(1) problems from lecture 21

$\lambda = 0.28\,nm = 2.8\times10^{-10}\,m$

$p = h/\lambda$ or

$\lambda = h/p$

$p = \frac{6.6\times10^{-34}}{2.8\times10^{-10}} \approx 3\times10^{-24}$ kgms^{-1}

$p = mv = 3\times10^{-24}$

$m_N \sim 2000\, m_e \sim 2\times10^{3}\times10^{-30} \sim 2\times10^{-27}$

so $v = \frac{3\times10^{-24}}{m} = \frac{3\times10^{-24}}{2\times10^{-27}}$

$\sim 1.5\times10^{3}$

~ 1500 m/s

(2)

λ (electron) $\sim 10^{-10}$ m.

$$p \text{ (electron)} \sim \frac{h}{\lambda}$$

$$\frac{6.6\times10^{-34}}{10^{-10}} = 6.6\times10^{-24} \text{ kgm/s}$$

$$E = p^2/2m = \frac{(6.6\times10^{-24})^2}{2\times10^{-30}}$$

$$\sim \frac{40\times10^{-48}}{2\times10^{-30}}$$

$$\sim 2\times10^{-18}\times10$$

$$= 2\times10^{-17} \text{ J}$$

(3) X-rays 16 keV

$= 16 \times 1000 \times 1.6 \times 10^{-19}$ J.

$\simeq \underline{25 \times 10^{-16}\ \text{J}}$

$\sim 2.5 \times 10^{-15}\ \text{J}$

$E = hf = \frac{hc}{\lambda}.$

$\rightarrow \lambda = hc/E = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{2.5 \times 10^{-15}}$

$\approx \frac{10^{-26} \times 20}{2.5 \times 10^{15}}$

$\approx \underline{10^{-10}\ \text{m}}$

(4)

electron energy = 38eV

$= 38 \times 1.6 \times 10^{-19}$ J.

$= 50 \times 10^{-19}$ J

$\approx 5 \times 10^{-18}$ J

$p^2/2m = 5 \times 10^{-18}$

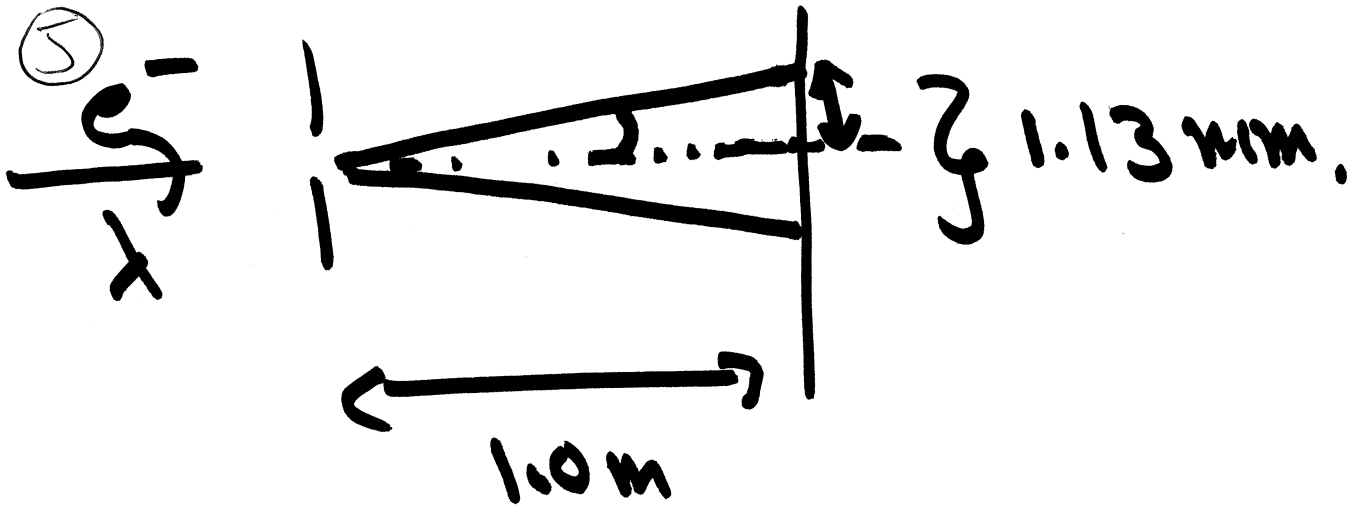
$p = \sqrt{2 \times 10^{30} \times 5 \times 10^{-18}}$

$\cong \sqrt{10^{-47}} \approx 10^{-23}$ ...

$\lambda = h/p = \frac{6.6 \times 10^{-34}}{10^{-23}}$

$\sim 6.6 \times 10^{-11}$ m

(5)



$$\theta \sim \frac{0.57\ \text{mm}}{1.0\ \text{m}} \sim \frac{0.57 \times 10^{-3}}{}$$

$$a \sin\theta = n\lambda$$

$n=1$ $\quad \sin\theta \approx \theta$

$$a = \lambda/\theta = \frac{6.6 \times 10^{-11}}{0.57 \times 10^{-3}}$$

$$= \frac{6.6 \times 10^{-11}}{5.7 \times 10^{-4}}$$

$$\sim 10^{-7}\ \text{m}$$

$$\sim 10^{-4}\ \text{mm}$$

(6)

$$E_n = -\frac{13.6}{n^2} \text{ (eV)}$$

$E_5 = -13.6/25$ $E_2 = -13.6/4$

$\Delta E = E_5 - E_2$

$= 13.6\left(\frac{1}{4} - \frac{1}{25}\right) = \frac{(25-4)}{100} 13.6$

$= \frac{21}{100} \times 13.6 \text{ eV}$

$\boxed{\Delta E = 2.7 \text{ eV}}$

$\Delta E = hf = \frac{hc}{\lambda}$.

$\lambda = \frac{hc}{\Delta E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{2.7 \times 1.6 \times 10^{-19}}$ m