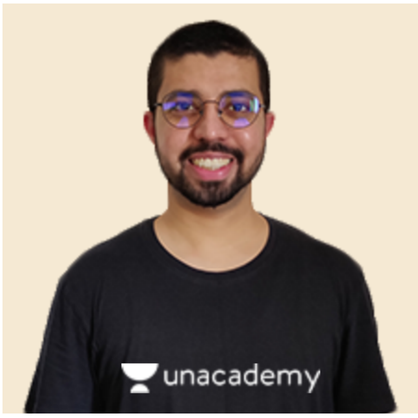
Atomic Structure
DPP-5



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1. Find the product of uncertainty in position and velocity for an electron of mass 9.10×10^{-31} kg. ($h = 6.62 \times 10^{-34}$ J. S., i.e., kg $m^2 s^{-1}$)

2. What conclusion may be drawn from the following results of (a) and (b)

(a) If a 1×10^{-3} kg body is travelling along the x–axis at 1 m/s within 0.01 m/s. Calculate the theoretical uncertainty in its position.

(b) If an electron is travelling at 100 m/s within 1 m/s, calculate the theoretical uncertainty in its position.

[$h = 6.63 \times 10^{-34}$ J. s, mass of electron = 9.109×10^{-31} kg]

3. The uncertainty principle may be stated mathematically

$$\Delta(m\nu)\ \Delta x \geq h/4\pi$$

where $\Delta(m\nu)$ represents the uncertainty in the momentum of a particle and Δx represents the uncertainty in its position.

(a) If a 1.00-g body is travelling along the x axis at 100 cm/s within 1cm/s, what is the theoretical uncertainty in its position?

(b) If an electron is travelling at 100 m/s within 1m/s, what is the theoretical uncertainty in its position ? Explain why the uncertainty principle is not important for macroscopic bodies.

4. Show that de Broglie's hypothesis applied to an electron moving in a circular orbit leads to Bohr's postulate of quantized angular momentum.

5. The wavelength associated with an electron moving in a potential difference of 2000V is 0.05 nm. How slow must a 0.01–kg hockey ball travel to have the same de Broglie wavelength as a 2000V electron?

6. An electron in a hydrogen atom in its ground state absorbs 1.50 times as much energy as the minimum required for it to escape from the atom. What is the wavelength of the emitted electron ?

7. What accelerating potential must be imparted to a proton beam to give it an effective wavelength of 0.050 Å ?

8. What accelerating potential is needed to produce an electron beam with an effective wavelength of 0.090 Å ?

9. An electron diffraction experiment was performed with a beam of electrons accelerated by a potential difference of 10.0kV. What was the wavelength of the electron beam ?

10. Dual behaviour of matter proposed by de Broglie led to the discovery of electron microscope often used for the highly magnified images of biological molecules and other type of material. If the velocity of the electron in this microscope is 1.6×10^6 ms^{-1}, calculate de Broglie wavelength associated with this electron. **(NCERT Problem)**

11. If the velocity of the electron in Bohr's first orbit is 2.19×10^6 ms^{-1}, calculate the de Broglie wavelength associated with it. **(NCERT Problem)**

12. The de Broglie wavelength of a tennis balls of mass 60g moving with a velocity of 10 meters per second is approximately

(a) 10^{-33} metres (b) 10^{-31} metres (c) 10^{-16} metres (d) 10^{-25} metres

13. Which of the following electron transitions in a hydrogen atom will require the largest amount of energy ?

(a) from n = 1 to n = 2 (b) from n = 2 to n = 3

(c) from n = ∞ to n = 1 (d) from n = 3 to n = 5

14. The uncertainty of position of a particle weighing 25.0g is 10^{-5} m. Hence, the uncertainty of its velocity (ms^{-1}) is (given Planck constant $h = 6.6 \times 10^{-34}$ J s)

(a) 2.1×10^{-28} (b) 2.1×10^{-34} (c) 0.5×10^{-34} (d) 5.0×10^{-24}

15. The relation $\lambda = h/p$ is true for

(a) photons (b) electrons (c) positrons (d) all of these

16. The radii of two of the first four Bohr orbits of the hydrogen atom are in the ratio 1 : 4. The energy difference between them may be

(a) 0.85 eV (b) 2.55 eV (c) 3.40 eV (d) 10.20 eV

17. Which of the following equations was suggested by de Broglie ?

(a) $2\pi r = n\lambda$ (b) $\lambda = \frac{p}{h}$ (c) $\pi r^2 = n\lambda$ (d) $2\pi r = n\frac{h}{\lambda}$

18. The uncertainty in the momentum of an electron is 1.0×10^{-5} kg m s^{-1}. The uncertainty of its position will be ($h=6.626\times10^{-34}$ km $m^2 s^{-1}$)

(a) 1.05×10^{-28} m (b) 1.05×10^{-26} m (c) 5.25×10^{-30} m (d) 5.25×10^{-28} m

19. The ratio of the de Broglie wavelength of the electron (λ_1) and that of the neutron (λ_2) both moving with the same velocity is

(a) 3.4×10^2 (b) 53 (c) 1.76×10^3 (d) none of these

20. If the wavelength of a photon is 2.2×10^{-11} m and $h= 6.6\times10^{-34}$ J s, its momentum is

(a) 3.00×10^{-23} kg m s^{-1} (b) 3.33×10^{22} kg m s^{-1}

(c) 1.45×10^{-44} kg m s^{-1} (d) 6.90×10^{-43} kg m s^{-1}

ANSWERS

1. 5.8×10^{-5} $m^2 s^{-1}$. **2.** **(a)** $\approx 3\times10^{-30}$ metre. **(b)** $\approx 3\times10^{-5}$ meter

3. **(a) 2.64×10^{-30} m, (b) 30μm** **5.** 1.325×10^{-19} cm s^{-1} **6.** 4.70×10^{-10} m

7. 33 V **8.** 18.6 k V **9.** 0.123 Å **10.** 4.53×10^{-10}m

11. 3.31×10^{-10}m **12.** (a) **13.** (a) **14.** (a) **15.** (d)

16. (d) **17.** (a) **18.** (c) **19.** (c) **20.** (a)