PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 15

Total Marks : 25

Max. Time : 25 min.

Topic : Atomic Structure

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6,8	(3 marks, 3 min.)	[21, 21]
Multiple choice objective ('–1' negative marking) Q.7	(4 marks, 4 min.)	[4, 4]

1. An electron in a H–like atom jumps from a higher energy level 'n' to ground state by emitting two successive photons of wave numbers 5.25×10^8 m^{-1} and 7.25×10^8 m^{-1}. If the same electron undergoes the same transition by emitting a single photon, then the wavelength of this photon is :

(A) 32.84 Å (B) 8 Å (C) 0.125 Å (D) 0.03 Å

2. The ratio of the difference in energy between the first and second Bohr orbit to that between the second and third Bohr orbit in a H-like species is :

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) $\frac{4}{9}$ (D) $\frac{27}{5}$

3. The radii of two of the first four Bohr orbits of the Hydrogen atom are in the ratio 1 : 4. The energy difference between them may be :

(A) Either 12.09 eV or 3.4 eV (B) Either 2.55 eV or 10.2 eV
(C) Either 13.6 eV or 3.4 eV (D) Either 3.4 eV or 0.85 eV

4. The ratio of radius of two different orbits in a H-atom is 4 : 9. Then, the ratio of the frequency of revolution of electron in these orbits is :

(A) 2 : 3 (B) 27 : 8 (C) 3 : 2 (D) 8 : 27

5. According to Bohr's theory, the ratio of electrostatic force of attraction acting on electron in 3rd orbit of He^+ ion and 2nd orbit of Li^{2+} ion is $\left(\frac{3}{2}\right)^x$. Then, the value of x is :

(A) 7 (B) –6 (C) 6 (D) –7

6. Suppose a hypothetical H-like atom produces a blue, yellow, red and violet line in emission spectrum. Match the above lines with their corresponding possible electronic transition :

Colour of spectral lines	Possible corresponding transitions
(A) Blue	(p) $6 \rightarrow 3$
(B) Yellow	(q) $2 \rightarrow 1$
(C) Red	(r) $5 \rightarrow 2$
(D) Violet	(s) $4 \rightarrow 3$

(A) (A) $\rightarrow$ r , (B) $\rightarrow$ p , (C) $\rightarrow$ s , (D) $\rightarrow$ q (B) (A) $\rightarrow$ r , (B) $\rightarrow$ s , (C) $\rightarrow$ q, (D) $\rightarrow$ p
(C) (A) $\rightarrow$ p , (B) $\rightarrow$ r , (C) $\rightarrow$ s , (D) $\rightarrow$ q (D) (A) $\rightarrow$ p , (B) $\rightarrow$ r , (C) $\rightarrow$ q, (D) $\rightarrow$ s

7. If the binding energy of 2nd excited state of a hypothetical H-like atom is 12 eV, then :

(A) I excitation potential = 81 V (B) II Excitation energy = 96 eV
(C) Ionisation potential = 192 V (D) Binding energy of 2nd state = 27 eV

8. Wave number of a spectral line for a given transition is x cm^{-1} for He^+ ion. Then, its value for Be^{3+} ion (isoelectronic of He^+) for same transition is :

(A) x cm^{-1} (B) 4x cm^{-1} (C) $\frac{x}{4}$ cm^{-1} (D) 2x cm^{-1}

Answer Key

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1.	(B)	**2.**	(D)	**3.**	(B)	**4.**	(B)	**5.**	(D)
6.	(A)	**7.**(A,B,D)		**8.**	(B)				

Hints & Solutions

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1. $E_{I\ Photon} + E_{II\ Photon} = E_{single\ Photon}$

$hc\bar{v}_1 + hc\bar{v}_2 = \frac{hc}{\lambda}$

$\therefore \lambda = \frac{1}{\bar{v}_1 + \bar{v}_2} = \frac{1}{5.25 \times 10^8 + 7.25 \times 10^8} = \frac{1}{12.5 \times 10^8} = 8 \times 10^{-10}\ m = 8\ Å$

2. Use : $E_1 - E_2\ /\ E_2 - E_3$

3. $\frac{r_1}{r_2} = \frac{1}{4} \Rightarrow \frac{r_3}{r_4} = \frac{9}{16} \Rightarrow \frac{r_2}{r_4} = \frac{1}{4}$

So corresponding energy of ratio $\frac{1}{4}$ is $E_2 - E_1$ and $E_4 - E_2$.

4. $\frac{R_1}{R_2} = \frac{4}{9} = \frac{n_1^2}{n_2^2}$, hence $\frac{n_1}{n_2} = \frac{2}{3}$.So, $\frac{f_1}{f_2} = \frac{n_2^3}{n_1^3} = \frac{27}{8}$.

5. Electrostatic force of attraction $F \propto \frac{Z^3}{n^4}$

$$\therefore \frac{(F_{n=3})_{He^+}}{(F_{n=2})_{Li^{2+}}} = \frac{2^3/3^4}{3^3/2^4} = \left(\frac{2}{3}\right)^7 = \left(\frac{3}{2}\right)^{-7} \quad \therefore x = -7 \qquad F = \frac{KZe^2}{R^2}$$

6. Order of energy $\rightarrow$ Violet > Blue > yellow > red

Order of energy $\rightarrow$ $E_{2\rightarrow 1} > E_{5\rightarrow 2} > E_{6\rightarrow 3} > E_{4\rightarrow 3}$

$\therefore$ Violet ($2 \rightarrow 1$), Blue ($5 \rightarrow 2$), yellow ($6 \rightarrow 3$), Red ($4 \rightarrow 3$)

7.* BE for (n = 3) = 1.51 Z^2 = 12 eV (given)

$\therefore Z^2 = 12/1.51$

I Excitation potential = 10.2 Z^2 = 10.2 $\times$ (12/1.51) = 81V

II Excitation potential = 12.09 Z^2 = 12.09 $\times$ (12/1.51) = 96eV

Ionisation potential = 13.6 Z^2 = 13.6 (12/1.51) = 108 V

BE of (n = 2) = 3.4 Z^2 = 3.4 x (12/1.51) = 27eV

8. Let the given transition for both the species is $n_1 \rightarrow n_2$

Then $X_{cm}^{-1} = R \times 2^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ For He^+ ..... (i)

and (wave no.) $Be^{3+} = R \times 4^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ For Be^{3+} ..... (ii)

From eq. (i) and (ii) (wave no.) Be^{3+} = 4x cm^{-1}.