THE GURUKUL INSTITUTE

Plot 5C, 2nd floor, complex, sec-13, opp. Jaipuria School,
Vasundhara,Ghaziabad (U.P).CELL;9810780903

ATOMIC STUCTURE

Planck's Quantum Theory

1. Calculate the energy in kilocalories per mole of the photons of an electromagnetic radiation of wavelength 7600 A.

Line Spectrum of hydrogen atom

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

3.Calculate the energy emitted when electrons of 1.0 gm atom of Hydrogen undergo transition giving the spectral lines of lowest energy in visible region of its atomic spectra.

Given that, $R_H = 1.1 \times 10^7\ m^{-1}$, $c = 3\times 10^8$ m/sec , $h = 6.625 \times 10^{-34}$ J sec.

4(i) Match the spectral line (in list I) with corresponding lowest energy transition (in list II);

List I (line)	**List II (Transition)**
A. Lyman	1.n=6 to n=5
B.Paschen	2. N=5 to n=4
C. Brackett	3. N=7 to n=4
D. Balmer	4. N= 4 to n=3
E. Pfund	5. n= 3 to n=2
F. Humphry	6. N=2 to n=1

(ii) In H atom , the energy of electron in the n^{th}- orbit is given as $E_n = - 13.6/n^2$ eV , show that $E_{(n+1)} - E_n = - 13.6\times 2/n^3$ eV for large values of n.

5. A doubly ionized Lithium atom is hydrogen like with atomic number 3.

(i) Find the wavelength of radiation required to excite the electron in Li^{++} from the first to the third Bohr Orbit. (Ionization energy of the hydrogen atom equal 13.6 ev).

(ii) How many spectral lines are observed in the emission spectrum of the above excited system?

6.Wavelength corresponding to a high energy transition of H- atom is 91.2 nm. Calculate the wavelength for the corresponding transition in He^+ ion.

7.To which orbit the electron in a ground state the hydrogen atom will jump on absorbing 12.09 ev of energy?

Particle and Wave Character (Dual Character) of Electrons

8. (i) 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.

(ii) Calculate the de Broglie wavelength of an electron that has been accelerated from rest through a potential difference of 1 kV.

9. Show that the Heisenberg uncertainty principle is not important for object equal to or heavier than an ordinary dust particle (mass = 10^{-9} kg)

10. Why electron cannot exist inside the nucleus according to Heisenberg's uncertainty principle?

11.(i) Calculate the minimum uncertainty in position of a particle when uncertainty in the momentum measurement is

(a) 1×10^{-2} gm cm sec^{-1} and (b) zero

(ii) Calculate the uncertainty in the velocity of an electron, if uncertainty in its position is 0.0001m.

QUANTUM NUMBER's

12. Name the orbitals corresponding to given set of quantum numbers

(i) n=3 , L=2 (ii) n=4 , L= 0 (iii) n=3 , L=1 (iv) n=2, L= 1

Electronic Configuration of Elements.

13.(a) Find the orbital angular momentum of an electron in the following orbital

(i) 3p (ii) 3d (iii) 3s

(b) Arrange the electrons represented by the following sets of quantum numbers in decreasing order of energy (The electrons do not belong to hydrogen atom but are part of other atom)

(i) n=4, ℓ=0, m=0, s=$\pm$1/2

(ii) n=3, ℓ=1, m=1, s=-1/2

(iii)n=3, ℓ=0, m=0, s=-1/2

14.Assertion-Reason Type Question

The question given below consist of an assertion (A) and the reason (R).use the following the key for the appropriate answer .

(A) If both (A) and (B) are correct and (R) is the correct reason for (A)

(B) If both (A) and (R) are correct but (R) is not the correct explanation for (A) .

(C) If (A) is correct but (R) is not.

(D) If (A) is incorrect but(R) is correct.

Assertion (A): For n=3 , ℓ may be 0,1 and 2 and m may be 0; 0$\pm$1;0, $\pm$1 and $\pm$2.

Reason (R): For each value of n, there are 0 to (n – 1) possible values of ℓ, and for each value of ℓ , there are 0 to $\pm$ ℓ values of m.

15. Consider the following electronic configuration of the element

(i) $1s^2\ 2s^1$ (ii) $1s^2\ 3s^1$

(a) Name of the element corresponding to (i)

(b) Does (ii) correspond to the same or different element

(c)How can (ii) be obtained from (i)

(d) Is it easier to remove one electron from (ii) or (i) ? Explain.

16.(i) Write down the electronic configuration of the following:

a) Mn^{4+} (b) S^{2-}

(ii) What is the maximum number of electrons that can b contained in

(a) 4f subshell (b) 3rd shell

(iii) Board Level Question

(a) Why electrons in Fe^{3+} are more stable than Fe^{2+}?

(b)What are the values of n, ℓ and m for $2p_x$ and $3p_z$ orbitals?

(c) State de Broglie principle.

(d) Which is the first energy level containing f – orbitals?

PROBLEMS

1.(i) What is the energy of photon and wavelength of radiation corresponding to frequency 3.4 MHz?

(ii)Also calculate the energy per mole of photons of the same wavelength

2.What is the wavelength of the first line in Paschen series of the hydrogen spectrum?

3. The wave number of the first Balmar line in the hydrogen spectrum is 1.52×10^6 /M. Calculate the Wavelength of the first Lyman line in the spectrum of He^+,Li^{2+}.

4. What is de Broglie wavelength for a hydrogen atom moving with a velocity of 2000 ms^{-1}? (Atomic mass of Hydrogen = 1.00797 a.m.u.)

5.(a)The minimum uncertainties in the position and velocity of a particle are 10^{-10} m and 5.27×10^{-24} m/sec. respectively. Calculate the mass of the particle.

(b)Find the number of waves made by a Bohr electron in one complete revolution in the 3rd Bohr orbit.

6.Calculate the wavelength of the spectral line obtained in the spectrum of Li^{2+} ion when the transition takes place between two levels hose sum is 4 and difference is 2.

7.500 ml of H_2 gas was given 56.07 kJ of energy at 1 atm and 300 K to excite all the electrons to the 3rd level of atomic hydrogen. Calculate the bond dissociation energy of H–H bond.

8. An electron in the H – atom jumps from some higher level to 3rd energy level. If three spectral lines are possible for the transition, find the initial orbit of electron.

9.A mixture contains atom of fluorine . The removal of an electron from each atom of sample absorbs 284 kJ while the addition of an electron to each atom of mixture releases 68.89 kJ. Determine the percentage composition of the mixture, given that the ionization energies of F and Cl are 27.91×10^{-22} and 20.77×10^{-22} kJ, respectively, and electron affinities are 5.53×10^{-22} AND 5.78×10^{-22} kJ, respectively.

10. Two hydrogen atoms with electrons in ground state collide head on and end up with zero kinetic energy. Each then emits a photon of wavelength 121.6 nm. Which transition leads to this wavelength? How fast were the hydrogen atoms traveling before collision?

$R_H = 1.09678 \times 10^7\ m^{-1}$

$M_H = 1.672 \times 10^{-27}$ kg

OBJECTIVE

1. If the total energy of an electron in a hydrogen like atom in excited state is -3.4 eV, then the de Broglie wavelength of the electron is

a) 6.6×10^{-10}M b) 3×10^{-10}M

c) 5×10^{9}M d) 9.3×10^{-12}M

2.The highest excited state that an unexcited hydrogen atom can reach when they are bombarded with 12.08 eV photons is

a) n=1 b) n=2 c) n=3 d) n=4

3.AIR service on Vividh Bharti is transmitted on 219 m band. What is its transmission frequency in Hz?

a) 19.6×10^{-19} b) 6.67×10^{19} c) 1.37×10^{6} d) 1.36×10^{-6}

4.The wave number of the longest wave length transition in Lyman series of atomic hydrogen will be

a) 4215 A b) 1437A c) 3942A d) 1216 A

5.Which have the same number of s electron as the d – electron in Fe^{2+}

a) Li b) Na c) N d) P

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

a) $\sqrt{6}\hbar$ b) $\sqrt{2}\hbar$ c) $\hbar$ d) $2\hbar$

7.Which ions has the maximum magnetic moment

a) Mn^{3+} b) Cu^{2+} c)Fe^{3+} d) V^{3+}

8. Ionization energy of hydrogen is 13.6 eV. A sample of hydrogen atoms in the ground state are excited by monochromatic light of energy 12.08 eV. The spectral lines emitted when it returns to ground state is

a) One b) Two c) Three d) Four

9.With increasing quantum number, the energy difference between adjacent energy levels in H atom (as per Bohr's model)

a) decreases

b) increases

c) remain constant

d) decreases for low Z and increases for high Z

10.The number of electrons in sulphur atom having $(n+\ell)=3$?

a) 2 b) 4 c)6 d) 8

11.Which atom has at least one electron with quantum number n=3, ℓ=2, m= -1, m_s = -1/2

a) Ne b) Co c) Cl d) K

12.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) velocity an electron undergoing transition

d) the difference in the energy levels involved in the transition.

13.If E_1, E_2 and E_3 represent respectively the kinetic energies of an electron ,α particle and a proton, each having same de Broglie's wave length then

a)$E_1>E_3>E_2$ b) $E_2>E_3>E_1$ c)$E_1>E_2>E_3$ d)$E_1=E_2=E_3$

14.The radius of the orbit of hydrogen atom in the ground state is 0.53 A. The radius of Li^{2+} in the similar state is

a)1.066 A b) 0.265 A c) 0.176 A d) 0.536 A

ASSIGNMENTS

SECTION – I

PART – A (Level – I)

1.Calculate the number of waves made by electron in the 5th Bohr obit of H – atom.

2.Explain why half filled and full filled configurations are more stable.

3.Calculate the "spin only" magnetic moments of the folloing

a) Cu^+ b) Fe^{2+} c) Co^{3+}

4. State and explain the following:

(i) Aufbau's principle (ii) Pauli's exclusion principle

(iii) Hund's rule of maximum multiplicity.

5.Write short notes on the following:

(i) Solar spectrum or continuous spectrum

(ii) Atomic spectra or line spectra

6.Briefly describe Rutherford's scattering experiment about the discovery of nucleus.

7.Why is the electronic configuration of oxygen written as $1s^2 2s^2 2p^2_x\ 2_y^1\ 2p_z^1$ and not as $1s^2 2s^2 2p^2_x\ 2p_y^2$? Name and state the rule governing this type of distribution.

8.Write the electronic configurations of atoms of Cr (at. no. 24) and Cu (at.no.29). Show the orientations of electron spins by arrows heads.

9.Calculate the kinetic energy of an α- particle which has a wavelength of 12 pm.

10.In what ways Heisenberg's uncertainty principle contradicts the concept of stationary orbit fo electron as suggested by Bohr?

LEVEL – II

1.A hydrogen like system has ionization energy 11808 kJ/mol. Find the number of protons in the nucleus of the system.

2. Calculate the wavelength of radiation, which excites the electron of hydrogen atom from ground state to fourth energy level. Ionization energy of hydrogen atom is 1312 kJ/mol.

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

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

5.What transition in the hydrogen spectrum would have the same wavelength as the Paschen transition in, n=6 to n=3 of Li^{2+} spectrum?

6.Calculate the speed of an electron placed in the third orbit of hydrogen atom. Also calculate the number of revolutions per second that this electron makes around the nucleus.

7.How much will the kinetic energy and total energy of an electron in H atom charge if the atom emits a photon of wavelength 4860 A?

8.Find the velocity (ms^{-1}) of electron in first Bohr's orbit of radius a_0. Also find the de Broglie wavelength (in 'm'). Find the orbital angular momentum of 2p orbital of hydrogen atom in units of $h/2\pi$.
9.Calculate the ratio between the wavelength of an electron and a proton if the proton is moving with the velocity of electron.
10.A bulb emits light of wavelength 4500 A. The bulb's rated as 150 watt and 8% of the energy is emitted as light. How many photons are emitted by the bulb per second?
11. Which jump is responsible for the wave number of emitted radiations equal to9.7490×10^{6} m^{-1} in Lyman series of hydrogen spectrum? ($R=1.096768\times10^{7}m^{-1}$)
12. Some energy is absorbed by hydrogen atom due to which an electron in it jumped from ground state to the state having principle quantum number 5 and again jumped back to the original level. What type of spectrum is observed and in which region. What is the name of series?
13. Calculate the minimum uncertainty in the measurement of position of an electron if it has a speed of 500 m/s with an uncertainty of 0.02%.
14. The dissociation energy of H_2 is 430. 53 kJ /mol. If H_2 is exposed to radiation energy of wavelength 253.7 nm, which produces H atoms in ground state, what % of radiation energy ill bee converted into kinetic energy?
15. What transition in hydrogen spectrum would have the same wavelength as the Balmer transition n=4 to n=2 of He^{+} spectrum.

PART – B
Multiple Choice Questions (Single Option Correct)

1. How many electron with $\ell=3$ are there in an atom having atomic number 54.
a) 3 b) 10 c) 14 d) None of these
2. The maximum number of electrons possible in sublevel is equal to
a) $2\ell+1$ b) $2n^2$ c) $2\ell^2$ d)$4\ell+2$
3. Rutherford's experiment, which established the nuclear model of the atom, used a bam 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 metal foil and got scattered
4. The correct set of quantum number for the unpaired electron of chlorine atom may be
a) n=2, $\ell=1$, m=0 b) n=2, $\ell=1$, m=1
c) n=3, $\ell=1$, m=1 d)n=3, $\ell=0$, m=0
5. If the energy of an electron in the first Bohr orbit of H-atom is -313.6 kcal/mol; then energy of electron in the second orbit will be
a) -34.84 kcal/mol b) -12.5kcal/mol
c)-78.4kcal/mol d) 78.4kcal/mol
6. The wavelength associated with a golf ball weighing 200 g and moving at speed 5 m/h is of the order
a) 10^{-10}m b) 10^{-20}m c) 10^{-30} m d) 10^{-40}m
7. The uncertainly in the momentum of electron is 1×10^{-5}kg ms^{-1}. The minimum uncertainly in its position will be
a) 1.05×10^{-28}m b) 1.05×10^{-26}m c) 5.27×10^{-30}m
d) 5.25×10^{-28}m
8. Which set of quantum number is not allowed?

	N	ℓ	m	s
a) →	3	2	-2	½
b) →	4	0	0	½
c) →	3	2	-3	½
d) →	5	3	0	½

9. Which set of quantum numbers represents an electron of lowest energy (in some atom other than H)

a) n=2, ℓ=0, m=0, s=+1/2

b) n=2, ℓ=1, m=0, s=+1/2

c) n=4, ℓ=0, m=0, s=+1/2

d) n=4, ℓ=0, m=0, s=-1/2

10.In the emission line spectra of hydrogen atom, how many lines can be accounted for all possible electronic transition from 5^{th} energy levels within the atom

a)4 b)5 c)10 d)20

11. The potential energy of an electron in hydrogen atom is -3.02 eV, its kinetic energy will be

a) 1.51 ev b)15.10 ev c)13.6 ev d) 1.36 ev

12. An electron in a hydrogen atom in its ground state absorbs twice its ionization energy what is the wavelength of the emitted electron?

a) 3.32×10^{-10}m b) 33.2×10^{-10}m c) 0.33×10^{-4}m

d) 0.33×10^{-6}m

13.For which of the following orbital angular momentum for the filled electron(as per Aufbau principle)electron is zero?

a)Mg^{2+} b) Fe c) K d) Cs^{+}

14. 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 electron in Bohr orbit of hydrogen is (are)

a)-3.4 eV b) -4.2 eV c)-6.8 eV d)+6.8 eV

15. which of the following transition of electron in H-atom will emit maximum energy?

a) $n_5 \longrightarrow n_4$ b) $n_4 \longrightarrow n_3$

c) $n_3 \longrightarrow n_2$ d)all will emit same energy

16. which of the following may correctly represent the set of four quantum numbers of a 4d electron ?

a)4, 3, 2,+1/2 b)4, 2, 1, +1/2 c) 4, 3, -2, +1/2

d) none of the above

17. The number of waves made by a Bohr electron in an obit of maximum magnetic moment number 3 is

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

18. The total energy of the electron of H-atom in the second quantum state is $-E_2$. The total energy of the He^+ atom in the third quantum state is

(A) $-(3/2)E_2$ (B) $-(2/3)E_2$

(C) $-(4/9)E_2$ (D) $-(16/9)E_2$

19. The circumference of second orbit of H-atom, if de Broglie wavelength of electron is 6.64×10^{-10} M.

(A) 13.28×10^{-10}M (B) 3.2×10^{-10}M

(C) 6.64×10^{-10}M (D) 1×10^{-10}M

20. How many maximum 3d electrons can have magnetic spin quantum number -1/2?

(A) 5 (B) 7 (C) 8 (D) 10

21. If the kinetic energy of a particle is doubled, de Broglie wavelength becomes

(A) 2 times (B) 4 times

(C) $\sqrt{2}$ times (D) $1/\sqrt{2}$ times

22. The speed of an electron in the first Bohr orbit is v_0, what is the speed in the 3^{dr} Bohr orbit of He^+ ions.

(A) 4/3v (B) 3/2v (C)2 v_0 (D) 2/3v

23. Sommerfield tied to explain the splitting of lines by considering

(A)Elliptical obits

(B) Electron in the same obit having different energy

(C) Transition of electrons
(D) Oscillation of nucleus

24.If s= +1/2 spin moment is equal to
a) $\sqrt{3}h/4\pi$ b) $\sqrt{3}h/2\ \pi$ c) $\sqrt{3}/2h$ d) $\sqrt{3}/4h$

25.The total number of orbitals in a shell with principle quantum number n is
a) 2n b)n^2 c) $2n^2$ d) n+1

26.s – orbital is spherically symmetrical hence
a) it is directional independent
b) angular dependent
c) both (a) and (b)
d) none of these

27. The ratio of the de Broglie wavelength of the electron (λ_1) and that of neutron (λ_2) both moving with same velocity is
a) 3.4×10^2 b) 53 c) 1.79×10^3 d) none of these

28.Which of the following equation was suggested by de Broglie
a) $2\ \pi r = n\ \lambda$ b) $\lambda = p/h$ c) $\pi r^2 = n\ \lambda$ d) $2\ \pi r = nh/\ \lambda$

29.Which of the following statements in relation to the hydrogen atom is correct?
a) 3s – orbital is lower in energy than 3p – orbital
b) 3p – orbital is lower in energy than 3d – orbital
c) 3s – and 3p – orbiatls are of lower energy than 3d – orbital
d) 3s,3p – and 3d – orbitals all have the same energy

30. The number of electrons in one molecule of CO_2 are
a) 22 b) 44 c)66 d)88

Multiple Choice Questions (Multiple Options Correct)

1.Good probability of finding an electron residing in $3d_{z^2}$ orbital is in
a) xy plane b) xz plane c) yz plane d) none of these

2.Which of the following statements are correct for an electron that has n=4 and m= -2?
a) The electron may be in a d – orbital.
b) The electron is in the fourth d – orbital
c) The electron may be in a p – orbital.
d)The electron may have the spin quantum number = +1/2

3.In the Bohr's model of the atom
a) the radius of nth orbit is proportional to n^2
b) the total energy of the electron in the nth orbit is inversely proportional to 'n'.
c) the orbital angular momentum of the electron is integral multiple of $h/2\pi$.
d) the magnitude of potential energy of an electron in an orbit is greater than kinetic energy.

NUMERICAL BASED

1.How many visible lines are emitted during transition from 5^{th} orbit to ground state in hydrogen emission spectrum?

2. Maximum number of electrons that can be accommodated in d – orbital.

MATCH the Following

Column – I	Column – II
A)Isobars	p) de – Broglie
B) α – particles	q) Bohr's model
C) hydrogen spectrum	r) positively charged particles
D) dual nature of matter	s) same atomic mass
	t) far end of spectrum is continuous

SECTION – II

Multiple Choice Questions(Single Option Correct)

1.The minimum and maximum values of wavelength in Balmer series of a H atom are, respectively,

a) 66.3 nm and 353. nm b) 36.7 nm and 656.44 nm

c) 6564 nm and 6347 nm d) 9.12 nm and 121.5 nm

2. Magnitude of K.E. in an orbit is equal to

a) Half of the potential energy

b) twice of the potential energy

c) one fourth of the potential energy

d) none of these

3. Which among the following series is obtained in both absorption and emission spectrum?

a) Lyman series b) Balmer series c) Paschen series

d) Brackett series

4.The ratio of specific charge of a proton and an α – particle is

a) 2:1 b) 1:2 c) 1:4 d) 1:1

5.The atomic number of an element is always equal to

a) atomic weight divided by 2

b) number of neutrons in the nucleus

c) weight of the nucleus

d) electrical charge of the nucleus in electronic units

6. The maximum number of electrons in a subshell having n=3 and ℓ=2 is

a)20 b) 18 c)14 d) 10

7.The charge of an electron is -1.6×10^{-19} C. The value of free charge on Li^+ ion will be

a)3.6×10^{-19}C b) 1×10^{-19}C c) 1.6×10^{-19} C

d) 2.6×10^{-19}C

8. If the radius of first Bohr's orbit of hydrogen atom is 'x' then de Broglie wavelength of electron in 3rd orbit is nearly

a)2 πx b) 6 πx c)9x d)x/3

9.The ratio of area covered by second orbit to the first orbit (in Bohr's model) is

a) 1:2 b) 1:16 c)8:1 d) 16:1

10.When a hydrogen atom emits a photon of energy 12.1 eV, the orbital angular momentum changes by

a) a) 1.05×10^{-34} J sec b) 2.11×10^{-34} J sec c) 3.16×10^{-34} J sec

d) 4.22×10^{-34} J sec