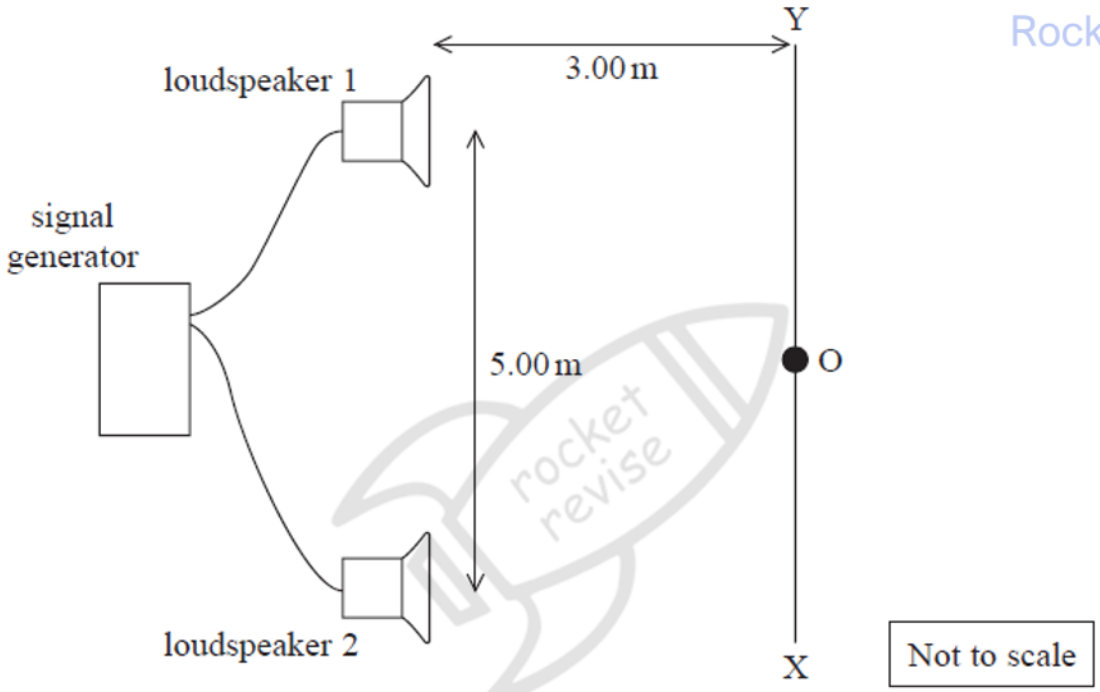
Questions

Q1.

A teacher set up a signal generator connected to two loudspeakers as shown.
This apparatus was used to determine the speed of sound in air in an open space.

A measuring tape was positioned along the ground at XY, which was a perpendicular distance of 3.00 m from the two loudspeakers.



The signal generator was set to a frequency of 160 Hz. The students walked along the line XY. As they walked, they heard a series of loud and quiet sounds. At O the students heard a loud sound.

(a) Explain why the students heard a loud sound at O.

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(b) As the students moved from O towards Y, the sound became quieter until a minimum

was reached. One student stood still at the minimum point while another student recorded from the measuring tape the distance from O at which this occurred.
He recorded this as 84 cm.

(i) Determine the speed of sound in air.

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Speed of sound in air = ...

(ii) The teacher suggested using a microphone connected to an oscilloscope to

determine where the loud and quiet zones were located along the line XY.
She said that this method would result in much less uncertainty than when students walked along the line XY.

Explain one reason why this is a suitable suggestion.

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(c) A student suggested that equally valid results would be obtained if the experiment was performed in the classroom.

Criticise this suggestion.

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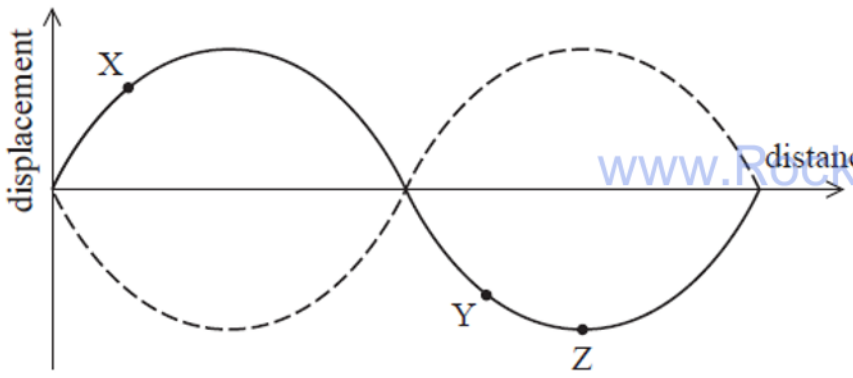
(Total for question = 12 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows how the displacement varies with distance along a stationary wave at two instants of time.



Which of the following statements is **not** correct?

☒ **A** Points X and Z are in antiphase with each other.

☒ **B** Points Y and Z have the same amplitude of vibration.

☒ **C** Points Y and Z have the same frequency of vibration.

☒ **D** Point Z is an antinode.

(Total for question = 1 mark)

Q3.

When laser light is shone through a diffraction grating a series of maxima is formed on a screen.

Assuming all other factors remain constant, which of the following changes would increase the distance between adjacent maxima?

(1)

☒ **A** Decreasing the distance between the diffraction grating and the screen.

☒ **B** Decreasing the distance between the lines on the diffraction grating.

☒ **C** Decreasing the intensity of the laser light used.

☒ **D** Decreasing the wavelength of the laser light used.

(Total for question = 1 mark)

Q4.

Two waves from the same source travel along different paths and then meet at a point P.
The phase difference between the waves at P is 1.5π radians.

Which of the following is a possible path difference that could result in this phase difference being produced at P?

☒ **A** $\frac{3\lambda}{2}$

☒ **B** $\frac{7\lambda}{4}$

☒ **C** 3λ

☒ **D** $\frac{7\lambda}{2}$

(Total for question = 1 mark)

Q5.

In an experiment, laser light is shone through a diffraction grating so that a series of bright dots appears on a screen. The equation $n\lambda = d \sin\theta$ can be used to determine the wavelength of the laser light.

Which of the following is a **correct** description of how the experiment should be performed?

☒ **A** The angle θ is measured using a protractor.

☒ **B** The diffraction grating is set up so that it is parallel to the laser light beam.

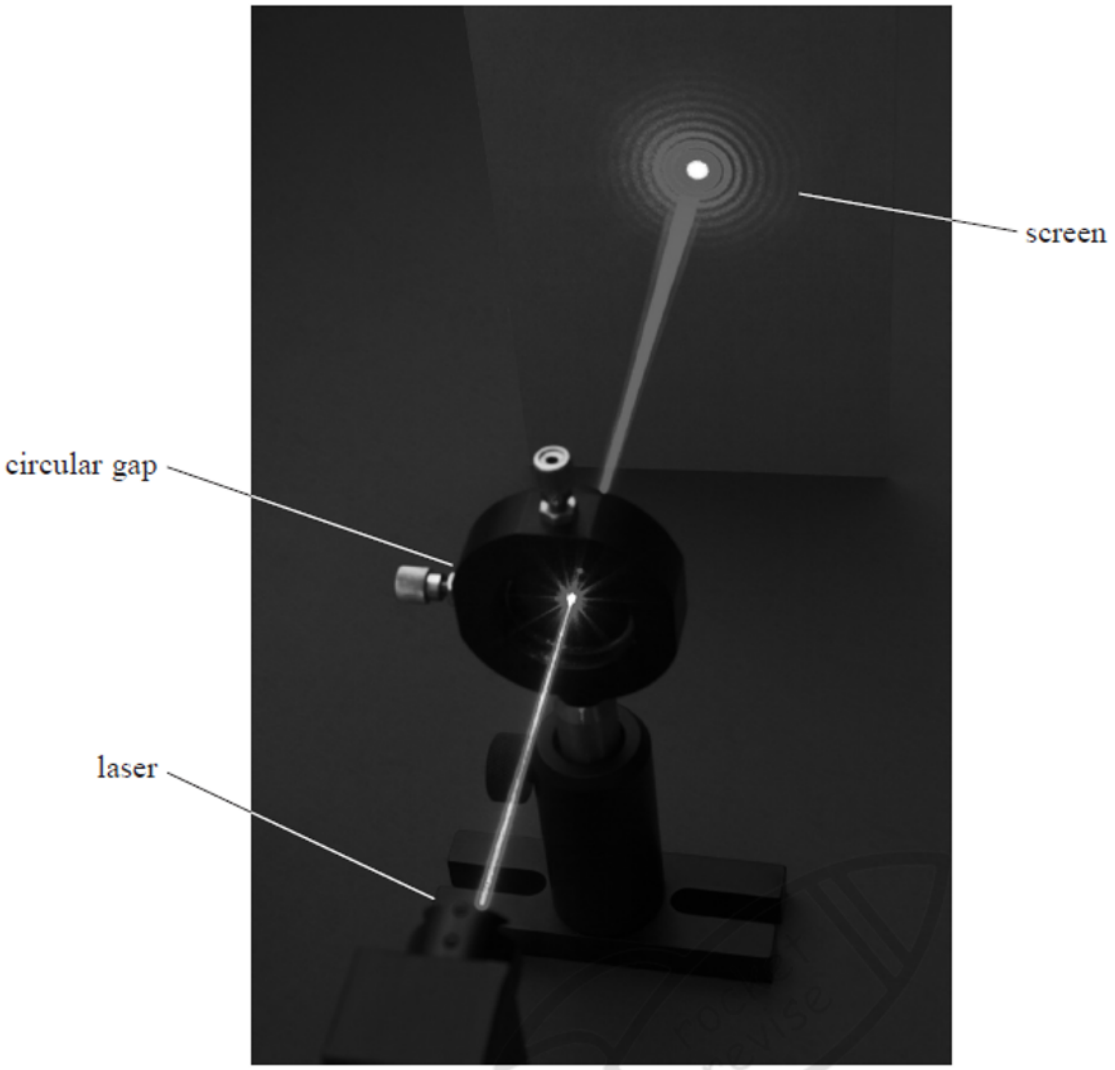
☒ **C** The diffraction grating is set up so that it is parallel to the screen.

☒ **D** The distance between the bright dots is measured with a micrometer.

(Total for question = 1 mark)

Q6.

When laser light is directed through a small circular gap, a diffraction pattern can be observed on a screen as shown.



(Source: © GIPHOTOSTOCK / SCIENCE PHOTO LIBRARY)

(a) Explain, using Huygens' construction, how diffraction occurs as waves pass through a gap.

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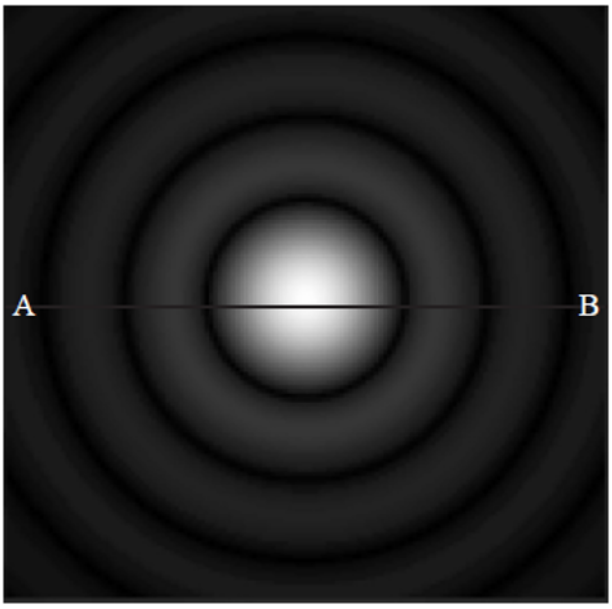
(b) The diffraction pattern consists of a central bright spot surrounded by concentric circles of light of decreasing intensity. A close-up of the pattern is shown below.



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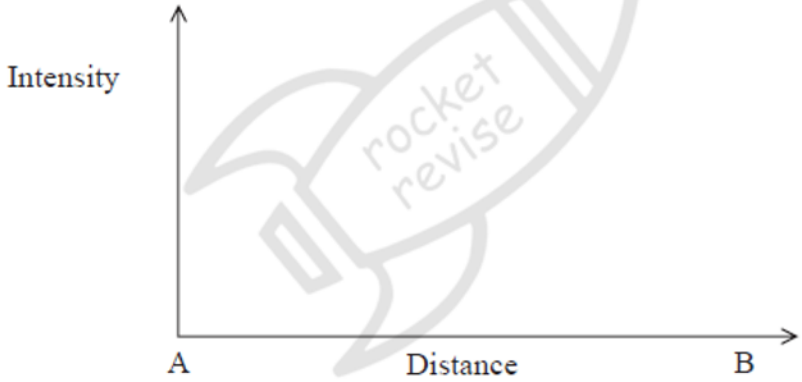
Sketch a graph showing how the intensity of the light in the diffraction pattern on the screen varies along the line AB.

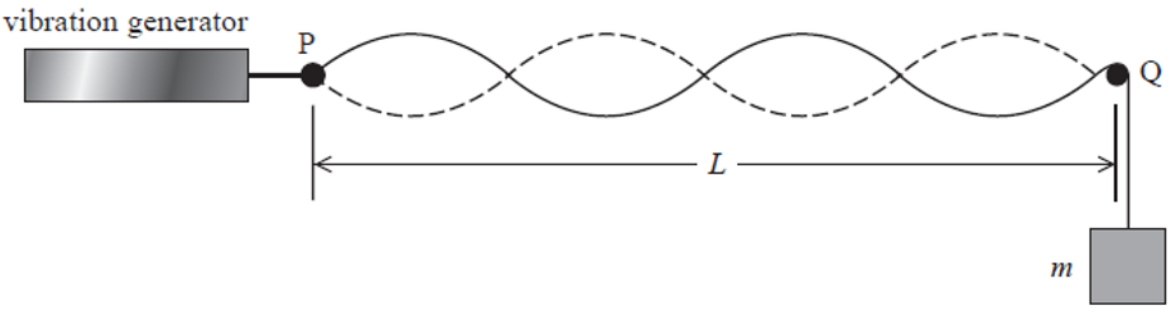
(3)



(Total for question = 5 marks)

Q7.

An experiment is carried out to investigate the speed of transverse waves on a stretched string of length *L*. A vibration generator causes the string to oscillate so that a stationary wave is produced. The frequency of the vibration generator is adjusted until the wave pattern shown in the diagram is produced.



Sourced from: https://people.highline.edu/iglozman/classes/physnotes/media/waves_9.jpg

(a) Determine the wavelength of the waves on the string when vibrating as shown.

length L = 1.70 m

(2)

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Wavelength = ...

(b) Calculate the speed of waves on the string.

mass m = 0.20 kg
mass per unit length of string = 4.5×10^{-3} kg m^{-1}

(3)

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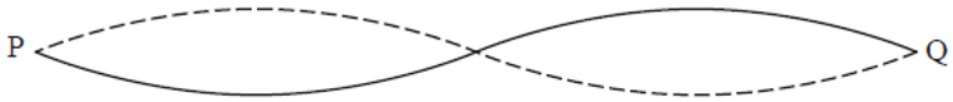
Speed = ...

(c) The frequency of the vibration generator is reduced until the wave pattern shown below is produced.



Explain the effect that this would have on the speed of the waves on the string.

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(Total for question = 7 marks)

Q8.

Two waves, of wavelength λ, from a single source diverge and then meet again.
Which of the following situations would cause constructive interference?

☒ **A** a path difference of $\frac{\lambda}{2}$

☒ **B** a path difference of λ

☒ **C** a phase difference of $\frac{\pi}{2}$

☒ **D** a phase difference of π

(Total for question = 1 mark)

Q9.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Two waves from the same source arrive at a point with a path difference of $\frac{3\lambda}{8}$, where λ is the wavelength.

Which of the following is the phase difference of the waves at this point?

☒ **A** 34°

☒ **B** 68°

☒ **C** 135°

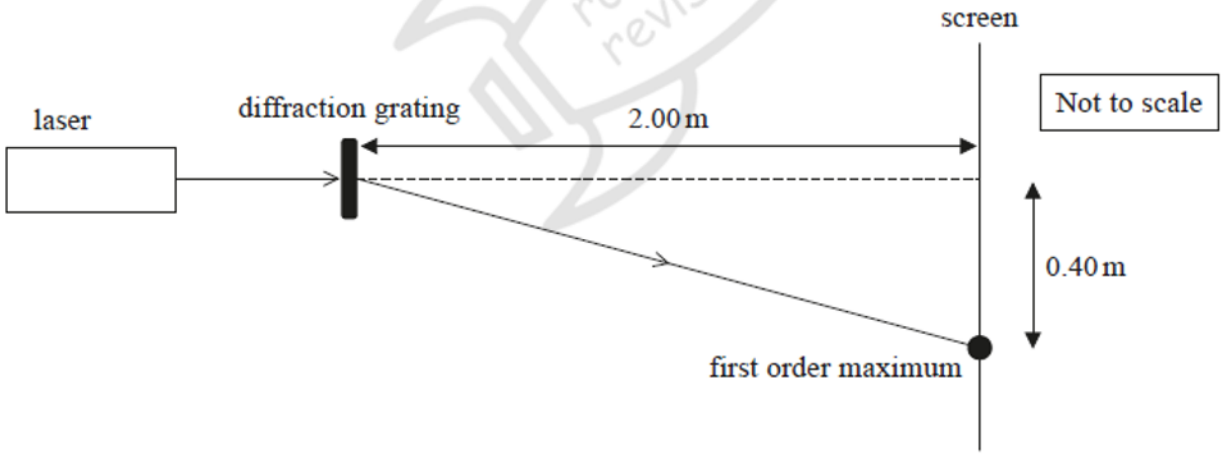
☒ **D** 270°

(Total for question = 1 mark)

Q10.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

A diffraction grating has 300 lines per mm. When laser light is directed towards the diffraction grating, a diffraction pattern is observed on a screen. The position of a first order maximum on the screen is shown in the diagram.



Which of the following calculations should be used to determine the wavelength, in mm, of the laser light used?

☒ **A** $300\sin\theta$ where $\theta = \sin^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **B** $300\sin\theta$ where $\theta = \tan^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **C** $\frac{\sin\theta}{300}$ where $\theta = \sin^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **D** $\frac{\sin\theta}{300}$ where $\theta = \tan^{-1}\left(\frac{0.40}{2.00}\right)$

(Total for question = 1 mark)

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A student investigates how different variables affect the speed of waves on a vibrating string.

Which of the following would increase the speed of waves along the string?

☒ **A** increasing the frequency

☒ **B** increasing the length of the string

☒ **C** increasing the mass per unit length of the string

☒ **D** increasing the tension in the string

(Total for question = 1 mark)

Q12.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two waves leave the same source in phase. The waves travel along different paths and then meet. The wavelength of the waves is 8.0 cm.

Which of the following would cause constructive interference when the waves meet?

☒ **A** path difference of 16.0 cm

☒ **B** path difference of $\frac{3\lambda}{2}$

☒ **C** phase difference of 180°

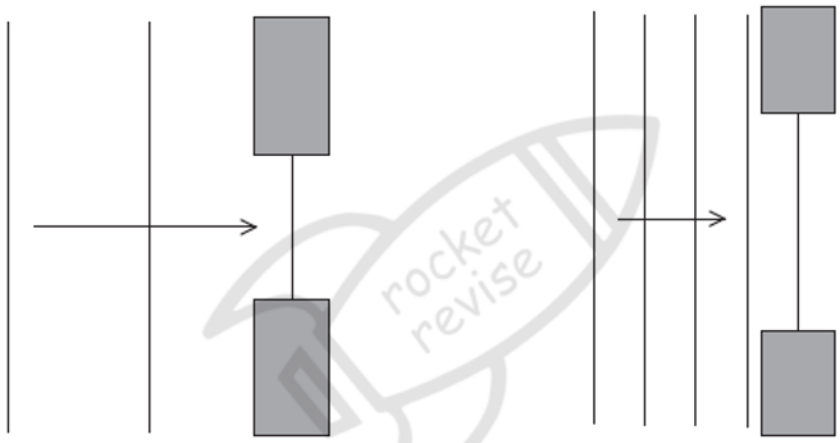
☒ **D** phase difference of 3π radians

(Total for question = 1 mark)

Q13.

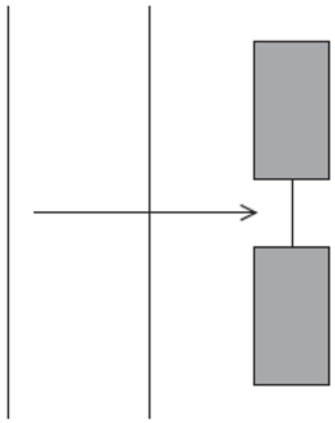
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The wavefront diagrams show consecutive waves approaching gaps of different sizes.

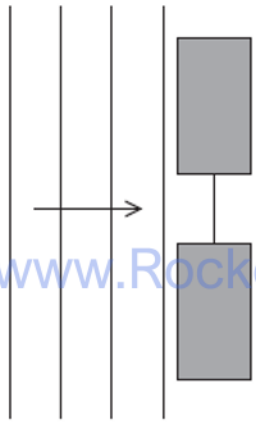


A

B



C



D

The wavefronts diffract as they pass through each gap.

In which diagram will the diffracted wavefronts **not** be semicircular?

☒ **A**

☒

B

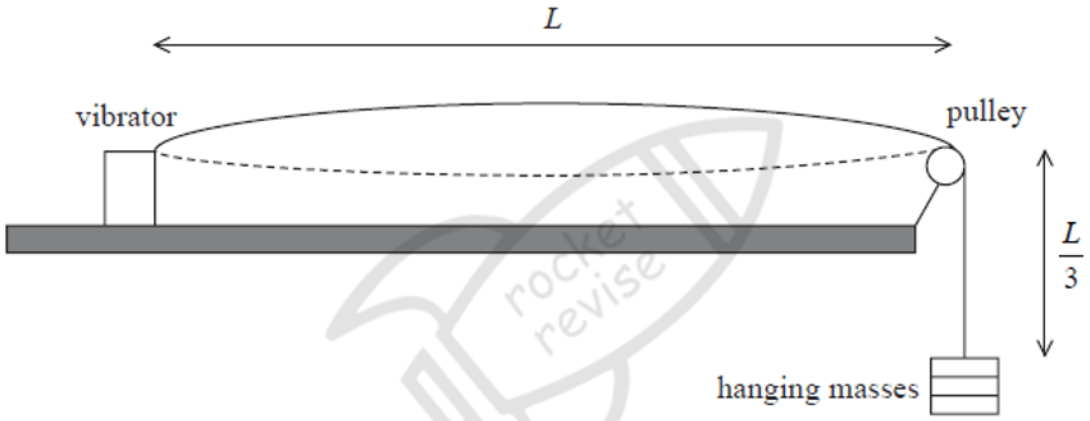
☒ **C**

☒ **D**

(Total for question = 1 mark)

Q14.

The speed of waves on a vibrating string is investigated using the apparatus shown.



length of string between vibrator and pulley = L

length of string between pulley and hanging masses = $\frac{L}{3}$

mass of whole string = m
mass of hanging masses = M

Which of the following expressions represents the speed of the waves on the string?

☒ **A** $\sqrt{\left(\frac{4MgL}{3m}\right)}$

☒ **B** $\sqrt{\left(\frac{2MgL}{3m}\right)}$

☒ **C** $\sqrt{\left(\frac{MgL}{m}\right)}$

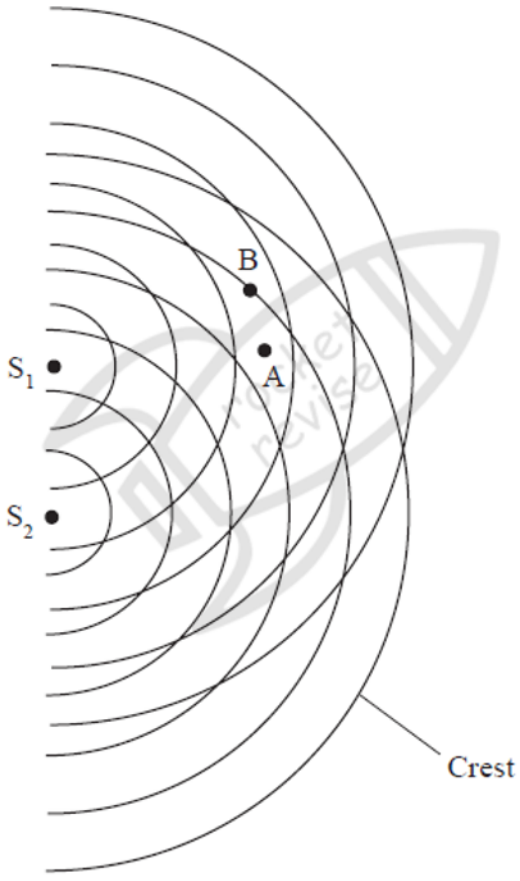
☒ **D** $\sqrt{\left(\frac{MgL}{3m}\right)}$

(Total for question = 1 mark)

Q15.

A student investigated the superposition of water waves in a ripple tank. There are two sources of waves S_1 and S_2, which are in phase.

The diagram shows the positions of successive crests of each wave at an instant in time.



Explain the type of superposition taking place at position A and at position B on the diagram.

(4)

Position A

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Position A

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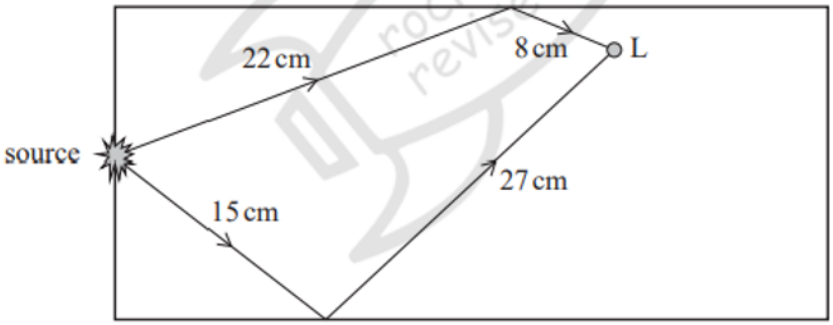
(Total for question = 4 marks)

Q16.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A microwave oven has a source that emits microwaves in all directions into the oven. The diagram shows the paths of two microwave rays that meet at point L as shown.



The interference between the waves following these two paths could cause heating effects at L depending on the wavelength of the microwaves.

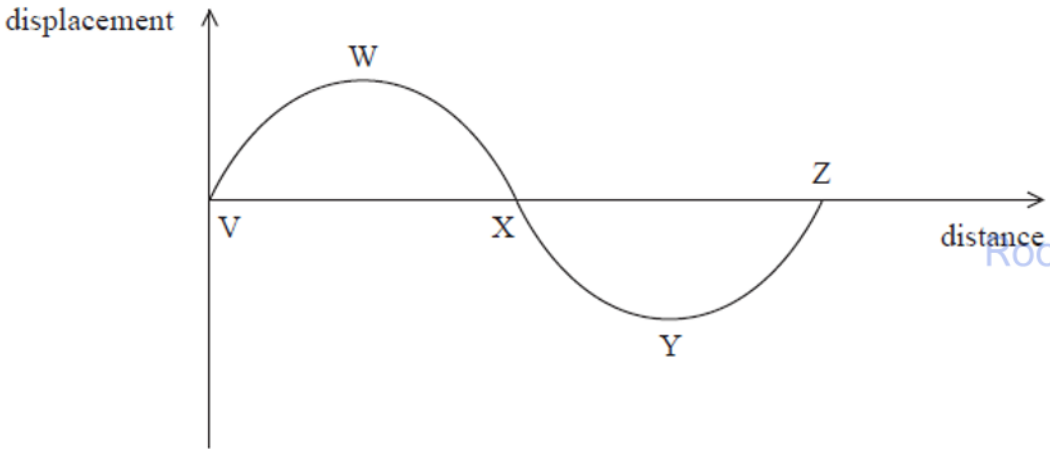
Which row of the table is possible at point L?

		Heating effect at L	Wavelength / cm
☒	**A**	maximum heating	24
☒	**B**	maximum heating	18
☒	**C**	no heating	24
☒	**D**	no heating	18

(Total for question = 1 mark)

Q17.

A sound wave travels through air. The diagram represents the displacement of air particles along the wave at an instant in time.



There is a compression at position V.

At which position is there also a compression?

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(Total for question = 1 mark)

Q18.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A student determines the wavelength of the light emitted by a laser. She uses the laser, a diffraction grating and a screen.

Which of the following measurements is **not** required?

☒ **A** the distance from the diffraction grating to the screen

☒ **B** the distance from the central maximum to the first order maximum

☒ **C** the distance from the laser to the diffraction grating

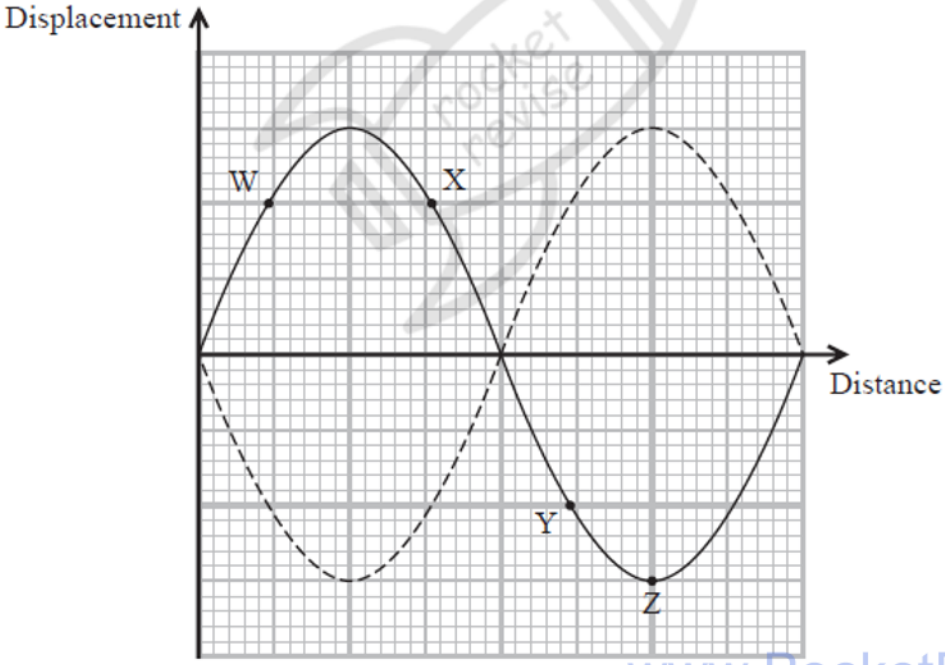
☒ **D** the distance between the slits in the diffraction grating

(Total for question = 1 mark)

Q19.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows how the displacement varies with distance along a stationary wave at two instants of time.



Which of the following statements is correct?

☒ **A** Points W and X are in antiphase.

☒ **B** Points W and Y are in phase.

☒ **C** Points X and Y are in phase.

☒ **D** Points X and Z are in antiphase.

(Total for question = 1 mark)

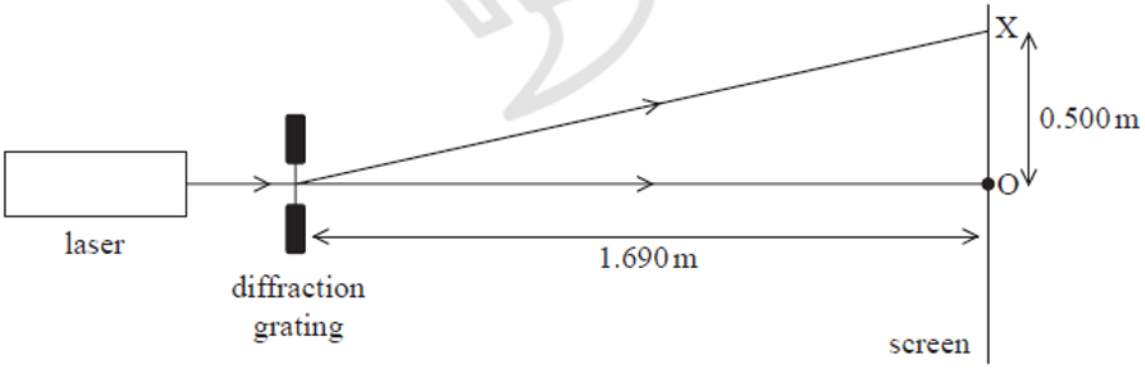
Q20.

A laser, a diffraction grating and a screen are set up as shown. The laser emits monochromatic light.

When the laser is switched on, a series of bright dots is seen on the screen.

(a) The diagram below shows the position of the central dot at O. The next bright dot appears at position X.

The diffraction grating has 450 lines per mm.



Determine the wavelength of the light from the laser.

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Wavelength = ...

(b) Explain why a series of bright dots is seen on the screen.

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(c) The laser is replaced by a source producing a parallel beam of bright white light.

Suggest what would now be observed on the screen.

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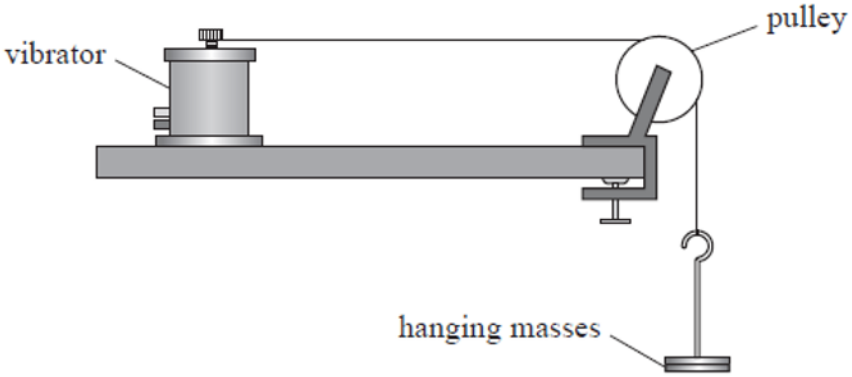
(Total for question = 9 marks)

Q21.

A student investigated stationary waves on a string, using the apparatus shown.



The frequency f of the vibrator was adjusted until a stationary wave was formed with a node at each end. This was repeated for various stationary waves on the string. A metre rule was used to measure the distance d between adjacent nodes on the string.

(a) The resolution of the metre rule was 1 mm, but the measurements were recorded to the nearest 0.5 cm.

Suggest why.

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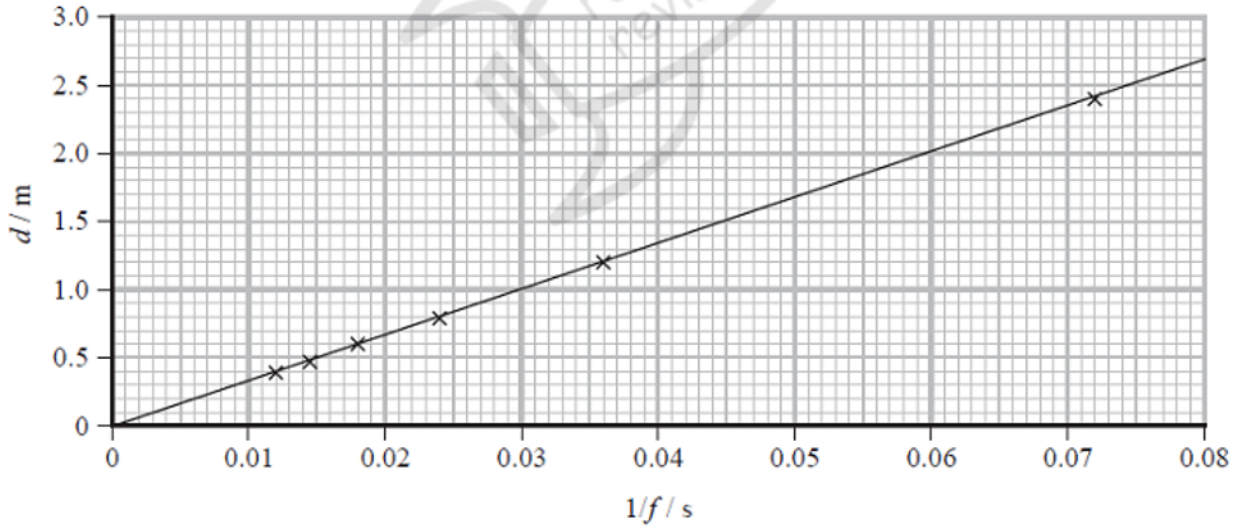
(b) The student plotted a graph of d against $1/f$ as shown.



(i) Determine the total mass of the hanging masses used in the investigation.

mass per unit length of string = 4.5×10^{-4} kg m^{-1}

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Total mass of hanging masses = ...

(ii) The string was replaced with one that had twice the mass per unit length.

The length of the string and the mass of the hanging masses did not change.

Add a line to the graph to show how d varied with $1/f$ for the new string.

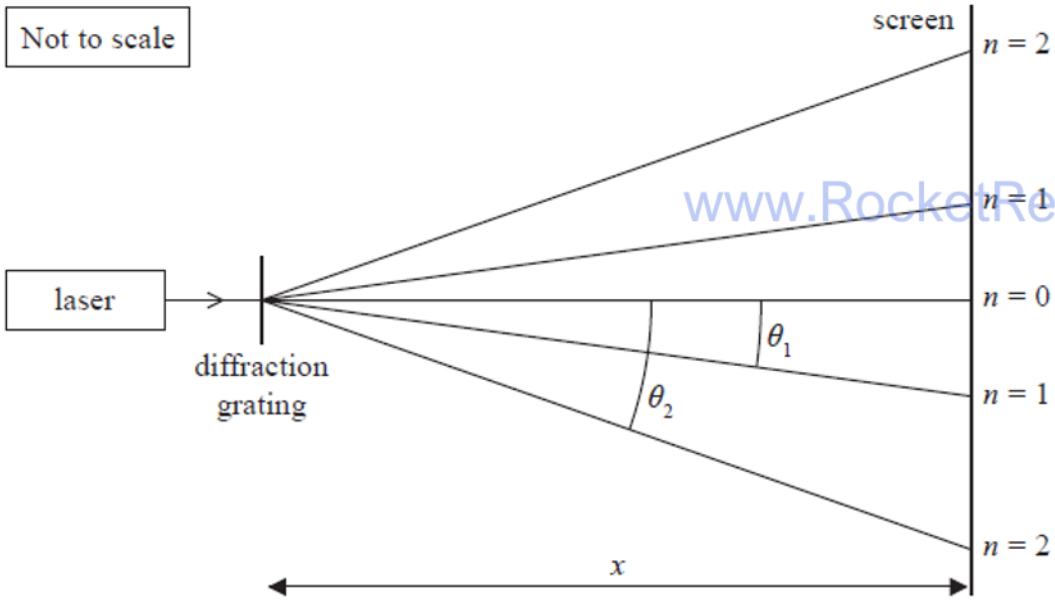
(2)

(Total for question = 8 marks)

Q22.

A student directed light from a laser so that the light was incident on a diffraction grating at 90°. The student placed a screen a distance x from the grating and observed a series of bright maxima of order n on the screen.

The student determined the value of θ_1 shown on the diagram.



The angle θ_1 is 14.0°.

(a) Calculate the angle θ_2.

(2)

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θ_2 = ...

(b) The student measured θ for values of n from 1 to 4.

Describe how a graphical method can be used to determine the wavelength of the light from the laser. Assume that the value of the grating spacing d is known.

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(c) In a separate experiment, the student uses a different diffraction grating that has been labelled as "300 lines per mm" by another student. The distance measured on the screen between the n = 0 maximum and the n = 2 maximum is 0.397 m.

Deduce whether the labelling of the diffraction grating is correct.

distance x from diffraction grating to screen = 2.00 m
wavelength of laser light = 650 nm

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(Total for question = 9 marks)

Q23.

The human ear can only hear two sounds as separate frequencies when the difference in frequency between the sounds is greater than 0.3%.

Sounds with a difference in frequency less than 0.3% are heard as the same frequency.

(a) Two sounds with frequencies of 880 Hz and 882 Hz are produced.

(i) Show that the person hears these two sounds as the same frequency.

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*(ii) When listening to these two sounds at the same time, the loudness of the sound increases and decreases repeatedly.

Explain why. Your answer should refer to coherence and phase difference.

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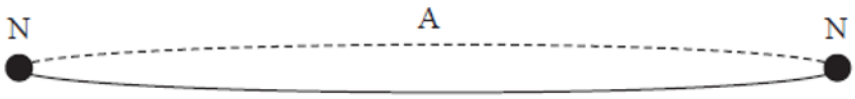
(b) A wire is stretched between two fixed points. The wire is made to vibrate and a stationary wave is created. This produces a sound wave in the air.

The fixed ends of the wire act as nodes (N). There is an antinode (A) in the middle of the wire, as shown.



A wire of length 18.7 cm produces a sound with a frequency of 882 Hz.
The tension in the wire is adjusted until the frequency of the sound is 880 Hz.

Calculate the decrease in tension required to cause this change in frequency.

mass per unit length of wire = 5.08×10^{-3} kg m^{-1}

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Decrease in tension = ...

(Total for question = 12 marks)

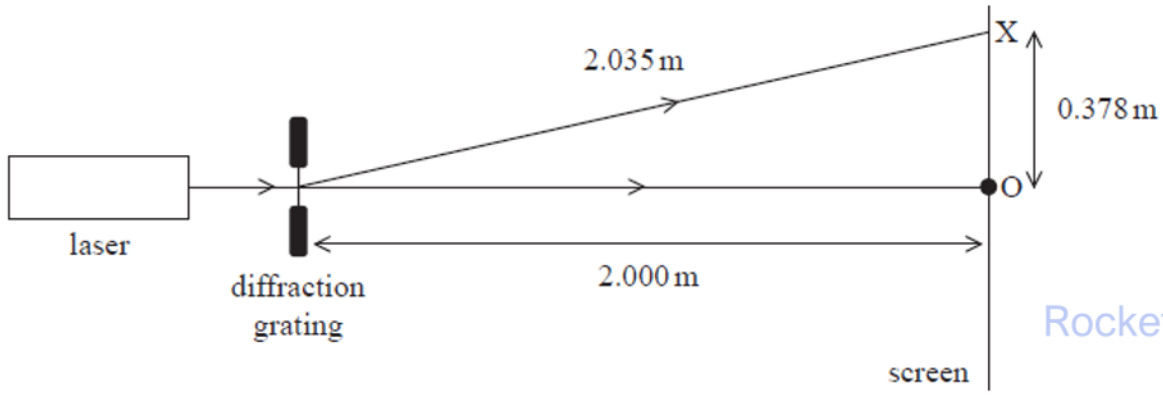
Q24.

Answer the question with a cross in the box you think is correct (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a

cross (☒).

A laser, diffraction grating and screen are set up as shown. The position of the central maximum is O and the position of the first order maximum is X.

The diffraction grating has 300 lines per mm.



Which of the following expressions gives the wavelength of the laser light?

☒ **A** $(300\,000) \times \left(\frac{0.378}{2.000}\right)$

☒ **B** $(300\,000) \times \left(\frac{0.378}{2.035}\right)$

☒ **C** $\left(\frac{1}{300\,000}\right) \times \left(\frac{0.378}{2.000}\right)$

☒ **D** $\left(\frac{1}{300\,000}\right) \times \left(\frac{0.378}{2.035}\right)$

(Total for question = 1 mark)

Q25.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two waves with wavelength λ are produced by the same source. The waves travel different distances and then meet.

At the point where they meet, the path difference between the two waves is $\frac{\lambda}{8}$.

Which of the following is the phase difference, in radians, between the two waves?

☒ **A** $\frac{\pi}{2}$

☒ **B** $\frac{\pi}{4}$

☒ **C** $\frac{\pi}{8}$

☒ **D** $\frac{\pi}{16}$

(Total for question = 1 mark)

Q26.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two waves are coherent.

Which of the following **must** be true for the two waves?

☒ **A** They are in antiphase with each other.

☒ **B** They are in phase with each other.

☒ **C** They have the same amplitude.

☒ **D** They have the same frequency.

(Total for question = 1 mark)

Q27.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question refers to the standing wave pattern on a string as shown.

Which of the following sections of the string would be in phase with each other?

☒ **A** VW and WX

☒ **B** WX and XY

☒ **C** VW and XY

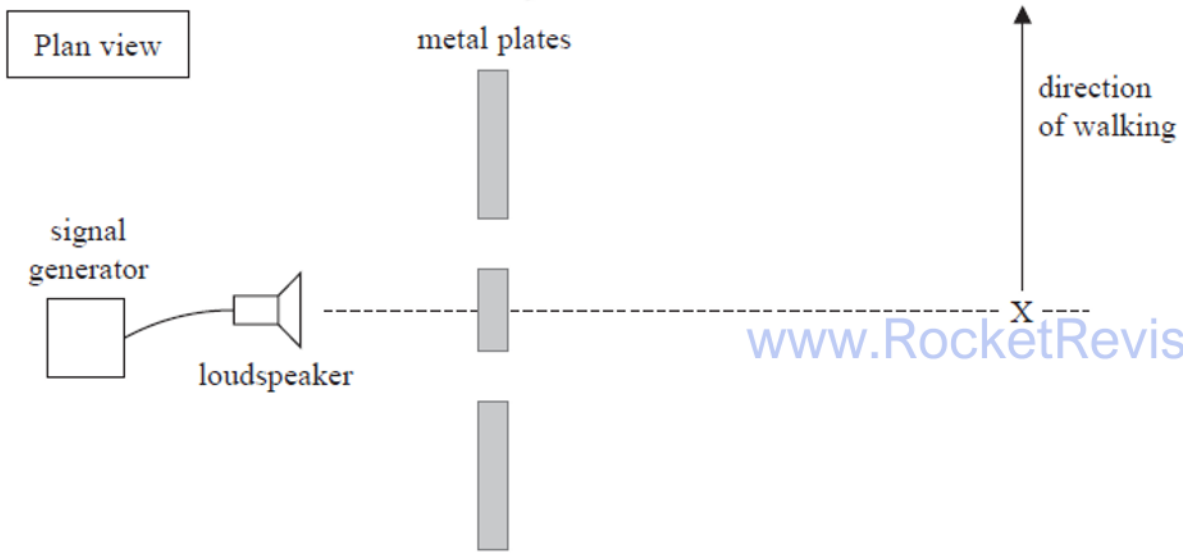
☒ **D** No sections are in phase.

(Total for question = 1 mark)

Q28.

A student connected a signal generator to a loudspeaker. The student arranged metal plates in front of the loudspeaker, as shown. The student left gaps between the metal plates.

Sound waves from the loudspeaker passed through the gaps. The gaps were approximately the same size as the wavelength of the sound waves.



The student stood at point X and heard a loud sound. The student walked in a straight line in the direction of the arrow. As her position changed, the sound became quieter until she heard no sound.

*(a) Explain why the sound became quieter until there was no sound.

Your explanation should refer to interference.

(6)

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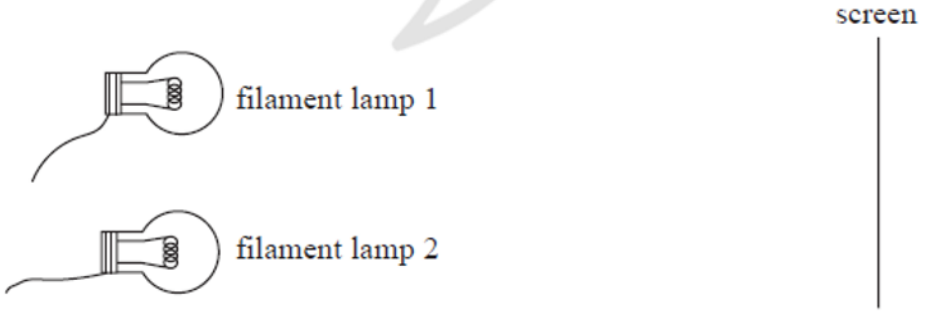
(b) Interference can be demonstrated using visible light.

A student connects two filament lamps to the same power supply. A screen is placed at a distance from the lamps, as shown.



Explain why it is **not** possible to create a consistent interference pattern on the screen using this arrangement.

(2)

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(Total for question = 8 marks)

Q29.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The equation $n\lambda = d \sin\theta$ can be used to determine the wavelength of laser light that has passed through a diffraction grating.

Which of the following is represented by d in the equation?

☒ **A** distance between adjacent lines on the diffraction grating

☒ **B** distance between the diffraction grating and the screen

☒ **C** number of lines per metre on the diffraction grating

☒ **D** order of the maximum observed on the screen

(Total for question = 1 mark)

Q30.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The formula for a diffraction grating in the list of equations is $n\lambda = d \sin\theta$.

Which of the following quantities does not have units?

☒ **A** n

☒ **B** λ

☒ **C** d

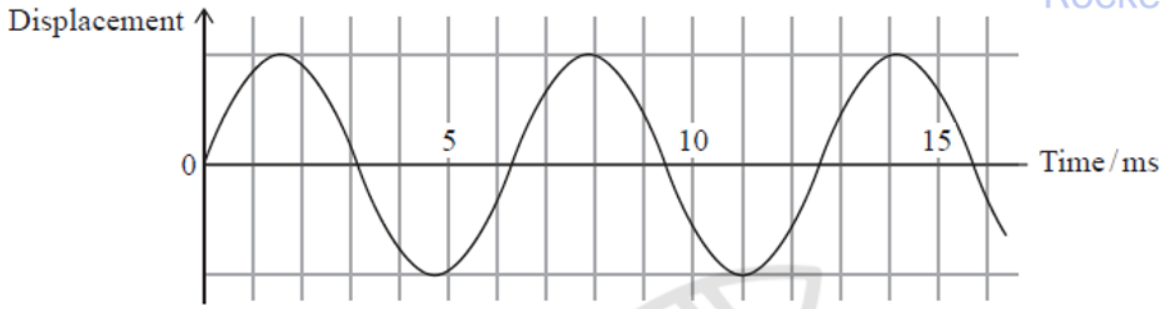
☒ **D** θ

(Total for question = 1 mark)

Q31.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The graph shows how displacement varies with time for a particular point as a wave passes.



Which of the following statements is **not** correct?

☒ **A** The time period can be determined directly from the graph.

☒ **B** The wavelength can be determined directly from the graph.

☒ **C** The wave could be longitudinal.

☒ **D** The wave could be transverse.

(Total for question = 1 mark)

Q32.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A string is placed under tension *T*. A wave travels along the string.

A second string has the same mass but twice the length. A wave travels along this string with the same velocity as the wave in the first string.

Which of the following is the tension in the second string?

☒ **A** $4T$

☒ **B** $2T$

☒ **C** $\frac{T}{2}$

☒ **D** $\frac{T}{4}$

(Total for question = 1 mark)

Q33.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following is **not** a correct statement about stationary waves?

☒ **A** All points between two adjacent nodes are in phase.

☒ **B** Antinodes are points of maximum amplitude.

☒ **C** The distance between adjacent nodes is equal to one wavelength.

☒ **D** The net energy transfer along a stationary wave is zero.

(Total for question = 1 mark)

Q34.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Waves may spread out as they pass an object.

Which of the following is the name of this process?

☒ **A** diffraction

☒ **B** interference

☒ **C** reflection

☒ **D** refraction

(Total for question = 1 mark)

Q35.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two waves, of wavelength 12 cm, leave a source in phase.

The waves travel along different paths to a point X. The path difference at X is 18 cm.

Which of the following is the phase difference between the two waves at X?

☒ **A** 0 radians

☒ **B** $\frac{\pi}{2}$ radians

☒ **C** π radians

☒ **D** $\frac{3\pi}{2}$ radians

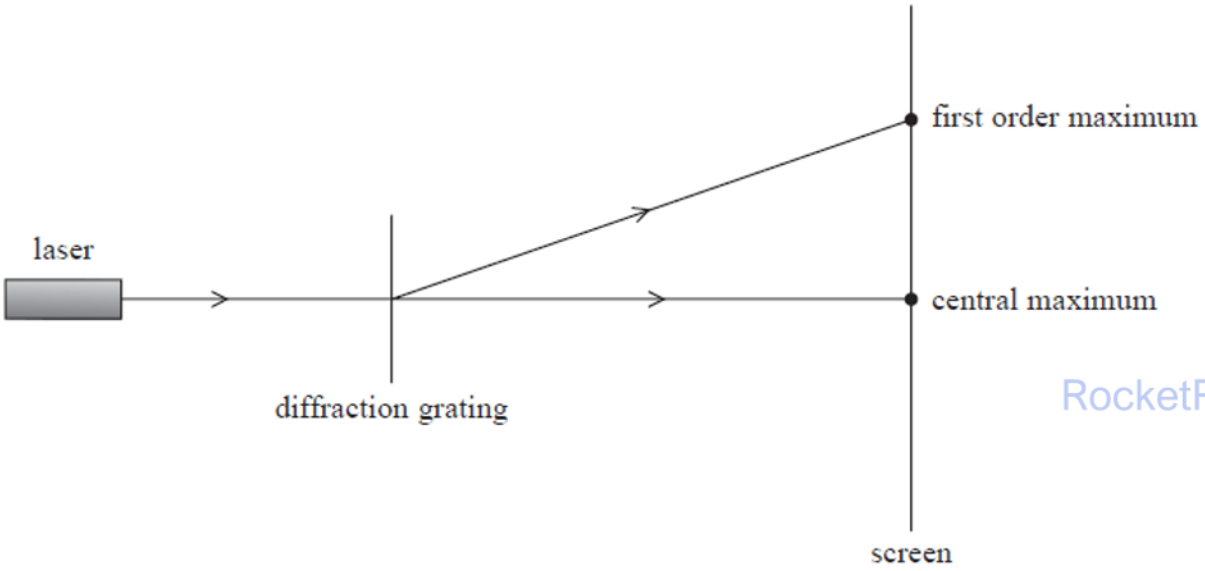
(Total for question = 1 mark)

Q36.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Light from a laser is incident on a diffraction grating, causing a series of maxima to be seen on a screen.

The positions of the central maximum and first order maximum are shown.



Which of the following changes would decrease the distance between the central maximum and the first order maximum?

☒ **A** Decreasing the distance from the laser to the diffraction grating

☒ **B** Increasing the distance from the diffraction grating to the screen

☒ **C** Using a diffraction grating with more lines per millimetre

☒ **D** Using light with a smaller wavelength

(Total for question = 1 mark)