

Q1. JEE Main 2026 (21 January Shift 2)

Consider the following spectral lines for atomic hydrogen :

- A. First line of Paschen series
- B. Second line of Balmer series
- C. Third line of Paschen series
- D. Fourth line of Bracket series.

The correct arrangement of the above lines in ascending order of energy is :

- (1) $D < C < A < B$
- (2) $D < A < C < B$
- (3) $C < D < B < A$
- (4) $A < B < C < D$

Q2. JEE Main 2026 (23 January Shift 1)

Given,

(A) $n = 5, m_l = -1$

(B) $n = 3, l = 2, m_l = -1, m_s = +\frac{1}{2}$

The maximum number of electron(s) in an atom that can have the quantum numbers as given in (A) and (B) respectively are :

- (1) 8 and 1
- (2) 2 and 4
- (3) 26 and 1
- (4) 4 and 1

Q3. JEE Main 2026 (23 January Shift 1)

Which of the following statements regarding the energy of the stationary state is true in the following one - electron systems ?

- (1) $+2.18 \times 10^{-18}$ J for second orbit of He^+ ion
- (2) -2.18×10^{-18} J for third orbit of Li^{2+} ion
- (3) -1.09×10^{-18} J for second orbit of H atom.
- (4) $+8.72 \times 10^{-18}$ J for first orbit of He^+ ion

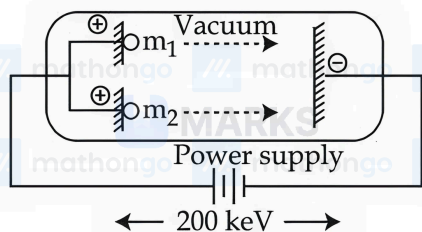
Q4. JEE Main 2026 (28 January Shift 2)

The wavelength of photon 'A' is 400 nm. The frequency of photon 'B' is 10^{16} s^{-1} . The wave number of photon 'C' is 10^4 cm^{-1} . The correct order of energy of these photons is :

- (1) $C > B > A$
- (2) $B > A > C$
- (3) $A > B > C$
- (4) $A > C > B$

Q5. JEE Main 2026 (28 January Shift 2)

Two positively charged particles m_1 and m_2 have been accelerated across the same potential difference of 200 keV as shown below.



[Given mass of $m_1 = 1$ amu and $m_2 = 4$ amu]

The deBroglie wavelength of m_1 will be x times of m_2 . The value of x is _____ (nearest integer)

Q6. JEE Main 2026 (24 January Shift 2)

The wavelength of spectral line obtained in the spectrum of Li^{2+} ion, when the transition takes place between two levels whose sum is 4 and difference is 2, is

- (1) 1.14×10^{-7} cm (2) 1.14×10^{-6} cm
(3) 2.28×10^{-7} cm (4) 2.28×10^{-6} cm

Q7. JEE Main 2026 (22 January Shift 2)

The energy of first (lowest) Balmer line of H atom is x J. The energy (in J) of second Balmer line of H atom is :

- (1) $1.35x$ (2) x^2 (3) $2x$ (4) $\frac{x}{1.35}$

Q8. JEE Main 2026 (22 January Shift 1)

The energy required by electrons, present in the first Bohr orbit of hydrogen atom to be excited to second Bohr orbit is _____ Jmol^{-1} . Given: $R_H = 2.18 \times 10^{-11}$ ergs.

- (1) 9.835×10^{12} (2) 1.635×10^{-18}
(3) 1.635×10^{-11} (4) 9.835×10^5

Q9. JEE Main 2026 (23 January Shift 2)

The work functions of two metals (M_A and M_B) are in the 1 : 2 ratio. When these metals are exposed to photons of energy 6 eV, the kinetic energy of liberated electrons of $M_A : M_B$ is in the ratio of 2.642 : 1. The work functions (in eV) of M_A and M_B are respectively.

- (1) 1.4, 2.8 (2) 2.3, 4.6
(3) 1.5, 3.0 (4) 3.1, 6.2

Q10. JEE Main 2026 (23 January Shift 2)

Identify the INCORRECT statements from the following:

- A. Notation ${}^{24}_{12}\text{Mg}$ represents 24 protons and 12 neutrons.
- B. Wavelength of a radiation of frequency $4.5 \times 10^{15} \text{ s}^{-1}$ is $6.7 \times 10^{-8} \text{ m}$.
- C. One radiation has wavelength = λ_1 (900 nm) and energy = E_1 . Other radiation has wavelength = λ_2 (300 nm) and energy = E_2 . $E_1 : E_2 = 3 : 1$.
- D. Number of photons of light of wavelength 2000 pm that provides 1 J of energy is 1.006×10^{16} .

Choose the correct answer from the options given below:

- (1) B and C Only
(2) A and D Only
(3) A and C Only
(4) A and B Only

Q11. JEE Main 2026 (21 January Shift 1)

Given below are two statements :

Statement I: When an electric discharge is passed through gaseous hydrogen, the hydrogen molecules dissociate and the energetically excited hydrogen atoms produce electromagnetic radiation of discrete frequencies.

Statement II: The frequency of second line of Balmer series obtained from He^+ is equal to that of first line of Lyman series obtained from hydrogen atom.

In the light of the above statements, choose the correct answer from the options given below :

- (1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are true
(3) Statement I is true but Statement II is false
(4) Both Statement I and Statement II are false

Q12. JEE Main 2026 (28 January Shift 1)

The wave numbers of three spectral lines of H atom are considered. Identify the set of spectral lines belonging to Balmer series.

(R = Rydberg constant)

- (1) $\frac{7R}{144}, \frac{3R}{16}, \frac{16R}{255}$
 (2) $\frac{5R}{36}, \frac{8R}{9}, \frac{15R}{16}$
 (3) $\frac{3R}{4}, \frac{3R}{16}, \frac{7R}{144}$
 (4) $\frac{5R}{36}, \frac{3R}{16}, \frac{21R}{100}$

Q13. JEE Main 2026 (28 January Shift 1)

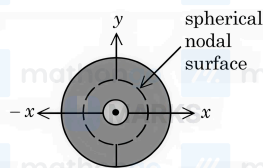


Figure 1. electron probability density for 2s orbital

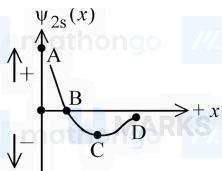


Figure 2. wave function for 2s orbital

Which of the following point in Figure 2 most accurately represents the nodal surface as shown in Figure 1?

- (1) D (2) A (3) C (4) B

Q14. JEE Main 2026 (24 January Shift 1)

The hydrogen spectrum consists of several spectral lines in Lyman series ($L_1, L_2, L_3 \dots$; L_1 has lowest energy among Lyman series). Similarly it consists of several spectral lines in Balmer series ($B_1, B_2, B_3 \dots$; B_1 has lowest energy among Balmer lines). The energy of L_1 is x times the energy of B_1 . The value of x is $____ \times 10^{-1}$. (Nearest integer)

ANSWERS AND SOLUTIONS

1. (2) 2. (1) 3. (2) 4. (2) 5. 2 6. (2) 7. (1) 8. (4)
9. (2) 10. (3) 11. (2) 12. (4) 13. (4) 14. 54

1. (2) The energy of a spectral line in the hydrogen atom is given by $E = 13.6 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ eV}$.

A. First line of Paschen series: $n_1 = 3, n_2 = 4$.

$$E_A = 13.6 \left(\frac{1}{3^2} - \frac{1}{4^2} \right) = 13.6 \left(\frac{1}{9} - \frac{1}{16} \right) = 13.6 \times \frac{7}{144} \approx 0.66 \text{ eV}.$$

B. Second line of Balmer series: $n_1 = 2, n_2 = 4$.

$$E_B = 13.6 \left(\frac{1}{2^2} - \frac{1}{4^2} \right) = 13.6 \left(\frac{1}{4} - \frac{1}{16} \right) = 13.6 \times \frac{3}{16} = 2.55 \text{ eV}.$$

C. Third line of Paschen series: $n_1 = 3, n_2 = 6$.

$$E_C = 13.6 \left(\frac{1}{3^2} - \frac{1}{6^2} \right) = 13.6 \left(\frac{1}{9} - \frac{1}{36} \right) = 13.6 \times \frac{3}{36} = 13.6 \times \frac{1}{12} \approx 1.13 \text{ eV}.$$

D. Fourth line of Brackett series: $n_1 = 4, n_2 = 8$.

$$E_D = 13.6 \left(\frac{1}{4^2} - \frac{1}{8^2} \right) = 13.6 \left(\frac{1}{16} - \frac{1}{64} \right) = 13.6 \times \frac{3}{64} \approx 0.6375 \text{ eV}.$$

Comparing the values: $E_D(0.6375) < E_A(0.66) < E_C(1.13) < E_B(2.55)$.

The ascending order of energy is $D < A < C < B$.

2. (1) For case (A) with $n=5, m_l = -1$:

The principal quantum number $n=5$ allows l from 0 to 4. Since $m_l = -1$, we need $l \geq 1$. For each l value (1, 2, 3, 4), the orbital $m_l = -1$ exists, giving 4 orbitals. Each orbital holds 2 electrons (spin up and down), so maximum electrons = 8.

For case (B) with $n=3, l=2, m_l = -1, m_s = +\frac{1}{2}$:

These quantum numbers completely specify a single electron in a unique orbital with a specific spin, so maximum electrons = 1.

Therefore, the answer is 8 and 1.

3. (2) The energy of an electron in the n^{th} stationary state of a one-electron system is given by the Bohr's formula:

$$E_n = -2.18 \times 10^{-18} \times \frac{Z^2}{n^2} \text{ J}$$

where Z is the atomic number and n is the principal quantum number.

For option (1): Second orbit of He^+ ($Z = 2, n = 2$)

$$E = -2.18 \times 10^{-18} \times \frac{2^2}{2^2} = -2.18 \times 10^{-18} \text{ J. (Incorrect sign in option)}$$

For option (2): Third orbit of Li^{2+} ($Z = 3, n = 3$)

$$E = -2.18 \times 10^{-18} \times \frac{3^2}{3^2} = -2.18 \times 10^{-18} \text{ J. (Correct)}$$

For option (3): Second orbit of H atom ($Z = 1, n = 2$)

$$E = -2.18 \times 10^{-18} \times \frac{1^2}{2^2} = -0.545 \times 10^{-18} \text{ J. (Incorrect value)}$$

For option (4): First orbit of He^+ ($Z = 2, n = 1$)

$$E = -2.18 \times 10^{-18} \times \frac{2^2}{1^2} = -8.72 \times 10^{-18} \text{ J. (Incorrect sign in option)}$$

4. (2) Photon A: $\lambda_A = 400 \text{ nm}$

$$E_A = \frac{hc}{\lambda_A} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{400 \times 10^{-9}} = 4.97 \times 10^{-19} \text{ J}$$

Photon B: $\nu_B = 10^{16} \text{ s}^{-1}$

$$E_B = h\nu_B = 6.626 \times 10^{-34} \times 10^{16} = 6.626 \times 10^{-18} \text{ J}$$

Photon C: $\bar{\nu}_C = 10^4 \text{ cm}^{-1} = 10^6 \text{ m}^{-1}$

$$\lambda_C = 10^{-6} \text{ m}$$

$$E_C = \frac{hc}{\lambda_C} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{10^{-6}} = 1.988 \times 10^{-19} \text{ J}$$

Order: $E_B > E_A > E_C$

5. (2) For a charged particle accelerated through potential V , the de Broglie wavelength is $\lambda = \frac{h}{\sqrt{2mVe}}$.

The wavelength is inversely proportional to $\sqrt{m}$.

$$\text{Therefore: } \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2}{m_1}} = \sqrt{\frac{4}{1}} = 2.$$

This means $\lambda_1 = 2\lambda_2$, so $x = 2$ (nearest integer).

6. (2) For Li^{2+} ($Z=3$): From $n_2 + n_1 = 4$ and $n_2 - n_1 = 2$, we get $n_2 = 3, n_1 = 1$

Using Bohr wavelength formula: $\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \times 9 \times \left(1 - \frac{1}{9} \right) = 9.873 \times 10^7 \times \frac{8}{9}$$

$$\frac{1}{\lambda} = 8.776 \times 10^7 \text{ m}^{-1}$$

$$\lambda = 1.14 \times 10^{-6} \text{ cm}$$

7. (1) First Balmer line:

$$\text{transition } n=3 \text{ to } n=2, \text{ energy } E_1 = 13.6 \left(\frac{1}{4} - \frac{1}{9} \right) = 13.6 \times \frac{5}{36} = x \text{ J.}$$

Second Balmer line:

$$\text{transition } n=4 \text{ to } n=2, \text{ energy } E_2 = 13.6 \left(\frac{1}{4} - \frac{1}{16} \right) = 13.6 \times \frac{3}{16} \text{ J.}$$

$$\text{Ratio: } \frac{E_2}{E_1} = \frac{\frac{3}{16}}{\frac{5}{36}} = \frac{3}{16} \times \frac{36}{5} = \frac{27}{20} = 1.35.$$

Thus second Balmer line energy is $1.35x \text{ J}$.

8. (4) The energy of an electron in the n^{th} Bohr orbit of a hydrogen atom is given by $E_n = -R_H \left(\frac{1}{n^2} \right)$.

The energy required for excitation from $n = 1$ to $n = 2$ for a single atom is

$$\Delta E = E_2 - E_1 = R_H \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = R_H \left(1 - \frac{1}{4} \right) = \frac{3}{4} R_H.$$

Given $R_H = 2.18 \times 10^{-11} \text{ ergs}$.

Converting ergs to Joules: $1 \text{ erg} = 10^{-7} \text{ J}$.

So, $R_H = 2.18 \times 10^{-11} \times 10^{-7} = 2.18 \times 10^{-18} \text{ J}$.

The energy required per atom is $\Delta E = \frac{3}{4} \times 2.18 \times 10^{-18} = 1.635 \times 10^{-18} \text{ J}$.

To find the energy required per mole of electrons, multiply by Avogadro's number $N_A \approx 6.022 \times 10^{23} \text{ mol}^{-1}$.

Energy per mole $= 1.635 \times 10^{-18} \times 6.022 \times 10^{23} \text{ J mol}^{-1}$.

Energy per mole $\approx 9.846 \times 10^5 \text{ J mol}^{-1}$.

Comparing with the given options, 9.835×10^5 is the closest value.

9. (2) The work functions satisfy $W_A : W_B = 1 : 2$.

Let $W_A = W$ and $W_B = 2W$.

Using the photoelectric equation

$KE = h\nu - W$, we have $KE_A = 6 - W$ and $KE_B = 6 - 2W$.

Given the kinetic energy ratio $\frac{KE_A}{KE_B} = 2.642$, we get $\frac{6-W}{6-2W} = 2.642$.

Solving: $6 - W = 2.642(6 - 2W)$ gives $6 - W = 15.852 - 5.284W$

So $4.284W = 9.852$ and $W = 2.3 \text{ eV}$.

Thus $W_A = 2.3 \text{ eV}$ and $W_B = 4.6 \text{ eV}$.

10. (3) Checking each statement:

(A) states ${}^{24}_{12}\text{Mg}$ has 24 protons, but the mass number is 24 and atomic number is 12, so this is INCORRECT.

(B) Using $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{4.5 \times 10^{15}} = 6.67 \times 10^{-8} \text{ m}$, which is CORRECT.

(C) For $\lambda_1 = 900 \text{ nm}$ and $\lambda_2 = 300 \text{ nm}$, since energy is inversely proportional to wavelength, $E_1 : E_2 = 1 : 3$, not $3 : 1$ as stated, so this is INCORRECT.

(D) For photons at $\lambda = 2000 \text{ pm}$, energy per photon is $E = \frac{hc}{\lambda} = 9.94 \times 10^{-17} \text{ J}$, giving $N = 1.006 \times 10^{16}$ photons for 1 J, which is CORRECT.

The incorrect statements are A and C.

11. (2) Statement I: Electric discharge through H_2 causes dissociation into excited H atoms which emit discrete frequencies (line spectrum). This is true.

Statement II: Using $\nu = RcZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

For He^+ ($Z=2$), second Balmer line ($n_1 = 2, n_2 = 4$): $\nu = 4Rc \left(\frac{1}{4} - \frac{1}{16} \right) = \frac{3Rc}{4}$

For H ($Z=1$), first Lyman line ($n_1 = 1, n_2 = 2$): $\nu = Rc \left(1 - \frac{1}{4} \right) = \frac{3Rc}{4}$

Both frequencies are equal. Statement II is true.

Both statements are true.

12. (4) For the Balmer series, transitions end at $n=2$.

Using the Rydberg formula $\bar{\nu} = R \left(\frac{1}{2^2} - \frac{1}{n^2} \right) = R \left(\frac{1}{4} - \frac{1}{n^2} \right)$, we calculate wavenumbers for transitions from different upper levels:

From $n=3$: $\bar{\nu} = R \left(\frac{1}{4} - \frac{1}{9} \right) = \frac{5R}{36}$

From $n=4$: $\bar{\nu} = R \left(\frac{1}{4} - \frac{1}{16} \right) = \frac{3R}{16}$

From $n=5$: $\bar{\nu} = R \left(\frac{1}{4} - \frac{1}{25} \right) = \frac{21R}{100}$

Option (4) contains exactly these three wavenumbers corresponding to the Balmer series transitions.

13. (4) The 2s orbital has one radial nodal surface, which is a spherical surface shown in Figure 1.

A nodal surface is where the electron probability density (and wave function) equals zero, meaning $\psi_{2s}(x) = 0$.

From the wave function graph in Figure 2, point B represents where the wave function crosses zero on the x-axis, indicating the location of the radial node.

Points A and C show maximum and minimum values respectively, while point D shows a non-zero region beyond the node.

14. (54) The energy of a spectral line in the hydrogen spectrum is given by $E = 13.6 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$ eV.

For the Lyman series, the lowest energy line L_1 corresponds to the transition from $n = 2$ to $n = 1$.

$$E(L_1) = 13.6 \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = 13.6 \left(1 - \frac{1}{4} \right) = 13.6 \times \frac{3}{4} \text{ eV.}$$

For the Balmer series, the lowest energy line B_1 corresponds to the transition from $n = 3$ to $n = 2$.

$$E(B_1) = 13.6 \left(\frac{1}{2^2} - \frac{1}{3^2} \right) = 13.6 \left(\frac{1}{4} - \frac{1}{9} \right) = 13.6 \times \frac{5}{36} \text{ eV.}$$

Given $E(L_1) = x \cdot E(B_1)$, we have:

$$13.6 \times \frac{3}{4} = x \times 13.6 \times \frac{5}{36}$$

$$\frac{3}{4} = x \times \frac{5}{36}$$

$$x = \frac{3}{4} \times \frac{36}{5} = 3 \times \frac{9}{5} = \frac{27}{5} = 5.4$$

The value of x is $5.4 = 54 \times 10^{-1}$.

Comparing with the required format $x = \text{integer} \times 10^{-1}$, the integer is 54.