ANSWERS Assignment 1

MCQs - Answers

1.(b) Angular momentum

2. (b)'r' is directly proportional to n^2

3.(b) $hv=E_f-E_i$

4. (b) $r=4\Pi E_0 \times h^2 / 4\pi^2 me^2$

5. (d) Balmer series

6. (b) kE=-E =-(-3.4)=3.4 eV

7. (b) Balmer

8. (d) 4 times

9. (c)orbiting electrons radiate energy

Assertion and Reason- Answers

10. Correct answer: A

11. Correct Answer: A

12. Correct Answer: A

13. Correct Answer: B

14. correct Answer D

Case Study Based question- Answers

15. (I) (d) Rydberg

(II) (b) His model is a modification of Rutherford atomic model.

(III) (c) For hydrogen like atoms

(IV) (b) It could not justify its stability

Short answer type questions (2M)- Answers

16. KE= 13.6 eV, PE= -27.2eV in the ground state

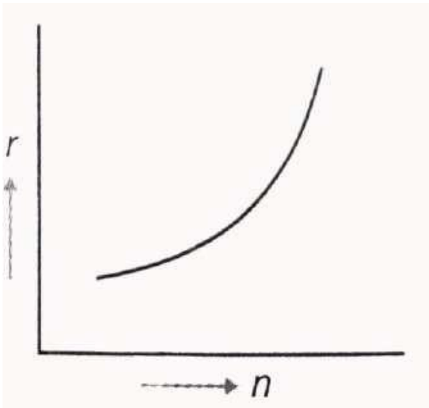
KE= 1.51 eV, PE = -3.02eV in the second excited state

17. Impact parameter perpendicular distance of the velocity vector of a-particle from the central line of the nucleus of the atom is called impact parameter (b).

for figure refer page no 115

$$b = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2 \cot \theta/2}{K}$$

18. Orbital radius is directly proportional to the square of principal quantum number



19. For n=1, r1 = 5.3x 10^{-11} m for ground state therefore r2 = 4 r1 , and r3= 9r1

r2 = 2.12x10^{-10}m r3= 4.77 x 10^{-10} m

λmin =3.646×10^{-7}m=364.6 nm**. This wavelength lies in the ultraviolet region**

20. Ionization energy: It is the minimum amount of energy required to remove an electron from the outermost orbit of an atom in its ground state.

$E_0 = \frac{me^4}{8s_0^2 h^2}$ i.e., E_0 a m

Therefore, ionization energy will become 200 times.

21. 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.

(ii) 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.

22. Kinetic Energy is given by the formula

$$\boldsymbol{E = \frac{13.6\ eV}{n^2} = \frac{13.6\ eV}{2^2} = \frac{13.6\ eV}{4}}$$

$= \mathbf{3.4 \times 1.6 \times 10^{-19}}\, \boldsymbol{J}$

De Broglie's wavelength,

$$\boldsymbol{\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31}E}} = 0.067\ nm}$$

23. 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,

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

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

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

iv from equation (1) and (2)

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

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

$$r_n = (\frac{{}_0 h^2}{\pi m_e^2 z e^2} n^2)$$

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

Short answer type questions (3M)- Answers

24. At closest approach, all K.E. of α-particles is completely converted into the P.E. of α-particle.

$$K.E. = 8MeV = 8 \times 10^6 \times 10^{-19} J.$$

K.E. is converted into P.E.

$$\frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze2e}{r_0} = 12.8 \times 10^{-13}$$

$$9 \times 10^9 \times \frac{80\times2\times16\times10^{-19}}{r_0} = 12.8 \times 10^{-13}$$

$$r_0 = \frac{9\times10^9\times160\times(1.6\times10^{-19})^2}{12.8\times10^{-13}} (m)$$

$$r_0 = \frac{9\times1.6\times1.6\times1.6\times10^{-14}}{12.8}$$

$$= 2.88 \times 10^{-14m}.$$

As we see that K.E.= $\frac{1}{4\pi\text{s}_0} . \frac{Ze2e}{r_0}$

$Hence,\quad K.E. \text{a} \frac{1}{r_0}$

If K.E. become twice, closest approach will be halved.

Hence, $r'_0 = \frac{r_0}{2}$

25. from Bohr's theory frequency of the radiation emitted when an electron de- excites from level n_2

to level n_1 is given as

$$f = \frac{2\pi^2 mk^2z^2e^4}{h^3} [\frac{1}{n_1^2} - \frac{1}{n_2^2}]$$

Given n_1 =n-1, n_2 =n

$$f = \frac{2\pi^2 mk^2z^2e^4}{h^3} \frac{2n-1}{(n-1)^2n^2}$$

For large n, 2n-1=2n, n-1=n and z=1

Thus, $f = \frac{4\pi^2 mk^2e^4}{n^3\ h^3}$

Which is same as orbital frequency of electron in n^{th} orbit

$$f = \frac{V}{2\pi r} =, \frac{4\pi^2 mk^2e^4}{n^3\ h^3}$$

Long answer question (5M) - Answers

26. $mvr = \frac{nh}{2\pi}$

$$\frac{mv^2}{r} = \frac{1}{4\pi\text{s}_0} \frac{e^2}{r^2}$$

$$r = \frac{e^2}{4\pi\text{s}_0 mv^2}$$

$$r = \frac{\text{s}_o n^2h^2}{\pi me^2}$$

P.E. $U = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r}$

$$= \frac{me^4}{4\varepsilon_0 n^2 h^2}$$

K.E. $= \frac{1}{2}\ mv^2 = \frac{1}{2}\ m\ \left(\frac{nh}{2\pi mr}\right)^2$

$$= \frac{n^2 h^2 \pi^2 m^2 e^4}{8\pi^2 m e_0^2 n^4 h^4}$$

K.E. $= \frac{me^4}{8\varepsilon_0^2 n^2 h^2}$

T.E. = K.E. + P.E.

$= -\frac{me^4}{8\varepsilon_0^2 n^2 h^2}$

(b) Rydberg formula for first member of Lyman series

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

$$\lambda = \frac{4}{3R}$$

For first member of Balmer Series

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

$$\lambda = \frac{36}{5R}$$