Dual nature of electron

1. (c) According to de-Broglie equation $\lambda = \frac{h}{mv}$ or $\frac{h}{p}$ or $\frac{h}{mc}$.

2. **(a) De Broglie equation**

The expressionλ=p/h is known as the **de Broglie relation**.

It relates a particle's wavelength (λ) to Planck's constant (h) and its momentum (p).

3. **(a) De Broglie equation**

- The expression λ=h/p is known as the **de Broglie relation**.
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4. (b) $\lambda = \frac{h}{p}$ or $\frac{h}{mv}$ or $\frac{h}{mc}$ de-Broglie equation.

5. (c) Emission spectra of different λ accounts for quantisation of energy.

6. (b) According to de-Broglie equation

$\lambda = \frac{h}{mv}, p = mv, \lambda = \frac{h}{p}, \lambda = \frac{h}{mc}$

7. (d) According to de-Broglie $\left(\lambda = \frac{h}{mv}\right)$.

8. (a) $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{10^{-3}\times100} = 6.63 \times 10^{-33} m$

9. (d) $\lambda = \frac{h}{mv}$. For same velocity $\lambda \propto \frac{1}{m}$.

SO_2 molecule has least wavelength because their molecular mass is high.

10. (d) de-Broglie equation is $\lambda = \frac{h}{p}$.

11. (c) Formula for de-Broglie wavelength is

$$\lambda = \frac{h}{p} \text{ or } \lambda = \frac{h}{mv} \Rightarrow eV = \frac{1}{2}mv^2 \text{ or } v = \sqrt{\frac{2eV}{m}}$$

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{6.62\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times2.8\times10^{-23}}}$$

$$\lambda = 9.28\times10^{-8} meter.$$

12. (c) $\lambda = \frac{h}{p}, p = mv$

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{9.1\times10^{-31}\times1.2\times10^{5}}$$

$$\lambda = 6.626\times10^{-9} m.$$

13. (b) Mass of the particle $(m) = 10^{-6} kg$ and velocity of the particle $(v) = 10 ms^{-1}$

$$\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{10^{-6}\times10} = 6.63\times10^{-29} m$$

14. Step 1: Bohr's quantization condition

For hydrogen atom in Bohr model:

$2\pi r_n = n\lambda$

So, the de-Broglie wavelength in the n^{th} orbit is:

$\lambda = (2\pi r_n) / n$

Step 2: Bohr radius formula

Radius of n^{th} orbit:

$r_n = n^2 a_0$, where $a_0 = 0.529$ Å $= 0.529 \times 10^{-8}$ cm

For n = 3:

$r_3 = 9a_0 = 9 \times 0.529 \times 10^{-8}$ cm

$= 4.761 \times 10^{-8}$ cm

Step 3: Find λ

$\lambda = (2\pi r_3) / 3$

$= (2\pi \times 4.761 \times 10^{-8}) / 3$

$\approx (29.9 \times 10^{-8}) / 3$

$= 9.96 \times 10^{-8}$ cm

Final Answer:

The de-Broglie wavelength associated with the hydrogen electron in its third orbit is:

λ = 9.96 × 10^{-8} cm

Correct Option: (b)

15. (b) According to de–Broglie

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-20} erg.sec}{\frac{2}{6.023\times10^{23}}\times5\times10^{4} cm/sec}$$

$$= \frac{6.62\times10^{-27}\times6.023\times10^{23}}{2\times5\times10^{4}} cm = 4\times10^{-8} cm = 4Å.$$

16. (c) $\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{0.2kg\times\frac{5}{60\times60ms^{-1}}} = 10^{-30} m.$

17. (c) From de Broglie equation

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{0.5\times100} = 1.32\times10^{-35} m.$$

18. (c) Dual nature of particle was proposed by de-broglie who gave the following equation for the wavelength.

$$\lambda = \frac{h}{mv}$$

19. (b) One percent of the speed of light is

$$v = \left(\frac{1}{100}\right)(3.00\times10^{8} ms^{-1}) = 3.00\times10^{6} ms^{-1}$$

Momentum of the electron $(p) = mv$

= $(9.11\times10^{-31} kg)(3.00\times10^{6} ms^{-1})$

= $2.73\times10^{-24} kgms^{-1}$

The de-broglie wavelength of this electron is

$$\lambda = \frac{h}{p} = \frac{6.626\times10^{-34}}{2.73\times10^{-24} kgms^{-1}}$$

$$\lambda = 2.424\times10^{-10} m.$$

20. (a) We know that the correct relationship between wavelength and momentum is $\lambda = \frac{h}{p}$. Which is given by de-Broglie.

21. (d) De-broglie equation applies to all the material object in motion.