

- M1.(a)** (i) Appreciation that one component changes speed while the other component at right angles does not ✓

When entering a denser medium a corpuscle / light accelerates or its velocity / momentum increases perpendicular to the interface ✓

There is a (short range) attractive force between light corpuscle and the (denser) material ✓

Not allowed:

Attraction due to opposite charges

Force making them move faster is not enough

Accelerate in medium

Not gains energy

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- (ii) Light (was shown by experiment to) travel slower in (optically) denser medium OWTTE ✓

Condone 'waves..' instead of 'light'

OWTTE e.g. speed in vacuum higher than speed in other medium

Newton's theory required light to travel faster, wave theory suggested slower speed ✓

or

Newton's theory could not explain the slower speed

or

Huygens theory could explain the slower speed

Not allowed:

Reference to Young's two slit- question asks them about refraction

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- (iii) A corpuscular theory predicts only two (bright) lines / high intensity patches of light whereas a wave theory predicts many fringes ✓

Corpuscles can only travel in straight lines

or

waves can produce fringes because (diffract and) interfere / superpose / arrive in and out of phase / have different path differences ✓

Need to describe the patterns ie not just interference fringes are seen for the first mark

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- (b) Substitutes data in photon wavelength = hc / E ; Allow for substitution with no conversion to J ✓

$$2.48 \times 10^{-10} \text{ m } \checkmark$$

For electron: Substitution in $\lambda = \frac{h}{\sqrt{2mE}}$

$$2.48 \times 10^{-10} \text{ (or their } \lambda \text{)}$$
$$= 6.6 \times 10^{-34} / (2 \times 9.11 \times 10^{-31} \times 1.6 \times 10^{-19} \text{ V})^{1/2} \checkmark$$

No conversion to J gives $\lambda \approx 4 \times 10^{-29}$ and $V \approx 9 \times 10^{38} \text{ V}$

$$V = 24(.4) \text{ V } \checkmark = 1.49 \times 10^{-18} / (\text{their } \lambda)^2 \checkmark$$

Allow small rounding errors in dp

May calculate v using $v = h / m\lambda$ then substitution in $V = \frac{1}{2} mv^2 / e \checkmark$ (for third mark)

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- M2.** (a) particles of light/corpuscles (1)
attracted towards glass surface (on entry into glass) (1)
velocity/momentum normal to surface increased (1)
velocity/momentum parallel to surface unchanged (1)

max 3

- (b) (i) Newton predicted speed_{glass} > speed_{air}
and Huygens predicted speed_{glass} < speed_{air} (1)
- (ii) named experiment (1)
relevance explained (1)
(e.g. Young's double slit (1) give rise to fringes/interference
which is a wave property (1)
or diffraction of light (1) which is a wave property (1))

3

[6]