

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

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

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

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)

4  
[11]

- 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<sub>glass</sub> > speed<sub>air</sub>  
and Huygens predicted speed<sub>glass</sub> < speed<sub>air</sub> (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]