DRGP Institute

Chapter 12

Atoms

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BOARD:- 2013

1. Write any two postulation of Bohr model for H atom.

⇒ 1st Postulation - An electron in an atom could revolve in certain stable orbits without the emission of radiant energy.

2nd Postulation - Define stable orbits. According to this the e⁻ revolves around the nucleus only in those orbits for which angular momentum is integral multiple of $h/2\pi$

$$L = mvr = \frac{nh}{2\pi} \quad \{n = 1, 2, 3 \cdots\}$$

3rd postulation - when e⁻ jumps from higher energy level to lower energy level (from outer stationary orbit to inner stationary orbit) then e⁻ will emmit energy in form of EM radiation or photon.

$$E_{n_2} - E_{n_1} = h\nu$$

BOARD:- 2014

2. The energy in the lowest orbit of hydrogen atom is -13.6 eV in this condition find K.E & P.E of electron.

⇒ $K.E = -T.E$

$P.E = 2(T.E)$

$K.E = +13.6\ eV$ $\qquad P.E = 2 \times -13.6 = -27.2\ eV$

BOARD:- 2015

3. Ground state energy is -X eV, then find K.E.

⇒ $K.E = -T.E$

$K.E = X\ eV$

BOARD:- 2016

4. How much energy is required to excite H atom from its ground state to 2nd excited state?

⇒ Excitation Energy - The amount of energy required to jump e⁻ from ground state to any excited state is called Excitation energy.

1st E.E ⇒ $E_2 - E_1$

2nd E.E ⇒ $E_3 - E_1$

n^{th} E·E $\Rightarrow$ $E_{n+1} - E_1$

Solution -

$$E_n = -\frac{2.18 \times 10^{-18}}{n^2} J \quad \text{or} \quad \frac{-13.6}{n^2} eV$$

Ground state $\Rightarrow$ $n = 1$

$$E_1 = -13.6 \text{ eV}$$

2^{nd} excited state $\Rightarrow$ $n = 3$

$$E_3 = \frac{-13.6}{(3)^2} = -1.51 eV$$

$$\Delta E = E_3 - E_1$$
$$\Delta E = -1.51 - (-13.6)$$
$$\Delta E = 12.09 \text{ eV}$$

5. write two drawback of Rutherford model of the atom.

⇒ 1. According to EM wave theory, when charged particle like e^- move in circular path (Accelerated motion) emmits energy in form of EM radiation. So, e^- will loose energy continuously. Due to which radius of path of e^- continuously decrease. Hence, path of e^- become spiral and e^- will fall in Nucleus. So, no stability of atom.

2. According to Rutherford's model spectrum of atom should be continuous but experimentally we observed line spectrum. It means this model can't explain line spectrum.

BOARD:- 2017

6. write two limitation of Bohr's atomic model.

⇒ 1. The Bohr atomic model is applicable to H atom or H like atom such as He^+, Li^{+2} etc. It can't explain even 2 e^- atoms.

2. This model is unable to explain the relative intensities of the freequencies in spectrum.

BOARD:- 2018

No question from current syllabus

BOARD:- 2018 (Supp)

7. obtain expression of total energy of e^- in n^{th} orbital of H atom.

⇒

$$F_e = F_c$$
$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} = \frac{mv^2}{r}$$
$$mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} \quad -①$$

(i) K·E :-

$$K = \frac{1}{2}mv^2$$

put value from eq^n ①

$$K = \frac{1}{8\pi\varepsilon_0}\frac{e^2}{r}$$

(ii) P.E :- $U = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$

(iii) T.E :-

$$E = K + U$$

$$E = \frac{1}{8\pi\varepsilon_0}\frac{e^2}{r} - \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

$$E = \frac{1}{\pi\varepsilon_0}\frac{e^2}{r}\left(\frac{1}{8} - \frac{1}{4}\right)$$

$$E = \frac{e^2}{\pi\varepsilon_0 r}\left(\frac{1-2}{8}\right)$$

$$E = -\frac{e^2}{8\pi\varepsilon_0 r} \quad - (2)$$

W.K.T

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

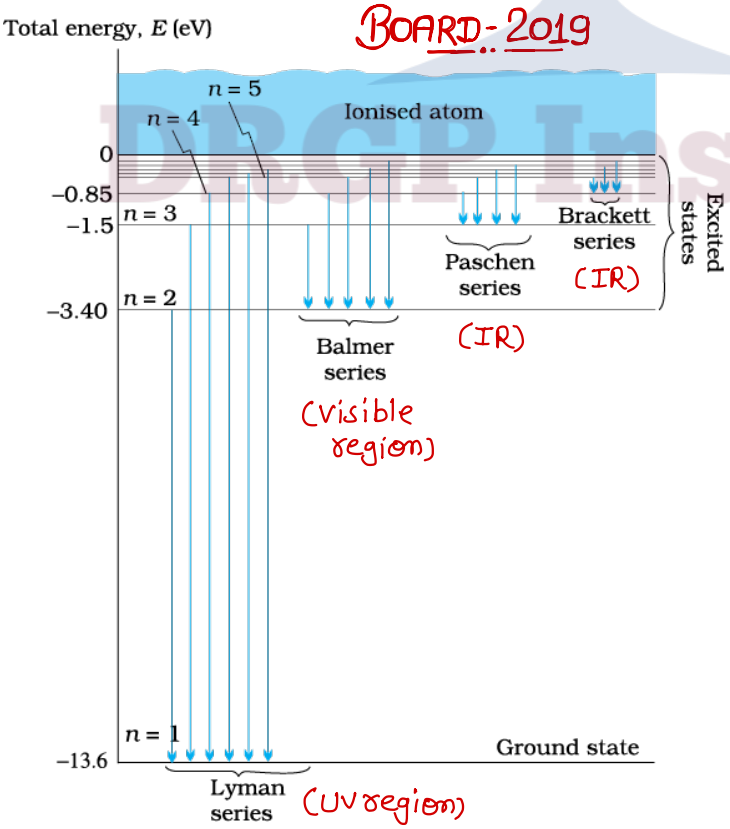
$$E = -\frac{e^2}{8\pi\varepsilon_0} \times \frac{\pi me^2}{n^2h^2\varepsilon_0}$$

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

$$E = -\frac{2.18 \times 10^{-18}}{n^2}\ J$$

$$\boxed{E = -\frac{13.6}{n^2}\ ev}$$

BOARD:- 2019



8. write name of series -

$n_2 = 2, 3, 4, 5 \cdots$

$n_1 = 1$

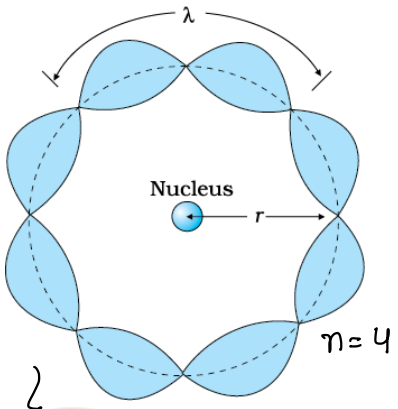
$\Rightarrow$ Lymen series.

9. write Bohr's postulation of H atom.

BOARD:- 2020

11. Explain Bohr's second postulation with the help of de Brogli hypothesis. Draw stationary wave model for e⁻ of orbit $n=3$.

⇒



According to de-Brogli, e⁻ moves in wave nature. The matter wave associated with e⁻ must be stationary/standing waves. (A wave in which energy doesn't propogate.

W.K.T

$$2\pi r = n\lambda$$
$$2\pi r = n\left(\frac{h}{mv}\right)$$

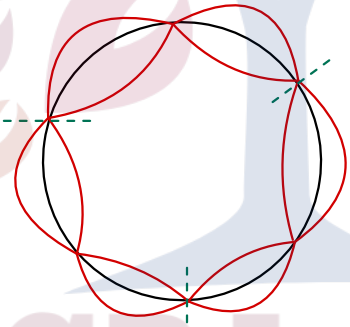
{ from de Brogli hypothesis $\lambda = \frac{h}{p} = \frac{h}{mv}$ }

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

⇓ ↳ Integral multiple of $h/2\pi$.

Angular momentum

→ This is Bohr's second postulation.



Stationary wave model for $n=3$.

BOARD:- 2021

11. The series of H-spectrum found in UV series Band.

⇒ Lymen series

BOARD:- 2022

No questions from current syllabus

BOARD:- 2023

12. The total energy in the lowest state of hydrogen atom is -13.6 eV in this condition find the Kinetic energy and potential energy of the electron.

⇒

$$K.E = -T.E$$
$$P.E = 2(T.E)$$

$$K.E = +13.6\ eV$$
$$P.E = 2(-13.6)$$
$$P.E = -27.2\ eV$$

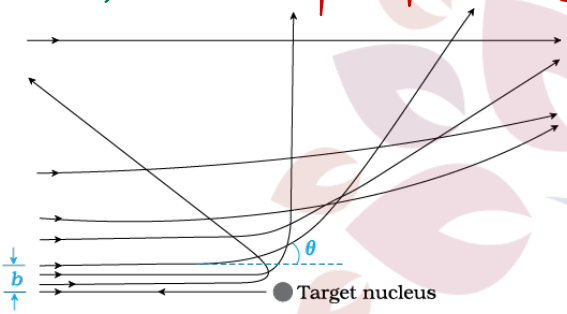
13. (i) Write two drawbacks of Rutherford's atomic model.
(ii) Name the range of hydrogen spectrum whose lines fall in the visible light region.

⇒ (i) ✓
(ii) Balmer Series

BOARD:- 2024

14. The value of scattering angle of α-particle for max. value of impact parameter is -
(a) 90° (b) 60° (c) 45° (d) 0°

⇒ Impact parameter - ⊥ distance b/w central line from nucleus & velocity of α-particle is called Impact parameter.



$$b = \frac{Ze^2 \cot(\theta/2)}{4\pi\varepsilon_0 (1/2 MV^2)}$$

$$b \propto \frac{1}{\text{Scattering Angle}}$$

if $\theta = 180°$ then $b = 0$
if $\theta = 0°$ then $b = max.$

15. The value of excitation energy required to bring an electron to the first excited state in H atom is -

⇒
$$E = \frac{-13.6}{n^2}$$

$n = 1$ Ground state
$E_1 = -13.6\ eV$
for 1st excited state - $n = 2$
$$E_2 = \frac{-13.6}{4} = -3.4\ eV.$$

$$\text{Excitation energy} = E_2 - E_1$$
$$= -3.4eV - (-13.6)eV$$
$$= -3.4eV + 13.6eV$$
$$= 10.2\ eV$$

16. If the radius of first orbital of H atom is 0.5×10^{-10} m, then the radius of its second orbit will be ..... m.

⇒
$$r_n = 0.529 \times \frac{n^2}{Z}\ A°$$

for H $Z = 1$ $n = 1$ $r_1 = 0.529\ A°$

$$r_n = r_1 n^2$$

But in question $r_1 = 0.5 \times 10^{-10} m$

$$r_2 = r_1 n^2$$
$$r_2 = (0.5 \times 10^{-10})(2)^2$$
$$r_2 = 2 \times 10^{-10} m$$
$$r_2 = 2 A^\circ$$

17. What is Ionisation Energy?

⇒ The amount of energy required to remove e^- completely from the atom is called Ionisation Energy.

$$I.E = -T.E = +13.6 \times \frac{Z^2}{n^2} eV$$

18. Explain the second postulation of Bohr's quantisation by de Broglie explanation.

Extra:- $v = 2.18 \times 10^6 \, Z/n \, m/s$

Best of Luck for Exam