Answer on Question #59719, Physics / Quantum Mechanics

Assuming Heisenberg Uncertainty Principle to be true what could be the minimum uncertainty in de-Broglie wavelength of a moving electron accelerated by potential difference of 6 Volts whose uncertainty in position is n.m.

Find: Δλ – ?

Given:

U=6 V

$m=9,1\times10^{-31}$ kg

$h=6,626\times10^{-34}$ J×s

$e=-1,6\times10^{-19}$ C

Solution:

de-Broglie wavelength:

$\lambda = \frac{h}{p}$ (1),

where p – momentum of electron

We believe that the electron is a classic ("electron accelerated by potential difference of 6 Volts").

The kinetic energy of the electron:

$E = \frac{mv^2}{2} = \frac{m^2v^2}{2m} = \frac{p^2}{2m}$ (2)

Of (2) $\Rightarrow$ $p = \sqrt{2mE}$ (3)

Kinetic energy is numerically equal to the work. The work is done by the forces of electric field.

$E = |e|U$ (4)

(4) in (3): $p = \sqrt{2m|e|U}$ (5)

Heisenberg Uncertainty Principle:

$\Delta x \Delta p_x \geq \hbar$ (6),

where Δx – uncertainties of coordinates,

Δp_x – uncertainties of corresponding momentum' projection,

$\hbar = \frac{h}{2\pi}$

Of (1) $\Rightarrow$ $\Delta\lambda\Delta p \geq h$ (7),

Of (6) $\Rightarrow$ $2\pi\Delta x\Delta p_x \geq h$ (8)

Of (7) and (8) $\Rightarrow$ $2\pi\Delta\lambda\Delta p \geq h$ (9)

We believe that $\Delta p \leq p$

(5) in (9): $2\pi\Delta\lambda\sqrt{2m|e|U} \geq h$ (10)

Of (10) $\Rightarrow$ $\Delta\lambda = \frac{h}{2\pi\sqrt{2m|e|U}}$ (11)

Of (11) $\Rightarrow$ $\Delta\lambda = 0,8\times10^{-10}$ m

Answer:

$0,8\times10^{-10}$ m