Exercise – I (JEE-Main Pattern)

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

1. In $^{14}_{7}N$ if mass attributed to electrons were doubled & the mass attributed to protons were halved, the atomic mass would become approximately :
(1) Halved (2) Doubled
(3) Reduced by 25% (4) Remain same

CAS001

2. In the different experiments α-particles, proton, deuteron and neutron are projected towards gold nucleus with the same kinetic energy. The distance of closest approach will be minimum for
(1) α-particle (2) proton (3) deuteron (4) neutron

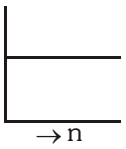
CAS002

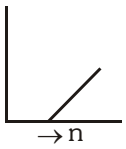
3. How much distance an electron revolving in 3rd orbit of He^+ ion will travel in one second
(1) 1.458×10^6 m (2) 3.28×10^6 m (3) 4.862×10^5 m (4) 2.917×10^6 m

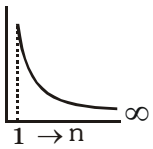
CAS003

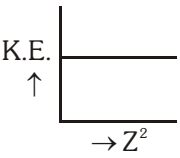
4. If the radius of 3rd Bohr's orbit of H is x, then radius of 4th orbit of $Li^{2\oplus}$ ion would be :-
(1) $\frac{27}{16}$x (2) $\frac{16}{27}$ x (3) $\frac{9}{16}$ (4) None of these

CAS004

5. Which of the following is a correct graph :
(1) 

(2) 

(3) 

(4) 

CAS005

6. When Lithium $\left(^{7}_{3}Li\right)$ vapours were filled in discharge tube for anode ray experiment, the anode rays were found to contain only $Li^{\oplus}$ ions. Thus the anode ray particle contains :
(1) 1 proton only (2) 3 proton and 4 neutron only
(3) 3 proton, 4 neutron and 2 electrons (4) 3 proton, 3 neutrons and 3 electrons

CAS006

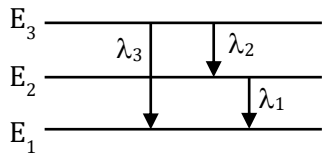
7. The first emission line in the H-atom spectrum in the Balmer series will have wave number :
(1) $\frac{5R}{36}$ cm^{-1} (2) $\frac{3R}{4}$ cm^{-1} (3) $\frac{7R}{144}$ cm^{-1} (4) $\frac{9R}{400}$ cm^{-1}

CAS007

8. Which quantum number is not related with Schrodinger equation
(1) Principal (2) Azimuthal (3) Magnetic (4) Spin

CAS008

9. In the following transition which statement is correct



(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

CAS009

10. An **α**-particle is accelerated through a potential difference of V volts from rest. The de-Broglie's wavelength associated with it is :

(1) $\sqrt{\frac{150}{V}}$ Å (2) $\frac{0.286}{\sqrt{V}}$ Å (3) $\frac{0.101}{\sqrt{V}}$ Å (4) $\frac{0.983}{\sqrt{V}}$ Å

CAS010

11. The orbital with zero angular momentum is :

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

CAS011

12. Three energy levels P, Q, R of a certain atom are such that $E_P < E_Q < E_R$. If λ_1, λ_2 and λ_3 are the wave length of radiation corresponding to transition $R \rightarrow Q$; $Q \rightarrow P$ and $R \rightarrow P$ respectively. The correct relationship between λ_1, λ_2 and λ_3 is

(1) $\lambda_1 + \lambda_2 = \lambda_3$ (2) $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

(3) $\lambda_3 = \sqrt{\lambda_1\lambda_2}$ (4) $\frac{2}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

CAS013

13. The fraction of volume occupied by the nucleus with respect to the total volume of an atom is :

(1) 10^{-15} (2) 10^{-5} (3) 10^{-30} (4) 10^{-10}

CAS015

14. Bohr's theory is not applicable to :

(1) $He^{\oplus}$ (2) $Li^{2\oplus}$ (3) $He^{2\oplus}$ (4) the H-atom

CAS016

15. Number of possible spectral lines which may be emitted in bracket series in H atom, if electrons present in 9th excited level returns to ground level, are

(1) 21 (2) 6 (3) 45 (4) 5

CAS017

16. In a certain electronic transition in the hydrogen atoms from an initial state (A) to a final state (B), the difference in the orbit radius ($\mathbf{r_1 - r_2}$) is 24 times the first Bohr radius. Identify the transition :

(1) 5 → 1 (2) 25 → 1 (3) 8 → 3 (4) 6 → 5

CAS018

17. What is the shortest wavelength in the Pfund series of He^+ ion :-

(1) $\frac{25}{R}$ (2) $\frac{4}{R}$ (3) $\frac{4R}{25}$ (4) $\frac{25}{4R}$

CAS019

18. In the emission of photoelectrons, the number of photoelectrons emitted per unit time depends upon
(1) energy of the incident radiation (2) intensity of the incident radiation
(3) frequency of the incident radiation (4) wavelength of the incident radiation

CAS020

19. If the shortest wavelength of H-atom in Lyman series is λ, then longest wavelength in Balmer series of $He^{\oplus}$ ion is :-

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

CAS133

20. An electron has kinetic energy 2.8×10^{-23} J. de-Broglie wavelength will be nearly :-

($m_e = 9.1 \times 10^{-31}$ kg)

(1) 9.28×10^{-24} m (2) 9.28×10^{-7} m (3) 9.28×10^{-8} m (4) 9.28×10^{-10} m

CAS144

SECTION-B

- This section contains **TEN** Questions. Attempt any five Questions. First five Questions Attempt will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777.... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4, if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 in all other cases.

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1. The wave numbers of two electromagnetic radiations are 4×10^6 m^{-1} and 2×10^5 cm^{-1}. The ratio of their frequencies is x : 1.00. the value of 'x' is.

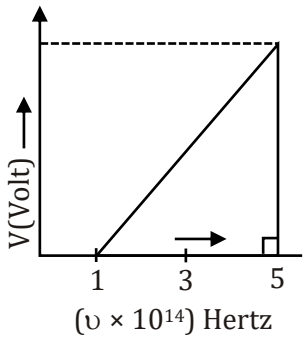
CAS021

2. Radius of nucleus may be given as $R_N = R_0.A^{1/3}$, where A = mass number and R_0 = constant. Calculate the density (in 10^{17} kg m^{-3}) of nucleus of an atom if $R_0 = 1.2 \times 10^{-15}$ m.

[$N_A = 6 \times 10^{23}$, $23 \times 8\pi \times (1.2)^3 = 1000$]

CAS022

3. Stopping potential [V volts] is plotted against frequency of light used [υ].
Find work function (in eV). ($h = 6.62 \times 10^{-34}$ J × s)



CAS023

4. The reaction between H_2 and Br_2 to form HBr in presence of light is initiated by the photo decomposition of Br_2 into free Br atoms (free radicals) by absorption of light. The bond dissociation energy of Br_2 is 192 KJ/mole. What is the longest wavelength (in Å) of the photon that would initiate the reaction.

$\left(1\frac{eV}{atom} = 96kJ/mol\ ;\ hc = 1240\ ev \times nm\right)$

CAS024

5. A potential difference of 20 kV is applied across an X-ray tube. Find the minimum wavelength (in Å) of X-ray generated.

CAS025

6. An electromagnetic radiation makes 5000 waves in 20 cm. The frequency of radiation (in 10^{12} Hz) is.

CAS026

7. How long (sec.) would it take a radio wave of frequency 6×10^3 sec^{-1} to travel from mars to the earth, a distance of 8×10^5 km ?

CAS027

8. Wavelength of the Balmer H_α line (first line) is 6565 Å. Calculate the wavelength (in Å) of H_β (second line).

CAS028

9. If $y \times 10^{-4}$ V potential difference must an electron pass to have a wavelength of 500 Å. Then find value of y.

CAS029

10. Suppose 10^{-17} J of light energy is needed by the interior of the human eye to see an object. How many photons of green light ($\lambda = 550$ nm) are needed to generate this minimum amount of energy?

CAS030

Exercise – II (JEE-Main PYQs)

1. The limiting line in Balmer series of 'H' spectrum will have a frequency of :
(Rydberg constant, $R_H = 3.29 \times 10^{15}$ cycles/s) **[AIEEE 2012]**
(1) $3.65 \times 10^{14}\ s^{-1}$ (2) $8.22 \times 10^{14}\ s^{-1}$ (3) $3.29 \times 10^{15}\ s^{-1}$ (4) $5.26 \times 10^{13}\ s^{-1}$

CAS031

2. If the kinetic energy of an electron is increased four times, the wavelength of the de-Broglie wave associated with it would become : **[AIEEE 2012]**
(1) Two times (2) Half (3) One fourth (4) Four times

CAS032

3. If the radius of first orbit of H atom is a_0, the de-Broglie wavelength of an electron in the third orbit is : **[AIEEE 2012]**
(1) $6\pi a_0$ (2) $8\pi a_0$ (3) $2\pi a_0$ (4) $4\pi a_0$

CAS033

4. 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 an hydrogen atom from level n = 1 to n = 2 will be : **[JEE (Main) 2013]**
($h = 6.62 \times 10^{-34}$ 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

CAS034

5. The radius of the second Bohr orbit for hydrogen atom is :
(Planck's constant $h = 6.6262 \times 10^{-34}$ Js; mass of electron = 9.1091×10^{-31} kg; charge of electron $= 1.60210 \times 10^{-19}$ C ; permittivity of vaccum $\varepsilon_0 = 8.854185 \times 10^{-12}\ kg^{-1}\ m^{-3}\ A^2$)
[JEE (Main) 2017]
(1) 1.65Å (2) 4.76Å (3) 0.529Å (4) 2.12Å

CAS037

6. For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$ the plot of wave number ($\bar{\nu}$) against $\left(\frac{1}{n^2}\right)$ will be (The Rydberg constant, R_H is in wave number unit). **[JEE (Main) 2019]**
(1) Linear with slope - R_H (2) Linear with intercept - R_H
(3) Non linear (4) Linear with slope R_H

CAS038

7. 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) 2019]**
(1) Paschen, $5 \rightarrow 3$ (2) Paschen, $\infty \rightarrow 3$ (3) Lyman, $\infty \rightarrow 1$ (4) Balmer, $\infty \rightarrow 2$

CAS040

8. The ratio of the shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are: **[JEE (Main) 2019]**
(1) Paschen and Pfund (2) Lyman and Paschen
(3) Brackett and Pfund (4) Balmer and Brackett

CAS042

9. Amongst the following statements, that which was not proposed by Dalton was :

[JEE (Main) 2020]

(1) all the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.

(2) chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.

(3) when gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume provided all gases are at the same T & P.

(4) matter consists of indivisible atoms.

CAS043

10. For the Balmer series in the spectrum of H atom, $\bar{\nu} = R_H\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\}$, the correct statements among (I) to (IV) are :

(I) As wavelength decreases, the lines in the series converge

(II) The integer n_1 is equal to 2

(III) The lines of longest wavelength corresponds to $n_2 = 3$

(IV) The ionization energy of hydrogen can be calculated from wave number of these lines

[JEE (Main) 2020]

(1) (II), (III), (IV) (2) (I), (II), (III) (3) (I), (III), (IV) (4) (I), (II), (IV)

CAS045

11. The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is :

[JEE (Main) 2020]

(1) $\frac{4a_0}{9}$ (2) $\frac{2a_0}{9}$ (3) $\frac{2a_0}{3}$ (4) $\frac{4a_0}{3}$

CAS046

12. The de Broglie wavelength of an electron in the 4^{th} Bohr orbit is : **[JEE (Main) 2020]**

(1) $8\pi a_0$ (2) $2\pi a_0$ (3) $4\pi a_0$ (4) $6\pi a_0$

CAS048

13. A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is _____.

[Given : $h = 6.63 \times 10^{-34}$ Js and $c = 3.0 \times 10^8$ ms^{-1}] **[JEE (Main) 2021]**

CAS049

14. The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is:

[Given: The threshold frequency of platinum is 1.3×10^{15} s^{-1} and $h = 6.6 \times 10^{-34}$ J s.**]**

[JEE (Main) 2022]

(1) 3.21×10^{-14} J (2) 6.24×10^{-16} J

(3) 8.58×10^{-19} J (4) 9.76×10^{-20} J

CAS050

15. The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of He^+ is **[JEE (Main) 2023]**

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

CAS179

16. The energy of one mole of photons of radiation of frequency 2×10^{12} Hz in $J\,mol^{-1}$ is _____.

(Nearest integer)

(Given: $h = 6.626 \times 10^{-34}$ Js; $N_A = 6.022 \times 10^{23}\,mol^{-1}$) **[JEE (Main) 2023]**

CAS180

17. The wave function (Ψ) of 2s is given by

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{1/2}\left(2-\frac{r}{a_0}\right)e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0 **[JEE (Main) 2023]**

(1) $r_0 = a_0$ (2) $r_0 = 4a_0$ (3) $r_0 = \frac{a_0}{2}$ (4) $r_0 = 2a_0$

CAS181

18. The energy of an electron in the first Bohr orbit of hydrogen atom is -2.18×10^{-18} J. Its energy in the third Bohr orbit is_____. **[JEE (Main) 2023]**

(1) $\frac{1}{27}$ of this value (2) One third of this value

(3) Three times of this value (4) $\frac{1}{9}$ th of this value

CAS182

19. The orbital angular momentum of an electron in 3s orbital is $\frac{xh}{2\pi}$. The value of x is

[JEE (Main) 2023]

CAS183

20. Given below are two statements:

Statement I: According to Bohr's model of hydrogen atom, the angular momentum of an electron in a given stationary state is quantised.

Statement II : The concept of electron in Bohr's orbit, violates the Heisenberg uncertainty principle.

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

[JEE (Main) 2023]

(1) Both Statement I and Statement II are correct.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct

(4) Both Statement I and Statement II are incorrect.

CAS184

Exercise - III (JEE Advanced Pattern)

SECTION–I

- This section contains **EIGHT** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

1. In a hydrogen like sample electron is in 2^{nd} excited state, the energy of 4^{th} state of this sample is –13.6 eV, then incorrect statement is :
(A) Atomic number of element is 4.
(B) 3 different types of spectral line will be observed if electrons make transition upto ground state from the 2^{nd} excited state.
(C) A 25 eV photon can set free the electron from the 2^{nd} excited state of this sample
(D) 2^{nd} line of Balmer series of this sample has same energy value as 1^{st} excitation energy of H-atoms.

CAS051

2. Given ΔH for the process $Li(g) \longrightarrow Li^{3\oplus}(g) + 3e^{\ominus}$ is 19800 kJ/mole & IE_1 for Li is 520 then IE_2 & IE_3 of Li are respectively (approx, value)
(A) 7472, 11808 (B) 520, 19280 (C) 11775, 19280 (D) Data insufficient

CAS052

3. Consider the following nuclear reactions involving X & Y.

$X \longrightarrow Y + {}_2^4He$

$Y \longrightarrow {}_8O^{18} + {}_1H^1$

If both neutrons as well as protons in both the sides are conserved in nuclear reaction then moles of neutrons in 4.6 gm of X
(A) 2.4 N_A (B) 2.4 (C) 4.6 (D) 0.2 N_A

CAS053

4. If λ_0 is the threshold wavelength for photoelectric emission, λ wavelength of light falling on the surface of metal, and m mass of electron, then de Broglie wavelength of emitted electron is :-

(A) $\left[\frac{h(\lambda\lambda_0)}{2mc(\lambda_0-\lambda)}\right]^{\frac{1}{2}}$ (B) $\left[\frac{h(\lambda_0-\lambda)}{2mc\lambda\lambda_0)}\right]^{\frac{1}{2}}$ (C) $\left[\frac{h(\lambda-\lambda_0)}{2mc\lambda\lambda_0)}\right]^{\frac{1}{2}}$ (D) $\left[\frac{h\lambda\lambda_0}{2mc}\right]^{\frac{1}{2}}$

CAS054

5. **Statement-1:** Energy emitted when an electron jump from $5 \rightarrow 2$ (energy level) is less than when an electron jump from $2 \rightarrow 1$ in all 'H' like atom.
Statement-2: The |total energy difference| between 1^{st} & 2^{nd} energy level is greater than that of any two energy level provided level '1' is not part of those two energy levels.
(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

CAS055

6. Give the correct order of initials T (true) or F (false) for following statements :-

(I) If an ion has 2 electrons in K shell, 8 electrons in L shell and 6 electrons in M shell, then number of S electrons present in that element is 6.

(II) The maximum number of electrons in a subshell is given by $2n^2$

(III) If electron has magnetic quantum number –1, then it cannot be present in s-orbital.

(IV) Only one radial node is present in 3p orbital.

(A) TTFF (B) FFTF (C) TFTT (D) FFTF

CAS056

7. Electromagnetic radiations having λ = 310 Å are subjected to a metal sheet having work function = 12.8 eV. What will be the velocity of photoelectrons with maximum Kinetic Energy....

(A) 0, no emission will occur (B) 2.18×10^6 m/s

(C) $2.18\sqrt{2} \times 10^6$ m/s (D) 8.72×10^6 m/s

CAS057

8. A particle X moving with a certain velocity has a De-Broglie wave length of 1 Å. If particle Y has a mass of 25% that of X and velocity 75% that of X, De-Broglie's wave length of Y will be :-

(A) 3 Å (B) 5.33 Å (C) 6.88 Å (D) 48Å

CAS058

SECTION-II

- This section contains **FIVE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4, if only (all) the correct option(s) is (are) chosen.

Partial Marks : +3, if all the four options are correct but ONLY three options are chosen.

Partial Marks : +2, if three or more options are correct but ONLY two options are chosen, both of which are correct options.

Partial Marks : +1, if two or more options are correct but ONLY one option is chosen and it is a correct option.

Zero Marks : 0, if none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –2 in all other cases.

9. The energies of energy levels A, B and C for a given atom are in the sequence $E_A < E_B < E_C$. If the radiations of wavelengths λ_1, λ_2 and λ_3 are emitted due to the atomic transitions C to B, B to A and C to A respectively then which of the following relations is correct :-

(A) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (B) $\lambda_3 = \lambda_1 + \lambda_2^2$ (C) $\lambda_3 = \lambda_1 + \lambda_2$ (D) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$

CAS059

10. The kinetic energy of photoelectron emitted on irradiating a metal surface with frequency υ is related by KE = hv – ϕ. The plots of KE vs. incidented frequency v shows :

(A) A straight line with slope equal to Planck's constant.

(B) A straight line with intercept on x-axis equal to the product of threshold frequency and Plank's constant.

(C) A straight line with extrapolated intercept on y-axis equal to threshold energy.

(D) A straight line with intercept on x-axis equal to threshold frequency.

CAS060

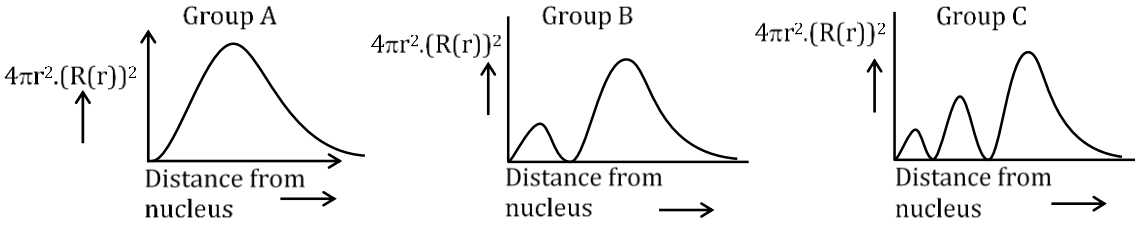
11. Which of the following could be derived from Rutherford's α-particle scattering experiment-
(A) Most of the space in the atom is empty
(B) The radius of the atom is about 10^{-10} m while that of nucleus is 10^{-15} m
(C) Electrons move in a circular path of fixed energy called orbits
(D) Electrons and the nucleus are held together by electrostatic forces of attraction.

CAS061

12. Select the correct statement(s):
(A) All electromagnetic radiation travel with speed of light in vaccum.
(B) Energy of photon of UV light is lower than that of yellow light.
(C) $He^{\oplus}$ and H have identical spectrum.
(D) The total energy of an electron in unielectronic specie is greater than zero

CAS063

13. For the three graphs given below of radial probability distribution and distance, which of the following option(s) is/are correct?



(A) Graph A may be for 3d orbital
(B) Graph B may be for 3p orbital
(C) Graph C may be for 3p orbital
(D) Graph C may be for 3s orbital

CAS156

SECTION-III

- This section contains **THREE** questions of matching type.
- This section contains **One** table (having 3 columns and 4 rows)
- Based on table, there are **THREE** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1, in all other cases

Column-I	Column-II	Column-III
(A) Energy of electron in H-like atomic orbital	(P) Principal quantum number(n)	(I) Radial function [R(r)]
(B) Orientation and shape of H-like atomic orbital	(Q) Azimuthal quantum number (l)	(II) Angular function
(C) Magnitude & direction of spin angular momentum	(R) Magnetic quantum number (m)	(III) Wave function [Ψ]
(D) Probability density of electron in s-orbital of H-like atom/ion	(S) Spin quantum number(s)	(IV) Cannot be determined from Schrodinger equation

Assume no external electric or magnetic fields in Q.14 and Q.15

14. Which of the following option is incorrectly matched -
(A) B – Q – II (B) B – R – II (C) B – P – I (D) B – Q – III

CAS064

15. Which option is correctly matched ?
(A) C – S – III (B) D – R – III (C) A – P – IV (D) C – S – IV

CAS065

16. If option (A) is considered in presence of external electric or magnetic field then which option is incorrect-
(A) A – P – III (B) A – Q – III (C) A – R – III (D) A – S – I

CAS066

SECTION-IV

- This section contains **FOUR** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +3, if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0, in all other cases.

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17. The vapours of Hg absorb some electrons accelerated by a potential difference of 4.5 volt as a result of which light is emitted. If the full energy of single incident electron is supposed to be converted into light emitted by single Hg atom, find the wave number (in 10^7 m^{-1}) of the light.

CAS067

18. The eyes of certain member of the reptile family pass a single visual signal to the brain when the visual receptors are struck by photons of wavelength 850 nm. If a total energy of 3.15×10^{-14} J is required to trip the signal, if minimum number of photons that must strike the receptor is $y \times 10^5$ then find value of y.

CAS068

19. Mr. Santa has to decode a number "ABCDEF" where each alphabet is represented by a single digit. Suppose an orbital whose radial wave function is represented as

$$\Psi_{(r)} = (r^2 - 5k_3 r + 6)$$

From the following information given about each alphabet then write down the answers in the form of "ABCDEF", for above orbital.
Info A = Value of n where "n" is principal quantum number
Info B = No. of angular nodes
Info C = Azimuthal quantum number of subshell to orbital belongs
Info D = No. of subshells having energy between (n + 5)s to (n + 5)p where n is principal quantum number
Info E = Orbital angular momentum of given orbital.
Info F = Radial distance of the spherical node which is farthest from the nucleus
(Assuming $k_3 = 1$)

CAS069

20. A proton and an electron, both at rest initially, combine to form a H-atom in ground state. A single photon is emitted in this process. Find the wavelength (in nm) of this photon
(use : hc = 1237.6 ev × nm)

CAS070

Exercise - IV (JEE Advanced PYQs)

1. Rutherford's experiment, which established the nuclear model of atom, used a beam of :– **[JEE (Advanced) 2002]**

(A) β-particles, which impinged on a metal foil and get absorbed.
(B) γ-rays, which impinged on a metal foil and ejected electron.
(C) Helium atoms, which impinged on a metal foil and got scattered.
(D) Helium nuclei, which impinged on a metal foil and got scattered.

CAS071

2. The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom? **[JEE (Advanced) 2004]**

(A) $He^{\oplus}$ (n = 2) (B) $Li^{2\oplus}$ (n = 2) (C) $Li^{2\oplus}$ (n = 3) (D) $Be^{3\oplus}$(n = 2)

CAS072

3. The Schrodinger wave equation for hydrogen atom is

$$\psi_{2s} = \frac{1}{4(2\pi)^{1/2}}\left(\frac{1}{a_0}\right)^{3/2}\left(2 - \frac{r_0}{a_0}\right)e^{-r/a}$$

Where a_0 is Bohr's radius. Let the radial node in 2s be at r_0. Then correct value of r_0 in terms of a_0 is **[JEE (Advanced) 2004]**

(A) $2a_0$ (B) a_0 (C) $4a_0$ (D) $a_0/2$

CAS073

4. The velocity of electron in first Bohr orbit of hydrogen atom is **[JEE (Advanced) 2005]**

(A) 2.197×10^6 m/s (B) 2.197×10^8 m/s (C) 2.197×10^4 m/s (D) 4.197×10^6 m/s

CAS074

5. The De-Broglie wavelength of the electron in first Bohr orbit is (Given $r = a_0$) **[JEE (Advanced) 2005]**

(A) 3.8 Å (B) 3.32 Å (C) 4.8 Å (D) 2.4 Å

CAS075

6. The orbital angular momentum of 2p-orbital is (in terms of $h/2\pi$) **[JEE (Advanced) 2005]**

(A) $3\sqrt{2}.\frac{h}{2\pi}$ (B) $2\sqrt{2}.\frac{h}{2\pi}$ (C) $\sqrt{2}.\frac{h}{2\pi}$ (D) $\sqrt{3}.\frac{h}{2\pi}$

CAS076

7. Given in hydrogen atom r_n, V_n, E, K_n stand for radius, potential energy, total energy and kinetic energy in n^{th} orbit. Find the value of u, v, x, y.

(1) $U = \frac{V_n}{K_n}$ (P) 1

(2) $\frac{1}{r_n} \propto E^x$ (Q) –2

(3) $r_n \propto Z^y$ (Z = Atomic number) (R) –1

(4) v = (Orbital angular momentum of electron in its lowest energy) (S) 0

[JEE (Advanced) 2006]

(A) (1) S, (2) P, (3) R, (4) Q (B) (1) Q, (2) S, (3) P, (4) R
(C) (1) P, (2) R, (3) S, (4) Q (D) (1) Q, (2) P, (3) R, (4) S

CAS077

8. Match the entries in Column I with the correctly related quantum number(s) in Column II. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) Orbital angular momentum of the electron in a hydrogen-like atomic orbital	(P) Principal quantum number
(B) A hydrogen-like one-electron wave function obeying Pauli principle	(Q) Azimuthal quantum number
(C) Shape, size and orientation of hydrogen like atomic orbitals	(R) Magnetic quantum number
(D) Probability density of electron at the nucleus in hydrogen-like atom	(S) Electron spin quantum number

[JEE (Advanced) 2008]

(A) (A) Q, R ; (B) P, Q, R, S ; (C) P, Q, R ; (D) P, Q
(B) (A) R, Q ; (B) P, Q, R ; (C) P, Q, R ; (D) P, Q
(C) (A) R, Q ; (B) P, Q, R, S ; (C) Q, R ; (D) P, Q
(D) (A) R, S ; (B) P, Q, S ; (C) P, Q, R ; (D) P, Q

CAS078

Paragraph for questions 9 to 11

The hydrogen-like species $Li^{2\oplus}$ is in a spherically symmetric state S_1 with one radial node. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom.

9. The state S_1 is :- **[JEE (Advanced) 2010]**

(A) 1s (B) 2s (C) 2p (D) 3s

CAS079

10. Energy of the state S_1 in units of the hydrogen atom ground state energy is :-

[JEE (Advanced) 2010]

(A) 0.75 (B) 1.50 (C) 2.25 (D) 4.50

CAS080

11. The orbital angular momentum quantum number of the state S_2 is :- **[JEE (Advanced) 2010]**

(A) 0 (B) 1 (C) 2 (D) 3

CAS081

12. The maximum number of electrons that can have principal quantum number, n = 3, and spin quantum number, s = – 1/2, is **[JEE (Advanced) 2011]**

CAS082

13. The work function (ϕ) of some metals is listed below. The number of metals which will show photoelectric effect when light of 300 nm wavelength falls on the metal is :-

Metal	Li	Na	K	Mg	Cu	Ag	Fe	Pt	W
ϕ(eV)	2.4	2.3	2.2	3.7	4.8	4.3	4.7	6.3	4.75

[JEE (Advanced) 2011]

CAS083

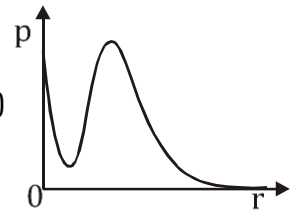
14. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

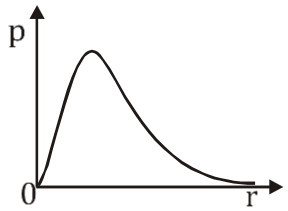
[JEE (Advanced) 2012]

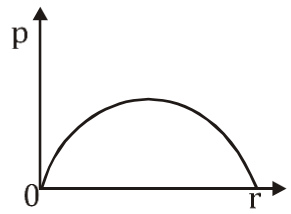
(A) $\frac{h^2}{4\pi^2 m a_0^2}$ (B) $\frac{h^2}{16\pi^2 m a_0^2}$ (C) $\frac{h^2}{32\pi^2 m a_0^2}$ (D) $\frac{h^2}{32\pi^2 m a_0^2}$

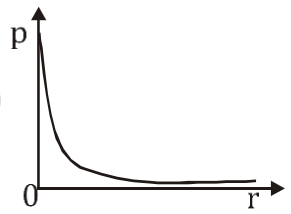
CAS084

15. P is the probability of finding the 1s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr, at a distance r from the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is - **[JEE (Advanced) 2016]**

(A) 

(B) 

(C) 

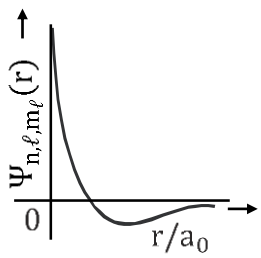
(D) 

CAS085

TABLE TYPE QUESTION

Answer Q.16, Q.17 and Q.18 by appropriately matching the information given in the three columns of the following table.

The wave function ψ_{n,ℓ,m_ℓ} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, ℓ and m_ℓ. Here r is distance from nucleus, θ is colatitude and ϕ is azimuth. In the mathematical functions given in the Table, Z is atomic number a_0 is Bohr radius.

Column-1	**Column-2**	**Column-3**
(I) 1s orbital	(i) $\psi_{n,\ell,m_\ell} \propto \left(\frac{Z}{a_0}\right)^{\frac{3}{2}} e^{-\left(\frac{Zr}{ae}\right)}$	(P) 
(II) 2s orbital	(ii) One radial node	(Q) Probability density at nucleus $\propto \frac{1}{a_0^3}$
(III) $2p_z$ orbital	(iii) $\psi_{n,\ell,m_\ell} \propto \left(\frac{Z}{a_0}\right)^{\frac{5}{2}} re^{-\left(\frac{Zr}{2a_0}\right)} \cos\theta$	(R) Probability density is maximum at nucleus
(IV) $3d_{z^2}$ orbital	(iv) xy - plane is a nodal plane	(S) Energy needed to excite electron from n = 2 state to n = 4 state is $\frac{27}{32}$ times the energy needed to excite electron from n = 2 state to n=6 state

16. For the given orbital in column 1, the only CORRECT combination for any hydrogen - like species is : **[JEE (Advanced) 2017]**

(A) (IV) (iv) (R) (B) (III) (iii) (P)
(C) (I) (ii) (S) (D) (II) (ii) (P)

CAS086

17. For $He^{\oplus}$ ion, the only INCORRECT combination is **[JEE (Advanced) 2017]**

(A) (I) (iii) (R) (B) (II) (ii) (Q)
(C) (I) (i) (R) (D) (I) (i) (S)

CAS087

18. For hydrogen atom, the only CORRECT combination is **[JEE (Advanced) 2017]**

(A) (I) (iv) (R) (B) (II) (i) (Q)
(C) (I) (i) (S) (D) (I) (i) (P)

CAS088

19. The ground state energy of hydrogen atom is –13.6 eV. Consider an electronic state Ψ of $He^{\oplus}$ whose energy, azimuthal quantum number and magnetic quantum number are –3.4 eV, 2 and 0 respectively. Which of the following statement(s) is(are) true for the state Ψ ?

[JEE (Advanced) 2019]

(A) It has 2 angular nodes
(B) It has 3 radial nodes
(C) It is a 4d state
(D) The nuclear charge experienced by the electron in this state is less than 2e, where e is the magnitude of the electronic charge.

CAS089

Answer the following by appropriately matching the lists based on the information given in the paragraph : (Q. 20-21)

Consider the Bohr's model of a one-electron atom where the electron moves around the nucleus. In the following List-I contains some quantities for the n^{th} orbit of the atom and List-II contains options showing how they depend on n.

List-I	**List-II**
(I) Radius of the n^{th} orbit	(P) $\propto n^{-2}$
(II) Angular momentum of the electron in the n^{th} orbit	(Q) $\propto n^{-1}$
(III) Kinetic energy of the electron in the n^{th} orbit	(R) $\propto n_0$
(IV) Potential energy of the electron in the n^{th} orbit	(S) $\propto n^1$
	(T) $\propto n^2$
	(U) $\propto n^{1/2}$

20. Which of the following options has the correct combination considering List-I and List-II?

[JEE (Advanced) 2019]

(A) (II), (R) (B) (I), (P)
(C) (I), (T) (D) (II), (Q)

CAS090

21. Which of the following options has the correct combination considering List-I and List-II?

[JEE (Advanced) 2019]

(A) (III), (S) (B) (IV), (Q)
(C) (IV), (U) (D) (III), (P)

CAS091

22. Consider a helium (He) atom that absorbs a photon of wavelength 330 nm. The change in the velocity (in cm s^{-1}) of He atom after the photon absorption is ___.
(Assume: Momentum is conserved when photon is absorbed.
Use: Planck constant = 6.6×10^{-34} J s, Avogadro number = 6×10^{23} mol^{-1}, Molar mass of He = 4 g mol^{-1}) **[JEE (Advanced) 2021]**

CAS093

23. For $He^{\oplus}$, a transition takes place from the orbit of radius 105.8 pm to the orbit of radius 26.45 pm. The wavelength (in nm) of the emitted photon during the transition is ___.
[**Use:**
Bohr radius, a = 52.9 pm
Rydberg constant, $R_H = 2.2 \times 10^{-18}$ J
Planck's constant, $h = 6.6 \times 10^{-34}$ J s
Speed of light, $c = 3 \times 10^8$ m s^{-1}] **[JEE (Advanced) 2023]**

CAS185

Answer Key

Exercise - I (JEE-Main Pattern)

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	4	1	2	3	3	1	4	3	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	1	2	1	3	2	1	4	2	1	3
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	0.20	2.30	0.41	6200	0.62	7.50	2.66	4862.96	6.03	28

Exercise - II (JEE-Main PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	2	2	1	1	4	4	2	2	3	2
Question	11	12	13	14	15	16	17	18	19	20
Answer	4	1	2	3	2	798	4	4	0	1

Exercise - III (JEE-Advanced Pattern)

Section-I	Q.	1	2	3	4	5	6	7	8
	A.	D	A	B	A	A	C	C	B
Section-II	Q.	9	10	11	12	13			
	A.	D	AD	AB	A	ABD			
Section-III	Q.	14	15	16					
	A.	C	D	D					
Section-IV	Q.	17	18	19	20				
	A.	0.36	1.35	300303	91				

Exercise - IV (JEE-Advanced PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	D	D	A	A	B	C	D	A	B	C
Question	11	12	13	14	15	16	17	18	19	20
Answer	B	9	4	C	B	D	A	C	AC	C
Question	21	22	23							
Answer	D	30	30							