2017 H2 Q10

Section: Particles and Waves

Topic: Diffraction grating — wavelength & angle

(a) How a maximum is formed (wave explanation)

At a bright maximum, light from adjacent slits arrives in phase at the screen. This occurs when the path difference between adjacent slits equals an integer multiple of the wavelength, so the waves interfere constructively and the intensity is large.

(b)(i) Wavelength of the laser

For first-order maxima (m = 1), the grating relation is d sinθ = mλ ⇒ λ = d sinθ. Using each grating's slit spacing d and measured angle θ from the table, calculate λ for each, then average.

> Example (one grating): if d = 1.7×10^-6 m and θ = 22°, then λ = d sinθ = 1.7×10^-6 × sin 22° = 6.4×10^-7 m.

Answer (average from the four gratings): λ ≈ 6.3 × 10^-7 m (≈ 630 nm).

(b)(ii) Angle for a grating with d = 2.0 × 10^-6 m

Use sinθ = mλ/d with m = 1 and λ from (i).

> sinθ = (6.3×10^-7) / (2.0×10^-6) = 0.315 ⇒ θ = 18.36°.

Answer: θ ≈ 18.4°

(c) Two improvements to increase reliability

- Measure θ on both sides of the central maximum and average (reduces alignment/systematic error).
- Place the screen further away to spread fringes and reduce percentage reading error in θ.

Other valid suggestions include the remaining points above.