CHAPTER

2

Structure of Atom

Section-A JEE Advanced/ IIT-JEE

A Fill in the Blanks

1. The mass of a hydrogen atom is ..... kg. *(1982 - 1 Mark)*
2. Isotopes of an element differ in the number of ..... in their nuclei. *(1982 - 1 Mark)*
3. When there are two electrons in the same orbital, they have ..... spins. *(1982 - 1 Mark)*
4. Elements of the same mass number but of different atomic numbers are known as ..... . *(1983 - 1 Mark)*
5. The uncertainty principle and the concept of wave nature of matter were proposed by ..... and ..... respectively. (Heisenberg, Schrodinger, Maxwell, de Broglie) *(1988 - 1 Mark)*
6. The light radiations with discrete quantities of energy are called ..... . *(1993 - 1 Mark)*
7. Wave functions of electrons in atoms and molecules are called ..... . *(1993 - 1 Mark)*
8. The $2p_x$, $2p_y$ and $2p_z$ orbitals of atom have identical shapes but differ in their ..... . *(1993 - 1 Mark)*
9. The outermost electronic configuration of Cr is ..... . *(1994 - 1 Mark)*

B True / False

1. The outer electronic configuration of the ground state chromium atom is $3d^4 4s^2$. *(1982 - 1 Mark)*
2. Gamma rays are electromagnetic radiations of wavelengths of 10^{-6} cm to 10^{-5} cm. *(1983 - 1 Mark)*
3. The energy of the electron in the 3*d*-orbital is less than that in the 4*s*-orbital in the hydrogen atom. *(1983 - 1 Mark)*
4. The electron density in the *XY* plane in $3d_{x^2-y^2}$ orbital is zero. *(1986 - 1 Mark)*
5. In a given electric field, β-particles are deflected more than α-particles in spite of α-particles having larger charge. *(1993 - 1 Mark)*

C MCQs with One Correct Answer

1. The number of neutrons in dipositive zinc ion with mass number 70 is *(1979)*
   (a) 34 (b) 36
   (c) 38 (d) 40
2. Rutherford's experiment on scattering of α-particles showed for the first time that the atom has *(1981 - 1 Mark)*
   (a) electrons (b) protons
   (c) nucleus (d) neutrons
3. Any *p*-orbital can accommodate upto *(1983 - 1 Mark)*
   (a) four electrons
   (b) six electrons
   (c) two electrons with parallel spins
   (d) two electrons with opposite spins
4. The principal quantum number of an atom is related to the *(1983 - 1 Mark)*
   (a) size of the orbital
   (b) spin angular momentum
   (c) orbital angular momentum
   (d) orientation of the orbital in space
5. Rutherford's scattering experiment is related to the size of the *(1983 - 1 Mark)*
   (a) nucleus (b) atom
   (c) electron (d) neutron
6. The increasing order (lowest first) for the values of *e*/*m* (charge/mass) for electron (*e*), proton (*p*), neutron (*n*) and alpha particle (α) is : *(1984 - 1 Mark)*
   (a) *e*, *p*, *n*, α (b) *n*, *p*, *e*, α
   (c) *n*, *p*, α, *e* (d) *n*, α, *p*, *e*
7. Correct set of four quantum numbers for the valence (outermost) electron of rubidium ($Z = 37$) is : *(1984 - 1 Mark)*
   (a) 5, 0, 0, +½ (b) 5, 1, 0, +½
   (c) 5, 1, 1, +½ (d) 6, 0, 0, +½
8. Which electronic level would allow the hydrogen atom to absorb a photon but not to emit a photon? *(1984 - 1 Mark)*
   (a) 3*s* (b) 2*p*
   (c) 2*s* (d) 1*s*

9. Bohr model can explain : ***(1985 - 1 Mark)***
(a) the spectrum of hydrogen atom only
(b) spectrum of an atom or ion containing one electron only
(c) the spectrum of hydrogen molecule
(d) the solar spectrum

10. The radius of an atomic nucleus is of the order of : ***(1985 - 1 Mark)***
(a) 10^{-10} cm (b) 10^{-13} cm
(c) 10^{-15} cm (d) 10^{-8} cm

11. Electromagnetic radiation with maximum wavelength is : ***(1985 - 1 Mark)***
(a) ultraviolet (b) radiowave
(c) *X*-ray (d) infrared

12. Rutherford's alpha particle scattering experiment eventually led to the conclusion that : ***(1986 - 1 Mark)***
(a) mass and energy are related
(b) electrons occupy space around the nucleus
(c) neutrons are buried deep in the nucleus
(d) the point of impact with matter can be precisely determined.

13. Which one of the following sets of quantum numbers represents an impossible arrangement? ***(1986 - 1 Mark)***

	n	l	m_l	m_s
(a)	3	2	–2	½
(b)	4	0	0	½
(c)	3	2	–3	½
(d)	5	3	0	–½

14. The ratio of the energy of a photon of 2000Å wavelength radiation to that of 4000Å radiation is : ***(1986 - 1 Mark)***
(a) ¼ (b) 4
(c) ½ (d) 2

15. The triad of nuclei that is isotonic is ***(1988 - 1 Mark)***
(a) $^{14}_{6}C$, $^{15}_{7}N$, $^{17}_{9}F$ (b) $^{12}_{6}C$, $^{14}_{7}N$, $^{19}_{9}F$
(c) $^{14}_{6}C$, $^{14}_{7}N$, $^{17}_{9}F$ (d) $^{14}_{6}C$, $^{14}_{7}N$, $^{19}_{9}F$

16. The wavelength of a spectral line for an electronic transition is inversely related to : ***(1988 - 1 Mark)***
(a) the number of electrons undergoing the transition
(b) the nuclear charge of the atom
(c) the difference in the energy of the energy levels involved in the transition
(d) the velocity of the electron undergoing the transition.

17. The orbital diagram in which the Aufbau principle is violated is : ***(1988 - 1 Mark)***

	2*s*	2*p*
(a)	↑↓	↑↓ ↑
(b)	↑	↑↓ ↑ ↑
(c)	↑↓	↑ ↑ ↑
(d)	↑↓	↑↓ ↑ ↑

18. The outermost electronic configuration of the most electronegative element is ***(1988 - 1 Mark)***
(a) $ns^2\ np^3$ (b) $ns^2\ np^4$
(c) $ns^2\ np^5$ (d) $ns^2\ np^6$

19. The correct ground state electronic configuration of chromium atom is : ***(1989 - 1 Mark)***
(a) [Ar] $3d^5\ 4s^1$ (b) [Ar] $3d^4\ 4s^2$
(c) [Ar] $3d^6\ 4s^0$ (d) [Ar] $4d^5\ 4s^1$

20. The correct set of quantum numbers for the unpaired electron of chlorine atom is : ***(1989 - 1 Mark)***

	n	l	m
(a)	2	1	0
(b)	2	1	1
(c)	3	1	1
(d)	3	0	0

21. Which of the following does not characterise *X*-rays? ***(1992 - 1 Mark)***
(a) The radiation can ionise gases
(b) It causes ZnS to fluorescence
(c) Deflected by electric and magnetic fields
(d) Have wavelengths shorter than ultraviolet rays

22. Which of the following relates to photons both as wave motion and as a stream of particles? ***(1992 - 1 Mark)***
(a) Inference (b) $E = mc^2$
(c) Diffraction (d) $E = h\nu$

23. A 3*p* orbital has : ***(1995S)***
(a) two non spherical nodes
(b) two spherical nodes
(c) one spherical & one non spherical node
(d) one spherical and two non spherical nodes

24. The orbital angular momentum of an electron in 2*s* orbital is: ***(1996 - 1 Mark)***
(a) $+\frac{1}{2}.\frac{h}{2\pi}$ (b) Zero
(c) $\frac{h}{2\pi}$ (d) $\sqrt{2}.\frac{h}{2\pi}$

25. For a *d*-electron, the orbital angular momentum is ***(1997 - 1 Mark)***
(a) $\sqrt{6}(h/2\pi)$ (b) $\sqrt{2}(h/2\pi)$
(c) $(h/2\pi)$ (d) $2(h/2\pi)$

26. The electrons, identified by quantum numbers n and l, (i) $n = 4, l = 1$, (ii) $n = 4, l = 0$, (iii) $n = 3, l = 2$, and (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as ***(1999 - 2 Marks)***
(a) (iv) < (ii) < (iii) < (i) (b) (ii) < (iv) < (i) < (iii)
(c) (i) < (iii) < (ii) < (iv) (d) (iii) < (i) < (iv) < (ii)

27. The number of nodal planes in a p_x orbital is *(2000S)*
(a) one (b) two
(c) three (d) zero

28. The electronic configuration of an element is $1s^2$, $2s^2\,2p^6$, $3s^2\,3p^6\,3d^5$, $4s^1$. This represents its *(2000S)*
(a) excited state (b) ground state
(c) cationic form (d) anionic form

29. The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 m/h is of the order *(2001S)*
(a) 10^{-10} m (b) 10^{-20} m
(c) 10^{-30} m (d) 10^{-40} m

30. The quantum numbers +1/2 and –1/2 for the electron spin represent *(2001S)*
(a) rotation of the electron in clockwise and anticlockwise direction respectively
(b) rotation of the electron in anticlockwise and clockwise direction respectively
(c) magnetic moment of the electron pointing up and down respectively
(d) two quantum mechanical spin states which have no classical analogue

31. Rurtherford's experiment, which established the nuclear model of the atom, used a beam of *(2002S)*
(a) β-particles, which impinged on a metal foil and got absorbed
(b) γ-rays, which impinged on a metal foil and ejected electrons
(c) helium atoms, which impinged on a metal foil and got scattered
(d) helium nuclei, which impinged on a metal foil and got scattered

32. If the nitrogen atom has electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^2 2s^2 2p^3$, because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed because it violates. *(2002S)*
(a) Heisenberg uncertainty principle
(b) Hund's rule
(c) Pauli exclusion principle
(d) Bohr postulate of stationary orbits

33. The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom? *(2004S)*
(a) He^+ $(n=2)$ (b) Li^{2+} $(n=2)$
(c) Li^{2+} $(n=3)$ (d) Be^{3+} $(n=2)$

34. The number of radial nodes of $3s$ and $2p$ orbitals are respectively *(2005S)*
(a) 2, 0 (b) 0, 2
(c) 1, 2 (d) 2, 1

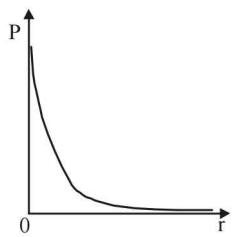
35. Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5%, 90% and 5%, respectively, the atomic mass of Fe is
(a) 55.85 (b) 55.95 *(2009S)*
(c) 55.75 (d) 56.05

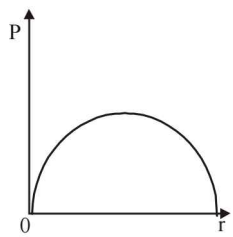
36. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius] : *(2012)*

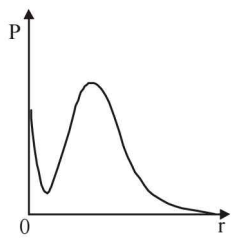
(a) $\dfrac{h^2}{4\pi^2 m a_0^2}$ (b) $\dfrac{h^2}{16\pi^2 m a_0^2}$

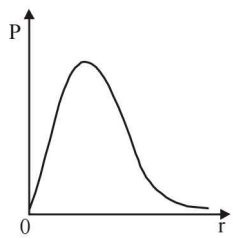
(c) $\dfrac{h^2}{32\pi^2 m a_0^2}$ (d) $\dfrac{h^2}{64\pi^2 m a_0^2}$

37. 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 Adv. 2016)*

(a) 

(b) 

(c) 

(d) 

D MCQs with One or More Than One Correct

1. An isotone of $^{76}_{32}Ge$ is : *(1984 - 1 Mark)*
(a) $^{77}_{32}Ge$ (b) $^{77}_{33}As$
(c) $^{77}_{34}Se$ (d) $^{78}_{34}Se$

2. Many elements have non-integral atomic masses because : *(1984 - 1 Mark)*
(a) they have isotopes
(b) their isotopes have non-integral masses
(c) their isotopes have different masses
(d) the constitutents, neutrons, protons and electrons, combine to give fractional masses

3. When alpha particles are sent through a thin metal foil, most of them go straight through the foil because : *(1984 - 1 Mark)*
(a) alpha particles are much heavier than electrons
(b) alpha particles are positively charged
(c) most part of the atom is empty space
(d) alpha particle move with high velocity

4. The sum of the number of neutrons and proton in the isotope of hydrogen is : *(1986 - 1 Mark)*

(a) 6 (b) 2

(c) 4 (d) 3

5. The energy of an electron in the first Bohr orbit of H atom is –13.6 eV. The possible energy value(s) of the excited state(s) for electrons in Bohr orbits of hydrogen is (are) *(1998 - 2 Marks)*

(a) –3.4 eV (b) –4.2 eV

(c) –6.8 eV (d) –1.5 eV

6. Which of the following satement(s) is (are) correct? *(1998 - 2 Marks)*

(a) The electronic configuration of Cr is [Ar] $3d^5 4s^1$. (Atomic Number of Cr = 24)

(b) The magnetic quantum number may have a negative value.

(c) In silver atom, 23 electrons have a spin of one type and 24 of the opposite type. (Atomic Number of Ag = 47)

(d) The oxidation state of nitrogen in HN_3 is – 3.

7. Decrease in atomic number is observed during *(1998 - 2 Marks)*

(a) alpha emission (b) beta emission

(c) positron emission (d) electron capture.

8. Ground state electronic configuration of nitrogen atom can be represented by *(1999 - 3 Marks)*

(a)  (b) 

(c)  (d) 

E Subjective Problems

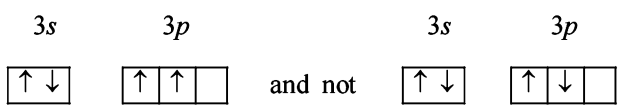
1. Naturally occurring boron consists of two isotopes whose atomic weights are 10.01 and 11.01. The atomic weight of natural boron is 10.81. Calculate the percentage of each isotope in natural boron. *(1978)*

2. The energy of the electron in the second and the third Bohr's orbits of the hydrogen atom is -5.42×10^{-12} erg and -2.41×10^{-12} erg respectively. Calculate the wavelength of the emitted radiation when the electron drops from the third to the second orbit. *(1981 - 3 Marks)*

3. Calculate the wavelength in Angstrom of the photon that is emitted when an electron in the Bohr orbit, $n = 2$ returns to the orbit, $n = 1$ in the hydrogen atom. The ionization potential of the ground state hydrogen atom is 2.17×10^{-11} erg per atom. *(1982 - 4 Marks)*

4. The electron energy in hydrogen atom is given by $E = (-21.7 \times 10^{-12})/n^2$ ergs. Calculate the energy required to remove an electron completely from the $n = 2$ orbit. What is the longest wavelength (in cm) of light that can be used to cause this transition? *(1984 - 3 Marks)*

5. Give reasons why the ground state outermost electronic configuration of silicon is : *(1985 - 2 Marks)*



6. What is the maximum number of electrons that may be present in all the atomic orbitals with principal quantum number 3 and azimuthal quantum number 2? *(1985 - 2 Marks)*

7. According to Bohr's theory, the electronic energy of hydrogen atom in the n^{th} Bohr's orbit is given by $E_n = \frac{-21.76 \times 10^{-19}}{n^2}$ J. Calculate the longest wavelength of light that will be needed to remove an electron from the third Bohr orbit of the He^+ ion. *(1990 - 3 Marks)*

8. Estimate the difference in energy between Ist and 2nd Bohr orbit for a hydrogen atom. At what minimum atomic number, a transition from $n = 2$ to $n = 1$ energy level would result in the emission of X-rays with $\lambda = 3.0 \times 10^{-8}$ m ? Which hydrogen atom-like species does this atomic number correspond to ? *(1993 - 5 Marks)*

9. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum? *(1993 - 3 Marks)*

10. Find out the number of waves made by a Bohr electron in one complete revolution in its 3rd orbit. *(1994 - 3 Marks)*

11. Iodine molecule dissociates into atoms after absorbing light of 4500 Å . If one quantum of radiation is absorbed by each molecule, calculate the kinetic energy of iodine atoms. (Bond energy of $I_2 = 240$ kJ mol^{-1}) *(1995 - 2 Marks)*

12. Calculate the wave number for the shortest wavelength transition in the Balmer series of atomic hydrogen. *(1996 - 1 Mark)*

13. Consider the hydrogen atom to be a proton embedded in a cavity of radius a_0 (Bohr radius) whose charge is neutralised by the addition of an electron to the cavity in vacuum, infinitely slowly. Estimate the average total energy of an electron in its ground state in a hydrogen atom as the work done in the above neutralisation process. Also, if the magnitude of the average kinetic energy is half the magnitude of the average potential energy, find the average potential energy. *(1996 - 2 Marks)*

14. Calculate the energy required to excite one litre of hydrogen gas at 1 atm and 298 K to the first excited state of atomic hydrogen. The energy for the dissociation of H–H bond is 436 kJ mol^{-1}. *(2000 - 4 Marks)*

15. Wavelength of high energy transition of H–atoms is 91.2nm. Calculate the corresponding wavelength of He atoms. ***(2003 - 2 Marks)***

16. The Schrodinger wave equation for hydrogen atom is ***(2004 - 2 Marks)***

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

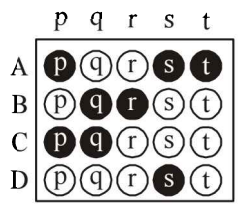
Where a_0 is Bohr's radius. If the radial node in $2s$ be at r_0, then find r_0 in terms of a_0.

17. A ball of mass 100 g is moving with 100 ms^{-1}. Find its wavelength. ***(2004 - 1 Mark)***

18. Find the velocity (ms^{-1}) of electron in first Bohr's orbit of radius a_0. Also find the de Broglie's wavelength (in m). Find the orbital angular momentum of $2p$ orbital of hydrogen atom in units of $h/2\pi$. ***(2005 - 2 Marks)***

F Match the Following

Each question contains statements given in two columns, which have to be matched. The statements in Column-I are labelled A, B, C and D, while the statements in Column-II are labelled p, q, r, s and t. Any given statement in Column-I can have correct matching with ONE OR MORE statement(s) in Column-II. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :
If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s then the correct darkening of bubbles will look like the given.



1. According to Bohr's theory, ***(2006 - 6M)***
E_n = Total energy, K_n = Kinetic energy, V_n = Potential energy, r_n = Radius of n^{th} orbit
Match the following :

Column I	Column II
(A) $V_n / K_n = ?$	(p) 0
(B) If radius of n^{th} orbit $\propto E_n^x$, $x = ?$	(q) –1
(C) Angular momentum in lowest orbital	(r) –2
(D) $\frac{1}{r^n} \propto Z^y$, $y = ?$	(s) 1

2. 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 ***(2008 - 6M)***

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

G Comprehension Based Questions

The hydrogen-like species Li^{2+} 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. ***(2010)***

1. The state S_1 is :
(a) 1 s (b) $2s$ (c) $2p$ (d) $3s$

2. Energy of the state S_1 in units of the hydrogen atom ground state energy is :
(a) 0.75 (b) 1.50 (c) 2.25 (d) 4.50

3. The orbital angular momentum quantum number of the state S_2 is :
(a) 0 (b) 1 (c) 2 (d) 3

H Assertion & Reason Type Questions

1. **ASSERTION :** Nuclide $^{30}_{13}Al$ is less stable than $^{40}_{20}Ca$ ***(1998 - 2 Marks)***
REASON : Nuclides having odd number of protons and neutrons are generally unstable.
(a) If both *assertion* and *reason* are correct, and *reason* is the correct explanation of the *assertion*.
(b) If both *assertion* and *reason* are correct, but *reason* is not the correct explanation of the *assertion*.

(c) If *assertion* is correct but *reason* is incorrect.
(d) If *assertion* is incorrect but *reason* is correct.

2. This question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason) and has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.
STATEMENT-1 : Band gap in germanium is small. because
STATEMENT-2 : The energy gap of each germanium atomic energy level is infinitesimally small. *(2007)*
(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(b) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
(c) Statement-1 is True, Statement-2 is False
(d) Statement-1 is False, Statement-2 is True.

3. **STATEMENT-1 :** The plot of atomic number (y-axis) versus number of neutrons (x-axis) for stable nuclei shows a curvature towards x-axis from the line of 45° slope as the atomic number is increased.
STATEMENT-2 : Proton-proton electrostatic repulsions begin to overcome attractive forces involving protons and neutrons in heavier nuclides. *(2008)*
(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(c) Statement-1 is True, Statement-2 is False
(d) Statement-1 is False, Statement-2 is True

I Integer Value Correct Type

1. 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 *(2011)*

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

2. The maximum number of electrons that can have principal quantum number, $n = 3$, and spin quantum $m_s = -\frac{1}{2}$, is *(2011)*

3. The atomic masses of 'He' and 'Ne' are 4 and 20 a.m.u., respectively. The value of the de Broglie wavelength of 'He' gas at —73°C is "M" times that of the de Broglie wavelength of 'Ne' at 727°C 'M' is *(JEE Adv. 2013)*

4. In an atom, the total number of electrons having quantum numbers $n = 4$, $|m_l| = 1$ and $m_s = -\frac{1}{2}$ is *(JEE Adv. 2014)*

5. Not considering the electronic spin, the degeneracy of the second excited state (n = 3) of H atom is 9, while the degeneracy of the second excited state of H^- is *(JEE Adv. 2015)*

Section-B JEE Main / AIEEE

1. In a hydrogen atom, if energy of an electron in ground state is 13.6. ev, then that in the 2nd excited state is **[2002]**
(a) 1.51 eV (b) 3.4 eV
(c) 6.04 eV (d) 13.6 eV.

2. Uncertainty in position of a minute particle of mass 25 g in space is 10^{-5} m. What is the uncertainty in its velocity (in ms^{-1})? ($h = 6.6 \times 10^{-34}$ Js) **[2002]**
(a) 2.1×10^{-34} (b) 0.5×10^{-34}
(c) 2.1×10^{-28} (d) 0.5×10^{-23}.

3. The number of d-electrons retained in Fe^{2+} **[2003]**
(At. no. of Fe = 26) ion is
(a) 4 (b) 5
(c) 6 (d) 3

4. The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{l(l+1)}.\frac{h}{2\pi}$. This momentum for an s-electron will be given by **[2003]**
(a) zero (b) $\frac{h}{2\pi}$
(c) $\sqrt{2}.\frac{h}{2\pi}$ (d) $+\frac{1}{2}.\frac{h}{2\pi}$

5. Which one of the following groupings represents a collection of isoelectronic species ?(At. nos. : Cs : 55, Br : 35) **[2003]**
(a) N^{3-}, F^-, Na^+ (b) Be, Al^{3+}, Cl^-
(c) Ca^{2+}, Cs^+, Br (d) Na^+, Ca^{2+}, Mg^{2+}

6. 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 **[2003]**
(a) $5 \rightarrow 2$ (b) $4 \rightarrow 1$
(c) $2 \rightarrow 5$ (d) $3 \rightarrow 2$

7. The de Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 metres per second is approximately **[2003]**
(a) 10^{-31} metres (b) 10^{-16} metres
(c) 10^{-25} metres (d) 10^{-33} metres
Planck's constant, $h = 6.63 \times 10^{-34}$ Js

8. Which of the following sets of quantum numbers is correct for an electron in 4f orbital ? **[2004]**
(a) $n = 4, \ell = 3, m = +1, s = +½$
(b) $n = 4, \ell = 4, m = -4, s = -½$
(c) $n = 4, \ell = 3, m = +4, s = +½$
(d) $n = 3, \ell = 2, m = -2, s = +½$

9. Consider the ground state of Cr atom (X = 24). The number of electrons with the azimuthal quantum numbers, $\ell = 1$ and 2 are, respectively **[2004]**

(a) 16 and 4 (b) 12 and 5

(c) 12 and 4 (d) 16 and 5

10. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = $1.097\times10^{7}\ m^{-1}$) **[2004]**

(a) 406 nm (b) 192 nm

(c) 91 nm (d) 9.1×10^{-8} nm

11. Which one of the following sets of ions represents the collection of isoelectronic species? **[2004]**

(a) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$ (b) $Na^+, Ca^{2+}, Sc^{3+}, F^-$

(c) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$ (d) $Na^+, Mg^{2+}, Al^{3+}, Cl^-$

(Atomic nos. : F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21)

12. In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields? **[2005]**

(A) $n = 1, l = 0, m = 0$ (B) $n = 2, l = 0, m = 0$

(C) $n = 2, l = 1, m = 1$ (D) $n = 3, l = 2, m = 1$

(E) $n = 3, l = 2, m = 0$

(a) (D) and (E) (b) (C) and (D)

(c) (B) and (C) (d) (A) and (B)

13. Of the following sets which one does NOT contain isoelectronic species? **[2005]**

(a) $BO_3^{3-}, CO_3^{2-}, NO_3^-$ (b) $SO_3^{2-}, CO_3^{2-}, NO_3^-$

(c) CN^-, N_2, C_2^{2-} (d) $PO_4^{3-}, SO_4^{2-}, ClO_4^-$

14. According to Bohr's theory, the angular momentum of an electron in 5th orbit is **[2006]**

(a) $10\ h/\pi$ (b) $2.5\ h/\pi$

(c) $25\ h/\pi$ (d) $1.0\ h/\pi$

15. Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 ms^{-1}, accurate upto 0.001% will be **[2006]**

(a) 1.92×10^{-2} m (b) 3.84×10^{-2} m

(c) 19.2×10^{-2} m (d) 5.76×10^{-2} m

($h = 6.63\times10^{-34}$ Js)

16. Which one of the following sets of ions represents a collection of isoelectronic species? **[2006]**

(a) $N^{3-}, O^{2-}, F^-, S^{2-}$ (b) $Li^+, Na^+, Mg^{2+}, Ca^{2+}$

(c) $K^+, Cl^-, Ca^{2+}, Sc^{3+}$ (d) $Ba^{2+}, Sr^{2+}, K^+, Ca^{2+}$

17. Which of the following sets of quantum numbers represents the highest energy of an atom? **[2007]**

(a) $n = 3, l = 0, m = 0, s = +1/2$

(b) $n = 3, l = 1, m = 1, s = +1/2$

(c) $n = 3, l = 2, m = 1, s = +1/2$

(d) $n = 4, l = 0, m = 0, s = +1/2$.

18. Which one of the following constitutes a group of the isoelectronic species? **[2008]**

(a) C_2^{2-}, O_2^-, CO, NO (b) $NO^+, C_2^{2-}, CN^-, N_2$

(c) $CN^-, N_2, O_2^{2-}, C_2^{2-}$ (d) N_2, O_2^-, NO^+, CO

19. The ionization enthalpy of hydrogen atom is 1.312×10^6 J mol^{-1}. The energy required to excite the electron in the atom from n = 1 to n = 2 is **[2008]**

(a) 8.51×10^5 J mol^{-1} (b) 6.56×10^5 J mol^{-1}

(c) 7.56×10^5 J mol^{-1} (d) 9.84×10^5 J mol^{-1}

20. Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3\ ms^{-1}$.

(Mass of proton = 1.67×10^{-27} kg and $h = 6.63 \times 10^{-34}$ Js)

(a) 0.40 nm (b) 2.5 nm **[2009]**

(c) 14.0 nm (d) 0.32 nm

21. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is ($h = 6.6 \times 10^{-34}$ kg m^2s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg) : **[2009]**

(a) 5.10×10^{-3} m (b) 1.92×10^{-3} m

(c) 3.84×10^{-3} m (d) 1.52×10^{-4} m

22. The energy required to break one mole of Cl – Cl bonds in Cl_2 is 242 kJ mol^{-1}. The longest wavelength of light capable of breaking a single Cl – Cl bond is

($c = 3 \times 10^8\ ms^{-1}$ and $N_A = 6.02 \times 10^{23}\ mol^{-1}$). **[2010]**

(a) 594 nm (b) 640 nm

(c) 700 nm (d) 494 nm

23. Ionisation energy of He^+ is 19.6×10^{-18} J $atom^{-1}$. The energy of the first stationary state ($n = 1$) of Li^{2+} is **[2010]**

(a) 4.41×10^{-16} J $atom^{-1}$ (b) -4.41×10^{-17} J $atom^{-1}$

(c) -2.2×10^{-15} J $atom^{-1}$ (d) 8.82×10^{-17} J $atom^{-1}$

24. A gas absorbs a photon of 355 nm and emits at two wavelengths. If one of the emissions is at 680 nm, the other is at: **[2011]**

(a) 1035 nm (b) 325 nm

(c) 743 nm (d) 518 nm

25. The electrons identified by quantum numbers n and ℓ :

(*A*) $n=4, \ell=1$ (*B*) $n=4, \ell=0$

(*C*) $n=3, \ell=2$ (*D*) $n=3, \ell=1$

can be placed in order of increasing energy as : **[2012]**

(a) $(C)<(D)<(B)<(A)$ (b) $(D)<(B)<(C)<(A)$

(c) $(B)<(D)<(A)<(C)$ (d) $(A)<(C)<(B)<(D)$

26. Energy of an electron is given by $E=-2.178\times10^{-18}\,J\left(\frac{Z^2}{n^2}\right)$.

Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be :

($h=6.62\times10^{-34}$ Js and $c=3.0\times10^{8}\ ms^{-1}$) **[JEE M 2013]**

(a) 1.214×10^{-7} m (b) $2.816\times10.^{-7}$ m

(c) 6.500×10^{-7} m (d) 8.500×10^{-7} m

27. The correct set of four quantum numbers for the valence electrons of rubidium atom ($Z=37$) is: **[JEE M 2014]**

(a) $5,0,0,+\frac{1}{2}$ (b) $5,1,0,+\frac{1}{2}$

(c) $5,1,1,+\frac{1}{2}$ (d) $5,0,1,+\frac{1}{2}$

28. Which of the following is the energy of a possible excited state of hydrogen ? **[JEE M 2015]**

(a) –3.4 eV (b) +6.8 eV

(c) +13.6 eV (d) –6.8 eV

29. A stream of electrons from a heated filaments was passed two charged plates kept at a potential difference V esu. If e and m are charge and mass of an electron, respectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by: **[JEE M 2016]**

(a) $\sqrt{meV}$ (b) $\sqrt{2meV}$

(c) meV (d) $2meV$