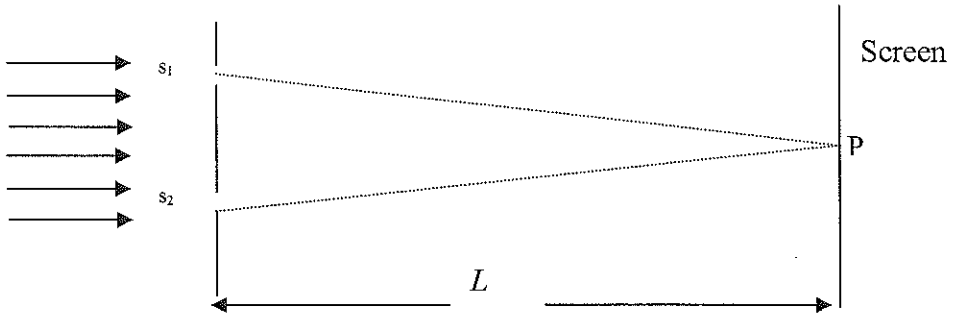
1. The interference pattern of two identical slits separated by a distance d =0.25 mm is observed on a screen at a distance L of 0.32 m from the plane of the slits. The slits are illuminated by monochromatic light of wavelength 589.3 nm travelling perpendicular to the plane of the slits. Bright bands are observed on each side of the central maximum P.



a. Calculate the distance between adjacent maxima of the interference pattern that would be observed at the screen

[2 marks]

b. Point P is the same distance from both light sources. Comment on the intensity of light that occurs at point P and explain why this is so.

[2 marks]

c. In a similar arrangement of apparatus, an experiment was conducted for which L = 1.0 m and d =0.10 cm, the bright fringes were 0.5 mm apart. What wavelength of light was being used?

[2 marks]

d. The colours seen in the two slit interference pattern when white light is the source are sometimes mistaken for the spectra of visible light also referred to as the rainbow colours. Explain why this is not possible with a two slit interference pattern.

[2 marks]

2. White light is incident on a diffraction grating with 300 lines per mm. A third order spectrum is observed to overlap a second order spectrum on a screen placed at a distance of 1.2 m from the grating. Given that the wavelength of a third order colour is 450 nm,

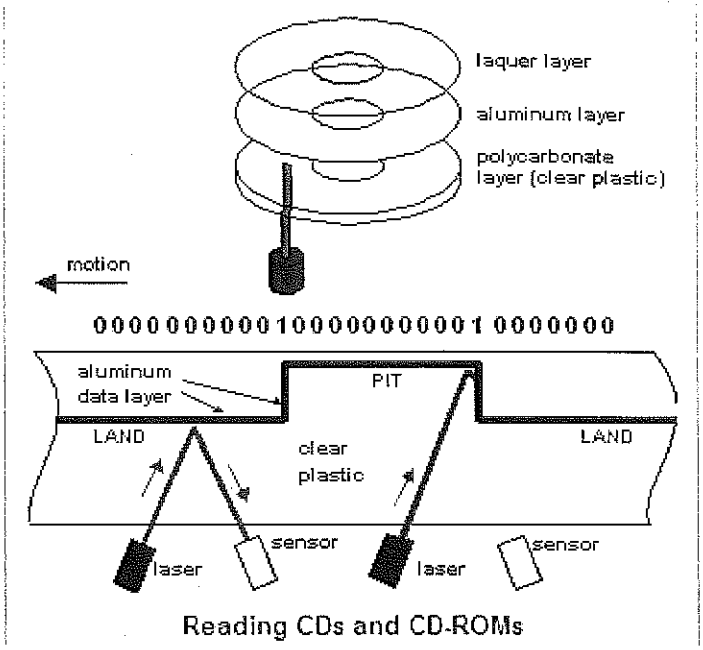
a. calculate the wavelength of the light for the second order that overlaps it.

[2 marks]

b. determine the angle at which the two wavelengths of light overlap on the screen.

[3 marks]

5. The diagram Reading CD's and CD ROMS provided shows the surface of a CD with binary code (000100100) for the pattern of a series of bumps.



Reading CDs and CD-ROMs

a) What is occurring where the binary code 1 is assigned?

_____ [1 mark]

b) Explain how a laser light wavelength = 694 nm is used to read the binary code 1 and binary code 0. Add quantitative information onto the diagram.

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[3 marks]

c) Describe with a diagram how a laser detects it is off track when reading the CD.

[4 marks]

6. In a laboratory experiment, Ultra Violet light with a photon energy E of 4.6 eV is incident on a metal with a known work function W of 1.8 eV.
   a. Calculate the threshold frequency f_o for this metal.

[2 marks]

   b. Determine the stopping voltage V_s for the photoelectrons released from the metal.

[2 marks]

c. Calculate the frequency f of the incident light.

[2 marks]

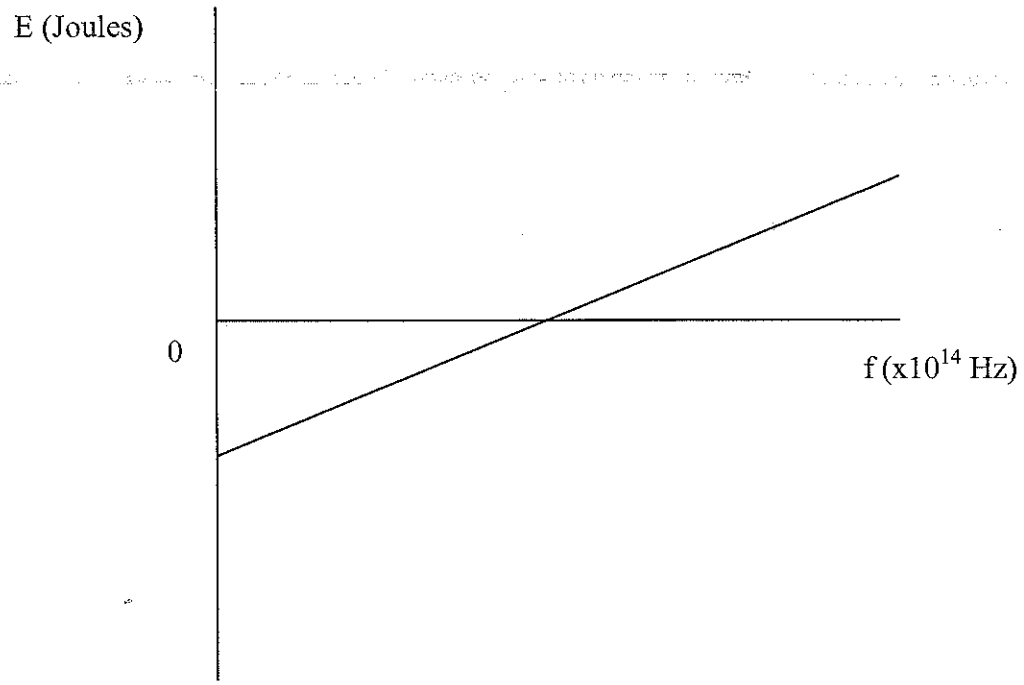
d. A range of photon energies were used to plot a graph for energy against frequency for the metal and a line of best fit was drawn as shown.

i) Label the work function W and the threshold frequency f_o for the metal.

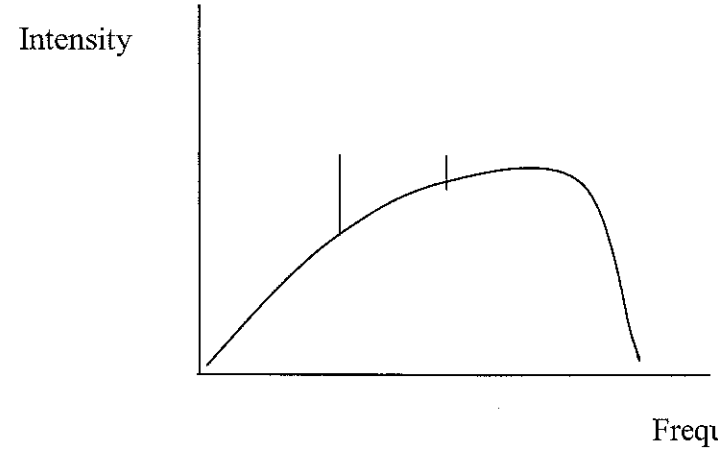
[2 marks]

ii) Sketch a line graph on the same axes for a metal with a smaller work function.

[2 marks]



7. Consider the typical intensity graphs for the X-rays emitted from an X-ray tube with accelerating potential of 70kV.



a. Explain the continuous range of frequencies and the sharp peaks in the spectrum of x-rays.

[4 marks]

b. The accelerating voltage was reduced with all other factors remaining constant. On the axes system shown above, sketch the graph that would result from the reduction.

[2 marks]

c. Determine the minimum accelerating voltage for an electron to produce an x-ray photon of wavelength 2.160×10^{-11}.

[3 marks]

8. It is proposed to send a beam of electrons travelling at a speed of 4.0×10^{6} ms^{-1} through a crystal with the spacing between the atoms being $d = 3.0 \times 10^{-10}$ m.

a. Find the wavelength of the electrons.

[3 mark]

b. Determine the first order angle of diffraction for the electron beam.

[2 marks]

c. Explain why there is only one possible order for the beam of electrons and crystal arrangement described above.

[2 marks]

d. Explain why electron microscopes achieve a much higher resolution than optical microscopes.

[2 marks]