HW 7 Chapter 5

5-5 $\lambda = \frac{h}{p}$ $\quad p = mv = (1.2\,kg)(6\,m/s) = 7.2\,kg\,m/s$

$$\lambda = \frac{6.62\times10^{-34}\,J\cdot s}{7.2\,kg\,m/s} = 9.2\times10^{-35}\,m$$

m. The deBroglie waves of the rock belong to the rock.
The mechanical waves of the water are properties of the medium.
And, obviously very different in size.

5-15 $K = eV = 3\,keV \Rightarrow E = K + m_0c^2$ $\quad m_0 = 0.511\,MeV/c^2 = 511\,keV/c^2$

$E = 514\,keV$

$$p = \frac{\sqrt{E^2 - m_0^2c^4}}{c}$$

$$= \frac{\sqrt{(514\,keV)^2 - (511\,keV)^2}}{c} = 55\,keV/c$$

$$\lambda = \frac{h}{p} = \frac{hc}{pc} = \frac{1240\,eV\cdot nm}{55\times10^3\,eV} = 22\times10^{-12}\,m$$

5-18 $K = 1 \times 10^{12}\ eV$

need p: $(pc)^2 = E^2 - E_0^2$ $\quad E = K + E_0$

$= (K + E_0)^2 - E_0^2$

$= K^2 + E_0^2 + 2KE_0 - E_0^2$

$= K^2 + 2KE_0$

$pc = \sqrt{K^2 + 2Km_0c^2}$

$$\lambda = \frac{h}{p} = \frac{hc}{pc} = \frac{1240\ eV \cdot nm}{\sqrt{(10^{12}\ eV)^2 + 2(10^{12})(938 \times 10^6\ eV)}}$$

Tevatron: $\lambda = 1.24 \times 10^{-18}\ m$

LHC $K = 7 \times 10^{12}\ eV$

$\lambda = 1.8 \times 10^{-19}\ m$

5-26

$\lambda = 4\,cm$

$v = 4.2\,cm/s$

a) $f = \frac{v}{\lambda} = \frac{4.2}{4} = 1.05\,Hz$

b) $T = \frac{1}{f} = 0.95\,s$

c) $k = \frac{2\pi}{\lambda} = \frac{\pi}{2}\,cm^{-1}$

d) $\omega = \frac{2\pi}{T} = 2.1\pi\,rad/s$

5-42 $\Delta x \Delta p \geq \frac{\hbar}{2}$

$\Delta x \, m \Delta v \geq \frac{\hbar}{2}$

$$\Delta v \geq \frac{\hbar}{2m} \frac{1}{\Delta x} = \frac{1.054 \times 10^{-34} \text{ J}\cdot\text{s}}{2(3\times10^{-15}\text{kg})(1\times10^{-6}\text{m})}$$

$$\geq 1.76 \times 10^{-14} \text{ m/s}$$

5-44 $\lambda \sim 0.14\text{ nm}$ looking for K of electrons.

$$p = \frac{h}{\lambda} = \frac{hc}{\lambda c} = \frac{1240 \text{ eV}\cdot\text{nm}}{(0.14\text{nm})c}$$

$$= 8.9 \times 10^3 \text{ eV}/c$$

$$K = E - E_0 = \sqrt{(pc)^2 + E_0^2} - E_0$$

$$= \sqrt{(8.9\text{ keV})^2 + (511\text{ keV})^2} - 511\text{ keV}$$

$$= 77\text{ eV}$$