Answer on Question #62828, Physics / Atomic and Nuclear Physics

To resolve an object in an electron microscope, the wavelength of the electrons must be close to the diameter of the object. What kinetic energy must the electrons have in order to resolve a protein molecule that is 4.20 nm in diameter? Take the mass of an electron to be 9.11× 10–31 kg.

Solution:

The de Broglie wavelength is found by λ = h/mv,

h = Planck's constant = 6.626 x 10^-34 J*s

m = 9.11× 10–31 kg

λ = 4.20 nm (1 m) / (10^9 nm) = 4.2 x 10^-9 m

Electron velocity = v = h/mλ = (6.626 x 10^-34 J*s)/(9.11× 10^–31 kg)(4.2 x 10^-9 m)

Remember that 1 J = 1 kg*m^2/s^2 when you cancel units.

v = 1.730 x 10^5 m/s

E = (1/2) mv^2 = (1/2) (9.11× 10–31 kg) (1.730 x 10^5 m/s)^2 = 13.63 x 10^-21 J

Answer: 13.63 x 10^-21 J