



ANSWER BOOK

The nature of light

Turning points · Year 13

AQA 3.12.2.1, 3.12.2.2, 3.12.2.3

10 questions · 28 marks

NAVY EDITION

SECTION A · Warm-up

- A1** No diffraction of light had been observed, and shadows seemed perfectly sharp, consistent with particles in straight lines; and Newton's enormous scientific authority made his theory the default. [2]
- A2** Light spreading from the two slits overlaps on the screen. Where the two sets of waves arrive in step they reinforce, giving a bright fringe; where they arrive out of step they cancel, giving darkness. [2]
- A3** ϵ_0 , the permittivity of free space, relates to the electric field strength due to a charged object in free space; μ_0 , the permeability of free space, relates to the magnetic flux density due to a current-carrying wire. [2]

SECTION B · Standard

- B1** $c = 1/\sqrt{(\mu_0\epsilon_0)} = 3.00 \times 10^8 \text{ m s}^{-1}$: equal to the measured speed of light, implying light is an electromagnetic wave. [1]
- B2** Adjacent nodes are half a wavelength apart, so $\lambda = 3.3 \text{ m}$ and $c = f\lambda = 3.0 \times 10^8 \text{ m s}^{-1}$: radio waves travel at the speed of light, confirming Maxwell's prediction. [3]
- B3** First blocking: the wheel advances half a tooth, $1/1440$ of a turn, during the round trip, so $t = 1/(1440 \times 12.6) = 5.51 \times 10^{-5} \text{ s}$. $c = 2d/t = 2 \times 8630/5.51 \times 10^{-5} = 3.1 \times 10^8 \text{ m s}^{-1}$. [3]
- B4** The dark fringes are places where light from one slit plus light from the other produces darkness. Streams of particles can only ever add together, giving more light; only waves arriving out of step can cancel, so the fringes demand a wave description. [3]

SECTION C · Stretch

- C1** Newton's corpuscular theory required light to travel faster in the denser medium to explain refraction toward the normal; Huygens' wave theory required it to travel slower. Light proved slower in water, so the wave theory's prediction was confirmed and the corpuscular account failed. [3]
- C2** Hertz generated previously unknown waves from purely electrical sparks, showed they reflect, refract and form stationary waves like light, and measured their speed as c . This confirmed Maxwell's electromagnetic theory directly, established that light belongs to a wider electromagnetic family, and opened the spectrum beyond the visible, radio first. [4]

- C3** Newton's reputation stood behind the corpuscular theory, and one experiment was not enough to overturn a century of consensus; acceptance came only as interference and diffraction evidence accumulated and the speed-in-water test went the wave theory's way.
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