Ex.1 10 Ex. 2.1
Ex.2 10 Ex. 2.3
Ex.3 10 Ex. 2.6
Ex.4 10 Ex. 2.8
Ex.5 5 Ex. 2.12
Ex.6  In general, if one includes the relativistic effect, the total energy for an electron is $E = \sqrt{m_0^2c^4 + p^2c^2}$, where $m_0$ is the rest mass of the electron, $c$ is the speed of light, and $p$ is the momentum of the electron. The kinetic energy $E_k$ is then defined by $E_k \equiv E - E_0$ with $E_0 \equiv m_0c^2$.

(a) 10 Show that the de Broglie wavelength is given by

$$\lambda \equiv \frac{h}{p} = \frac{hc}{\sqrt{2E_0E_k + E_k^2}},$$

and verify that in the limit $E_0 \gg E_k$, one recovers the non-relativistic form $\lambda_{\text{non}} = h/\sqrt{2m_0E_k}$. Therefore, one finds

$$\frac{\lambda}{\lambda_{\text{non}}} = \frac{1}{\sqrt{1 + E_k/2E_0}}.$$

This is an expression one can use to estimate when one should include the relativistic effect in computing the wavelength of the electron.

(b) 10 Show that the phase speed of a relativistic electron is greater than $c$, but the group velocity is equal to the classical particle velocity of the electron.