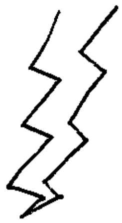
Homework 10 –

Ch 27 : 2, 4, 13, 26, 34, 38, 42, 44

(2) a)  $T = 10^4\ K$ b)  $T = 10^7\ K$

Wiens Law //

$$\lambda_{max} T = 0.2898 \times 10^{-2}\ m \cdot K$$

$$\Rightarrow \lambda_{max} = \frac{0.2898 \times 10^{-2}\ m \cdot K}{T}$$

a) $\lambda_{max} = 2.898 \times 10^{-7}\ m$ $\boxed{UV}$ b) $\lambda_{max} = 2.898 \times 10^{-10}\ m$ $\boxed{\gamma\text{-rays}}$

//

(4) $E = 2500\ eV$

$\lambda_{red} = 690\ nm$ $\lambda_{blue} = 420\ nm$

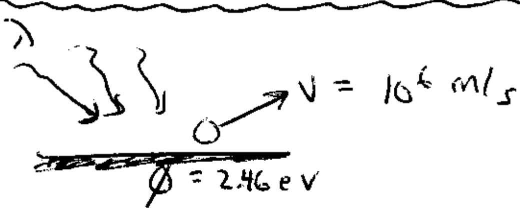
quantization of energy //

$$E = nhf = \frac{nhc}{\lambda} \Rightarrow n = \frac{E\lambda}{hc}$$

$(hc = 1240\ eV \cdot nm)$

$$\Rightarrow \begin{cases} n_{red} \simeq 1400 \text{ photons} \\ n_{blue} \simeq 850 \text{ photons} \end{cases}$$

(13) photo-electric effect //



$$KE = hf - \phi$$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \phi$$

$$\frac{1}{2}mv^2 + \phi = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{\frac{1}{2}mv^2 + \phi} \Rightarrow \boxed{\lambda = 234\,nm}$$

m = mass of e^-

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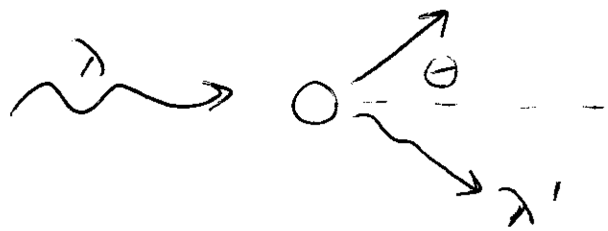
(26)



ompton effect

$$\Delta\lambda = \frac{h}{mc}(1-\cos\theta) \longrightarrow \text{Compton effect}$$

want to solve for θ

$$\frac{mc\,\Delta\lambda}{h} = 1-\cos\theta$$

$$\frac{mc\,\Delta\lambda}{h} - 1 = -\cos\theta$$

$$\cos\theta = 1 - \frac{mc\,\Delta\lambda}{h}$$

m = mass of e^-
c = speed of light
h = planck's const
$\Delta\lambda = 1.5 \times 10^{-3}$ nm

$\Rightarrow \theta = 67.5^\circ$

(34) de Broglie $\lambda = \frac{h}{p}$

de Broglie hypothesis

$p = mv$, classically, but near speed of light, need special relativity

$$p \rightarrow \gamma m v \equiv \frac{mv}{\sqrt{1-v^2/c^2}}$$

m = mass of proton, c = speed of light, h = planck's const

$v = 2\times10^{4}$ m/s $\Rightarrow p = \gamma m v \Rightarrow \lambda = \frac{h}{p} = 2\times10^{-11}$ m

$v = 2\times10^{7}$ m/s $\Rightarrow \lambda = 2\times10^{-14}$ m

(38) according to problem, require $\lambda = 0.075\,m$ to notice diffraction

de Broglie wavelength "

$$\lambda = h/p \quad \Rightarrow \quad p = h/\lambda = mv$$

$$v = \frac{h}{m\lambda} = \frac{h}{(80\,Kg)(0.075\,m)} \approx \underline{\underline{10^{-34}\ \tfrac{m}{s}}}$$

<u>very</u> S L O W - - -

$$v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{15\,cm}{10^{-34}\ m/s} \approx 10^{33}\,s$$

<u>very</u> L O N G !

much larger than age of universe!

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(42) Heisenberg says: $\Delta x\, \Delta p \geq \frac{\hbar}{2} = \frac{h}{4\pi}$

Heisenberg uncertainty principle "

suppose best case $\Rightarrow$ $\Delta x \Delta p = h/4\pi$

$m = 50\,g = 0.05\,Kg$, $v = 30\ m/s$ $\Rightarrow$ $p = mv$

$\Delta p = 1.5 \times 10^{-3}\ Kg \frac{m}{s}$

$$\Delta x = \frac{h}{4\pi \Delta p} = \underline{\underline{3.5 \times 10^{-32}}}\ m$$

for macroscopic things, we can know <u>both</u> momentum and position extremely well.

(44) quack!

"h" $\rightarrow 2\pi$ J·s

$m = 2$ Kg

$\Delta x = 1$ m

Heisenberg uncertainty principle

$$\Delta v = \frac{\Delta p}{m} \geq \frac{\text{"}h\text{"}}{4\pi m \Delta x} = 0.25 \text{ m/s}$$

uncertainty in future position due to uncertainty in initial position and initial speed:

$$\Delta x = \Delta x_0 + \Delta v_0 t$$

$$= 1\text{m} + (0.25 \text{ m/s})(5 \text{ s})$$

$$= 2.25 \text{ m}$$