocity of charge carriers in the copper track.
- (i) Describe the measurements and calculations needed to estimate the mean drift velocity.

[3]

- (ii) Explain why the drift velocity of charge carriers in a conductor is a **mean** value.

[2]

- (d) Some components on a circuit board are made using semiconductors.

When the temperature of a semiconductor increases, the number density of charge carriers increases.

Explain what happens to the resistance of a length of semiconductor when the temperature increases.

.....

.....

.....

..... [2]

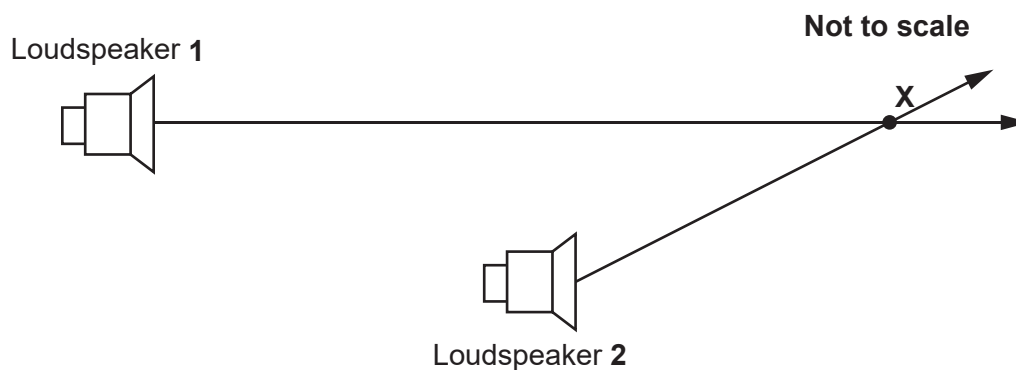
21
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Turn over for the next question

24 This question is about sound waves.

- (a) **Figure 24.1** shows two paths taken by sound waves emitted in phase from two coherent loudspeakers.

Figure 24.1



Distance from loudspeaker 1 to **X** is 21.0 m.
Distance from loudspeaker 2 to **X** is 7.00 m.

- (i) The waves superpose at **X** forming a point of minimum amplitude.

A student says that the wavelength of the sound waves could be 0.80 m.

Explain why the student is correct.

Use calculations in your answer.

.....

.....

.....

.....[2]

- (ii) Explain why the minimum amplitude is **not** exactly 0 at **X**.

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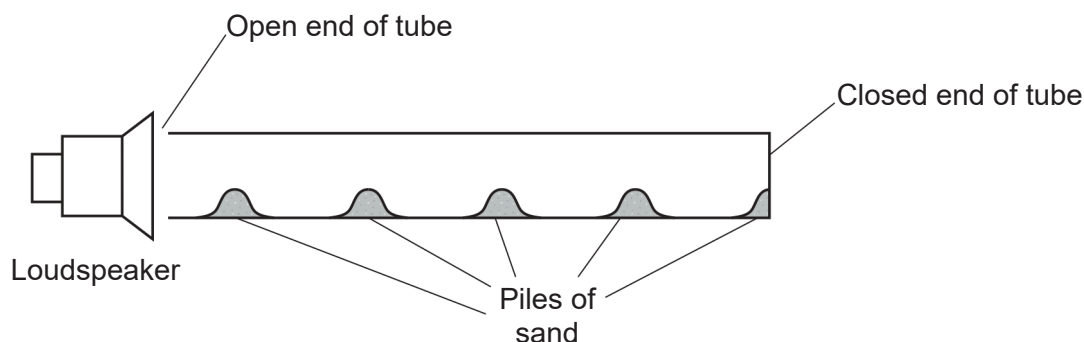
.....

.....[2]

- (b) A loudspeaker produces sound in a sand-lined horizontal tube as shown in **Figure 24.2**.

The tube is open at one end and closed at the other. Sound from the loudspeaker produces a stationary wave in the air in the tube.

Figure 24.2



- (i) Suggest why the sand forms equally spaced piles along the tube.

.....

[2]

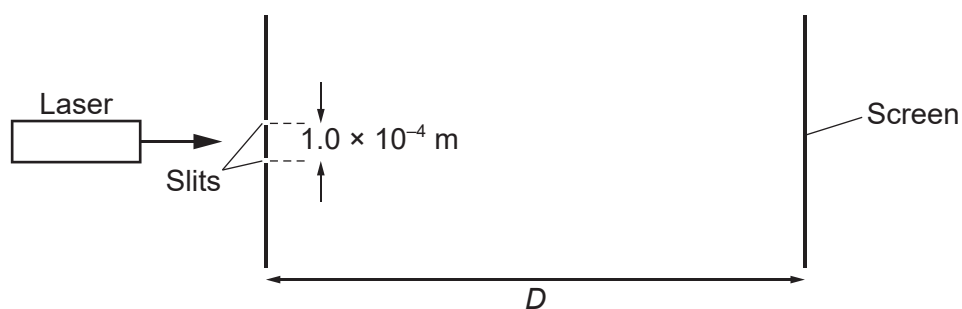
- (ii) The frequency of the sound wave is measured.

Describe how to determine the speed of sound in air using the apparatus in **Figure 24.2**.

.....

[3]

24 A student investigates the Young double-slit experiment using a laser as shown. A pattern of
 25 fringes is observed on a screen.



(a) The student's results are shown in the table:

Quantity	Value	Absolute uncertainty
Slit-separation, a / m	1.0×10^{-4}	Negligible
Distance from slits to screen, D / m	4.00	± 0.01
Fringe spacing, x / mm	19	± 1

(i) Calculate the wavelength using the student's results.

Give your answer in nm.

Wavelength = ... nm [2]

(ii) Calculate the absolute uncertainty in the student's value for the wavelength.

Use your answer from (a)(i).

Absolute uncertainty = ... nm [3]

- (b) The student collects further data and obtains a final value of $495 \text{ nm} \pm 3\%$.
The supplier of the laser states that the wavelength is $532 \text{ nm} \pm 3.5\%$.

Evaluate whether the student's final value is consistent with the supplier's value.

Include calculations in your answer.

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.....

.....

.....[2]

- (c) The laser is now replaced by an electron beam.

The electrons are accelerated to 10% of the speed of light in a vacuum.

- (i) Calculate the de Broglie wavelength of the electrons in the beam.

Give your answer to **2** significant figures.

de Broglie wavelength = ... m [3]

- (ii) Explain why a double-slit with separation $1.0 \times 10^{-4} \text{ m}$ could **not** be used to show an interference pattern using this electron beam.

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.....[2]

END OF QUESTION PAPER

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