Diffraction Review – Questions and Fully Worked Solutions

1. What is diffraction?

Diffraction is the spreading of waves when they pass through an opening or around an obstacle. It occurs for all types of waves and is most noticeable when the size of the opening is comparable to the wavelength.

2. What was Young's Double Slit Experiment? What surprising result came from this experiment?

Young's experiment involved shining light through two closely spaced slits and observing the pattern on a screen. Instead of two bright regions, an interference pattern of bright and dark fringes appeared, demonstrating that light behaves as a wave.

3. Draw a diagram explaining constructive and destructive interference.

Constructive interference occurs when waves arrive in phase, producing a bright fringe. Destructive interference occurs when waves arrive out of phase by half a wavelength, producing a dark fringe.

4. Does interference only occur with visible light? Give an example.

No. Interference occurs with all waves. For example, sound waves can interfere to create loud and quiet regions.

5. What is the result when light interferes destructively?

The light intensity is reduced or zero, producing a dark fringe.

6. Would red or green light diffract more?

Red light diffracts more because it has a longer wavelength.

7. A He–Ne laser shines on a double slit (d = 2.03 × 10■■ m). The first bright fringe occurs at 18.16°. Find the wavelength.

Using $d \sin\theta = m\lambda$ with $m = 1$:
$\lambda = d \sin\theta = (2.03\times10^{■■})(\sin 18.16°) \approx 6.33\times10^{■■}$ m (633 nm).

8. Slit separation is 3.33×10■³ mm. Find the angle between first and second bright fringes for λ = 589 nm.

Convert $d = 3.33\times10^{■■}$ m.
$\theta_{■} = \sin^{■¹}(\lambda/d) \approx 10.2°$
$\theta_{■} = \sin^{■¹}(2\lambda/d) \approx 21.2°$
Angle difference ≈ 11.0°.

9. Blue light (λ = 435.8 nm) gives first bright fringe at 16.2°. Find slit separation.

$d = \lambda / \sin\theta = (435.8\times10^{■■})/\sin(16.2°) \approx 1.57\times10^{■■}$ m.

10. Slit separation is 0.0018 mm. Second bright fringe at 32.5°. Find wavelength.

Convert d = 1.8×10■■ m.
λ = d sinθ / m = (1.8×10■■ sin 32.5°)/2 ≈ 4.83×10■■ m.

11. λ = 574 nm, d = 0.0025 mm. Find angle to second order.

Convert d = 2.5×10■■ m.
θ = sin■¹(2λ/d) ≈ 27.5°.

12. Convert into slit spacing d.

a) 300,000 lines/m → d = 1/300000 = 3.33×10■■ m
b) 2150 lines/cm → d = 1/(2.15×10■) ≈ 4.65×10■■ m
c) 428 lines/mm → d = 1/(4.28×10■) ≈ 2.34×10■■ m