Answer on Question #51221, Physics, Other

An electron has a deBroglie wavelength equal to that of a photon. Show that the ratio of the kinetic energy of the electron to the energy of the photon is

$$[\ (m^2c^4 + h^2v^2)^{1/2} - mc^2\ ] / (\ hv\ )$$

Solution:

For electron,

$$\lambda = \frac{h}{mv}$$

$$v = \frac{h}{m\lambda}$$

with

$$\lambda = \frac{c}{\nu}$$

Thus, velocity is

$$v = \frac{h\nu}{mc}$$

Now, kinetic energy

$$K = \frac{1}{2}mv^2 = \frac{m}{2}\left[\frac{h\nu}{mc}\right]^2$$

i.e.

$$K_e = \frac{h^2\nu^2}{2mc^2} = mc^2 + \frac{h^2\nu^2}{2mc^2} - mc^2 = mc^2\left[1 + \frac{h^2\nu^2}{2m^2c^4}\right] - mc^2 =$$

$$= mc^2\left[1 + \frac{h^2\nu^2}{m^2c^4}\right]^{\frac{1}{2}} - mc^2 = mc^2\left[\frac{m^2c^4 + h^2\nu^2}{m^2c^4}\right]^{\frac{1}{2}} - mc^2$$

$$K_e = (m^2c^4 + h^2\nu^2)^{\frac{1}{2}} - mc^2$$

For photon,

$$K_p = h\nu$$

Thus,

$$\frac{K_e}{K_p} = \frac{(m^2c^4 + h^2\nu^2)^{\frac{1}{2}} - mc^2}{h\nu}$$