DPP – 6 [Spectrum of Hydrogen Atom]

Chapter: Structure of Atom

"Ek chapter tumhari life nahi badlega… Par har din ka effort milkar destiny badal deta hai."

TYPE 1: wavelength/frequency/energy calculations of transitions

Q.1 **According to the Bohr Theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon?**

(1) $n = 5$ to $n = 3$
(2) $n = 6$ to $n = 1$
(3) $n = 5$ to $n = 4$
(4) $n = 6$ to $n = 5$

Q.2 **Which of the following electron transitions will require the largest amount of energy in a hydrogen atom?**

(1) From $n = 1$ to $n = 2$
(2) From $n = 2$ to $n = 3$
(3) From $n = \infty$ to $n = 1$
(4) From $n = 3$ to $n = 5$

Q.3 **The transition of electron in H-atom that will emit maximum energy is**

(1) $n_3 \rightarrow n_2$
(2) $n_4 \rightarrow n_3$
(3) $n_5 \rightarrow n_4$
(4) All have same energy

Q.4 **Maximum frequency of emission is obtained for the transition**

(1) $n = 2$ to $n = 1$
(2) $n = 6$ to $n = 2$
(3) $n = 1$ to $n = 2$
(4) $n = 2$ to $n = 6$

Q.5 **The radiation of low frequency will be emitted in which transition of hydrogen atom?**

(1) $n = 1$ to $n = 4$
(2) $n = 2$ to $n = 5$
(3) $n = 3$ to $n = 1$
(4) $n = 5$ to $n = 2$

Q.6 **In which of the following transitions will the wavelength be minimum?**

(1) $n = 6$ to $n = 4$
(2) $n = 4$ to $n = 2$
(3) $n = 3$ to $n = 1$
(4) $n = 2$ to $n = 1$

Q.7 **For the transition from $n = 2 \rightarrow n = 1$, which of the following will produce the shortest wavelength?**

(1) H atom
(2) D atom
(3) He^+ ion
(4) Li^{2+} ion

Q.8 **Which one of the following electron transitions between energy levels produces the line of shortest wavelength in hydrogen spectrum?**

(1) $n_2 \rightarrow n_1$
(2) $n_3 \rightarrow n_1$
(3) $n_4 \rightarrow n_1$
(4) $n_4 \rightarrow n_3$

Q.9 **The wavelength of radiation emitted when an electron in a hydrogen atom makes a transition from an energy level with $n = 3$ to a level with $n = 2$ is**
(Given $E_n = -1312/n^2$ kJ mol^{-1})

(1) 6.56×10^{-7} m
(2) 65.6 nm
(3) 65.6×10^{-7} m
(4) Any of the above

Q.10 **The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be**
(Rydberg constant $= 1.097 \times 10^7$ m^{-1}) **[AIEEE-2004]**

(1) 9.1×10^{-8} nm
(2) 192 nm
(3) 406 nm
(4) 91 nm

Q.11 **The wavelength of the radiation emitted, when in He^+ electron falls from infinity to stationary state, would be ($R = 1.097 \times 10^7$ m^{-1})**

(1) 2.2×10^{-8} m
(2) 2.2×10^{-9} m
(3) 120 m
(4) 22×10^7 m

Q.12 **For H-spectrum, electron transition takes place from $n = 5$ to $n = 2$, then emitted wavelength of photon is 434 nm. The wavelength of photon in electron transition from $n = 4$ to $n = 2$ will be**

(1) 586.16 nm
(2) 48.608 nm
(3) 486 nm
(4) 400.16 nm

Q.13 **Energy of an electron is given by $E = -2.178 \times 10^{-18}$ J$\left(\frac{Z^2}{n^2}\right)$. Wavelength of light required to excite an electron in a hydrogen atom from level $n = 1$ to $n = 2$ will be**
($h = 6.62 \times 10^{-34}$ Js and $c = 3.0 \times 10^8$ ms^{-1})

(1) 1.214×10^{-7} m
(2) 2.816×10^{-7} m
(3) 6.500×10^{-7} m
(4) 8.500×10^{-7} m

Q.14 **The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be (Given ionization energy of H atom $= 2.18 \times 10^{-18}$ J atom^{-1})**

(1) 1.03×10^{15} s^{-1}
(2) 3.08×10^{15} s^{-1}
(3) 2.00×10^{15} s^{-1}
(4) 1.54×10^{15} s^{-1}

Q.15 **The frequency of light emitted for the transition $n = 4$ to $n = 2$ of He^+ is equal to the transition in H atom corresponding to which of the following?** **[AIEEE-2011]**

(1) $n = 3$ to $n = 1$
(2) $n = 2$ to $n = 1$
(3) $n = 3$ to $n = 2$
(4) $n = 4$ to $n = 3$

Q.16 **Calculate the frequency of the spectral line corresponding to $n_1 = 2$ and $n_2 = 4$. To which spectral series does this line belong?**
($R = 109677$ cm^{-1}, $c = 3 \times 10^8$ ms^{-1})

(1) 6.172×10^{14} s^{-1}; Balmer series
(2) 3.086×10^{14} s^{-1}; Lyman series
(3) 6.172×10^{14} s^{-1}; Paschen series
(4) 1.234×10^{15} s^{-1}; Balmer series

Q.17 **In a Bohr's model of an atom, when an electron jumps from $n = 1$ to $n = 3$, how much energy will be emitted or absorbed per atom?**

(1) 2.389×10^{-12} ergs
(2) 0.239×10^{-10} ergs
(3) 2.15×10^{-11} ergs
(4) 0.1936×10^{-10} ergs

Q.18 **If the energy difference between the ground state of an atom and excited state is 4.4×10^{-19} J. The wavelength of photon required to produce this transition is**

(1) 4.5×10^{-7} m
(2) 4.5×10^{-7} nm
(3) 4.5×10^{-7} Å
(4) 4.5×10^{-7} cm

TYPE 2 : Spectral Series — Identification & Properties

Q.19 **Third line of Balmer series is produced by which transition in spectrum of H-atom?**

(1) $5 \to 2$ (2) $5 \to 1$ (3) $4 \to 2$ (4) $4 \to 1$

Q.20 **The value of n_1 for Paschen series of hydrogen spectrum is (n_1 = orbit number in which electron falls)**

(1) 1 (2) 2 (3) 3 (4) 4

Q.21 **The third line in the Balmer series corresponds to an electronic transition between which Bohr orbits in hydrogen?**

(1) $5 \to 2$ (2) $4 \to 2$ (3) $3 \to 2$ (4) $6 \to 2$

Q.22 **In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen?**

(1) $3 \rightarrow 1$ (2) $5 \rightarrow 2$ (3) $2 \rightarrow 5$ (4) $3 \rightarrow 2$

Q.23 When an electron in H-atom jumps from $n = 4$ to $n = 1$, ultraviolet light is emitted. If the transition corresponds to $n = 4$ to $n = 2$, then which of the following colours will be emitted?

(1) Ultraviolet (2) Green (3) Infrared (4) No colour

Q.24 Which series has the highest energy in hydrogen spectrum?

(1) Balmer
(2) Brackett
(3) Pfund
(4) Lyman

Q.25 Which transition emits a photon of maximum frequency?

(1) Second spectral line of Balmer series
(2) Second spectral line of Paschen series
(3) Fifth spectral line of Humphrey series
(4) First spectral line of Lyman series

Q.26 Smallest wavelength occurs for

(1) Lyman series
(2) Balmer series
(3) Paschen series
(4) Brackett series

TYPE 3: Hydrogen Spectrum [wavelength]

Q.27 Calculate the wavelength of 1st line of Balmer series in hydrogen spectrum. ($R = 1/912$ Å^{-1})

(1) 6566 Å (2) 4861 Å (3) 1216 Å (4) 9120 Å

Q.28 Calculate the wavelength of 3rd line of Brackett series in hydrogen spectrum. ($R = 109678$ cm^{-1}, 1 R $= 912$ Å)

(1) 21667 Å (2) 18751 Å (3) 40520 Å (4) 26253 Å

Q.29 Maximum wavelength of Balmer series for H-atom ($R_H = 10^7$ m^{-1}) is

(1) 720 nm (2) 520 nm (3) 700 nm (4) 400 nm

Q.30 In Bohr's model of H-atom, what will be the shortest wavelength in Paschen series?

(1) 820.8 nm (2) 100.8 nm (3) 520.8 nm (4) 700.8 nm

Q.31 What will be the longest wavelength line in Balmer series of spectrum of H-atom?

(1) 546 nm (2) 656 nm (3) 566 nm (4) 556 nm

Q.32 The wavelength of the third line of the Balmer series for a H atom is

(1) $\frac{21}{100R}$
(2) $\frac{100}{21R}$
(3) $\frac{21R}{100}$
(4) $\frac{100R}{21}$

Q.33 The wavelength of first line of the Lyman series for hydrogen is 1216 A°. The wavelength for the first line of this series for a 10 times ionised sodium atom ($z = 11$) will be

(1) 1000 A° (2) 100 A° (3) 10 A° (4) 1 A°

Q.34 If the shortest wavelength of Lyman series of H atom is x, then the wavelength of the first line of Balmer series of H atom will be

(1) $\frac{9x}{5}$
(2) $\frac{36x}{5}$
(3) $\frac{5x}{9}$
(4) $\frac{5x}{36}$

Q.35 In which transition of hydrogen will the atom have the same wavelength as in Balmer series transition of He^+ ion ($n = 4$ to $n = 2$)?

(1) 4 to 2
(2) 3 to 2
(3) 2 to 1
(4) 4 to 1

Q.36 What transition in He^+ will have the same λ as the 1st line in Lyman series of H-atom?

(1) $5 \rightarrow 3$ (2) $3 \rightarrow 2$ (3) $6 \rightarrow 4$ (4) $4 \rightarrow 2$

TYPE 4 : Hydrogen Spectrum [Frequency and wave number]

Q.37 Calculate the frequency of the last line of the Lyman series in hydrogen spectrum.
($c = 3 \times 10^{10}$ cm s^{-1}, $R = 109678$ cm^{-1})

(1) 3.29×10^{15} s^{-1}
(2) 1.64×10^{15} s^{-1}
(3) 6.58×10^{15} s^{-1}
(4) 8.22×10^{14} s^{-1}

Q.38 The limiting line in Balmer series will have a frequency of

(1) 3.65×10^{14} sec^{-1}
(2) 3.29×10^{15} sec^{-1}
(3) 8.22×10^{14} sec^{-1}
(4) -8.22×10^{14} sec^{-1}

Q.39 The first emission line in the atomic spectrum of hydrogen in the Balmer series appears at

(1) $\frac{5R}{36}$ cm^{-1}
(2) $\frac{3R}{4}$ cm^{-1}
(3) $\frac{7R}{144}$ cm^{-1}
(4) $\frac{9R}{400}$ cm^{-1}

Q.40 The wave number of 1st line of Balmer series of hydrogen spectrum is 15200 cm^{-1}. The wave number of 1st line of Balmer series of Li^{2+} spectrum will be

(1) 136800 cm^{-1}
(2) 45600 cm^{-1}
(3) 15200 cm^{-1}
(4) 1689 cm^{-1}

TYPE 5 : Hydrogen Spectrum [Ratio of wavelength and frequency]

Q.41 Calculate the ratio of maximum λ of Lyman series to maximum λ of Balmer series in hydrogen spectrum.

(1) 5 : 27 (2) 27 : 5 (3) 1 : 4 (4) 4 : 1

Q.42 What will be the ratio of the wavelength of the first line to that of the second line of Paschen series of H atom?

(1) 256 : 175
(2) 175 : 256
(3) 15 : 16
(4) 24 : 27

Q.43 The ratio of minimum wavelengths of Lyman & Balmer series will be

(1) 1.25 (2) 0.25 (3) 5 (4) 10

Q.44 The ratio of wavelengths of first line of Lyman series in Li^{2+} and first line of Lyman series in deuterium (^2_1H) is

(1) 1 : 9 (2) 9 : 1 (3) 1 : 4 (4) 4 : 1

Q.45 The ratio of the shortest wavelength of two special series of hydrogen spectrum is found to be about 9. The spectral series are [JEE Main (April) 2019]

(1) Paschen and Pfund
(2) Balmer and Brackett
(3) Lyman and Paschen
(4) Brackett and Pfund

Q.46 The ratio of minimum frequency of Lyman & Balmer series will be

(1) 1.25 (2) 0.25 (3) 5.4 (4) 10

Q.47 Find out ratio of following for photon: $(\nu_{max})_{Lyman} : (\nu_{max})_{Brackett}$

(1) 1 : 16 (2) 16 : 1 (3) 4 : 1 (4) 1 : 4

TYPE 6 : Number of Spectral Lines

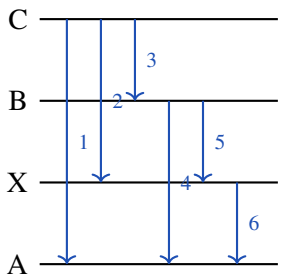
Q.48 In H-atom, electron transits from 6^{th} orbit to 2^{nd} orbit in multi steps. Then total spectral lines (without Balmer series) will be

(1) 6 (2) 10 (3) 4 (4) 0

Q.49 An atom has x energy levels, then total number of lines in its spectrum are

(1) $1+2+3+\ldots+(x+1)$
(2) $1+2+3+\ldots+x^2$
(3) $1+2+3+\ldots+(x-1)$
(4) $(x+1)(x+2)(x+4)$

Q.50 The figure indicates the energy level diagram for the origin of six spectral lines in emission spectrum (e.g. line no. 5 arises from the transition from level B to X). Which of the following spectral lines will not occur in the absorption spectrum?



(1) 1, 2, 3 (2) 3, 2, 5 (3) 4, 5, 6 (4) 3, 2, 1

Q.51 A certain electronic transition from an excited state to ground state of the H atom in one or more steps gives rise to three lines in the ultraviolet region of the spectrum. How many lines does this transition produce in the infrared region of the spectrum?

(1) 1 (2) 2 (3) 3 (4) 4

Q.52 In a hydrogen spectrum, if electron moves from 7 to 1 orbit by transition in multi steps, then the total number of lines in the spectrum is

(1) 21 (2) 15 (3) 28 (4) 10

Q.53 In a hydrogen spectrum, if electron moves from 6^{th} to 2^{nd} orbit by transition in multi steps, then the total number of lines in the spectrum is

(1) 10 (2) 6 (3) 15 (4) 4

Q.54 A certain electronic transition from an excited state to ground state of the hydrogen atom in one or more steps gives rise to 5 lines in the ultraviolet region of the spectrum. How many lines does this transition produce in the infrared region of the spectrum?

(1) 6 (2) 3 (3) 10 (4) 1

Q.55 In H atom, if the electron moves from n^{th} orbit to 1^{st} orbit by transition in multi steps, and the total number of lines observed in the spectrum are 10, then find the value of n.

(1) 3 (2) 4 (3) 5 (4) 6

Q.56 Number of spectral lines in Balmer series when an electron returns from 7^{th} orbit to 1^{st} orbit of hydrogen atom are

(1) 5 (2) 6 (3) 21 (4) 8

Q.57 What is the maximum number of emission lines obtained when the excited electron of a hydrogen atom in $n = 5$ drops to ground state? [NCERT Pg. 45]

(1) 5 (2) 10 (3) 15 (4) 8

Q.58 Maximum number of spectral lines emitted when electrons jump from $n = 5$ to $n = 1$ in hydrogen atom sample is

(1) 1 (2) 2 (3) 10 (4) 6

Q.59 When the electron of a hydrogen atom jumps from $n = 4$ to $n = 1$ state, the number of spectral lines emitted is

(1) 15 (2) 6 (3) 3 (4) 4

Q.60 Total number of spectral lines in UV region, during transition from 5^{th} excited state to 1^{st} excited state

(1) 10 (2) 3 (3) 4 (4) Zero

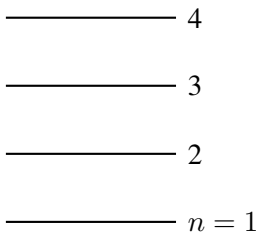
Q.61 Total number of lines emitted in infrared region when electron de-excited from 5^{th} excited state to 1^{st} excited state will be

(1) 3 (2) 8 (3) 2 (4) 6

Q.62 Number of spectral lines falling in Balmer series when electrons are de-excited from n^{th} shell will be given as

(1) $(n-2)$ in UV
(2) $(n-2)$ in visible region
(3) $(n-3)$ in near IR
(4) $(n-3)$ in far IR

Q.63 Four lowest energy levels of H-atom are shown in the figure. The number of emission lines could be



(1) 3 (2) 4 (3) 5 (4) 6

Q.64 In the above problem (Q.26), the number of absorption lines could be

(1) 3 (2) 4 (3) 5 (4) 6

Q.65 If 9.9 eV energy is supplied to H atom, the number of spectral lines emitted is equal to

(1) 0 (2) 1 (3) 2 (4) 3

TYPE 7 : Miscellaneous

Q.66 The first Lyman transition in the hydrogen spectrum has $\Delta E = 10.2$ eV. The same energy change is observed in the second Balmer transition of

(1) Li^{2+} (2) Li^{+} (3) He^{+} (4) Be^{3+}

Q.67 Given that in the H-atom the transition energy for $n = 1$ to $n = 2$ Rydberg states is 10.2 eV. The energy for the same transition in Be^{3+} is

(1) 20.4 eV
(2) 163.2 eV
(3) 30.6 eV
(4) 40.8 eV

Q.68 Heat treatment of muscular pain involves radiation of wavelength of about 900 nm. Which spectral line of H-atom is suitable for this purpose?
($R_H = 1 \times 10^5$ cm^{-1}, $h = 6.6 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms^{-1}) **[JEE Main (Jan.) 2019]**

(1) Paschen, $5 \to 3$
(2) Balmer, $\infty \to 2$
(3) Lyman, $\infty \to 1$
(4) Paschen, $\infty \to 3$

Q.69 When a hydrogen sample in ground state is bombarded, what potential is required to accelerate an electron so that the first Paschen line is emitted?

(1) 2.55 V
(2) 0.65 V
(3) 12.09 V
(4) 12.75 V

TYPE 8 : Theortical Questions

Q.70 The line spectra of two elements are not identical because

(1) The elements don't have the same number of neutrons.
(2) They have different mass numbers.
(3) Their outermost electrons are at different energy levels.
(4) They have different valencies.

Q.71 The spectrum of He is expected to be similar to that of

(1) H (2) Na (3) He^+ (4) Li^+

Q.72 Which one of the following species will give a series of spectral lines similar to that of Mg^{2+}?

(1) Al^{3+} (2) Na (3) Mg^+ (4) F

Q.73 The wavelength of photon obtained by electron transition between two levels in H-atom and singly ionised He are λ_1 and λ_2 respectively, then

(1) $\lambda_2 = \lambda_1$
(2) $\lambda_2 = 2\lambda_1$
(3) $\lambda_2 = \lambda_1/2$
(4) $\lambda_2 = \lambda_1/4$

Q.74 In an electronic transition, an atom cannot emit

(1) Visible light
(2) γ-rays
(3) Infrared light
(4) Ultraviolet light

Q.75 In the following transition, which statement is correct? (Refer energy level: $E_3 > E_2 > E_1$, transitions λ_3, λ_2, λ_1 as shown)

(1) $E_{3-1} = E_{3-2} - E_{2-1}$
(2) $\lambda_3 = \lambda_1 + \lambda_2$
(3) $\nu_3 = \nu_2 + \nu_1$
(4) All of these

Q.76 In which transition is one quantum of energy emitted?

(1) $n = 4 \rightarrow n = 2$
(2) $n = 3 \rightarrow n = 1$
(3) $n = 4 \rightarrow n = 1$
(4) All of them

Q.77 Which of the electronic levels would allow the hydrogen to absorb a photon but not emit a photon?

(1) 3s (2) 2p (3) 2s (4) 1s

Q.78 The spectrum of He^+ is expected to be similar to that of

(1) H (2) Li^+ (3) Na (4) He