TURNING POINTS

2-4 Matter Waves

1. (a) $h = 6.63 \times 10^{-34}$ Js, $m_e = 9.11 \times 10^{-31}$ kg, $v = 3.2 \times 10^{6}$ ms^{-1}

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3.2 \times 10^{6}}$$

$$= 2.27 \times 10^{-10} \text{ m to 3 sf}$$

(b) $h = 6.63 \times 10^{-34}$ Js, $m_p = 1.67 \times 10^{-27}$ kg, $v = 3.2 \times 10^{6}$ ms^{-1}

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 3.2 \times 10^{6}}$$

$$= 1.24 \times 10^{-13} \text{ m to 3 sf}$$

2. p.d. = 2800 V, $e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg

k.e. gained = electrical energy supplied

$$\tfrac{1}{2} m v_e^2 = eV$$

$$v_e^2 = \frac{2eV}{m_e} = \frac{2 \times 1.60 \times 10^{-19} \times 2800}{9.11 \times 10^{-31}}$$

$$= 9.835\ldots \times 10^{14} \text{ m}^2\text{s}^{-2}$$

$$V_e = 3.14 \times 10^{7} \text{ ms}^{-1}$$

De Broglie wavelength,

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 3.14 \times 10^{7}}$$

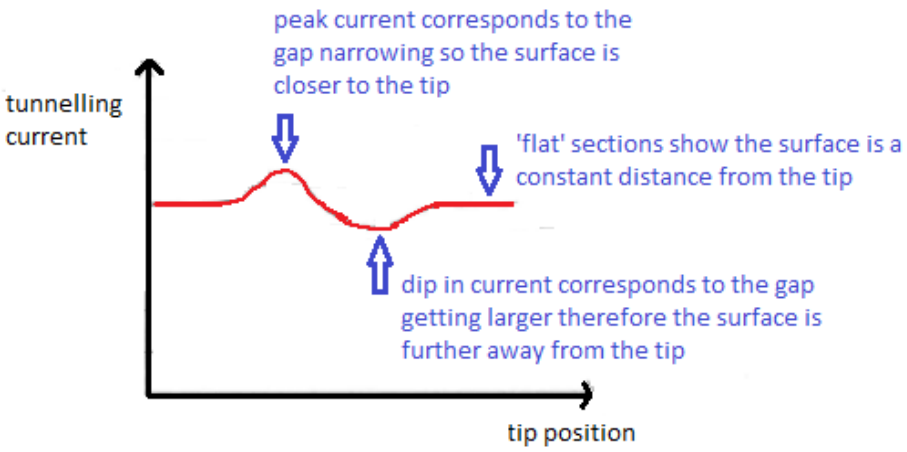
$$= 2.32 \times 10^{-11} \text{ m to 3 sf}$$

3. (a) If the anode p.d. is increased then the speed of the electrons is increased and thus the de Broglie wavelength decreases. As the wavelength decreases and the amount of diffraction in the objective lens decreased so the resolving power increases.
The image therefore shows more detail.

(b) When the beam passes through a thicker part of the sample the electrons that emerge will have a lower speed and hence a longer de Broglie wavelength. They will diffract more and resolution will be lost so the image will be less clear.

4. (a) ‘matter waves’ are waves associated with a particle that is normally considered to have particle properties but can exhibit wave-like properties as well.

(b)



The tip height is constant so current variations occur as the gap between the tip and the surface changes.

The current profile reflects the surface profile