

# SOLVED PROBLEMS (NUMERICALS)

20.1 A hydrogen atom is in its ground state ( $n = 1$ ). Using Bohr's theory, calculate (a) the radius of the orbit, (b) the linear momentum of the electron, (c) the angular momentum of the electron (d) the kinetic energy, (e) the potential energy, and (f) the total energy.

**Solution:**

**Given Data:**

State of H-atom	=	n	=	1
Charge on electron	=	e	=	$1.6 \times 10^{-19} \text{C}$
Coulomb constant	=	k	=	$9 \times 10^9 \text{ Nm}^2 \text{C}^{-2}$
Planck constant	=	h	=	$6.63 \times 10^{-34} \text{ Js}$
Speed of light	=	c	=	$3.0 \times 10^8 \text{ ms}^{-1}$

**To find**

- |     |                              |                     |
|-----|------------------------------|---------------------|
| (a) | Radius of the orbit          | = $r_n = ?$         |
| (b) | Linear momentum of electron  | = $P = ?$           |
| (c) | Angular Momentum of electron | = $L = ?$           |
| (d) | K.E of electron              | = $\text{K.E.} = ?$ |
| (e) | P.E of electron              | = $\text{P.E.} = ?$ |
| (f) | Total Energy of electron     | = $E_n = ?$         |

**Calculation:**

(a) **Radius of orbit**

According to Bohr's theory we have

$$r_n = n^2 \times 0.053 \text{ nm}$$

Put  $n = 1$

$$r_1 = 0.053 \text{ nm}$$

(b) **Linear momentum of electron**

From II-Postulate of Bohr's theory we have

$$m v r = \frac{nh}{2\pi}$$

$$\Rightarrow p = mv = \frac{nh}{2\pi r}$$

Putting values

$$P = \frac{1 \times 6.63 \times 10^{-34}}{2\pi \times 0.053 \times 10^{-9}}$$

$$P = 1.99 \times 10^{-24} \text{ kg ms}^{-1}$$

(c) **Angular Momentum of e<sup>-</sup> electron**

From II-Postulate of Bohr's theory we have

$$L = m v r = \frac{nh}{2\pi}$$

$$\Rightarrow L = \frac{1 \times 6.63 \times 10^{-34}}{2\pi}$$

$$L = 1.05 \times 10^{-34} \text{ kgm}^2 \text{ s}^{-1}$$

(d) **K.E. of Electron**

As  $\text{K.E} = \frac{1}{2} mv^2$

# Chapter 20 Numericals

**J Elliott**



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