Wave Behaviour of Particles Assignment ***SOLUTIONS***

1.

a) $p = \frac{h}{\lambda}$ (or) $\lambda = \frac{h}{p}$

Particles exhibit a wavelength inversely proportional to their momentum

b) $m = m_\alpha = 6.645\times10^{-27}$ kg

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{6.63\times10^{-34}}{6.645\times10^{-27}\times1.67\times10^{7}} = 5.97\times10^{-15} \text{ m}$$

2.

a) Should be *smooth* curve that does not tightly fit all points, just shows the general wavy pattern

b) ~50°

c) The maximum intensity indicates an interference maxima. It can therefore be inferred that electrons exhibit wave behaviour.

d) $d\sin\theta = m\lambda$

$$\therefore \lambda = \frac{d\sin\theta}{m}$$

$$= \frac{0.909\times10^{-9}\times\sin 50°}{1}$$

$$= 7\times10^{-10} \text{ m (1 s.f.)}$$

e) $E = \frac{1}{2}mv^2$

$\therefore mE = \frac{1}{2}m^2v^2$

$\therefore mE = \frac{1}{2}p^2$

$\therefore p = \sqrt{2mE}$

$m = 9.11\times10^{-31}$ kg $\quad E = 3\times1.60\times10^{-19} = 4.8\times10^{-19}$ J

$\therefore p = \sqrt{2\times9.11\times10^{-31}\times4.8\times10^{-19}} = 9.35\times10^{-25}$ kgms^{-1}

According to de Broglie's relation:

$$\lambda = \frac{h}{p} = \frac{6.63\times10^{-34}}{9.35\times10^{-25}} = 7\times10^{-10} \text{ m (1 s.f.)}$$

Since this is the same as the experimental result, de Broglie's relation is verified.

3. Higher resolution, because of smaller wavelength

Higher magnification, because electric/magnetic fields are used instead of glass