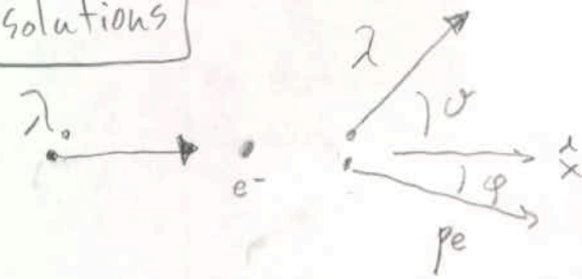
#1 **Quiz #4 solutions**

$\Delta\lambda = \lambda_0 - \lambda$,



Compton Shift:

$$\lambda - \lambda_0 = \frac{h}{m_e c}(1-\cos(\theta))$$

$$\Delta\lambda = (2.43\times10^{-12})(1-\cos(\theta))$$

Solve for θ: $\frac{\Delta\lambda}{2.43\times10^{-12}} = 1-\cos(\theta) \Rightarrow \cos(\theta) = 1 - \frac{\Delta\lambda}{2.43\times10^{-12}} =$

$$= 1 - \frac{0.87\times10^{-12}}{2.43\times10^{-12}} = 1 - 0.35 = 0.65 = \cos(\theta) \Rightarrow \boxed{\theta = 50^\circ}$$

#2 For matter (electrons, not photons since photons have no mass), wave-particle duality is demonstrated via

> the interference pattern obtained when electrons pass thru a double-slit system.

#3 $\Delta x \Delta p_x \simeq \frac{\hbar}{2}$ or $\Delta x \sim \frac{\hbar}{2\Delta p_x}$ & if $\Delta p_x \uparrow$, then $\Delta x \downarrow \Rightarrow$ less we know about its **location**

#4 ΔV_s is the potential that causes **the electric-current to vanish**

, i.e., $W = \Delta KE = \frac{1}{2} m v_{max}^2 = eV_s$.

#5 $p_p = 4p_e = 4\frac{h}{\lambda_e} = \frac{h}{\lambda_p} \Rightarrow \boxed{\lambda_p = \frac{\lambda_e}{4}}$

#6 $\phi = 2.46\,eV$; $\lambda = 300\,nm$; photo-electric effect:

$$\frac{hc}{\lambda} = \phi + KE_{max} \Rightarrow KE_{max} = \frac{hc}{\lambda} - \phi = \frac{1240\,eV\cdot nm}{300\,nm} - 2.46\,eV =$$

$$KE_{max} = 4.133\,eV - 2.46\,eV = \boxed{1.67\,eV}$$

#7 cut-off wavelength occurs when $KE_{max} = 0$; i.e.,

$$\frac{hc}{\lambda_c} = \phi \Rightarrow \lambda_c = \frac{hc}{\phi} = \frac{1240\,eV\cdot nm}{2.46\,eV} = \boxed{504\,nm}$$

#8 non-relativistic speed: $p = \frac{mv}{(1-\frac{v^2}{c^2})^{1/2}} \simeq mv = \frac{h}{\lambda}$ = momentum.
$v \lll c$

thus, $p_e = \frac{h}{\lambda_e} = m_e V_e$ & $p_p = \frac{h}{\lambda_p} = m_p V_p$. If, $\lambda_e = \lambda_p \Rightarrow p_e = p_p$

$\Rightarrow$ $\boxed{\text{momentum is the same}}$, note since $m_e \neq m_p$, $V_e \neq V_p$ &

as a result $V_e = \lambda_e f_e \neq V_p = \lambda_p f_p \Rightarrow f_e \neq f_p$ &

$$KE_e = \frac{p_e^2}{2m_e} \neq KE_p = \frac{p_p^2}{2m_p}.$$

#9 At $t = 0$, $p = mv = \frac{h}{\lambda} \Rightarrow \lambda = \frac{h}{mv} = \frac{6.626\times10^{-34}\,J\cdot sec}{0.1\,Kg\cdot 50\,m/sec} =$

$\boxed{1.33\times10^{-34}\,m}$ in SI units.

#10 $E_0 = 75\,KeV = \frac{hc}{\lambda_0} \Rightarrow \lambda_0 = \frac{1240\,eV\cdot nm}{75\,KeV}$. $\lambda = \lambda_0 + \frac{h}{m_e c}(1-\cos(\theta))$

$$\lambda = 0.01653\,nm + 0.00243(1-\cos(75°)) = 0.01653\,nm + (0.7411)(0.00243)\,nm$$

$$\lambda = 0.01833\,nm = \boxed{1.833\times10^{-11}\,m}$$