AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.3 WAVES AND 3.6.1 PERIODIC MOTION

SCORE	PERCENTAGE
/347	%

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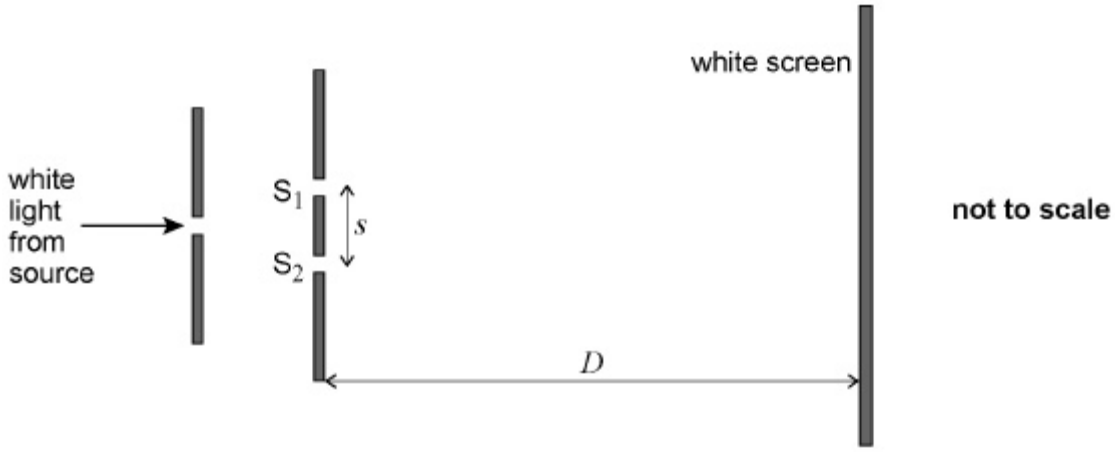
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Q1.

The figure below shows a diagram of apparatus used to demonstrate the formation of interference fringes using a white light source in a darkened room. Light from the source passes through a single slit and then through two narrow slits S_1 and S_2.



(a) Describe the interference pattern that is seen on the white screen.

(2)

(b) A filter transmits only green light of wavelength λ and red light of wavelength 1.2λ This filter is placed between the light source and the single slit.

Describe the interference pattern now seen on the white screen.

Use a calculation to support your answer.

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(4)

(c) A student decides to use the apparatus shown in the figure to determine the wavelength of red light using a filter that transmits only red light.

The student suggests the following changes:

- decrease slit separation s
- decrease D, the distance between the slits and the screen.

The student decides to make each change independently.

Discuss the effects each independent change has on the interference pattern, and whether this change is likely to reduce uncertainty in the determination of the wavelength.

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(6)

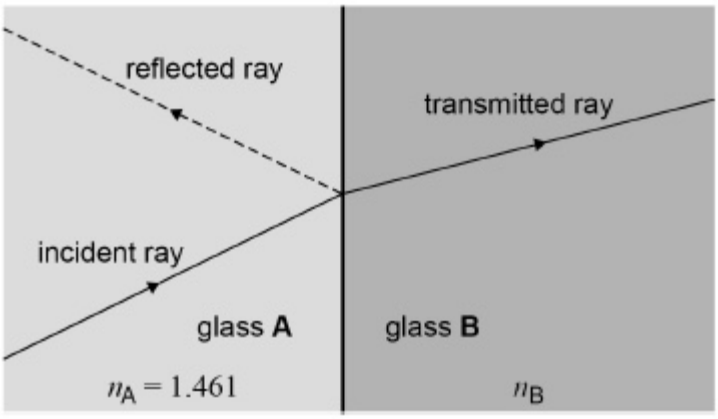
(Total 12 marks)

Q2.

(a) **Figure 1** shows an incident ray of light being partially reflected at the boundary between glass **A** and glass **B**. The refractive index n_A of glass **A** is 1.461

The speed of light in glass **B** is 3.252% less than the speed of light in glass **A**.

Figure 1



Calculate the refractive index n_B of glass **B**.

Give your answer to an appropriate number of significant figures.

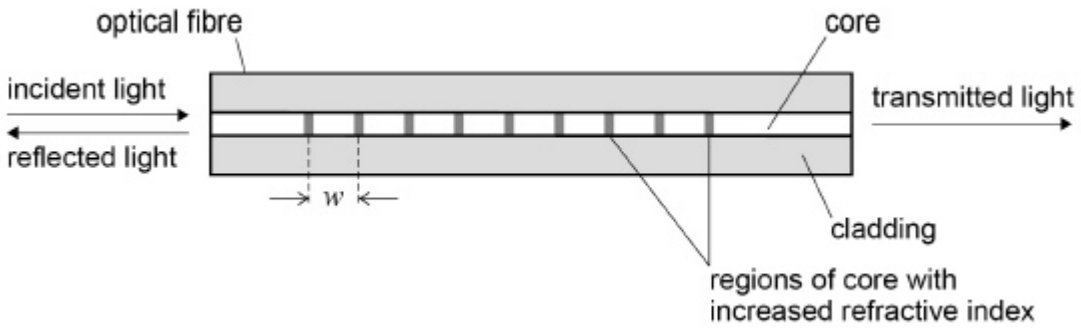
speed of light in a vacuum = 2.998×10^8 m s^{-1}

n_B = _____

(3)

(b) **Figure 2** shows a cross-sectional view of an optical fibre strain gauge.

Figure 2



A maximum intensity of the reflected light is produced due to superposition of the

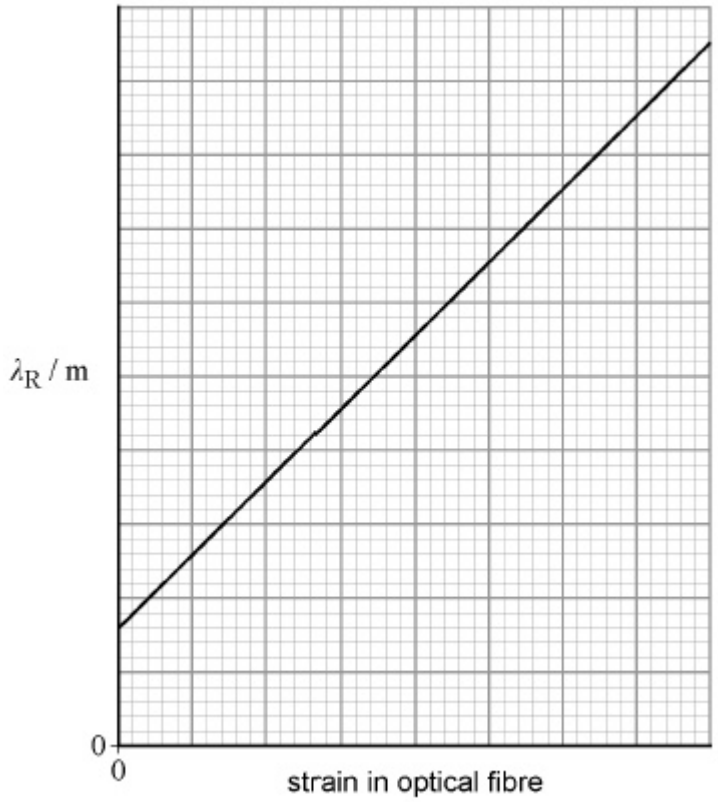
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light reflected from each of the regions with increased refractive index in the core.

This maximum intensity occurs at a particular wavelength λ_R.

Figure 3 shows the relationship between λ_R and the strain in the optical fibre.

Figure 3



A cable is used to raise and lower a lift. An engineer fixes the optical fibre strain gauge to the cable to monitor changes of the strain in the cable.

The lift is initially at rest and then accelerates downwards for a short time before reaching a constant velocity.

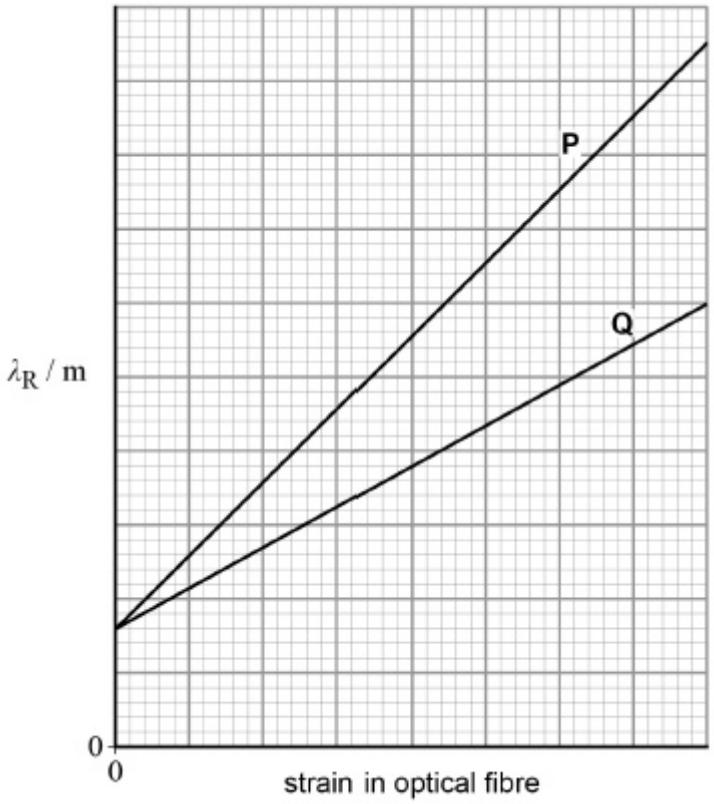
Discuss how the value of λ_R changes.

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(3)

(c) **Figure 4** shows the relationship between λ_R and the strain in two optical fibre strain gauges **P** and **Q**. The engineer wishes to measure small accelerations in another lift. She can choose to fix either optical fibre strain gauge **P** or optical fibre strain gauge **Q** to the lift's cable.

Figure 4



Explain which gauge the engineer should select.

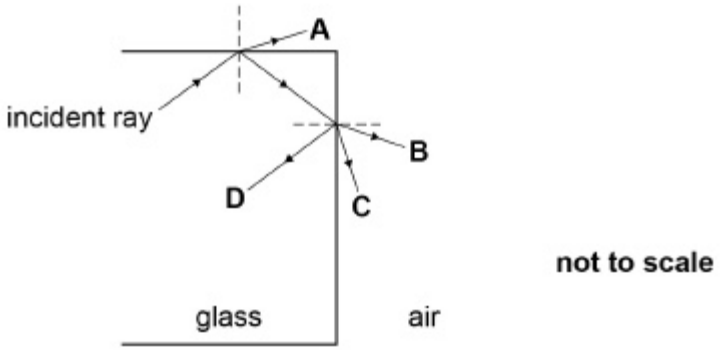
(2)

(Total 8 marks)

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Q3.

A ray of light is incident on a glass–air boundary of a rectangular block as shown.



The refractive index of this glass is 1.5
The refractive index of air is 1.0
The angle of incidence of the light at the first glass–air boundary is 44°

What is the path of the ray of light?

A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

Q4.

The fundamental frequency f is the lowest frequency heard when a stretched string is vibrating.

The string is now lightly touched one third of the way along its length.

What is the lowest frequency heard?

A $\frac{f}{3}$ ⬭

B $\frac{2f}{3}$ ⬭

C f ⬭

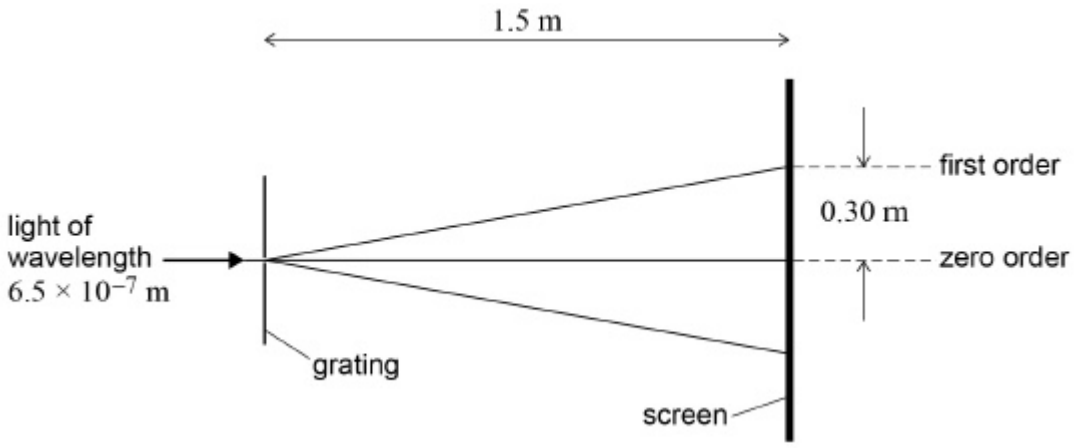
D $3f$ ⬭

(Total 1 mark)

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Q5.

A diffraction grating is illuminated normally with light of wavelength 6.5×10^{-7} m
When a screen is 1.5 m from the grating, the distance between the zero and first-order maxima on the screen is 0.30 m



What is the number of lines per mm of the diffraction grating?

A 3.3×10^{-6} ⬭

B 3.3×10^{-3} ⬭

C 3.0×10^{2} ⬭

D 3.0×10^{5} ⬭

(Total 1 mark)

Q6.

Two points on a progressive wave have a phase difference of $\frac{\pi}{6}$ rad
The speed of the wave is 340 m s^{-1}

What is the frequency of the wave when the minimum distance between the two points is 0.12 m?

A 240 Hz ⬭

B 470 Hz ⬭

C 1400 Hz ⬭

D 2800 Hz ⬭

(Total 1 mark)

Q7.

Figure 1 shows the structure of a violin and **Figure 2** shows a close-up image of the tuning pegs.

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Figure 1

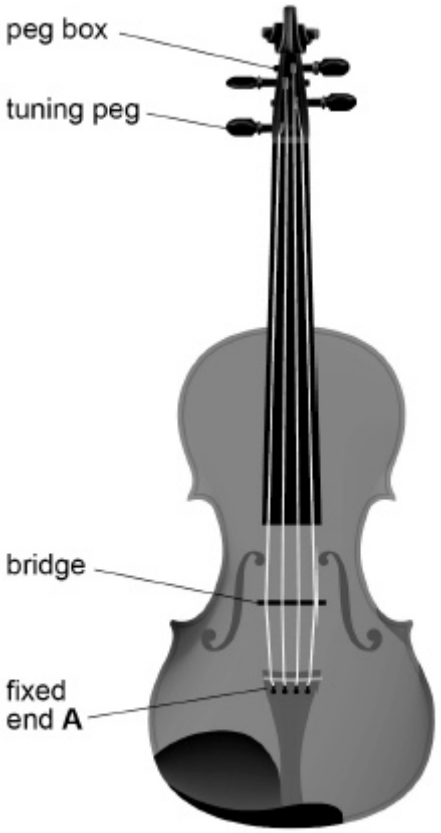
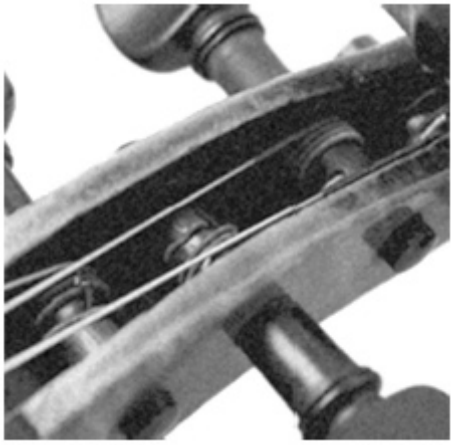


Figure 2



The strings are fixed at end **A**. The strings pass over a bridge and the other ends of the strings are wound around tuning pegs that have a circular cross-section. The tension in the strings can be increased or decreased by rotating the tuning pegs.

(a) Explain how a stationary wave is produced when a stretched string is plucked.

(3)

(b) The vibrating length of one of the strings of a violin is 0.33 m
When the tension in the string is 25 N, the string vibrates with a first-harmonic frequency of 370 Hz

Show that the mass of a 1.0 m length of the string is about 4×10^{-4} kg

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(2)

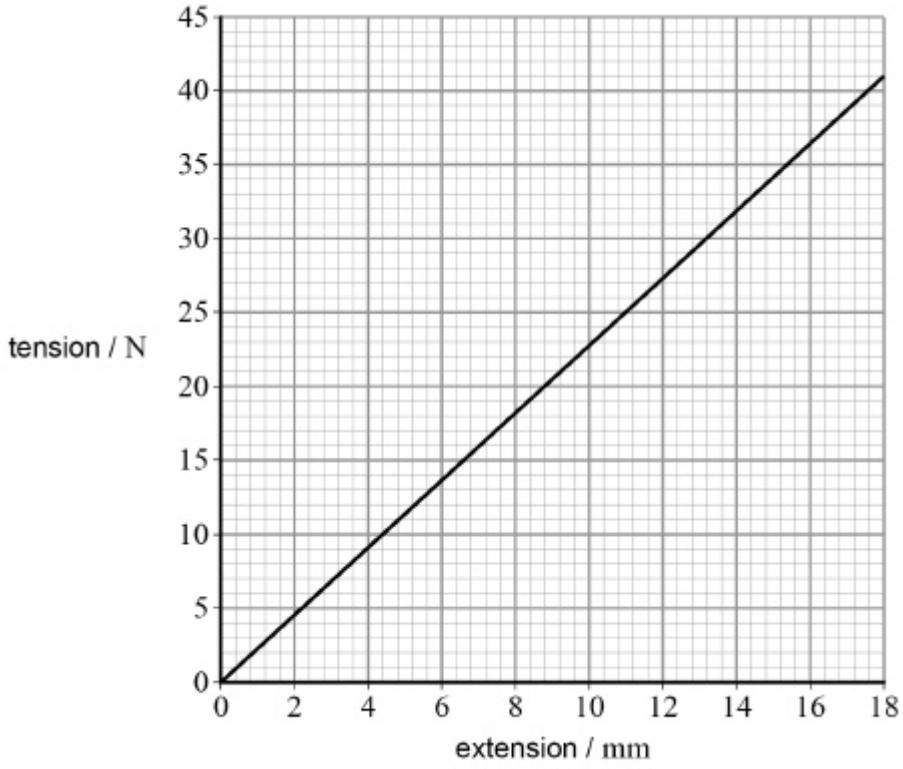
(c) Determine the speed at which waves travel along the string in question **(b)** when it vibrates with a first-harmonic frequency of 370 Hz

speed of waves = _____ m s^{-1}

(1)

(d) **Figure 3** shows how the tension in the string in question **(b)** varies with the extension of the string.

Figure 3



The string with its initial tension of 25 N is vibrating at a frequency of 370 Hz
The diameter of the circular peg is 7.02 mm

Determine the higher frequency that is produced when the string is stretched by rotating the tuning peg through an angle of 75°

Assume that there is no change in the diameter of the string.

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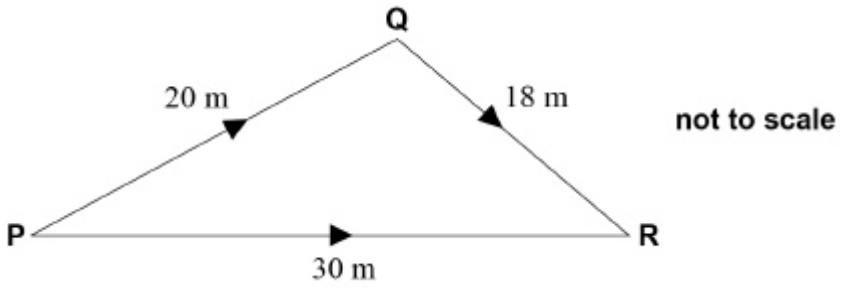
frequency = _____ Hz

(4)

(Total 10 marks)

Q8.

In the diagram, **P** is the source of a wave of frequency 50 Hz



The wave travels to **R** by two routes, **P** → **Q** → **R** and **P** → **R**. The speed of the wave is 30 m s−1

What is the path difference between the two waves at **R** in terms of the wavelength λ of the waves?

A 4.8λ ⬭

B 8.0λ ⬭

C 13.3λ ⬭

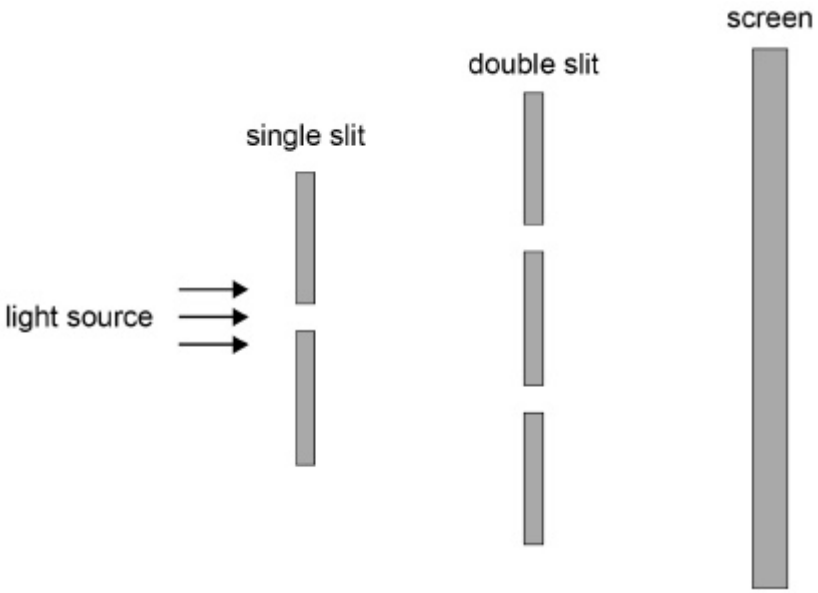
D 20.0λ ⬭

(Total 1 mark)

Q9.

Light from a point source passes through a single slit and is then incident on a double-slit arrangement. An interference pattern is observed on the screen.

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What will increase the fringe spacing?

A increasing the separation of the single slit and the double slit ⬭

B increasing the width of the single slit ⬭

C decreasing the distance between the double slits and the screen ⬭

D decreasing the separation of the double slits ⬭

(Total 1 mark)

Q10.

A diffraction grating has 500 lines per mm. When monochromatic light is incident normally on the grating the third-order spectral line is formed at an angle of 60° from the normal to the grating.

What is the wavelength of the monochromatic light?

A 220 nm ⬭

B 580 nm ⬭

C 960 nm ⬭

D 1700 nm ⬭

(Total 1 mark)

Q11.

An electromagnetic wave enters a fibre-optic cable from air. On entering the cable, the wave slows down to three-fifths of its original speed.

What is the refractive index of the core of the fibre-optic cable?

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A 0.67 ⬭

B 1.33 ⬭

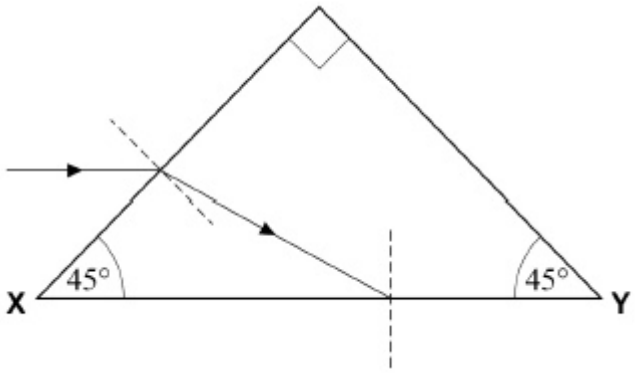
C 1.50 ⬭

D 1.67 ⬭

(Total 1 mark)

Q12.

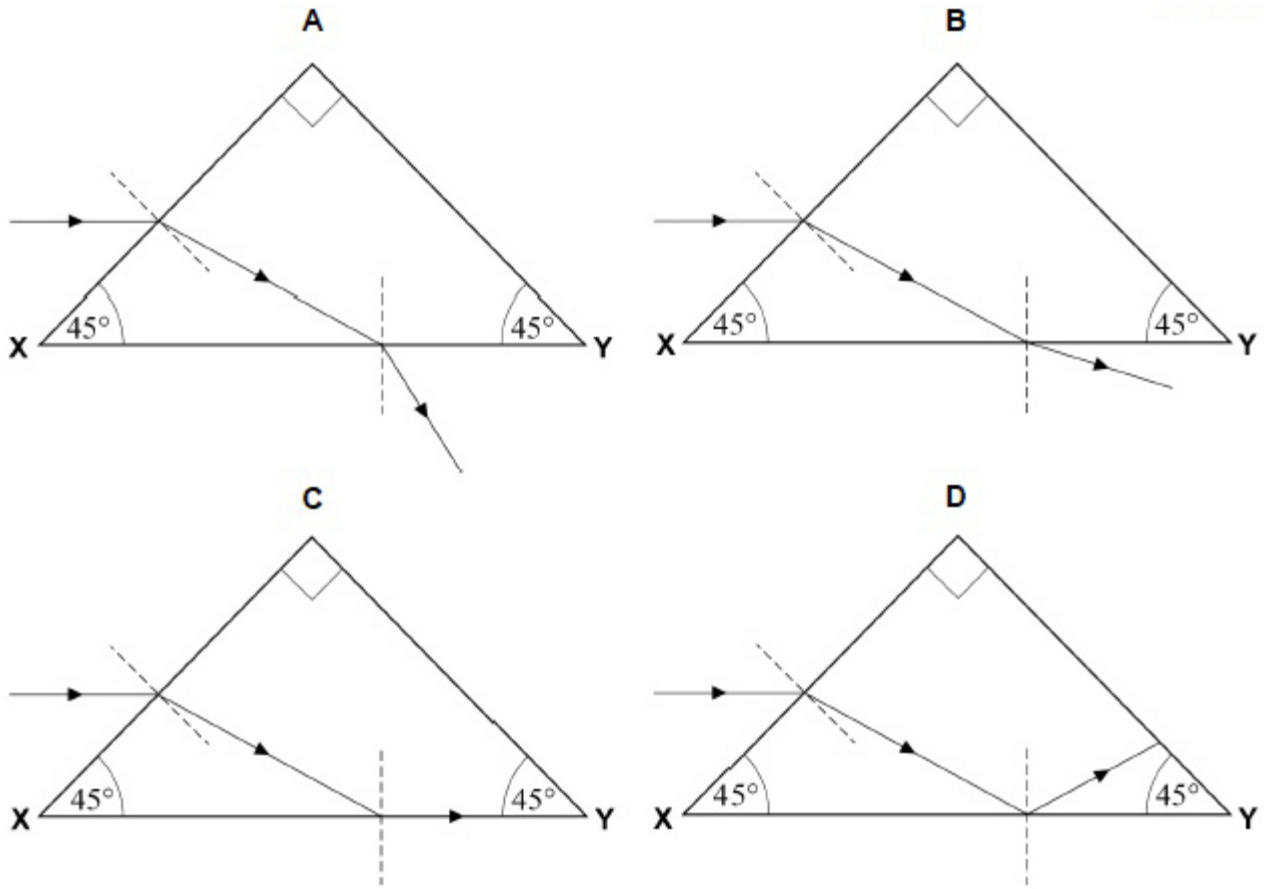
The diagram shows part of the path of a ray of light through a right-angled prism.



The prism is made of glass of refractive index 1.5
The incident light ray is parallel to the face **XY**. The ray is refracted towards the face **XY**.

What is the path of the ray after it is incident on face **XY**?

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A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

Q13.

A body performs simple harmonic motion.

What is the phase difference between the variation of displacement with time and the variation of acceleration with time for the body?

A 0 ⬭

B $\frac{\pi}{4}$ rad ⬭

C $\frac{\pi}{2}$ rad ⬭

D π rad ⬭

(Total 1 mark)

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Q14.

An object of mass 0.15 kg performs simple harmonic motion. It oscillates with amplitude 55 mm and frequency 0.80 Hz

What is the maximum value of its kinetic energy?

A 5.7×10^{-3} J ⬭

B 11×10^{-3} J ⬭

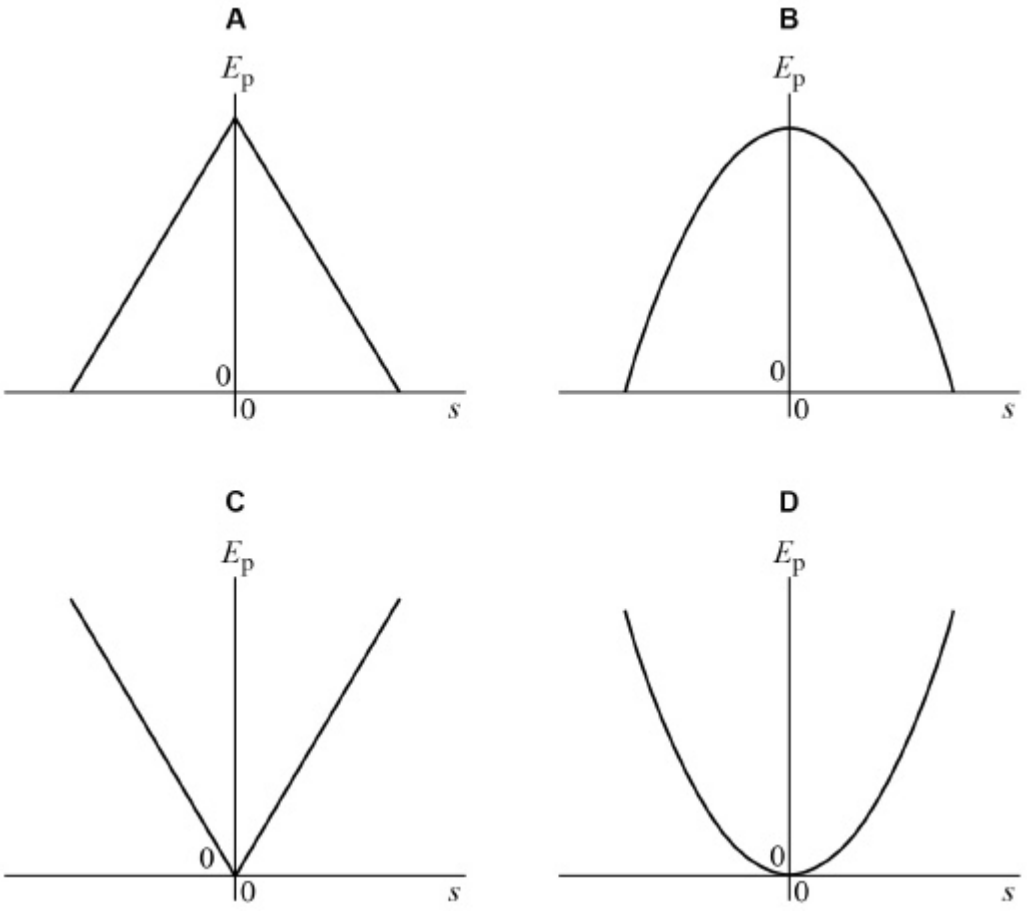
C 0.57 J ⬭

D 11 J ⬭

(Total 1 mark)

Q15.

Which graph shows how the gravitational potential energy E_p of a simple pendulum varies with displacement s from the equilibrium position?



A ⬭

B ⬭

C ⬭

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D 

(Total 1 mark)

Q16.

Figure 1 shows an arrangement used to investigate double slit interference using microwaves. **Figure 2** shows the view from above.

Figure 1

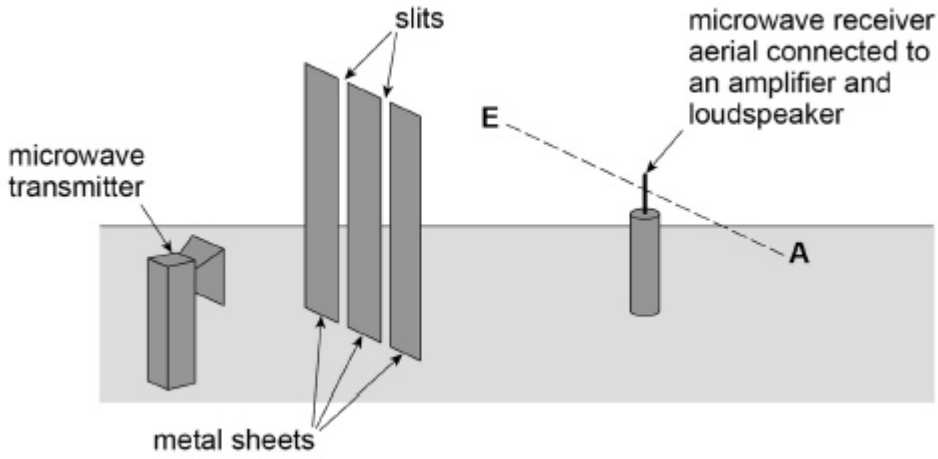
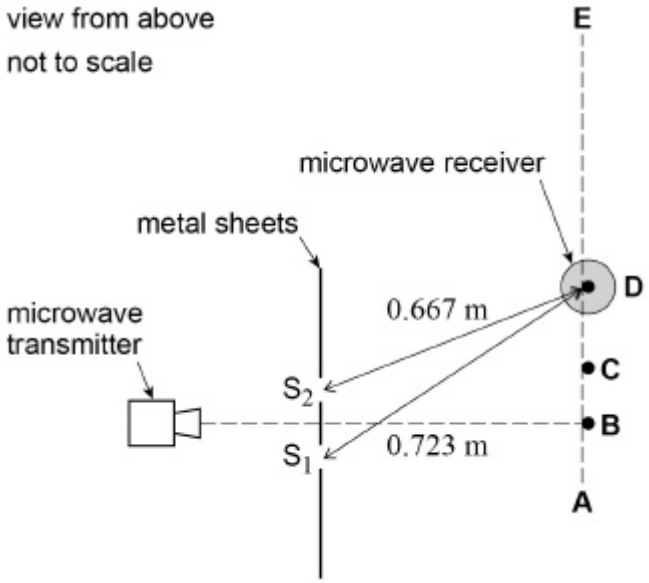


Figure 2



The microwaves from the transmitter are polarised. These waves are detected by the aerial in the microwave receiver (probe). The aerial is a vertical metal rod.

The receiver is moved along the dotted line **AE**. As it is moved, maximum and minimum signals are detected. Maximum signals are first detected at points **B** and **C**. The next maximum signal is detected at the position **D** shown in **Figure 2**.

Figure 2 shows the distances between each of the two slits, S_1 and S_2, and the microwave receiver when the aerial is in position **D**.
S_1D is 0.723 m and S_2D is 0.667 m.

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(a) Explain why the signal strength falls to a minimum between **B** and **C**, and between **C** and **D**.

(3)

(b) Determine the frequency of the microwaves that are transmitted.

frequency = _____ Hz

(3)

(c) The intensity of the waves passing through each slit is the same.

Explain why the minimum intensity between **C** and **D** is not zero.

(2)

(d) The vertical aerial is placed at position **B** and is rotated slowly through 90° until it

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lies along the direction **AE**.

State and explain the effect on the signal strength as it is rotated.

_____

_____

_____

_____

_____

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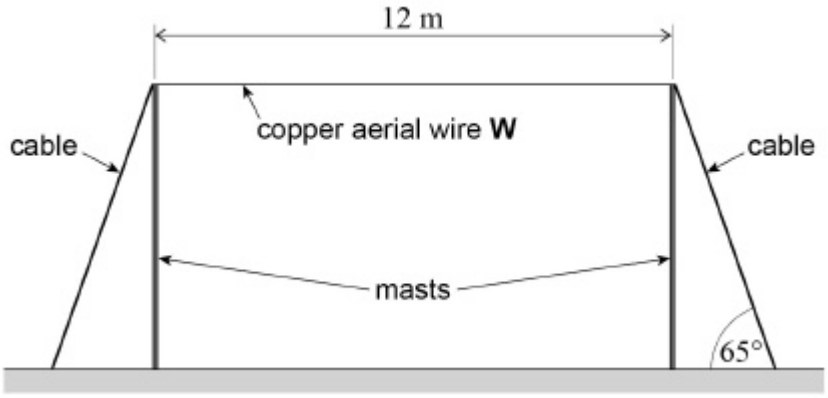
(3)

(Total 11 marks)

Q17.

Figure 1 shows a structure that supports a horizontal copper aerial wire **W** used for transmitting radio signals.

Figure 1



The copper aerial wire is 12 m long and its area of cross-section is 1.6×10^{-5} m^2.
The tension in the copper aerial wire is 5.0×10^2 N.

Young modulus of copper = 1.2×10^{11} Pa

(a) Show that the extension produced in a 12 m length of the aerial wire when the tension is 5.0×10^2 N is less than 4 mm.

(2)

(b) The cables that support each mast are at an angle of 65° to the horizontal.

Calculate the tension in each supporting cable so that there is no resultant horizontal force on either mast.

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tension = _____ N

(1)

(c) When wind blows, stationary waves can be formed on the aerial wire.

Explain how stationary waves are produced and why only waves of specific frequencies can form on the aerial wire.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) Calculate the mass of a 1.0 m length of the aerial wire.

Density of copper = 8900 kg m^{-3}

mass = _____ kg

(1)

(e) Calculate the frequency of the wave when the third harmonic is formed on the aerial wire.

frequency = _____ Hz

(2)

(f) Sketch, on **Figure 2**, the standing wave on the wire when the third harmonic is formed.

Figure 2

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(1)

(g) High winds produce large amplitudes of vibration of the aerial wire.

Explain why the wire may sag when the high wind stops.

_____

_____

_____

_____

(2)

(Total 13 marks)

Q18.

Which row correctly shows electromagnetic radiations in order of decreasing wavelength?

A gamma > ultraviolet > microwave ⬭

B ultraviolet > gamma > microwave ⬭

C microwave > ultraviolet > gamma ⬭

D gamma > microwave > ultraviolet ⬭

(Total 1 mark)

Q19.

Which statement is correct about the properties of an unpolarised electromagnetic wave as it passes through a polariser?

A The wave remains unchanged. ⬭

B The wave does not pass through the polariser. ⬭

C The wave's electric field oscillates along the direction of travel. ⬭

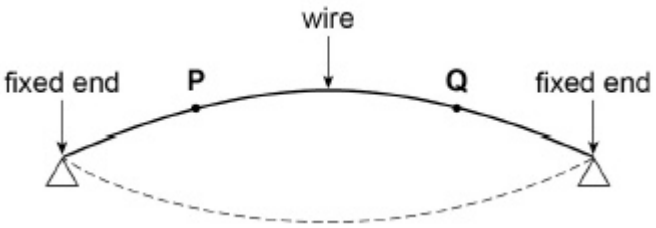
D The intensity of the wave is reduced. ⬭

(Total 1 mark)

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Q20.

A uniform wire, fixed at both ends, is plucked in the middle so that it vibrates at the first harmonic as shown.



What is the phase difference between the oscillations of the particles at **P** and **Q**?

A zero ⬭

B $\frac{\pi}{4}$ rad ⬭

C $\frac{\pi}{2}$ rad ⬭

D $\frac{3\pi}{4}$ rad ⬭

(Total 1 mark)

Q21.

Which row shows the change in velocity, frequency and wavelength of an electromagnetic wave as it travels from an optically less dense to an optically more dense medium?

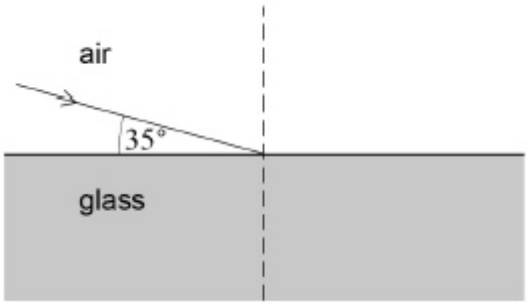
	Velocity	**Frequency**	**Wavelength**	
A	decreases	decreases	unchanged	⬭
B	increases	unchanged	increases	⬭
C	decreases	unchanged	decreases	⬭
D	increases	increases	unchanged	⬭

(Total 1 mark)

Q22.

The diagram shows a ray of light travelling in air and incident on a glass block of refractive index 1.5

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What is the angle of refraction in the glass?

A 22.5° ⬭

B 23.3° ⬭

C 33.1° ⬭

D 59.4° ⬭

(Total 1 mark)

Q23.

Intensity maxima are produced on a screen when a parallel beam of monochromatic light is incident on a diffraction grating. Light of a longer wavelength can be used or the distance from the diffraction grating to the screen can be increased.

Which row gives the change in appearance of the maxima when these changes are made independently?

	Longer wavelength	**Distance from grating to screen increased**	
A	closer together	more widely spaced	⬭
B	more widely spaced	more widely spaced	⬭
C	more widely spaced	closer together	⬭
D	closer together	closer together	⬭

(Total 1 mark)

Q24.

Light of wavelength 500 nm is passed through a diffraction grating which has 400 lines per mm.

What is the angular separation between the two second-order maxima?

A 11.5° ⬭

B 23.1° ⬭

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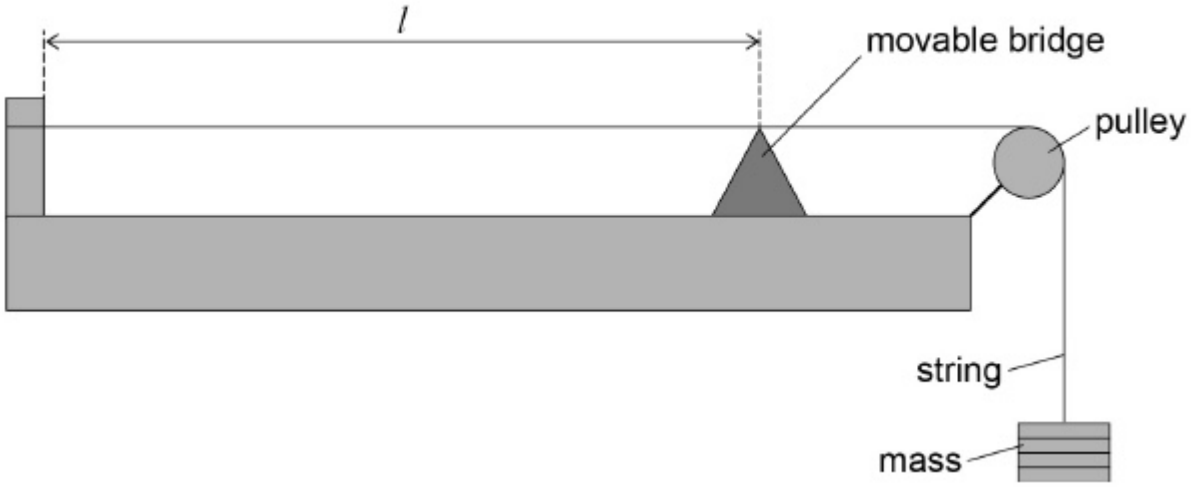
C 23.6° ⬭

D 47.2° ⬭

(Total 1 mark)

Q25.

The diagram shows an arrangement used by a student to investigate vibrations in a stretched nylon string of fixed length l. He measures how the frequency f of first-harmonic vibrations for the string varies with the mass m suspended from it.



The table shows the results of the experiment.

m / kg	f / Hz
0.50	110
0.80	140
1.20	170

(a) Show that the data in the table are consistent with the relationship

$$f \propto \sqrt{T}$$

where T is the tension in the nylon string.

(2)

(b) The nylon string used has a density of 1150 kg m^{-3} and a uniform diameter of 5.0×10^{-4} m.

Determine the length l of the string used.

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l = _____ m

(3)

(c) The student uses the relationship in question (a) to predict frequencies for tensions that are much larger than those used in the original experiment.

Explain how the actual frequencies produced would be different from those that the student predicts.

_____

_____

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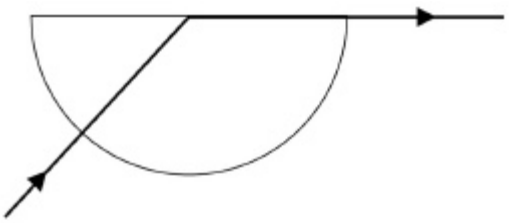
(2)

(Total 7 marks)

Q26.

Figure 1 shows a ray of monochromatic green light incident normally on the curved surface of a semicircular glass block.

Figure 1



(a) The angle of refraction of the ray at the plane surface is 90°.

Refractive index of the glass used = 1.6

Calculate the angle of incidence of the ray on the flat surface of the block.

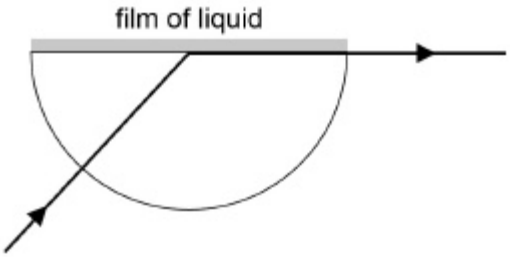
angle of incidence = _____ degrees

(1)

(b) A thin film of liquid is placed on the flat surface of the glass block as shown in **Figure 2**.

Figure 2

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The angle of incidence is changed so that the angle of refraction of the green light ray at the glass-liquid interface is again 90°. The angle of incidence is now 58°.

Calculate the refractive index of the liquid.

refractive index = _____

(2)

(c) The source of green light is changed for one that contains only red and blue light. For any material red light has a lower refractive index than green light, and blue light has a higher refractive index than green light. The angle of incidence at the glass-liquid interface remains at 58°.

Describe and explain the paths followed by the red and blue rays immediately after the light is incident on the glass-liquid interface.

_____

_____

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_____

_____

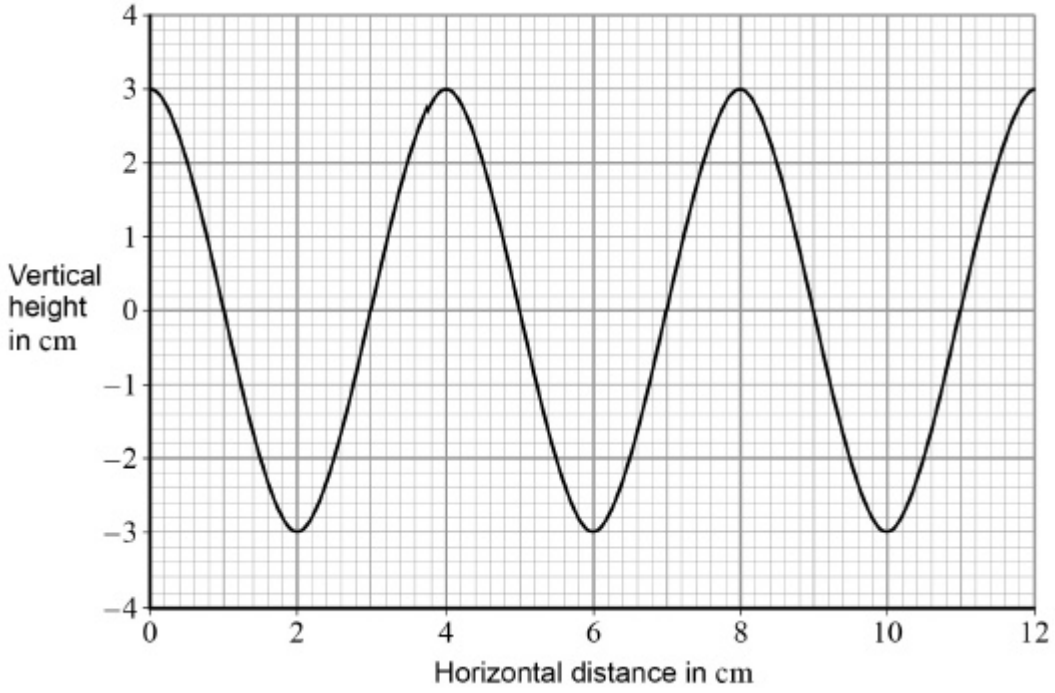
(3)

(Total 6 marks)

Q27.

The graph shows how the vertical height of a travelling wave varies with distance along the path of the wave.

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The speed of the wave is 20 cm s^{-1}.

What is the period of the wave?

A 0.1 s ⬭

B 0.2 s ⬭

C 5.0 s ⬭

D 10.0 s ⬭

(Total 1 mark)

Q28.

Which statement is **not** correct for ultrasound and X-rays?

A Both can be refracted ⬭

B Both can be diffracted ⬭

C Both can be polarised ⬭

D Both can be reflected ⬭

(Total 1 mark)

Q29.

A stationary wave is set up on a stretched string of length l and diameter d.
Another stationary wave is also set up on a second string made from the same material and with the same tension as the first.

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What length and diameter are required for the second string so that both strings have the same first-harmonic frequency?

	Length of second string	Diameter of second string	
A	$2l$	$2d$	⬭
B	l	$2d$	⬭
C	$\frac{l}{2}$	$2d$	⬭
D	l	$\frac{d}{2}$	⬭

(Total 1 mark)

Q30.

When a monochromatic light source is incident on two slits of the same width an interference pattern is produced.

One slit is then covered with opaque black paper.

What is the effect of covering one slit on the resulting interference pattern?

A The intensity of the central maximum will increase ⬭

B The width of the central maximum decreases ⬭

C Fewer maxima are observed ⬭

D The outer maxima become wider ⬭

(Total 1 mark)

Q31.

When light of wavelength 5.0×10^{-7} m is incident normally on a diffraction grating the fourth-order maximum is observed at an angle of 30°.

What is the number of lines per mm on the diffraction grating?

A 2.5×10^{2} ⬭

B 2.5×10^{5} ⬭

C 1.0×10^{3} ⬭

D 1.0×10^{6} ⬭

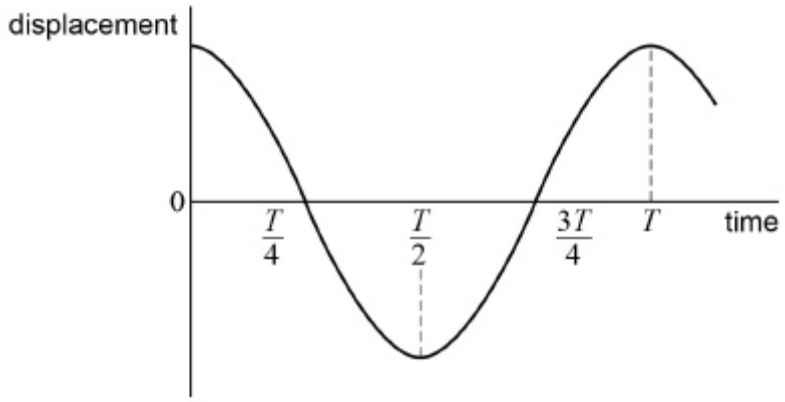
(Total 1 mark)

Q32.

The graph shows how the displacement of a particle performing simple harmonic motion

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varies with time.



Which statement is **not** correct?

A The speed of the particle is a maximum at time $\frac{T}{4}$ ⬭

B The potential energy of the particle is zero at time $\frac{3T}{4}$ ⬭

C The acceleration of the particle is a maximum at time $\frac{T}{2}$ ⬭

D The restoring force acting on the particle is zero at time T ⬭

(Total 1 mark)

Q33.

This question is about an experiment to measure the wavelength of microwaves.

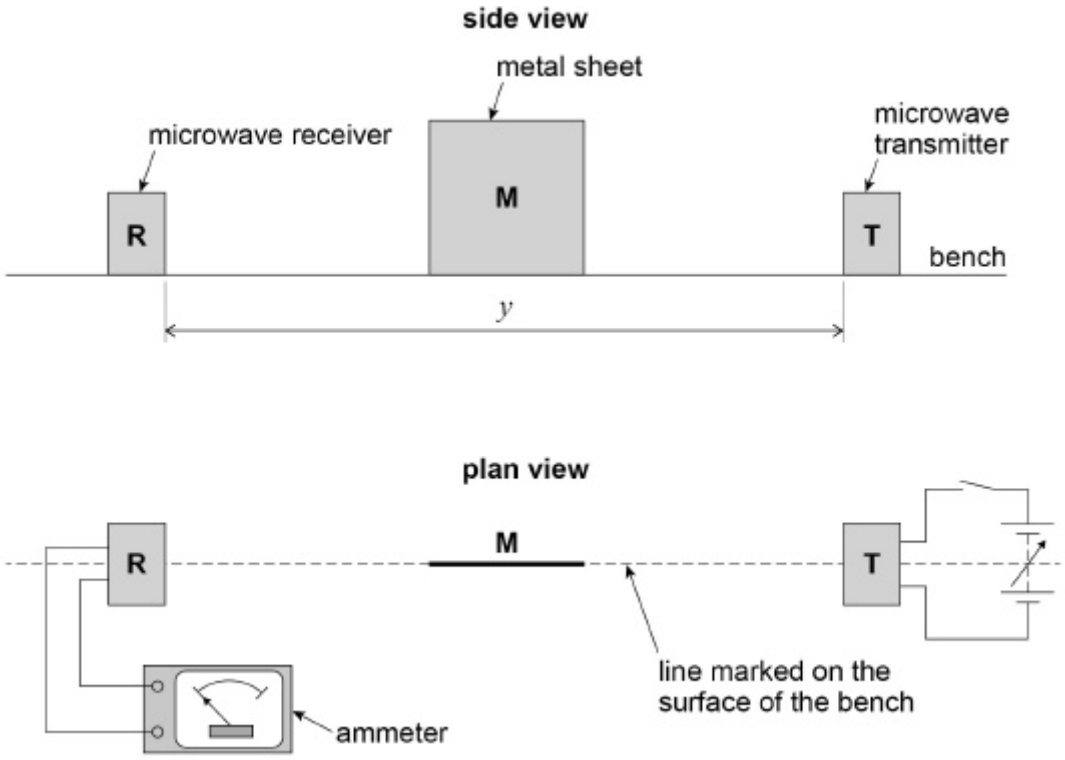
A microwave transmitter **T** and a receiver **R** are arranged on a line marked on the bench.

A metal sheet **M** is placed on the marked line perpendicular to the bench surface.

Figure 1 shows side and plan views of the arrangement.
The circuit connected to **T** and the ammeter connected to **R** are only shown in the plan view.

Figure 1

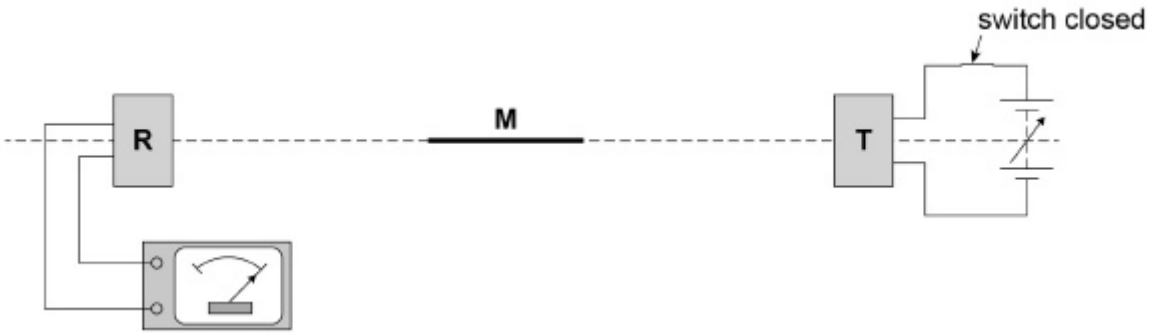
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The distance y between **T** and **R** is recorded.

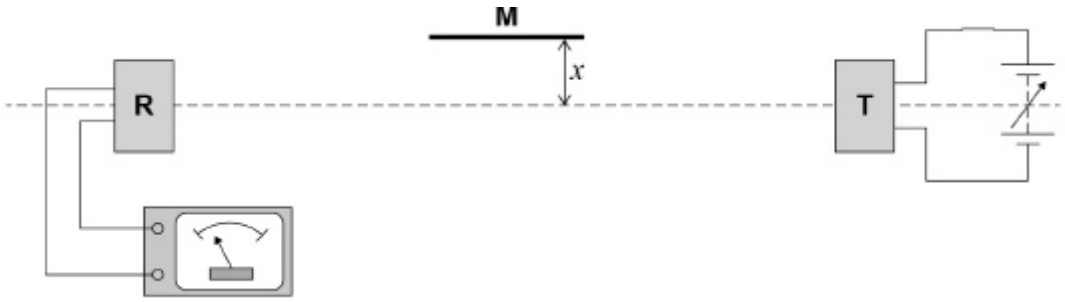
T is switched on and the output from **T** is adjusted so a reading is produced on the ammeter as shown in **Figure 2**.

Figure 2



M is kept parallel to the marked line and moved slowly away as shown in **Figure 3**.

Figure 3



The reading decreases to a minimum reading **which is not zero**.
The perpendicular distance x between the marked line and **M** is recorded.

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(a) The ammeter reading depends on the superposition of waves travelling directly to **R** and other waves that reach **R** after reflection from **M**.

State the phase difference between the sets of waves superposing at **R** when the ammeter reading is a **minimum**.
Give a suitable unit with your answer.

(1)

(b) Explain why the minimum reading is **not** zero when the distance x is measured.

(1)

(c) When **M** is moved further away the reading increases to a maximum then decreases to a minimum.

At the first minimum position, a student labels the minimum n = 1 and records the value of x.
The next minimum position is labelled n = 2 and the new value of x is recorded.
Several positions of maxima and minima are produced.

Describe a procedure that the student could use to make sure that **M** is parallel to the marked line before measuring each value of x.
You may wish to include a sketch with your answer.

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(2)

(d) It can be shown that

$$n\lambda = \sqrt{4x^2 + y^2} - y$$

where λ is the wavelength of the microwaves and y is the distance defined in **Figure 1**.

The student plots the graph shown in **Figure 4**.

The student estimates the uncertainty in each value of $\sqrt{4x^2 + y^2}$ to be 0.025 m and adds error bars to the graph.

Determine

- the maximum gradient G_{max} of a line that passes through all the error bars
- the minimum gradient G_{min} of a line that passes through all the error bars.

G_{max} = _____

G_{min} = _____

(3)

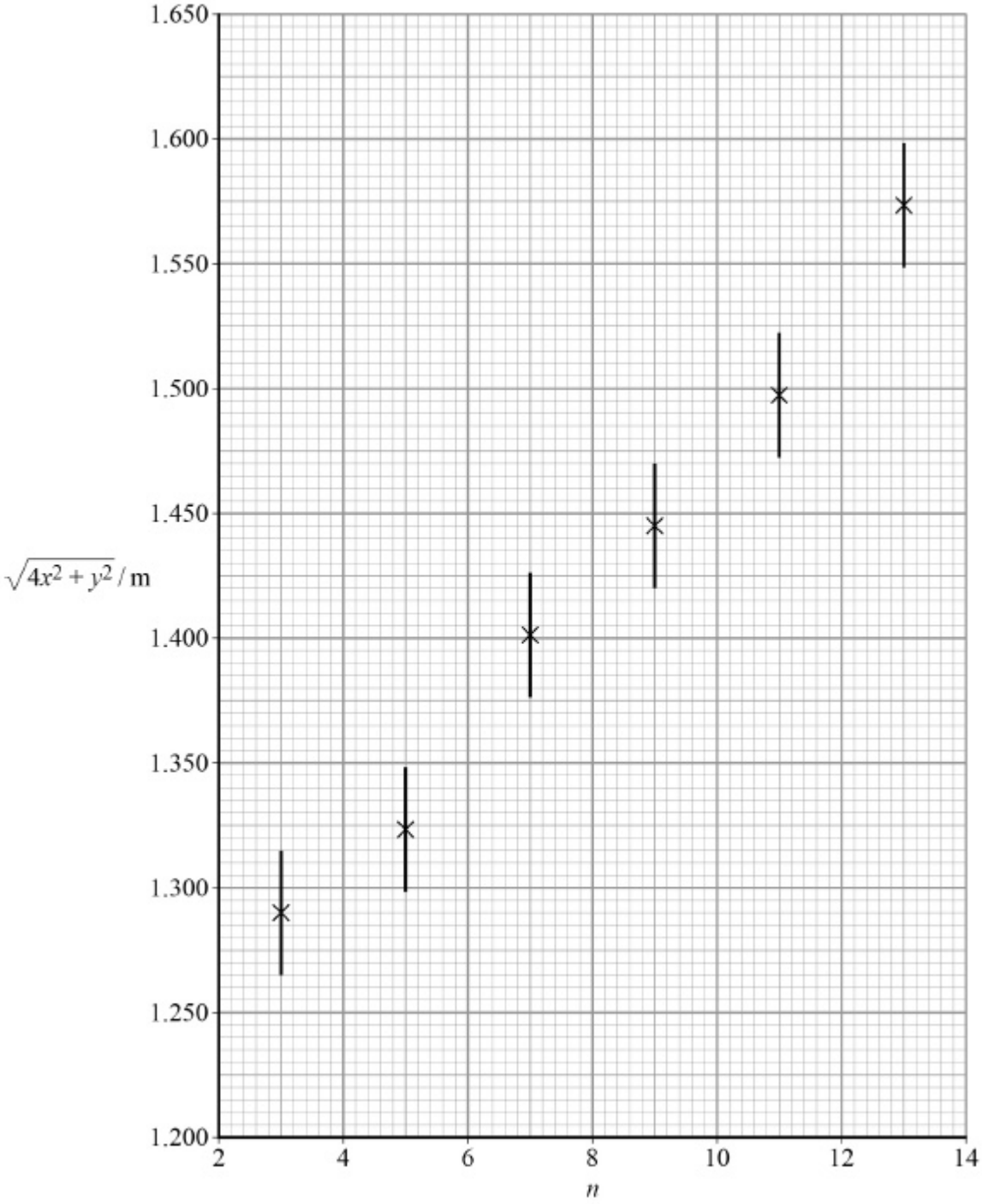
(e) Determine λ using your results for G_{max} and G_{min}.

λ = _____ m

(2)

Figure 4

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(f) Determine the percentage uncertainty in your result for λ.

percentage uncertainty in λ = _____ %

(3)

(g) Explain how the graph in **Figure 4** can be used to obtain the value of y.
You are **not** required to determine y.

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(2)

(h) Suppose that the data for n = 13 had not been plotted on **Figure 4**.

Add a tick (✓) in each row of the table to identify the effect, if any, on the results you would obtain for G_{max}, G_{min}, λ and y.

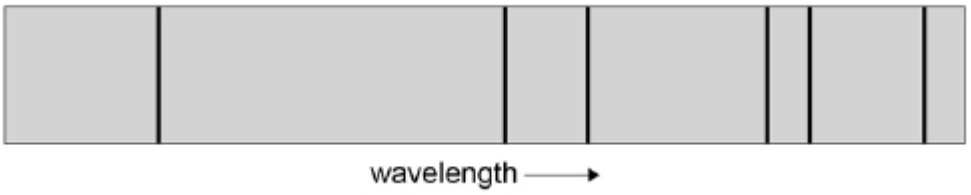
Result	Reduced	Not affected	increased
G_{max}			
G_{min}			
λ			
y			

(4)

(Total 18 marks)

Q34.

The diagram below shows the line spectrum of a gas.



Explain how line spectra are produced. In your answer you should describe:

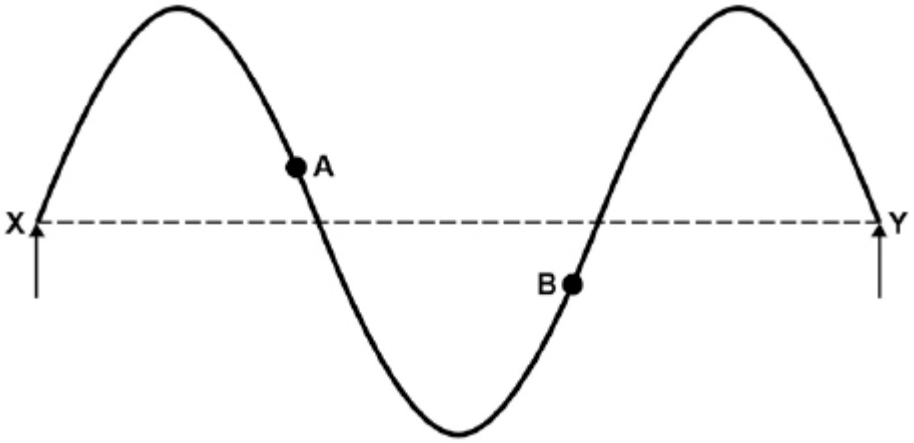
- how the collisions of charged particles with gas atoms can cause the atoms to emit photons.
- how spectral lines are explained by the concept of discrete energy levels.

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(Total 6 marks)

Q35.

The diagram below shows one position of a guitar string stretched between points **X** and **Y**.
The string vibrates at a frequency of 330 Hz.



(a) State the phase relationship between points **A** and **B** on the string.

(1)

(b) Points **X** and **Y** are 0.66 m apart.

Calculate the speed of the wave along the string.

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speed = _____ m s^{-1}

(2)

(c) The total mass of the string is 3.1 g and the total length of the string is 0.91 m.

Show that the tension in the string when it is sounding the harmonic shown in the diagram above is about 70 N.

(3)

(d) The string is fixed at one end and wrapped around a tuning peg of radius 3.0 mm at the other. The tuning peg needs to be turned through 3 complete rotations to increase the tension in the string from 0 to 70 N in part **(c)**.

Discuss, by estimating the energy stored in the string, whether there is a significant risk to the guitar player when the string breaks.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q36.

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?

A zero ⬭

B 90° ⬭

C 180° ⬭

D 360° ⬭

(Total 1 mark)

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Q37.

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

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. ⬭

(Total 1 mark)

Q38.

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?

A 107 m ⬭

B 214 m ⬭

C 428 m ⬭

D 857 m ⬭

(Total 1 mark)

Q39.

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?

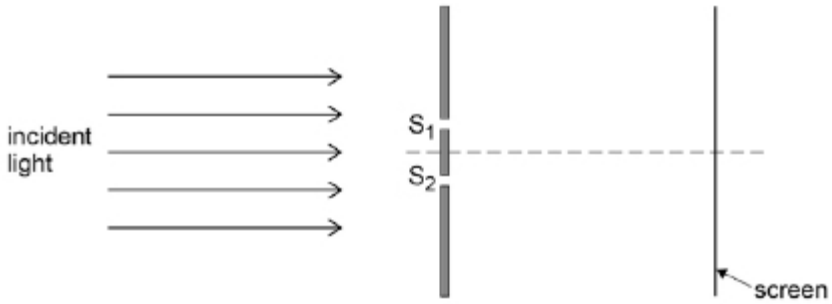
	Frequency condition	**Phase condition**	
A	same frequency	variable phase difference	⬭
B	constant frequency difference	constant phase difference	⬭
C	constant frequency difference	in phase	⬭
D	same frequency	constant phase difference	⬭

(Total 1 mark)

Q40.

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.

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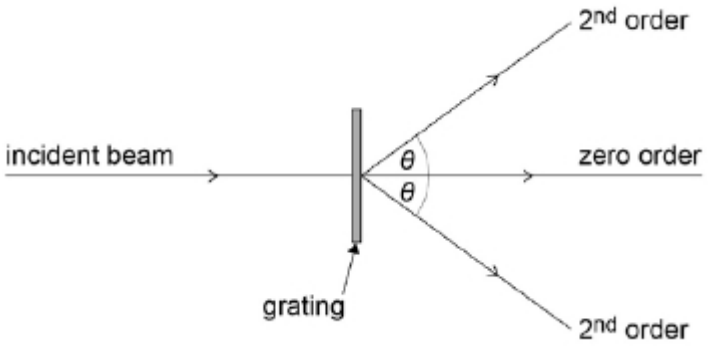
Which line in the table gives the changes that will increase the spacing of the fringes?

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

(Total 1 mark)

Q41.

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?

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. ⬭

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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. ⬭

(Total 1 mark)

Q42.

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?

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 ⬭

(Total 1 mark)

Q43.

(a) Distinguish between longitudinal and transverse waves.

_____

_____

_____

_____

_____

(2)

(b) A piano repairer replaces the wire that produces the highest note on a piano. The wire has a vibrating length of 0.050 m. He uses a wire with the following properties:

diameter = 3.5×10^{-4} m
density = 7.8×10^{3} kg m^{-3}
breaking stress = 3.0×10^{9} N m^{-2}

Calculate the tension required for the vibrating wire to produce its correct frequency of 4.1 kHz.

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tension = _____ N

(2)

(c) Evaluate, using the data provided in part **(b)**, whether it is safe to use this wire.

_____

_____

_____

_____

_____

(2)

(d) The repairer uses faulty wire so that the diameter of the wire increases linearly with distance along its length. The profile of the vibration produced when the wire sounds its second harmonic is shown in the diagram below.



The speed c of a transverse progressive wave travelling along a string of mass per unit length μ and under tension T is given by

$$c = \sqrt{\frac{T}{\mu}}$$

Explain which end of the wire, **A** or **B**, has the greater diameter and why the profile of the stationary wave has the shape shown in the diagram above.

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 10 marks)

Q44.

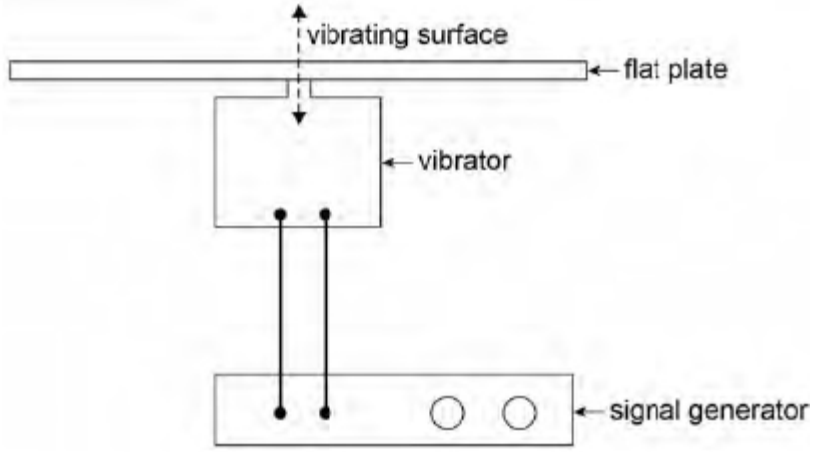
(a) State the conditions for simple harmonic motion.

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(2)

(b) A rigid flat plate is made to vibrate vertically with simple harmonic motion. The frequency of the vibration is controlled by a signal generator as shown in **Figure 1**.

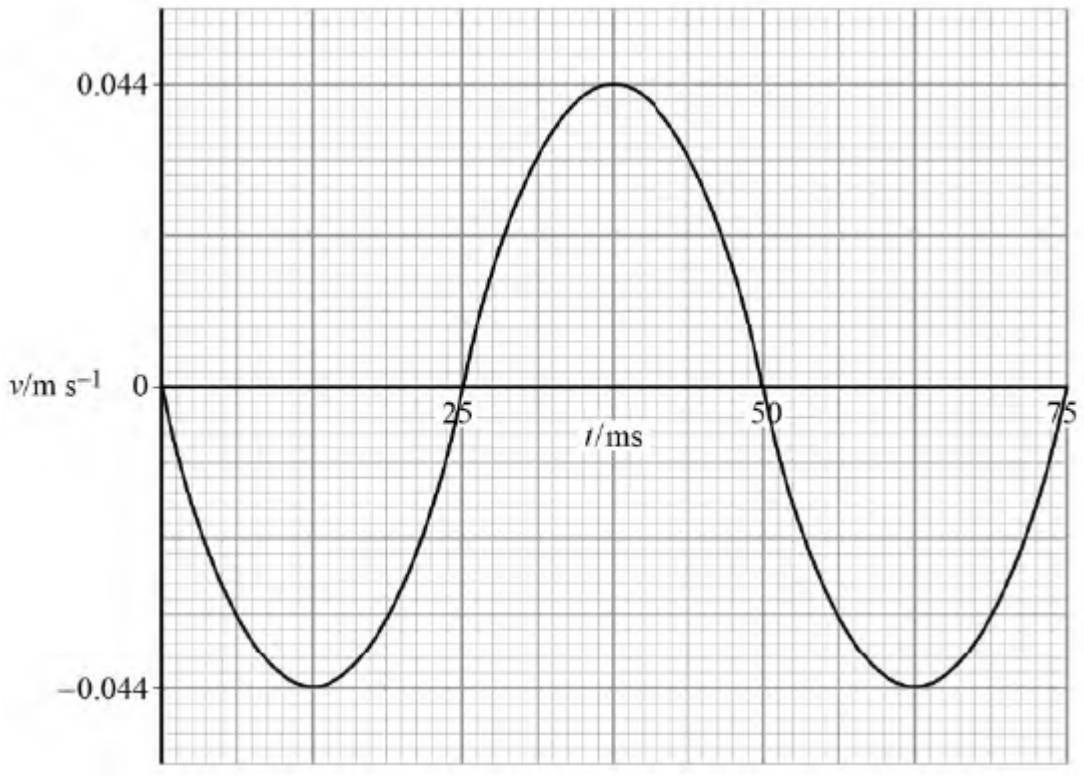
Figure 1



The velocity−time (v−t) graph for the vibrating plate at one frequency is shown in **Figure 2**.

Figure 2

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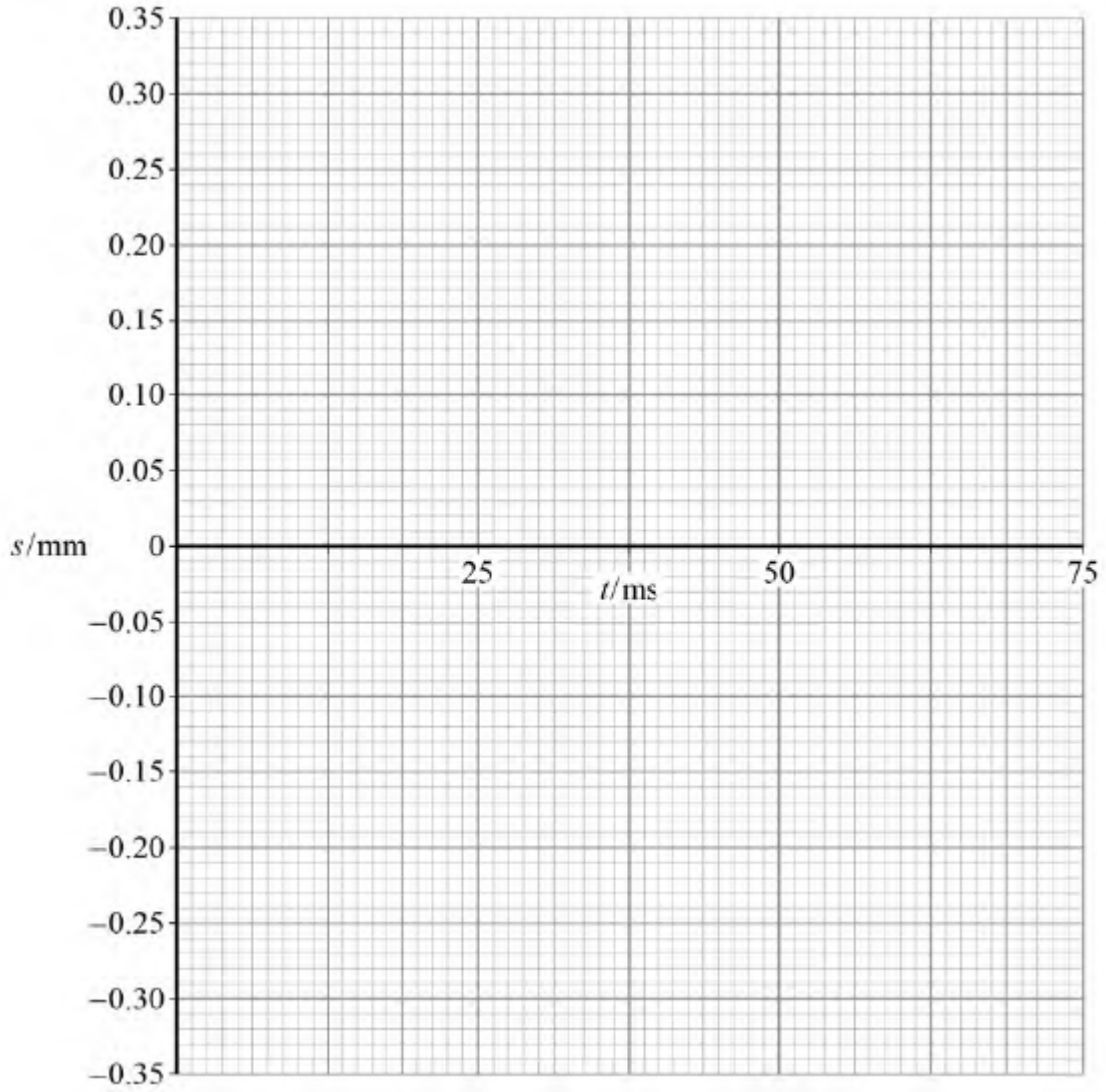
Show that the maximum displacement of the plate is 3.5×10^{-4} m.

(2)

(c) Draw on **Figure 3** the displacement−time (*s*−*t*) graph between 0 and 75 ms.

Figure 3

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(1)

(d) State **one** time at which the plate has maximum potential energy.

time = _____ s

(1)

(e) A small quantity of fine sand is placed onto the surface of the plate. Initially the sand grains stay in contact with the plate as it vibrates. The amplitude of the vibrating surface remains constant at 3.5×10^{-4} m over the full frequency range of the signal generator. Above a particular frequency the sand grains lose contact with the surface.

Explain how and why this happens.

_____

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_____

_____

_____

_____

_____

_____

_____

(3)

(f) Calculate the lowest frequency at which the sand grains lose contact with the surface of the plate.

frequency = _____ Hz

(2)

(Total 11 marks)

Q45.

What is the correct order of increasing photon energy in the electromagnetic spectrum?

1 is least energy, 4 is greatest energy.

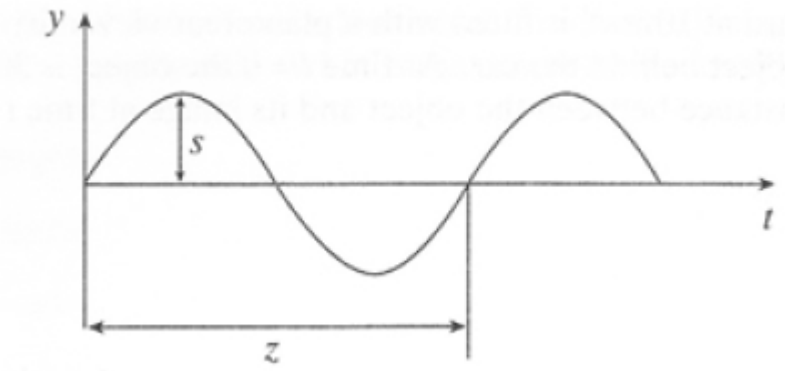
	Radio waves	γ rays	Visible light	Infrared	
A	1	4	3	2	⬭
B	4	1	2	3	⬭
C	1	4	2	3	⬭
D	4	1	3	2	⬭

(Total 1 mark)

Q46.

For waves on a water surface, the following graph shows how the displacement y of a water particle in the surface varies with the time t.

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What are the quantities z and s?

	z	s	
A	frequency	amplitude	⬭
B	period	half-amplitude	⬭
C	wavelength	half-amplitude	⬭
D	period	amplitude	⬭

(Total 1 mark)

Q47.

Monochromatic light of wavelength 600 nm is used to illuminate a pair of slits 0.50 mm apart. The fringes are observed at a distance of 1.50 m from the slits.

What is the separation of the fringes?

A 2.0×10^{-7} mm ⬭

B 1.8×10^{-3} mm ⬭

C 5.6×10^{-1} mm ⬭

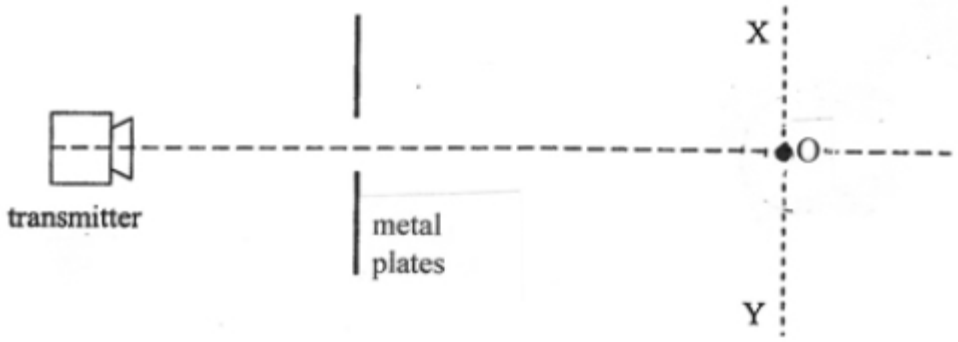
D 1.8 mm ⬭

(Total 1 mark)

Q48.

Microwaves from a transmitter are incident on a gap between two metal plates. The microwaves that pass through the gap are detected by a receiver.

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The receiver is placed at O.

What change causes the received signal to decrease and then increase?

A make the gap narrower ⬭

B move the receiver towards X ⬭

C rotate the receiver through 90° ⬭

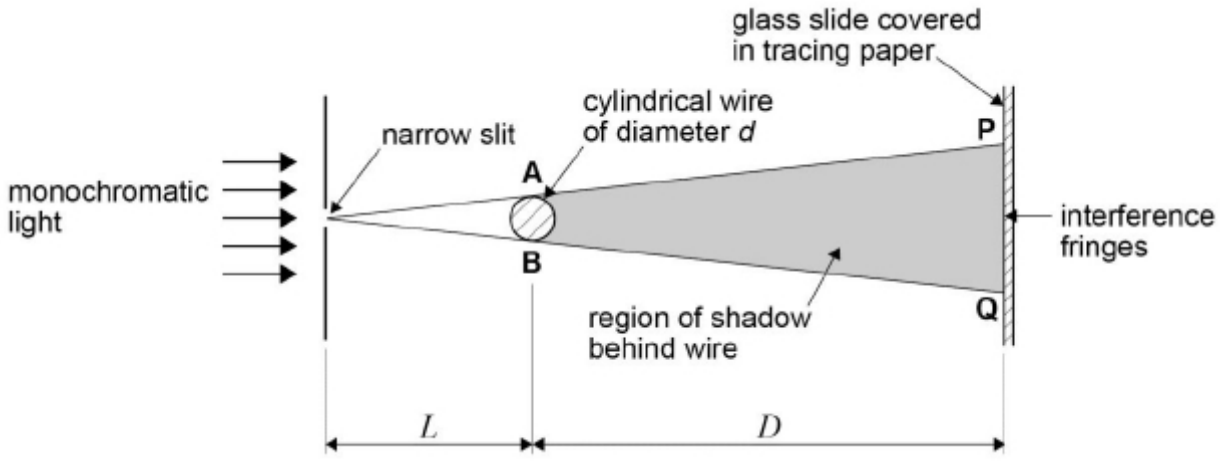
D move the transmitter away from the receiver ⬭

(Total 1 mark)

Q49.

A student carries out an experiment to determine the diameter of a cylindrical wire based on the theory of Young's double−slit experiment, using the arrangement shown in **Figure 1**.

Figure 1



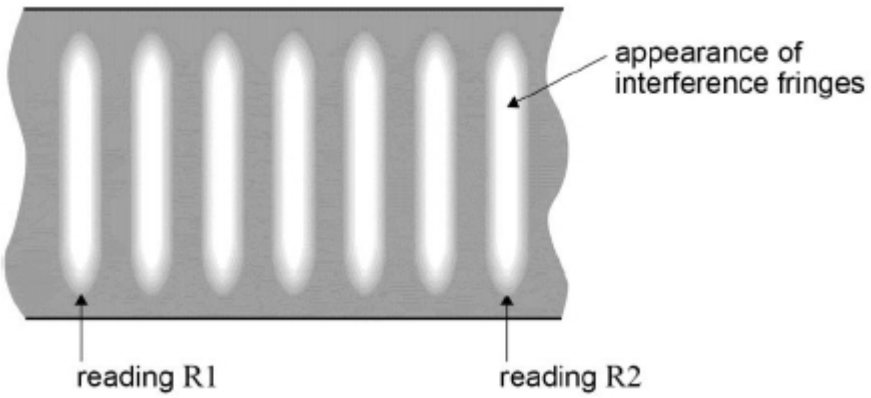
The wire is mounted vertically in front of a single narrow slit which is illuminated by monochromatic light. The wire produces a shadow between points **P** and **Q** on a glass slide covered with tracing paper. The light diffracts as it passes the wire. Points **A** and **B** act as coherent sources causing interference fringes to be seen between **P** and **Q**.

The student uses a metre ruler to measure the distances L and D shown in **Figure 1**.

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Figure 2 shows the pattern of interference fringes between **P** and **Q**. The student takes readings from a vernier scale to indicate the positions of the centres of two of the fringes.

Figure 2



The student's measurements are shown in **Table 1**.

Table 1

L/mm	D/mm	R1/mm	R2/mm
46	395	8.71	11.16

(a) Determine the spacing of the interference fringes w using **Figure 1** and the data in **Table 1**.

Give your answer to an appropriate number of significant figures.

w _____ m

(2)

(b) Determine the diameter d of the wire.

wavelength of the monochromatic light = 589.3 nm

d = _____ m

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(2)

(c) Estimate the number of interference fringes seen between **P** and **Q**.

number of interference fringes = _____

(3)

(d) The student uses a micrometer screw gauge to confirm his result for d.

Describe a suitable procedure that the student should carry out before using the micrometer to ensure that the measurements are not affected by systematic error.

_____

_____

_____

_____

(2)

(e) To reduce the impact of random error, the student takes several measurements of the diameter at different points along the wire so that he can calculate a mean value for d.

These measurements are shown in **Table 2**.

***d*/mm**
0.572
0.574
0.569
0.571
0.566
0.569

Use the data from **Table 2** to determine the percentage uncertainty in the student's result for d.

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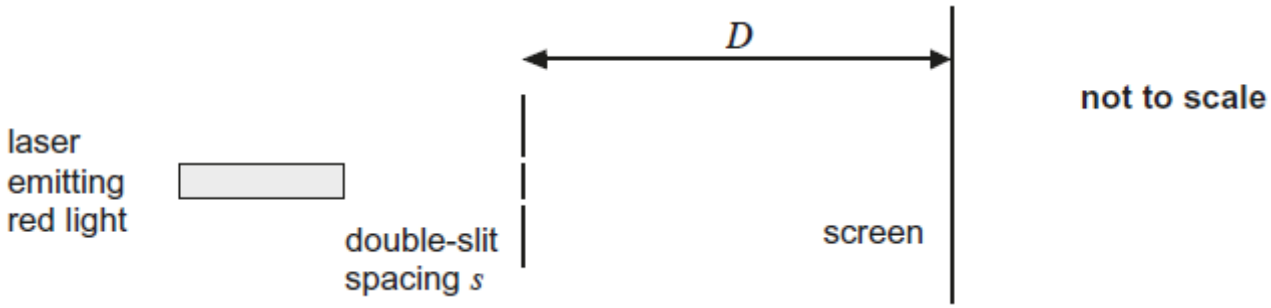
percentage uncertainty = _____ %

(2)

(Total 11 marks)

Q71.

The diagram shows the arrangement of apparatus in an experiment to measure the wavelength of red light emitted by a laser. The light is incident on a double-slit so that an interference pattern is produced on the screen.



A student sets up the apparatus and measures the fringe width *w* of the interference pattern and the distance *D* between the double-slit and screen.

The student makes further measurements of *w* using the same laser but with different values of *D* and different slit spacing *s*.

The student's results are shown in the table below

***D*/m**	$s/10^{-3}$ m	$\left(\frac{D}{s}\right)/10^{3}$	$w/10^{-3}$m
1.000	0.70		1.03
0.900	0.70		0.93
0.800	0.70	1.14	0.84
1.000	1.00	1.00	0.76
0.800	1.00	0.80	0.62
0.600	1.00	0.60	0.50

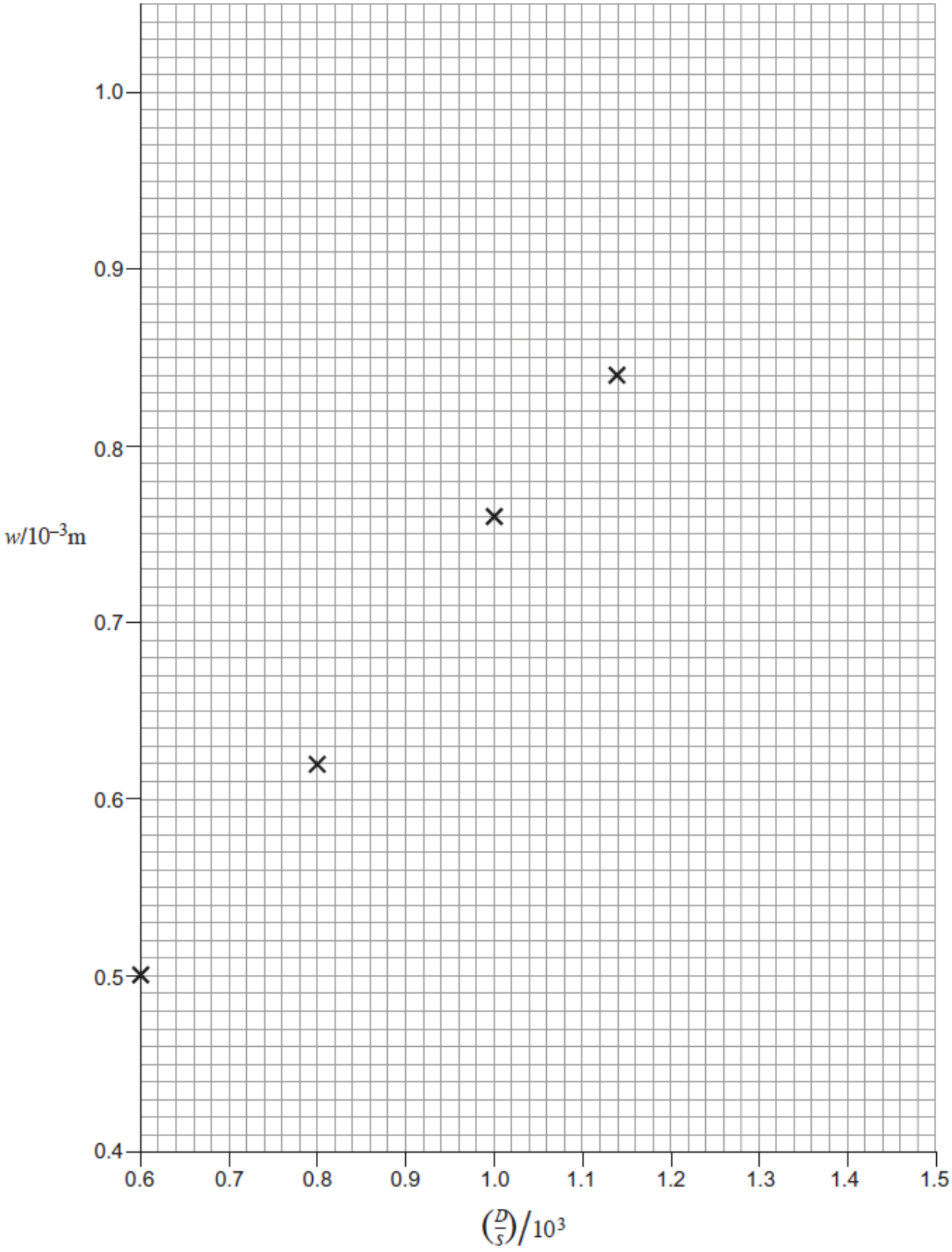
(a) Complete the table above.

(1)

(b) Complete the graph below by plotting the two remaining points and drawing a best fit straight line.

(2)

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(c) (i) Determine the gradient of the graph above.

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(3)

(ii) Determine the wavelength of the red laser light used in this experiment.

(1)

(d) (i) Theory suggests that the graph above should go through the origin.

State and explain what this suggests about the relationship between w and $\frac{D}{S}$.

(2)

(ii) The student discovers that the best fit line drawn in the graph does not go through the origin.

Determine, using information from the graph above, the value of w corresponding to $\left(\frac{D}{S}\right) = 0$.

(2)

(iii) The graph suggests a systematic error in a measurement.

Identify the measurement.

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(1)

(e) The interference pattern produced on the screen is much brighter in the centre of the screen than at the edges.

State what causes this effect.

_____

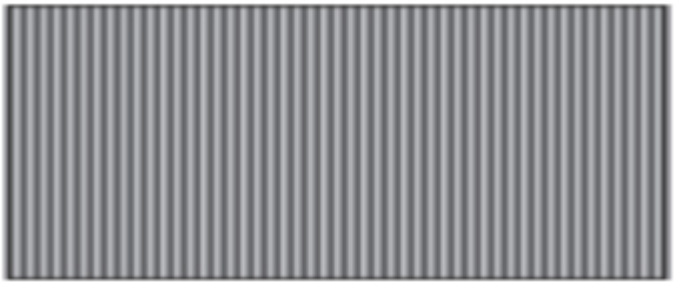
_____

(1)

(Total 13 marks)

Q72.

(a) The image below shows a full-size photograph of a double-slit interference pattern, using a laser.



Determine the fringe width w using a ruler to take measurements from the image above.
You may use a hand-lens to help you make this measurement.

_____

_____

_____

_____

(3)

(b) Calculate the uncertainty in the value of w measured in part **(a)**.

_____

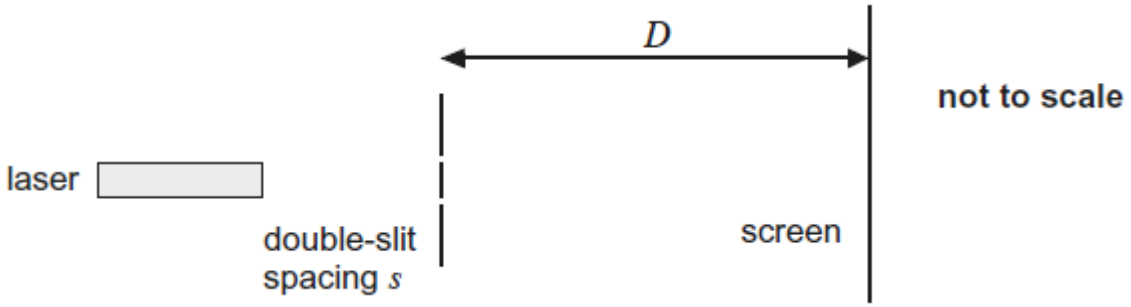
_____

_____

(2)

(c) In the experiment shown in the diagram below, the fringe pattern in the image in part **(a)** is produced.

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s = 0.60 ± 0.02 mm
D = 1.500 ± 0.002 m

Using these data and your answers to part **(a)** and part **(b)**, determine

(i) the wavelength of the laser light used

_____

_____

_____

(1)

(ii) the percentage uncertainty in this value of wavelength

_____

_____

_____

(1)

(iii) the absolute uncertainty in this value of wavelength.

_____

_____

_____

(1)

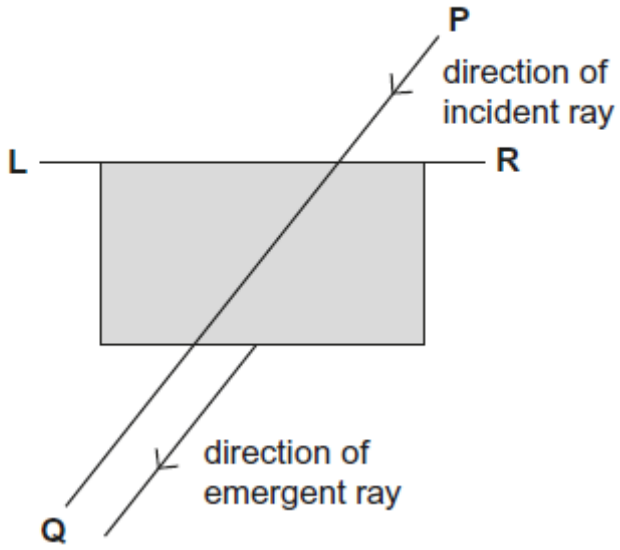
(Total 8 marks)

Q73.

A student aligns the longer edge of a rectangular glass block along a line **LR**, as shown in **Figure 1**.

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Figure 1



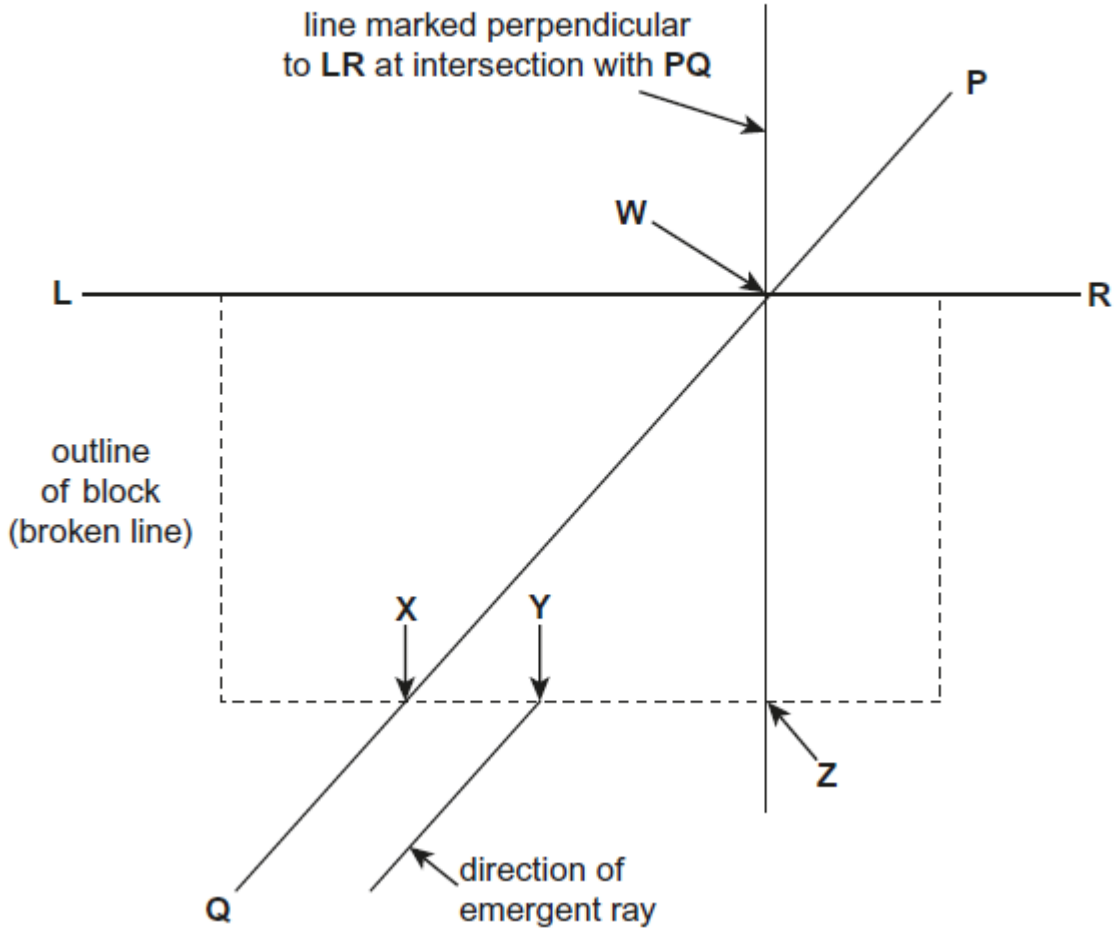
The student marks the outline of the block and directs a ray along **PQ**.

The student marks the direction of the emergent ray then removes the block and marks a line perpendicular to **LR** where **PQ** and **LR** intersect.

The student then marks the points **W**, **X**, **Y** and **Z** that are defined in **Figure 2**.

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Figure 2



(a) Show that the refractive index n of the block is given by the equation

$$n = \frac{XZ \times WY}{YZ \times WX}$$

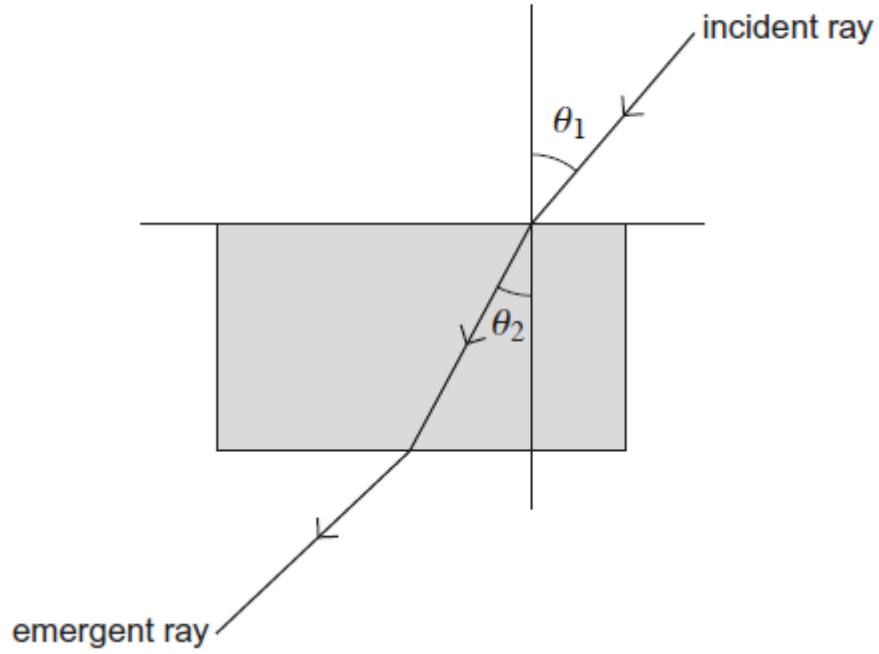
You may wish to use the equation $n = \frac{\sin\theta_1}{\sin\theta_2}$

where θ_1 and θ_2 are the angles shown in **Figure 3**.

You may also wish to illustrate your answer with a diagram.

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Figure 3



(2)

(b) The student repeats the procedure for different directions of the incident ray **PQ**. The student measures **XZ**, **WX**, **YZ** and **WY** for each direction of **PQ**.
State and explain how the student can use these results to obtain a value of n by a graphical method.

(2)

(c) The student used a block with dimensions 114 mm × 65 mm × 19 mm to perform the experiment.

The student's data are shown in the table below.

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WX/mm	WY/mm	XZ/mm	YZ/mm
130	78	113	44
103	75	80	38
90	73	63	33
81	71	49	27
75	69	38	22
67	66	15	10

Explain whether the range of measurements made by the student is suitable.

_____

_____

_____

_____

_____

_____

(3)

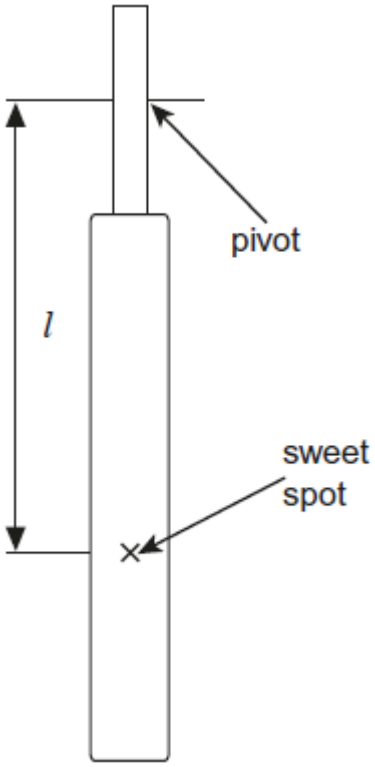
(Total 7 marks)

Q74.

In a compound pendulum the mass is distributed along its length rather than being a 'point' mass as in a simple pendulum.

When used to strike a ball, a cricket bat behaves like a compound pendulum. The bat has a sweet spot. When the ball hits this spot there is a maximum momentum transfer from the bat to the ball and the bat oscillates in the batsman’s hands.

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The diagram above shows a cricket bat pivoted at the point at the centre of the batsman's grip. The position of the sweet spot is also marked on the bat.

It is suggested that the distance l between the pivot and the sweet spot is the same as the length of a simple pendulum with the same period of oscillation as the bat.

Describe how you would use the pivoted bat shown in the diagram to investigate whether the distance from the sweet spot to the pivot is equal to the length of the equivalent simple pendulum.

You should consider the uncertainties in the measurements for the bat and the pendulum in your answer

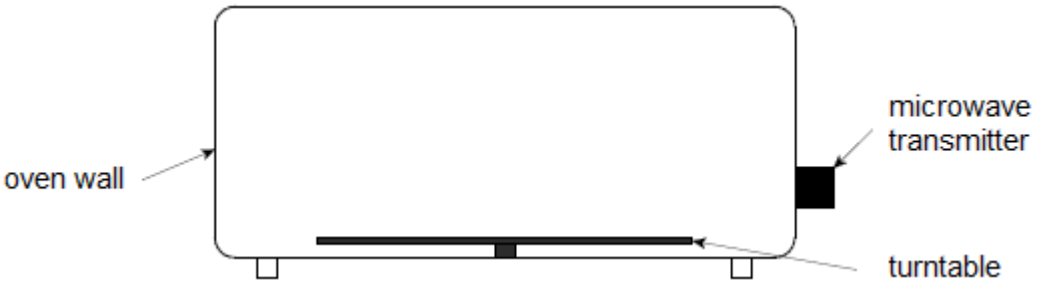
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(Total 5 marks)

Q75.

Figure 1 is a diagram of a microwave oven.

Figure 1



A student wants to use the stationary waves formed in the microwave oven to measure the frequency of the microwaves emitted by the transmitter.

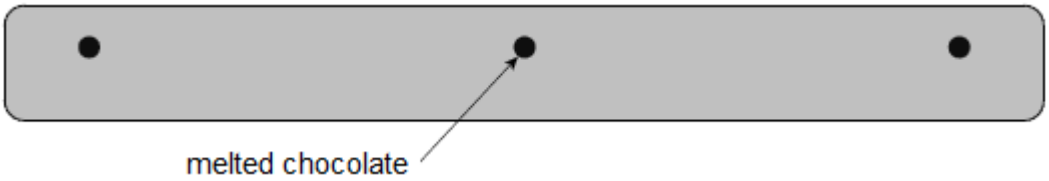
(a) Suggest how stationary waves are formed in the microwave oven.

(2)

(b) The student removes the turntable and places a bar of chocolate on the floor of the oven. He then switches the oven on for about one minute. When the chocolate is removed the student observes that there are three small patches of melted chocolate with unmelted chocolate between them. **Figure 2** is a full-sized diagram of the chocolate bar.

Figure 2

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Suggest why the chocolate only melts in the positions shown.

_____

_____

_____

_____

(2)

(c) Calculate, by making suitable measurements on **Figure 2**, the frequency of the microwaves used by the oven.

frequency = _____ Hz

(5)

(d) Explain why most microwave ovens contain a rotating turntable on which the food is placed during cooking.

_____

_____

_____

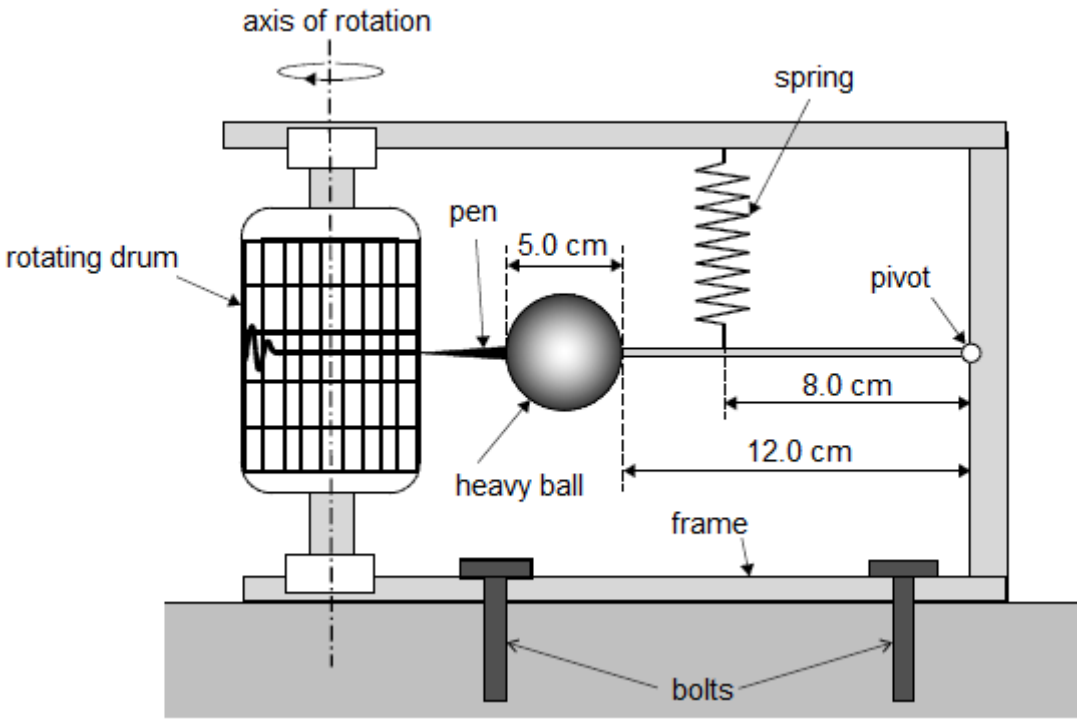
(1)

(Total 10 marks)

Q76.

A seismometer is a device that is used to record the movement of the ground during an earthquake. A simple seismometer is shown in the diagram.

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A heavy spherical ball is attached to a pivot by a rod so that the rod and ball can move in a vertical plane. The rod is suspended by a spring so that, in equilibrium, the spring is vertical and the rod is horizontal. A pen is attached to the ball. The pen draws a line on graph paper attached to a drum rotating about a vertical axis. Bolts secure the seismometer to the ground so that the frame of the seismometer moves during the earthquake.

(a) The ball is made of steel of density 8030 kg m^{-3} and has a diameter of 5.0 cm.

Show that the weight of the ball is approximately 5 N.

(3)

(b) The distance from the surface of the ball to the pivot is 12.0 cm, as shown in the diagram above.

Calculate the moment of the weight of the ball about the pivot when the rod is horizontal. Give an appropriate unit for your answer.

moment = _____ unit = _____

(3)

(c) The spring is attached at a distance of 8.0 cm from the pivot and the spring has a stiffness of 100 N m^{-1}.

Calculate the extension of the spring when the rod is horizontal and the spring is vertical. You may assume the mass of the pen and the mass of the rod are

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negligible.

extension = _____ m

(3)

(d) Before an earthquake occurs, the line being drawn on the graph paper is horizontal.

Explain what happens to the line on the graph paper when an earthquake is detected and the frame of the seismometer accelerates rapidly downwards.

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

Q77.

What is the phase difference between two points 0.16 m apart on a progressive sound wave of frequency 256 Hz?

speed of sound = 330 m s^{-1}

A $\frac{\pi}{8}$ ⬭

B $\frac{\pi}{6}$ ⬭

C $\frac{\pi}{4}$ ⬭

D $\frac{\pi}{3}$ ⬭

(Total 1 mark)

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Q78.

The frequency of the first harmonic of a standing wave on a wire is f. The length of the wire and tension in the wire are both doubled.

What is the frequency of the first harmonic as a result?

A $\frac{f}{\sqrt{2}}$ ⬭

B f ⬭

C $\sqrt{2}f$ ⬭

D $2f$ ⬭

(Total 1 mark)

Q79.

In a diffraction-grating experiment the maxima are produced on a screen.

What causes the separation of the maxima of the diffraction pattern to decrease?

A using light with a longer wavelength ⬭

B increasing the distance between the screen and grating ⬭

C increasing the distance between the source and grating ⬭

D using a grating with a greater slit separation ⬭

(Total 1 mark)

Q80.

White light passes through a single narrow slit and illuminates a screen.

What is observed on the screen?

A a set of equally spaced white fringes ⬭

B a central maximum made up of a spectrum surrounded by white fringes ⬭

C a white central maximum surrounded by coloured fringes ⬭

D a single narrow white line ⬭

(Total 1 mark)

Q81.

Which of the following is correct when total internal reflection occurs?

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A the angle of incidence is less than the critical angle ○

B the light meets an optically less dense medium ○

C the light enters a medium with a higher refractive index ○

D the angles that the incident and refracted rays make with the normal are the same ○

(Total 1 mark)

Q82.

What is the speed of light in glass of refractive index 1.42?

A 4.26×10^{7} m s^{-1} ○

B 2.11×10^{8} m s^{-1} ○

C 3.00×10^{8} m s^{-1} ○

D 4.73×10^{8} m s^{-1} ○

(Total 1 mark)

Q83.

(a) Explain what is meant by a progressive wave.

_____

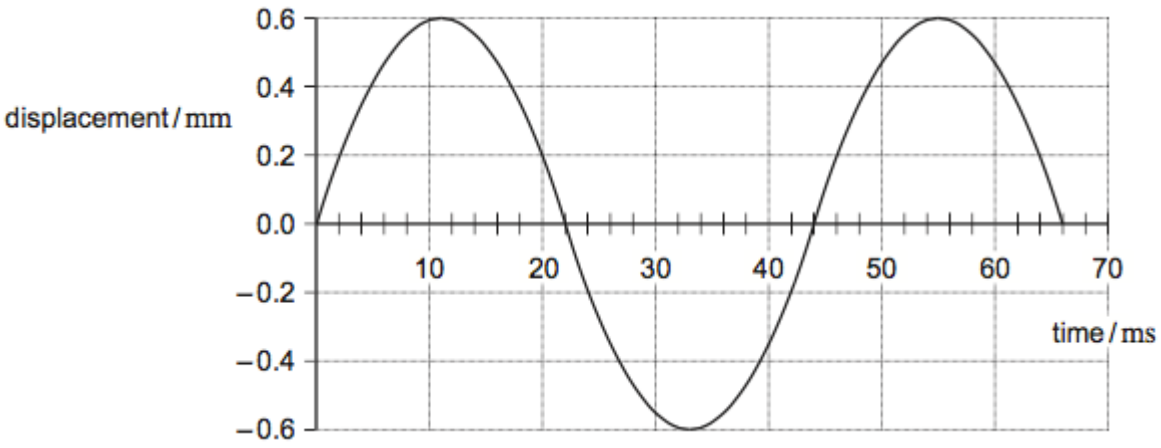
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(2)

(b) **Figure 1** shows the variation with time of the displacement of one point in a progressive wave.

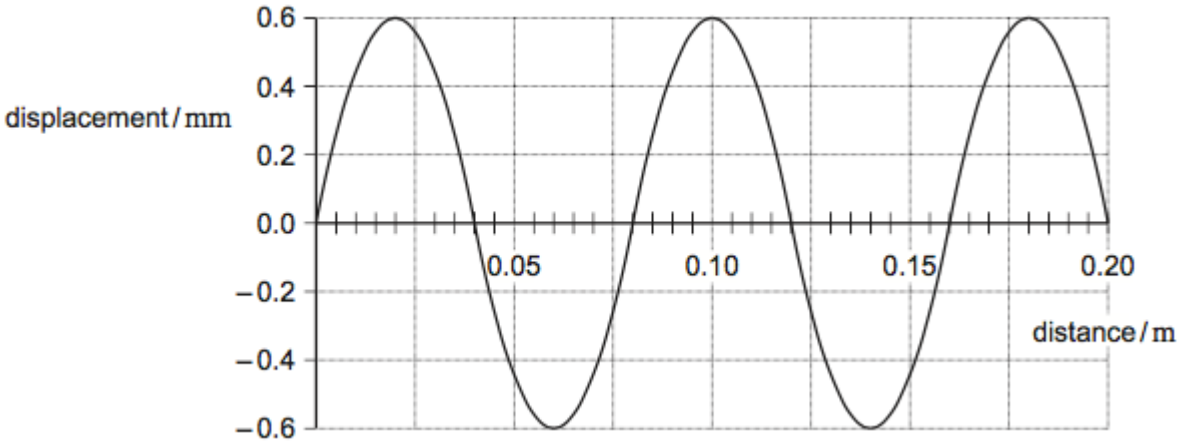
Figure 1



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Figure 2 shows the variation of displacement of the same wave with distance.

Figure 2



Use **Figures 1 and 2** to determine

(i) the amplitude of the wave

amplitude = _____ mm

(1)

(ii) the wavelength of the wave

wavelength = _____ m

(1)

(iii) the frequency of the wave

frequency = _____ Hz

(1)

(iv) the speed of the wave

speed = _____ m s^{-1}

(1)

(c) Which of the following statements apply?
Place a tick (✓) in the right-hand column for each correct statement.

	✓ if correct
sound waves are	

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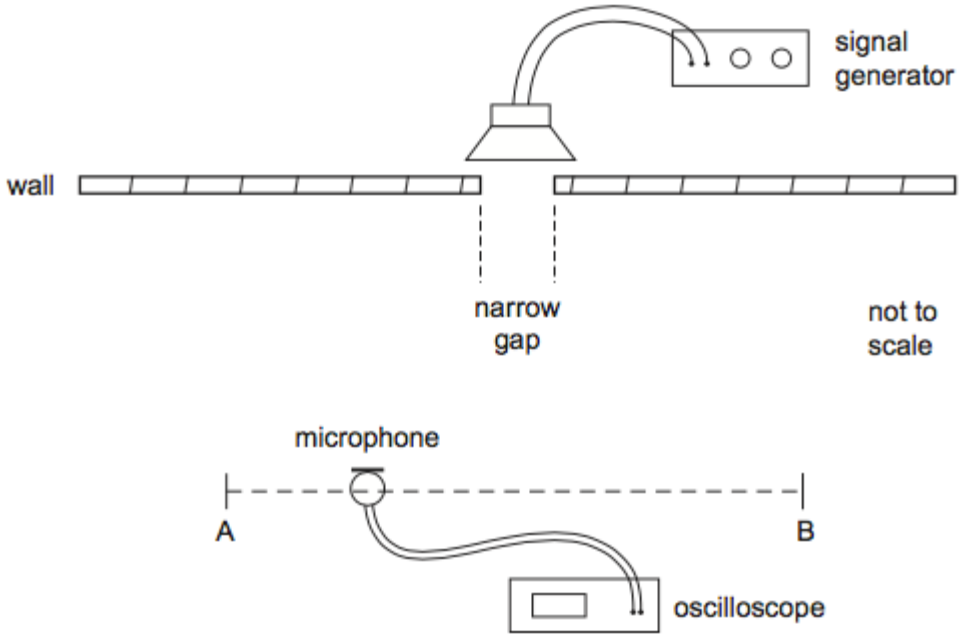
transverse	
sound waves are longitudinal	
sound waves can interfere	
sound waves can be polarised	

(1)

(d) In an investigation, a single loudspeaker is positioned behind a wall with a narrow gap as shown in **Figure 3**.

A microphone attached to an oscilloscope enables changes in the amplitude of the sound to be determined for different positions of the microphone.

Figure 3

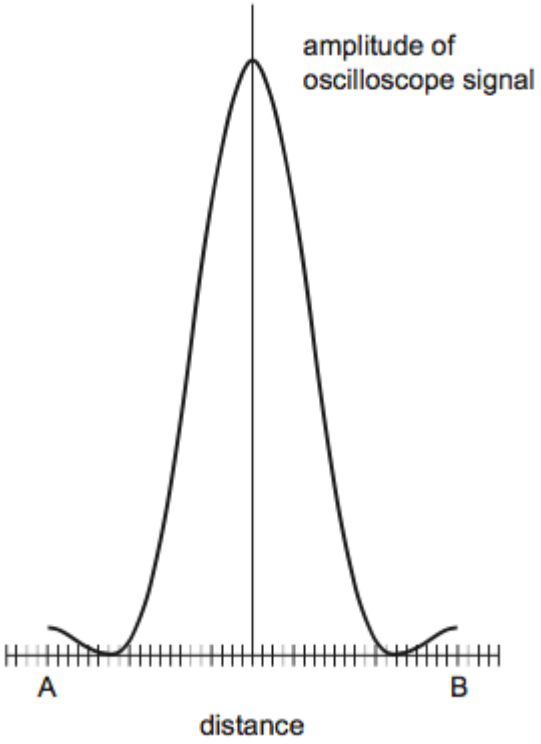


The amplitude of sound is recorded as the microphone position is moved along the line AB a large distance from the gap.

The result of the measurements is shown in **Figure 4**.

Figure 4

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The signal generator is adjusted so that sound waves of the same amplitude but of a higher frequency are emitted by the loudspeaker. The investigation using the apparatus shown in **Figure 3** is then repeated.
Explain the effect this has on **Figure 4**.

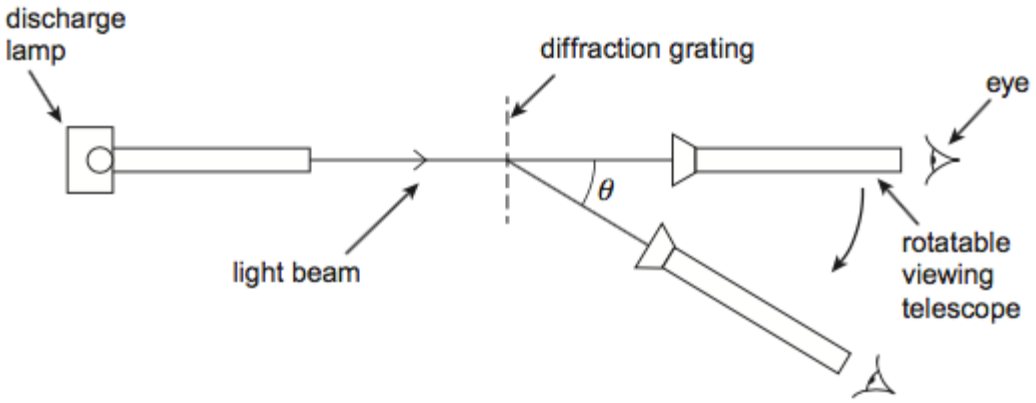
(3)

(Total 10 marks)

Q84.

A discharge lamp emits light of four colours: red, green, blue and violet. The diagram shows light from the lamp incident normally on a diffraction grating with slit separations of 1.8×10^{-6} m. The light is viewed through a telescope which can be rotated as shown.

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As the telescope is rotated from the straight-through position, each of the four colours is observed as a bright line at its corresponding first-order diffraction angle.

(a) Which colour would be observed first as the telescope is rotated from the straight-through position?

Place a tick (✓) in the right-hand column to show the correct answer.

	✓ if correct
red	
green	
blue	
violet	

(1)

(b) Explain how a bright line is formed by the diffraction grating at the first-order diffraction angle.

(3)

(c) (i) The wavelength of the green light is 5.3×10^{-7} m.

Calculate the first-order diffraction angle for this colour.

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angle = _____ degree

(2)

(ii) As the telescope is rotated further, higher-order diffraction maxima are observed.
Calculate the highest order observed for the green light.

highest order = _____

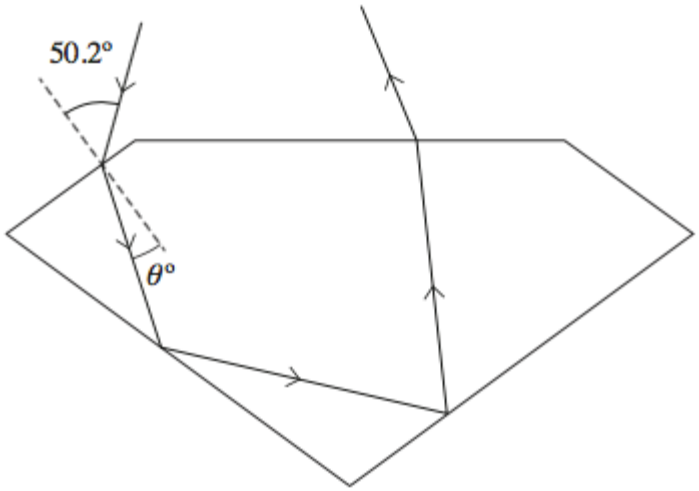
(3)

(Total 9 marks)

Q85.

Diamond jewels sparkle because light that enters the diamond at different incident angles is reflected back to an observer. **Figure 1** shows the path of one of these incident rays through a diamond.

Figure 1



(a) (i) Calculate the critical angle for diamond.

Refractive index of diamond = 2.42

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critical angle = _____ degree

(2)

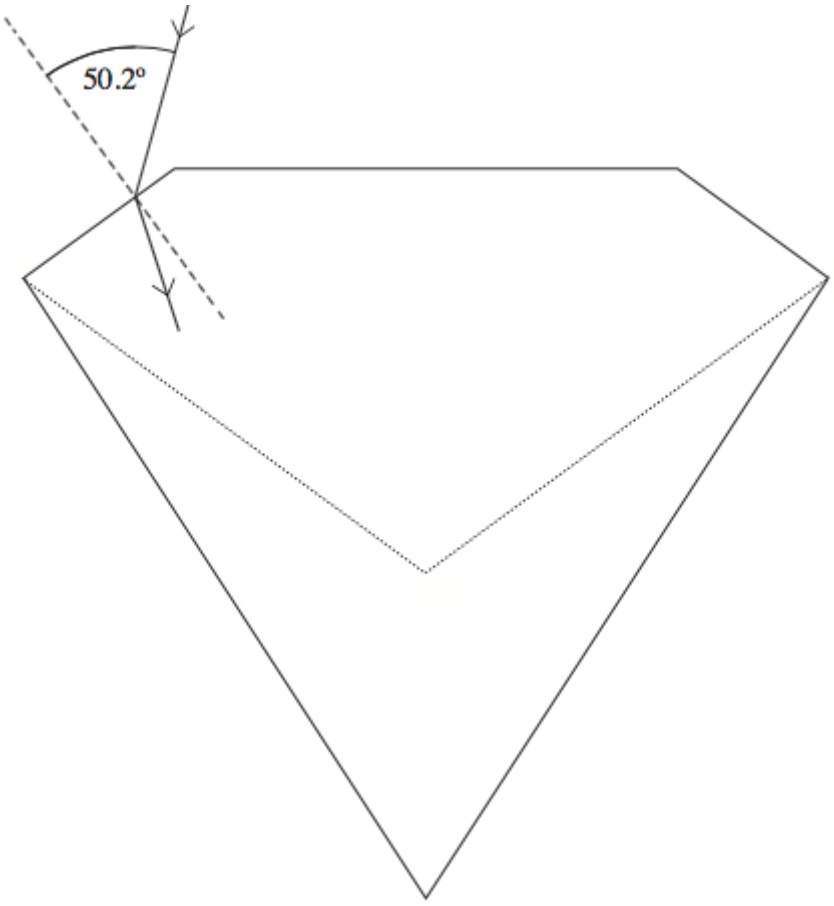
(ii) The ray shown in **Figure 1** enters at an angle of incidence of 50.2°.
Calculate the angle of refraction θ.

θ = _____ degree

(2)

(iii) The angles of a diamond are chosen to maximise the amount of light reflected.
Figure 2 shows a diamond with different angles to that of a normally shaped diamond. The dotted lines show the normal shape of a diamond.

Figure 2



Draw on **Figure 2** the path of the ray until it leaves the diamond.

(2)

(iv) Moissanite is a transparent material with a refractive index of 2.67.

Discuss whether this material, if made to the diamond shape shown in **Figure**

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1, would reflect light back more or less than diamond.

_____

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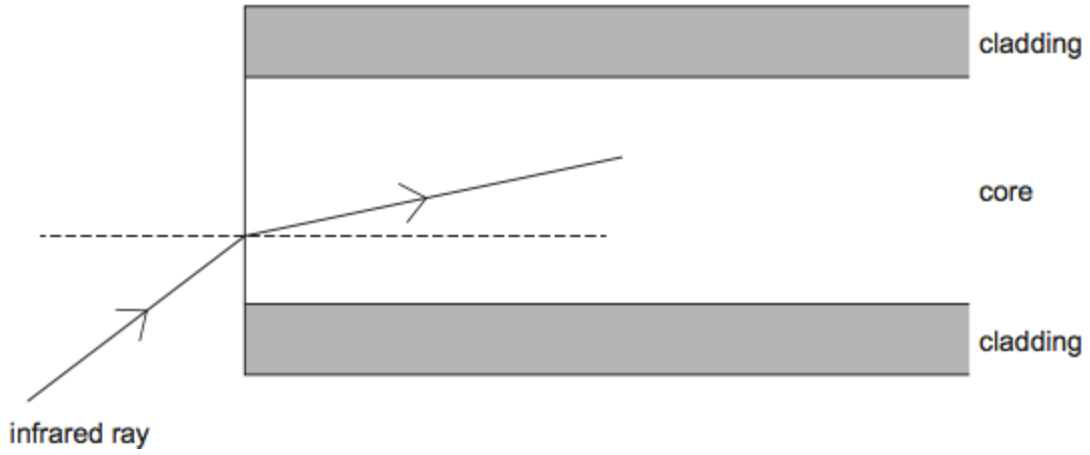
_____

_____

(2)

(b) **Figure 3** shows an infrared ray entering an optical fibre. The refractive index of the core is 1.55 at infrared frequencies.

Figure 3



(i) Calculate the speed at which infrared radiation travels in the core.

speed = _____ m s^{-1}

(1)

(ii) The wavelength of this infrared radiation is 1300 nm in air.
Calculate the wavelength of infrared in the core.

wavelength = _____ m

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(2)

(iii) State **one** reason for surrounding the core with cladding.

_____

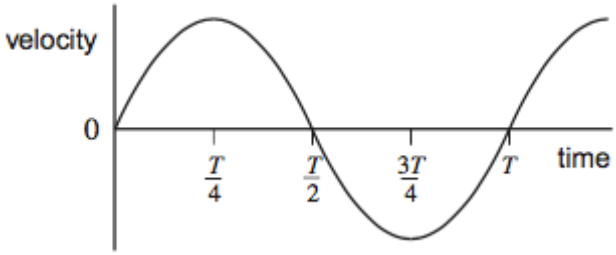
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(1)

(Total 12 marks)

Q86.

The graph shows how velocity changes with time for a simple pendulum moving with simple harmonic motion.



Which one of the following statements related to the motion of the pendulum is **incorrect**?

A The acceleration is a minimum at $\frac{T}{4}$

B The acceleration is a maximum at $\frac{T}{2}$

C The kinetic energy is a maximum at $\frac{T}{2}$

D The restoring force is a minimum at $\frac{3T}{4}$

(Total 1 mark)

Q87.

A mass hanging on the end of a spring undergoes vertical simple harmonic motion.
At which point(s) is the magnitude of the resultant force on the mass a minimum?

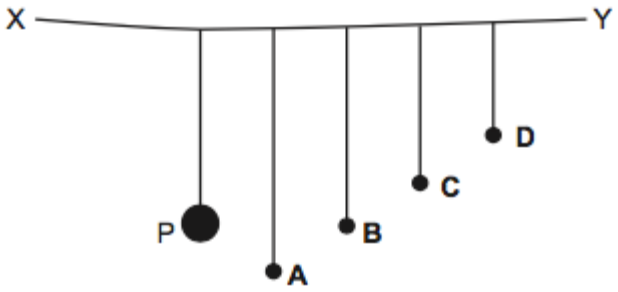
A at both the top and bottom of the oscillation
B only at the top of the oscillation
C only at the bottom of the oscillation
D at the centre of the oscillation

(Total 1 mark)

Q88.

The diagram shows a string XY supporting a heavy pendulum P and four pendulums **A**, **B**, **C** and **D** of smaller mass.

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Pendulum P is set in oscillation perpendicular to the plane of the diagram.

Which one of the pendulums, **A** to **D**, then oscillates with the largest amplitude?

(Total 1 mark)

Q89.

Within certain limits, the bob of a simple pendulum of length l may be considered to move with simple harmonic motion of period T, where

$$T = 2\pi\sqrt{\frac{l}{g}}$$

(a) State **one** limitation that applies to the pendulum when this equation is used.

_____

_____

(1)

(b) Describe an experiment to determine the value of the Earth's gravitational field strength g using a simple pendulum and any other appropriate apparatus.

In your answer you should:

- describe how you would arrange the apparatus
- indicate how you would make the measurements
- explain how you would calculate the value of g by a graphical method
- state the experimental procedures you would use to ensure that your result was accurate.

You may draw a diagram to help you with your answer.

The quality of your written communication will be assessed in your answer.

_____

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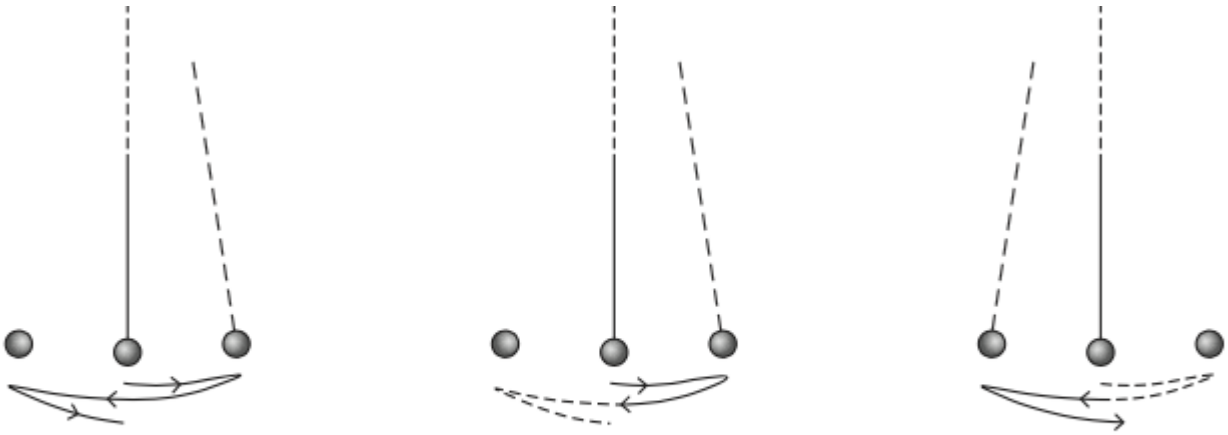
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(6)

(c) When carrying out the experiment in part **(b)**, a student measures the time period incorrectly. Mistakenly, the student thinks that the time period is the time taken for half of an oscillation instead of a full oscillation, as illustrated in the diagram.



Deduce the effect this will have on the value of g obtained from the experiment, explaining how you arrive at your answer.

(3)

(Total 10 marks)

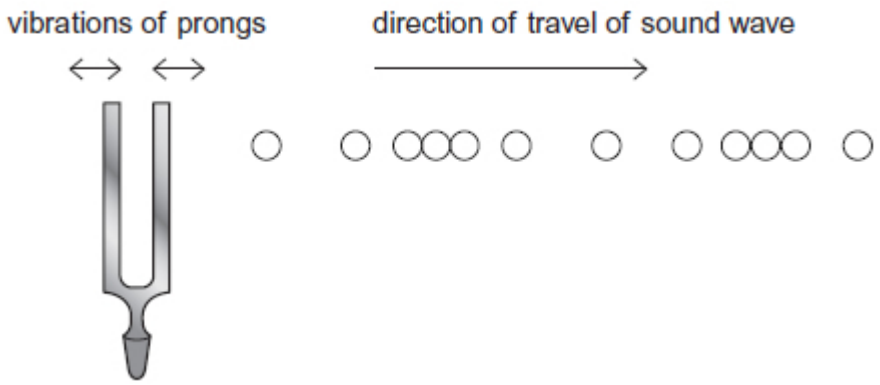
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Q90.

Musicians can use tuning forks to tune their instruments.
A tuning fork produces a specific frequency when it vibrates.

Figure 1 shows a tuning fork vibrating in air at a single instant in time.
The circles represent the positions of air particles in the sound wave.

Figure 1



(a) The tuning fork emits a wave that has a frequency of 0.51 kHz.

(i) State the meaning of the term frequency of a wave.

_____

(1)

(ii) Air particles vibrate in different phases in the direction in which the wave is travelling.

Calculate the minimum separation of particles that vibrate 180° out of phase.

speed of sound in air = 340 m s^{-1}

minimum separation _____ m

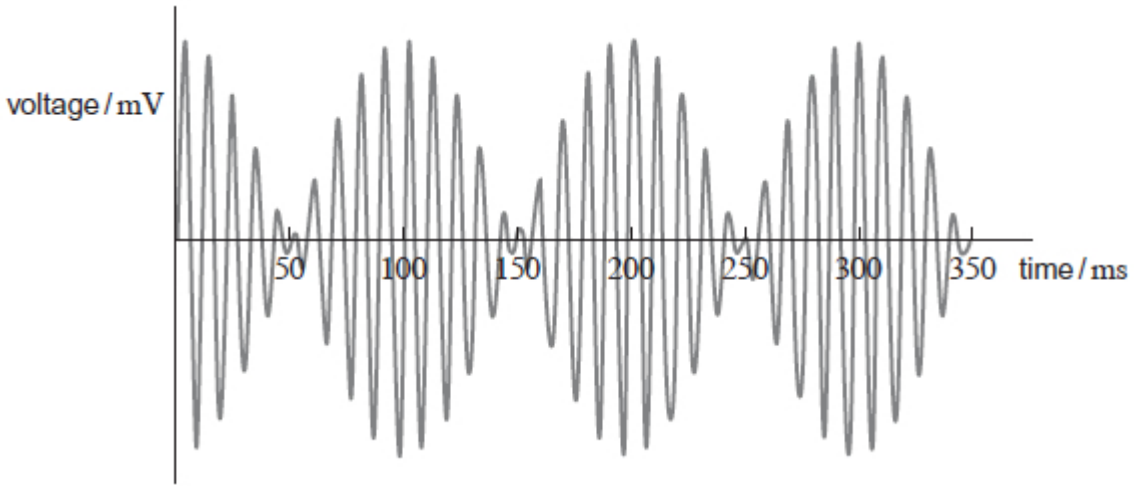
(3)

(b) A student sets a tuning fork of lower frequency vibrating at the same time as the 0.51 kHz tuning fork in part (a).

The student detects the resultant sound wave with a microphone. The variation with time of the voltage generated by the microphone is shown in **Figure 2**.

Figure 2

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(i) Explain why the two tuning forks are **not** coherent sources of sound waves.

_____

_____

_____

_____

(2)

(ii) Explain why the resultant sound has a minimum amplitude at 50 ms.

_____

_____

_____

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_____

(3)

(iii) Calculate the frequency of the tuning fork that emits the lower frequency.

frequency _____ Hz

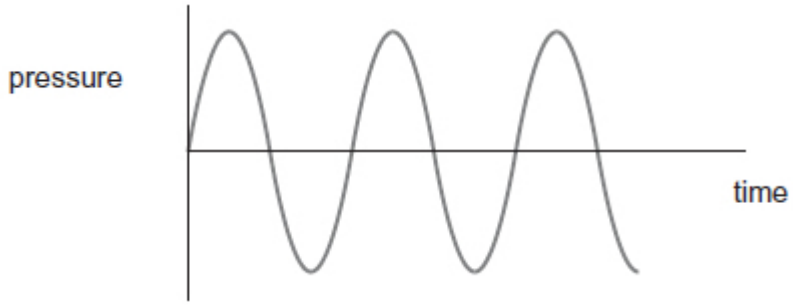
(3)

(c) A signal generator connected to a loudspeaker produces a sinusoidal sound wave with a frequency of 440 Hz.

The variation in air pressure with time for this sound is shown in **Figure 3**.

Figure 3

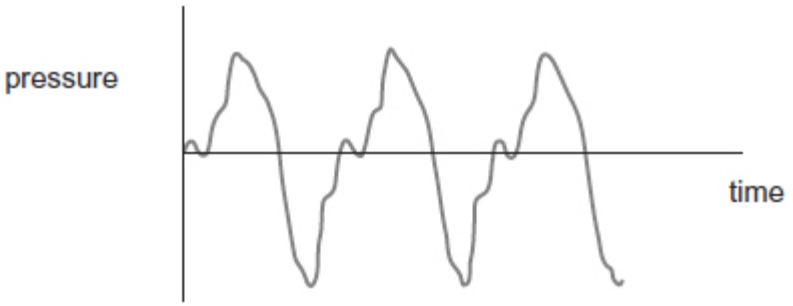
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A violin string has a fundamental frequency (first harmonic) of 440 Hz.

Figure 4 shows the variation in air pressure with time for the sound created by the violin string.

Figure 4



(i) The two sounds have the same pitch but sound different.

What term describes the difference between the sounds heard?
Tick (✓) the correct answer.

Frequency modulation	☐
Octaves	☐
Path difference	☐
Quality	☐

(1)

(ii) The complex sound in **Figure 4** can be electronically synthesised.

Describe the process of electronically synthesising this sound.

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_____

_____

(3)

(Total 16 marks)

Q91.

Describe a laboratory experiment to investigate how the fundamental frequency of a stretched string depends on the tension in the string.
The stretched string has a mass per unit length of 1.5×10^{-3} kg m^{-1}.

Your detailed method should include:

- a labelled diagram of the experiment arrangement
- suitable estimates of any quantities involved in the experiment
- how you would use the data to demonstrate the relationship between fundamental frequency and tension.

The quality of your written communication will be assessed in your answer.

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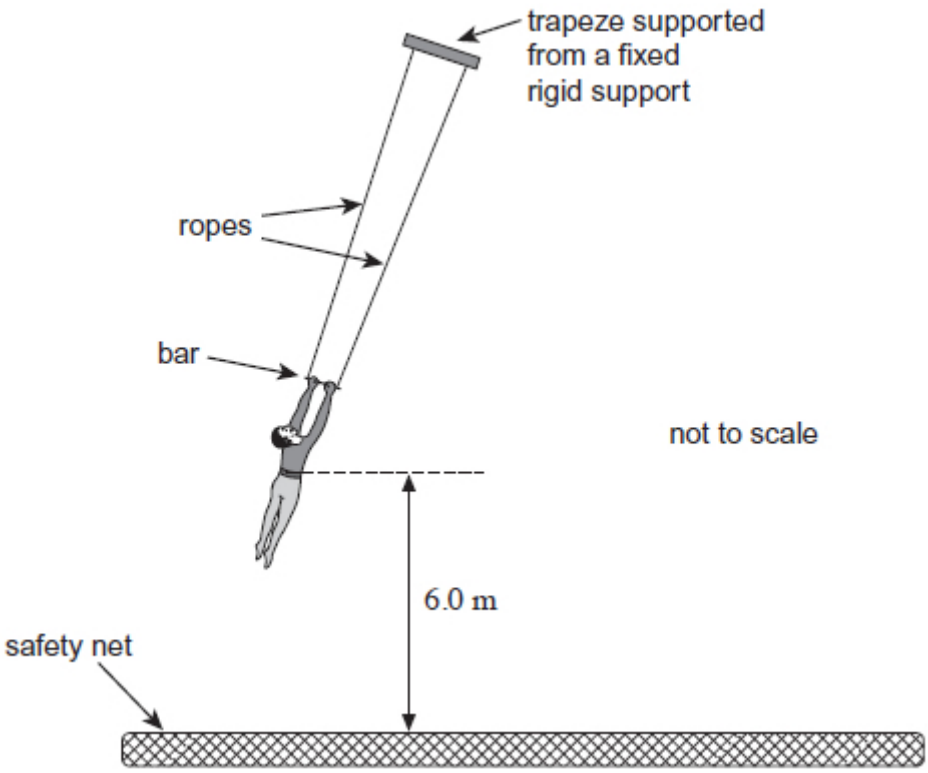
(Total 6 marks)

Q92.

Figure 1 shows an acrobat swinging on a trapeze.

Figure 1

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(a) (i) State and explain how the tension in the ropes of the trapeze varies as the acrobat swings on the trapeze.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) The period of the oscillation of the acrobat on the trapeze is 3.8 s.

Calculate the distance between the point of suspension of the trapeze and the centre of mass of the acrobat.

Assume that the acrobat is a point mass and that the system behaves as a simple pendulum.

distance _____ m

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(2)

(b) At one instant the amplitude of the swing is 1.8 m. The acrobat lets go of the bar of the trapeze at the lowest point of the swing. He lands in a safety net when his centre of mass has fallen 6.0 m.

(i) Calculate the speed of the acrobat when he lets go of the bar.

speed _____ m s^{-1}

(3)

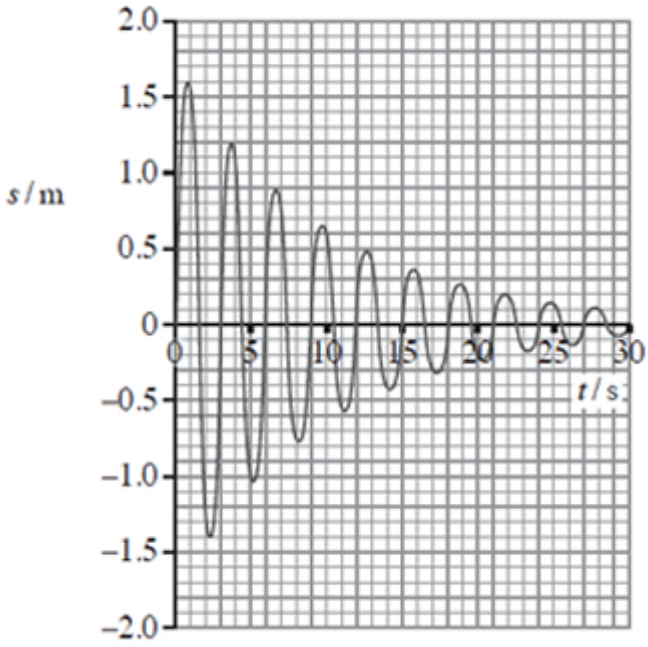
(ii) Calculate the horizontal distance between the point of suspension of the trapeze and the point at which the acrobat lands on the safety net.

horizontal distance _____ m

(3)

(c) **Figure 2** shows the displacement−time (s–t) graph for the bar of the trapeze after the acrobat has let go of the bar.

Figure 2



(i) Show that the amplitude of the oscillations decreases exponentially.

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(3)

(ii) Explain why the period of the trapeze changes when the acrobat lets go of the bar.

_____

_____

_____

_____

(2)

(Total 16 marks)

Q93.

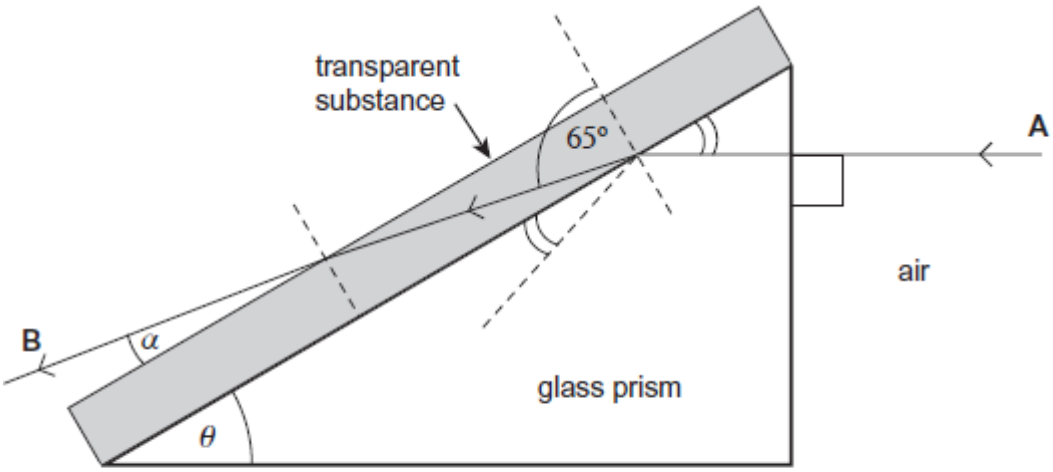
(a) Tick (✓) the appropriate boxes in the table to indicate how the wavelength, frequency and speed of light are affected when a ray of light travels from air into glass.

	Wavelength	**Frequency**	**Speed**
increases			
stays the same			
decreases			

(2)

(b) **Figure 1** shows a right-angled glass prism in contact with a transparent substance on one of the faces. One of the other angles of the prism is θ.

Figure 1



refractive index of glass prism = 1.70

refractive index of transparent substance = 1.09

angles are not shown to scale

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(i) A ray **A** enters perpendicularly to one face of the prism. It is partially refracted and partially reflected at the interface between the glass and the transparent substance. The angle of refraction is 65.0°. The ray eventually leaves at an angle α to the surface of the transparent substance.

Determine the angle α.

angle α = _____ degree

(2)

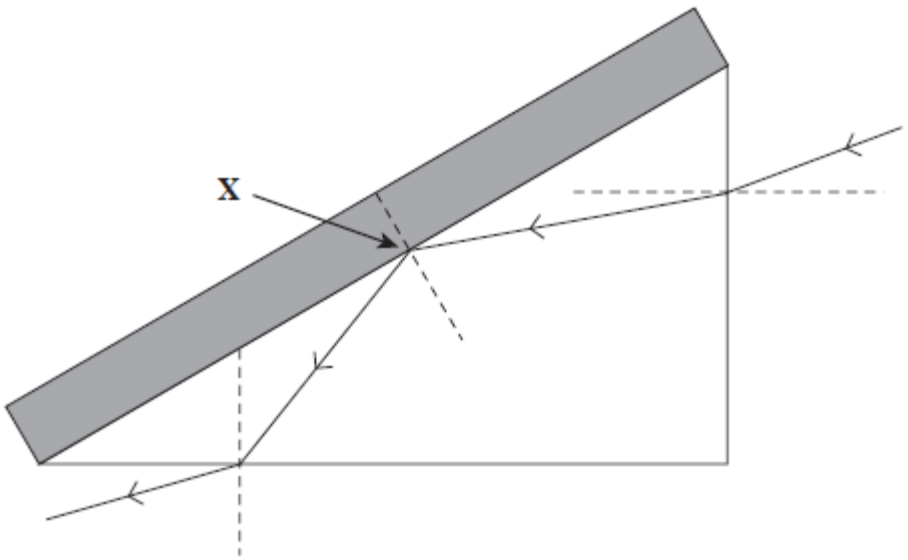
(ii) Determine the angle θ in **Figure 1**.

angle θ = _____ degree

(2)

(c) **Figure 2** shows another ray entering the prism.

Figure 2



(i) Identify the effect that takes place at **X** in **Figure 2**.

_____

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(1)

(ii) Explain, with a diagram, how the effect that occurs at **X** is used to transmit information along an optic fibre.

(3)

(Total 10 marks)

Q94.

A stationary wave is formed on a stretched string. Discuss the formation of this wave. Your answer should include:

- an explanation of how the stationary wave is formed
- a description of the features of the stationary wave
- a description of the processes that produce these features.

The quality of your written communication will be assessed in your answer.

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_____

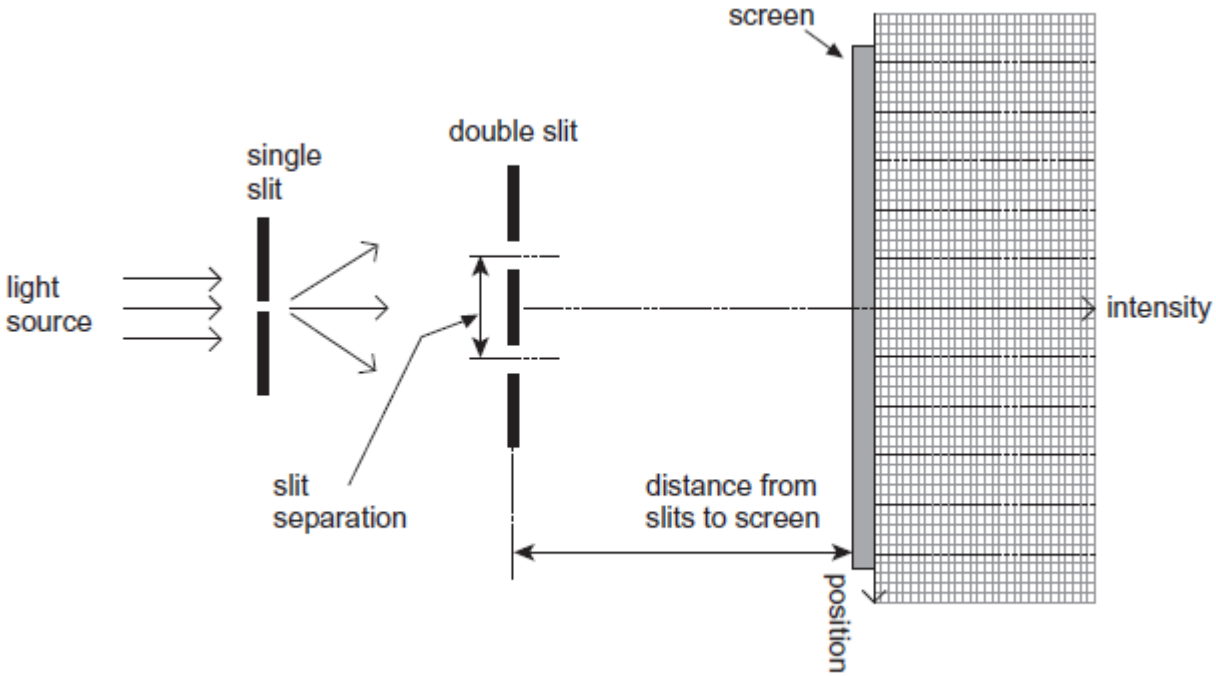
_____

_____

(Total 6 marks)

Q95.

The diagram shows Young's double-slit experiment performed with a tungsten filament lamp as the light source.



not to scale

(a) On the axes in the diagram above, sketch a graph to show how the intensity varies with position for a **monochromatic** light source.

(2)

(b) (i) For an interference pattern to be observed the light has to be emitted by two **coherent sources**.
Explain what is meant by coherent sources.

_____

_____

_____

_____

(1)

(ii) Explain how the use of the single slit in the arrangement above makes the light from the two slits sufficiently coherent for fringes to be observed.

_____

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_____

_____

_____

(1)

(iii) In this experiment light behaves as a wave.
Explain how the bright fringes are formed.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(c) (i) A scientist carries out the Young double-slit experiment using a laser that emits violet light of wavelength 405 nm. The separation of the slits is 5.00×10^{-5} m.

Using a metre ruler the scientist measures the separation of two adjacent bright fringes in the central region of the pattern to be 4 mm.

Calculate the distance between the double slits and the screen.

distance = _____ m

(2)

(ii) Describe the change to the pattern seen on the screen when the violet laser is replaced by a green laser. Assume the brightness of the central maximum is the same for both lasers.

_____

_____

_____

(1)

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(iii) The scientist uses the same apparatus to measure the wavelength of visible electromagnetic radiation emitted by another laser.
Describe how he should change the way the apparatus is arranged and used in order to obtain an **accurate** value for the wavelength.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)

Q96.

For a body performing simple harmonic motion, which one of the following statements is correct?

A The maximum kinetic energy is directly proportional to the frequency.

B The time for one oscillation is directly proportional to the frequency.

C The speed at any instant is directly proportional to the displacement.

D The maximum acceleration is directly proportional to the amplitude.

(Total 1 mark)

Q97.

(a) Musical **concert pitch** has a frequency of 440 Hz.
A correctly tuned A-string on a guitar has a first harmonic (fundamental frequency) two octaves below concert pitch.

Determine the first harmonic of the correctly tuned A-string.

frequency_____ Hz

(1)

(b) Describe how a note of frequency 440 Hz can be produced using the correctly tuned A-string of a guitar.

_____

_____

(1)

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(c) Describe the effect heard when notes of frequency 440 Hz and 430 Hz of similar amplitude are sounded together.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q98.

An optical fibre consists of a core, cladding and an outer sheath.

(a) State the purpose of the outer sheath in an optical fibre.

_____

_____

(1)

(b) For one fibre, the speed of monochromatic light in the core is 1.97×10^8 m s^{-1} and the speed in the cladding is 2.03×10^8 m s^{-1}.

Calculate the critical angle for this light at the interface between the core and the cladding.

critical angle _____ degrees

(2)

(Total 3 marks)

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