Raffles Institution
Year 5-6 Physics Department

2025 Year 6 H2 Physics Remedial
Chapter 12: Superposition

1 A double star is at a distance of 20 light years from the Earth. A telescope with a diameter of 3.0 m is used to view the star.

(A light year is the distance light travels in a vacuum in one year. This is 9.5×10^{15} m .)

What is the approximate minimum separation between the two stars of the double star that can be detected by the telescope? [1]

A 5.0×10^{8} m **B** 1.0×10^{9} m **C** 3.0×10^{10} m **D** 3.0×10^{11} m

2 A double-slit system with individual slit widths of 0.030 mm and a slit separation of 0.18 mm is illuminated with 500 nm light directed perpendicular to the plane of the slits.

What is the total number of bright fringes appearing between the two first order minima of the diffraction pattern? [2]

3 **(a)** Describe the formation of a stationary wave. [1]

(b) A stretched string is used to form a stationary wave. Part of this wave, at a particular instant, is shown in Fig. 3.1.

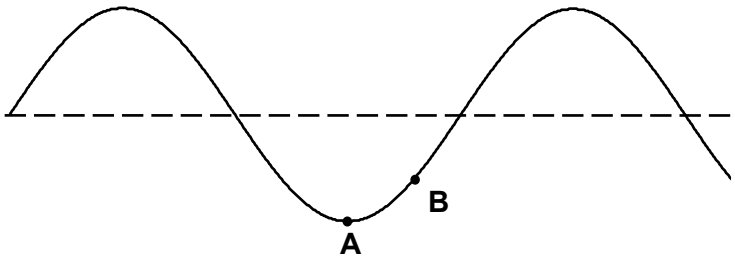

Fig. 3.1

The points on the string are at their maximum displacement.

(i) State the phase difference between the particles labelled A and B. [2]

(ii) State the number of antinodes shown in Fig. 3.1 for this wave. [1]

(iii) The period of vibration of this wave is *T*. On Fig. 3.1, sketch the stationary wave $0.25T$ after the instant shown in Fig. 5.1. [1]

[SRJC/Prelims 2014/P2/5]

4 **(a)** While Alvin drives through a long underground tunnel in Singapore, it is obvious that nothing can be seen a few metres into the tunnel without additional sources of light. However, his radio continues playing songs from Gold 90.5FM, which is broadcast at a frequency of 90.5 MHz, and his Global Positioning System (GPS) continues to display his car position. Further into the tunnel, the GPS reports that it has lost its connection with the satellites but his radio continues to play.

(i) State the type of electromagnetic waves that Alvin's GPS system uses to communicate with its satellites. Explain how you come to this conclusion. [2]

One particular day, the traffic was particularly heavy in the tunnel. When driving very slowly, Alvin finds that there were many points in the tunnel where the radio connection appears to be lost. Alvin decided to count those points and found there were exactly 400 points.

(ii) Assuming that the tunnel is perfectly straight, calculate the distance between the first and the last point where the radio connection is lost. [2]

(b) The apparatus illustrated in Fig. 4.1 is used to demonstrate two-source interference using light.

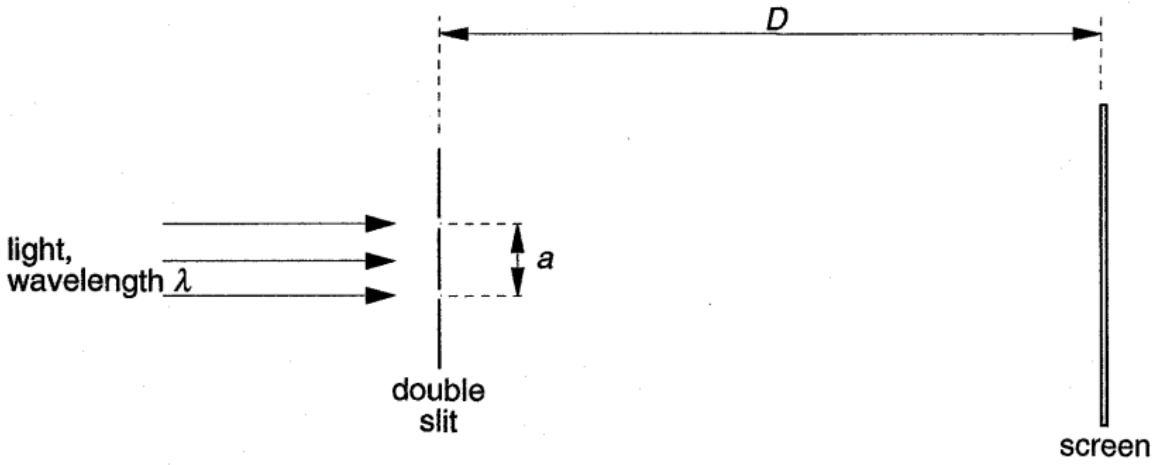

Fig. 4.1 (not to scale)

For a particular experiment, red light of λ = 690 nm is used, with a = 0.333 mm and D = 1.20 m.

(i) Calculate the fringe separation. [2]

The double slit in the experiment above is now replaced by a diffraction grating, which is labelled 300 lines mm^{-1}.

(ii) Determine the highest order of light that is still visible on the screen, given that the screen is flat and 2.40 m wide. [3]

[HCI/Prelims 2014/P2/3]

5 **(a)** State two necessary conditions that must be satisfied in order that coherent waves may interfere. [2]

(b) Light from a light source is incident on a double slit after passing through a single slit, as shown in Fig. 5.1. Interference fringes are observed on the screen.

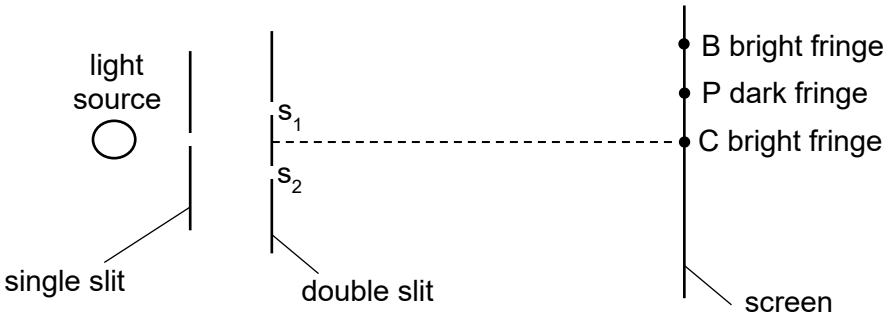

Fig. 5.1 (not to scale)

(i) Explain why a single slit is used in the apparatus. [1]

(ii) The intensity at B due to each wave is I. Determine, in terms of I, the resultant intensity of the waves at B. [2]

(iii) State the phase difference between the waves that meet at P. [1]

(iv) A third slit s_3 is now made at an equal distance below s_2, as shown in Fig. 5.2.

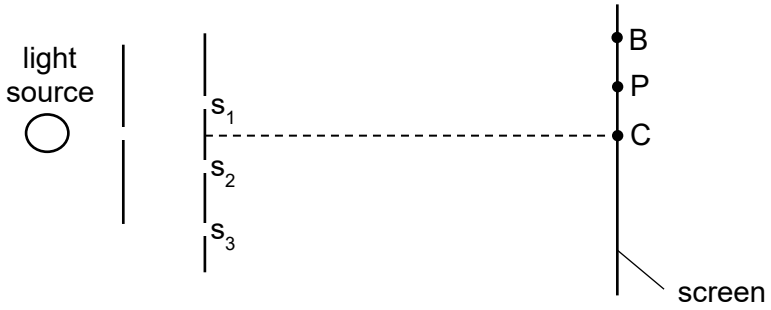

Fig. 5.2 (not to scale)

Explain if point P on the screen remains dark. [2]

[DHS/Prelims 2014/P2/2]

6 **(a)** Explain the term *interference*. [1]

(b) A ripple tank is used to demonstrate interference between water waves.
Describe the apparatus used to produce two sources of coherent waves that have circular wavefronts and how the pattern of interfering waves may be observed. [3]

(c) Sound waves travel from a source S to a point X along two paths SX and SPX, as shown in Fig. 6.1. The waves undergo a phase change of π radians as it reflects off the surface at P.

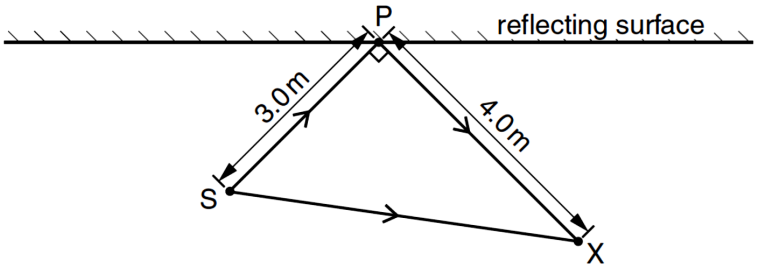

Fig. 6.1

(i) The frequency of the sound from S is 400 Hz and the speed of sound is 320 m s^{-1}. Calculate the wavelength of the sound waves. [2]

(ii) The distance SP is 3.0 m and the distance PX is 4.0 m. The angle SPX is 90°. Suggest whether a maximum or a minimum is detected at point X. Explain your answer. [2]

[IJC/Prelims 2014/P3/4]