EXERCISE 1

[NCERT TEXT BOOK EXERCISE]

1. What are the dimensions of Planck constant? What other physical quantity has the same dimension.

2. What experimental support is available for deBroglie's concept?

3. Two particles A and B are in motion. If the wavelength associated with particle A is 5×10^{-8} m, Calculate the wavelength associated with particle B if its momentum is half of A.

4. Calculate the wavelength of 1000 kg rocket moving with a velocity of 3000 km per hour. ($h = 6.626 \times 10^{-34}$ Js)

5. The sodium flame test has a characteristic yellow colour due to emissions of wavelengths 589 nm. What is the mass equivalence of one photon of this wavelength?

6. Calculate the uncertainty in the velocity of a wagon of mass 2000 kg whose position is known to an accuracy of ± 10m.

7. Calculate the uncertainty in position of a dust particle with mass equal to 1mg if the uncertainty in its velocity is 5.5×10^{-20} ms^{-1}.

8. On the basis of Heisenberg uncertainty principle, show that electron cannot exist within the atomic nucleus (Radius = 10^{-15} m), $h = 6.626 \times 10^{-34}$ Jsec.

9. Why can't we overcome the uncertainty predicted by Heisenberg's principle by building more precise devices to reduce the error in measurement below the $h/4\pi$ limit?

10. What physical meaning is attributed to the square of the absolute value of wave function $|\Psi|^2$?

11. Which of the four quantum numbers (n, l, m_l, m_s) determine (a) the energy of an electron in a hydrogen atom and in a many-electron atom. (b) The size of an orbital. (c) the shape of an orbital, (d) the orientation of an orbital in space?

12. Draw the shapes (boundary surfaces) of the following orbitals : (a) $2p_y$, (b) $3d_{z^2}$, (c) $3d_{x^2-y^2}$. (Show coordinate axes in your sketches).

13. Discuss the similarities and differences between a 1s and a 2s orbital.

14. For each of the following pair of hydrogen orbitals, indicate which is higher in energy;
(A) 1s, 2s; (B) 2p, 3p; (C) $3d_{xy}$, $3d_{yz}$; (D) 3s, 3d; (E) 4f, 5s

15. Which orbital in each of the following pairs is lower in energy in a many-electron atom?
(a) 2s, 2p; (b) 3p, 3d; (c) 3s, 4s; (d) 4d , 5f

16. Explain the meaning of the symbol $4d^6$.

17. The ground-state electron configurations listed here are incorrect. Explain what mistakes have been made in each and write the correct electron configurations.
Al: $1s^2 2s^2 2p^4 3s^2 3p^3$ B $1s^2 2s^2 2p^5$ F $1s^2 2s^2 2p^6$

18. Draw orbital diagrams for atoms with the following electronic configuration:
(a) $1s^2 2s^2 2p^5$ (b) $1s^2 2s^2 2p^6 3s^2 3p^3$ (c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$

19. What do you understand by
(i) radial probability density, R^2 and
(ii) radial probability function. $4\pi r^2 R^2$? How do they vary with *r* for *1s*, *2s* and *2p* atomic orbitals of hydrogen atoms.

EXERCISE 2

CONCEPTUAL OBJECTIVE

[SINGLE CORRECT]

1. For the same velocity of alpha particles highest deviation will be for
(A) gold foil (B) Cu-foil (C) Al-foil (D) same for all the above

2. The frequency of wave is 6×10^{15} s^{-1}. Its wave number would be
(A) 10^5 cm^{-1} (B) 2×10^{-5} cm^{-1} (C) 2×10^{-7} cm (D) 2×10^5 cm^{-1}

3. The wavelength of light having frequency 60 MHz is
(A) 2.0 m (B) 6.0 m (C) 20 m (D) 5.0 m

4. Energy of a photon having wave number 1.00 cm^{-1} is
(A) 6.62×10^{-34} J (B) 1.99×10^{-23} J (C) 6.62×10^{-32} J (D) 6.62×10^{-36} J

5. The energy of a photon of radiation having wavelength 3000Å is nearly
(A) 6.63×10^{-19} J (B) 6.63×10^{-18} J (C) 6.63×10^{-16} J (D) 6.63×10^{-49} J

6. The number of photons of light having wavelength 100 nm which can provide 1.00 J energy is nearly
(A) 10^7 photons (B) 5×10^{18} photons (C) 5×10^{17} photons (D) 5×10^7 photons

7. The atomic transition gives rise to radiation of frequency of 10^4 MHz. The change in energy per mole of atoms taking place would be
(A) 3.99×10^{-6} J (B) 3.99 J (C) 6.62×10^{-24} J (D) 6.62×10^{-30} J

8. An electronic transition is associated with an energy change of 1 eV. The wavelength of the radiation emitted would be
(A) 12397×10^{-10} m (B) 1239.7×10^{-10} m (C) 12397×10^{-10} cm (D) 12.397 m

9. The maximum kinetic energy of the photo-electrons is found to be 6.63×10^{-19} J when the metal is irradiated with a radiation of frequency 3×10^{15} Hz. The threshold frequency of the metal is
(A) 1×10^{15} Hz (B) 3×10^{15} Hz (C) 2×10^{16} Hz (D) 2×10^{15} Hz

10. The work function of a metal is 4.0 eV. If the metal is irradiated with radiation of wavelength 200 nm, then the maximum kinetic energy of he photoelectrons would be about
(A) 6.4×10^{-19} J (B) 3.5×10^{-19} J (C) 1.0×10^{-18} J (D) 2.0×10^{-19} J

11. If threshold wavelength (λ^o) for ejection of electron from metal is 330 nm, then work function for the photoelectric emission is
(A) 6×10^{-10} J (B) 1.2×10^{-18} J (C) 3×10^{-19} J (D) 6×10^{-19} J

12. The ratio of radii of the third and fifth orbits of Li^{+2} will be
(A) 9 : 25 (B) 25 : 9 (C) 2 : 3 (D) 4 : 5

13. The ratio of radii of the fifth orbits of He^+ and Li^+ will be
(A) 2 : 3 (B) 3 : 2 (C) 4 : 1 (D) 5 : 3

14. What should be the circumference of the second orbit of hydrogen atom?
(A) 13.3 Å (B) 3.7 Å (C) 26.6 Å (D) 3.4 Å

15. The diameter of the second orbit of hydrogen atom should be:
(A) 2.12 Å (B) 4.23 Å (C) 2.10 Å (D) 4.01 Å

16. What should be the ratio of the radii of the orbits of electron in Na^{+10} and hydrogen atom?
(A) 11:1 (B) 1 : 11 (C) 1 : 1 (D) 1 : 2

17. The expression for calculation of velocity is
(A) $v = \left(\frac{Ze^2}{mr}\right)^{\frac{1}{2}}$ (B) $v = \frac{2\pi Ze^2}{nh}$ (C) $v = \frac{nh}{2\pi Ze^2}$ (D) All of the above are correct

18. If the velocities of first, second, third and fourth orbits of hydrogen atom are v_1, v_2, v_3 and v_4 respectively, then which of the following should be their increasing order?
(A) $v_1 > v_2 > v_3 > v_4$ (B) $v_1 < v_2 < v_3 < v_4$ (C) $v_1 > v_2 < v_3 > v_4$ (D) Equal for all

19. If v_1, v_2, v_3 and v_4 are velocities of the electron present in the first orbit of H, He^+, Li^{+2} and Be^{+3}, then which of the following should be their increasing order?
(A) $v_1 < v_2 < v_3 < v_4$ (B) $v_4 > v_3 > v_2 > v_1$
(C) $v_1 < v_2 < v_3 > v_4$ (D) $v_1 > v_2 < v_3 > v_4$

20. What should be the velocity of the electron present in the fourth orbit of hydrogen atom, if the velocity of the electron present in its first orbit is 2.188×10^{-8} cm per second?
(A) 1.094×10^8 cm per second (B) 5.47×10^7 cm per second
(C) 4.376×10^8 cm per second (D) 2.188×10^6 cm per second

21. What should be the velocity of the electrons present in the first, second and third orbits of H, He^+ and Li^{+2}, respectively?
(A) 2.188×10^8 cm per second (B) 5.47×10^7 cm per second
(C) 4.376×10^8 cm per second (D) 2.188×10^6 cm per second

22. What should be the ratio of energies of the third and fifth orbits of He^+?
(A) 25 : 9 (B) 5 : 3 (C) 16 : 9 (D) None of these

23. What should be the correct of energies, if E_1, E_2, E_3 and E_4 are the energies of Lyman, Balmer, Paschen and Brackett series, respectively.
(A) $E_1 > E_2 > E_3 > E_4$ (B) $E_4 > E_3 > E_2 > E_1$ (C) $E_1 < E_2 < E_3 < E_4$ (D) $E_4 < E_3 < E_2 < E_1$

24. Which of the following should be the correct value of the wave number of first line in Balmer series of hydrogen atom?
(A) 5R/36 (B) –5R/36 (C) R/9 (D) –R/9

25. Which of the following should be the expression for the last line of Paschen series?
(A) $\frac{1}{\lambda} = R\left(\frac{1}{9} - \frac{1}{\infty^2}\right)$ (B) $\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{9}\right)$ (C) $\frac{1}{\lambda} = R\left(\frac{1}{9} - \frac{1}{16}\right)$ (D) $\frac{1}{\lambda} = R\left(\frac{1}{16} - \frac{1}{\infty}\right)$

26. Which of the following frequencies is associated with the visible region of a spectrum?
(A) 3×10^9 cycle/second (B) 6×10^{14} cm cycle/second
(C) 5.0×10^{-3} cycle/second (D) None of these

27. What should be the wavelength energy respectively of the emitted light when the electron of hydrogen atom undergoes transition from first excited state to ground state?
(A) 1215 Å and 21.8×10^{-12} erg (B) 6.560 Å and 16.35×10^{-12} erg
(C) 1215 Å and 16.35×10^{-12} erg (D) 6560 Å and 21.8×10^{-12} erg

28. The ratio of the radii of first orbits of H, He (i) and Li (ii) is
(A) 1 : 2 : 3 (B) 6 : 3 : 1 (C) 9 : 4 : 1 (D) 6 : 3 : 2

29. A ball of 100 g mass is thrown with a velocity of 100 ms^{-1}. The wavelength of the de Broglie wave associated with the ball is about
(A) 6.63×10^{-35} m (B) 6.63×10^{-30} m (C) 6.63×10^{-35} cm (D) 6.63×10^{-33} m

ving particle is 1.0×10^{-15} kg m s^{-1}, the minimum uncertainty in its position would be
(A) 5.28×10^{-20} m (B) 5.28×10^{-49} m (C) 6.63×10^{-49} m (D) 6.63×10^{-22} m

31. For the electron if the uncertainty in velocity is Δv, the uncertainty in its position (Δx) is given below:
(A) $\frac{h}{2}\pi m \Delta v$ (B) $\frac{2\pi}{hm\Delta v}$ (C) $\frac{h}{4\pi m \Delta v}$ (D) $\frac{2\pi m}{h\Delta v}$

32. The momentum of a photon of frequency $5 \times 10^{17}\ s^{-1}$ is nearly:
(A) 1.1×10^{-24} kg ms^{-1} (B) 3.33×10^{-43} kg ms^{-1}
(C) 2.27×10^{-40} kg ms^{-1} (D) 2.27×10^{-38} kg ms^{-1}

33. The de Broglie wavelength of a 66 kg man sking down Kufri Hill in Shimla at 1×10^{3} m sec^{-1} is:
(A) 1×10^{-36} m (B) 1×10^{-37} m (C) 1×10^{-38} m (D) 1×10^{-39} m

34. Magnetic quantum number specifies :
(A) size of orbitals (B) shape of orbitals
(C) orientation of orbitals in space (D) nuclear stability

35. For azimuthal quantum number $l = 3$, the maximum number of electrons will be :
(A) 2 (B) 6 (C) zero (D) 14

36. The electrons occupying the same orbital have always ________ spin .
(A) paired (B) unpaired (C) both (A) and (B) (D) none of these

37. Which is not permissible subshell ?
(A) 2d (B) 4f (C) 6P (D) 3S

38. The number of waves made by an electron moving in an orbit having maximum magnetic quantum number + 3 is :
(A) 4 (B) 3 (C) 5 (D) 6

39. Which d-orbital has different shape from rest of all d-orbitals ?
(A) $d_{x^2-y^2}$ (B) d_{z^2} (C) d_{xy} (D) d_{xz} (E) d_{yz}

40. The total number of orbitals in a shell with principal quantum number 'n' is :
(A) 2n (B) $2n^2$ (C) n^2 (D) n + 1

41. Which orbital is dumb-bell shaped ?
(A) s (B) $2p_y$ (C) 3s (D) $3d_{z^2}$

42. What is the correct orbital designation for the electron with the quantum numbers,
$n = 4$, $l = 3$, $m = -2$, $s = 1/2$
(A) 3s (B) 4f (C) 5p (D) 6s

43. The principal quantum number 'n' can have integral values ranging from :
(A) 0 to 10 (B) 1 to ∞ (C) 1 to (n – 1) (D) 1 to 50

44. The valency orbital configuration of an element with Z = 23 is :
(A) $3d^5$ (B) $3d^3, 4s^2$ (C) $3d^2, 4s^2, 4p^1$ (D) $3d^3, 4s^1, 4p^1$

45. Two electrons in the same orbital may be identified with :
(A) n (B) l (C) m (D) s

46. An improbable configuration is :
(A) [Ar] $3d^4, 4s^2$ (B) [Ar] $3d^5, 4s^1$ (C) [Ar] $3d^6, 4s^2$ (D) [Ar] $3d^{10}, 4s^1$

47. The total number of electrons that can be accommodated in all the orbitals having principal quantum number 2 and azimuthal quantum number 1 is :

(A) 2 (B) 4 (C) 6 (D) 8

48. Which atom has as many as s - electron as p - electron ?

(A) H (B) Mg (C) N (D) Na

49. Krypton ($_{36}Kr$) has the electronic configuration ($_{18}Ar$) $4s^2\,3d^{10}\,4p^6$, the 37^{th} electron will go into which of the following subshells .

(A) 4 f (B) 4 d (C) 3 p (D) 5 s

50. For a 'd' electrons , the orbital angular momentum is :

(A) $\sqrt{6}\,\hbar$ (B) $\sqrt{2}\,\hbar$ (C) $\hbar$ (D) $2\hbar$

51. The correct Schrodinger's wave equation for an electron with E as total energy and V as potential energy is :

(A) $$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi^2}{mh^2}(E - V)\,\psi = 0$$

(B) $$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi m}{h^2}(E - V)\,\psi = 0$$

(C) $$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E - V)\,\psi = 0$$

(D) $$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} + \frac{8\pi m^2}{h}(E - V)\,\psi = 0$$

52. Which has minimum number of unpaired d - electrons ?

(A) Fe^{3+} (B) Co^{3+} (C) Co^{2+} (D) Mn^{2+}

EXERCISE 3

CONCEPTUAL SUBJECTIVES

1. Calculate the energy per quantum associated with light of wavelengths .
(a) 5890 Å (b) 250×10^{-9} m (c) 4.0×10^{-8} cm (d) 600 nm
Also calculate the energy per mol of photon in case (d) .

2. A certain laser transition emits 6.37×10^{15} quanta per second per square metre . Calculate the power output in joule per square metre per second . Given $\lambda = 632.8$ nm .

3. Calculate the number of photons emitted in 10 hour by a 60 W sodium lamp .
[λ_{photon} = 5893 Å]

4. 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 ?

5. A certain dye absorbs light of λ = 4530 Å and then fluorescence light of 5080 Å . Assuming that under given conditions 47 % of the absorbed energy is re-emitted out as fluorescence . Calculate the ratio of quanta emitted out to the number of quanta absorbed .

7. A photon of 300 nm is absorbed by a gas and then re-emits two photons . One re-emitted photon has wavelength 496 nm . Calculate energy of other photon re-emitted out .

8. Electromagnetic radiations of wavelength 242 nm is just sufficient to ionize sodium atom. Calculate the ionization energy of sodium in kJ mol^{-1}.

9. Calculate the shortest and longest wavelength in H spectrum of Lyman series. $R_H = 109678\ cm^{-1}$.

10. Calculate the frequency of the spectral line emitted when the electron in n = 3 in H atom de-excites to ground state. $R_H = 109737\ cm^{-1}$.

11. Calculate the wavelength of radiations emitted producing a line in Lyman series, when a electron falls from fourth stationary state in hydrogen atom. ($R_H = 1.1 \times 10^7\ m^{-1}$)

12. Calculate λ of the radiations when the electron jumps from III to II orbit for H atom. The electronic energy in II and III Bohr's orbit of H atom are -5.42×10^{-12} and -2.41×10^{-12} erg respectively.

13. A series of lines in the spectrum of atomic H lies at wavelength 656.46, 486.27, 434.17, 410.29 nm. What is the wavelength of next line in this series?

14. With what velocity must an electron travel so that its momentum is equal to that of a photon of wavelength of λ = 5200 Å?

15. 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 ($1/\lambda$) of the light.

16. Calculate the accelerating potential that must be imparted to a proton beam to give it an effective wavelength of 0.005 nm.

17. An electron moves in an electric field with a kinetic energy of 2.5 eV. What is the association de Broglie wavelength?

18. A dust particle having mass equal to 10^{-11} g, diameter of 10^{-4} cm and velocity 10^{-4} cm sec^{-1}. The error in measurement of velocity is 0.1 % . Calculate uncertainty in its position. Comment on the result.

19. Calculate the uncertainty in velocity of an electron if the uncertainty in its position is of the order of 1 Å.

20. Calculate the uncertainty in velocity of a cricket ball (mass=0.15 kg) if its uncertainty in position is of the order of 1 Å.

21. What is the maximum precision with which the momentum of an electron can be known if the uncertainty in the position of electron is ±0.001 Å? Will there be any problem in describing the momentum if it has a value of $\frac{h}{2\pi a_0}$, where a_0 is Bohr's radius of first orbit, i.e., 0.529 Å?

22. Energy required to stop the ejection of electrons from Cu plate is 0.24 eV. Calculate the work function when radiations of λ= 253.7 nm strikes the plate.

23. Wavelength of the K_a characteristic X-ray of iron and potassium are 1.931×10^{-8} and 3.737×10^{-8} cm respectively. What is the atomic number and name of the element for which characteristic K_a wave length is 2.289×10^{-8} cm?

24. The binding energy of electrons in a metal is 250 kJ mol^{-1}. What is the threshold frequency of metal ?

EXERCISE 4

BRAINSTORMING OBJECTIVES

[SINGLE CORRECT]

1. If the radii of first, second, third and fourth orbits of hydrogen atom are r_1, r_2, r_3 and r_4 respectively, then their correct increasing order will be:
(A) $r_4 < r_3 < r_2 < r_1$ (B) $r_1 < r_2 < r_3 < r_4$ (C) $r_1 > r_2 > r_3 > r_4$ (D) Equal in all

2. If the radii of first orbits of H, He^+, Li^{+2} and Be^{+3} are r_1, r_2, r_3 and r_4 respectively, then their correct decreasing order will be:
(A) $r_1 > r_2 > r_3 > r_4$ (B) $r_3 < r_2 > r_4 < r_1$ (C) $r_1 < r_2 < r_3 > r_4$ (D) Radius of all are equal

3. What should be the ratio of energies of the fifth orbits of Li^{+2} and He^+?
(A) 4 : 9 (B) 9 : 4 (C) 12 : 16 (D) 7 : 2

4. What should be the correct order of energies of the first orbits of H, He^+ and Li^{+2}, if these are represented as E_1, E_2 and E_3 respectively?
(A) $E_1 < E_2 < E_3$ (B) $E_3 < E_2 < E_1$ (C) $E_3 < E_2 < E_1$ (D) $E_1 = E_2 = E_3$

5. Which orbits of H, He^+ and Li^{+2} have identical energies?
(A) Second orbits of all the three
(B) First orbit of H, second orbit of He^+ and third orbit of Li^{+2}
(C) Third orbit of all the three
(D) Fourth orbit of H, First orbit of He^+ and Fifth orbit of Li^{+2}

6. What should be the ratio of energies of the electrons of the first orbits of Na^{+10} and H?
(A) 11:1 (B) 121 : 1 (C) 1 : 121 (D) 1 : 11

7. What should be the frequency (in cycles per second) of the emitted radiation when an electron undergoes transition from M energy level to K energy level, if the value of R is 10^5 cm^{-1}.
(A) $3/2 \times 10^{15}$ (B) $8/3 \times 10^{15}$ (C) $8/5 \times 10^{15}$ (D) $9/4 \times 10^{15}$

8. What should be the frequency of radiation of the emission spectrum when the electron present in hydrogen atom undergoes transition from n = 3 energy level to the ground state?
(A) 3×10^{15} $second^{-1}$ (B) 3×10^5 $second^{-1}$ (C) 3×10^{10} $second^{-1}$ (D) 3×10^8 $second^{-1}$

9. What should be the quantum number of the highest energy state when an electron falls from the highest energy state to Lyman series and for this transition the wave number will be = 97492.2cm^{-1}?
(A) 2 (B) 3 (C) 4 (D) 5

10. The ionization energy of the ground state hydrogen atom is 2.18×10^{-18} J. The energy of an electron in second orbit of He^+ will be
(A) -1.09×10^{-18} J (B) -4.36×10^{-18} J (C) 2.18×10^{-18} J (D) -2.18×10^{-18} J

11. If kinetic energy of a proton is increased nine times the wavelength of the de-Broglie wave associated with it would become
(A) 3 times (B) 9 times (C) 1/3 times (D) 1/9 times

12. We can say that the energy of a photon of frequency ν is given by $E = h\nu$, where h is plank's constant. The momentum of a photon is $p = h/\lambda$, where λ is the wavelength of photon. Then we may conclude that velocity of light is equal to:
(A) $(E/p)^{1/2}$ (B) E/p (C) Ep (D) $(E/p)^2$

13. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy, T_A(expressed in eV) and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.20 V is $T_B = T_A - 1.50\text{eV}$. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then which is not correct ?

(A) The work function of A is 2.25 eV (B) The work function of B is 3.70 eV

(C) $T_A = 2.00$ eV (D) $T_B = 2.75$ eV

14. An ion Mn^{a+} has the magnetic moment equal to 4.9 B.M. The value of 'a' is :

(A) 3 (B) 4 (C) 2 (D) 5

15. Which one represents an impossible arrangement ?

	n	l	m	s		n	l	m	s
(A)	3	2	– 2	1/2	(B)	4	0	0	1/2
(C)	3	2	– 3	1/2	(D)	5	3	0	1/2

16. Correct set of four quantum number for valency (outermost) electron of rubidium (Z = 37) is :

(A) 5 , 0 , 0 , + 1/2 (B) 5 , 1 , 0 , + 1/2 (C) 5 , 1 , 1 , + 1/2 (D) 6 , 0 , 0 , + 1/2

17. In potassium the order of energy level for 19th electron is :

(A) 3 s > 3 d (B) 4 s < 3 d (C) 4 s > 3 p (D) 4 s = 3 d

18. The electronic configuration of the element which is just above the element with atomic number 43 in the same particle group is :

(A) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1 4p^6$ (B) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^2$

(C) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6, 4s^1$ (D) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^2 4p^5$

19. The number of vacant d - orbitals in completely excited Cl atom is :

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

20. The approximate quantum number of a circular orbit of diameter 20.6 nm of the hydrogen atom according to Bohr's theory is :

(A) 10 (B) 14 (C) 12 (D) 16

21. The probability of finding an electron residing in a p_x orbital is not zero :

(A) In the yz plane (B) In the xy plane

(C) In the y direction (D) In the z direction

22. ψ^2 (psi) the wave function represents the probability of finding electron . Its value depends :

(A) inside the nucleus (B) far from the nucleus

(C) near the nucleus (D) upon the type of orbital

23. The number of nodal planes in a p_x orbital is :

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

24. For an electron in a hydrogen atom , the wave function , ψ is proportional to $\exp^{-r/a_0}$, where a_0 is the Bohr's radius . What is the ratio of the probability of finding the electron at the nucleus to the probability of finding it at a_0 .

(A) e (B) e^2 (C) $1/e^2$ (D) zero

25. The maximum probability of finding electron in the d_{xy} orbital is :

(A) along the x-axis (B) along the y-axis

(C) at an angle of 45° from the x & y-axis (D) at an angle of 90° from the x & y-axis

26. Which among the following is correct of $_5B$ in normal state?

	2s	2p		
(A)	$\boxed{\uparrow\uparrow}$	$\boxed{}\boxed{\uparrow}\boxed{}$	:	Against Hund's rule
(B)	$\boxed{\uparrow}$	$\boxed{\uparrow}\boxed{\uparrow}\boxed{}$	:	Against Aufbau principle as well as Hunds rule
(C)	$\boxed{\uparrow\uparrow}$	$\boxed{\uparrow}\boxed{}\boxed{}$	:	Violation of Pauli's exclusion principle and not Hund's rule
(D)	$\boxed{\uparrow\downarrow}$	$\boxed{\uparrow}\boxed{}\boxed{}$	:	Against Aufbau principle

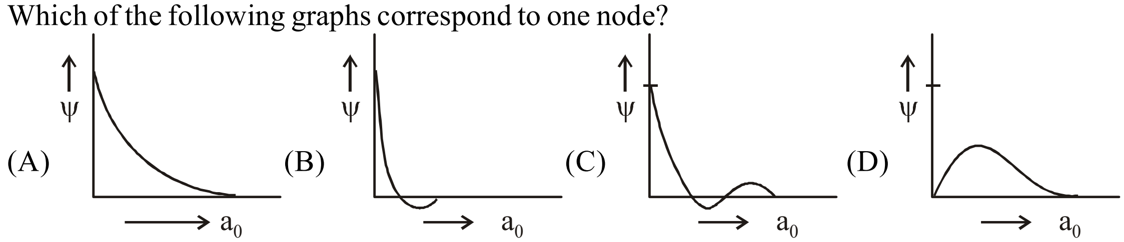
27. Maximum value (n + l + m) for unpaired electron in second excited state of chlorine $_{17}Cl$ is:
(A) 28 (B) 25 (C) 20 (D) none of these

28. The distance between 3rd and 2nd Bohr orbits of hydrogen atom is
(A) 0.529×10^{-8} cm (B) 2.645×10^{-8} cm (C) 2.116×10^{-8} cm (D) 1.058×10^{-8} cm

29. If m = magnetic quantum number l = azimuthal quantum number, then:
(A) $m = l + 2$ (B) $m = 2l^2 + 1$ (C) $l = \frac{m-1}{2}$ (D) $l = 2m + 1$

30. The ratio of $(E_2 - E_1)$ to $(E_4 - E_3)$ for the hydrogen atom is approximately equal to:
(A) 10 (B) 15 (C) 17 (D) 12

31. Which of the following graphs correspond to one node?



32. The number of waves made by a Bohr electron in an orbit of maximum magnetic quantum number 3 is:
(A) 3 (B) 4 (C) 2 (D) 1

33. If the radius of first Bohr orbit of hydrogen atom is 'x' then de Broglie wavelength of electron in 3rd orbit is nearly:
(A) 2px (B) 6px (C) 9x (D) $\frac{x}{3}$

34. How many times does light travel faster in vacuum than an electron in Bohr first orbit of hydrogen atom?
(A) 13.7 times (B) 67 times (C) 137 times (D) 97 times

35. A compound of vanadium has a magnetic moment of 1.73 BM. The electronic configuration of vanadium ion in the compound is:
(A) $[Ar]^3d^2$ (B) $[Ar]^3d^14s^0$ (C) $[Ar]^3d^3$ (D) $3d^04s^1$

36. The orbital angular momentum of an electron in p-orbital is:
(A) zero (B) $\frac{h}{\sqrt{2\pi}}$ (C) $\frac{h}{2\pi}$ (D) $\frac{1}{2}\frac{h}{2\pi}$

EXERCISE 5

BRAINSTORMING SUBJECTIVE

1. When 50 kV d.c. is applied across an X-ray tube, heat is produced in the target at the rate of 495 W. Assuming that 1% of the energy of the incident electrons gets converted to X-rays, find

(a) the number of electrons striking the target per second

(b) the velocity of the incident electron

(c) the shortest wavelength of X-ray produced.

Assume that the electrons are non-relativistic.

2. Consider the hydrogen atom to be a proton embedded in a cavity of radius a_0(Bohr's radius), whose charge is neutralized by the addition of an electron to the cavity in vacuum, infinitely slowly.

(a) Estimate the average of total energy of an electron in its ground state in a hydrogen atom as the work done in the above neutralization process. Also, if the magnitude of the average kinetic energy is half the magnitude of the average potential energy, find the average potential energy.

(b) Also derive the wavelength of the electron when it is a_0 from the proton. How does this compare with the wavelength of an electron in the ground state Bohr's orbit?

3. The velocity of electron in a certain Bohr's orbit of H atom bears the ratio 1 : 275 to the velocity of light

(a) What is the quantum number (n) of orbit?

(b) Calculate the wave number of radiations emitted when electron jumps from (n + 1) state to ground state.

4. The λ of H_α line of Balmer series is 6500Å. What is the λ of H_β line of Balmer series?

5. Calculate the longest wavelength which can remove the electron from I Bohr's orbit . Give E_1 = 13.6 eV.

6. The ionization energy of a H like Bohr's atom is 4 Rydberg.

(a) Calculate the wavelength radiated when electron jumps from he first excited state to ground state.

(b) What is the radius of I orbit of this atom?

7. The IP_1 of H is 13.6 eV. It is exposed to electromagnetic waves of 1028 Å and gives out inducted radiations. Find the wavelength of these induced radiations.

8. The energy E for an electron in H atom is $-\dfrac{21.7\times10^{-12}}{n^2}$ erg. Calculate the energy required to remove electron completely from n = 2 orbit. Also calculate the longest wavelength of light that can be used to cause this transition.

9. Calculate the energy emitted when electrons of 1.0 g atom of hydrogen undergo transition giving the spectral lines of lowest energy in the visible region of its atomic spectra.

10. 1.8 g hydrogen atoms are excited to radiations. The study of spectra indicates that 27% of the atoms are in IIIrd energy level and 15 % of atoms in IInd energy level and the rest in ground state. IP of H is 13.6 eV. Calculate

(a) No. of atoms present in III and II energy level

(b) Total energy evolved when all the atoms return to ground state

11. For He^+ and Li^{2+}, the energies are related to the quantum no. n, through an expression :

$E_n = -\frac{Z^2 B}{n^2}$; where Z is the atomic no. of species and $B = 2.179 \times 10^{-18}$ J.

(a) What is the energy of lowest level of a He^+ ion?

(b) What is the energy of III level of Li^{+2} ion?

12. What hydrogen like ion has the wavelength difference between the first lines of Balmer and Lyman series equal to 59.3 nm? $R_H = 109678\ cm^{-1}$.

13. A stationary He^+ ion emitted a photon corresponding to the first line (H_α) of the Lyman series. That photon liberated a photo electron from a stationary H atom in ground state. What is the velocity of photo electron? $R_H = 109678\ cm^{-1}$.

14. To what series does the spectral lines of atomic hydrogen belong if its wave number is equal to the difference between the wave numbers of the following two lines of the Balmer series: 486.1 and 410.2 nm? What is the wavelength of that line?

15. A hydrogen-like atom (atomic number Z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies 10.20 eV and 17.00 eV respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energy 4.25 eV and 5.95 eV respectively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energy 4.25 eV and 5.95 eV respectively. Determine the values of n and Z.

16. Estimate the difference in energy between 1st and 2nd Bohr's orbit for a H atom. At what minimum at. no., 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 no. corresponds to?

17. The angular momentum of an electron in a Bohr's orbit of H-atom is 4.2178×10^{-34} kg-m^2/sec. Calculate the spectral line emitted when electron falls from this level to next lower level.

18. Find the quantum no. 'n' corresponding to the excited state of He^+ ion if on transition to the ground state that ion emits two photons in succession with wavelengths 108.5 and 30.4 nm.

19. A single electron atom has nuclear charge +Ze where Z is atomic number and e is electronic charge. It requires 42.7 eV to excite the electron from the second Bohr's orbit to third Bohr's orbit. Find

(a) the atomic number of element.

(b) the energy required for transition of electron from third to fourth orbit.

(c) the wavelength required to remove electron from first Bohr's orbit to infinity.

(d) the kinetic energy of electron in first Bohr's orbit.

20. Calculate the angular frequency of an electron occupying the second Bohr's orbit of He^+ ion.

21. The photo electric emission requires a threshold frequency v_0. For a certain metal $\lambda_1 = 2200$Å and $\lambda_2 = 1900$Å produced electrons with a maximum kinetic energy KE_1 and KE_2.
If $KE_2 = 2KE_1$ calculate v_0 and corresponding λ_0.

22. The minimum energy required to overcome the attractive forces between electron and the surface of Ag metal is 7.52×10^{-19}. What will be the maximum kinetic energy of electron ejected out from A which is being exposed to U.V. light of $\lambda = 360$ Å?

23. When 50 kV d.c. is applied across an X-ray tube, heat is produced in the target at the rate of 495 W. Assuming that 1% of the energy of the incident electrons gets converted to X-rays, find

(a) the number of electrons striking the target per second

(b) the velocity of the incident electron

(c) the shortest wavelength of X-ray produced.

Assume that the electrons are non-relativistic.

24. A monochromatic light source of frequency v illuminates a metallic surface and ejects photo electrons. The photo electrons having maximum energy are just able to ionize the hydrogen atoms in ground state. When the whole experiment is repeated with an incident radiation of frequency (5/6.v), the photo electrons so emitted are able to excite the hydrogen atom beam which then emit a radiation of wavelength 1215Å, find the work function of metal and the frequency v.

25. The stopping potential for the photoelectrons emitted from a metal surface of work function 1.7 eV is 10.4V. Find the wavelength of the radiation used. Also identify the energy levels in hydrogen atom which will emit this wavelength. $[R = 1.1 \times 10^{7}\ m^{-1}]$

26. An energy of 68 eV is required to excite a hydrogen like atom from its second Bohr orbit to the third. The nuclear charge is Ze. Find the value of Z, the kinetic energy of the electron in the first Bohr orbit and the wavelength of the radiation required to eject the electrons from the first Bohr orbit to infinity.

27. A particle of charge equal to that of an electron and mass 208 times the mass of the electron moves in a circular orbit around a nucleus of charge +3e. Assuming that the Bohr model of the atom is applicable to this system, (a) derive an expression for the radius of the nth bohr orbit, (b) find the value of n form which the radius of the orbit is approximately the same as that of the first bohr orbit for the hydrogen atom, and (c) find the wavelength of the radiation emitted when the revolving particle jumps from the third orbit to the first.

28. An alpha particle after passing through a potential difference of 2×10^{6} volt falls on a silver foil. The atomic number of silver is 47. Calculate (i) the K.E. of the alpha-particles at the time of falling on the foil. (ii) K.El. of α-particle at a distance of 5×10^{-14} m from the nucleus, (iii) the shortest distance from the nucleus of silver to which the α-particle reaches.

29. Suppose the potential energy between electron and proton at a distance r is given by $\frac{ke^2}{3r^3}$. Use Bohr's theory to obtain energy of such a hypothetical atom.

30. A proton captures a free electron whose K.E. is zero & forms a hydrogen atom of lowest energy-level (n = 1). If a photon is emitted in this process, what will be the wavelength of radiation? In which region of electromagnetic spectrum, will this radiation fall? (Ionization potential of hydrogen = 13.6 volt, $h = 6.6 \times 10^{-34}$ K/s, $C = 3.0 \times 10^{8}$ m/s)

31. The ionisation energy of the hydrogen atom is given to be 13.6 eV. A photon falls on hydrogen atom which is initially in the ground state and excites it to the (n = 4) state.

(a) show this transition in the energy-level diagram &

(b) Calculate the wavelength of the photon

32. Find the wavelength of the first line of He^{+} ion spectral series whose interval between extreme line is

$$\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2} = 2.7451 \times 10^{4}\,cm^{-1}\right]$$

33. The ionisation energy of a H-like Bohr atom is 4 Rydbergs

(i) What is the wavelength of radiation emitted when the e^{-} jumps from the first excited state to the ground state.

(ii) What is the radius of first Bohr orbit for this atom. [1 Rydberg = 2.18×10^{-18} J]

34. Photon having wavelength 12.4 nm was allowed to strike a metal plate having work function 25 eV. Calculate the

(a) Maximum kinetic energy of photoelectrons emitted in eV.

(b) Wavelength of electon with maximum kinetic energy in $\mathring{A}$.

(c) Calculate the uncertainity in wavelenght of emitted electron if the uncertainity in the momentum is 6.62×10^{-28} Kg m/sec.

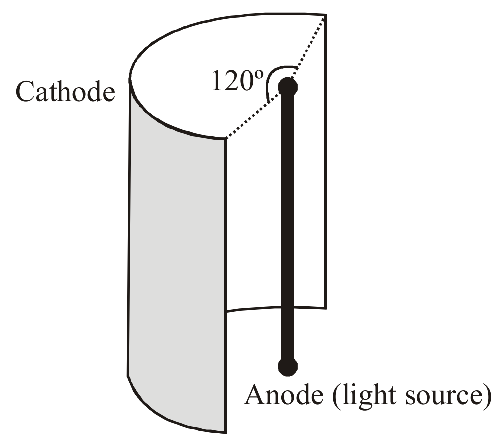
35. Electron present in single electron species jumps from energy level 3 to 1. Emitted photons when passed through a sample containing excited He^{+}ion causes further excitation to some higher energy level (Given $En = -13.6\frac{Z^2}{n^2}$). Determine

(i) Atomic number of single electron species.

(ii) Principal quantum number of initial excited level & higher energy level of He^{+}.

36. The angular momentum of an electron in a Bohr's orbit of H-atom is 3.1652×10^{-34} kg-m^2/sec. Calulate the wavenumber in terms of Rydberg constant (R) of the spectral line emitted when an electron falls from this level to the ground state. [Use $h = 6.626 \times 10^{-34}$ Js]

37. A cylindrical source of light which emits radiation radially (from curved surface) only, placed at the centre of a hollow, metallic cylindrical surface, as shown in diagram.



The power of source is 90 watt and it emits light of wavelength 4000 $\mathring{A}$ only. The emitted photons strike the metalllic cylindrical surface which results in ejection of photoelections. All ejected photoelectrons reaches to anode (light source). The magnitude of photocurrent is [Given : $h = 6.4 \times^{-34}$ J/sec]

38. Mr. Ramesh 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

$$\psi_{(r)} = k_1.e^{-r/k_2}\left(r^2 - 5k_3r + 6k_3^2\right)$$

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 robital belongs

Info D = No. of subshells haviang 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 nuclius (Assuming $k_3 = 1$).

39. In the Bohr's model, for unielectronic species following symbols are used

$r_{n,z} \rightarrow$Radius of n^{th} orbit with atomic number "z"

$U_{n,z} \rightarrow$Potential energy of electron in n^{th}orabit with atomic number "z"

$K_{n,z}$ →Kinetic energy of electron in n^{th} orbit with atomic number "z"
$v_{n,z}$ →Velocity of electron in n^{th} orbit with atomic number"z"
$T_{n,z}$ →Time period of revolution of electron in n^{th} orbit with atomic number"z"
Calculate z in all in cases.

(i) $U_{1,2} : K_{1,z} = -8 : 1$ (ii) $r_{1,z} : r_{2,1} = 1 : 8$
(iii) $V_{1,z} : V_{3,1} = 9 : 1$ (iv) $T_{1,2} : T_{2,z} = 9 : 32$

Represent your answer as abcd, where a, b, c and d represent number from 0 to 9 a, b, c and d represents the value of "z" in parts (i), (ii), (iii) & (iv). Suppose your answer is 1, 2, 3 & 4 then the same must be filled in OMR sheet as 1234.00

40. Instead of principal quantum number n, *l* and m, a set of new quantum numbers was introduced with similar logic but different values as defined below

s = 1,2,3.... all +ive integral values
t = (s – 1), (s – 3), (s – 5)......... No negative value
u = $\left(t+\frac{1}{2}\right)$ to $-\left(t+\frac{1}{2}\right)$ in integral steps

For each value of 'u' there will be three electron.

(i) Calculate the number of electrons in s = 1 shell?
(ii) Corresponding to t = 0 , 1, 2, 3.... a sub - sheel is represented by s, p, d, f, g.... respectively. Calculate the number of electrons in 3d subshell.
(iii) (s + t) rule is defined similar to (n + *l*) rule then write the principla quantum number and azimuthal quantum number of the last subshell for Fe and represent it as n *l*.

Represent your answer as abcdef, where a, b, c, d, e and f represent number from 0 to 9 'ab' and d represents your answer of (i) part, 'cd' represents answer of (ii) part and 'ef' represents answer of (iii) part. Suppose your answer is 2, 36, 9 then the same must be filled in OMR sheel as '0236.09'.

EXERCISE 6

NEW IIT-JEE PATTERN QUESTION

MULTIPLE CHOICE ANSWER TYPE

1. The protons and neutrons are collectively called
(A) deutrons (B) positrons (C) mesons (D) nucleons

2. The correct configuration of $_{29}Cu$ is
(A) $[Ar]\,4s^1$ (B) $[Ar]4s^2$ (C) $[Ar]\,3d^{10}4s^1$ (D) $[Ar]3d^94s^2$.

3. The atomic orbitals are progressively filled in order of increasing energy. This principle is called.
(A) Hund's rule (B) Aufbau principle (C) Exclusion principle (D) de- Broglie rule.

4. The value of Azimuthal quantum number for all electrons present in 5p orbitals is
(A) 4 (B) 5 (C) 2 (D) 1

5. Which of the following sets of quantum number is not possible?
(A) $n = 3;\ l = 0 + 2,\ m_l = 0,\ m_s = +\frac{1}{2}$ (B) $n = 3;\ l = 0\ ,\ m_l = 0,\ m_s = -\frac{1}{2}$
(C) $n = 3;\ l = 0,\ m_l = -1,\ m_s = +\frac{1}{2}$ (D) $n = 3;\ l = 1,\ m_l = 0,\ m_s = -\frac{1}{2}$

6. $^{13}_{6}C$ and $^{12}_{6}C$ differ from each in respect of number of
(A) electrons (B) protons (C) neutrons (D) none of these

7. $^{30}_{14}Si$ and $^{31}_{15}P$ are
(A) isotopes (B) isobars (C) isomorphs (D) isotones

8. In Aufbau principle, the word 'Aufbau'
(A) represents the name of scientist (B) is a German word
(C) is related to the energy of electron (D) none of these

9. The electrons of the same orbitals can be distinguished by
(A) principal quantum number (B) azimuthal quantum number
(C) spin quantum number (D) magnetic quantum number.

10. The maximum number of electrons in $_{19}K$ atom with quantum number ($n = 3,\ m_l = +1,\ m_s = +\frac{1}{2}$) is
(A) 6 (B) 4 (C) 2 (D) 1

11. Be's 4th electron will have the four quantum numbers

	n	l	m_l	m_s
(A)	1	0	0	$+\frac{1}{2}$
(B)	1	1	+1	$+\frac{1}{2}$
(C)	2	0	0	$-\frac{1}{2}$
(D)	2	1	0	$+\frac{1}{2}$

12. Isotopes of an element have

(A) similar chemical properties but different physical properties

(B) similar chemical and physical properties

(C) similar physical properties but different chemical properties.

(D) different chemical and physical properties.

13. For a given principal level n = 4, the energy of its subshells is in the order

(A) s < p < d < f (B) s > p > d > f (C) s < p < f < d (D) f < p < d < s.

14. Which quantum number is sufficient to determine the energy of the electron in hydrogen atom?

(A) l (B) n (C) m_s (D) m_l

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

(A) Li^+ (B) H (C) Na (D) He

16. $^{22}_{11}Na$ contains

(A) 22 Protons (B) 22 Neutrons (C) 11 Neutrons (D) None of these

17. For the energy levels in an atom, which one of the fallowing statement is correct?

(A) There are seven principal electron energy levels

(B) the second principal energy level has four orbitals and contains a maximum of eight electrons

(C) The M energy level can have a maximum of 32 electrons

(D) The 4s sub-energy level has higher energy that 3d sub-energy level.

18. The maximum number of electrons in a sub-shell is given by the expression

(A) $4l - 2$ (B) $4l + 2$ (C) $2l + 1$ (D) $2n^2$

19. If atomic numbers of nickel and copper are 28 and 29 respectively which of the following does the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ represent?

(A) Cu^+ (B) Cu^{2+} (C) Ni^{+2} (D) Ni

20. The credit of discovering neutron goes to

(A) Rutherford (B) Thomson (C) Goldstein (D) Chadwick

21. The maximum number of electrons in a subshell for which $l = 3$ is:

(A) 14 (B) 10 (C) 8 (D) 4

22. The wavelength of the radiowaves having frequency 3MHz would be:

(A) 100 m (B) 300 m (C) 100 nm (D) 300 nm.

23. The number of sub-shells in the fifth energy level is

(A) 4 (B) 11 (C) 9 (D) 5

24. The number of orbitals in the fourth energy level is:

(A) 4 (B) 16 (C) 32 (D) 9

25. The maximum number of electrons with clockwise spin that can be accommodated in a f-sub-shell is

(A) 14 (B) 7 (C) 5 (D) 10

26. The maximum value of m for an electron in fourth energy level is:

(A) +4 (B) +3 (C) +5 (D) +9

27. The maximum number of electrons that can b accommodated in fifth energy level is:

(A) 10 (B) 25 (C) 50 (D) 32

28. In magnesium atom, in ground state, the number of electrons with m = 0 is:

(A) 4 (B) 6 (C) 2 (D) 8

29. In chromium atom, in ground state, the number of occupied orbital is

(A) 14 (B) 15 (C) 7 (D) 12

0

30. In Mn^{2+} ion, the number of unpaired electrons is

(a) 2 (B) 3 (C) 4 (D) 5

31. For a 'd'-electron, the orbital angular momentum is

(A) $\sqrt{6}\ \hbar$ (B) $\sqrt{2}\ \hbar$ (C) $\hbar$ (D) $2\hbar$

32. The radius of the first orbit of hydrogen is 0.53 Å. The radius of second orbit would be:

(A) 1.06 Å (B) 2.12 Å (C) 0.53 Å (D) 0.26 Å

33. The radius of the first orbit of hydrogen is 0.53 Å. The radius of second orbit of He+ would be

(A) 1.06 Å (B) 2.12Å (C) 0.53 Å (D) 0.26Å

34. The ratio of the radii of first orbits of H, He^+ and Li^{2+} is

(A) 1 : 2 : 3 (B) 6 : 3 : 2 (C) 1 : 4 : 9 (D) 9 : 4 : 1

35. Which electronic transition in hydrogen atom is accompanied by maximum release of energy?

(A) n = 2 to n = 1 (B) n = 3 to n = 2 (C) n = 4 to n = 3 (D) n = 4 to n = 2

36. The ionization energy of hydrogen atom is 13.6 eV. The second ionization energy of He would be

(A) 13.6 eV (B) 27.2 eV (C) 40.8 eV (D) 54.4 eV

37. The wave number of the limiting line in Lyman series of hydrogen is 109678 cm^{-1}. The wave number of the limiting line in Balmer series of He^+ would be:

(A) 54839 cm^{-1} (B) 219356 cm^{-1} (C) 109678 cm^{-1} (D) 438712 cm^{-1}

38. The ratio of the radius of the atom to the radius of the nucleus is of the order of

(A) 10^5 (B) 10^6 (C) 10^{-5} (D) 10^{-8}

39. A body of mass 10 mg is moving with a velocity of 100 ms^{-1}. The wavelength of the de Broglie wave associated with it would be:

(A) 6.63×10^{-37} m (B) 6.63×10^{-31} m

(C) 6.63×10^{-34} m (D) 6.63×10^{-35}m

40. Which of the following sets of the quantum numbers is permitted?

(A) $n = 4, l = 2, m_l = +3, m_s = +\frac{1}{2}$ (B) $n = 3, l = 3, m_l = +3, m_s = +\frac{1}{2}$

(C) $n = 4, l = 0, m_l = 0, m_s = +\frac{1}{2}$ (D) $n = 4, l = 3, m_l = +1, m_s = 0$

41. The uncertainty in momentum of moving particle is 1.0×10^{-15} kg ms^{-1}, the minimum uncertainty in its position would be :

(A) 5.28×10^{-20}m (B) 5.28×10^{-49}m

(C) 6.63×10^{-49}m (D) 6.63×10^{-22} m

42. The charge to mass ratio of protons is

(A) 9.55×10^{-4} C/g (B) 9.55×10^{4} C/g

(C) 1.76×10^{8} C/g (D) 1.76×10^{-8} m

43. A sub-shell with n = 6, l = 2 can accommodate a maximum of

(A) 12 electrons (B) 36 electrons (C) 10 electrons (D) 72 electrons

44. The charge to mass ratio of α-particles is approximately ..... the charge to mass ratio of protons

(A) twice (B) half (C) four times (D) Six times.

45. What electronic transition in Li^{2+} produces the radiation of the same wavelength as the first line in the Lyman series of hydrogen?

(A) n = 4 to n = 2 (B) n = 9 to n = 6 (C) n= 9 to n = 3 (D) n = 6 to n = 3

46. An electron has spin quantum number, $m_s = +\frac{1}{2}$ and magnetic quantum number, $m_l = +1$. it cannot be present in

(A) s-orbital (B) p-orbital (C) d-orbital (D) f-orbital

47. The first use of quantum theory to explain the structure of atom was made by

(A) Heisenberg (B) Bohr (C) Planck (D) Einstien

48. The ratio of specific charge of an electron to that of a proton is

(A) 1 : 1 (B) 1837 : 1 (C) 1 : 1837 (D) 2 : 1

49. According to Aufbau principle, the 19th electron in an atom goes into the

(A) 4s-orbital (B) 3d-orbital (C) 4p-orbital (D) 3p-orbital.

50. In a multielectron atom, the energy of the electron in a particular orbital is determined by

(A) n only (B) l only (C) n and l (D) n, l and m_l.

51. The orbital diagram in which both Pauli's exclusion principle and Hund's rule are violated is:

(A) $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\uparrow}\boxed{\uparrow}\boxed{}$ (B) $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{}$

(C) $\boxed{\uparrow\downarrow}\ \boxed{\downarrow}\boxed{\downarrow}\boxed{\downarrow}$ (D) $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\downarrow}$

52. Who modified Bohr's theory by introducing elliptical orbits for electron path?

(A) Hund (B) Thomson (C) Rutherford (D) Sommerfeld

53. The electrons, identified by quantum numbers n and l, (i) n = 4, l = 1 (ii) n= 4, l = 0 (iii) n = 3, l = 2 (iv) n = 3, l = 1 can be placed in order of increasing energy, from the lowest to highest, as

(A) (iv) < (ii) < (iii) < (i) (B) (ii) < (iv) < (i) < (iii)

(C) (i) < (iii) < (ii) < (iv) (D) (iii) < (i) < (iv) < (ii)

54. Which of the following has the maximum number of unpaired d-electrons?

(A) Zn (B) Fe^{2+} (C) Ni^{3+} (D) Cu^{+}

55. Which of the following ions has the maximum value of magnetic moment?

(A) Cu^{+} (B) Cu^{2+} (C) Fe^{2+} (D) Fe^{3+}

56. How many electrons in argon have m = 0?

(A) 6 (B) 8 (C) 10 (D) 12.

57. Which of the following triads represents isotones?

(A) ${}^{12}_{6}C$, ${}^{13}_{6}C$, ${}^{14}_{6}C$ (B) ${}^{40}_{18}Ar$, ${}^{42}_{20}Ca$, ${}^{43}_{21}Sc$

(C) ${}^{40}_{18}Ar$, ${}^{40}_{20}Ca$, ${}^{41}_{21}Sc$ (D) ${}^{14}_{7}N$, ${}^{16}_{8}O$, ${}^{18}_{9}F$

58. 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 for electrons in Bohr orbits of Li^{2+} is

(A) –61.2 eV (B) –13.6 eV (C) –122.4 eV (D) +6.8 eV

59. The number of nodal planes in a p_x orbital is

(A) one (B) two (C) three (D) Zero

60. The electronic configuration of an element is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$. This represents its

(A) excited state (B) ground state (C) cationic form (D) anionic form

61. The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 m/h is of the order

(A) 10^{-10}m (B) 10^{-20}m (C) 10^{-30}m (D) 10^{-40} m

62. The quantum numbers $+\frac{1}{2}$ and $-\frac{1}{2}$ for the electron spin represent

(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.

63. Identify the least stable among the following:

(A) Li^- (B) Be^- (C) B^- (D) C^-.

64. If the nitrogen atom had electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^22s^22p^3$, because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed. It violates.

(A) Heisenberg's uncertainty principle (B) Hund's rule

(C) Pauli's exclusion principle (D) Bohr postulate of stationary orbits.

65. Rutherford experiment which established the nuclear model of the atom used a beam of

(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.

66. The number of radial nodes in 3s and 2p respectively are:

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

More than one correct:

67. Which of the following orbitals has (have) one spherical node?

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

68. For an electron, magnetic quantum number m = +2. The electron may be present in

(A) 5s-sub-shell (B) 5d-sub-shell

(C) 5p-sub-shell (D) 5f-sub-shell

69. The energy of an electron in the first energy level of H atom is –13.6 eV. The possible energy value(s) of the excited state(s) for electrons in He+ is(are)

(A) – 54.4 eV (B) – 13.6 eV (C) – 3.4 eV (D) – 6.4 eV

70. Which of the following sets of quantum number is(are) correct:

(A) $n = 5, l = 4, m = 0, s = +\frac{1}{2}$ (B) $n = 3, l = 3, m = +3, s = +\frac{1}{2}$

(C) $n = 6, l = 0, m = +1, s = -\frac{1}{2}$ (D) $n = 4, l = 2, m = +2, s = 0$

71. Which of the following species has (have) five unpaired electrons?

(A) Cr (B) Mn (C) Mn^{2+} (D) Fe^{2+}

72. Which of the following species is(are) expected to be paramagnetic?

(A) N_2 (B) N_2^{2+} (C) O_2 (D) O_2^{2+}

73. In magnesium atom, energy of an electron in an orbital is determined by quantum number(s)

(A) n (B) l (C) m (D) s

74. Which of the following species has(have) two unpaired electrons?

(A) O_2^{2+} (B) O_2^{2-} (C) N_2 (D) B_2

75. Which of the following species have identical bond order?

(A) CN^- (B) O_2^- (C) NO^+ (D) CN^+

76. Which of the following statements is(are) correct?

(A) The electronic configuration of Cr is $[Ar]3d^5\,4s^1$ (atom in no. 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 no. of Ag = 47)

(D) The oxidation sate of nitrogen in NH_3 is –3.

77. Ground state electronic configuration of nitrogen atom can be represented as

(A) $\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\,|\,\uparrow\,|\,\uparrow}$

(B) $\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\,|\,\downarrow\,|\,\uparrow}$

(C) $\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\,|\,\downarrow\,|\,\downarrow}$

(D) $\boxed{\uparrow\downarrow}\quad\boxed{\uparrow\downarrow}\quad\boxed{\downarrow\,|\,\downarrow\,|\,\downarrow}$

78. Which of the following substances have London force as the intermolecular forces?

(A) HCl (B) CO_2 (C) N_2 (D) H_2O

79. Which of the following substance have hydrogen bond as the intermolecular forces?

(A) ammonia (B) ethanol (C) Diethyl ether (D) Ethanal

80. In which of the following situations the heavier of the two particles has smaller de Broglie wavelength? The two particles

(A) move with the same speed

(B) move with the same linear momentum

(C) move with the same kinetic energy

(D) have fallen through the same height

81. If the wavelength of light in an experiment on photoelectric effect is doubled,

(A) the photoelectric emission will not take place

(B) the photoelectric emission may or may not take place

(C) the stopping potential will increase

(D) the stopping potential will decrease

82. In photoelectric effect, stopping potential depends on

(A) frequency of the incident light

(B) intensity of the incident light by varying source distance

(C) emitter's properties

(D) frequency and intensity of the incident light

83. Let ν_1 be the frequency of the series limit of the Lyman series, ν_2 be the frequency of the first line of the Lyman series, and ν_3 be the frequency of the series limit of the Balmer series, then

(A) $\nu_1 - \nu_2 = \nu_3$ (B) $\nu_2 - \nu_1 = \nu_3$ (C) $\nu_3 = \frac{1}{2}(\nu_1 + \nu_2)$ (D) $\nu_1 + \nu_2 = \nu_3$

84. Whenever a hydrogen atom emits a photon in the Balmer series,

(A) it may emit another photon in Balmer series

(B) it must emit another photon in Lyman series

(C) the second photon, if emitted, will have a wavelength of about 122 nm

(D) it may emit a second photon, but the wavelength of this photon cannot be predicted

85. An electron in hydrogen atom first jumps from second excited state to first excited state and then from first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be a, b and c respectively. Then

(A) $c = \frac{1}{a}$ (B) $a = \frac{9}{4}$ (C) $b = \frac{5}{27}$ (D) $c = \frac{5}{27}$

86. Choose the correct statement among the following

I Radial distribution function ($\psi^2 . 4\pi r^2 dr$) give probability at a particular distance along one chosen direction

II ψ^2 (r) give probability density at a particular distance over a spherical surface

III For 's' orbitals $\psi(r)\,\psi(\theta)\psi(\phi) = \psi(x, y, z)$ is independent of π and ϕ

IV '2p' orbital with quantum numbers. $n = 2$, $l = 1$, $m = 0$, also shows angular dependence

(A) III, IV (B) II, III, IV (C) I, III, IV (D) III, IV

87. Correct statement (s) regarding $3P_y$ orbital is /are

(A) Angular part of wave function is independent of angles (θ and ϕ)

(B) No. of maxima when a curve is plotted between $4\pi r^2 R^2(r)$ vs r are '2'

(C) 'xz' plane acts as nodal plane

(D) Magnetic quantum number must be '–1'

88. Select the corect 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^+ and H have similar spectrum.

(D) The total energy of an electron in unielectronic species is greater than zero

89. Choose the incorrect statement(s) :

(A) Increasing order of wavelength is

Micro waves > Radio waves > IR waves > visible waves > UV waves

(B) The roder of Bohr radius is (r_n: where n is orbit number for a given atom)

$r_1 < r_2 < r_3 < r_4$

(C) The order of total energy is (E_n : where n is orbit number for a given atom)

$E_1 > E_2 > E_3 > E_4$

(D) The order of velocity of electron in H, He^+, Li^+, Be^{3+} species in second Bohr orbit is

$Be^{3+} > Li^{+2} > He^+ > H$

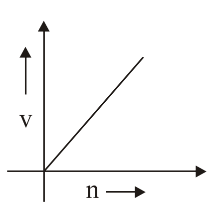
90. Select the correct curve (s) :

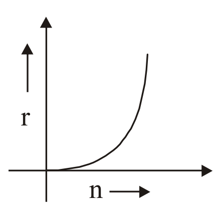
If : v = velosity of electron in Bohr's orbit

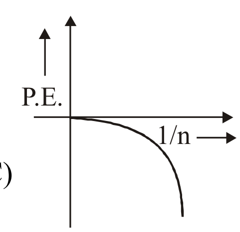
r = Radius of elecctron in Bohr's orbit

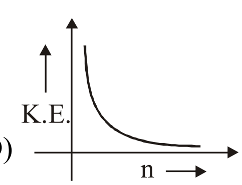
P. E. = Potential energy of electron in bohr's orbit

K.E. = Kinetic energy of electron in Bohr's orbit.

(A) 

(B) 

(C) 

(D) 

REASONING TYPE

ASSERTION -REASON

The following questions consist of two statements, one labelled as Statement-I and the other labelled as Statement-II. Examine both the statements and mark the correct choice according to the instructions given below:

(A) if both statement-I and Statement-II are correct and Statement-II is the correct reason of Statement-I

(B) if both statement-I and Statement-II are correct but Statement-II is not the correct reason of Statement-I

(C) Statement-I is correct and statement–II is wrong

(D) Statement-I is wrong and statement–II is correct.

91. Statement-I: s-orbital cannot accommodate more than two electrons.
Statement-II: s-orbitals are extremely poor shielders.

92. Statement-I: In H atom, the energy of 3d-level is smaller than 4s-level.
Statement-II: An orbital with lower value of $(n + l)$ has energy smaller than the orbital with larger value of $(n + l)$.

93. Statement-I: 2p-orbitals do not have any spherical node.
Statement-II: The number of spherical node in p-orbitals is given by $(n – 2)$, here n is principal quantum number.

94. Statement-I: In fourth energy level, their is no g-subshell.
Statement-II: g-subshll has in orbitals.

95. Statement-I: The two electrons present in the first energy level cannot have same value of spin quantun number.
Statement-II: There is only one orbital in the first energy level.,

96. Statement-I: In multielectron atoms, such as sodium, all the subshells of a particular energy level has different energies.
Statement-II: Electrons in different subshlls feel different screening effect.

97. Statement-I: The maximum value of m for an electron in third energy level is 3.
Statement-II: The maximum value of l for an electron in third energy level is 2.

98. Statement–1 : The atomic number of specie is 29.
Statement–2 : The charge on the specie is +1.

99. Statement–1 : The radial function of the orbital is $R(r) = \dfrac{1}{9\sqrt{6}a_0^{3/2}}(5-\sigma)\sigma e^{-\sigma/2}, \sigma = \dfrac{r}{2}$
Statement–2 : The robital has 1 radial node & 0 angular node.

100. 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 may two energy level provided level '1' is not part of those two energy levels.

101. Statement–1 : Emitted radiations will fall in visible range when an electron jump from higher level to n = 2 in Li^{+2} ion.
Statement–2 : Balmer series radiations belong to visible range in all H atoms.

102. Statement–1 : Minimum principla quantum number of an orbital belonging to 'g' sub-shell is 5.
Statement–2 : For a given value of principal quantum number (n) l may have values 0 to $(n –1)$ only.

LINKED COMPREHENSION TYPE

Passage-1

A ruby laser produces radiation of wavelength 633 nm in pulses of duration 1 ns. The laser produces 0.376 J of energy per pulse. Answer the following question:

103. The number of photons produces in each pulse is

(A) 1.18×10^{19} (B) 1.197×10^{20} (C) 1.18×10^{-19} (D) $1.197 + 10^{18}$

104. The frequency of the radiation emitted is

(A) 2.11×10^{14}Hz (B) 4.74×10^{14}Hz (C) 2.11×10^{15}Hz (D) 4.74×10^{15}Hz

105. The power (in watts) delivered by the laser is

(A) 3.76×109 W (B) 3.76×10^{-9} W (C) 3.76×10^{8} W (D) 2.65×10^{9}W

106. Ruby is a mineral containing

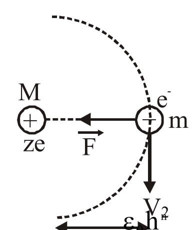
(A) ZnS (B) Al_2O_3

(C) Al_2O_3 in which some of Al^{3+} ions are replaced by Fe^{+3} ions

(D) Al_2O_3 in which some of Al^{3+} ions are replaced by Cr^{3+} ions.

Passage-2

Hydrogen is the simplest atom of nature. There is one proton in its nucleus and an electron moves around the nucleus in a circular orbit. According to Niel Bohr, this electron moves in a stationary orbit. When this electron is in the stationary orbit, it emits no electromagnetic radiation. The angular momentum of the electron is quantized, i.e., $mvr = n\left(\frac{h}{2\pi}\right)$, where, m = mass of the electron, v = velocity of the electron in the orbit, r = radius of the orbit, n = 1, 2, 3 …….. When transition takes placed from Kth orbit to Jth orbit, energy photon is emitted. If the wavelength of the emitted photon is λ, we find that $\frac{1}{\lambda} = R\left(\frac{1}{J^2} - \frac{1}{K^2}\right)$ where R is Rydberg's constant. On a different planet, the hydrogen atom's structure was somewhat different from ours. There the angular momentum of electron was $P = 2n\left(\frac{h}{2\pi}\right)$, i.e., an even multiple of $\left(\frac{h}{2\pi}\right)$.



Answer the following questions based on above passage :

107. The minimum permissible radius of the orbit will be

(A) $\frac{2\varepsilon_0 h^2}{mpe^2}$ (B) $\frac{4\varepsilon_0 h^2}{mpe^2}$ (C) $\frac{\varepsilon_0 h^2}{mpe^2}$ (D) $\frac{\varepsilon_0 h^2}{2mpe^2}$

108. In our world, the velocity of electron is V_0 when the hydrogen atom is in the ground state. The velocity of electron in this state on the other planet should be

(A) V_0 (B) $V_0/2$ (C) $V_0/4$ (D) $V_0/8$

109. In our world, the ionization potential energy of a hydrogen atom is 13.6 eV. On the other planet, this ionization potential energy will be

(A) 13.6 eV (B) 3.4 eV (C) 1.5 eV (D) 0.85 eV

Passage-3

The atomic number of chromium is 24. Its electronic configuration in ground state $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^5$. Chromium atom by losing 3 electrons forms Cr^{3+} ions. A chromium atom contains 17%

more neutrons than the protons. Now answer the following questions:

110. The number of unpaired electrons in Cr^{3+} ions is:

(A) 3 (B) 6 (C) 1 (D) 5

111. The number of electrons having n = 3 and $m_l = 0$, in chromium atom is:

(A) 2 (B) 5 (C) 4 (D) 1

112. The group number and period of the chromium in the periodic table are respectively

(A) 6 and 3 (B) 5 and 3 (C) 6 and 4 (D) 5 and 4

113. The chromium atom can be represented by the symbol

(A) $^{50}_{24}Cr$ (B) $^{52}_{24}Cr$ (C) $^{24}_{52}Cr$ (D) $^{52}_{50}Cr$

114. The number of occupied sub-shells in Cr^{3+} ion is

(A) 3 (B) 4 (C) 5 (D) 6

Passage-4

The French physicist Louis de-Broglie in 1924 Postulated that matter, like radiation, should exhibit a dual behaviour. He proposed the following relationship between the wavelength λ of a material particle, its linear momentum p and planck constant h.

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

The de Broglie relation implies that the wavelength of a particle should decreases as its velocity increases. It also implies that for a given velocity heavier particles should have shorter wavelength than lighter particles. The waves associated with particles in motion are called matter waves or de Broglie waves. These waves differ from the electromagnetic waves as they

(i) have lower velocities

(ii) have no electrical and magnetic fields and

(iii) are not emitted by the particle under consideration.

The experimental confirmation of the de-Broglie relation was obtained when Davisson and Germer, in 1927, observed that a beam of electrons is diffracted by a nickel crystal. As diffraction is a characteristic property of waves, hence the beam of electron behaves as a wave, as proposed by de Broglie.

Werner Heisenberg considered the limits of how precisely we can measure properties of an electron or other microscopic particle like electron. He determined that there is a fundamental limit of how closely we can measure both position and momentum . The more accurately we measure the momentum of a particle, the less accurately we can determine its position. The converse is also true. This is summed up in what we now call the "Heisenberg uncertainty principle: It is impossible to determine simultaneously and precisely both the momentum and position of a particle. The product of uncertainly in the position,

Δx and the uncertainly in the momentum $\Delta(mv)$ must be greater than or equal to $\frac{h}{4\pi}$ .i.e.

$$\Delta x \ \Delta(mv) \geq \frac{h}{4\pi}$$

115. The correct order of wavelength of Hydrogen ($_1H^1$), Deuterium ($_1H^2$) and Tritum ($_1H^3$) moving with same kinetic energy is

(A) $\lambda_H > \lambda_D > \lambda_T$ (B) $\lambda_H = \lambda_D = \lambda_T$ (C) $\lambda_H < \lambda_D < \lambda_T$ (D) $\lambda_H < \lambda_D > \lambda_T$

116. The transition, so that the de-Broglie wavelength of electron becomes 3 tims of its initial value in He^{+}ion will be

(A) $2 \rightarrow 5$ (B) $3 \rightarrow 2$ (C) $2 \rightarrow 6$ (D) $1 \rightarrow 2$

117. If the uncertainty in velocity & position is same, then the uncertainty in momentum will be

(A) $\sqrt{\frac{hm}{4\pi}}$ (B) $m\sqrt{\frac{h}{4\pi}}$ (C) $\sqrt{\frac{h}{4\pi m}}$ (D) $\frac{1}{m}\sqrt{\frac{h}{4\pi}}$

Passage-5

The only electron in the hydrogen atom resides under ordinary conditions on the first orbit. When energy is supplied, the electron moves to higher energy orbit depending on the amount of energy absorbed. When this electron returns to any of the lower orbits, it emits energy. Lyman series is formed when the electron returns to the lowest orbit while Balmer series is formed when the electron returns to second orbit. Similarly, paschen, Brackett and P fund series are formed when electron returns to the third, fourth and fifth orbits from higher energy orbits respectively .Maximum number of lines produced when an electron jumps from nth level to ground level is equal to $\frac{n(n-1)}{2}$. For example, in the case of $n = 4$, number of lines produced is 6. ($4 \rightarrow 3, 4 \rightarrow 2, 4 \rightarrow 1, 3 \rightarrow 2, 3 \rightarrow 1, 2 \rightarrow 1$). When an electron returns from n_2 to n_1 state, the number of lines in the spectrum will be equal to

$$\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

If the electron comes back from energy level having energy E_2 to energy level having energy E_1, then the difference may be expressed in terms of energy of photon as:

$$E_2 - E_1\ \Delta E,\ \lambda = \frac{hc}{\Delta E}$$

Since h and c are constants, ΔE corresponds to definite energy; thus each transition from one energy level to another will produce a ligtht of definite wavelength. This is actually observed as a line in the spectrum of hydrogen atom.

Wave number of line given by the formula $\vec{v} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

where R is a Rydberg's constant ($R = 1.1 \times 10^{7}\ m^{-1}$)

118. The energy photon emitted corresponding to transition $n = 3$ to $n = 1$ is [$h = 6 \times 10^{-34}$J-sec.]

(A) 1.76×10^{-18}J (B) 1.98×10^{-18}J (C) 1.76×10^{-17}J (A) None of these

119. Inb a collection of H-atom electrons make transition from 5^{th} excited state to 2nd excited state then maximum number of different types of photons observed are

(A) 3 (B) 4 (C) 6 (D) 15

120. The difference in the wavelength of the 1^{st} line of Lyman series and 2^{nd} line of Balmer series in hydrogen atom is

(A) $\frac{9}{2R}$ (B) $\frac{4}{R}$ (C) $\frac{88}{15R}$ (D) None

121. The wave number of electromagnetic radiation emitted during the transition of electron in between two levels of Li^{2+}ion whose principal quantum numbers sum is 4 and difference is 2 is

(A) 3.5 R (B) 4R (C) 8 R (D) $\frac{8}{9}$R

MATRIX MATCH TYPE

Math the column–

122.

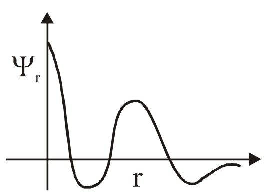
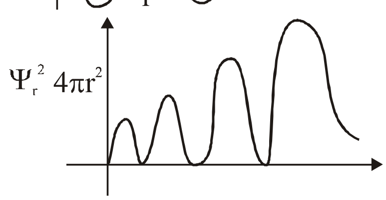
Column–I		Column–II	
(A)	$E = hc\bar{v}$	(p)	Rydberg formula
(B)	$\Delta x.\Delta p \geq \frac{h}{4\pi}$	(q)	de-Broglie relation
(C)	$\bar{v} = 109677\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$	(r)	Heisenberg uncertainty principle
(D)	$\lambda = \frac{h}{p}$	(s)	Energy of photon

123.

Column–I		Column–II	
(A)	4	(p)	Number of node in 3s
(B)	5	(q)	Number of sub-shell in third energy level
(C)	3	(r)	Number of unpaired electrons in Fe^{3+}
(D)	2	(s)	Number of electrons with $m_l = 0$ and $m_s = +\frac{1}{2}$ in an

atom of phosphorus

124. Column I & column II contain date on Schrondinger Wave–Mechanical model, where symbols have their usual meanings. Match the columns.

Column–I		Column–II	
(A)		(p)	4s
(B)		(q)	$5p_x$
(C)	$\psi(\theta, \phi)$=K (independent of θ, ϕ)	(r)	3s
(D)	atleast one angular node is present	(s)	$6d_{xy}$

125.

Column–I		Column–II	
(A)	Electron moving in 2^{nd} orbit in He^+ion electron is	(p)	Radius of orbit in which movong is 0.529 Å
(B)	Electron moving in 3^{nd} orbit in H-atom	(q)	Total energy of electron is (–) 13.5× 9 eV
(C)	Electron moving in 1^{st} orbit in Li^{+2} ion	(r)	Velocity of electron is $\frac{2.188\times10^6}{3}$ m/sec
(D)	Electron moving in 2^{nd} orbit is Be^{+3} ion	(s)	De-broglie wavelength of electron is $\sqrt{\frac{150}{13.6}}$ Å

FILL IN THE BLANKS

126. The shape of p orbital is ....

127. Bohr's theory could not explain the spectra of ....

128. The orbitals having same energy are called ....

129. For each value of l, the possible values of m_l are ....

130. The statement that no two electrons can have same set of four quantum numbers is called ....

131. The shape of 1 s orbital is............

132. The light radiation with discrete quantities of energy are called............

133. Wave functions of electrons in atoms and molecules are called............

134. The $2p_x$, $2p_y$ and $2p_z$ orbitals of atom have identical shapes but differ in their............

135. Size of the orbital is determined by .... quantum number.

136. The number of unpaired electrons in Cr^{3+} ion is ....

137. In hydrogen atom the order of energies of sub-shell of third energy level is............

138. The electronic configuration of Ti^{3+} ion is ....

139. The maximum value of l in fourth energy level is............

140. In fourth energy level, the number of orbital is............

141. The charge on α-particles is .... the charge on proton.

142. The radius of nucleus is of the order of .... m.

143. The e/m ratio for electrons was determined by ....

144. The angular momentum of the electron, according to Bohr's model, is whole number multiple of ....

144. ${}^{14}_{6}C$ and ${}^{16}_{8}O$ are ....

145. The energy of the electron in second orbit of hydrogen is same as the energy of the electron in .... orbit of Li^{2+}.

146. The shape of the orbital is determined by .... quantum number.

147. A sub-shell with n =6 and l = 3 is designated as ....

148. The maximum value of l for third energy level is ....

149. The outermost electronic configuration of Cr is............

150. The dual nature of radiation s was proposed by......

151. The wave character of electrons was experimentally verified by...

152. Neutrons were discovered by ....

153. Rutherford's experiment of scattering of α-particles showd or the first time that the atom has............

154. The orbital angular momentum of an electron in 2 s orbital is............

155. Radiation of λ = 155 nm was irradiated on Li (work function = 5 eV) plate. The stopping potentail (in eV) is ________________.

156. Increasing order of magnetic moment among the following species is ___________
Na^+ , Fe^{+3}, Co^{2+}, Cr^{+2}

157. If in the hydrogen atom P. E. at ∞ is chosen to be 13.6 eV then the ratio of T. E. to K. E. for 1^{st} orbit of H-atom is ______________.

158. A neutral atom of an element has two K, eight L, nine M and two N electrons then electronic configuration of the element is __________.

159. The light radiations with discrete quantities of energy are called_____________.

TRUE OR FALSE

True/ False

160. Neutrons can be found in all the atoms.

161. Principal quantum number determines the sub-energy level of an electron.

162. The electron distribution is spherically symmetrical for $l = 0$

163. The dual nature of matter was proposed by de-Broglie.

164. The magnetic quantum number gives the orientations of electron clouds with respect to external magnetic field.

165. The orbital is the region of space around nucleus where the probability of finding the electrons a maximum.

166. The total number of orbitals in the third principal shell will be 18.

167. The energy levels of H atom can be compared to the steps of the ladder placed at equal distance.

168. Energy has to be released when electron jumps from lower energy shell to higher energy shell.

169. In the third energy level, there are three orbitals.

170. Electrons were discovered by Goldstein.

171. In hydrogen atom energy of the electron is minimum when it is in the first energy level.

172. In Ca^{2+} ion there are 18 protons and 20 electrons.

173. Isobar s contain same number of nucleons.

174. Bohr's model failed to explain atomic spectra of multielectron atoms.

175. The two electrons in the same orbital should have parallel spins.

176. e/m ratio of proton is greater than that of electron.

177. Ti^{3+} ion is diamagnetic.

178. Fe^{2+} has more number of unpaired electrons than Fe^{3+}.

178. ${}^{13}_{6}C$ and ${}^{14}_{7}N$ are isotones whereas ${}^{13}_{6}C$ and ${}^{14}_{6}C$ are isotopes.

179. In fifth energy level, a maximum of 25 electrons can be accommodated.

180. In palladium (Z = 46), the fourth energy level has 18 electrons.

181. The orbital angular momentum of for a 'p'-electron is equal to $\sqrt{2}\ h/2\pi$.

182. The three '2p' orbitals are triply degenerated.

183. The dual character of radiation was proposed by de-Broglie.

184. For hydrogen atom, the radius of second orbit is twice the radius of the first orbit.

185. The second orbit in He^{+} has radius as the first orbit in hydrogen atom.

186. The velocity of the electron is maximum in the Bohr's first orbit.

190. The energy of the electron in sodium atom is determined by n only.

191. For hydrogen atom, the energies of the sub-shells 4s, 4p, 4d and 4f, are in the order 4f > 4d > 4p > 4s.

EXERCISE 7

QUESTION FROM OTHER EXAMS

1. The following quantum number are possible for how many orbitals? **[CBSE Med. 2001]**

$n = 3, l = 2, m = +2$

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

2. The maximum number of unpaired electrons are in **[DCE & NSIT 2001]**

(A) Fe^{+2} (B) Fe^{+3} (C) Fe^{4+} (D) Fe

3. The 19th electron of chromium has which of the following sets of quantum numbers? **[DCE & NSIT 2001]**

	n	l	m	s
(A)	3	0	0	$\frac{1}{2}$
(B)	3	2	–2	$\frac{1}{2}$
(C)	4	0	0	$\frac{1}{2}$
(D)	4	1	–1	$\frac{1}{2}$

4. Which of the following sets of the quantum numbers is not possible? **[UP CPMT 2001]**

(A) $n = 2, l = 1, m = -1, s = -\frac{1}{2}$

(B) $n = 2, l = 0, m = 0, s = +\frac{1}{2}$

(C) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$

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

5. Which one of the following pairs of ions have the same electronic configuration? **[EAMCET 2001]**

(A) Cr^{3+}, Fe^{3+} (B) Fe^{3+}, Mn^{2+} (C) Fe^{3+}, Co^{3+} (D) Sc^{3+}, Cr^{3+}

6. Which of the following ions has the maximum magnetic moment? **[AIEEE 2002]**

(A) Mn^{2+} (B) Fe^{2+} (C) Ti^{2+} (D) Cr^{2+}

7. In a hydrogen atom, if the energy of electron in the ground state is –13.6 eV, then that in the 2nd excited state is: **[AIEEE 2002]**

(A) –1.51 eV (B) – 3.4 eV (C) –6.04 eV (D) –13.6 eV

8. In hydrogen atom energy of first excited state is –3.4 eV. Then find out the K.E. of the electron in the same orbit of hydrogen atom: **[CBSE Med. 2002]**

(A) 3.4 eV (B) + 6.8 eV (C) –13.6 eV (D) +13.6 eV

9. The value of Planck's constant is 6.63×10^{-34} Js. The velocity of light is 3.0×10^8 ms^{-1}, Which value is closest to the wavelength in nanometers of a quantum of light with frequency of $8 + 10^{15}$ s^{-1}? **[CBSE Med. 2003]**

(A) 5×10^{-18} (B) 4×10^1 (C) 3×10^7 (D) 2×10^{-25}.

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

(A) $\sqrt{2}.\frac{h}{2\pi}$ (B) $\frac{1}{2}.\frac{h}{2\pi}$ (C) zero (D) $\frac{h}{2\pi}$

11. The number of d-electrons retained in Fe^{2+} (At. no. of Fe = 26) ion is **[AIEEE 2003]**

(A) 6 (B) 3 (C) 4 (D) 5

12. The de-Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 metres per second is approximately **[AIEEE 2003]**

[Planck's constant, $h = 6.63 \times 10^{-34}$ Js]

(A) 10^{-25} metres (B) 10^{-33} metres (C) 10^{-31} metres (D) 10^{-16} metre

13. 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?

(A) $2 \rightarrow 5$ (B) $3 \rightarrow 2$ (C) $5 \rightarrow 2$ (D) $4 \rightarrow 1$ **[AIEEE 2003]**

14. Which of the following sets of quantum numbers is correct for an electron in 4f-orbital? **[AIEEE 2004]**

(A) $n = 4, l = 3, m = 4, s = +\frac{1}{2}$ (B) $n = 4, l = 4, m = -4, s = -\frac{1}{2}$

(C) $n = 4, l = 3, m = +1, s = +\frac{1}{2}$ (D) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$

15. 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]**

(A) 91 nm (B) 192 nm (C) 406 nm (D) 9.1×10^{-8} nm

16. Consider the ground state of Cr atom (z = 24). The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively. **[AIEEE 2004]**

(A) 12 and 4 (B) 12 and 5 (C) 16 and 4 (D) 16 and 5

17. For principal quantum number n = 4, the total number of orbitals having $l = 3$ is **[AIIMS 2004]**

(A) 3 (B) 7 (C) 5 (D) 9

18. 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 = 2.18×10^{-18} J $atom^{-1}$ and $h = 6.625 \times 10^{-34}$ Js) **[CBSE PMT 2004]**

(A) $1.03 \times 10^{15}\ s^{-1}$ (B) $3.08 \times 10^{15}\ s^{-1}$

(C) $2.00 \times 10^{15}\ s^{-1}$ (D) $1.54 \times 10^{15}\ s^{-1}$

19. The energy of second Bohr orbit of hydrogen atom is –328 kJ mol^{-1}, hence energy of fourth Bohr orbit would be: **[CBSE PMT 2005]**

(A) –41 kJ mol^{-1} (B) –82 kJ mol^{-1} (C) –164 kJ mol^{-1} (D) –1312 kJ mol^{-1}

20. In a multielectron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic and electric fields. **[AIEEE 2005]**

(i) $n = 1, l = 0, m = 0$ (ii) $n = 2, l = 0, m = 0$ (iii) $n = 2, l = 1, m = 1$ (iv) $n = 3, l = 2, m = 1$ (v) $n = 3, l = 2, m = 0$.

(A) (iv) and (v) (B) (iii) and (iv) (C) (ii) and (iii) (D) (i) and (ii)

21. Which of the following statements in relation to the hydrogen atom is correct? **[AIEEE 2005]**

(A) 3s, 3p and 3d orbitals all have the same energy.

(B) 3s and 3p orbitals are of lower energy than 3d orbital.

(C) 3p orbital is lower in energy than 3d orbital.

(D) 3s orbital is lower is energy than 3p orbital.

22. According to Bohr's theory, the angular momentum of an electron in 5th orbital is: **[AIEEE 2006]**

(A) 25 h/π (B) 1.0 h/π (C) 10 h/π (D) 2.5 h/π

23. 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: **[AIEEE 2006]**

(A) 19.2×10^{-2} m (B) 5.76×10^{-2}m (C) 1.92×10^{-34} (D) 3.84×10^{-2} m

(h = 6.63×10^{-34}Js)

24. Given: The mass of electron is 9.11×10^{-31} kg; Planck constant is 6.626×10^{-34}Js, the uncertainty involved in the measurement of velocity within a distance of 0.1 Å is: **[AIPMT 2006]**

(A) $5.79 \times 10^{5}\,ms^{-1}$ (B) $5.79 \times 10^{6}\,ms^{-1}$

(C) $5.79 \times 10^{7}\,ms^{-1}$ (D) $5.79 \times 10^{8}\,ms^{-1}$.

25. With which of the following electronic configuration an atom has the lowest ionization enthalpy?

(A) $1s^2, 2s^2, 2p^6$ (B) $1s^2, 2s^2, 2p^5$ **[AIPMT 2007]**

(C) $1s^2, 2s^2, 2p^3$ (D) $1s^2, 2s^2, 2p^5, 3s^1$

26. Consider the following sets of quantum numbers: **[AIPMT 2007]**

	n	l	m	s
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	0	–2	–1/2
(iv)	1	0	–1	–1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum numbers is not possible?

(A) (i) and (iii) (B) (ii), (iii) and (iv)

(C) (i), (iii) and (iv) (D) (ii), (iv) and (v)

27. Which of the following sets of quantum numbers represents the highest energy of an atom?

(A) $n = 3, l = 1, m = 1, s = +\frac{1}{2}$ (B) $n = 3, l = 2\ m = 1\ s = +\frac{1}{2}$ **[AIEEE 2007]**

(C) $n = 4, l = 0, m = 0, s = +\frac{1}{2}$ (D) $n = 3, l = 0, m = 0, s = +\frac{1}{2}$

28. Which one of the following consitutes a group of the isoelectronic species?

(A) C_2^{2-}, O_2^-, CO, NO (B) $NO^+, C_2^{2-}, CN^-, N_2$ **[AIEEE 2008]**

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

29. 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

(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}

EXERCISE 8

IIT - JEE FLASH BACK

[OBJECTIVE]

1979

1. The number of neutrons in dipositive zinc ion with mass number 70 is
(A) 34 (B) 36 (C) 38 (D) 40

1981

2. Rutherford's experiment on scattering of α-particles showed for the first time that the atom has
(A) electrons (B) protons (C) nucleus (D) neutrons

1982

3. The mass of ahydrogen atom is ....kg.

1983

4. Isotopes of an element differ in the number of ....in their nuclei.

5. Whan there are two electrons in the same orbital, they have ....spins.

6. The outer electronci configuration of the ground state chromium atom is 3 $d^4 4s^2$.

7. Elements of the same mass number but of different atomic numbers are known as ....

8. Gamma rays are electromagnetic radiations of wavelengths of 10^{-6} cm to 10^{-5} cm.

9. The energy of the electron in the 3d-orbital is less than that in the 4s-orbital in the hydrogen atom.

10. Any p-orbital can accommodate upto
(A) four electrons (B) six electrons (C) two electrons with parallel spins
(D) two electrons with opposite spins

11. The principal quantum number of an atom is related to the
(A) size of the orbital
(B) spin angular momentum
(C) orbital angular momentum
(D) orientation of the orbital in space

12. Rutherford's scattering experiment is related to the size of the
(A) nucleous (B) atom (C) electron (D) neutron

1984

13. 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:
(A) e, p, n, α (B) n, p, e, α (C) n, p, α, e (D) n, α, p, e

14. An isotone of ${}^{76}_{32}Ge$ is :
(A) ${}^{76}_{32}Ge$ (B) ${}^{77}_{33}As$ (C) ${}^{77}_{34}Se$ (D) ${}^{78}_{34}Se$

15. Many elements have non-integral atomic masses because
(A) they have isotopes
(B) their isotopes have non-integral masses
(C) their isotopes have different masses
(D) their constitutents, neutrons, protons and electrons combine to give fractionsl masses

16. When alpha particles are sent through a thin metal foil, most of them go straight through the foil because:
(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

1985

17. Bohr model can explain:
(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

18. The radius of an atomic nucleus is of the order of :
(A) 10^{-10}cm (B) 10^{-13} (C) 10^{-15}cm (D) 10^{-8}cm

1986

19. The sum of the number of neutrons and proton in the isotope of hydrogen is :
(A) 6 (B) 5 (C) 4 (D) 3

20. Rutherford's alpha particle scattering experiment eventually led to the conclusion that :
(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.

21. Correct set of four quantum numbers for the valence (outermost) electron of rubidium (Z = 37) is :
(A) 5,0, 0, +½ (B) 5, 1, 0, +½ (C) 5, 1, 1, +½ (D) 6, 0, 0, +½

22. Which electronci level would allow the hydrogen atom to absorb a photon but not to emit a photon?
(A) 3s (B) 2p (C) 2s (D) 1s

23. The electron density in xy plane of $3d_{x^2-y^2}$ orbital is zero.

24. The ratio of energy of radiations of wavelengths 2000 Å and 4000 Å is –
(A) 2 (B) 4 (C) 1/2 (D) 1/4

25. Which one of the following represents an impossible arrangement –

	n	l	m	s		n	l	m	s
(A)	3	2	–2	½	(B)	4	0	0	½
(C)	3	2	–3	½	(D)	5	3	0	½

1987

26. Arrange the electrons represented by the following sets of quantum number in decreasing order of energy –

(i) n = 4	l = 0	$m_e = 0$	$m_s = +\frac{1}{2}$
(ii) n = 3	l = 1	$m_e = 1$	$m_s = -\frac{1}{2}$
(iii) n = 3	l = 2	$m_e = 0$	$m_s = +\frac{1}{2}$
(iv) n 4= 3	l = 0	$m_e = 0$	$m_s = -\frac{1}{2}$

27. The photoelectric effect supports quantum nature of light because –
(A) there is a minimum frequency of light below which no photoelectrons are emitted
(B) the maximum kinetic energy of photoelectrons depends only on the frequency of light are not on its intensity
(C) even when metal surface is faintly illuminated the photoelectrons leave the surface immediately
(D) electric charge of photoelectrons is quantised

1988

28. The uncertainty principle and the concept of wave nature of matter were proposed by .... and .... respectively.

29. The size of the nucleus is measured in –

(A) amu (B) angstrom (C) cm (D) fermi

30. The triad of nuclei that is isotonic is –

(A) ${}^{14}_{6}C$, ${}^{14}_{7}N$, ${}^{19}_{9}F$ (B) ${}^{12}_{6}C$, ${}^{14}_{7}N$, ${}^{19}_{9}F$ (C) ${}^{14}_{6}C$, ${}^{14}_{7}N$, ${}^{17}_{9}F$ (D) ${}^{14}_{6}C$, ${}^{15}_{7}N$, ${}^{17}_{9}F$

31. The wavelength of a spectral line for an electronic transition is inversely related to –

(A) number of electrons undergoing transition

(B) the nuclear charge of the atom

(C) the velocity of an electron undergoing transition

(D) the difference in the energy levels involved in the transition

32. The orbital diagram in which 'Aufbau principle' is violated is –

	2s	← 2p →		2s	← 2p →
(A)	[↑↓]	[↑↓ | ↑ |]	(B)	[↑]	[↑↓ | ↑ | ↑]
(C)	[↑↓]	[↑ | ↑ | ↑]	(D)	[↑↓]	[↑↓ | ↑↓ | ↑]

33. The outermost electronic configuration of the most electronegative element is

(A) $ns^2 np^3$ (B) $ns^2 np^4$ (C) ns^2np^5 (D) $ns^2 np^6$

1989

34. The correct ground state electronic configuration of chromium atom is :

(A) $[Ar]\ 3d^5\ 4s^1$ (B) $[Ar]\ 3d^4\ 4s^2$ (C) $[Ar]\ 3d^6\ 4s^0$ (D) $[Ar]\ 3d^5\ 4s^1$

35. The correct set of quantum numbers for the unpaired electron of chlorine atom is :

	n	l	m		n	l	m
(A)	2	1	0	(B)	2	1	1
(C)	3	1	1	(D)	3	0	0

1990

36. h/π is the angular momentum of the electron in the .... orbit of He^+.

37. Transition of the electron in hydrogen atom from the fourth to first energy shell emits a spectral line which falls in .... series.

38. The quantum number not obtained from the Schrodinger's wave equation is –

(A) n (B) l (C) m (D) s

1992

39. Which of the following does not characterise X-rays ?

(A) the radiations can ionise gases (B) it causes ZnS to fluorescence

(C) deflected by electric and magnetic fields (D) have wavelengths shorter than ultra-violet rays

40. The wave number of the first line of Balmer series of hydrogen is 15200 cm^{-1}. The wave number of the first Balmer line of Li^{2+} ion is –

(A) 15,200 cm^{-1} (B) 60,800 cm^{-1} (C) 76,000 cm^{-1} (D) 1,36,800 cm^{-1}

41. Which of the following relates to photons both as wave motion and as a stream of particles ?

(A) interference (B) diffraction (C) $E = hv$ (D) $E = mc^2$

1993

42. In a given electric field, β-particles are deflected more than α–particles in spite of α-particles having larger charge.

1993

43. The light radiations with discrete quantities of energy are called ....

44. Wave functions of electrons in atoms and molecules are called ....

45. The $2p_x$, $2p_y$ and $2p_z$ of an atom have identical shapes but differ in their ....

46. Which of the following has non-spherical shell of electron ?
(A) He (B) B (C) Be (D) Li

1994

47. The outer configuration of the Cr-atom is ....

1995

48. A 3 p orbital has:
(A) two non spherical nodes (B) two spherical nodes
(C) one spherical & one non spherical node (D) one spherical and two non spherical nodes

1996

49. The orbital angular momentum of an electron in 2 s orbital is –
(A) $+\frac{1}{2}\frac{h}{2\pi}$ (B) zero (C) $\frac{h}{2\pi}$ (D) $\sqrt{2}\frac{h}{2\pi}$

50. Which of the following has the maximum, number of unpaired electrons ?
(A) Mg^{2+} (B) Ti^{3+} (C) V^{3+} (D) Fe^{2+}

1997

51. The angular momentum (L) of an electron in a Bohr's orbit is given as –
(A) $L=\frac{nh}{2\pi}$ (B) $L=\sqrt{\ell(\ell+1)\frac{h}{2\pi}}$ (C) $L=\frac{mg}{2\pi}$ (D) $L=\frac{h}{4\pi}$

52. The first use of quantum theory to explain the structure of atom was made by
(A) Heisenberg (B) Bohr (C) Planck (D) Einstein

53. For a d-electron, the orbital angular momentum is
(A) $\sqrt{6}\left(h/2\pi\right)$ (B) $\sqrt{2}\left(h/2\pi\right)$ (C) $\left(h/2\pi\right)$ (D) $2\left(h/2\pi\right)$

1998

54. Assertion : Nuclide ${}^{30}_{13}Al$ is less stable than ${}^{40}_{20}Ca$
Reason : Nuclides having odd number of protons and neutrons are generally unstable.

55 . The energy of an electron in the first Bohr orbit of H atom is –13.6. The posssble energy value(s) of the excited state(s) for electrons in Bohr orbits of hydrogen is (are)
(A) –3.4 eV (B) –4.2 eV (C) –6.8 eV (D) +6.8 eV

56. Decrease in atomic number is observed during
(A) alpha emission (B) beta emission (C) positron emission (D) electron capture

57. 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 the electrons in Bohr orbits of hydrogen is (are) :
(A) –3.4 eV (B) –4.2 eV (C) –6.8 eV (D) +6.8 eV

58. The energy of the electron in the first orbit of He^+ is -871.6×10^{-20} J. The energy of the electron in the first orbit of hydrogen would be –
(A) -871.6×10^{-20} j (B) -435×10^{-20} J (C) -217.9×10^{-20} J (D) -108.9×10^{-20} J

59. Which of the following statement (s) are correct ?

1. Electronic configuration of Cr is [Ar] $3d^5\,4s^1$ (Atomic no. of Cr = 24)
2. The magnetic quantum number may have negative value
3. In silver atom, 23 electrons have a spin of one type and 24 of the opposite type (Atomic No. of Ag = 47)
4. The oxidation state of nitrogen in HN_3 is –3.

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

1999

60. The electrons identified by quantum number n and l, (i) n = 4, l = 1 (ii) n = 4, l = 0 (iii) n = 3, l = 2 (iv) n = 3, l = 1 can be placed in order of increasing energy, from the lowest to highest as –

(A) (iv) < (ii) < (iii) <(i) (B) (ii) < (iv) < (i) < (iii)
(C) (i) < (iii) < (ii) < (iv) (D) (iiii) < (i) < (iv) < (ii)

61. The wavelength of the radiation emitted when an electron falls from Bohr's orbit 4 to 2 in hydrogen atom is –

(A) 243 nm (B) 972 nm (C) 486 nm (D) 182 nm

62. Ground state electronic configuration of nitrogen atom can be represent by –

1. $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\,|\,\uparrow\,|\,\uparrow}$ 2. $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\,|\,\downarrow\,|\,\uparrow}$

3. $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\,|\,\downarrow\,|\,\downarrow}$ 4. $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\downarrow\,|\,\downarrow\,|\,\downarrow}$

(A) 1 only (B) 1,2 only (C) 1, 4 only (D) 2, 3 only

2000

63. The wavelength associated with a golf ball weighing 200 g and moving with a speed of 5 m/h is of the order of –

(A) 10^{-10} m (B) 10^{-20} m (C) 10^{-30} m (D) 10^{-40} m

64. The number of nodal planes in p_x orbital is –

(A) one (B) two (C) three (D) zero

65. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5, 4s^1$. This represents –

(A) excited state (B) ground state (C) cationic state (D) anionic state

2001

66. The quantum numbers $+\frac{1}{2}$ and $-\frac{1}{2}$ for the electron spin represents :

(A) rotation of the electron in clockwise and anticlockwise direction respectively
(B) rotation of the electron in anticlockwise and clockwise direction respectively
(C) magnetic momentum of electron pointing up and down respectively
(D) two quantum mechanical spin states which have no classical analogues

2002

67. If the nitrogen atom had 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 –

(A) Heisenberg uncertainty principle (B) Hund's rule
(C) Pauli exclusion principle (D) Bohr postulates of stationary orbits

68. Rutherford's experiment, which established the nuclear model of the atom, used a beam of –

(A) β-particle, 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 meal foil and got scattered

2004.

69. Which of the following will have same radius as hydrogen, n = 1

(A) He^{+}, n = 2 (B) Be^{3+}, n = 2 (C) Li^{2+}, n = 2 (D) Li^{2+}, n = 3

2005.

70. The number of radial nodes of 3s and 2p orbitals are respectively

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

2006.

71. Given in hydrogenic 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

(A)	$U = \dfrac{V_n}{K_n}$	(p)	1
(B)	$\dfrac{1}{r_n} \propto E^{x}$	(q)	-2
(C)	$r_n \propto Z^{y}$ (Z = Atomic number)	(r)	-1
(D)	v = (Angular momentum of electron in its lowest energy level)	(s)	0

2007

72. STATEMENT-1 : Band gap in germanium is small, because

STATEMENT-2 : The energy spread of each germanium atomic energy level is infinitesimally small.

2008

73. 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	(r)	Magnetic quantum number
(D)	Probability density of electron at the nucleus in hydrogen-like atom	(s)	Electron spin quantum number

2009

74. The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$ is

(A) 0 (B) 2.84 (C) 4.90 (D) 5.92

EXERCISE 9

IIT - JEE FLASH BACK SUBJECTIVE

1978

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.

1979

2. Account for the follwoing. Limit your answer to two sentences:
Atomic weights of most of the elements are fractional.

1981

3. The energy of the electron in the second and the third Bohr's orbits of the hydrgen atom is -542×10^{-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.

1982

4. Calculate the wavelength in Angstrons 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. The ionization potential of the ground state hydrogen atom is 2.17×10^{-11} erg per atom.

1984

5. The electron energy in hydrogen atom is given by $E = (-2.17 \times 10^{-12})/n^2$ 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 sto cause this transition?

1985

6. Give reasons why the ground state outermost electronic configuration of sillicon is:

3s	3p			3s	3p
↑↓	↑ ↑	and not		↑↓	↑ ↓

1985

7. 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?

1986

8. The ionisation energy of H atom is 13.6 eV. What will be ionisation energy of He^+ and Li^{2+} ions ?

1987

9. Calculate the velocity of an electron placed in III orbit of H atom. Also calculate the no. of revolution/sec. round the nucleus.

1988

10. Calculate the wavelength and energy of radiation emitted for the electronic transition from infinity to stationary state for one H atom.

1989

11. The ionisation energy of He^+ is 19.6×10^{-18} J atom^{-1}. Calculate the energy of first stationary state of Li^{2+}.

12. A gas of identical H-like atom has some atoms in the lowest (ground) energy level A and some atoms in a particular upper (excited) energy level B and there are no atoms in any other energy level. The atoms of the gas make transition to a higher energy level by absorbing monochromatic light of photon energy 2.7 eV. Subsequently, the atoms emit radiation of only six different photons energies. Some of the emitted photons have energy 2.7 eV. Some have more and some have less than 2.7 eV.

(i) Find the principal quantum number of initially excited level B.

(ii) Find the ionisation energy for the gas atoms.

(iii) Find the maximum and the minimum energies of the emitted photons.

1990

13. According to Bohr's theory, the electronic energy of H atom in nth Bohr's orbit is given by

$E_n = -\dfrac{21.76\times10^{-19}}{n^2}$ joule. Calculate the longest λ of light that will be needed to remove an electron from III Bohr's orbit of He^+ ion ?

1991

14. Calculate the frequency, energy and wavelength of radiations corresponding to spectral line of lowest frequency in Lyman series in the spectra of H atom. Also calculate the energy of corresponding line in the spectra of L^{i+2}. $R_H = 1.09678 \times 10^7\ m^{-1}$, $c = 3 \times 10^8\ m\ sec^{-1}$, $h = 6.625 \times 10^{-34}$ J sec

1992

15. Electromagnetic radiations of wavelength 242 mm is just sufficient to ionise sodium atom. Calculate the ionisation energy of sodium in kJ mol^{-1}.

1993

16. Calculate the energy emitted when electrons of 1.0 g atom of hydrogen undergo transition giving the spectral lines of lowest energy in the visible region of its atomic spectra.
$R_H = 1.1 \times 10^7\ m^{-1}$, $c = 3 \times 10^8\ m\ sec^{-1}$, $h = 6.62 \times 10^{-34}$ J sec

17. Estimate the difference in energy between 1^{st} and 2^{nd} Bohr's orbit for a H atom. At what minimum at. no., 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 no. corresponds to ?

18. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition n = 4 to n = 2 of He^+ spectrum ?

1994

19. Find out the number of waves made by a Bohr electron in one complete revolution in its 3^{rd} orbit.

1995

20. Calculate the wavelength of radiations emitted producing a line in Lyman series, when an electron falls from fourth stationary state in hydrogen atom. ($R_H = 1.1 \times 10^7\ m^{-1}$)

21. Iodine molecule dissociates into atoms after absorbing light of 4500Å. 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})

22. A bulb emits light of λ 4500Å. The bulb is rated as 150 watt and 8% of the energy is emitted as light. How many photons are emitted by the bulb per second ?

1996

23. Consider the hydrogen atom to be a proton embedded in a cavity of radius a_0 (Bohr's radius), whose charge is neutralised by the addition of an electron to the cavity in vacuum, infinitely slowly –
(A) Estimate the average of 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.

(B) Also derive the wavelength of the electron when it is at distance a_0 from the proton. How does this compare with the wavelength of an electron in the ground state Bohr's orbit ?

24. Calculate the wave number for the shortest wavelength transition in Balmer series of atomic hydrogen.

1997

25. An electron beam can undergo diffraction by crystals. Through what potential should a beam of electrons be accelerated so that its wavelength becomes equal to 1.54 Å ?

26. A compound of vanadium has a magnetic moment of 1.73 BM. Work out the electronic configuration of the vanadium ion in the compound.

27. With what velocity should an α-particle travel towards the nucleus of copper atom so as to arrive at a distance of 10^{-13} metre from the nucleus of copper atom ?

2000

28. 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}. Also calculate the minimum frequency of photon to break this bond.

2003

29. Wavelength of high energy transition of H-atoms is 91.2 nm. Calculate the corresponding wavelength of He atoms.

2004.

30. The Schrodinger wave equation for hydrogen atom is

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

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.

31. A ball of 100g moving with the velocity of 0.1 m/s. Calculate the wavelength associated with the ball.

2005

32. 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 $h/2\pi$.

ANSWERSHEET

Exercise - 01

3.	10^{-7} m	**4.**	7.95 × 10–39 m	**6.**	2.6×10^{-39} ms^{-1}
7.	9.58×10^{-10} m	**14.**	(A) 2s, (B) 3p (C) same energy (D) 3d (E) 4f		
15.	(A) 2s (B) 3p (C) 3s (D) 4d				

Exercise - 02

1.	A	**2.**	D	**3.**	D	**4.**	B	**5.**	A	**6.**	B
7.	B	**8.**	A	**9.**	D	**10.**	B	**11.**	D	**12.**	A
13.	B	**14.**	A	**15.**	B	**16.**	B	**17.**	D	**18.**	B
19.	A	**20.**	B	**21.**	A	**22.**	A	**23.**	A	**24.**	A
25.	A	**26.**	B	**27.**	C	**28.**	D	**29.**	A	**30.**	A
31.	C	**32.**	A	**33.**		**34.**	C	**35.**	D	**36.**	A
37.	A	**38.**	A	**39.**	B	**40.**	C	**41.**	B	**42.**	B
43.	B	**44.**	B	**45.**	D	**46.**	A	**47.**	C	**48.**	B
49.	D	**50.**	A	**51.**	C	**52.**	C				

Exercise - 03

1. (a) 3.37×10^{-12} erg (b) 7.95×10^{-12} erg
(c) 4.97×10^{-9} erg (d) 3.3×10^{-12} erg ; E/mole photon = 19.88×10^{11} erg

2.	2×10^{-3} Jm^{-2} sec^{-1}	**3.**	6.40×10^{24}	**4.**	28
5.	0.527	**7.**	2.625×10^{-19} joule	**8.**	494.5 kJ mol^{-1}
9.	911.7 Å	**10.**	2.92×10^{15} sec^{-1}		
11.	$\lambda = 0.9696 \times 10^{-7}$ meter			**12.**	6603 Å
13.	$n_2 = 6$, $\lambda = 397.2$ nm	**14.**	1400 m sec^{-1}	**15.**	3.63 × 106 m^{-1}
16.	32.85 volt	**17.**	7.7×10^{-8} cm	**18.**	5.27×10^{-10} cm
19.	5.8×10^{5} m sec^{-1}	**20.**	3.51×10^{-24} m sec^{-1}	**21.**	2×19^{-24} Ns
22.	4.65 eV	**23.**	Z = 24, chromium	**24.**	6×10^{14} sec^{-1}

Exercise - 04

1.	B	**2.**	A	**3.**	B	**4.**	B	**5.**	B	**6.**	B
7.	B	**8.**	A	**9.**	B	**10.**	C	**11.**	C	**12.**	B
13.	D	**14.**	B	**15.**	C	**16.**	A	**17.**	B	**18.**	B
19.	A	**20.**	B	**21.**	B	**22.**	D	**23.**	A	**24.**	D
25.	C	**26.**	C	**27.**	B	**28.**	B	**29.**	C	**30.**	B
31.	B	**32.**	B	**33.**	B	**34.**	C	**35.**	B	**36.**	B

Exercise - 05

1. (a) 6.25×10^{16}, B 1.3×10^{8} m/s, C 0.248 Å

2. (a) 303.89Å, (b) 2.645×10^{-9}cm **3.** 9.75×10^{4} cm^{-1} **4.** 4814.8 Å

5. 912.24 Å **6.** 303.89 Å , 2.645×10^{-9}cm **7.** 6568 Å

8. 3663.6 Å **9.** 182.5 kJ **10.**

11. (a) -8.716×10^{-18}J (b) -2.179×10^{-18} J **12.** Z = 3; li^{+2}

13. 3.09×10^{8} cm sec^{-1}

14. $n_1 = 4$, $n_2 = 6$, $\lambda = 2.63 \times 10^{-4}$ cm **15.** Z=3, n = 6

16. z = 2 **17.** 1.8×10^{-4} cm **18.** 5th orbit

19. (a) Z = 5 (b) 26.5×10^{-12} ers (c) 3.65×10^{-7} cm (d) 4.45×10^{-10} ers

20. 2.067×10^{16} sec^{-1} **21.** 2612.6 **22.** 47.68×10^{-19}J

23. (a) 6.25×10^{16}, B 1.3×10^{8} m/s, C 0.248 Å **24.** 6.875 eV, 5×10^{15} Hz

25. $\lambda = 1026$ Å energy levels n = 3 to n = 1 **26.** 6 ; 489.6 eV , 25.28 Å

27. $r_n = \dfrac{n^2h^2}{4\pi^2 \times 3e^2 \times 208m_e}$ n = 25 ; 55.2 pm **28.** 6.4×10^{-13} J, 2.1×10^{-3} J, 3.4×10^{-14} m

29. $E = \dfrac{n^6h^6}{384m^3K^2e^4\pi^6}$ **30.** 910 Å; U.V. **31.** 973.5 Å

32. 4689Å **33.** 303.89Å, 2.645×10^{-9} cm

34. (a) 75 eV ; (b) 1.414 Å ; (c) 2×10^{-14} m

35. Energy of emitted photons can not be greater than 13.6 eV (otherwise He^+ will ionise) therefore single electron species must be hydrogen energy emitted = $E_3 - E_1 = -1.51 + 13.6 = 12.09$ For He^+ ion this energy corresponds to excitation from 2 to 6.

36. $R\left(\dfrac{8}{9}\right)$ **37.** 10 amp **38.** 300303

39. 1233.00 **40.** 0618.32

Exercise - 06

1.	D	**2.**	C	**3.**	B	**4.**	D	**5.**	C	**6.**	C
7.	D	**8.**	B	**9.**	C	**10.**	D	**11.**	C	**12.**	A
13.	A	**14.**	B	**15.**	B	**16.**	C	**17.**	B	**18.**	B
19.	A	**20.**	D	**21.**	A	**22.**	A	**23.**	D	**24.**	B
25.	B	**26.**	B	**27.**	C	**28.**	D	**29.**	B	**30.**	D
31.	A	**32.**	B	**33.**	A	**34.**	B	**35.**	A	**36.**	D
37.	C	**38.**	A	**39.**	B	**40.**	C	**41.**	A	**42.**	B
43.	C	**44.**	B	**45.**	D	**46.**	A	**47.**	B	**48.**	B

49.	A	**50.**	C	**51.**	A	**52.**	D	**53.**	A	**54.**	B
55.	D	**56.**	C	**57.**	B	**58.**	B	**59.**	A	**60.**	B
61.	C	**62.**	D	**63.**	B	**64.**	C	**65.**	D	**66.**	A
67.	BD	**68.**	BD	**69.**	BD	**70.**	A	**71.**	BC	**72.**	C
73.	AB	**74.**	D	**75.**	AC	**76.**	ABC	**77.**	AD	**78.**	BC
79.	AB	**80.**	ACD	**81.**	BD	**82.**	AC	**83.**	A	**84.**	BC
85.	ACD	**86.**	AD	**87.**	BC	**88.**	AC	**89.**	AC	**90.**	BCD
91.	B	**92.**	C	**93.**	B	**94.**	B	**95.**	A	**96.**	A
97.	D	**98.**	C	**99.**	**B**	**100.**	**A**	**101.**	B	**102.**	A
103.	D	**104.**	B	**105.**	C	**106.**	D	**107.**	B	**108.**	B
109.	B	**110.**	A	**111.**	B	**112.**	D	**113.**	B	**114.**	D
115.	A	**116.**	C	**117.**	A	**118.**	A	**119.**	C	**120.**	B
121.	C	**122.**	A-s, B-r; C-p; D-q			**123.**	A-r, B- s, C-q, D-p				
124.	A-p, B-p,q,s C-p,r D-q,s					**125.**	A-s B-r C-q D-p				
126.	dumb-bell type			**127.**	multielectron atoms				**128.**	degenerate	
129.	$+l$, ...0.....$-l$			**130.**	Pauli's exclusion principle				**131.**	spherical	
132.	photons			**133.**	orbitals				**134.**	orientation	
135.	principal			**136.**	Three				**137.**	3s = 3p = 3d	
138.	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^1$								**139.**	3	
140.	16		**141.**	twice		**142.**	10^{-15}		**143.**	J.J. Thomson	
144.	$\frac{h}{2\pi}$		**144.**	Isotones		**145.**	sixth		**146.**	Aziuthal	
147.	6f		**148.**	2		**149.**	$3d^5, 4s^1$		**150.**	Einstein	
151.	Davisson and Germer					**152.**	James Chadwick				
153.	nucleus		**154.**	zero.		**155.**	**3 eV**				
156.	**Na^+ , Co^{2+}, Cr^{+2} , Fe^{3+},**					**157.**	**non-zero**				
158.	**$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^1, 4s^2$**					**159.**	**Photons**				
160.	**F**	**161.**	**F**	**162.**	**T**	**163.**	**T**	**164.**	**T**	**165.**	**T**
166.	**F**	**167.**	**F**	**168.**	**F**	**169.**	**F**	**170.**	**F**	**171.**	**T**
172.	**F**	**173.**	**T**	**174.**	**T**	**175.**	**F**	**176.**	**F**	**177.**	**T**
178.	**F**	**178.**	**T**	**179.**	**F**	**180.**	**T**	**181.**	**T**	**182.**	**T**
183.	**F**	**184.**	**F**	**185.**	**F**	**186.**	**T**	**190.**	**F**	**191.**	**F**

Exercise - 07

1.	C	**2.**	B	**3.**	C	**4.**	D	**5.**	B	**6.**	A
7.	A	**8.**	A	**9.**	B	**10.**	C	**11.**	A	**12.**	B
13.	C	**14.**	C	**15.**	A	**16.**	B	**17.**	B	**18.**	B
19.	B	**20.**	A	**21.**	A	**22.**	D	**23.**	C	**24.**	B
25	D	**26.**	D	**27.**	B	**28.**	B	**29.**	D		

Exercise - 08

1.	D		**2.**	C		**3.**	1.66×10^{-27} kg			**4.**	neutrons
5.	Anti parallel		**6.**	F		**7.**	Isobar			**8.**	F
9.	F	**10.**	D	**11.**	A	**12.**	A	**13.**	D	**14.**	B D

15. A C **16.** A C **17.** B **18.** B **19.** D **20.** B
21. A **22.** D **23.** F **24.** A **25.** C **26.** iii > i > ii > iv
27. A **28.** Heisenberg, de-Broglie **29.** D **30.** D **31.** D
32. B **33.** C **34.** A **35.** C **36.** Second
37. Lyman **38.** B **39.** C **40.** D **41.** C **42.** T
43. photons **44.** orbitals **45.** Orientation in space **46.** B
47. $3d^5 4s^1$ **48.** C **49.** B **50.** D
51. A **52.** B **53.** A **54.** C **55 .** A **56.** A B C
57. A **58.** C **59.** A **60.** A **61.** B **62.** C
63. C **64.** A **65.** B **66.** D **67.** C **68.** D
69. B **70.** A **71.** A-q, B-p, C-r D-s
72. B **73.** A-q B-s C-p,q,r D-p,q **74.** A

Exercise - 09

1. 80% **2.** **3.** 6.603 Å **4.** 1220 Å
5. 5.42×10^{-12} ergs, 3.67×10^{-5}cm **6.** **7.** 10
8. 54.4 eV, 122.4 eV **9.** $V = 7.29 \times 10^7$ cm sec^{-1} ; 2.44×10^{14}

10. 911 Å, 217.9×10^{-20} J **11.** 44.1×10^{-18} J $atom^{-1}$
12. (i) 2 (ii) 14.4 eV (iii) $E_{max} = 13.5$ eV , $E_{min} = 0.7$ eV
13. 2055 Å
14. $v = 2.467 \times 10^{15}$ Hz, $E_H = 16.36 \times 10^{-19}$, l = 1215.6 Å, $E_{Li^{+3}} = 14.7 \times 10^{-18}$ J
15. 494.5 kJ mol^{-1} **16.** 182.5 kJ **17.** 10.2 eV, Z = 2
18. $n_1 = 2$; $n_2 = 2$ **19.** 3 **20.** $\lambda = 0.9696 \times 10^{-7}$ metre
21. 0.216×10^{-19} J **22.** $n = 27.2 \times 10^{18}$
23. (a) $T. E. = -\frac{e^2}{4\pi\varepsilon_0 a_0}$, (b) $\lambda = \frac{h}{\sqrt{\frac{e^2 m}{4\pi\varepsilon_0 a_0}}}$ **24.** 27419.25 cm^{-1}
25. 63.3 volt **26.** $_{23}V^{4+}$ **27.** 6.32×10^8 cm/sec
28. 98.18 kJ, 10.93×10^{14} sec^{-1} or Hz **29.** 22.85 nm
30. $2a_0$ **31.** 6.625×10^{-32} m **32.** 3.34×10^{-10}m,
$\sqrt{2}\frac{h}{2\pi}$