

Questions

Q1.

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

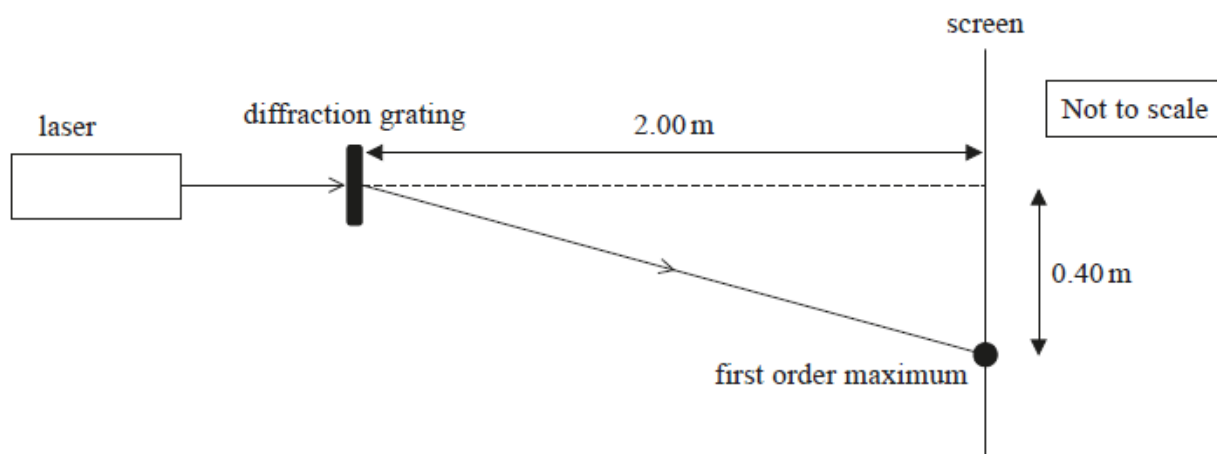
☐ **D** θ

(Total for question = 1 mark)

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 ☐.

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)

Q3.

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)

Q4.

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

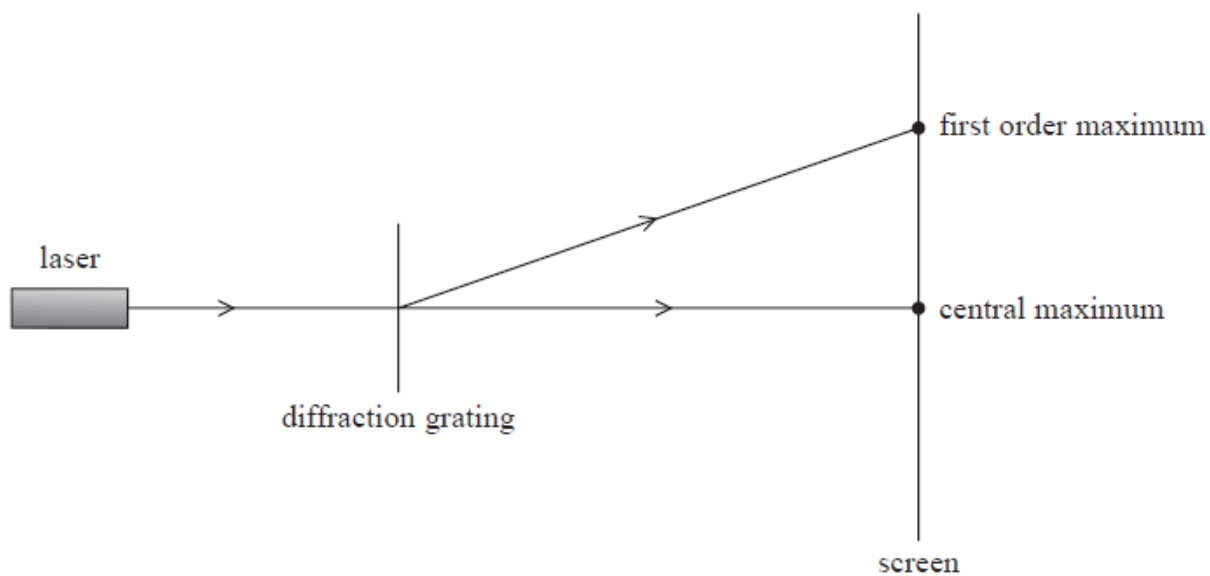
(Total for question = 1 mark)

Q5.

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)

Q6.

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)

Q7.

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.

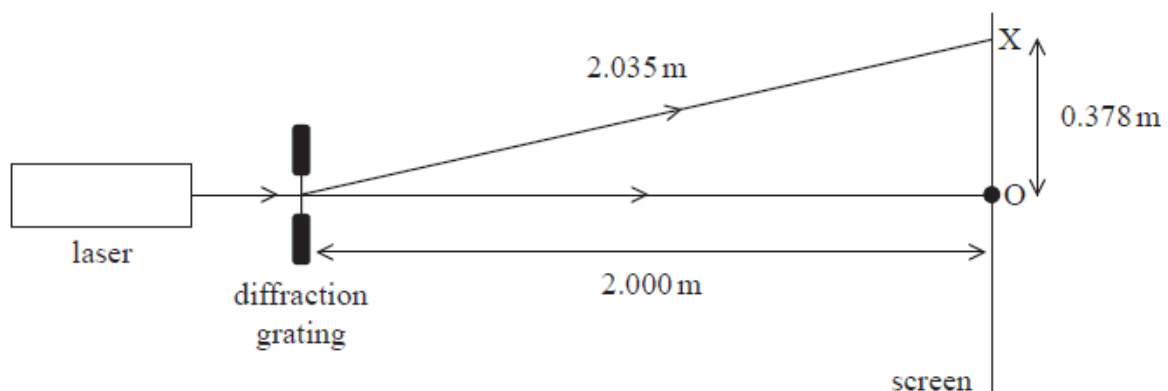
(Total for question = 1 mark)

Q8.

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)

Q9.

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.

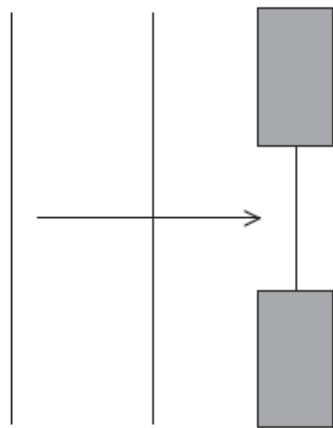
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Q10.

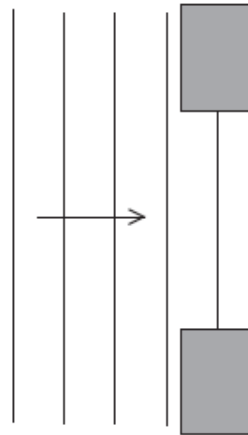
Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer

with a cross ☒.

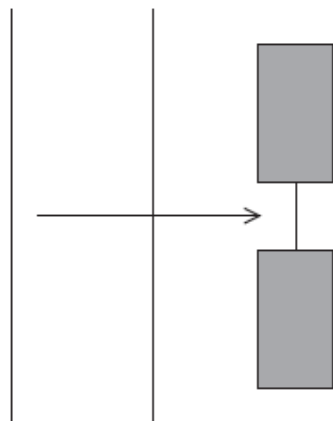
The wavefront diagrams show consecutive waves approaching gaps of different sizes.



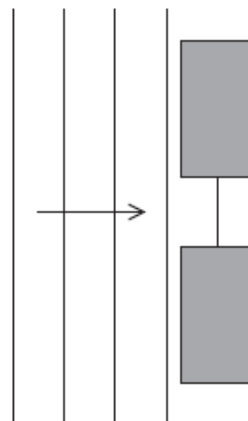
A



B



C



D

The wavefronts diffract as they pass through each gap.

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

☐ **A**

☐ **B**

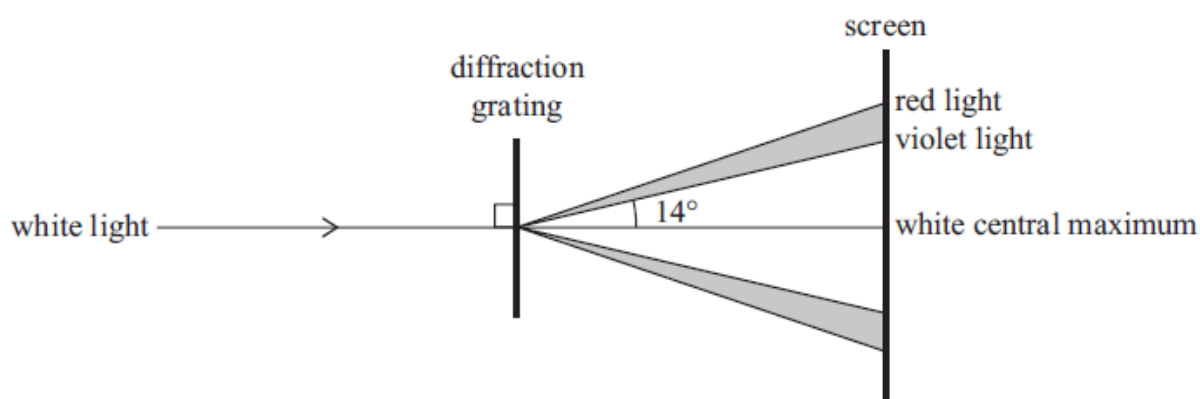
☐ **C**

☐ **D**

(Total for question = 1 mark)

Q11.

A student directs a beam of white light through a diffraction grating and onto a screen. A white central maximum forms on the screen with a visible spectrum of light on either side, as shown.



(a) In the visible spectrum formed on the screen, violet light is closest to the central maximum and red light is furthest away.

Explain why the violet light is closest to the central maximum.

(2)

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(b) The diffraction grating has a line spacing of 1.62×10^{-6} m.

Calculate the wavelength of the violet light.

(2)

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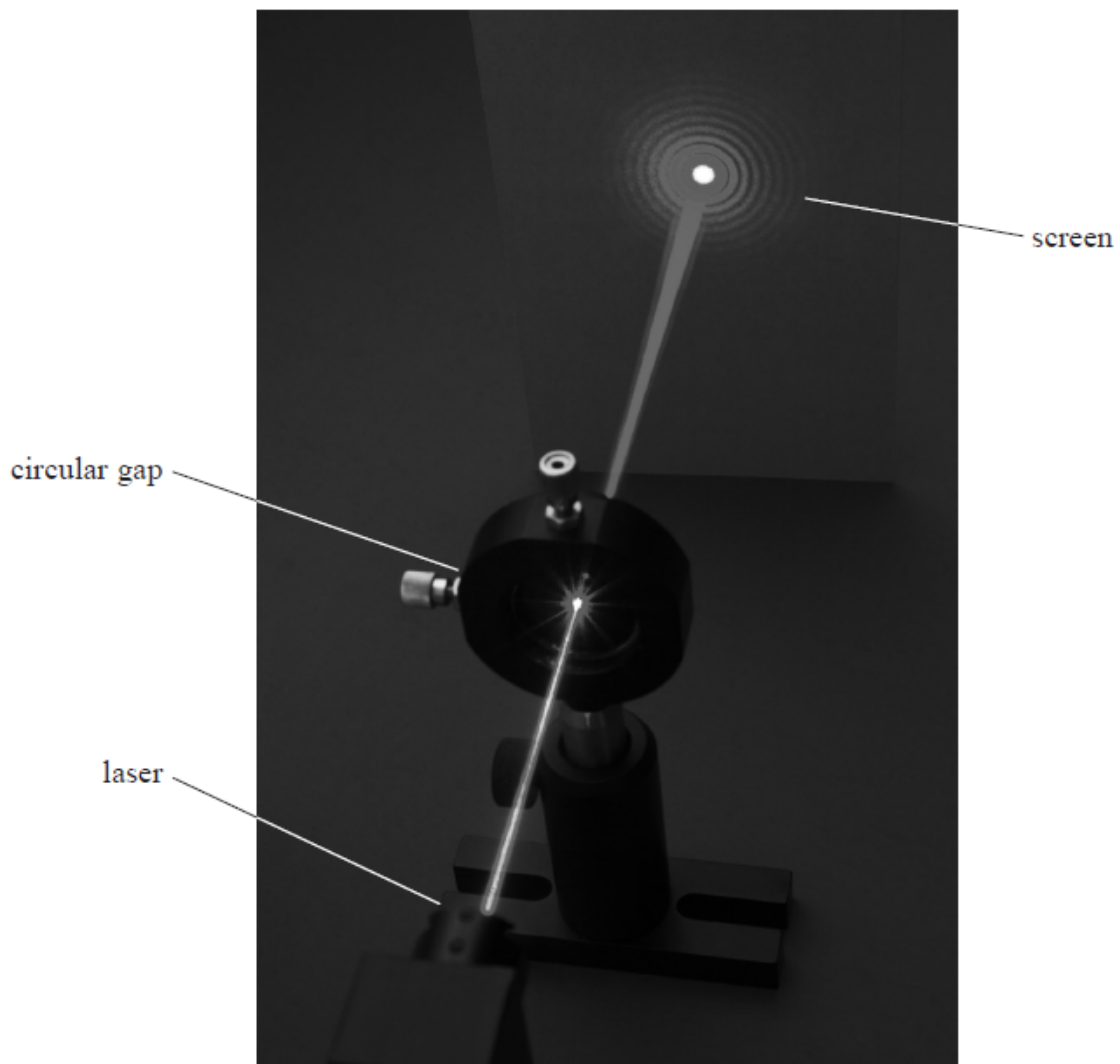
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Wavelength of the violet light =

(Total for question = 4 marks)

Q12.

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.

(2)

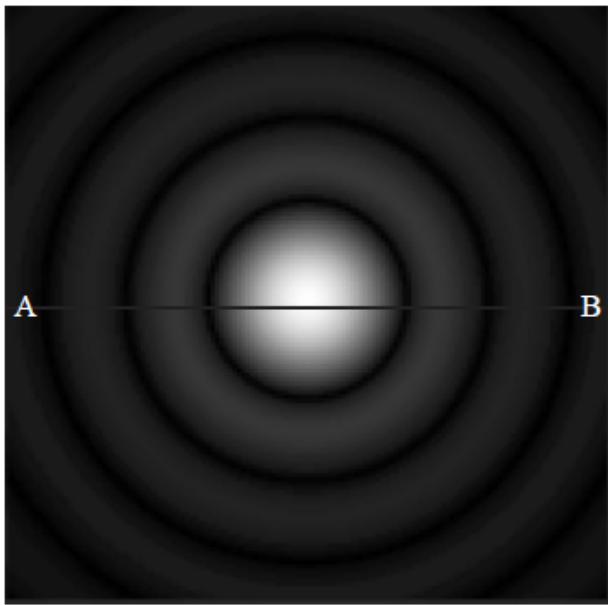
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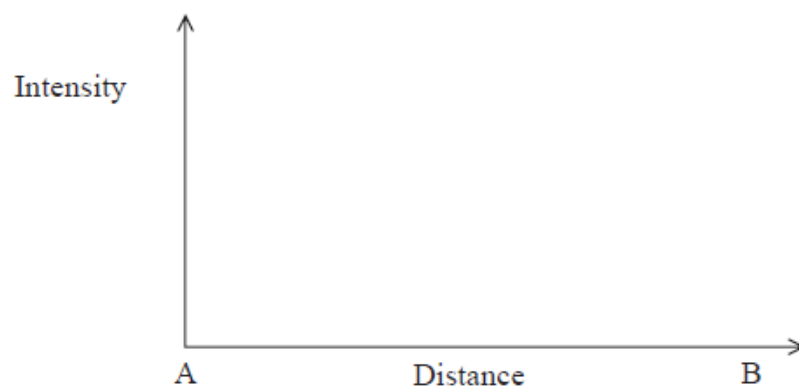
(b) The diffraction pattern consists of a central bright spot surrounded by concentric circles of light of decreasing intensity. A close-up of the pattern is shown below.



© KaiMartin

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

(3)



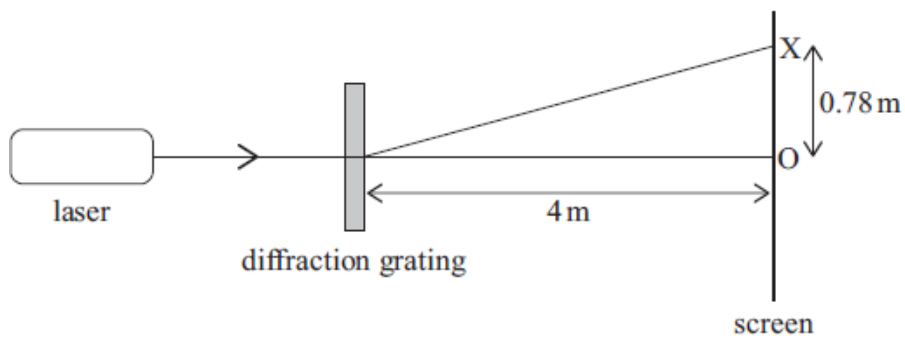
(Total for question = 5 marks)

Q13.

A student directed light from a laser onto a diffraction grating.

The student saw a series of maxima on the screen.

The diagram shows the position of the central maximum at O and the first order maximum at X.



(a) Calculate the number of lines per mm on the diffraction grating.

wavelength of light from laser = 635 nm

(4)

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Number of lines per mm =

(b) Explain why there is a maximum at X.

(3)

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(Total for question = 7 marks)

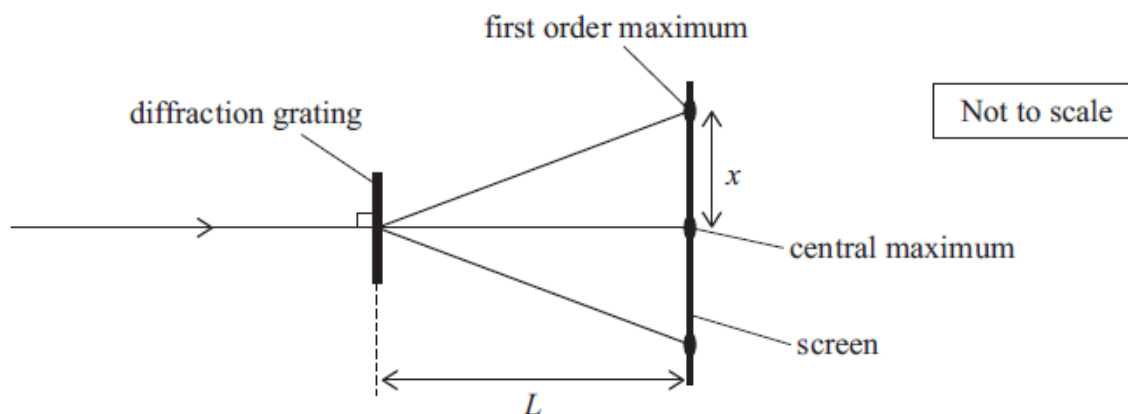
A student used a diffraction grating to investigate the properties of light.

(a) Light is a transverse wave.

State what is meant by a transverse wave.

(1)

(b) The student directed monochromatic light of wavelength λ onto the diffraction grating. A series of maxima was produced on a screen a distance L from the diffraction grating, as shown.



The distance between the central maximum and the first order maximum was x .

(i) Calculate the number of lines per mm on the diffraction grating.

$\lambda = 650 \text{ nm}$
 $L = 1.30 \text{ m}$
 $x = 0.22 \text{ m}$

(4)

Number of lines per mm =

(ii) Explain how a first order maximum is produced on the screen.

(3)

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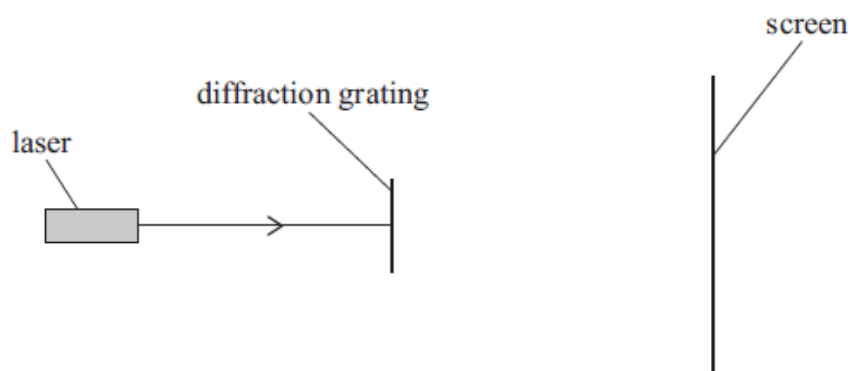
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(Total for question = 8 marks)

Q15.

A student investigated the diffraction of light from a laser using a diffraction grating.

The diffraction grating has 250 lines per mm. The diagram shows the arrangement used.



(a) Give **one** safety precaution the student should take during the experiment.

(1)

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(b) State what measurements the student should make to determine the wavelength of the light from the laser.

(2)

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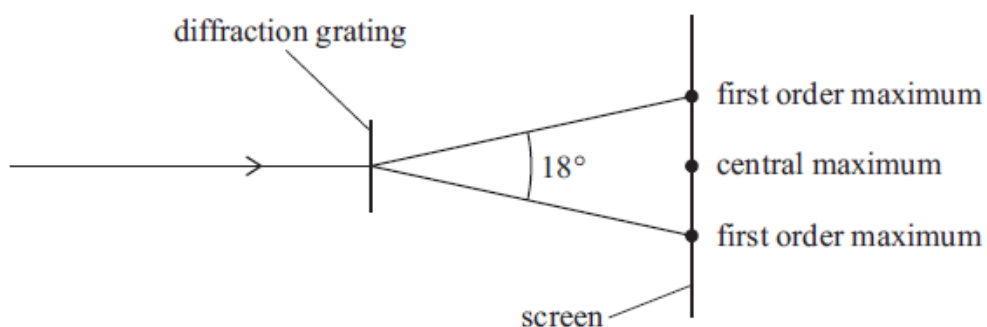
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(c) The student observed the two first order maxima.

The angle between the two first order maxima was 18° , as shown.



(i) Show that the wavelength of the light from the laser is about 600 nm.

(4)

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(ii) The student observed maxima beyond the first order.

Determine the greatest order of maximum that the student could observe.

(2)

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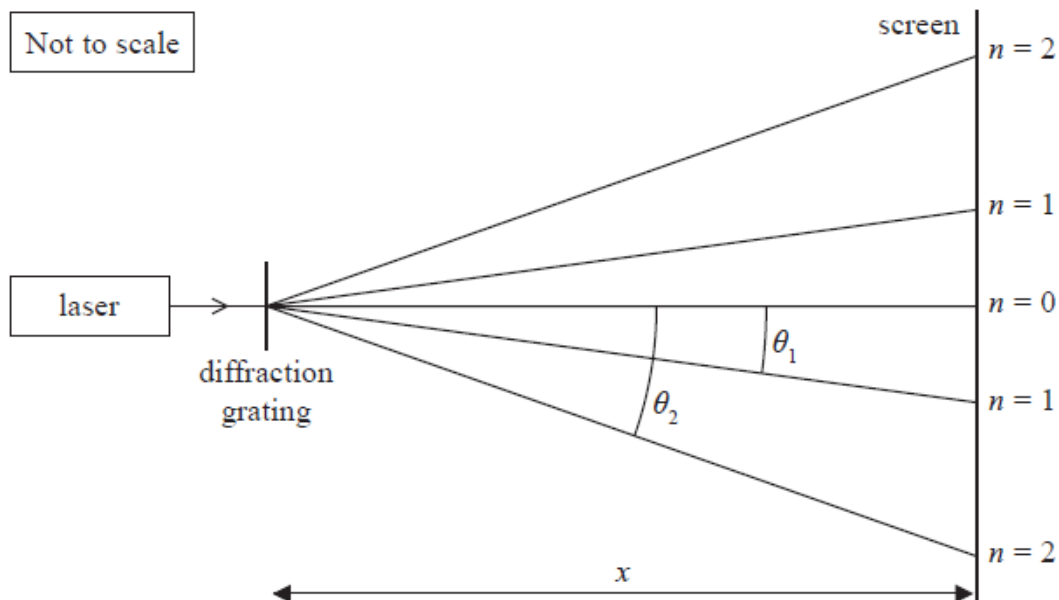
Greatest order of maximum =

(Total for question = 9 marks)

Q16.

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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$\theta_2 =$

(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.

(3)

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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

(4)

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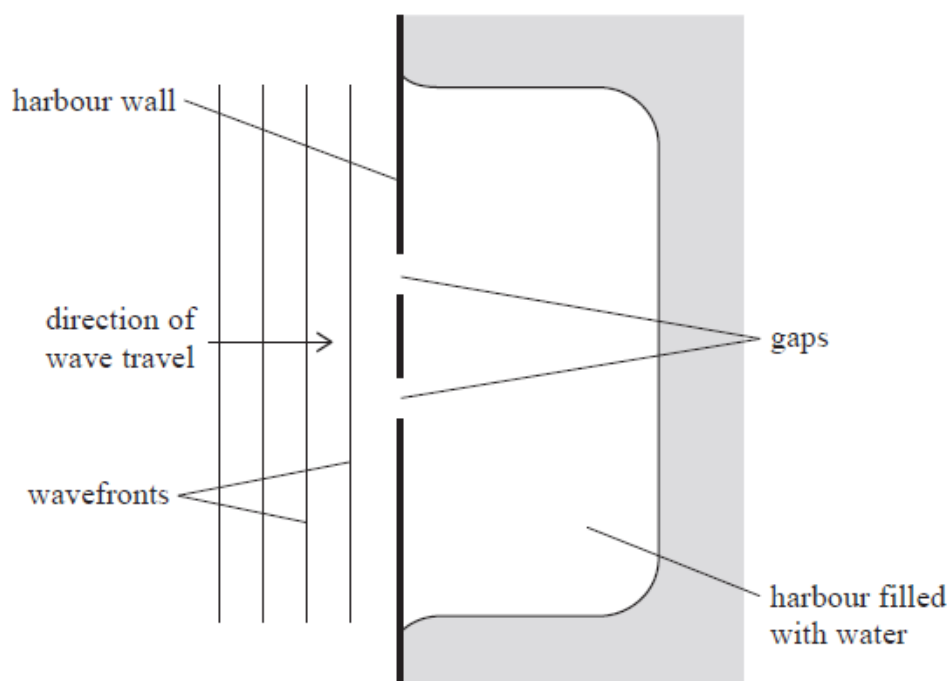
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(Total for question = 9 marks)

Q17.

Boats can shelter from waves on the sea in a harbour.

The diagram shows a harbour where boats can enter and leave through two gaps in the harbour wall.



Waves on the sea are diffracted as they pass through the gaps in the harbour wall.

(a) Describe how Huygens' construction can be used to predict the shape of diffracted wavefronts.

(2)

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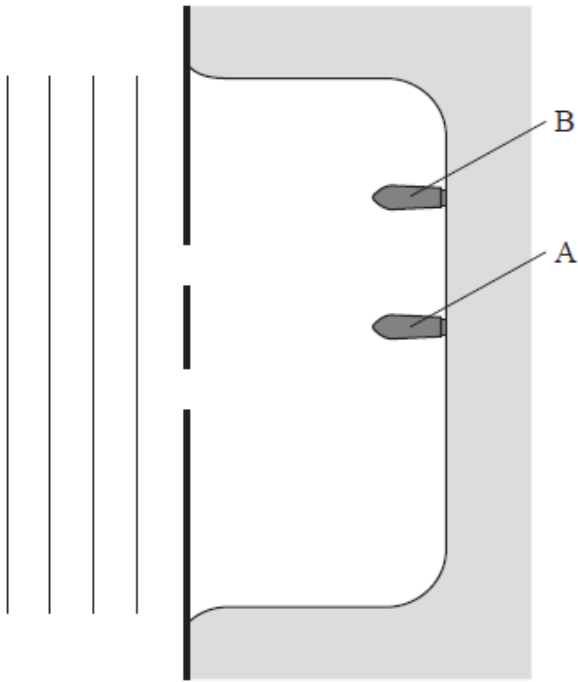
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*(b) The wavefronts in the sea arrive parallel to the harbour wall. The wavelength of the waves varies as the weather varies.

There are identical boats at two positions, A and B, in the harbour, as shown.



As the wavelength of the waves varies:

- the boat at position A always oscillates with a large amplitude
- the boat at position B sometimes oscillates with a large amplitude and sometimes oscillates with a very small amplitude.

Explain why the boats oscillate as described.

(6)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Total for question = 8 marks)

Q18.

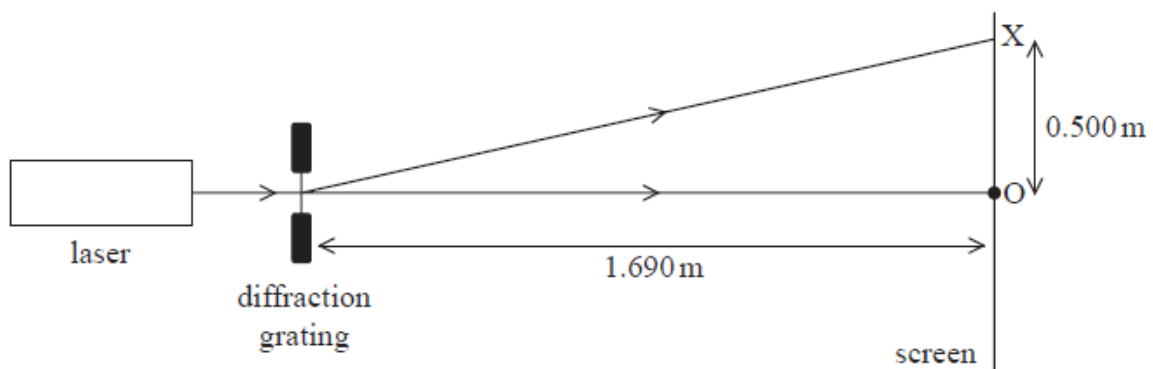
A laser, a diffraction grating and a screen are set up as shown. The laser emits monochromatic light.



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.

(4)

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Wavelength =

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

(3)

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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.

(2)

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(Total for question = 9 marks)

Q19.

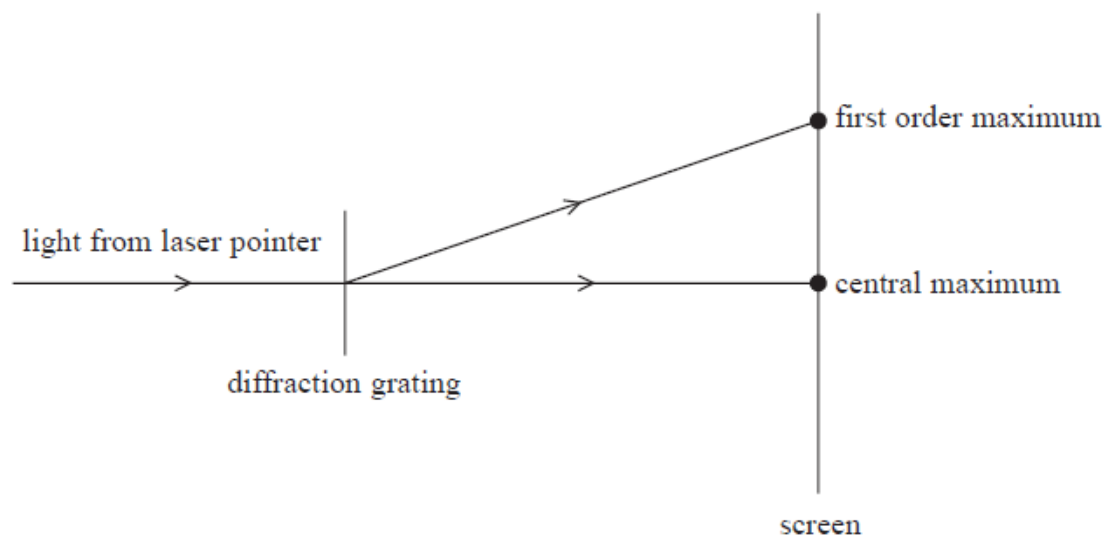
A teacher has a laser pointer. The laser pointer emits a narrow beam of plane polarised light.

(a) Describe how the teacher can demonstrate that the light from the laser pointer is plane polarised.

(2)

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- (b) The teacher shines light from the laser pointer onto a diffraction grating as shown. This produces a diffraction pattern on a screen.



- (i) The diffraction grating equation is

$$n\lambda = d \sin \theta$$

State the quantity represented by d .

(1)

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- (ii) The teacher made the following measurements:

distance from central maximum to first order maximum = 1.61 m

distance from diffraction grating to screen = 2.74 m

The wavelength of the light from the laser pointer was 532 nm.

Calculate the number of lines per millimetre on the diffraction grating.

(3)

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Number of lines per millimetre =

(iii) Using this diffraction grating and laser pointer, only the first order maxima and the central maximum are produced.

Explain how the teacher, using the same laser pointer, could improve his value for the number of lines per millimetre.

(3)

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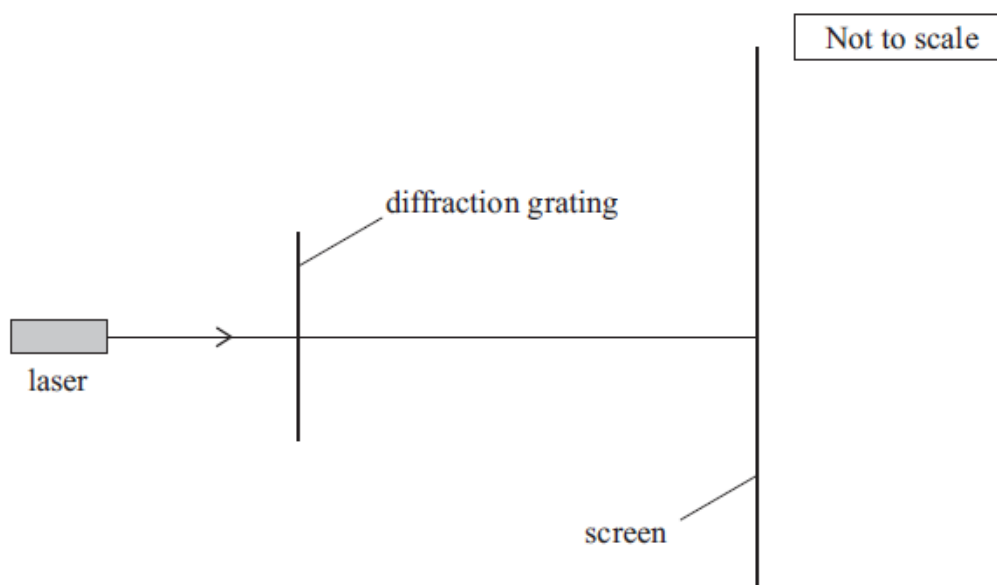
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(Total for question = 9 marks)

Q20.

A student directed light from a laser onto a diffraction grating, as shown.



A series of bright dots was formed on the screen.

(a) (i) The light from the laser is coherent.

State what is meant by coherent light.

(1)

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(ii) Explain why a series of bright dots was formed on the screen.

(3)

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(b) The diffraction grating has a grating spacing d of 1.07×10^{-6} m.

(i) Calculate the angle between the central maximum and the first order maximum.

wavelength of laser light = 532 nm

(2)

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Angle =

(ii) The student observed first and second order maxima.

Explain why it is **not** possible for a third order maximum to be produced.

(3)

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(c) The student replaced the laser with a lamp that produced a narrow beam of white light.
Describe the pattern that formed on the screen.

(3)

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(Total for question = 12 marks)