Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Question Bank

FYBSc Chemistry

CHEM1101: Physical and Inorganic Chemistry

Section I: Physical Chemistry

Unit 1: Chemical Mathematics

Q.1. Solve the following with log table:

1. Given log 2 = 0.30103, find the numbers of digits in 2^{64}
2. Find the fifth root of 8.012.
3. Evaluate $\sqrt{\frac{0.0075 \times 0.014}{80.35}}$
4. Find the value of (a) log_{81} 243 (b) log_2 3 (c) $log_{0.5}$ 0.04 (d) $log_{\sqrt{2}}$ 324
5. Calculate the pH and pOH of following solutions,
   (a) 3.45×10^{-3} M HCl (b) 8.86×10^{-2} M NaOH (c) 0.003 M $Ba(OH)_3$
   (d) 0.1 M H_2SO_4
6. The pH of the solution is 6.66. Calculate the hydrogen ion concentration.
7. Find the concentration of hydroxyl ion in a solution whose pH is 4.6.
8. What is H^+ ion concentration if pOH of HCl is 11.35 ?

Q.2. Attempt the Following:

Graphical Representation:

1. Find whether the following lines are parallel or perpendicular.
   (a) 3x – y = - 5 and 3x – y = 4 (b) y = 2x + 1 and y = $-\frac{1}{2}$ x – 6
2. Find equation of line and its slope that pass through the points (2,3) and (4,-9).
3. Find the slope and y- intercept of the line having equation 2x + 5 = 4y.
4. Deduce the equation of straight line with x and y intercepts are -3 and 4.
5. Find equation of line having slope 2 and intercept on y- axis is -3
6. Find equation of line having slope ($-\frac{3}{2}$) passing through point (1,2)
7. Find the equation of line which passes through origin and makes an angle of 65.5^0 with x- axis (Given tan 65.5^0 = 2)
8. Find out the slope of the curve from following data.

Time(min)	0.0	1.0	2.0	4.0	8.0	16.0
Pressure(atm)	4.9	5.6	6.3	7.4	8.6	9.5

9. Represent rate constant k of first order reaction graphically. It is given by the equation:
   k = $\frac{2.303}{t}$ log $\frac{a}{a-x}$

10. Arrhenius equation relates rate constant k, with temperature T and activation energy Ea, the equation is given as, $\log k = \log A - \frac{Ea}{2.303\ RT}$

    Draw the graph between log k against $\frac{1}{T}$ and find the slope and intercept.

11. The electromotive force, E of a cell is related to standard EMF, E^0 by the equation:

    $E = E^0 - \frac{0.0591}{n} \log Q$

    where Q = reaction quotient and n = no. of electrons involved in cell reaction.

    Represent this equation by using a suitable graph and find the slope and intercept.

12. Draw the graph for the following exponential functions,

    $f(x) = 2^x$ and $g(x) = 2^{-x}$ by taking values of x = -3,-2,-1,0,+1,+2,+3.

    State the properties of the exponential function observed from the graph.

13. Draw the graph for the following logarithmic function,

    $f(x) = \log_2 x$ by taking values of x = $\frac{1}{8}, \frac{1}{4}, \frac{1}{2}$, 1,2,4,8

    State the properties of the logarithmic function observed from the graph.

14. Explain the term: pole, polar axis, polar co-ordinates and polar graph paper.
15. Explain how to sketch the polar plot of s orbital and p_z orbital.

Functions and variables:

1. Which variables are used in chemistry?
2. What do you mean by function and variable?

Derivative:

1. State any four rules of derivative.
2. Differentiate the following with respect to x:

   i) $y=3x^2+x-1$ ii) $y=(x^2+1)(\frac{x2}{2}+1)$ iii) $x/(x+2)$ iv) $x^2\log x$

3. If $u= 2x^3y + x^4y^2 + e^xy^3$, find du.
4. If V=f(P.T), using ideal gas law PV= nRT (n=constant), evaluate the partial derivatives.

Integration:

1. State any four rules of integration.
2. Solve the following:

   i) $\int (5x^2 - 6x + 3)dx$ ii) $\int (4x + 6)^2\, dx$ iii) $\int \left(\frac{x^4}{4}\right) dx$

   iv) $\int_{V=1}^{V=10} \frac{RT}{V} dV$ (T=Const.) v) $\int_1^{10} RTd(logV)$ $(T = const.)$ vi) $\int_0^2 5xdx$

Unit 2: Gaseous and Liquid states

Q.1. Multiple choice questions:

1. Mathematically, Boyle's law can be represented as
   (a) $V \propto 1/P$ (b) $V \propto k/P$ (c) $VP = k$ (d) all of these
2. Which of the following is the correct mathematical expression for Charle's law?
   (a) $V \propto T$ (b) $V \propto t$ (c) $V = kt$ (d) none of these
3. For one mole of a gas, the ideal gas equation is
   (a) $PV = RT$ (b) $P V = 1/2RT$ (c) $P V = 3/2RT$ (d) $P V = 5/2RT$
4. The unit of R, the molar gas constant is
   (a) erg K^{-1} mol^{-1} (b) cal K^{-1} mol^{-1} (c) joule K^{-1} mol^{-1} (d) all of these
5. For one mole of a gas, the kinetic energy is given by
   (a) $E = 1/2RT$ (b) $E = 3/2RT$
   (c) $E = 5/2RT$ (d) $E = 7/2RT$
6. The kinetic gas equation is given by the relation
   (a) $PV = 1/3\ m N \mu^2$ (b) $P V = 1/2\ m N \mu^2$
   (c) $P V = 3/2\ m N \mu^2$ (d) $P V = 2/3\ m N \mu^2$
7. The compressibility factor, z i.e. the extent to which a real gas deviates from ideal behavior is given by
   (a) $z = PV/ RT^2$ (b) $z = PV/2RT$
   (c) $z = PV/ RT$ (d) $z = 2PV/ RT$
8. The mass of 2240 ml CO_2 at NTP will be
   (a) 4.0 g (b) 4.4 g
   (c) 8.8 g (d) 8.0 g
9. The compressibility factor, z for an ideal gas is
   (a) zero (b) less than one
   (c) greater than one (d) equal to one
10. Viscosity of a liquid is a measure of
    (a) repulsive forces between liquid molecules (b) frictional resistance
    (c) intermolecular forces between liquid molecules (d) none of the above
11. The SI unit of coefficient of viscosity is
    (a) kg m^2 sec (b) kg m sec^{-1}
    (c) kg m^{-1} sec (d) kg m^{-1} sec^{-1}
12. Which of the following liquids has the maximum viscosity?
    (a) water (b) acetone
    (c) ethyl alcohol (d) glycerin
13. The fluidity of liquids ---------- with increase in temperature
    (a) decreases (b) remains the same
    (c) increases (d) none of these
14. The rate of evaporation of a liquid depends upon

(a) surface area (b) temperature
(c) nature of liquid (d) all of these

15. The highest temperature at which vapour pressure of a liquid can be measured is
(a) boiling point of the liquid (b) inversion temperature
(c) freezing point of the liquid (d) critical temperature

Q.2. Define the following terms:

(1) Boiling point of the liquid (2) Vapour pressure of liquid

(3) Viscosity of the liquid (4) Fluidity of the liquid

(5) Trouton law (6) Ideal gas

(7) Real gas (8) Compressibility factor

(9) Boyle's temperature (10) Van der Waal's forces

Q.3. Write Short notes on:

1. Effect of temperature on Vapour pressure of liquid
2. Effect of temperature on Viscosity of liquid
3. Compressibility factor and deviation from ideal nature of gas.
4. Relation between boiling point and intermolecular forces in liquid.
5. Liquid crystals.

Q.4. Short answer type questions:

1. What is an ideal gas equation? Why does real gas deviate from ideal behavior?
2. The ideal gas equation, PV= n RT is a limiting law, Explain.
3. What is the significance of molar gas constant R in ideal gas equation?
4. Define and explain compressibility factor.
5. Define- a) Critical pressure b) Critical volume c) Critical temperature.
6. What is Boyle temperature? Illustrate with example.
7. State Van der Waals equation for one mole of a gas and explain meaning of each term involved in it.
8. State and explain the units of Van der Waals constants, 'a' and 'b'

9. What is the applicability or limitations of Van der Waals equation?
10. Define vapour pressure of a liquid. Discuss its dependence on temperature.
11. Explain the term viscosity of liquid. What is effect of temperature on it?
12. Define the term coefficient of viscosity. Give Poiseuille's equation and significance of each term involved in it.
13. Explain the following:
    a) The vapour pressure of liquid increases with temperature.
    b) Liquids like water, benzene flow readily, while those like glycerin flow less readily.
    c) Two gases 1 & 2 obey Van der Waals equation. The constants $a_1 = a_2$ and $b_1 \neq b_2$. Which of the gas under ideal conditions will occupy more volume? Why?
14. What do you mean by liquid crystals? What are types of liquid crystal phases?
15. Explain the types of liquid crystals? Discuss the applications of liquid crystals.

Q.5. Long answer type questions:

1. Define ideal and non-ideal / real gases. Explain the deviation of non-ideal gases from its ideal behavior.
2. Define the ideal gas. Explain why the Real gases behave ideally at high temperature and low pressure.
3. Explain in detail the assumptions / postulates of kinetic molecular theory of gases.
4. What is compressibility factor? Explain its dependence on pressure and temperature of the gas.
5. Explain- Compressibility factor is an index of deviation from ideality of the gas.
6. Derive an expression of Van der Waals equation of state for real gases. What are the significances of Van der Waals constants, a & b?
7. Obtain the values of Pc, Vc and Tc in terms of the constants a, b and R.
8. Obtain the values of Van der Waals constants a & b and molar gas constant R in terms of critical constants Pc, Vc & Tc.
9. What is vapour pressure of liquid? Describe isoteniscopic method for measurement of vapour pressure of liquid.

10. What is viscosity of liquid? Give unit of viscosity coefficient. Discuss the method to measure viscosity of liquid by Ostwald's viscometer.

Q.6. Problems:

1. Calculate the number of molecules in one liter of gas at 1 atm and 27^0C.
2. Calculate the density of CO_2 at 100^0C and 800 mm Hg pressure.
3. Calculate the volume occupied by 8.8 g of CO_2 at 31.1^0C and 1 bar pressure.
4. Calculate the values of volume of 20 g of H_2O at 100^0C and 0.5 atm pressure using i) ideal gas equation, ii) Van der Waals equation. (Given: b= 3.04×10^{-2} liter $mole^{-1}$ and R= 0.082 liter atm K^{-1} $mole^{-1}$)
5. Calculate the pressure exerted by one mole of CO_2 at 127^0C when it occupies a volume of 0.5 liter. (Given: a = 3.66 atm $liter^2 mole^{-2}$, b= 0.0428 liter $mole^{-1}$ and R= 0.082 liter atm K^{-1} $mole^{-1}$)
6. Determine critical constants Pc, Vc & Tc of a gas with Van der Waals parameters, a = 0.751 atm $liter^2 mole^{-2}$, b= 0.0226 liter $mole^{-1}$ and R= 0.082 liter atm K^{-1} $mole^{-1}$.
7. The critical temperature and critical pressure of a gas are 133.4 K and 35.97×10^5 Nm^{-2} respectively. Calculate the Van der Waals constants a and b.
8. At 200^0C a pressure of 42.4 atm is required to reduce the molar volume of NH_3 to 0.851 liters. What pressure would have been calculated on the basis of, i) ideal gas equation, ii) Van der Waals equation. (Given: a = 4.25 atm $liter^2 mole^{-2}$, b= 3.74×10^{-2} liter $mole^{-1}$ and R= 0.082 liter atm K^{-1} $mole^{-1}$)
9. At 0^0C, 10 mole of methane occupy a volume of 1.754 liters at 100 atm pressure. Calculate the compressibility factor. Comment on the behavior of methane gas.
10. What would be the pressure exerted by 0.8 mole of NO_2 in a vessel of volume 20 dm^3 at 300 K from Van der Waals equation. (Given: a = 0.535 N $m^4 mole^{-2}$, b= 4.442×10^{-5} $m^3 mole^{-1}$ and R= 0.082 J K^{-1} $mole^{-1}$)
11. One mole of diethyl ether occupies 15 liters at 227^0C. Calculate the pressure if the Van der Waals constants for diethyl ether are a = 17.38 atm $liter^2 mole^{-2}$, b= 0.134×10^{-2} liter $mole^{-1}$.
12. Assuming hydrogen obeys Van der Waals equation; calculate critical constants Pc, Vc & Tc for it. (Given: a = 0.2476×10^5 N m^{-2} $dm^6 mole^{-2}$, b= 0.02662 d $m^3 mole^{-1}$)

13. In viscosity measurement by Ostwald's viscometer, water takes 40 seconds to travel between the two marks A and B. The other liquid with density 1400 g dm^{-3} at the same temperature, take 60 seconds. If the density of water at the same temperature is 995 g dm^{-3}, calculate the viscosity of other liquid. (Given: Viscosity of water = 0.01002 poise)

14. Calculate the time of flow for benzene at 20^0C from following data. Viscosity of benzene = 0.0065 poise, Viscosity of water = 0.01002 poise, Density of benzene = 879 g dm^{-3}, Density of water = 998.2 g dm^{-3}, Flow time of water = 10 seconds.

15. In viscosity measurement by Ostwald's viscometer, if (d×t) of liquid and that of water are 54000 and 29946 g dm^{-3} s respectively. If η_w = 1 centipoise, calculate the viscosity of the given liquid.

Unit 3: Solid State

Q.1. Multiple choice questions:

1. Which one is the amorphous solid?
   (a) Diamond (b) Graphite (c) Common salt (d) Glass
2. Which one is NOT the property of crystalline solid?
   (a) Isotropic nature (b) Sharp melting point
   (c) A definite and regular geometry (d) High intermolecular forces
3. The number of crystal systems known is
   (a) 7 (b) 8 (c) 6 (d) 4
4. A match box exhibits
   (a) cubic geometry (b) monoclinic geometry
   (c) orthorhombic geometry (d) tetragonal geometry
5. The number of atoms per unit cell in a simple cubic, face centred cubic and body centred cubic are ------ respectively.
   (a) 1, 4, 2 (b) 4, 1, 2 (c) 2 ,4, 1 (d) 4, 8, 2
6. An ionic crystal lattice has r^+/ r^- radius ratio of 0.524, its coordination number is
   (a) 2 (b) 4 (c) 6 (d) 8
7. The major binding force in NaCl is
   (a) ionic bond (b) covalent bond
   (c) hydrogen bond (d) dipole- dipole attraction.
8. In the crystal of CsCl, the nearest neighbors of each Cs ion are
   (a) six chloride ions (b) eight Cs ions
   (c) six Cs ions (d) eight chloride ions
9. Bragg's law is given by the equation
   (a) n λ= 2 θ sin θ (b) n λ= 2 d sin θ

(c) 2 n λ= θ sin θ (d) $n\frac{\theta}{2}=\frac{d}{2}$ sin θ

10. In Bragg's equation for diffraction of X- rays, the 'n' represents
    (a) number of mole (b) quantum number
    (c) order of reflection (d) Avogadro's number

Q.2. Define the following:

(1) Space lattice (2) Unit cell (3) Crystallography (4) Crystalline solid
(5) Lattice points and Bravais lattices (6) Isotropic and anisotropic crystal
(7) Polymorphism (8) Heat of crystallization (9) Heat of fusion

Q.3. **Write short notes on:**

(1) Fundamental crystal systems (2) Ionic and covalent
(3) Hydrogen bonded molecular solids (4) Symmetry elements in crystals
(5) Difference between crystalline and amorphous solids.

Q.4. Short answer type questions (1-2 marks)

1. Sketch (100), (110), and (111) planes in simple cubic lattice.
2. Sketch (100), (110), and (111) planes in body centered cubic lattice.
3. Sketch (100), (110), and (111) planes in face centered cubic lattice.
4. State the law of constancy of interfacial angles.
5. State the law of rationality of indices
6. State the law symmetry.
7. What do you mean by Miller indices and Weiss indices?
8. What is meant by space lattice of crystal?
9. The intercepts by crystal plane on three crystallographic axes are ½, 2 and∞. Calculate the Miller indices.
10. If Weiss indices of a plane are ¼: ¾: 2, what are Miller indices?

Q.5. Long answer type questions (3-6 marks)

1. Explain with example, why amorphous solids are isotropic and crystalline solids are anisotropic in nature?
2. State and explain the laws of crystallography.
3. Explain the various types of symmetry in crystal.
4. What are elements of symmetry? Show that a cubic crystal possesses a total of 23 elements of symmetry.
5. What is element of symmetry? Explain plane of symmetry, axis of symmetry and centre of symmetry with suitable diagrams.
6. What is cubic lattice? Describe the types and their characteristics.
7. What is coordination number of unit cell? Determine the coordination number for simple cubic, body- centred cubic and face- centred cubic structure.
8. Derive Bragg's equation, n λ= 2 d sin θ
9. Explain the X-ray diffraction method to determine the crystal structure.
10. Explain in detail the crystal structure of NaCl.

Q.6. Problems:

1. Calculate the inter planer spacing of set of planes if the angle for first order diffraction is 22.5^0 when x-ray wavelength 1.53 Å is used.
2. Calculate the angle at which first order diffraction will occur in an x-ray diffractometer when x-rays of wavelength 1.54 Å are diffracted by the atoms of crystal, given that, inter planar distance is 4.01 Å.
3. The inter planar spacing of a set of planes is 1.58 Å. Calculate the wavelength of beam of light used for first order diffraction by 23^0 3'.
4. The first order diffraction of beam of x-rays from a given crystal occurs at 6.3^0. At what angle it will have the third order diffraction?
5. Lithium forms body-centred cubic crystals. Calculate the atomic radius of lithium if the length of the side of a unit cell is 351 pm.
6. Sodium chloride has a face centered cubic lattice and the length of the cube edge is 5.64 Å. Calculate d_{100}, d_{110}, and d_{111}.
7. The first order reflection of a beam of x-rays from (100) plane of NaCl occurs at an angle of 6.2°. Calculate the wavelength of x-rays. What would be the angle of reflection if x-rays of wavelength 154.0 pm are used? (d_{100} for NaCl=282.0 pm)
8. The first order reflection of a beam of x-rays from a given crystal occurs at 5°50'. Calculate the angle at which the third order reflection is obtained from the same face.
9. The first order reflection maxima from (100), (110) and (111) planes of a given cubic crystal occur at 7.2°, 10.2° and 12.5° respectively. What type of cubic lattice does the crystal possess?
10. Miller indices of the plane of a crystal are (436). Calculate Weiss indices or calculate the intercept on crystallographic axes.
11. Silver iodide has face centered cubic structure. Its density is 5.67 g ml^{-1} and length of unit cell is 6.5 Å. calculate Avogadro's number. (Atomic weight; Ag=108, I=127)
12. Calculate the angle of reflection for third order reflection for sodium chloride crystal if the distance between 100 plane is 2.82 Å and wavelength of x-rays is 1.54 Å.
13. A cubic crystalline material of cell length 10.67 Å is to be examined by using K_α radiation (λ=1.54 Å) of copper. At what angle would you expect to get the maximum reflection from the forth order of (100) plane.
14. The crystal of unit cell of MgO is a cube of 4.2 Å an edge. The structure is interpenetrating face centered. What is the density of crystalline MgO? (Atomic weight Mg=24, O=16, Avogadro's number = 6.023×10^{23})
15. Density of CaF_2 is 3.18 g/cc. Atomic weight of Ca and F are 40 and 19 respectively. Unit cell of CaF_2 is face centered and contains 4 of Ca^{2+} and 8 of F^- ions. Calculate the length of the edge of the unit cell.

Section II: Inorganic Chemistry

Q.1. Multiple choice questions:

1. Molar mass is------
   a) Mass of one mole substance b) equal to gram ionic value c) Both a and b
   d) None of these
2. The value of N is ----------
   a) 6 .023 x10^{23} b) 2 .023 x10^{23} c) 5 .023 x10^{23} d) 22400
3. Gram molecular volume is 1 gram mole of ---------- gas occupying 22.4 liters at STP
   a) Any gas b) Nitrogen c) Ideal gas d) Oxygen
4. Substance such as ---------- are used as primary standard substances
   a) $CaCO_3$, Acetic acid b) NaOH, Salicylic acid c) Na_2CO_3, Benzoic acid
   d) KOH, HCl
5. The process of conversion of Ca to Ca^{2+} is called ----------
   a) Reduction b) Oxidation c) Redox d) Oxidation-Reduction
6. In $FeCl_3$, iron has oxidation number of ----------
   a) +2 b) -1 c) +3 d) zero
7. Equivalent weight is equal to ----------
   a) Formula wt/Change in valency b) Mol. wt / Change in oxidation state
   c) Mol. wt / Difference in valency d) Mol. wt / change in number of electrons

Q.2. Answer in one sentence / Define the following terms.

1) Mole
2) Molecular weight
3) Equivalent weight
4) Normality
5) Molality
6) Reduction
7) Redox Reaction
8) Oxidizing agent
9) Reducing agent
10) Oxidation number
11) Molar mass

Q.3. Write Short notes on

a) Oxidizing agent b) Reducing agent c) Redox reaction d) Oxidation
e) Reduction

Q.4. Short answer question

1. What do you understand by redox reaction?
2. What is normal solution? Is it different from standard solution?

3. Why we standardize a solution?
4. How will you prepare –a) 300 ml 0.5N NaCl and b) 200 ml 0.2 N Na_2SO_3 solution (At. wt. Na =23, Cl=35.5, S=32, O=16)
5. What do you understand by a standard solution?
6. How many moles are present in a) 24.5 gm of H_2SO_4 b) 855 gm of cane sugar ($C_2H_{22}O_{11}$)

Q.5. Long answer question

1. Calculate the oxidation state of 'Mn' in the following compounds

   a) $KMnO_4$ b) MnO_2 c) $MnSO_4$ d) $MnCO_3$ e) $MnCl_4$

2. What do you understand by a primary and secondary standard solution?
3. Explain the rules for calculating the oxidation number
4. Balance the following reactions by ion-electron method.

   $$KMnO_4 + HCl \rightarrow KCl + MnCl_2 + Cl_2 + H_2O$$

5. Balance the following reactions by ion-electron method.

   $$Zn + NaNO_2 + NaOH \rightarrow Na_2ZnO_2 + NH_3 + H_2O$$

6. Balance the following reactions by oxidation method.

   $$K_2Cr_2O_7 + H_2SO_4 + Na_2SO_3 \rightarrow K_2SO_4 + Na_2SO_4 + Cr_2(SO_4)_3 + H_2O$$

7. Equivalent weight is an experimental quantity. Prove the statement with suitable example.