CH # 38
H.W. Solution

 # 6

$\lambda = 590\ nm = 590 \times 10^{-9}\ m$

$f = \frac{c}{\lambda} = \frac{3 \times 10^{8}}{590 \times 10^{-9}} = 5.085 \times 10^{14}\ Hz$

$E = hf = 5.085 \times 10^{14} \times 6.63 \times 10^{-34}$

$= 3.37 \times 10^{-19}\ J$

$E = KE = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2 \times 3.37 \times 10^{-19}}{9.11 \times 10^{-34}}}$

$= 2.72 \times 10^{7}\ m/s.$

 # 11 a. E = energy per 1-photon

$= h \times \frac{c}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{589 \times 10^{-9}}$

$= 3.37 \times 10^{-19}\ J$

$\text{Power} = \frac{\text{Energy}}{\text{Time}} = \left(\frac{N}{t}\right) \times 3.37 10^{-19}$

$\therefore \left(\frac{N}{t}\right) = \frac{100}{3.37 \times 10^{-19}} = 2.96 \times 10^{20}\ \frac{\text{photons}}{\text{sec.}}$

where N is the number of photons.

$\therefore T = e^{-2 \times 7.19 \times 10^{11} \times 0.7 \times 10^{-9}}$

$= e^{-306.6} \simeq 0$

a. $I = \frac{q}{t}$ = current

$= \left(\frac{N}{t}\right) e$

$\frac{N}{t} = \frac{I}{e} = \frac{1000}{1.6 \times 10^{-19}} = 6.25 \times 10^{21}$ electron/sec

b. For electron

$b = 5.11 \times 10^{9}$

$T = e^{-(5.11 \times 10^{9} \times .7 \times 10^{-9})}$

$= e^{-3.58}$

$T = 0.0279$

time $= 6.25 \times 10^{21} \times 0.0279$

$= 1.74 \times 10^{20}$ sec.

$= 5.6 \times 10^{12}$ years.

59

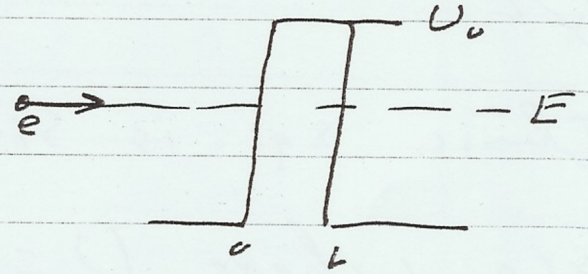
$$\Delta P_x \Delta x = \hbar = \frac{h}{2\pi}$$

$$\Delta P_x = \frac{h}{2\pi \times 50 \times 10^{-12}}$$

$$= \frac{6.63 \times 10^{-34}}{2\pi \times 50 \times 10^{-12}}$$

$$= 2.11 \times 10^{-24} \text{ kg.m/s.}$$

64#



$$T = e^{-2bL}$$

a. $$b = \sqrt{\frac{8\pi^2 \times mp(U_0 - E)}{h^2}}$$

mp = proton mass = 1.67×10^{-27}

$U_0 - E = 1\,ev = 1.6 \times 10^{-19}$ J

$$b = \sqrt{\frac{8\pi^2 \times 1.67 \times 10^{-27} \times 1.6 \times 10^{-19}}{(6.63 \times 10^{-34})^2}}$$

$$= 2.19 \times 10^{11}$$

#57

Schrodinger eq. with a potential

$U = U_0$

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h}[E - U_0]\psi = 0$$

let $k^2 \equiv \frac{8\pi^2 m}{h}(E - U_0) = \text{constant}$

$$\frac{d^2\psi}{dx^2} + k^2\psi = 0$$

This eq. is similar to the case where $U = 0$ (Free particle).

solution will be

$$\psi = A e^{ikx} + B e^{-ikx}$$

#5 2

a. $n n^* = (a+ib)(a-ib)$

$= a^2 - iab + iab - (i)^2 b^2$

$= a^2 + b^2$

b. $|n| = \sqrt{n n^*} = \sqrt{a^2+b^2}$

$|m| = \sqrt{c^2+d^2}$

$|nm| = |(a+ib)(c+id)|$

$= |ac + i(bc+ad) - bd|$

$= |(ac-bd) + i(bc+ad)|$

$|nm| = \sqrt{(ac-bd)^2 + (bc+ad)^2}$

$|n||m| = \sqrt{(a^2+b^2)(c^2+d^2)}$

$|nm| = \sqrt{a^2c^2 - 2acbd + b^2d^2 + b^2c^2 + 2bacd + a^2d^2}$

$= \sqrt{a^2c^2 + b^2d^2 + b^2c^2 + a^2d^2}$

$|n||m = \sqrt{a^2c^2 + a^2d^2 + b^2c^2 + b^2d^2}$

$|n||m| = |nm|$

#45

a. $P = \sqrt{2mk}$

$k = 300\ eV = 4.8 \times 10^{-17}\ J.$

m = mass of sodium

$= 22\ u$

$= 22 \times 1.66 \times 10^{-27}\ kg$

$\therefore P = \sqrt{2 \times 22 \times 1.66 \times 10^{-27} \times 4.8 \times 10^{-17}}$

~~$= 1.87 \times 10^{-66}\ kg \cdot \frac{m}{s}$~~

$= 1.87 \times 10^{-21}\ kg \cdot \frac{m}{s}.$

b. $\lambda = \frac{h}{P} = \frac{6.63 \times 10^{-34}}{1.87 \times 10^{-21}}$

$= 3.54 \times 10^{-13}\ m.$

#30.

a. $E = 0.511 \times 10^{6}$ eV

$= 0.511 \times 1.6 \times 10^{-14} \times 10^{6}$

$= 8.176 \times 10^{-14}$ J

$E = h\dfrac{c}{\lambda}$

$\therefore \lambda = \dfrac{hc}{E} = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{8.17 \times 10^{-14}}$

~~$= 2.4 \times 10^{-6}$ m.~~

$= 2.43 \times 10^{-12}$ m.

b. $\Delta\lambda = \dfrac{h}{mc}[1 - \cos\phi]$

$= \dfrac{h}{mc} = \dfrac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^{8}}$

$= 2.42 \times 10^{-12}$ m.

$\lambda' = \lambda + \Delta\lambda = 4.85 \times 10^{-12}$ m.

c. $E = \dfrac{hc}{\lambda'} = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{4.85 \times 10^{-12}}$

$= 4.1 \times 10^{-14}$ J

$= 0.256$ MeV

#28.

$$\Delta\lambda = \frac{h}{mc}\left[1 - \cos\phi\right]$$

a. $\Delta\lambda = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^{8}}\left[1 - (-1)\right]$

$= 4.85 \times 10^{-12}$ m.

b. $\Delta f = f - f' = \frac{c}{\Delta\lambda} = 6.18 \times 10^{19}$ Hz.

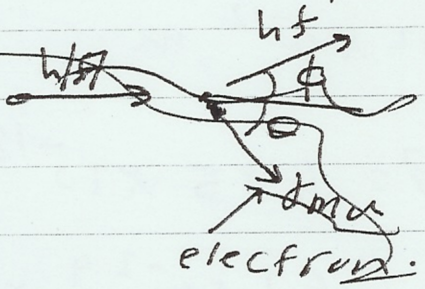
$\Delta E = h(\Delta f) = 4.0 \times 10^{-14}$ J.

c. $KE = \Delta E = hf - hf'$

$= 4.1 \times 10^{-14}$ J

$= 2.56 \times 10^{5}$ ev.

d.



d. $\theta = 0°$

#20

$$\phi = h f_c$$

where f_c = cut-off-frequency

$$\phi = 6.63\times10^{-34} \times \frac{3\times10^{8}}{325\times10^{-9}}$$

$$= 6.12\times10^{-19}\ J.$$

$$hf = KE + \phi$$

$$\therefore KE = hf - \phi$$

$$= 6.63\times10^{-34} \times \frac{3\times10^{+8}}{254\times10^{-9}} - 6.12\times10^{-19}$$

$$= (7.83 - 6.12)\times10^{-19}$$

$$= 1.71\times10^{-19}\ J$$

$$= 1.069\ eV$$

11. c

$$I = \frac{100}{4\pi(2)^2} = 1.99 \frac{J}{m^2 \cdot sec}.$$

$$flux = \frac{I}{\text{Energy of 1 photon}}$$

$$= \frac{1.99}{3.37 \times 10^{-19}}$$

$$= 5.9 \times 10^{18} \text{ photons}/m^2 \cdot sec.$$

#13.

$$hf = K_{max} + \phi$$

K_{max} = stoping potential

$$= 5. eV = 5 \times 1.6 \times 10^{-19} J.$$

ϕ = work-function

$$= 2.2 eV = 2.2 \times 1.6 \times 10^{-19} J$$

$$f = \frac{5 \times 1.6 \times 10^{-19} + 2.2 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$= 1.74 \times 10^{15} Hz$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1.7 \times 10^{15}} = 172 nm.$$

~~3~~ 11.b

$$I = \frac{Power}{4\pi d^2}$$

$$d = \sqrt{\frac{Power}{4\pi I}}$$

~~I = Energy per one photone~~

I = Energy per unit time per unit area

= # number of photons × Energy per 1 photon per unit time per unit area

$$= \frac{1\ \text{photon} \times 3.37\times10^{-19}\ J}{cm^2 \cdot sec}$$

$$= \frac{3.37\times10^{-19}}{10^{-4}\ m^2 \cdot sec} = \frac{3.37\times10^{-15}\ J}{m^2 \cdot sec}$$

$$\therefore d = \sqrt{\frac{100}{4\pi \times 3.37\times10^{-15}}}$$

$$d = 4.86\times10^{7}\ m$$

~~flux = I × Area~~

~~= 3.37 × 10^-15 × 4~~

~~=~~