Unit 11 · Interference of Light

HARDER PRACTICE QUESTIONS

Full marks 28

Write your answers on separate paper. Show your working.

1 Spot the error [3]

Find the mistake in the working and correct it.

Light of wavelength 560 nm falls on two slits 0.30 mm apart, with the screen 1.5 m away. Sneha finds the fringe width:

"$\beta = \frac{\lambda D}{d} = \frac{560 \times 10^{-9} \times 1.5}{0.30 \times 10^{-2}} = \mathbf{0.28\ mm}$."

2 Show that [2]

Show that in Young's experiment each dark fringe lies exactly halfway between two bright fringes.

3 Predict, then explain [4]

Write your prediction first, then explain it.

In a Young's experiment (λ = 500 nm, d = 0.50 mm, D = 1.0 m), a thin glass sheet 3.0 μm thick (μ = 1.5) is placed over one slit.

i. Predict: does the pattern move, and if so towards which side?
ii. Find the extra optical path the sheet adds.
iii. Find by how many fringes, and how far, the pattern shifts.

4 Read the data [3]

Answer from the data.

Aarati measures the fringe width at different screen distances, with slits 0.30 mm apart:

D (m)	0.50	1.00	1.50	2.00
β (mm)	0.98	1.96	2.94	3.92

i. How does β depend on D?
ii. Find the wavelength of the light.

5 A real setting [3]

The numbers are made up.

Two loudspeakers 1.5 m apart play the same 680 Hz note, in phase. A listener 4.0 m in front of them, on the line midway between them, walks sideways along a line parallel to the speakers. About how far does she walk before the sound is quietest? (Speed of sound = 340 m/s.)

6 What if? [3]

In a Young's experiment the light reaching one slit is reflected first in a way that turns its waves upside down (a phase change of π), while the light to the other slit is not. What would you see at the center of the screen, and where would the bright fringes be?

7 Estimate it [3]

Two very fine slits are only 2.0 μm apart, lit by light of wavelength 550 nm, and the screen is wide enough to catch light at any angle. How many bright fringes can be seen in all? (Use d sin θ = nλ; sin θ can't be more than 1.)

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Nabin wrote: “At a dark fringe the light energy is destroyed. Any two bulbs of the same color are coherent sources. And bringing the slits closer together makes the fringes narrower.”

9 Work backwards [2]

In a Young’s experiment with slits 0.50 mm apart and a screen 1.5 m away, the second dark fringe is 3.3 mm from the center. Find the wavelength.

10 Make your own [2]

Choose a slit separation and a screen distance that would give fringes 2.0 mm wide with light of wavelength 550 nm.