Mod-2 and Mod-3

***Option in bold letters is the answer**

Q1. Which one of the following is incrrect about Thomson's atomic model

(a) J.J. Thomson gave the first idea regarding structure of atom.

(b) An atom is a solid sphere in which entire positive charge and it's mass is uniformly distributed and in which negative charge (i.e. electrons) are embedded like seeds in watermelon.

(c) This model explained successfully the phenomenon of thermionic emission, photoelectric emission and ionization

(d) This model explains the scattering of α-particles, and the origin of spectral lines observed in the spectrum of hydrogen and other atoms.

Q2. Rutherford's α-particle experiment showed that the atoms have

(a) Proton **(b) Nucleus** (c) Neutron (d) Electrons

Q3. Which one of the following is incrrect about Rutherford's Atomic Model

(a) Most of the mass (at least 99.95%) and all of the charge of an atom is concentrated in a very small region called atomic nucleus.

(b) Nucleus is positively charged and it's size is of the order of $10^{-10}\ m \approx$ 1fermi.

(c) the nucleus occupies only about 10^{-15} of the total volume of the atom or less.

(d) In an atom there is maximum empty space and the electrons revolve around the nucleus in the same way as the planets revolve around the sun.

Sol. Nucleus is positively charged and it's size is of the order of 10^{-15} m ≈ 1fermi.

Q4. In any Bohr orbit of the hydrogen atom, the ratio of kinetic energy to potential energy of the electron is

(a) 1/2 (b) 2 **(c) -1 / 2** (d) -2

Sol. (c) $\Rightarrow K = -\frac{U}{2} \Rightarrow \frac{K}{U} = -\frac{1}{2}$

Q5. The spectral series of the hydrogen spectrum that lies in the ultraviolet region is the

(a) Balmer series (b) Pfund series (c) Paschen series **(d) Lyman series**

Q6. The ratio of the energies of the hydrogen atom in its first to second excited state is

(a) 1/4 (b) 4/9 **(c) 9/4** (d) 4

Sol. **(c)** First excited state i.e., second orbit (n = 2)

Second excited state i.e., third orbit (n = 3)

$\because\ E = -\frac{13.6}{n^2} \Rightarrow \frac{E_2}{E_3} = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$

Q7. An electron jumps from the 4th orbit to the 2nd orbit of hydrogen atom. Given the Rydberg's constant $R = 10^5\ cm^{-1}$. The frequency in Hz of the emitted radiation will be

(a) $\frac{3}{16} \times 10^5$ (b) $\frac{3}{16} \times 10^{15}$ **(c) $\frac{9}{16} \times 10^{15}$** (d) $\frac{3}{4} \times 10^{15}$

Sol. **(c)**

$$\nu = RcZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 10^5 \times 3 \times 10^{10} \times 1^2 \times \left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{9}{16} \times 10^{15}\ Hz$$

Q8. Ratio of the wavelength of first line of Lyman series and first line of Paschen sereis is

(a) 1 : 3 (b) 27 : 144 (c) 5 : 27 **(d) 7 : 108**

Sol. **(c)**

$$\lambda_{max} = \frac{n^2(n+1)^2}{(2n+1)R} \Rightarrow \lambda_{\max(L)} = \frac{1^2(1+1)^2}{(2\times1+1)R}$$

$$\Rightarrow \lambda_{\max(L)} = \frac{4}{3R} \ldots (1)$$

$$\lambda_{max} = \frac{n^2(n+1)^2}{(2n+1)R} \Rightarrow \lambda_{\max(P)} = \frac{3^2(3+1)^2}{(2\times3+1)R}$$

$$\Rightarrow \lambda_{\max(P)} = \frac{144}{7R} \ldots\ldots (2)$$

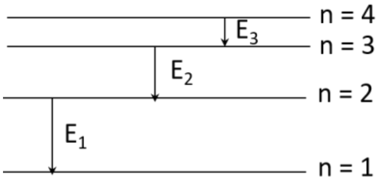
$$\frac{(1)}{(2)} \Rightarrow \frac{\lambda_{\max(L)}}{\lambda_{\max(P)}} = \frac{\frac{4}{3R}}{\frac{144}{7R}} \Rightarrow \frac{\lambda_{\max(L)}}{\lambda_{\max(P)}} = \frac{4}{3R} \times \frac{7R}{144} = \frac{7}{108}$$

Q9. With the increase in principal quantum number, the energy difference between the two successive energy levels

(a) Increases **(b) Decreases**

(c) Remains constant (d) Sometimes increases and sometimes decreases

Sol. **(b)** $E_1 > E_2 > E_3$



Q10. A hydrogen atom (ionisation potential 13.6 eV) makes a transition from third excited state to first excited state. The energy of the photon emitted in the process is

(a) 1.89 eV **(b) 2.55 eV** (c) 12.09 eV (d) 12.75 eV

Sol. **(b)** First excited state i.e., second orbit (n = 2)

third excited state i.e., third orbit (n = 4)

Energy released

$$\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)e = 13.6 \times 1^2 \times \left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right] = \mathbf{2.55\ eV}$$