Answer on Question#55946 - Physics - Quantum Mechanics

An electron has de Broglie 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:

Since the de Broglie wavelength of the electron is equal to that of a photon, the electron momentum p equals the momentum of photon. Momentum of the photon related to its energy hv by the following relation:

$$pc = hv$$

Therefore

$$p = \frac{hv}{c}$$

The kinetic energy of the electron is given by

$$K = \sqrt{m^2c^4 + p^2c^2} - mc^2$$

The ratio of the kinetic energy of the electron to the energy of the photon is

$$\frac{K}{hv} = \frac{\sqrt{m^2c^4 + p^2c^2} - mc^2}{hv} = \frac{\sqrt{m^2c^4 + \left(\frac{hv}{c}\right)^2 c^2} - mc^2}{hv} = \frac{\sqrt{m^2c^4 + h^2v^2} - mc^2}{hv}$$

Answer: $\frac{\sqrt{m^2c^4+h^2v^2}-mc^2}{hv}$.