Assignment 3 Answer key

MCQs- Answers (1 mark)

1.(c)Ground state, n=1

Excited state, n=2

r proportional to n^2

$r2/r1 = 2^2/1^2$

r2/r1=4 =4:1

2. (c) 1:4:9

3. (c)10^{-12} cm

4. (b) 3.4 eV

5. (c)second line of balmer series

6. (a)K.E=-P.E/2

Assertion Reason - Answers (1 mark)

7. Correct Answer: C

8. Correct Answer: B

9. Correct Answer: B

Case Study based question – Answers (5 marks)

10. (I) b) -3.4 eV

(II) c) n = 1

(III) b) ionisation energy

(IV) The acronym LASER stands for Light Amplification by Stimulated Emission of Radiation.

(V) When the principal quantum number n = infinity then the corresponding state is having energy 0 eV. And this energy of atom is possible only when electron is totally removed from the nucleus and hence it goes to rest.

Short answer type questions (2M) – Answers

11. third excited state, n2 = 4, and n1 = 3, 2, 1 Hence there are 3 spectral lines.

Greater the energy lower the wavelength

12. For the first line in balmer series

$\lambda 1=R(1/2^2-1/3^2)=365R$

For second balmer line:

$4861=R(1/2^2-1/4^2)=163R$ Divide both equations:

$\lambda=4861\times 27/20=6562.35\ ^0A$

13. For shortest wavelength in the Balmer series: n1=2 n2=∞

$\lambda min=3.646\times 10^{-7}m=364.6$ nm**. This wavelength lies in the ultraviolet region**

14. $\boldsymbol{h\nu = \frac{hc}{\lambda} = (E_2 - E_1)}$

$$\boldsymbol{\lambda = \frac{h\nu}{(E_2 - E_1)}}$$

$$\boldsymbol{\lambda = \frac{6.63\times 10^{-34}\times 3\times 10^{8}}{[-0.85-(-3.4)]\times 6\times 10^{-19}}}$$

$$\boldsymbol{\lambda = 4.87\times 10^{-7}m}$$

This wavelength belongs to Balmer series.

15. Energy of electron in n=2 is 3.4eV

Energy ground state = -13.6eV

K.E. = - T.E.= +13.6eV

$E_n = \frac{x}{n^2}$

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

Energy of ground state x=-13.6eV.

P.E. = 2T.E. = -2 x 13.6 eV = -27.2 eV

<u>Short answer type questions (3M) – Answers</u>

16. (i) $L = \frac{nh}{2\pi}$ i.e. angular momentum and orbiting electron is quantized

According to de-Broglie hypothesis

linear momentum, $p = \frac{h}{\lambda}$

for circular orbit, $L = r_n p$ where r_n is radius of n^{th}orbit

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

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

$$\frac{r_n}{\lambda} = \frac{nh}{2\pi}$$

$$2\pi r_n = n\lambda$$

∴ circumference of permitted orbits are integral multiples of the wavelength λ

(ii)

$$E_C - E_B = \frac{hc}{\lambda_1} \quad ......(1)$$

$$E_B - E_A = \frac{hc}{\lambda_2} \quad .....(2)$$

$$E_C - E_A = \frac{hc}{3} \quad .....(3)$$

According to equations (1) and (2)

$$E_C - E_A = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} \quad ......(4)$$

Using equation (3) and (4), we get

$$\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$$

$$\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$$

Long answer type questions (5M) – Answers

17. (i) Limitations of Rutherford's atomic model are as follows:

(1) According to Rutherford's atomic model, the electron orbiting around the nucleus continuously radiates energy because of its acceleration, due to which the atom will not remain stable. So, Rutherford could not explain the stability of an atom.

(2) Since electron spirals inwards, its angular velocity and frequency change continuously, therefore it will emit a continuous spectrum. Therefore, this model could not explain the line spectra of hydrogen.

According to Bohr's model of hydrogen atom, Electron in an atom can revolve in certain stable orbits without emitting the energy. Energy is released or absorbed only when an electron jumps from one stable orbit to another stable orbit resulting in a discrete spectrum.

$$\frac{1}{\lambda} = R\left(\frac{1}{2^1} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda} = 1.1 \times 10^7 \left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\lambda = 656.3\ nm$$

(ii) From Bohr′s first postulate,

coloumb force F = centripetal force F_{cp}

$$\therefore \frac{Ze^2}{4\pi\varepsilon_0 r_n^2} = \frac{m_e v_n^2}{r_n}$$

$$v_n^2 = \frac{Ze^2}{4\pi\varepsilon_0 r_n m_e} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

according to Bohr’s second postulate,

$$m_e r_n v_n = \frac{nh}{2\pi}$$

$$m_e^2 r_n^2 v_n^2 = \frac{n^2 h^2}{4\pi^2}$$

$$v_n^2 = \frac{n^2 h^2}{4\pi^2 m_e^2 r_n^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

iv from equation (1) and (2)

$$\frac{n^2 h^2}{4\pi^2 m_e^2 r_n^2} = \frac{Ze^2}{4\pi\varepsilon_0 r_n m_e}$$

$$r_n = \frac{n^2 h^2 \varepsilon_0}{\pi m_e Z e^2}$$

$$r_n = \left(\frac{\varepsilon_0 h^2}{\pi m_e^2 z e^2} n^2\right)$$

this is the required equation for radius of n^{th} orbit.