Modern physics Chapter 3-4. Solutions to exercises.

3.1.1 The deBroglie wavelength is

$$\lambda = \frac{h}{p} \Rightarrow p = \frac{h}{\lambda} = \frac{6.63\times10^{-34}}{350\times10^{-9}} kgm/s \approx 1.89\times10^{-27} kgm/s$$

3.2.1 $E = hf = \dfrac{hc}{\lambda} = \dfrac{6.63\times10^{-34}\times3.0\times10^{8}}{2.0\times10^{-9}\times1.6\times10^{-19}} eV \approx 620eV$

3.2.2 With $E = eV$ and $\lambda = \dfrac{h}{p}$ and $E = \dfrac{p^2}{2m} \Rightarrow p = \sqrt{2mE}$ we get

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2meV}} = \frac{6.63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\times10\times10^{3}}} m \approx 12.3 pm$$

3.2.3 $\lambda_C = 1.7Å$ and $eV = \dfrac{hc}{\lambda_C} \Rightarrow V = \dfrac{hc}{\lambda e} = \dfrac{6.63\times10^{-34}\times3.00\times10^{8}}{1.7\times10^{-10}\times1.6\times10^{-19}} volt \approx 7.3kV$

3.2.4 $eV = mv^2/2$; $v = \sqrt{\dfrac{2eV}{m}} = \sqrt{\dfrac{2\times1.6\times10^{-19}\times1.2\times10^{3}}{9.1\times10^{-31}}} m/s \approx 21\times10^{6} m/s$

3.2.5 The deBroglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{2eV}{m}}} = \frac{h}{\sqrt{2meV}} = \frac{6.63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\times1.0\times10^{-3}}} m \approx 39Å$$

4.1.1 $\Phi = 2{,}02eV$ och med Einsteins relation $hf = \Phi + K$ får vi

$$K = hf - \Phi = \frac{hc}{\lambda} - \Phi = \frac{6{,}63\times10^{-34}\times3{,}00\times10^{8}}{400\times10^{-9}} - 2{,}02\times1{,}60\times10^{-19} J =$$

$4{,}9725\text{x}10^{-19} - 2{,}02\text{x}1{,}60\text{x}10^{-19}\ J = 1{,}7405\text{x}10^{-19}\ J \approx 1{,}7\times10^{-19} J$

4.1.2 Kinetiska energin $K = \dfrac{mv^2}{2}$ ger hastigheten $v = \sqrt{\dfrac{2K}{m}}$

4.1.3 $K = eV = 1.602\text{x}10^{-19}$ J Einstein's relation $hf = \Phi + K$ and with $c = f\lambda$ we have

$\dfrac{hc}{\lambda} = \Phi + K$ which gives

$$\Phi = \frac{hc}{\lambda} - K = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{369\times10^{-9}} - 1.602\times10^{-19}\times0.68J =$$

$5.12195\text{x}10^{-19}/1.602\text{x}10^{-19} - 0.68$ eV = *2.5 eV*

4.21. The Compton wavelength $\lambda_C = \dfrac{h}{m_p c} = \dfrac{6.63\times10^{-34}}{1.673\times10^{-27}\times3.00\times10^{8}} m = 1.32\times10^{-15} m$

4.2.2 $E = hf = hc/\lambda$ gives $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{0.15\times10^{6}\times1.602\times10^{-19}}m = 8.29\,pm$

4.2.3 The wavelength difference $\Delta\lambda = \frac{h}{m_e c}\left(1-\cos 90^o\right) = \frac{h}{m_e c} = 2.43\,pm$

4.2.4 $K = E - E'$ is the kinetic energy. $K = \frac{hc}{\lambda} - \frac{hc}{\lambda'} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right)$

$\lambda = 8.27$ pm gives $\lambda' = \lambda + \Delta\lambda = 9.27 + 2.43$ pm $= 10.70$ pm

$$K = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right) = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{1.602\times10^{-19}}\left(\frac{1}{8.27} - \frac{1}{10.70}\right)\times10^{12}\,eV = 34\,keV$$

4.3.1 Incoming photon energy $hf_0 = 2\,m_e c^2$ = 2x511 keV = 1.022 MeV
$hf = 2\,m_e c^2 + K_e + K_p$
$K_p = 3.0 - 1.022 - 0.25\ MeV = 1.73\ MeV$