

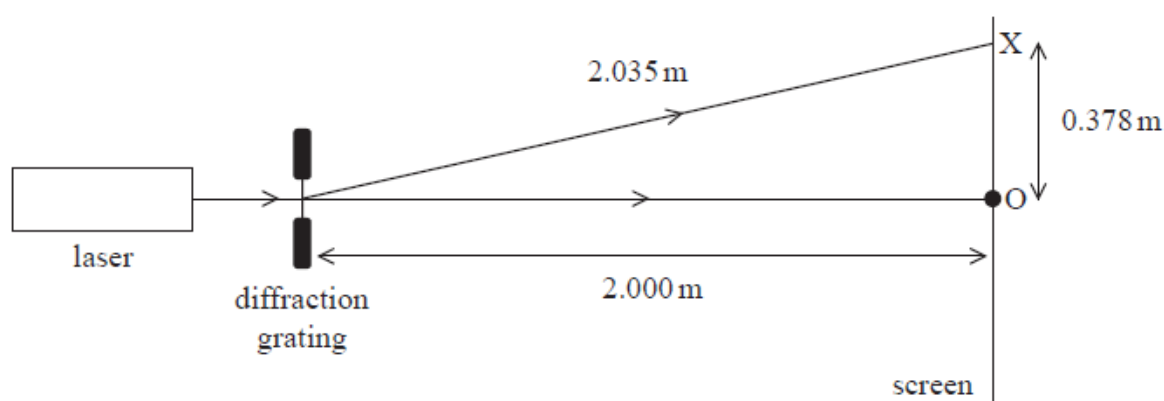
Questions

Q1.

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)

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 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)

Q3.

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.

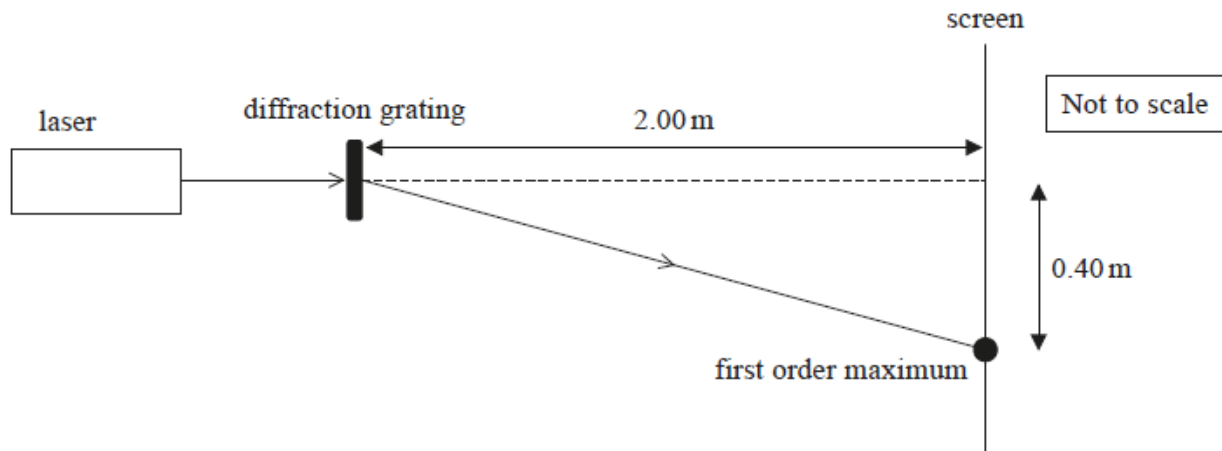
(Total for question = 1 mark)

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 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 $\theta = \tan^{-1} \left(\frac{0.40}{2.00} \right)$

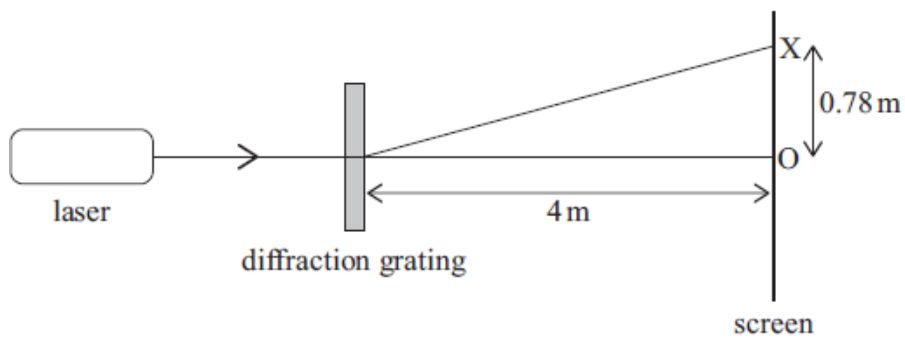
(Total for question = 1 mark)

Q5.

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)

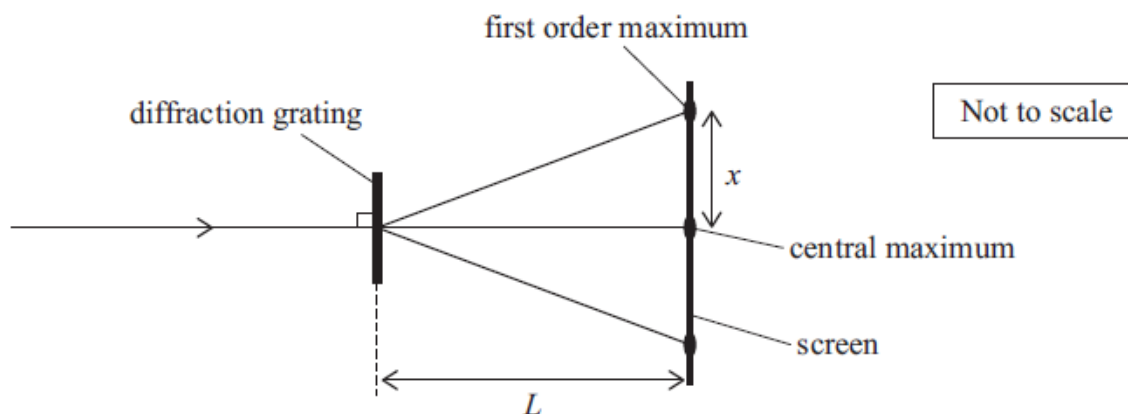
A student used a diffraction grating to investigate the properties of light.

(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.

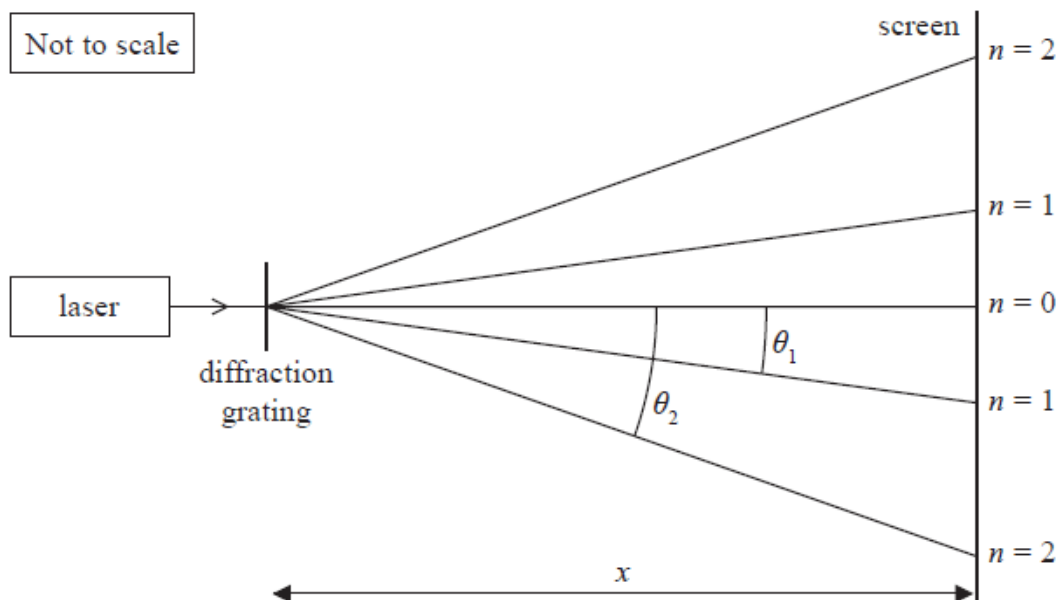
(3)

(Total for question = 8 marks)

Q7.

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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$$\theta_2 = \text{.....}$$

(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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(Total for question = 9 marks)

Q8.

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)

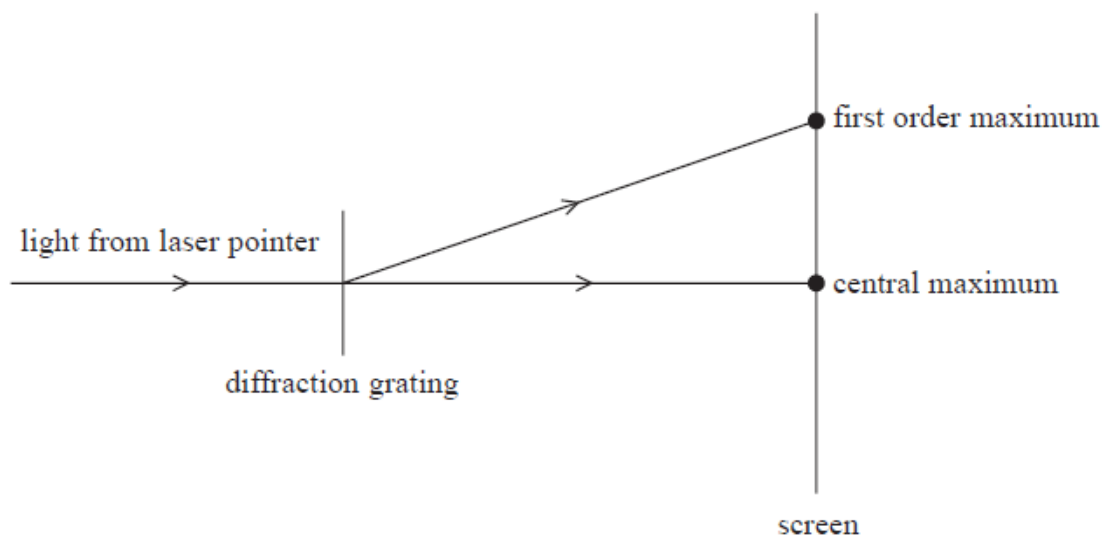
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(b) The teacher shines light from the laser pointer onto a diffraction grating as shown. This produces a diffraction pattern on a screen.



(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.

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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.

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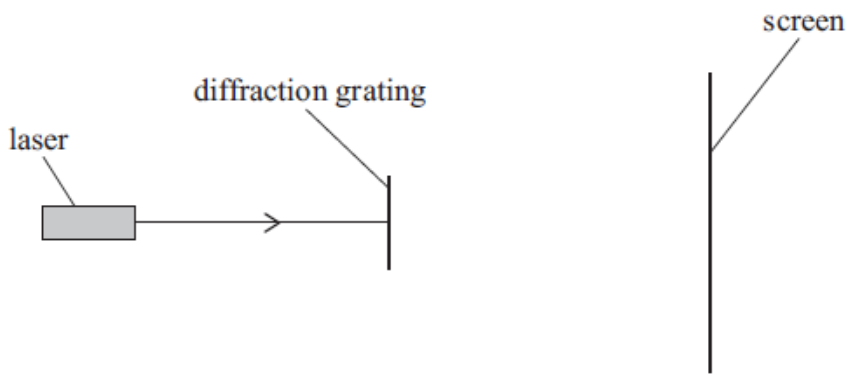
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(Total for question = 9 marks)

Q9.

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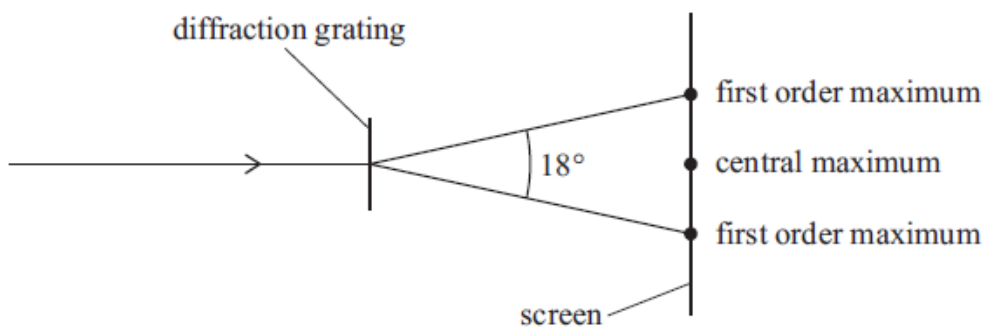
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(c) The student observed the two first order maxima.

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.

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

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

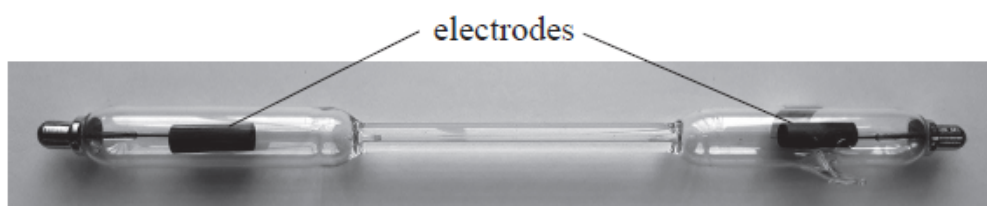
(2)

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Greatest order of maximum =

(Total for question = 9 marks)

Q10.

In 1857, Heinrich Geissler invented the first gas discharge tube. A sodium gas discharge tube is shown.



When a high potential difference is applied between the electrodes, electrons move through the sodium gas in the tube. The electrons collide with the sodium atoms. The tube then gives out visible light with a wavelength of 589 nm.

(a) Describe the process by which visible light is emitted from the sodium atoms.

(3)

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(b) Calculate the energy, in eV, of a photon of visible light with a wavelength of 589 nm.

(3)

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Photon energy = eV

(c) Light from the tube was directed through a diffraction grating, labelled as having 300 lines per mm. The diffraction pattern produced was displayed on a flat screen. The student measured the distance s between the central maximum and the first-order maximum on the screen. He also measured the distance D from the diffraction grating to the screen.

Determine whether the labelling of the diffraction grating as having 300 lines per mm was correct.

$s = 0.234$ m
 $D = 1.30$ m
 $\lambda = 589$ nm

(3)

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(Total for question = 9 marks)