Unit 12 · Diffraction

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 633 nm falls on a slit 0.25 mm wide, and the screen is 1.8 m away. Rupesh finds the width of the central maximum:
"The first dark band is at $x = \lambda D/d = 633 \times 10^{-9} \times 1.8 \div 0.25 \times 10^{-3} = 4.6$ mm, and that is the width of the central maximum: **4.6 mm**."

2 Show that [2]

Show that if a slit is narrower than the wavelength of the light, there is no dark band at all in its diffraction pattern.

3 Predict, then explain [3]

Write your prediction first, then explain it.

White light falls on a grating. Predict which color is turned through the larger angle in the first order, red or violet, and compare with a glass prism. Explain why.

4 Read the data [3]

Answer from the data.

Light of wavelength 633 nm falls normally on a grating of 5500 lines per centimeter. Bimal records the angles of the maxima he sees:

Order	1	2	3
Angle (°)	20.4	44.1	(none seen)

i. Check the first two angles.
ii. Explain why there is no third order.

5 A real setting [3]

A bird is perched on a wire 160 m away. Your pupil is 2.5 mm across, and the light is 550 nm. What is the smallest detail of the bird you could possibly tell apart?

6 Check the claim [3]

A seller says his microscope, used dry (numerical aperture 0.85) with red light of 650 nm, resolves finer detail than a second one used with oil ($\mu = 1.5$, the same θ) and blue light of 450 nm. Check the claim.

7 Estimate it [3]

A radio telescope 100 m across works with radio waves 21 cm long. Estimate the smallest angle it can resolve, and compare it with your eye's (pupil 2.5 mm, light 550 nm).

8 Correct the misconceptions [3]

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

> Kamala wrote: “A wider slit gives a wider central maximum. A grating’s maxima get wider and fuzzier the more slits it has. And a higher-magnification eyepiece lets a telescope resolve two closer stars.”

9 Work backwards [2]

Light of wavelength 600 nm falls normally on a grating, and the first-order maximum is at 30°. Find the grating element, and the number of lines per centimeter.

10 Design it [3]

You need a grating that shows the first-order maxima of two yellow lines, 577.0 nm and 579.1 nm, at least 0.05° apart. With N lines per meter, a small change $\Delta\lambda$ moves the first-order angle by about N $\Delta\lambda/\cos\theta$ radians. Is a grating of 7000 lines per centimeter good enough?