HW 3 solution

Problem 3-42.

The stopping potential for photoeffect is given by the equation

$$eV_0 \;=\; hf - \phi$$

Writing two of them for $\lambda_1 = 4.5\times10^{-11}$,m $V_0^{(1)} = 0.52$V and for $\lambda_2 = 3\times10^{-11}$,m $V_0^{(2)} = 1.9$V we get

$$\left.\begin{array}{rcl} V_0^{(1)} &=& \frac{h}{\lambda_1 e} - \frac{\phi}{e} \\ V_0^{(2)} &=& \frac{h}{\lambda_2 e} - \frac{\phi}{e} \end{array}\right\} \Rightarrow \begin{array}{rcl} \frac{\phi}{e} &=& \frac{\lambda_2 V_0^{(2)} - \lambda_1 V_0^{(1)}}{\lambda_1 - \lambda_2} \;\simeq\; 2.24\text{V} \\ h &=& e\frac{\lambda_2 V_0^{(2)} - \lambda_2 V_0^{(1)}}{\lambda_1 - \lambda_2}\lambda_1\lambda_2 \end{array} \begin{array}{l} \Rightarrow\; \phi \simeq 2.24\text{eV} \simeq 3.6\times10^{-19}\text{J} \\ \Rightarrow\; h \simeq 4.14\times10^{-15}\text{eV}\cdot\text{s} \simeq 6.63\times10^{-34}\text{J}\cdot\text{s} \end{array}$$

Problem 3-49.

From Compton equation (3-25) we get

$$\frac{1}{hf_2} \;=\; \frac{1}{hf_1} + \frac{1}{mc^2}(1-\cos\theta) \quad\Leftrightarrow\quad hf_2 \;=\; hf_1\frac{mc^2}{hf_1(1-\cos\theta)+mc^2}$$

The energy of recoil photon is

$$E_k \;=\; hf_1 - hf_2 \;=\; E_\gamma - E_\gamma\frac{mc^2}{E_\gamma(1-\cos\theta)+mc^2} \;=\; E_\gamma - E_\gamma\frac{mc^2}{2E_\gamma\sin^2\frac{\theta}{2}+mc^2}$$

It is clear that maximal E_k corresponds to minimal $\frac{mc^2}{E_\gamma+2mc^2\sin^2\frac{\theta}{2}}$ which occurs at $\sin\frac{\theta}{2}=1$. Thus, we get

$$E_k^{\max} \;=\; \frac{2E_\gamma^2}{2E_\gamma+mc^2}$$