ATOMIC STRUCTURE

1. The number of orbitals associated with quantum numbers n = 5, $m_s = +\frac{1}{2}$ is :

(1) 11 (2) 25 (3) 15 (4) 50

2. For the Balmer series in the spectrum of H atom, $\bar{\nu} = R_H\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\}$, the correct statements among (I) and (IV) are :

(I) As wavelength decreases, the lines in the series converge

(II) The integer n_1 is equal to 2

(III) The lines of longest wavelength corresponds to $n_2 = 3$

(IV) The ionization energy of hydrogen can be calculated from wave number of these lines

(1) (II), (III), (IV)
(2) (I), (II), (III)
(3) (I), (III), (IV)
(4) (I), (II), (IV)

3. The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is :

(1) $\frac{4a_0}{9}$ (2) $\frac{2a_0}{9}$

(3) $\frac{2a_0}{3}$ (4) $\frac{4a_0}{3}$

4. The de Broglie wavelength of an electron in the 4th Bohr orbit is :

(1) $8\pi a_0$ (2) $2\pi a_0$

(3) $4\pi a_0$ (4) $6\pi a_0$

5. The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series of He^+ is :-

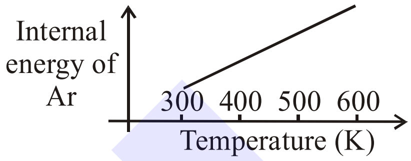
(1) $\frac{5\lambda_1}{9}$ (2) $\frac{27\lambda_1}{5}$ (3) $\frac{9\lambda_1}{5}$ (4) $\frac{36\lambda_1}{5}$

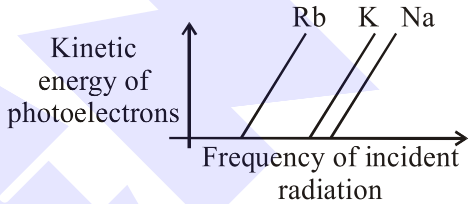
6. The difference between the radii of 3rd and 4th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3rd and 4th orbits of He^+ is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :

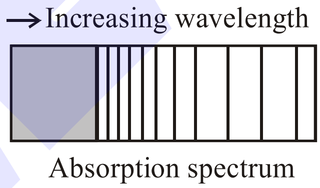
(1) 8 : 3 (2) 3 : 2

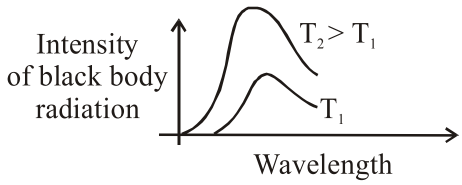
(3) 3 : 8 (4) 2 : 3

7. The figure that is not a direct manifestation of the quantum nature of atoms is :

(1)


(2)


(3)


(4)


8. The work function of sodium metal is 4.41×10^{-19} J. If the photons of wavelength 300 nm are incident on the metal, the kinetic energy of the ejected electrons will be ________ $\times 10^{-21}$ J.

($h = 6.63 \times 10^{-34}$ Js; $c = 3 \times 10^8$ m/s)

SOLUTION

1. NTA Ans. (2)

Sol. No. of orbitals = $n^2 = 5^2 = 25$

For n = 5, no. of orbitals = n^2 = 25

Total number of orbitals is equal to no. of electrons having $m_s = \frac{1}{2}$

2. NTA Ans. (2)

Sol. For balmer : $n_1 = 2$, $n_2 = 3, 4, 5, \dots \infty$

$$\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda_{longest}} = R_H\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

Ans.(2)

3. NTA Ans. (4)

Sol. $r_n = \frac{n^2 \times a_0}{z}$

For 2nd Bohr orbit of Li^{+2}

n = 2

z = 3

$$\Rightarrow r_n = \frac{2^2 \times a_0}{3} = \frac{4a_0}{3}$$

4. NTA Ans. (1)

Sol. $2\pi r = n\lambda$

for $n = 1, r = a_0$

$n = 4, r = 16a_0$

So, $2\pi \times 16a_0 = 4 \times \lambda$

$\lambda = 8\pi a_0$

5. Official Ans. by NTA (3)

Sol. As we know $\Delta E = \frac{hc}{\lambda}$

So $\lambda = \frac{hc}{\Delta E}$ for λ minimum i.e.

shortest; ΔE = maximum

for Lyman series n = 1 & for ΔE_{max}

Transition must be form n = ∞ to n = 1

So $\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$\frac{1}{\lambda} = R_H Z^2 (1-0)$$

$$\frac{1}{\lambda} = R \times (1)^2 \Rightarrow \lambda_1 = \frac{1}{R}$$

For longest wavelength ΔE = minimum for Balmer series n = 3 to n = 2 will have ΔE minimum

for He^+ Z = 2

So $\frac{1}{\lambda_2} = R_H \times Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$\frac{1}{\lambda_2} = R_H \times 4\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\frac{1}{\lambda_2} = R_H \times \frac{5}{9}$$

$$\lambda_2 = \lambda_1 \times \frac{9}{5}$$

6. Official Ans. by NTA (4)

Sol. $$\frac{\Delta R_1}{\Delta R_2} = \frac{(r_4 - r_3)_{4^{2+}}}{(r_4 - r_3)_{He^+}} = \frac{\frac{4^2}{3} - \frac{3^2}{3}}{\frac{4^2}{2} - \frac{3^2}{2}} = \frac{7/3}{7/2} = \frac{2}{3}$$

7. Official Ans. by NTA (1)

8. Official Ans. by NTA (222.00)

Sol. $E = W + K{\cdot}E_{max}$

$K{\cdot}E_{max} = E - W$

$$= \frac{hc}{\lambda} - 4.41 \times 10^{-19}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{300 \times 10^{-9}} - 4.41 \times 10^{-19}$$

$= 2.22 \times 10^{-19}$ J

$= 222 \times 10^{-21}$ J