F.Y.B.Sc. (Chemistry) SEM- II
Question Bank
CHEM-1201 (Physical & Inorganic Chemistry)
Section I (Physical Chemistry)

Unit I: Atomic Structure

Multiple Choice Questions:

1. The nucleons are
   a. Protons and electrons
   b. Neutrons and electrons
   c. Protons and neutrons
   d. None of these
2. The electrons present in the outermost shell are called
   a. Valency electrons
   b. Octate electrons
   c. Duplet electrons
   d. Valence electrons
3. An alpha particle contains
   a. 4 positive charge and 2 mass unit
   b. 2 positive charge and 4 mass unit
   c. 2 positive charge and 2 mass unit
   d. 4 positive charge and 4 mass unit
4. Who is credited with the discovery of electron?
   a. JJ Thomson
   b. James Chadwick
   c. Ernest Rutherford
   d. Niel Bohr
5. Which of the following mostly accounts for the mass of an atom?
   a. neutrons
   b. neutron and proton
   c. electron and proton
   d. electron and neutron
6. Which metal was used by Rutherford in his alpha-scattering experiment?
   a. gold
   b. platinum
   c. silver
   d. lead
7. Almost the entire mass of an atom is concentrated in the
   a. proton
   b. electrons
   c. nucleus
   d. neutrons
8. Which of the following is not a fundamental particle?
   a. Proton
   b. Neutron

c. Alpha particle
d. Electron

9. The atomic theory of matter was first proposed by
   a. John Dalton
   b. Rutherford
   c. J. J. Thomson
   d. Niels Bohr
10. The radius of first orbit of hydrogen atom
   a. 0.329 Å
   b. 0.429 Å
   c. 0.529 Å
   d. 0.229 Å
11. Mass of electron is
   a. 9.1 x 10–31 kg
   b. 9.109 x 10–32 gm
   c. 8.1 x 10–31 g
   d. 9.1 x 10–31 mg
12. Alpha particles are identical to
   a. hydrogen atoms
   b. helium atoms
   c. helium nuclei
   d. fast moving electrons
13. The distance between the two adjacent crests or troughs is called
   a. wave number
   b. frequency
   c. wavelength
   d. amplitude
14. The value of Planck's constant "h" is
   a. 6.625 x 10–34 cal
   b. 6.625 x 10–34 J sec
   c. 6.625 x 10–34 kJ
   d. 6.625 x 10–34 k cal
15. In the Bohr's model of atom the electron in an energy level emits or absorbs energy only when it
   a. remains in the same energy level
   b. dies out
   c. changes its energy level
   d. jumps away
16. The energy associated with an electron resolving in first orbit is
   a. – 2.178 x 10–18 k J/mol
   b. – 1313.31 k J/mol
   c. – 328.32 k J/mol
   d. – 82.08 k J/mol
17. The spectral lines of Lyman series (UV region) are produced when electron jumps from higher orbit to

a. 1st orbit
b. 2nd orbit
c. 3rd orbit
d. 4th orbit

18. The spectral lines of Balmer series (visible region) are produced when electron jumps from higher orbit to
    a. 1st orbit
    b. 2nd orbit
    c. 3rd orbit
    d. 4th orbit
19. The spectral lines of Paschen series (visible region) are produced when electron jumps from higher orbit to
    a. 1st orbit
    b. 2nd orbit
    c. 3rd orbit
    d. 4th orbit
20. The spectral lines of Bracket series (visible region) are produced when electron jumps from higher orbit to
    a. 1st orbit
    b. 2nd orbit
    c. 3rd orbit
    d. 4th orbit
21. A dual character of matter particles in motion was postulated by
    a. De–Broglie
    b. Planck
    c. Einstein
    d. Schrodinger
22. If an electron is moving with a velocity of 2.188 x 106 m/s then its wavelength will be
    a. 0.33 x 106 nm
    b. 0.33 x 10–2 nm
    c. 0.33 nm
    d. 0.22 nm
23. If a stone of 1gm is many with a velocity of 10m/s then its wavelength will be
    a. 6.65 x 10–30 m
    b. 6.65 x 10–25 m
    c. 6.65 x 10–28 m
    d. 6.65 x 10–12 m
24. The space around the nucleus where the probability of finding the electron is maximum is called
    a. an orbital
    b. an orbit
    c. energy level
    d. a shell
25. Which orbital has dumb–bell shape
    a. s–orbital
    b. p–orbital

c. d–orbital
d. f–orbital

26. Which of the following electromagnetic radiation have wavelengths shorter than visible light?
    a. UV
    b. Microwave
    c. Radio wave
    d. Infra red

Define:

1. Wavelength
2. Frequency
3. Wave number
4. Ionization potential
5. Black body
6. Photoelectric effect
7. Work function
8. Threshold frequency
9. de Broglie hypothesis
10. Wave-particle duality
11. Heisenberg's uncertainty principle
12. Wave function
13. Orbital

Explain:

1. Hydrogen spectrum
2. Black body radiation
3. Photoelectric effect
4. Quantization of energy
5. de Broglie hypothesis
6. Wave-particle duality
7. Heisenberg's uncertainty principle
8. Wave function

Short answer type questions:

1. What is the relation between wavelength and frequency?
2. Which atom have simplest spectrum? Why?
3. State radius of the Bohr's atom.
4. State velocity of an electron in Bohr's atom.
5. State energy of the electron in Bohr's atom.
6. What is black body radiation?

7. State Rayleigh-Jean's law.
8. State Planck's distribution law for black body radiation.
9. What is photoelectric effect?
10. Express the de Broglie wavelength in terms of kinetic energy of particles.
11. State Heisenberg's uncertainty principle.
12. State Schrödinger equation and explain each term in it.
13. Write Schrödinger equation for hydrogen atom.
14. What is wave function?

Long answer type questions:

1. Explain the spectral series of hydrogen atom.
2. State and explain the postulate of Bohr's theory.
3. Explain the assumptions of Bohr's theory and give its limitations.
4. Derive the expression for the radius of the Bohr's atom.
5. Derive the expression for energy of an electron in hydrogen atom on the basis of Bohr's theory.
6. What is photoelectric effect? Explain the experiment which describes the photoelectric effect.
7. Describe the influence of frequency and intensity of incident electromagnetic radiation on the current in the photoelectric effect.
8. What is wave particle duality? Give its significance.
9. Derive de Broglie equation.
10. Derive the expression for de Broglie wavelength in terms of momentum of the particle.
11. Derive the expression for de Broglie wavelength in terms of kinetic energy of a particle.
12. What is Heisenberg's uncertainty principle? Give its significance.
13. What is wave function? Give its interpretation.

Numerical:

1. Calculate the energy associated with a wave of wavelength 2000Å.
2. Calculate the wavelength in nanometers of the radiation of the following frequencies; $5.00 \times 10^{15}\ s^{-1}$, $2.11 \times 10^{14}\ s^{-1}$.
3. Calculate frequencies and wave numbers of radiation of each of the following wavelengths; 442 nm, 4.92 cm, 4.55×10^{-9} cm.
4. Calculate the wave number of the spectral line in the Balmer's series when electron jumps from 4^{th} orbit of hydrogen atom.
5. Calculate wavelength of the 3^{rd} spectral line in Paschen series of spectrum of hydrogen atom.
6. Calculate the shortest and longest wavelength line in hydrogen atom spectrum of Lyman series.

7. Calculate the radius of the second orbit in the hydrogen atom.
8. Calculate the radius of L shell of hydrogen atom.
9. Calculate the radius of K shell of hydrogen atom.
10. Calculate the velocity of the electron in the second Bohr orbit of hydrogen atom.
11. Calculate the energy of electron in the third orbit of hydrogen atom.
12. Calculate the threshold frequency for sodium if the work function for sodium metal is 1.82 eV.
13. Calculate the wavelength and momentum of an α particle moving with a speed of 10^5 cm s^{-1}.
14. Find the wavelength of carbon dioxide molecule at a velocity of 540 m s^{-1}.
15. Velocity of an electron is 300 ms^{-1}. Calculate the uncertainty in the position of an electron if uncertainty in its velocity is 0.05%.
16. The speed of electron is 1.2 x 10^8 m s^{-1}. Calculate de Broglie wavelength of the electron.
17. Calculate the uncertainty in velocity of a cricket ball (mass=0.15 kg) if uncertainty in its position is of the order of 1 Å.
18. Calculate the uncertainty in velocity of electron if uncertainty in its position is of the order of 1 Å.

Unit II: Chemical Thermodynamics

Multiple Choice Questions:

1. Thermodynamics is applicable to ……
   a) microscopic systems only b) macroscopic systems only
   c) homogenous systems only d) heterogeneous systems only
2. A thermos flask is an example of …….
   a) closed system b) isolated system
   c) open system d) homogenous system
3. A closed system is one which cannot transfer matter but transfer …….. to and from its Surrounding.
   a) heat b) work
   c) radiations d) all of these
4. A system in which no thermal energy passes into or out of the system is called
   a) adiabatic system b) reversible system
   c) open system d) closed system
5. Which of the following sets of properties constitute intensive properties?
   a) temperature, pressure and volume b) mass, density and volume
   c) density, pressure and temperature d) internal energy, density and pressure
6. For cyclic process, the change in internal energy of the system is…..
   a) always positive b) always negative

c) equal to zero d) 1.983 cal.

7. Which of the following is incorrect?
   a) heat flow into the system is + ve b) heat flow out of the system is - ve
   c) work done on the system is - ve d) none of these
8. The units erg, joule and calorie are interconvertable, which of the following is incorrect?
   a) 10^7 ergs = 1 Joule b) 4.184 J = 1 cal
   c) 1 Joule = 0.2390 cal d) 1erg = 4.184 cal.
9. The mathematical relation for the first law of thermodynamics is
   a) $\Delta E = q - w$ b) $\Delta E = 0$ for all cyclic process
   c) $\Delta E = q$ for an isochoric process d) all of these
10. For an adiabatic process, according to first law of thermodynamics,
   a) $\Delta E = - w$ b) $\Delta E = w$
   c) $\Delta E = q - w$ d) none of these
11. The enthalpy change, ΔH of a process is given by the relation
   a) $\Delta H = \Delta E + p\Delta v$ b) $\Delta H = \Delta E + \Delta n RT$
   c) $\Delta H = \Delta E + w$ d) all of these
12. Which of the following relation is true?
   a) $C_p > C_v$ b) $C_p < C_v$
   c) $C_p = C_v$ d) $C_p = C_v = 0$

13. One mole of an ideal gas at 300 K is expanded isothermally from 1 litre volume to 10 litre volume, ΔE for this process is… (R =2 cal K^{-1} mol^{-1})
   a) 300 cal b) 604.87 cal
   c) 1208 cal d) 0 cal
14. For the reaction, $H_2 + I_2 = 2$ HI, the ΔH is equal to
   a) $\Delta E + 2 RT$ b) $\Delta E - 2 RT$
   c) ΔE d) $\Delta E + RT$
15. The work done when 1 mole of an ideal gas expands reversibly and isothermally from 5 atm to 1 atm at 300 K is
   a) - 4015 J b) + 4015 J
   c) - 1500 J d) zero
16. In an endothermic reaction
   a) $E_R > E_P$ b) $E_R < E_P$
   c) $E_R = E_P$ d) $E_R = E_P = 0$
17. For the reaction, $N_2 + 3\ H_2 \leftrightarrow 2\ NH_3$, the change in enthalpy is given by
   a) $\Delta H = \Delta E - 2 RT$ b) $\Delta H = \Delta E + 2 RT$
   c) $\Delta H = \Delta E + 3 RT$ d) $\Delta H = \Delta E + RT$
18. The Kirchhoff 's equation is
   a) $\Delta H_2 - \Delta H_1 = \Delta C_p (T_2 - T_1)$ b) $\Delta E_2 - \Delta E_1 = \Delta C_V (T_2 - T_1)$

c) both d) neither (a) nor (b)

19. The change in enthalpy of a system when one mole of the substance is completely burnt in excess of air or oxygen is called
    a) heat of reaction b) heat of formation
    c) heat of oxidation d) heat of combustion
20. The calorific value is defined as the amount of heat produced in calories when ….. of a substance is completely burnt.
    a) one gram b) one mole
    c) 100 grams d) 1000 grams
21. The heat of neutralization of a strong acid and a strong base is always
    a) zero b) constant
    c) positive d) changing
22. The process of sublimation for a solid occurs
    a) at a temperature below its melting point b) at the melting point
    c) at a temperature above its melting point d) at – 273 ^{o}C

23 Hess's law is used to determine
    a) heat of formation of substances which are otherwise difficult to measure
    b) heat of transition
    c) heats of various other reactions like dimerization
    d) all of the above

24. When a bond is broken, the bond energy is positive because heat …..
    a) is evolved b) is absorbed
    c) is remains unchanged d) is equal to zero
25. The heat of combustion of ethane (C_2H_6) is – 337.0 kcal at 25^{o}C. The heat of the reaction when 3 g of ethane is burnt completely is
    a) - 3.37 kcal b) + 3.37 kcal
    c) - 33.7 kcal d) + 33.7 kcal

Define / Explain the terms

a) An isothermal reversible expansion b) Adiabatic expansion c) internal energy d) Enthalpy e) Ideal gas f) Thermodynamic state of the system g) Molar heat capacity h) Standard state i) Thermochemistry j) Standard heat of reaction k) Standard heat of formation l) Bond energy m) Exothermic and endothermic reaction n) Thermochemical equation o) Heat of combustion p) Heat of neutralization q) Heat of solution r) Joule- Thomson coefficient s) Inversion tempareture

Short answer questions

1. What is chemical thermodynamics? Give its scopes and limitations.
2. What do you mean by thermodynamic state and path function? Explain with examples.
3. Explain the different types of systems with examples.

4. Describe different types of thermodynamic process.
5. What do you mean by intensive and extensive properties? Explain with examples.
6. Explain the terms spontaneous and non-spontaneous process. Give their examples.
7. State the first law of thermodynamics and give its mathematical equation.
8. Define work and heat, give its units.
9. What do you mean by thermodynamic equilibrium? Explain its different types.
10. Give mathematical expression of C_p and C_v. How are they related?
11. What are the sources of internal energy?
12. Define the terms with examples- Heat of fusion, Heat of vaporization, Heat of sublimation and Heat of transition
13. What is Joule- Thomson effect? Give its application.
14. What do you mean by isothermal and adiabatic expansion? Write pressure volume relation for adiabatic expansion.
15. What is thermochemical equation? Explain with example.
16. Write the expressions for Kirchhoff's equations.
17. What do you mean by bond energy? On which factors its value is depends.

Long answer questions

1. State and explain the first law of thermodynamics in as many ways as possible. Obtain the mathematical expression for the law with sign conventions.
2. Distinguish between
   (a) Reversible and irreversible process
   (b) Isothermal and adiabatic process
   (c) Extensive and intensive properties
   (d) Exothermic and endothermic reaction
3. Explain the concept of maximum work. Derive the expression of maximum work when n moles of an ideal gas are expanded isothermally and reversibly from volume V_1 to V_2
4. Define and explain molar heat capacity at constant pressure and molar heat capacity at constant volume. Give their mathematical expressions. How are they related?
5. Explain in detail – internal energy and enthalpy of a system. Derive the expression for relation between ΔH and ΔE.
6. Derive the thermodynamic expressions for C_v and C_p. Obtain the relation between them.
7. Show that for n moles of an ideal gas, $\Delta E = n C_v (T_2 - T_1)$ and $\Delta H = n C_P (T_2 - T_1)$
8. Derive the pressure volume relationship in adiabatic expansion of an ideal gas.
9. Derive the expression for work done in adiabatic reversible expansion of an ideal gas.
10. Derive the mathematical expression for variation in enthalpy of reaction with temperature.
11. State and explain with example, Hess's law of constant heat summation. What are the applications of Hess's law.

Problems

1. Convert the following as per instruction.
   a) 5.6 J into erg. b) 2.5 lit-atm into cal and kcal c) 7.9 cal into erg and joule
   d) 5.249 kcal into lit-atm e) 16.2 J into kcal
2. Calculate the work done in lit-atm, cal and kcal when one mole of an ideal gas expands isothermally from 10 litres to 35 litres against a constant pressure of 2 atm at 300 K.
   (Given: 1 lit-atm = 24.22 cal)
3. Calculate the final volume, if the work done is 40 lit-atm during the expansion of 25 litres of a gas against a pressure of 1.5 atm.
4. Calculate the work done during evaporation of 1 mole of water at 373 K and at 1 atm pressure.
5. One mole of magnesium metal reacts with hydrochloric acid. If the condition is STP, calculate the work of expansion in this reaction.
6. Calculate the work done in an open vessel at 300 K, when 112 g iron reacts with dil. HCl.
7. A gas absorbs 200 J of heat and expands against the external pressure of 1.5 atm from a volume of 0.5 litre to 1.0 litre. Calculate the change in internal energy.
8. Two litre of N_2 at 0^oC and 5 atm pressure, are expanded isothermally against a constant external pressure of 1 atm until the pressure of gas reaches 1 atm. Assuming gas to be ideal, calculate work of expansion.
9. During 200 J work done on the system, 140 J of heat is given out. Calculate the change in internal energy.
10. Calculate the work done in an open vessel at 300 K, when 112 g iron reacts with dil. HCl.
11. Find ΔE, q and w if 2 moles of hydrogen at 3 atm pressure expand isothermally at 50^oC and reversibly to a pressure of 1 atm.
12. One gm of water at 373 K is converted into steam at the same temperature. The volume of water becomes 1671 ml on boiling, Calculate the change in the internal energy of the system if the heat of vaporization is 540 cal g^{-1}
13. Calculate the maximum work done when pressure of 10 g of hydrogen is reduced from 20 to one atm at a constant temperature of 273 K. The gas behaves ideally. Will there be any change in internal energy? Also calculate the value of q.
14. For the reaction, $H_2F_{2\,(g)} \rightarrow H_{2\,(g)} + F_{2\,(g)}$ the ΔE = - 14.2 kcal $mole^{-1}$ at 25^oC. Calculate ΔH for the reaction.
15. Calculate the value of ΔE and ΔH on heating 64.0 g of oxygen from 0^oC to 100^oC, if C_v and C_p values are 5.0 and 7.0 cal mol^{-1} deg^{-1} respectively.
16. Three moles of an ideal gas (C_v = 5.0 cal mol^{-1} deg^{-1}) at 10 atm and 0^oC are converted to 2 atm at 50^oC. Find ΔE and ΔH for the change.
17. Calculate the maximum work done when 44 g of Neon gas expands reversibly and isothermally from 10 atm to 2 atm pressure at constant temperature 27^oC.
    (At. mass of Neon = 20, R= 2 cal mol^{-1} deg^{-1})
18. The heat of combustion of ethylene at 17^oC and at constant volume is – 332.19 kcal. Calculate the heat of combustion at constant pressure considering water to be in liquid state.

(R= 2 cal mol $^{-1}$ deg $^{-1}$)

19. The heat of reaction, $N_2 + 3H_2 \rightarrow 2NH_3$ at 27^{o}C was found to be – 21.976 kcal. What will be the heat of reaction at 50^{o}C.
(C_p values for N_2, H_2 and NH_3 are 6.8, 6.77 and 8.86 cal mol^{-1} deg^{-1})
20. Given the energies for H–H, O=O and O–H bonds are 104, 118 and 111 kcal mol^{-1} respectively, calculate the heat of reaction for $H_{2\,(g)} + ½\ O_{2(g)} \rightarrow H_2O_{(g)}$

Section II (Inorganic Chemistry)

Attempt the following (1to 2 Marks)

1) Draw the structure for PCl_5.
2) How many bonded pairs present in BrF_3.
3) Draw the structure for BrF_3.
4) How many bonded pairs present in BrF_3
5) Draw the structure for NH_3, IF_7.
6) How many bonded pairs present in BrF_3
7) Draw the structure for H_2O, ClF_3.
8) How many bonded pairs present in BrF_3
9) Draw the structure for SF_6, CH_4.
10) Which hybridization present in $TeCl_4$.
11) Which hybridization present in ICl_2^-
12) Which hybridization present in ClF_3
13) Which hybridization present in NH_3
14) Which hybridization present in PCl_5
15) Which hybridization present in PCl_5, IF_7
16) Define Hybridization
17) Define metallic Bond, co-ordinate bond

Attempt the following (4to6 Marks)

1) Explain bonding and shapes for NF_3 molecule.
2) Explain bonding and shapes for PBr_5 molecule.
3) Explain bonding and shapes for BF_3 molecule.
4) Explain bonding and shapes for $[Ni(CO)_4]$ molecule.
5) Explain bonding and shapes for $[Ni(CN)_4]^{2-}$ ion with help of dsp^2 hybridization.
6) What is octahedral hybridization? Explain the formation and shape of SF_6 molecule with the help of sp^3d^2 hybridization.

7) What is Trigonal bipyramidal hybridization? Explain the formation and shape of PCl_5 molecule with the help of sp^3d hybridization.
8) What is tetrahedral hybridization? Explain the formation and shape of CH_4 molecule with the help of sp^3 hybridization.
9) What is linear hybridization? Explain the formation and shape of BeF_2 molecule with the help of sp^2 hybridization.
10) Draw the structure for 1) SF_6 2) IF7 3) BrF_5 4) BF_3
11) What are assumptions of VSEPR Theory?
12) Explain the need of VSEPR Theory.
13) Explain bonding and shapes of the molecules ClF_3 and BrF_3 using VSEPR theory.
14) Explain the factors affecting geometry of the molecules
15) State the different types of hybridization using S, P and d orbitals.
16) What are important features of hybridization and hybrid orbitals?
17) What is hybridization? What is need of hybridization?
18) Explain the difference between dsp3 and sp3d hybridization with the help of suitable examples.