

- 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

3

- (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

2

- (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

2

- (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 $\lambda = \frac{h}{\sqrt{2mE}}$

$$2.48 \times 10^{-10} \text{ (or their } \lambda)$$

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

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)

4
[11]

M2.(a) (i) wavelength = $\frac{h}{mv}$ **(1)**

$$= \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 1.2 \times 10^3} \text{ (1) } (= 6.1 \times 10^{-7} \text{ m})$$

(ii) charge (= current \times time = $4.8 \times 10^{-13} \times 1.0 \times 10^{-3}$) = $4.8 \times 10^{-16} \text{ C}$ **(1)**

$$\text{number of electrons per fringe} = \frac{4.8 \times 10^{-16}}{(1.6 \times 10^{-19} \times 6)} = 500 \text{ (1)}$$

(4)

(b) (i) same **(1)**

(ii) interference fringes would be further apart **(1)**
at twice the spacing **(1)**

as the wavelength would be doubled **(1)**

because $\lambda \propto \frac{1}{\text{speed}}$ [or $\propto \frac{1}{\text{momentum}}$] **(1)**

(max 4)

(c) $f \left(= \frac{c}{\lambda} \right) = \frac{300 \times 10^8}{6.1 \times 10^{-7}}$ **(1)**

$= 4.9 \times 10^{14}$ Hz **(1)**

(2)

[10]