# 10. BOHR'S THEORY

## SOLUTIONS

## TEACHING TASK

### JEE MAINS LEVEL QUESTIONS

1 The ratio of the radii of the first three Bohr orbits is **(FA & SA- 2 Marks)**

A) 1:0.5:0.33 B)1:2:3 C)1:4:9 D)1:8 27

**Answer:C**

Solution:1. Ratio of the radii of the first three Bohr orbits

In the Bohr model for hydrogen-like atoms: $r_n = \frac{n^2h^2\varepsilon_0}{\pi mZe^2} = a_0\frac{n^2}{Z}$

For hydrogen (Z=1): $r_n \propto n^2$

So for n=1,2,3:

$r_1 : r_2 : r_3 = 1^2 : 2^2 : 3^2 = 1:4:9$

2. The ionization potential of hydrogen atom is 13.6 eV. The wavelength of the energy radiation required for the ionization of H-atom

A) 1911 nm B) 912 nm C) 68 nm D) 91.2 nm

**Answer:D**

Solution:Energy needed E=13.6 eV

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E}$$

$$\lambda = \frac{6.62\times10^{-34}\times3\times10^8}{13.6\times1.6\times10^{-19}J} = 91.2nm$$

3 The ratio of the radius of the Bohr orbit for the electron orbiting the hydrogen nucleus that of the electron orbiting the deuterium nucleus is approximately.

A) 1 : -1 B) 1 : 1 C) 1 : 2 D) 2 : 1

**Answer:B**

Solution: $r\alpha\frac{n^2}{Z}$

For Hydrogen& Deuterium both have Z=1

For ground state n=1

$r_H$:$r_D$=1:1

4. In a certain Bohr orbit the total energy is $-4.9\,eV$ for this orbit, the kinetic energy and potential energy are respectively **(FA & SA- 3 Marks/4 Marks)**

A) $9.8\,eV, -4.9\,eV$ B) $4.9\,eV, -9.8\,eV$ C) $4.9\,eV, -4.9\,eV$ D) $9.8eV, -9.8eV$

**Answer:B**

Solution:Given total energy TE=-4.9 eV

Bohr results: KE=-TE and PE=2TE

KE=-TE=-(-4.9eV)=4.9eV

PE=2TE=2(-4.9eV)=-9.8eV

5. The energy of the second Bohr orbit of hydrogen atom is - 3.41 eV. The energy of the second orbit of $He^+$ would be

A) -0.85eV B) -13.6eV C) -1.70eV D) -6.82eV

**Answer:B**

Solution:For hydrogen-like ions

$$E_n = -13.6\frac{Z^2}{n^2}eV$$

For $He^+$ ,Z=2,n=2

$$E_n = -13.6\frac{2^2}{2^2} = -13.6eV$$

6. The ratio of the difference in energy between the first and the second Bohr orbit to that between the second and the third Bohr orbit is

**(FA & SA- 5 Marks/8 Marks)**

A) 1/2 B) 34/19 C) 102/121 D) 102/19

**Answer:D**

Solution:The energy difference b/w 1st and 2nd bohrs orbits is

$$E_1 - E_2 = 13.6\times 1^2[\frac{1}{1^2}-\frac{1}{2^2}] = 13.6\times\frac{3}{4}$$

The energy difference b/w 2nd and 3rd bohrs orbits is

$$E_2 - E_3 = 13.6\times 1^2[\frac{1}{2^2}-\frac{1}{3^2}] = 13.6\times\frac{5}{36}$$

$$\frac{E_1-E_2}{E_2-E_3} = \frac{13.6\times\frac{3}{4}}{13.6\times\frac{5}{36}} = \frac{3}{4}\times\frac{36}{5} = \frac{108}{20} \approx \frac{102}{19}$$

7. A single electron in an ion has ionization energy equal to 217.6eV. What is the total number of neutrons present in one ion of it?

A) 2 B) 4 C) 5 D) 9

**Answer:C**

Solution:Ionization energy for hydrogen-like:

IE=13.6Z $^2$ eV

$13.6Z^2 = 217.6 \Rightarrow Z^2 = 16 \Rightarrow Z = 4$

So element is $Be^{3+}$ (beryllium ion with 1 electron).

Atomic number 4 $\Rightarrow$ beryllium: protons = 4, mass number usually 9 , neutrons = 5.

8. In a certain electronic transition in the hydrogen atom from an initial state (A) to a final state (B), the difference in the orbital radius $(r_1 - r_2)$ is 24 times the first Bohr radius. Identify the transition.

A) $5 \to 1$ B) $25 \to 1$ C) $8 \to 3$ D) $1 \to 5$

**Answer:A**

Solution: $r_n = n^2 a_0$

Difference for transition, $n_i \to n_f : r_{n_i} - r_{n_f} = (n_i^2 - n_f^2) a_0$

We need $n_i^2 - n_f^2 = 24$

Check options: for $5 \to 1$: 25-1=24

9. In an atom, two electrons move round the nucleus in circular orbits of radii R and 4R. The ratio of the time taken by them to complete one revolution is

A) 1:4 B) 4:1 C) 1:8 D) 8:1

**Answer:C**

Solution:

$$TimePeriod = \frac{2\pi r}{v} \propto r^{3/2}$$

$$\frac{T_1}{T_2} = [\frac{r_1}{r_2}]^{3/2} = (\frac{1}{4})^{3/2} = \frac{1}{8}$$

10. When a hydrogen atom emits a photon of energy 12.1 eV, the oribital angular monetum changes by

A) $\frac{h}{2\pi}$ B) $\frac{3h}{2\pi}$ C) $\frac{h}{\pi}$ D) $\frac{2h}{\pi}$

**Answer:C**

Solution:Energy change: $E_n = -\frac{13.6}{n^2}$

Photon energy $= E_i - E_f = 12.1 eV$

Try $n = 3 \to n = 1 : E_3 = -1.511, E_1 = -13.6, difference = 12.089 \approx 12.1 eV$

So transition: n=3 $\to$ n=1.

Angular momentum $L = n\frac{h}{2\pi}$

Chamge: $L_f - L_i = 1 \cdot \frac{h}{2\pi} - 3 \cdot \frac{h}{2\pi} = -2\frac{h}{2\pi} = -\frac{h}{\pi}$ :Magnitude = $\frac{h}{\pi}$

11. Energy of electron moving in the second orbit of of $He^+$ ion is

A) -13.6ev B) -3.4 ev C) -1.51 ev D) -0.84

**Answer:A**

Solution:

$$Formula : E_n = -13.6\frac{Z^2}{n^2}eV$$

$$He^+ : Z = 2, n = 2$$

$$E_n = -13.6\frac{2^2}{2^2}eV = -13.6eV$$

12. According to Bohr's theory of hydrogen atom **(IIT 1991)**

A) there is only fixed set of allowed orbitals for the electron

B) the allowed orbitals of the electrons are elliptical in shape

C) the moment of an electron from one allowed to another allowed orbital is forbidden

D) no light is emitted as long as the electron remains in an allowed orbital

**Answer:D**

Solution:Bohr's model depicts electrons orbiting the nucleus in fixed, discrete circular orbits. When an electron transitions from a higher energy level to a lower energy level, it emits a photon of light. However, if the electron stays in the same energy level (orbit), it does not emit any light.

13. If the speed of electron in the Bohr's first orbit of hydrogen in x, the speed in the third orbit is **(IIT 90)**

A) x/9 B) x/3 C) 3x D) 9x

**Answer:B**

Soluion:In Bohr model: $v_n \propto \frac{1}{n}$

So, $v_3 = \frac{v_1}{3} = \frac{x}{3}$

14. With increasing atomic number of a single electron species, the energy difference between two orbits

A) increases B) decreases

C) remains constant D) first increases followed by a decrease

**Answer:A**

Solution: Energy difference: $\Delta E = 13.6Z^2(\frac{1}{n_1^2} - \frac{1}{n_2^2})$

As Z increases, $\Delta E$ increases.

# JEE ADVANCED LEVEL QUESTIONS

**Multi correct answer type:**

1. To Which of the following is bohr's theory applicable

A)$He^{+}$ B)$Li^{+2}$ C)Tritium D)$Be^{+3}$

**Answer:A,B,C,D**

Solution:Bohr's theory works for one-electron systems (hydrogen-like ions).

A) $He^{+} \rightarrow$ 1 electron $\rightarrow$ Yes

B) $Li^{+2} \rightarrow$ 1 electron $\rightarrow$ Yes

C) Tritium $\rightarrow$ Hydrogen isotope ($^{1}H$ with 2 neutrons), 1 electron $\rightarrow$ Yes

D) $Be^{+3} \rightarrow$ 1 electron $\rightarrow$ Yes

All are one-electron systems.

2. Bohr's theory is not applicable to

A)Helium B)$Li^{+2}$ C)$He^{+2}$ D)H-atom

**Answer:A,C**

Solution:A) Helium $\rightarrow$ 2 electrons $\rightarrow$ Not applicable

B) $Li^{2+} \rightarrow$ 1 electron $\rightarrow$ Applicable (so not correct for "not applicable")

C) $He^{2+} \rightarrow$ No electrons (fully ionized helium nucleus) $\rightarrow$ Bohr model needs one electron, so not applicable here (no electron at all) $\rightarrow$ Not applicable

D) H-atom $\rightarrow$ 1 electron $\rightarrow$ Applicable (so not correct for "not applicable")

**Assertion and Reason Type:**

A) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
B) Both Assertion and Reason are true, but Reason is NOT the correct explanation for Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true

3. **Assertion** : In an atom, the velocity of electrons in the higher orbits keeps on decreasing

**Reason** : Velocity of electron is inversely proportional to the radius of the orbit

**Answer:A**

Solution:Bohr's formula for electron velocity in hydrogen-like atoms

$$v_n = \frac{Ze^2}{2\varepsilon_0 hn} \text{ or more precisely } v_n \propto \frac{1}{n}$$

Radius of orbit: $r_n \propto n^2$

So, $v_n \propto \frac{1}{r_n}$ ------> velocity decreases as radius increases

4. **Assertion** : Bohr's orbits are called stationary orbits.
**Reason** : Electrons remain stationary in these orbits for some time.

**Answer:C**

Solution:

Assertion: Bohr's orbits are called stationary orbits $\rightarrow$True.
Reason: Electrons remain stationary in these orbits for some time.$\rightarrow$ False.
Stationary means fixed energy, not motionless — electrons move in circular orbits but do not radiate.

**Comprehension Type:**

*Radius of hydrogen atom:*

$$r = \frac{n^2h^2}{4\pi^2 mKZe^2} \text{ where n = 1, 2, 3, ... } \infty$$

Hence only certain orbits whose radii are given by the above equation are available for the electron. The greater the value of n, i.e., farther the level from the nucleus the greater is the radius.

The radius of the smallest orbit (n = A) for hydrogen atom (Z = A) is $r_0$.

$$r_0 = \frac{n^2h^2}{4\pi^2 me^2K} = \frac{1^2 \times (6.626\times10^{-34})^2}{4\times(3.14)^2\times9\times10^{-31}\times(1.6\times10^{-19})^2\times9\times10^9} = 5.29\times10^{-11}\text{m} \;;$$

$$r_0 = 0.529\text{Å}$$

5. Which of the following is radius of first orbit of hydrogen?
A) 0.529 A° B) 0.136 A° C) 0.262 A° D) 0.329 A°

**Answer:A**

Solution:The Bohr radius for hydrogen (Z=1, n=1):$a_0$ =0.529 A°

6. The radius of the first orbit of hydrogen atom is 0.52 × $10^{-8}$cm. The radius of the first orbit of helium atom is:
A) 0.26 × $10^{-8}$ cm B) 0.52 × $10^{-8}$ cm C) 1.04 × $10^{-8}$ cm D) 2.08 × $10^{-8}$ cm.

**Answer:A**

Solution:Hydrogen-like ion formula: $r_n = \frac{n^2 a_0}{Z}$

For helium atom (Z=2) in first orbit (n=1):

$$r_1 = \frac{1^2 \times 0.52\times10^{-8}}{2} = 0.26\times10^{-8}\text{ cm}$$

**Integer type:**

7. The ratio of radius of 3rd and 4th Bohr orbits in hydrogen atom is

**Answer:9/16**

Solution:

$$r_n = n^2 a_0 / Z$$
$$r_3 = 3^2 a_0 / Z$$
$$r_4 = 4^2 a_0 / Z$$
$$\frac{r_3}{r_4} = \frac{3^2 a_0 / Z}{4^2 a_0 / Z} = \frac{9}{16}$$

8. If an electron in H atom has an energy of –78.4 kcal/mol. The orbit in which the electron is present is

**Answer:2**

Solution: First, convert energy per atom: $1 mol = 6.022 \times 10^{23}\, atoms$

Energy per atom = $\frac{-78.4\, kcal / mol}{N_A}$ in kcal × 4184 J/kcal to get joules, but easier:

We know 1 eV/atom=23.06 kcal/mol

So E in eV/atom = -78.4/23.06˜-3.4 eV

Hydrogen energy levels: $E_n = \frac{-13.6}{n^2} eV$

$$\frac{-13.6}{n^2} = -3.4$$
$$n^2 = \frac{13.6}{3.4} = 4$$
$$n = 2$$

**Matrix Matching Type:**

9 **Column-I** **Column-II**

| | Column-I | | Column-II |
|---|---|---|---|
| A) | Potential energy of an electron $\alpha$ | 1) | $\frac{Ze^2}{[4\pi\varepsilon_0]r^2}$ |
| B) | Frequency of revolution of an electron $\alpha$ | 2) | $\frac{Z^2}{h^3}$ |
| C) | Coulombic force of attraction $\alpha$ | 3) | $\frac{Z}{n}$ |
| D) | The velocity of an electron in the $n^{th}$ orbit = | 4) | $\frac{Z^2}{n^2}$ |
| | | 5) | $\frac{n^2}{Z}$ |

**Answer: A–4, B–2, C–1, D–3**

Solution:

A) Potential energy of an electron $\alpha$ — 4) $\frac{Z^2}{n^2}$

B) Frequency of revolution of an electron $\alpha$ — 2) $\frac{Z^2}{h^3}$

C) Coulombic force of attraction $\alpha$ — 1) $\frac{Ze^2}{[4\pi\varepsilon_0]r^2}$

D) The velocity of an electron in the $n^{th}$ orbit = — 3) $\frac{Z}{n}$

---

## LEARNERS TASK

---

## CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. Angular momentum of an electron is quantised according to
   A) Plank B) Rutherford C) Bohr D) Thomson

**Answer:C**

Solution:Angular momentum of an electron is quantised according to

Bohr proposed $mvr = \frac{nh}{2\pi}$ i.e. angular momentum is quantised

2. Boh's model of atom explains
   A) zeeman effect B) photo electric effect
   C) stark effect D) hydrogen atomic spectrum .

**Answer:D**

Solution: Bohr's model of atom successfully explains the hydrogen atomic spectrum.

3 Bohr's model of an atom is Contradicted by
   A) Pauli's exclusive principle
   B) Planck's quantum theory
   C) Heisenberg's uncertainty principle
   D) all the above

**Answer:C**

Solution:It assumes fixed orbits with known position and momentum, violating Heisenberg's uncertainty principle.
Also contradicts Pauli's principle (but that's for multi-electron atoms, not direct contradiction for H). Main direct contradiction: Heisenberg's uncertainty principle.

4. The total energy of the electron in any orbit of one electron containing species

is given by the expression

A) $-e^2/r^2$ B) $-n^2h^2/2\pi^2Z^2e^4m$ C) $-2\pi^2mZ^2e^4/n^2h^2$ D) nh / 2$\pi$

**Answer:C**

Solution:Bohr model energy formula for hydrogen-like atoms:$E_n = -2\pi^2mZ^2e^4/n^2h^2$

5. According to Bohr's theory energy is .............. when an electron moves from a lower to a higher orbit.

A) Absorbed B) emitted C) No change D) both 1 and 2

**Answer:A**

Solution:When an electron jumps from a lower orbit (lower n) to a higher orbit (higher n), it must absorb energy (a photon) to overcome the Coulomb attraction.

6. As we move away from nucleus, the energy of orbit

A) decrease B) increase

C)remain unchanged D)none

**Answer:B**

Solution:In Bohr's model: $E_n = -13.6\frac{Z^2}{n2}$ eV

As n increases, $E_n$ becomes less negative $\rightarrow$ energy increases (toward zero).

7. According to Bohrs theroy, the angular momentum for an electron in 5 th orbit is

A)2.5 $h/\Pi$ B) 5 $h/\Pi$ C) 25 $h/\Pi$ D) $5\Pi/2h$

**Answer:A**

Solution:Bohr's postulate: $L = n\frac{h}{2\pi}$

For n=5: $L = 5\frac{h}{2\pi} = \frac{2.5h}{\pi}$

8. For the electron moving in the circular orbit in the hydrogen atom, the forces of attraction of the nucleus is balanced by the force equal to

A) $\frac{1}{2}mv^2$ B) $\frac{mV^2}{r}$ C) $\frac{-e^2}{2r}$ D) $\frac{m}{Vr^2}$

**Answer:B**

Solution:The centripetal force required to keep the electron in circular motion is

F=$\frac{mV^2}{r}$

and the electrostatic (Coulomb) attraction between nucleus and electron is

$F = \frac{e^2}{r^2}$

These two balance each other: $F = \frac{e^2}{r^2} = \frac{mV^2}{r}$

9. Energy difference between two adjacent orbits is minimum if they are
   A) K,L - shells  B) L,M - shells  C) M,N - shells  D) N,O - shells

**Answer:D**

Solution:Energy level spacing $|\Delta E|$ decreases as n increases, so the smallest difference is for the largest shells listed: N $\rightarrow$ O

10. Bohr's model of atom can explain the spectrum of all except
   A) H  B) $He^+$  C) $Li^{++}$  D) He

**Answer:D**

Solution:Bohr's model works for hydrogen-like (one-electron) systems: H, $He^+$, $Li^{2+}$ — but not neutral He (two electrons)

11. The ratio of kinetic energy and total energy of an electron in a Bohr orbit of a hydrogen atom is
   A) 1/2  B) -1/2  C) 1  D) -1

**Answer:D**

Solution:For Coulombic orbits KE=-TE. Thus KE/TE=-1

12. The energy of an electron in the first Bohr orbit for hydrogen is $-13.6\,eV$. Which one of the following is a possible excited state for electron in Bohr orbit of hydrogen atom?
   A) $-3.4\,eV$  B) $-6.8\,eV$  C) $-1.7\,eV$  D) $-13.6\,eV$

**Answer:A**

Solution:Energy levels: $E_n = -13.6/n^2\,eV$

Possible excited states: $n \geq 2$
n=2: -3.4 eV
n=3: -1.51 eV
n=4: -0.85 eV

## JEE MAINS LEVEL QUESTIONS

1. The angular momentum of an electron present in the excited state of Hydrogen is $\frac{1.5h}{\pi}$. The electron present in **(FA & SA- 2 Marks)**
   A) Third orbit  B) Second orbit  C) Fourth orbit  D) Fifth orbit

**Answer:A**

Solution:Bohr's postulate:

$L = mvr = \frac{nh}{2\pi}$

$Given L = \frac{1.5h}{\pi}$

$\frac{n}{2} = 1.5 \Rightarrow n = 3$

2. If the electron of a hydrogen atom is present in the first orbit, the total energy of the electron is

A) $-e^2/r$ B) $-e^2/r^2$ C) $-e^2/2r$ D) $-e^2/2r^2$

**Answer:C**

Solution:From Bohr's derivation:

Total energy E= $E = -\frac{ke^2}{2r}(in CGS, k = 1, So E = -\frac{e^2}{2r})$

3. Which one of the following statement is ***not*** correct ?

A) $E_n = -13.6 \frac{Z^2}{n^2}$ eV / atom as the value of n increases , energy of an electron in the orbit increases.

B) The angular momentum of the electron in the ground state hydrogen atom is equal to $\frac{h}{\pi}$

C) The angular momentum of the electron in the ground state hydrogen atom is equal to $\frac{h}{2\pi}$

D) The radius of first Bohr orbit of hydrogen atom is $2.116 \times 10^{-8}$ cm.

**Answer:B**

Solution:Angular momentum in ground state $= \frac{h}{2\pi}$

4. Which of the following electronic transition in a hydrogen atom will require the largest amount of energy

A) From n=1 to n=2 B) from n= 2 to 3

C) From n=$\infty$ to 1 D) From n= 3 to n= 5

**Answer:A**

Solution:

$$\Delta E = |E_f - E_i| = 13.6(\frac{1}{n_i^2} - \frac{1}{n_f^2})eV$$

$$A) From n = 1 to n = 2 : \Delta E_A = 13.6\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 13.6\left(1 - \frac{1}{4}\right) = 13.6\left(\frac{3}{4}\right) = 10.2eV$$

$$B) From n = 2 to n = 3 : \Delta E_B = 13.6\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 13.6\left(\frac{1}{4} - \frac{1}{9}\right) = 13.6\left(\frac{5}{36}\right) \approx 1.89 eV$$

C) From n=infinity to n=1:
This is an emission transition, where the electron moves from a higher energy level to a lower one, releasing energy. This option does not require energy.

$$\Delta E_D = 13.6(\frac{1}{3^2} - \frac{1}{5^2}) = 13.6(\frac{1}{9} - \frac{1}{25}) = 13.6(\frac{16}{225}) \approx 0.97eV$$

Comparing the calculated energy values, the transition from n=1 to n=2 requires the largest amount of energy, 10.2 eV.

5. The minimum energy required to excite a hydrogen atom from its ground state

A) $13.6\,eV$ B) $-13.6\,eV$ C) $3.4\,eV$ D) $10.2\,eV$

**Answer:D**

Solution: Minimum energy to excite hydrogen from ground state (to n=2) =

$$E_2 - E_1 = -3.4 - (-13.6) = 10.2eV$$

6. Hydrogen electron is excited from the 1st shell to the 2nd shell. The maximum number of possibilities that the electron is present with different spin values, and with different orientations of the orbitals

A) 1 B) 2 C) 4 D) 8

**Answer:D**

Solution:For n=2 orbitals: 2s (1 orbital) + 2p (3 orbitals) = 4 spatial orbitals. Each orbital can have 2 spin states $\rightarrow$4×2=8 possibilities

7. The energy difference between the states of n = 2 and n = 3 is 'E' eV in Hydrogen atom. The ionization potential of H atom is

A) 3.2 E B) 7.2 E C) 5.6 E D) 13.2 E

**Answer:B**

Solution:

Let $\Delta E_{2\rightarrow 3} = E. We have$

$$\Delta E_{2\rightarrow 3} = 13.6(\frac{1}{4} - \frac{1}{9}) = 13.6\frac{5}{36} = \frac{17}{9} eV$$

Ionization potential = 13.6 eV = $\frac{13.6}{17/9}E = 7.2E$

8. The minimum energy (numerical value) required to be supplied to H-atom to

push its electron from 2nd orbit to the 3rd orbit

**(FA & SA- 3 Marks / 4 Marks)**

A) $1.9\,eV$ B) $2.2\,eV$ C) $2.7\,eV$ D) $7.0\,eV$

**Answer: A**

Solution:Minimum energy to push electron from n=2 to n=3

$$E = 13.6(\frac{1}{4} - \frac{1}{9}) = 13.6 \times \frac{5}{36} \approx 1.888\,eV \approx 1.9\,eV$$

9. The ionization energy of the ground state of hydrogen atom is $2.18 \times 10^{-18}\,J$. The energy of an electron in its second orbit would be

**(FA & SA- 5 Marks/8 Marks)**

A) $-1.09 \times 10^{-18}\,J$ B) $-2.18 \times 10^{-18}\,J$ C) $-4.36 \times 10^{-18}\,J$ D) $-5.45 \times 10^{-19}\,J$

**Answer:D**

Solution:Ionization energy = $2.18 \times 10^{-18}\,J$, find energy in second orbit

Ionization energy = $E_\infty - E_1 = 0 - E_1 = -E_1$

So $E_1$=- $2.18 \times 10^{-18}\,J$

For hydrogen-like atoms: $E_n = \frac{E_1}{n^2}$

For n=2: $E_2 = \frac{-2.18 \times 10^{-18}}{4} = -5.45 \times 10^{-19}\,J$

10. The velocity of an electron in the first Bohr orbit of hydrogen atom is $2.19 \times 10^6\,ms^{-1}$. Its velocity in the second orbit would be

A) $1.10 \times 10^6\,ms^{-1}$ B) $4.38 \times 10^6\,ms^{-1}$ C) $5.5 \times 10^5\,ms^{-1}$ D) $8.76 \times 10^6\,ms^{-1}$

**Answer:A**

Solution:In Bohr model: $v_n \propto \frac{1}{n}$

$$So v_2 = \frac{v_1}{2} = \frac{2.19 \times 10^6}{2} = 1.095 \times 10^6\,m/s \approx 1.10 \times 10^6\,m/s$$

## JEE ADVANCED LEVEL QUESTIONS

**Multi correct answer type:**

1. Which of the following statements are wrong
   1. If the value of l = 0, the electron distribution is spherical
   2. The shape of orbital is given by magnetic quantum number

3. Angular momentum of 1s,2s,3s electreons are equal
4. In an atom all electrons travel with the same velocity in an orbit

**Answer:2,4**

Solution:(1) If l=0, electron distribution is spherical — True (s orbital).
(2) Shape of orbital is given by magnetic quantum number — False; shape is determined by l, $m_l$ gives orientation.
(3) Angular momentum of 1s, 2s, 3s electrons are equal — True; for s orbitals, orbital angular momentum = 0 for all.
(4) In an atom all electrons travel with the same velocity in an orbit — False; different orbits have different velocities.

2. According to Bohr's theory, which of the following quantities can take up only discrete values

A) Kinetic energy B) Potential energy
C) Angular momentum D) Momentum

**Answer:A,B,C,D**

Solution:Bohr's model postulates that electrons can only occupy certain discrete energy levels around the nucleus, and this leads to the quantization of their angular momentum, which in turn determines their kinetic and potential energies as well.

**Assertion and Reason Type:**

A) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
B) Both Assertion and Reason are true, but Reason is NOT the correct explanation for Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true

3. **Assertion** :Bohr's model could not explain even hydrogen spectrum obtained using high resolution spectroscopes.
**Reason** :Bohr's model ignored dual character of electron.

**Answer:A**

Solution:Assertion: Bohr's model could not explain even hydrogen spectrum obtained using high resolution spectroscopes.
True. Fine structure (splitting) due to electron spin and relativistic effects not explained by Bohr.

Reason: Bohr's model ignored dual character of electron.
True. Bohr treated electron as a particle in fixed orbits, not as a wave.

Is the reason the correct explanation?
Yes — ignoring wave nature meant no wave mechanics, so failed for high-resolution spectra.

4. **Assertion** :Energy of radiation is large if it's wave length is large
**Reason** :Energy is equal to hv

**Answer:D**

Solution:Assertion: Energy of radiation is large if its wavelength is large. False.

$E=h\upsilon=hc/\lambda$, so large $\Rightarrow$ small E.

Reason: Energy is equal to $h\upsilon$--> True.

Assertion false, reason true

5. **Assertion** :The angular momentum of an electron in an atom is quantised
**Reason** :In an atom only those are orbits are permitted in which angular momentum of the electron is whole number mulptiple of $h/2\Pi$

**Answer:A**

Solution:Bohr's quantization postulate: $L = n\dfrac{h}{2\pi}$

This exactly matches the Reason.

**Integer type:**

6. Difference between $n^{th}$ and $(n + A)^{th}$ Bohr's radius of H–atom is equal to its $(n – A)^{th}$ Bohr's radius. The value of n is

**Answer:4**

Solution:

$$(n+A)^2 - n^2 = (n-A)^2$$
$$n^2 + A^2 + 2nA - n^2 = n^2 + A^2 - 2nA$$
$$n^2 = 4nA$$
$$n = 4A$$

7. No. of wave in third Bohr's orbit of hydrogen is

**Answer:3**

Solution:

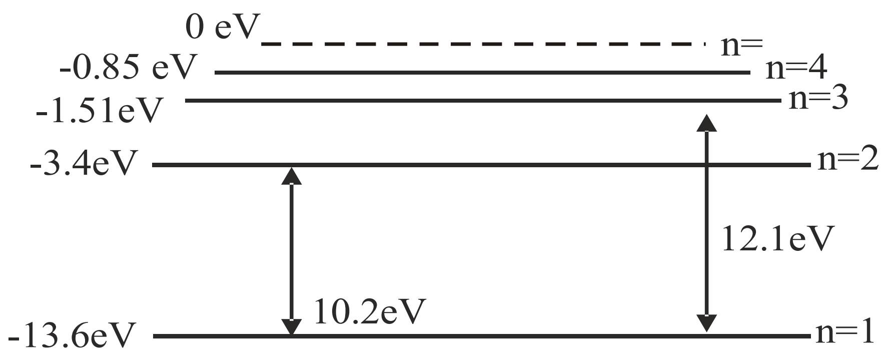
The number of standing waves along orbit is equal to principal quantum number n.

In Bohr's model: circumference = integer multiple of wavelength: $2\pi r_n = n\lambda$

For third orbit (n=3): number of waves = 3

**Comprehension Type:**

The gap between two orbits is proportional to the energy difference of the orbits.




Energy level diagram of H-atom

8. Which of the following statement is correct
   A) Ionisation energy of $Li^{2+}$ ion = -122.4eV
   B) Ground state of $He^{+}$ ion = -54.4eV
   C) Ionisation energy of $He^{+}$ ion = -54.4eV
   D) All the above

**Answer:B**

Solution:B) Ground state of $He^{+}$ ion = -54.4 eV
   Z=2, n=1:$E_1$ =-13.6×4=-54.4 eV

9. Binding energy of ground state of an atom or ion is equal to
   A) Excitation energy of an atom or ion
   B) Ionisation Energy of an atom or ion
   C) Both A & B
   D) None

**Answer:B**

Solution:Binding energy of ground state = energy required to remove electron from ground state to infinity = Ionisation Energy.

Not equal to excitation energy (that's to a higher orbit, less than IE).

**Matrix Matching Type:**

10.

| **List - I** | **List - II** |
|---|---|
| A) Energy | 1) $\frac{2\pi z e^2}{nh}$ |
| B) Velocity | 2) $\frac{-2\pi^2 m z^2 e^4}{n^2 h^2}$ |
| C) Rydberg constant | 3) $\frac{2\pi^2 m z^2 e^4}{h^3 c}$ |
| D) Radius | 4) $\frac{n^2 h^2}{4\pi^2 m z e^2}$ |

5) $\dfrac{-4\pi^2 mz^2\ e^4}{n^2\ h^2}$

**Answer:A-2,B-1,C-3,D-4**

Solution:

A) Energy — 2) $\dfrac{-2\pi^2\ mz^2\ e^4}{n^2h^2}$

B) Velocity — 1) $\dfrac{2\pi ze^2}{nh}$

C) Rydberg constant — 3) $\dfrac{2\pi^2\ mz^2\ e^4}{h^3c}$

D) Radius — 4) $\dfrac{n^2\ h^2}{4\pi^2 mz\ e^2}$

# KEY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | TEACHING TASK | | | | | |
| | | | JEE MAINS LEVEL QUESTIONS | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| C | D | B | B | B | D | C | A | C | C |
| 11 | 12 | 13 | 14 | | | | | | |
| A | D | B | A | | | | | | |
| | | | JEE ADVANCED LEVEL QUESTIONS | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| A,B,C,D | A,C | A | C | A | A | Ans:9/16 | 2 | A-4,B-2,C-1,D-3 | |
| | | | | LEARNERS TASK | | | | | |
| | | | CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's) | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| C | D | C | C | A | B | A | B | D | D |
| 11 | 12 | | | | | | | | |
| D | A | | | | | | | | |
| | | | JEE MAIN LEVEL QUESTIONS | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A | C | B | A | D | D | B | A | D | A |
| | | | JEE ADVANCED LEVEL QUESTIONS | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| B,D | A,B,C,D | A | D | A | 4 | 3 | B | B | |
| 10 | | | | | | | | | |
| A-2,B-1,C-3,D-4 | | | | | | | | | |