Problem-solving Example 23

Calculate percentage of uncertainty, Δx in position of an electron in hydrogen atom which travels at a velocity of $2.19 \times 10^{6}\ ms^{-1}$ at the first Bohr orbit $(n=1)$

Solution

Solution :

$m_e = 9.110 \times 10^{-31}$ kg
$V = 2.19 \times 10^{6}$ ms^{-1}

$$p = m.V = (9.110 \times 10^{-31} kg)(2.19 \times 10^{6} ms^{-1}) = 2.0 \times 10^{-24} kg\,ms^{-1}$$

Assume that the measured momentum is allowed to have experimental error of 100%, then

$$\Delta p = 2.0 \times 10^{-24} kg\,ms^{-1}$$

According to Uncertainty Principle :

$$\Delta x . \Delta p = \frac{h}{4\pi}$$

$$\therefore \Delta x = \frac{h}{4\pi . \Delta p} = \frac{(6.626 \times 10^{-34} Js)}{4\pi (2.0 \times 10^{-24} kg\,ms^{-1})}$$

$$= 2.636 \times 10^{-11} m$$

$$= 0.2636 \text{ Å}$$

← this is half of fi[rst] Bohr radius, a_0 =

$r_1 = a_0 = 0.529$ Å → diameter, $2a_0 = 1.058$ Å.

∴ Percentage Δx (compared to the diameter of Bohr orbit)

$$= \frac{\Delta x}{1.058} \times 100 = \frac{0.264}{1.058} \times 100$$

$$= 25\%$$

← percentage unce[rtainty] in electron posi[tion] at the orbit.

Prepared by
V.Manoharan
vmano@usm.my
manovv1955@yahoo.com
04-6533888 ext 3566