Hallett Cove School

RECEPTION TO YEAR 12

Name ……..

12Pc 2007 Summative Test

e - m waves and the Interference of Light

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1. a) A radio station transmits on 107.9MHz. What sized objects would be needed to produce diffraction effects with these waves?

(5 marks)

b) The antenna receiving this signal is horizontally polarised. Explain what this tells you about the electromagnetic wave being produced by the transmitter.

(3 marks)

2. An aircraft carrying LADS equipment is depth sounding over a shallow sea. The laser pulse it produces is directed normally onto the water and seafloor. The reflected pulses are timed at 2.859μs and 3.483μs respectively. Given that the speed of light in sea water is 2.234×10^8 ms^{-1}, calculate:

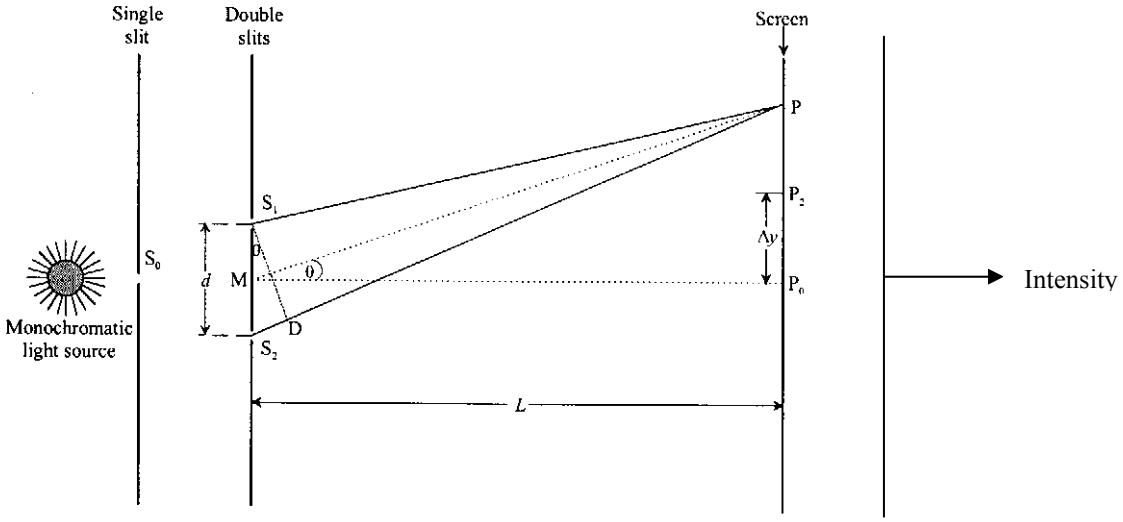
a) The height of the aircraft above the ocean.

(3 marks)

b) The depth of the sea below the aircraft.

(4 marks)

3. The diagram below shows an arrangement for a double slit interference experiment.



a) What is the purpose of the monochromatic light source and the single slit?

(2 marks)

b) If the path difference between the two rays is S_2D, and is two wavelengths of light, sketch a graph showing the intensity of light as seen on the screen. Do your sketch on the axis to the right of the diagram.

(3 marks)

c) If the light is of wavelength 670nm, the slits are 0.12mm apart, and the screen is 0.40m away from the slits find:

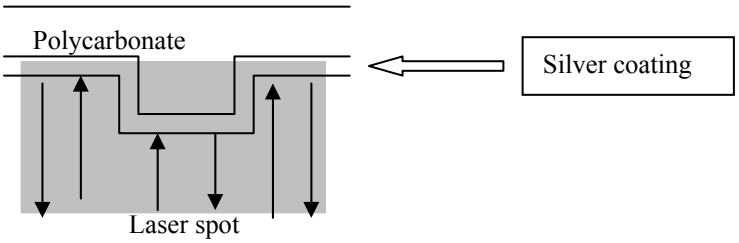
(i) The angular position of the first minimum on the screen.

(4 marks)

(ii) The fringe spacing Δy.

(4 marks)

4. The reflecting surface of a compact disc has a series of many bumps on it.



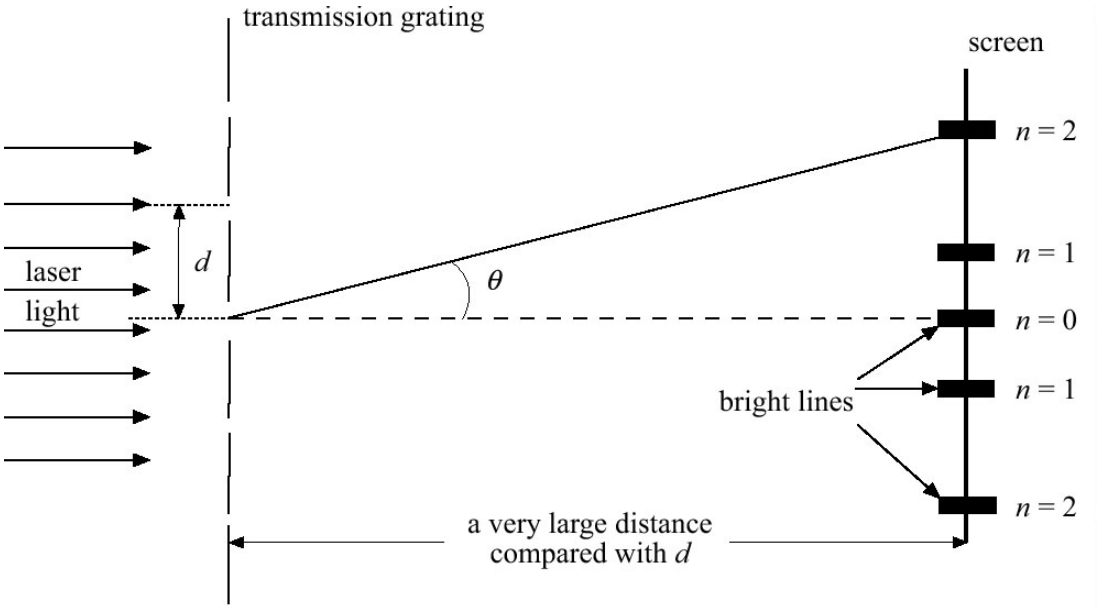
a) A spot of laser light reflects off the bump and the area surrounding the bump. With reference to the wavelength of the laser light, what is the height of the bump off the surface? Use this to help you in explaining how a digital signal can be produced as the beam tracks a long series of these bumps.

(4 marks)

b) CD players sometimes use two extra beams to keep the laser reading the CD on track. Briefly describe how the three beams are produced and how the laser is kept on track.

(2 marks)

5.(a) A transmission grating with spacing *d*, is illuminated by a beam of laser light of wavelength $\lambda = 6.328 \text{ X } 10^{-7}$ m. The light is incident perpendicular to the grating and the screen is set parallel to the grating. A pattern of bright lines is observed on the screen, as shown in the diagram below.



[*This diagram is not drawn to scale.*]

(i) *On the diagram above,* draw appropriate construction lines and explain why $\sin\theta = \frac{2\lambda}{d}$ for the *m =2* bright lines.

(5 marks)

(ii) The laser light is now replaced with parallel beams of white light. Describe the pattern that would be observed.

(2 marks)

(iii) Using $\sin\theta = \frac{m\lambda}{d}$, explain why this pattern would be produced.

(3 marks)

(b) A source of sodium light with visible wavelengths $\lambda_1 = 5.890 \text{ X } 10^{-7}$ m and $\lambda_2 = 5.896 \text{ X } 10^{-7}$m, is used to illuminate a transmission grating with grating spacing $d = 1.000 \text{ X } 10^{-5}$ m.

(i) Calculate the angle θ for the second order (n = 2) of bright lines for each wavelength.

(3 marks)

(ii) Calculate the angle between the two bright lines.

(1 mark)

(iii) What is the total number of visible pairs of bright lines?

(2 marks)

(iii) Calculate the distance between these two bright lines when observed on a screen 2.000 m from the diffraction grating.

(2 marks)