IX-Class Foundation Plus.

Bohr's Theory and Hydrogen Spectrum.

TEACHING TASK.

JEE MAIN LEVEL.

1. B.

Solution.

Lyman series $n_1 = 1$

last line $n_2 = \infty$

$$\frac{1}{\lambda_1} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right].$$

$$\frac{1}{\lambda_1} = R_H\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$$

$$\frac{1}{\lambda_1} = R_H. \quad \text{——} (1).$$

Balmar series $n_1 = 2$

Second line in balmar $n_2 = \cancel{4}\ 4$

$$\frac{1}{\lambda_2} = R_H\left[\frac{1}{2^2} - \frac{1}{4^2}\right].$$

$$\frac{1}{\lambda_2} = R_H\left[\frac{1}{4} - \frac{1}{16}\right].$$

$$\frac{1}{\lambda_2} = R_H \frac{3}{16}. \quad \text{——} (2).$$

from (1) & (2) $\frac{1}{\lambda_2} = \frac{1}{\lambda_1} \times \frac{3}{16}$ $\Rightarrow$ $\boxed{\frac{16}{\lambda_2} = \frac{3}{\lambda_1}}$

1

2. c.

Last line in lyman series of H.

$n_1 = 1$, $n_2 = \alpha$.

$\nu_1 = K\left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right]Z^2$

$\nu_1 = KZ^2$ H $Z = 1$

$\nu_1 = K$ —— (1).

Last line Lyman series of He^+

$n_1 = 1$, $n_2 = \alpha$ $Z = 2$

$\nu_2 = K\left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right]2^2$

$\nu_2 = 4K$. — (2).

Last line Balmer series of He^+

$n_1 = 2$ $n_2 = \alpha$.

$\nu_3 = K\left[\frac{1}{2^2} - \frac{1}{\alpha^2}\right]2^2$

$\nu_3 = K$ —— (3).

from (1) (2) (3).

$$\boxed{\nu_2 = 4\nu_1}$$

3

3. c.

H: atom last line of lyman series.

$n_1 = 1, \quad n_2 = \alpha.$

$\cancel{\nu} \quad \nu = \frac{c}{\lambda}.$

$\nu_1 = R \cdot c \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right].$

$\nu_1 = RC \left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right].$

$\nu_1 = K \left[\frac{1}{1^2} - \frac{1}{0^2}\right].$

R, C are so constants. $= K.$

$\nu_1 = K \quad \text{——} (1).$

first line of lyman series $n_1 = 1, n_2 = 2$

$\cancel{\nu_2} =$

$\nu_2 = K \left[\frac{1}{1^2} - \frac{1}{2^2}\right].$

$\nu_2 = K \left[\frac{1}{1} - \frac{1}{4}\right].$

$\nu_2 = \frac{3K}{4} \quad \text{——} (2).$

Series limit of balmar Series

$n_1 = 2, \quad n_2 = \alpha.$

$\nu_3 = K \left[\frac{1}{2^2} - \frac{1}{\alpha^2}\right].$

$\nu_3 = \frac{K}{4} \quad \text{——} (3).$

$$\boxed{\nu_1 - \nu_2 = \nu_3.}$$

$K - \frac{3K}{4} = \frac{K}{4}$

2

4. C

$n_1 + n_2 = 4.$

$n_2 - n_1 = 2.$

$n_1 = 1 \quad , \quad n_2 = 3. \qquad Z = 3.$

$$\bar{\upsilon} = R_H\, Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right].$$

$$\bar{\upsilon} = R_H\, 3^2 \left[\frac{1}{1^2} - \frac{1}{3^2} \right].$$

$$\bar{\upsilon} = R_H\, 9 \left[1 - \frac{1}{9} \right].$$

$$\bar{\upsilon} = R_H\, 9 \left[\frac{8}{9} \right]$$

$$\boxed{\bar{\upsilon} = 8 R_H}$$

5. A.

$4 \rightarrow 3$
$3 \rightarrow 2$
$2 \rightarrow 1$
$4 \rightarrow 1$

4 differend photons emitted.

Maximum number of defferend photons emitted is 4.

4

6. B, C.

$$\frac{((n_2-n_1)\,(n_2-n_1)+1)}{2}$$

4^{th} exited state $n_2 = 5$.

2^{nd} state $n_1 = 2$.

$$\frac{(5-2)((5-2)+1)}{2}$$

$$\frac{3(4)}{2} = \frac{12}{2} = \underline{\underline{6}}.$$ different spectral lines observered.

3 lines belongs to balmer series.

$$\left.\begin{array}{l} 5 \longrightarrow 2 \\ 4 \longrightarrow 2 \\ 3 \longrightarrow 2 \end{array}\right\} \longrightarrow 3\text{ lines}.$$

5

7.

Lymar series of H atom. Shortest

$n_1 = 1$, $n_2 = \infty$

$$\frac{1}{\lambda_L} = R_H\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right].$$

$$\frac{1}{\lambda_L} = R_H. \quad \text{——— (1)}$$

Balmar series 1st line in H atom.

$n_1 = 2$, $n_2 = 3$.

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

$$\frac{1}{\lambda_B} = R_H\left[\frac{1}{4} - \frac{1}{9}\right].$$

$$\frac{1}{\lambda_B} = R_H \frac{5}{36} \qquad R_H = \frac{1}{\lambda_L}$$

$$\frac{1}{\lambda_B} = \frac{5}{36\lambda_L} \qquad \lambda_L = x.$$

$$\frac{1}{\lambda_B} = \frac{5}{36x}.$$

$$\boxed{\lambda_B = \frac{36x}{5}.}$$

8. C.

$n_1 = 2 \qquad n_2 = 5$

$n_2 - n_1 = 5 - 2 = 3.$

$n = 3.$

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

$\boxed{mvr. = \frac{3h}{2\pi}.}$

9. 12.15 ev (A.)

$n_2 = 4.$

$E = \frac{13.6.}{n^2.} = \frac{13.6}{4^2} = \frac{13.6}{16} = 0.85.$

$13 - 0.85 = \underline{\underline{12.15}}$ ev.

(7)

10. A.

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right].$$

$$\frac{1}{\lambda} = R.$$

$R = 1.097 \times 10^{7}\ m^{-1}$

$$\frac{1}{\lambda} = 1.097 \times 10^{7}.$$

$$\lambda = \frac{1}{1.09 \times 10^{7}}$$

$$\lambda = 0.9115 \times 10^{-7}.$$

$$= 9.115 \times 10^{-8}\ m$$

$1nm = 10^{-9} m.$

$$= 91\ nm.$$

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11. A.

Solⁿ

$$\nu = \frac{c}{\lambda}$$

$$\nu_{He^+} = \nu_{H}.$$

$$\frac{c}{\lambda_{He}} = \frac{c}{\lambda_H}$$

$$\frac{1}{\lambda_{He}} = \frac{1}{\lambda_H} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]2^2 = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] 1^2$$

$$R\left[\frac{1}{4} - \frac{1}{16}\right]4 = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{1} - \frac{1}{4} = \frac{1}{n_1^2} - \frac{1}{n_2^2} = \boxed{n_1 = 1,\ n_2 = 2.}$$

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MULTI ANSWER:-

1. A, B, D.

- Balmar series for marginal line.

$n_1 = 2, \quad n_2 = \infty$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right].$$

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

$$\frac{1}{\lambda} = R_H\left[\frac{1}{4} - \frac{1}{0}\right].$$

$$\frac{1}{\lambda} = \frac{R_H}{4}$$

$$\boxed{\lambda = \frac{4}{R_H}}$$

- Lyman series Last line $n_2 = \infty$. $n_1 = 1$

$$\boxed{\infty \longrightarrow 1}$$

- for humphry series $n_1 = 6, \quad n_2 = 7, 8, 9 \ldots$

2. B.

only B i.e 1^{st} line of Lyman series

$= 2 \rightarrow 1$ not $3 \rightarrow 1$

STATEMENT TYPE

3. B.

Wave number of spectral line for an electr-megnetic transition is quantised.

- Wave number of electron $\bar{\nu}$

according to De-Broglie $\lambda = \frac{h}{mv}$

$$\frac{1}{\lambda} = \frac{mv}{h} \qquad \frac{1}{\lambda} = \bar{\nu}$$

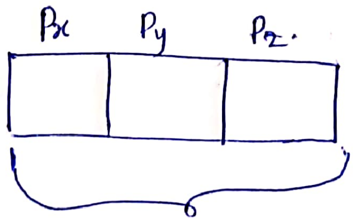
$$\bar{\nu} = \frac{mv}{\lambda} \quad \therefore \boxed{\bar{\nu} \propto v}$$

4. Both Incorrect.

$2P_z \longrightarrow 2P_y$. Spectral line will not form

because these two are degenerate orbitals.

there is no defference in their energies.



Degenerate orbitals.

COMPREHENSION TYPE

×

5. C

1.

Spectral Line belongs to Balmer series

$n_1 = 2, \quad n_2 = 3.$ H_α line. [1st line] of He^+

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]Z^2$$

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right].2^2$$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right]4$$

$$\frac{1}{\lambda} = R\left[\frac{5}{36}\right].4$$

$$\frac{1}{\lambda} = \frac{20R}{36}$$

$$\lambda = \frac{36}{20 \times 109677 \ cm^{-1}}$$

$$\lambda = \frac{36}{2193540}$$

$$\lambda = 0.0001226 \ cm$$

$$\lambda = \frac{0.0001226 \times 10^9}{100} \ nm.$$

$\boxed{\lambda = 1226 \ nm}$ $\boxed{\text{Visible rang } 400 \text{ to } 700 \ nm}$

2.

In the Balmer series of H-atom maximum lines are in UV region is wrong because maximum lines in visible region.

3.

2nd line of Lyman series of He^+

$n_1 = 1, \quad n_2 = 3.$

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{3^2}\right] 2^2$$

$$\frac{1}{\lambda} = R\left[\frac{8}{9}\right]4 = \frac{32R}{9}$$

$$\lambda = \frac{9}{32 \times 109677} = 2.564 \times 10^{-6} \text{ cm.}$$

$$E = \frac{hc}{\lambda} \qquad h = 6.62 \times 10^{-34} \text{ J.s}, \quad c = 3 \times 10^{8} \text{ m/s}$$

$$\lambda = \frac{2.564 \times 10^{-6}}{100} \text{ m.} = 2.564 \times 10^{-8}$$

$$E = \frac{6.625 \times 10^{-34} \text{ J.}\cancel{s} \times 3 \times 10^{8} \cancel{m}/\cancel{s}}{2.564 \times 10^{-8} \cancel{m}}$$

$$E = 7.75 \times 10^{-18} \text{ J}$$

$$1 \text{J} = 6.242 \times 10^{18} \text{ eV}$$

$$E = 7.75 \times \cancel{10^{-18}} \times 6.242 \times \cancel{10^{18}}$$

$$\boxed{E = 48.3755 \text{ eV}}$$

6. C

wave number of first line in Paschen series of Be^{+2} is

$n_1 = 3, \quad n_2 = 4, \quad Z = 4$

$$\bar{\nu} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] Z^2$$

$$\bar{\nu} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] 4^2$$

$$\bar{\nu} = R\left[\frac{1}{9} - \frac{1}{16}\right] 16$$

$$\bar{\nu} = R\left[\frac{16-9}{144}\right] 16.$$

$$\bar{\nu} = R\left[\frac{7}{144}\right] 16.$$

$$\bar{\nu} = \frac{7 \times R \times \cancel{16}\,1}{\cancel{144}\,9}$$

$$\boxed{\bar{\nu} = \frac{7R}{9}}$$

INTEGER TYPE

16.

The wave length of marginal line of Brackett series

$n_1 = 4, \quad n_2 = \infty.$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{4^2} - \frac{1}{\infty^2}\right]$$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{16} - \frac{1}{0}\right].$$

$$\frac{1}{\lambda} = \frac{R_H}{16}.$$

$$\boxed{\lambda = \frac{16}{R_H}}$$

where $x = 16.$

8. 3.

For Balmar series longest wave length means minimum Energy.

$$n_1 = 2 \ , \quad n_2 = 3.$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{9-4}{36}\right]$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{5}{36}\right]$$

$$\lambda_1 = \frac{1}{RZ^2} \times \frac{36}{5} \quad \text{——} \ (1).$$

for Lyman Series longest wave length when electron Jumps from $n_1 = 1$, $n_2 = 2$.

$$\frac{1}{\lambda_2} = RZ^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$\frac{1}{\lambda_2} = RZ^2\left[1 - \frac{1}{4}\right]$$

$$\frac{1}{\lambda_2} = RZ^2\left[\frac{4-1}{4}\right]$$

$$\frac{1}{\lambda_2} = RZ^2 \times \frac{3}{4}$$

$$\lambda_2 = \frac{1}{RZ^2} \times \frac{4}{3} \quad \text{——} \ (2)$$

$$\lambda_1 - \lambda_2 = \frac{1}{Rz^2}\left(\frac{36}{5} - \frac{4}{3}\right) = 59.3 \times 10^{-9}\,m$$

$$\frac{1}{Rz^2} \times \frac{(108 - 20)}{15} = 59.3 \times 10^{-9}\,m.$$

$$\frac{1}{Rz^2} \times \frac{88}{15} = 59.3 \times 10^{-9}\,m.$$

$$R = 109677\ cm^{-1} = 109677 \times 10^{2}\ m^{-1}$$

$$z^2 = \frac{88}{15} \times \frac{1}{R \times 59.3 \times 10^{-9}\,m}$$

$$= \frac{88}{15} \times \frac{1}{109677 \times 10^{2} \times 59.3 \times 10^{-9}}$$

$$= \frac{88}{9.76}.$$

$$z^2 = 9.01$$

$$\boxed{z = 3}$$

9. 0

No spectral lines observed. because

in Balmer series of He^+ ion

first line means longest wave length

1226 nm.

And last line means shortest wavelength

91.17 nm.

MATRIX MATCHING TYPE

10. A → r , B → s , C → p , D → q

A] Lyman series 2^{nd} line $n_1 = 1$, $n_2 = 3$.

$$\bar{\nu} = R\left[\frac{1}{1^2} - \frac{1}{3^2}\right] = R\left[1 - \frac{1}{9}\right] = \boxed{\frac{8R}{9}}$$

B] Balmer series 2^{nd} line $n_1 = 2$, $n_2 = 4$.

$$\bar{\nu} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = R\left[\frac{1}{4} - \frac{1}{16}\right] = \boxed{\frac{3R}{16}}$$

C] No. of spectral lines $= \frac{(n_2 - n_1)\left[(n_2 - n_1) + 1\right]}{2}$

$n_1 = 2$, $n_2 = 5$.

$$\frac{(5-2)\left[(5-2)+1\right]}{2} = \frac{3\left[3+1\right]}{2} = \frac{3(4)}{2} = \frac{12}{2} = 6.$$

D] maximum number of spectral lines observed - 2.

$$\left.\begin{array}{l} 3 \rightarrow 2 \\ 3 \rightarrow 1 \end{array}\right\} \text{2 - spectral lines.}$$

$(n-1)$ $3-1 = 2$

LEARNERS TASK.

CONCEPTUAL UNDERSTANDING Questions.

1. D.

$N = 4^{th}$ shell.

$4 \rightarrow 1 \rightarrow$ UV.

$4 \rightarrow 2 \rightarrow$ Visible

$4 - 3 \rightarrow$ IR.

2. A.

$n_1 = 2, \; n_2 = 3.$

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

$$\bar{\upsilon} = R_H \left[\frac{1}{4} - \frac{1}{9} \right].$$

$$\bar{\upsilon} = R_H \frac{5}{36}$$

$$\boxed{\bar{\upsilon} = \frac{5R}{36}}$$

3. B.

$$R_H = \frac{2\pi^2 z^2 m e^4 K^2}{Ch^3}.$$

$$\boxed{R_H \propto M}$$

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4. B.

$$R_H = \frac{2\pi^2 z^2 m e^4 k^2}{ch^3}$$

$$\boxed{R_H \propto Z^2}$$

Z = atomic number.

5. D.

$n_2 - n_1 = 2$ then its H_β line.

$4 - 2 = 2$

6. D.

Lyman series → UV, Balmer → Visible, etc.

7. A.

$n_1 = 2$, $n_2 = 3, 4, 5, 6 \ldots\ldots$

Balmer series.

8. B.

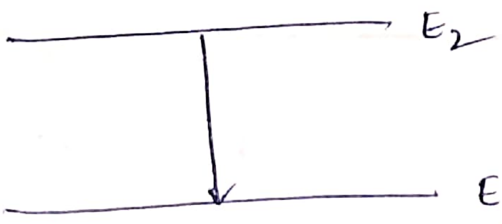
Balmer series visible lines appear

for Balmer series $n_1 = 2$, $n_2 = 3, 4, 5 \ldots$

9. A.

Lyman → UV radiation more energitic than others.

10. D.



$\Delta E = E_2 - E_1$

$\Delta E = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{\Delta E}$

$\boxed{\lambda \propto \Delta E}$

3

11. B.

If $n = 4$ 3 Spectral lines.

$4 \longrightarrow 1$

$3 \longrightarrow 1$ So $n-1$

$2 - 1$

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12. A.

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

$n = 5$

$$E = \frac{-13.6}{5^2} = \frac{-13.6}{25} = -0.54 \text{ ev}.$$

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13. C.

He^+ have one electron.

H ~~also~~ also have one electron.

14

14. C.

Balmer series of H is visible range $n_2 = 3, 4, 5 \ldots, n_1 = 2$

$$\left.\begin{array}{l} 5 \rightarrow 2 \\ 4 \rightarrow 2 \\ 3 - 2 \end{array}\right\} \text{— 3 lines.}$$

JEE MAINS LEVEL QUESTIONS.

1. D.

$$\bar{\upsilon} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] Z^2$$

$$\bar{\upsilon} \propto Z^2$$

$$\frac{\bar{\upsilon}_H}{Z_H^2} = \frac{\bar{\upsilon}_{Li}}{Z_{Li}^2}$$

$$\frac{15000}{1^2} = \frac{\bar{\upsilon}_{Li}}{3^2}$$

$$\bar{\upsilon}_{Li} = 9 \times 15000.$$

$$\boxed{\bar{\upsilon}_{Li} = 1.35 \times 10^5 \text{ cm}^{-1}}$$

2. A

$n_1 = 1,\ n_2 = \infty.$

$$\lambda_\alpha = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right].$$

$$\lambda_\alpha = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right].$$

$$\lambda_\alpha = R \quad \text{— (1)} \quad \text{Highest posible}$$

$n_1 = 1,\ n_2 = 2$

$$\lambda_1 = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right].$$

$$\lambda_1 = R\frac{3}{4}$$

$$\lambda_1 = \lambda_\alpha \frac{3}{4}$$

$$\boxed{\frac{\lambda_\alpha}{\lambda_1} = \frac{4}{3}}$$

3. B.

$n_1 = 1,\ n_2 = \infty.$

$$\bar{v} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\bar{v} = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right].$$

$$\boxed{\bar{v} = R}$$

4. C.

$n_1 = 1$, $n_2 = 2$.

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = R\left[\frac{1}{1} - \frac{1}{4}\right] = \frac{R3}{4}.$$

$$\frac{1}{\lambda} = \frac{3R}{4}.$$

$$E = \frac{hc}{\lambda}$$

$$\boxed{E = \frac{hc3R}{4}}$$

5. D.

$n_1 = 2$, $n_2 = 4$.

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{16}\right].$$

$$\frac{1}{\lambda} = R\left[\frac{3}{16}\right].$$

$$\frac{1}{\lambda} = \frac{3R}{16}.$$

$$\boxed{\lambda = \frac{16}{3R}}$$

6. A.

$$E_2 - E_1 = 12.75 - 13.6 = -0.85$$

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

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

$$n^2 = \frac{-13.6}{0.85}$$

$$n^2 = 16$$

$$n = \sqrt{16}$$

$$n = 4$$

$\left.\begin{array}{l} 4 \rightarrow 1 \\ 3 \rightarrow 1 \\ 2 \rightarrow 1 \end{array}\right\}$ lyman

3

$\left.\begin{array}{l} 4 \rightarrow 2 \\ 3 \rightarrow 2 \end{array}\right\}$ Balmer

2

$4 \rightarrow 3$ paschen

1

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7. D.

Red colour Indicates Visible region

So Balmer Series.

for Balmer series $n_1 = 2$, $n_2 = 3, 4, 5 \ldots$

8 C $3 \rightarrow 2$. Balmer series Visible quanta.

9. C.

$\lambda_{Li^{+2}} = \lambda_{He^+}$ of $2 \rightarrow 4$.

$\lambda_{He} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] 4.$

$\lambda_{He} = R\left[\frac{1}{4} - \frac{1}{16}\right].$

$\lambda_{He^+} = \frac{3R}{4}$ —— (1).

$\boxed{\frac{1}{\lambda_{He^+}} = \frac{3R}{4}} \leftarrow \frac{1}{\lambda_{Li}} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] 3^2$

$\cancel{R}\, 9\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = \frac{3\cancel{R}}{4}$

$\frac{1}{n_1^2} - \frac{1}{n_2} = \frac{\cancel{3}^1}{\cancel{36}_{12}} = \frac{1}{12} = \frac{4-1}{36}$

$3 \longrightarrow 6$

(19)

10. B.

7^{th} excited state $n_2 = 8$.

Paschen series : $n_1 = 3$.

$$\left.\begin{array}{l} 8 \longrightarrow 3 \\ 7 \longrightarrow 3 \\ 6 \longrightarrow 3 \\ 5 \longrightarrow 3 \\ 4 \longrightarrow 3 \end{array}\right\} 5$$

11. D

$n_2 = 6$. Infrared paschen series.

$n_1 = 3$.

$$\left.\begin{array}{l} 6 \longrightarrow 3 \\ 5 \longrightarrow 3 \\ 4 \longrightarrow 3 \end{array}\right\} \text{3 lines.}$$

12. D.

$3 \longrightarrow 2$

Balmar series

$n_1 = 2$ $n_2 = 3, 4, 5 \ldots$

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13. D.

1st Line of Balmer series. of Li^{+2}

$n_1 = 2, \quad n_2 = 3.$

$\bar{\upsilon}_1 = R Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\bar{\upsilon}_1 = R\, 3^2 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$\bar{\upsilon} = R \cdot 9 \left[\frac{1}{4} - \frac{1}{9}\right]$

$\bar{\upsilon} = R \cdot 9 \left[\frac{5}{36}\right]$ — (1).

Last line of paschen Series of Li^{+2}

$n_1 = 3, \quad n_2 = \infty$

$\bar{\upsilon}_2 = R\, 3^2 \left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$

$\bar{\upsilon}_2 = R \cdot 9 \left[\frac{1}{9}\right].$ — (2).

$\bar{\upsilon}_1 - \bar{\upsilon}_2$

$R \cdot 9 \left[\frac{5}{36}\right] - R \cdot 9 \left[\frac{1}{9}\right]$

$R \times 9 \left[\frac{5}{36} - \frac{1}{9}\right]$

$R \times 9 \left[\frac{5-4}{36}\right] = \frac{R9}{36} = \boxed{\frac{R}{4}}$

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14. C.

$$\left.\begin{array}{l} 5 \rightarrow 1 \\ 4 \rightarrow 1 \\ 3 \rightarrow 1 \\ 2 \rightarrow 1 \end{array}\right\}$$ four lines.

15. D.

0.52×10^{-8} cm. not 2.116×10^{-8} cm.

— . —

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ADVANCED LEVEL QUESTIONS.

MULTI CORRECT ANSWER TYPE

1. A, B.

A) mono chromic Radiation wave length 970.6 A°

then its energy is.

$$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} J.\cancel{s} \times 3 \times 10^{8} \cancel{m}/\cancel{s}}{970.6 \times 10^{-10} \cancel{m}}$$

$$= 0.02 \times 10^{-16} J$$

$$1J = 6.242 \times 10^{18} eV$$

$$0.02 \times 10^{-16} \times 6.242 \times 10^{18}$$

$$= 0.124 \times 10^{2} = 12.4 eV.$$

$n_1 = 1$ shell, $n_2 = 4$ shell

1^{st} shell energy is -13.6 eV

4^{th} shell energy is -0.85 eV

$$n_2 - n_1 = -0.85 - (-13.6)$$

$$-0.85 + 13.6. = \underline{\underline{12.75 \text{ eV}}}.$$

so electron Excite to 4^{th} shell.

13) Longest wave length of Spectral line.

4th Excited state to 3rd shell

$n_1 = 3, \quad n_2 = 4.$

$$\text{wave length} = \frac{912}{\frac{1}{n_1^2} - \frac{1}{n_2^2}}$$

$$= \frac{912}{\frac{1}{3^2} - \frac{1}{4^2}}$$

$$= \frac{912}{\frac{1}{9} - \frac{1}{16}} = \frac{912}{\frac{16-9}{144}} = \frac{912}{\frac{7}{144}}$$

$$\frac{912 \times 144}{7} = \frac{131328}{7} = 18761 \, A^\circ$$

$$1.8761 \times 10^4 \, A^\circ$$

STATEMENT TYPE

2. D.

Limiting line in Balmer series.

$$n_1 = 2, \quad n_2 = \infty$$

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right].$$

$$\frac{1}{\lambda} = \frac{R}{4}$$

$$\lambda = \frac{4}{R} = \frac{4}{109677.} = 3.64 \times 10^{-5}\ cm, \quad 36.4 \times 10^{-5}\ mm.$$

• Limiting line is obtained for a Jump of electron from $n = \infty$ to $n = 2$ for Balmer Series is Correct.

3. A.

Humphry Series has lowest energy radiation Among all series.

Lowest state for this series is 6

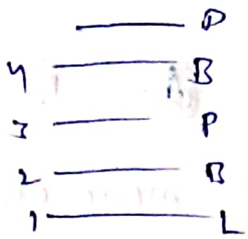
$$n_1 = 6, \quad n_2 = 7, 8, 9 \ldots\ldots$$

Advanced level Questions.

4. A.

for Brackett series

$$n_1 = 4, \quad n_2 = \infty$$



$$\frac{1}{\lambda_B} = R\left[\frac{1}{4^2} - \frac{1}{\infty^2}\right]$$

$$\frac{1}{\lambda_1} = \frac{R}{16} \quad \text{—} (1)$$

$$\boxed{R = \frac{16}{\lambda_1}}$$

2nd line of Lyman series

$$n_1 = 1, \quad \cancel{n_2 = 4}. \quad n_2 = 3.$$

$$\frac{1}{\lambda_2} = R\left[\frac{1}{1^2} - \frac{1}{3^2}\right].$$

$$\frac{1}{\lambda_2} = R\left[1 - \frac{1}{9}\right]$$

$$\frac{1}{\lambda_2} = R\left[\frac{8}{9}\right].$$

$$\frac{1}{\lambda_2} = \frac{8R}{9} \quad \text{—} (2)$$

from (1) & (2).

$$\frac{1}{\lambda_2} = \frac{8}{9} \times \frac{16}{\lambda_1}$$

$$\boxed{\frac{9}{\lambda_2} = \frac{128}{\lambda_1}}$$

5. c.

For Paschen series first line.

$n_1 = 3, \quad n_2 = 4 \qquad Be^{+3} \quad z = 4.$

$$\bar{\upsilon} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] z^2$$

$$\bar{\upsilon} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] 4^2$$

$$\bar{\upsilon} = R\left[\frac{1}{9} - \frac{1}{16}\right] 16.$$

$$\bar{\upsilon} = R\left[\frac{16-9}{144}\right] 16.$$

$$\bar{\upsilon} = R\left[\frac{7}{144}\right] 16.$$

$$\boxed{\bar{\upsilon} = \frac{7R}{9}}$$

INTEGER TYPE

6. 5.

$n_1 = 2, \quad n_2 = 3.$

$= R\left[\frac{1}{2^2} - \frac{1}{3^2}\right].$

$= R\left[\frac{1}{4} - \frac{1}{9}\right].$

$= R\left[\frac{9-4}{36}\right].$

$= \frac{R\,5}{36}.$

$\boxed{x = 5}$

7. 0

Zero Balmer lines of H-atom can be present within the wave length range 94.5 nm to 130 nm

Because Balmer series range is.

656.6 nm 1st line

364.8 nm Last line limit in Balmer series.

MATCHING TYPE

8. $A \rightarrow R$, $B \rightarrow S$, $C \rightarrow Q$, $D \rightarrow P$.

Solution

Shortest wave length Liman Series of H atom

$n_1 = 1$, $n_2 = \alpha$.

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right].$$

$$\frac{1}{\lambda} = R$$

$$\boxed{\lambda = \frac{1}{R}} \qquad \frac{1}{R} = x.$$

A) for Li^{+2}.

$n_1 = 1$, $n_2 = \alpha$, $Z = 3$.

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right]3^2$$

$$\frac{1}{\lambda} = 9R.$$

$$\lambda = \frac{1}{9R} \qquad \frac{1}{R} = x.$$

$$\boxed{\lambda = \frac{x}{9}}$$

B) Longest wave length in Lyman of Li^{+2}.

$n_1 = 1, \quad n_2 = 2, \quad Z = 3.$

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]3^2$$

$$\frac{1}{\lambda} = R\left[1 - \frac{1}{4}\right]3^2$$

$$\frac{1}{\lambda} = R\left[\frac{3}{4}\right]9$$

$$\frac{1}{\lambda} = \frac{27R}{4}$$

$$\lambda = \frac{4}{27R} \qquad \frac{1}{R} = x.$$

$$\boxed{\lambda = \frac{4x}{27}.}$$

c) Shortest wave Length in Balmer of Li^{+2}

$n_1 = 2, \quad n_2 = \infty. \quad Z = 3.$

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]3^2$$

$$\frac{1}{\lambda} = R\left[\frac{1}{4}\right]9$$

$$\frac{1}{\lambda} = \frac{9R}{4}$$

$$\lambda = \frac{4}{9R} \qquad \frac{1}{R} = x.$$

$$\boxed{\lambda = \frac{4x}{9}}$$

D) Longest wave length in Balmer series of Li^{+2}

$n_1 = 2$, $n_2 = 3$, $Z = 3$.

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]3^2$$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right]3^2$$

$$\frac{1}{\lambda} = R\left[\frac{5}{36}\right]9$$

$$\frac{1}{\lambda} = \frac{R\,45}{36}.$$

$$\lambda = \frac{36}{45\,R}. \qquad \frac{1}{R} = x.$$

$$\boxed{\lambda = \frac{4x}{5}}$$

9. A $\longrightarrow$ P, Q, R, S. for Lyman series.
$n_1 = 1$, $n_2 = 2, 3, 4, 5 \ldots$

B $\longrightarrow$ Q, R, S Balmar $n_1 = 2$, $n_2 = 3, 4, 5 \ldots$

C $\longrightarrow$ R, S. Paschen $n_1 = 3$, $n_2 = 4, 5 \ldots$

D $\longrightarrow$ S. Bracket $n_1 = 4$, $n_2 = 5, 6 \ldots$