

**1st Semester Examination, 2020****Time : 3 hours****Full Marks : 60**Answer any **one** Group as per your Syllabus.

Answer from all the sections as per direction.

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***GROUP—A  
(MODEL SYLLABUS)  
(INORGANIC CHEMISTRY-I)****SECTION—A**

1. Answer all the questions : 1 × 8
- (a) What is the designation given to an orbital having  $n = 3$  and  $l = 2$  ?
- (b) The number of radial nodal planer in 3S orbital is ———.
- (c) In case of hydrogen atom maximum number of lines that are found when an excited electron drops from  $n = 5$  to ground state is ———.
- (d) Which out of Be, Na, O and Br is a member of chalcogens ?
- (e) To which group of periodic table the element strontium belong ?
- (f) Cations, anions and atoms carrying same number of electrons are called ———.
- (g) Between  $N_2$  and NO, which has higher bond order ?
- (h) Which is more stable between NaCl and CsCl ?

**SECTION—B**

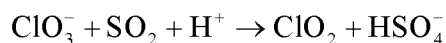
2. Answer any *eight* of the following : 1.5 × 8

- (a) Explain significance of  $\psi^2$ .
- (b) Draw the shape of  $d_{xy}$ ,  $d_{x^2 - y^2}$  and  $d_{z^2}$  atomic orbitals.
- (c) Why is covalent radius smaller than van der Waal's radius ?
- (d) Between He and  $\text{Li}^+$  whose ionisation potential is higher ? Give reasons for the answer.
- (e) Why  $\text{AlCl}_3$  is mostly covalent, but  $\text{AlF}_3$  is mostly ionic ?
- (f) Define Hydrogen bond. Name the elements which form such bonds.
- (g) Between ionic and covalent compounds whose melting point is higher ? Give reasons for your answer.
- (h) Between  $\text{NaCl}$  and  $\text{MgO}$ , which is more soluble in water and why ?
- (i) Why bond angle of  $\text{NH}_3$  is more than that of water though both have  $\text{SP}^3$  hybridisation ?
- (j) Give one example each for molecules or ions having  $\text{SP}^2$ ,  $\text{dSP}^2$  and  $\text{SP}^3\text{d}$  hybridised central atoms.

#### SECTION-C

3. Answer any *eight* questions out of the following : 2 × 8

- (a) Give a brief account of Aufbau's principle.
- (b) State Heisenberg's uncertainty principle and explain its significance.
- (c) Define periodicity of elements and give reasons for periodicity.
- (d) Why are fully filled and half filled orbitals stable ?
- (e) Between F and Cl which has higher electron affinity and why ?
- (f) Why  $\text{NF}_3$  has less dipole moment than  $\text{NH}_3$  ?
- (g) Amongst  $\text{LiF}$  and  $\text{LiI}$  which has more covalent character and why ?
- (h) Distinguish between n-type and p-type semiconductors.
- (i) Why nickel electrode acts as cathode in a Co-Ni cell ?
- (j) Balance the following redox reaction by ion-electron method :



SECTION–D

Answer all the questions as directed :

4. (a) Derive de-Broglie equation. What are its significances ? 4+2

*Or*

- (b) Explain the significance of different quantum numbers. 6

5. (a) Explain variation of ionisation enthalpy and electron gain enthalpy along the groups and periods in the periodic table. 3+3

*Or*

- (b) Explain Allred and Rochow's scale of electronegativity. 6

6. (a) Draw MO diagram of O<sub>2</sub> molecule and calculate bond order. 5+1

*Or*

- (b) Write a note on Fajan's rules and consequences of polarisation. 6

7. (a) Write a short note on bond theory of metallic bonding. 6

*Or*

- (b) Explain Schottky and Frenkel defects in ionic compounds. 3+3

**GROUP—B**

**(OLD SYLLABUS)**

**(INORGANIC CHEMISTRY)**

SECTION–A

1. Answer *all* questions : 2 × 6

(a) Give the mathematical expression for determining the wave length of a moving object.

(b) Write the significance of  $\psi$ .

(c) What is the cause of periodicity of elements ?

(d) Explain : HCl(g) is polar covalent but HCl(aq) is ionic.

- (e) Write the type of hybridisation in the C atom of graphite and diamond. Write the shape of graphite and diamond.
- (f) Write the oxidation number of chromium in  $K_2Cr_2O_7$ .

SECTION-B

Answer *all* questions :

12 × 4

2. Derive the time-independent Schrödinger wave equation. Write the significance of  $\psi$  and  $\psi^2$ . 12

*Or*

What is quantum number ? Briefly discuss about four types of quantum number. 2+10

3. (a) Define electronegativity. Explain the factors on which the electronegativity of an atom depend ? 8
- (b) Give the merits of long form of the periodic table. 4

*Or*

(c) Define electron affinity. Describe various factors on which the electron affinity of an atom depend. Explain the electron gain enthalpy of fluorine is less than that of chlorine. 2+8+2

4. (a) Write the various postulates of molecular orbital theory. Distinguish between bonding and anti-bonding molecular orbital. 4+4
- (b) Draw the molecular orbital energy level diagram for  $He_2$  molecule. Write its Bond order and magnetic behaviour. 4

*Or*

(c) What is lattice energy ? How can you determine the lattice energy of an ionic compound, NaCl by Born-Haber cycle ? 2+6

(d) What is radius ratio rule ? Write its limitations. 4

5. (a) Write short notes on : 4 × 2
- (i) H-bonding
- (ii) Band theory in metallic bonding

(b) Explain the following type of forces : 4

(i) Dipole-dipole attractions

(ii) Ion-dipole attractions

*Or*

(c) Give a brief account on standard electrode potential. Discuss about the importance of electro-chemical series. 4+4

(d) Explain briefly the principles involved in the volumetric analysis of iron and copper. 4

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(MODEL SYLLABUS)  
(PHYSICAL CHEMISTRY-I)****SECTION—A****1. Answer all the questions :****1 × 8**

- (a) The expression  $\sqrt{2RT/M}$  represents —— velocity.
- (b) A linear molecule containing  $N$  number of atoms has —— vibrational degrees of freedom.
- (c) In capillary tube method of determination of surface tension of liquid, height of liquid column in the capillary tube is measured by ——.
- (d) Which between ice and liquid water has less open structure ?
- (e) In Bragg's equation, the expression for  $d$  is given by ——.
- (f) In which type of liquid crystal there is layer structure ?
- (g) The expression for hydrolysis constant  $K_h$  for salt of weak acid and strong base is ——.
- (h) If  $S$  is the solubility, the expression for solubility product of  $\text{Ag}_2\text{CrO}_4$  is ——.

## SECTION–B

2. Answer any *eight* of the following questions : 1.5 × 8
- (a) Define critical temperature, critical pressure and critical volume of a gas.
  - (b) What is an ideal gas ? Under what conditions of pressure and temperature real gases behave ideally ?
  - (c) What are the values of  $C_p/C_v$  for monoatomic, diatomic and triatomic gases ?
  - (d) Mention the nature of distribution curves for solid, liquid and gas in the plot of radial probability distribution of molecules against distance.
  - (e) Distinguish between evaporation and boiling.
  - (f) What is Ostwald's dilution law ? What is its limitation ?
  - (g) Calculate pH of  $10^{-4}$  M NaOH solution.
  - (h) Calculate the Miller indices of crystal planes which cut through the crystal axes at (2a, -3b, -3c).
  - (i) What do you mean by isotropy and anisotropy ?
  - (j) What is buffer capacity ? Under what condition buffer capacity is maximum ?

## SECTION–C

3. Answer any *eight* of the following : 2 × 8
- (a) Write down the important postulates of kinetic theory of gases.
  - (b) Calculate root mean square velocity of  $\text{CO}_2$  gas at 300 K (given  $R = 8.314 \text{ JK}^{-1}$ ).
  - (c) Calculate the number of translational, vibrational and rotational degrees of freedom for a diatomic gas molecule.
  - (d) Mention important effects of surface tension.
  - (e) Explain recovery of NaCl from seawater by application of principle of common ion effect and solubility product.
  - (f) What are the seven crystal systems ?

- (g) Define law of constancy of interfacial angles and law of rational indices for crystalline solids.
- (h) Explain metal excess defect in solids due to extra cation occupying interstitial sites and anion vacancies.
- (i) Explain why aqueous solution of  $\text{Na}_2\text{SO}_4$  is neutral but that of  $\text{Na}_2\text{CO}_3$  is alkaline.
- (j) How are acidic and basic buffer solutions are prepared ? Give examples.

#### SECTION–D

Answer all the questions as directed.

4. (a) Derive the reduced equation of state given by  $\left(\pi + \frac{3}{\phi^2}\right)(3\phi - 1) = 8\theta$  . 6

*Or*

- (b) Draw and explain  $p \sim v$  isotherms of  $\text{CO}_2$  gas. 6

5. (a) Explain how surface tension of a liquid can be determined by Double capillary method. 6

*Or*

- (b) Explain why : 3+3

(i) Viscosity of liquids increase with increase in pressure

(ii) Stepwise dissociation constants of  $\text{H}_3\text{PO}_4$  are in the order  $K_{a_1} > K_{a_2} > K_{a_3}$  .

6. (a) Compare the crystal structures of  $\text{NaCl}$  and  $\text{CsCl}$ . 3+3

*Or*

- (b) Explain smectic, nematic and cholestric liquid crystals giving examples. 2+2+2

7. (a) Derive the relation :  $\text{pOH} = \text{pKb} + \log \frac{[\text{SaH}]}{[\text{Base}]}$   
for basic buffer solution. 6

*Or*



(b) Explain following titration curves : 3+3

(i) Strong acid versus strong base

(ii) Weak acid versus strong base

**GROUP—B**  
**(OLD SYLLABUS)**  
**(PHYSICAL CHEMISTRY-I)**

SECTION—A

1. Answer *all* questions : 2 × 6

(a) Define Boyle's temperature and critical temperature.

(b) Calculate the root mean square velocity of oxygen molecule at 300 K.

(c) Write the relationship between different types of molecular velocities.

(d) Write the structural difference between three states.

(e) Calculate the interplanar spacing between the (111) planes of a cubic Lattice of length 300 pm.

(f) What is buffer capacity ?

SECTION—B

Answer *all* questions :

2. (a) Derive van der Waal's equation for  $n$ -moles of a real gas. What is the effect of temperature on the van der Waal's constants  $a$  and  $b$  ? Prove that  $b$  the co-volume, is equal to four times the actual volume of the molecule. 4 × 2 + 4

*Or*

(b) Write the main postulates of kinetic theory of gases. Derive  $PV = \frac{1}{3} mNc^2$ . 8

(c) Write a note on Law of corresponding states. 4

3. Explain the term 'viscosity'. How is it determined ? Discuss the effect of temperature on the viscosity of a liquid. What is relative viscosity ? 12

*Or*

Briefly explain about surface tension and surface energy. How they are related to each other ? Explain one method of measuring surface tension in the laboratory. 12

4. Explain the following : 2+4+4
- (i) Law of constancy of interfacial angles
  - (ii) Law of Rational indices and Miller indices
  - (iii) Law of symmetry

*Or*

What is Bragg's law ? Derive Bragg's equation. Explain the determination of interplanar distance in a solid. 2+4+4

5. Write short notes on : 4 × 3
- (i) Buffer solution
  - (ii) Ionic product of water
  - (iii) pH value

*Or*

Give an account of hydrolysis of salt. Derive the Henderson-Hasselbalch equation for calculating the pH of acidic and basic buffer. 6+6

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( 4 )

2019

( 1st Semester )

Time :  $2\frac{1}{2}$  hours

Full Marks : 60

Answer from both the Sections as directed

*The figures in the right-hand margin indicate marks**Candidates are required to answer in their own words as far as practicable***( INORGANIC CHEMISTRY )****SECTION – A**

2 × 6

1. Answer the following questions :

(a) Write significance of  $\psi$  and  $\psi^2$ .

(b) What are isoelectronic ions? Give one example.

(c) What is the cause of periodicity of elements?

( Turn Over )

(d) Calculate Lattice energy of  $MgF_2$  from the following data : 4

(i) Heat of sublimation of magnesium = 146.4 kJ/mol

(ii) Dissociation energy of fluorine = 158.8 kJ/mol

(iii) Electron affinity of fluorine = -332.6 kJ/mol

(iv) Ionisation energy of magnesium = 2186.0 kJ/mol

(v) Heat of formation of magnesium fluoride = -1096.5 kJ/mol

5. (a) What are semiconductor? Explain what is meant by *n*-Type and *p*-type semiconductor? 8

(b) What do you mean by H-bonding and what are types of H-bonding? 4

Or

(c) Explain the Mo energy level diagram of  $Bef_2$ . 8(d) What is the difference between  $\sigma$  and  $\pi$  bond? 4

( 2 )

- (d)  $H_2O$  is a liquid but  $H_2S$  is a gas why? 6
- (e) Define Radius Ratio. 3
- (f) Why  $NF_3$  is pyramidal while  $BF_3$  is planar (Trigonal) though both are Tetraatomic molecules? 3
- SECTION - B**
- Answer all questions : 12 x 4
2. (a) What is Schrödinger wave equation? Derive and explain its significance. 8
- (b) Write a short note on De-Broglie's concept. 4
- Or*
- (c) Discuss the main postulates of Bohr's Atomic Model. 8
- (d) Name four quantum numbers. What is significance of Azimuthal quantum number. 4
3. (a) Why size of cation is smaller while that of anion is greater than that of its corresponding neutral atom? 3

SH CHE-01

( Continued )

( 3 )

- (b) Write a note on Allred and Rochow's Scale. 6
- (c) Write two factors on which the value of electro-negativity of an atom depend. 3
- Or*
- Write notes on : 4 x 3
- (d) Ionisation enthalpy
- (e) Covalent radii
- (f) Shielding effect
4. (a) What are main postulates of VSEPER Theory? 8
- (b) Electrovalent compounds are soluble in  $H_2O$  where as covalent compounds are mostly insoluble in water why? 4
- Or*
- (c) What are main postulates of valence bond theory? 8

SH CHE-01

( Turn Over )

Or

- (c) Give an account of powder pattern method for study of crystal ? 8
- (d) Define : 4
- (i) Centre of symmetry
- (ii) Plane of symmetry.
5. (a) Derive Handerson's equation for acidic and basic buffer mixture ? 10
- (b) Define and explain Ionic Product of  $H_2O$ . 2

Or

- (c) What is solubility product and common ion effect? Discuss the application of solubility product and common ion effect in qualitative analysis. 10
- (d) What is buffer solution? Explain with example? 2

2019

( 1st Semester )

Time :  $2\frac{1}{2}$  hours

Full Marks : 60

Answer from both the Sections as per direction

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as far as practicable*

( PHYSICAL CHEMISTRY - I )

SECTION - A

1. Answer the following questions : 2 x 6
- (a) Define the term critical temperature and pressure ?
- (b) How many vibrational degree of freedom are there in nonlinear  $O_3$  molecule ?

( 2 )

- (c) Define Ionic product of water ?
- (d) What information is given by the value of  $a$  and  $b$  in van der Waal's equation of state ?
- (e) Give suitable reason for the following cooling is caused by evaporation ?
- (f) The structure of CSCL is different from that of NaCl though both have similar formula. Give reason ?

SECTION – B

Answer all questions : 12 x 4

2. (a) What do you understand by the term average velocity, root mean square velocity and most probable velocity of gas molecules ? How are they mutually reacted ? 8
- (b) Write note on Mean free path ? 4
- Or*
- (c) What are the postulates of kinetic molecular Theory of Gases ? 8

SH CHE 02

( Continued )

( 3 )

- (d) Calculate the various degree of freedom of the following molecules (i)  $\text{CO}_2$  (ii)  $\text{H}_2\text{O}$  (iii)  $\text{N}_2$  (iv) He 4
3. (a) What do you understand by surface tension of a liquid. Give one experimental method for its determination ? 8
- (b) What are strong and weak electrolytes ? Give two examples in each case. 4

*Or*

- (c) Explain the term viscosity. How is it determined experimentally ? 8
- (d) Define pH. What is the effect of temperature on pH ? 4
4. (a) Distinguish between Schottky defect and Frankel defect ? 8
- (b) What are different types of crystalline solid ? Give one example of each. 4

SH CHE 02

( Turn Over )

( 6 )

(b) Comment on the following statements : 6

- (i) Alkynes are more reactive towards nucleophilic addition as compared to alkenes.
- (ii) Alkenes are more reactive towards electrophilic addition compared to alkynes.
- 

2019

(1st Semester)

Time :  $2\frac{1}{2}$  hours

Full Marks : 60

Answer from both the Sections as per direction

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(ATOMICS STRUCTURE BONDING, GENERAL  
ORGANIC CHEMISTRY AND ALIPHATIC  
HYDROCARBONS )

## SECTION—A

1. Answer the following questions :  $2 \times 6$ 

- (a) What is the maximum number of lines when an excited electron drops from  $n = 6$  to the ground state in case of a hydrogen atom ?

( 2 )

- (b) Calculate the wavelength of 1000 kg rocket moving with a velocity of 3000 km per hour ( $h = 6.626 \times 10^{-34}$  Js)
- (c) Predict the shape of PF<sub>5</sub> molecule by VSEPR theory.
- (d) Which is more acidic :  
Metachloro benzoic acid or parachloro-benzoic acid ?
- (e) Alkynes and alkanes do not show geometrical isomerism. Explain.
- (f) What is Peroxide effect (Khrash effect).

#### SECTION – B

Answer all questions :

2. (a) Give the postulates of Bohr's model of atom. Give its applications and limitations. 10
- (b) Write electronic configuration of atoms with atomic number 24 and 29. 2

SG CHE 01

( Continued )

( 3 )

Or

- (a) Name four quantum numbers. Write the significance of the four quantum numbers. Also define electronic configuration. 6
- (b) State and explain Paulis exclusion principle. 3
- (c) Write Schrödinger wave equation and give the significance of  $\psi$  and  $\psi^2$ . 3
3. (a) Give the difference between Valence bond theory and molecular orbital theory. 4
- (b) Draw the molecular orbital energy level diagram of CO, O<sub>2</sub><sup>+</sup> and NO<sup>+</sup>. 6
- (c) Define lattice energy. Give its importance. 2

Or

- (a) Give the postulates of VSEPR theory and explain the structure of ClF<sub>6</sub> and ICl<sub>4</sub><sup>-</sup> with the help of this theory. 8
- (b) Define atomic orbital and molecular orbital. 2

SG CHE 01

( Turn Over )



( 4 )

- (c) Which out of lp-lp repulsion and bp-bp repulsion is greater and why? 2
4. (a) Define the term resonance? What are the conditions for resonance? Describe the various characteristics of resonance hybrid. 1 + 3 + 3
- (b) What are carbocations? Write the structure and stability of carbocations. 1 + 2 + 2

Or

- (a) Write what do you know about 'Electromeric effect'? How does it differ from Inductive effect? 6
- (b) Differentiate between Enantiomers and Diastereoisomers. 4
- (c) Out of the following pairs, which is a stronger acid? 2
- (i) Bromoacetic acid and Bromopropanoic acid.
- (ii) Ortho chloro benzoic acid and meta chloro benzoic acid.

SG CHE 01

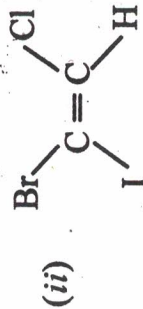
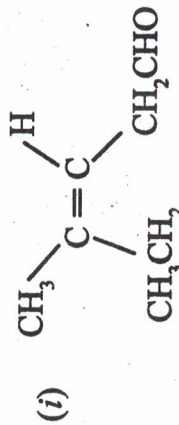
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SG CHE 01

(Turn Over)

( 5 )

5. (a) Describe the acidic nature of acetylene. 4
- (b) How acetylene is prepared from calcium carbide? How does the gas obtained is purified? 4
- (c) Assign E or Z configuration to each of the following compounds: 4



Or

- (a) Write a note on Markownikoff's rule. Use Markownikoff's rule to predict the product of the reaction. 6
- (i) HCl with  $\text{CH}_3\text{C}(\text{Cl})=\text{CH}_2$  and
- (ii) HCl with  $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)_2$ .

SG CHE 01

(Continued)

SG CHE 01

(Turn Over)

Total Pages—5

SHCHE 02

2018

( 1st Semester )

Time :  $2\frac{1}{2}$  hours

Full Marks : 60

Answer from both the Sections as directed

*The figures in the right-hand margin indicate marks*

*Candidates are required to answer in their own words  
as far as practicable*

( PHYSICAL CHEMISTRY - I )

SECTION - A

1. Answer the following questions : 2 × 6
- (a) Calculate the average kinetic energy of 32g methane at 27° C.  $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ .
  - (b) Write notes on Mean free path.
  - (c) Explain why the boiling point of liquid rises with increase of pressure.

( Turn Over )

( 2 )

- (d) Explain the symmetry elements and symmetry operations with examples. 5
- (e) What is meant by Buffer capacity? 2
- (f) Calculate the pH of  $10^{-8}$  M HCl. 3 + 3

#### SECTION - B

Answer all questions : 12 x 4

2. (a) What is degree of freedom? Explain molecular basis of heat capacities. 2 + 4
- (b) Explain the terms : Collision frequency and collision number. Derive a relationship between mean free path and collision diameter of a molecule in gaseous phase. 2 + 4

Or

- (c) Define compressibility factor Z. How does it vary with pressure (i) for different gases at same temperature and (ii) for same gas at different temperature? 5

( 3 )

- (d) Derive the relation between critical constants and van der Waal's constants. 5
- (e) Explain the effect of pressure and temperature on the viscosity of gases. 2
3. (a) Discuss qualitatively the structure of liquids. What is radial distribution function? 3 + 3
- (b) Explain cleansing action of detergent. 4
- (c) Explain why glycerol is more viscous than water. 2

Or

- (d) Define vapour pressure of liquid. What are the factors on which vapour pressure of a liquid depends? 4
- (e) Explain the effect of addition of various solutes on surface tension and viscosity of a liquid. 4
- (f) The radius of a given capillary is 0.0355 cm. A liquid whose density is  $0.866 \text{ g/cm}^3$

( 4 )

rises to a height of 2.0 cm in the capillary when it is dipped in the liquid. Calculate the surface tension of the liquid. 4

4. (a) Write notes on : 4 × 2  
(i) Law of constancy of Interfacial Angles  
(ii) X-ray diffraction.

(b) X-ray of wavelength 0.134 nm give first order diffraction when the value of  $\theta$  is  $10.5^\circ$ . Calculate the distance between the planes in the crystal parallel to the surface. 4

Or

- (c) Explain various types of defects in crystals. 6  
(d) Discuss power diffraction pattern of crystalline solids NaCl and CsCl. 6

5. (a) What do you mean by hydrolysis ? Explain the hydrolysis of a salt of weak acid and strong base. 6

( 5 )

(b) Explain— why aqueous solution of  $\text{NaHCO}_3$  is basic ? 3

(c) Calculate pH of a 0.1 M  $\text{Na}_2\text{CO}_3$  solution.  $K_{\text{HCO}_3^-} = 5.6 \times 10^{-11}$  and  $K_{\text{H}_2\text{CO}_3} = 4.3 \times 10^{-7}$  3

Or

- (d) Write notes on : 4 × 3  
(i) Common ion effect  
(ii) Solubility product  
(iii) Theory of acid-base indicator.

2017

INORGANIC CHEMISTRY-I

Time : 2½ Hours]

[Full Marks : 60

Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

SECTION-A

1. Answer the following questions : 2×6
- (a) What informations are conveyed by  $\Psi$  and  $\Psi^2$  ?
  - (b) What is de Broglie relation ?
  - (c) What is wave particle duality ?
  - (d) What is the difference between electronegativity and electron affinity ?
  - (e) Determine the four quantum numbers to describe  $3p^1$  electron.
  - (f) Which is more covalent between KCl and LiCl ?

SECTION-B

Answer all questions :

2. (a) (i) How does Bohr's theory explain the spectrum of H-atom ? 5

(2)

(ii) State Pauli Exclusion Principle and show that there can be maximum of 2, 6 and 10 electrons in  $s$ ,  $p$  and  $d$  orbitals. 2

(iii) Calculate the ratio of the wavelength of hydrogen to  $\text{Li}^{2+}$  ion for 1st line of Balmer series. 5

OR

(b) (i) Write the Schrodinger equation indicating all the terms. 2

(ii) Assume a 0.01% in accuracy in determination of the velocity of a 100 gm mass moving with a velocity of  $200 \text{ ms}^{-1}$ . Calculate the uncertainty in its position. Comment on the answer. 5

(iii) Describe the de Broglie equation and calculate the wavelength associated with a bullet of 2.0 gm which is shot with a velocity of  $2 \times 10^4 \text{ cm/sec}$ . 5

3. (a) (i)  $\text{K}^+$  and  $\text{Cl}^-$  are isoelectronic but they differ in their ionic radii. Explain. 2

(ii) Discuss the lanthanide contraction and its consequences. 5

(iii) What is radius ratio rule? Why do  $\text{LiX}$  ( $\text{X} = \text{halides}$ ) flout from the radius ratio rules? 2+3

OR

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(Continued)

(3)

(b) (i) Write the electronic configuration of  $\text{Cu}^+$  and  $\text{Mn}$ . 2

(ii) Describe the variation of atomic and ionic radii in period and group of the periodic table. 5

(iii) What are transition elements? Describe their special characteristics. 2+3

4. (a) (i) Nitrogen does not form  $\text{NCl}_5$  but Phosphorus forms  $\text{PCl}_5$ . Explain. 5

(ii)  $\text{CCl}_4$  does not hydrolyse but  $\text{SiCl}_4$  hydrolyses. Explain with reaction product. 5

(iii)  $\text{NaCl}$  dissolves readily in water but it is insoluble in  $\text{C}_2\text{H}_5\text{OH}$ . Explain. 2

OR

(b) (i) Determine the structure of  $\text{NH}_4^+$  and  $\text{CO}_3^{2-}$  using valence bond theory. 5

(ii) Draw the molecular orbital diagram of  $\text{O}_2$  and determine the bond order. 5

(iii) State and explain the Bent's rule with an example. 2

5. (a) (i) Justify, whether it is possible to store  $\text{NiSO}_4$  in a  $\text{Zn}$  container or not. 2

Given  $E^\circ_{\text{Ni}^{2+}/\text{Ni}} = -0.25 \text{ V}$  and

$E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$

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(Turn Over)

(4)

(ii) Calculate the equilibrium constant for the reaction that would occur from the following potential:

Given  $E^{\circ}_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77 \text{ V}$  and

$E^{\circ}_{\text{Sn}^{4+}/\text{Sn}^{2+}} = 0.15 \text{ V}$

5

(iii) What are dipole-dipole and induced dipole interactions? Give one example of each.

5

OR

(b) (i) Why do we need metallic bond concept to explain metallic properties? Explain the Band theory of metallic bond.

2+3

(ii)  $\text{Cu}(\text{NO}_3)_2$  is known but  $\text{CuNO}_3$  is unknown. Explain.

Given  $E^{\circ}_{\text{Cu}^{2+}/\text{Cu}} = 0.15 \text{ V}$  and

$E^{\circ}_{\text{NO}_3^-/\text{NO}} = 0.96 \text{ V}$

5

(iii) What is van der Waals force? Explain with example.

2

2017

PHYSICAL CHEMISTRY - I

Time : 2½ Hours] [Full Marks : 60

Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

SECTION-A

1. Answer the following questions : 2×6

- (a) Calculate the pressure exerted by one mole of carbon dioxide gas in a 1.32 dm<sup>3</sup> vessel at 48°C using van der Waals equation, where  $a = 3.59 \text{ dm}^6 \text{ atm mol}^{-2}$  and  $b = 0.0427 \text{ dm}^3 \text{ mol}^{-1}$ .
- (b) What are Newtonian and non-Newtonian liquids ?
- (c) What are colour centres ? How do they arise ?
- (d) What are Bravais lattices ? How many of them exist in seven crystal systems ?
- (e) What is common ion effect ? Illustrate with an example.
- (f) What are Lewis acids and Lewis bases ? Give examples.



(2)

**SECTION-B**

Answer all questions :

2. (a) (i) State the basic postulates of kinetic theory of gases and derive the kinetic gas equation. 5  
(ii) Calculate the values of gas constant. 3  
(iii) Using kinetic gas equation, derive Boyle's law and Avogadro's law. 4

**OR**

- (b) (i) Derive the van der Waals equation for real gases. 5  
(ii) Illustrate how this equation explains the departure of real gases from ideal behavior at different pressure and temperature satisfactorily. 5  
(iii) Calculate the Boyle's temperature of  $\text{CO}_2$  gas, assuming it to be van der Waals gas, given  $a = 3.59 \text{ dm}^3 \text{ atm mol}^{-2}$ ,  $b = 0.0427 \text{ dm}^3 \text{ mol}^{-1}$ . 2

3. (a) (i) Define the terms 'surface tension' and 'surface energy'. Derive an expression for the determination of surface tension by capillary rise method. 6

- (ii) Explain the effect of temperature on surface tension. 4

(3)

- (iii) Calculate the height to which water will rise in a glass capillary, if the radius of the tube is 0.02 cm and surface tension of water is  $0.0728 \text{ Nm}^{-1}$ . 2

**OR**

- (b) (i) Discuss the term 'viscosity' and explain the effect of temperature and pressure on the viscosity of a liquid. 6  
(ii) Define the term 'vapors pressure of liquid' and show the energy distribution diagram of molecules in a liquid. 4

- (iii) Using Trouton's rule, estimate the vapors pressure of *n*-heptane if its boiling point is  $36^\circ\text{C}$ . 2

4. (a) (i) Derive the Bragg equation in X-ray crystallography. 3

- (ii) Give a simple account of rotating crystal method and powder pattern method. 4

- (iii) Give an account on analysis of powder diffraction pattern of NaCl, CsCl and KCl. 5

**OR**

- (b) Explain briefly the following types of defect : 12

- (i) Schottky defect

(4)

(ii) Metal deficiency defect

(iii) Line defect

5. (a) (i) What is buffer solution? Explain with example. 4

(ii) What should be the pH of an aqueous solution obtained by mixing 5 gm of acetic acid and 7.5 gm of sodium acetate and making volume equal to 500 ml. Dissociation constant of acetic acid at 25°C is  $1.75 \times 10^{-5}$ . 4

(iii) Calculate the solubility of magnesium hydroxide in grams per liter. Given solubility product of magnesium hydroxide at 25°C is  $1.4 \times 10^{-11}$ . 4

OR

(b) (i) Discuss in detail the phenomenon of hydrolysis of salt. Illustrate your answer taking examples of salt of weak acid with strong base and salts of weak acid with weak base. 6

(ii) What are acid-base indicators? Illustrate the mechanism of their action taking suitable examples and give the qualitative treatment of acid-base titration curve. 6

2017

Time : 2½ Hours] [Full Marks : 60

Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

SECTION-A

1. Answer the following questions : 2×6

- (a) What is the physical significance of  $\psi$  and  $\psi^2$  ?
- (b) What is Heisenberg uncertainty principle ?
- (c) Write down the electronic configuration of  $N_2$  molecule.
- (d) Define Fajans' rule.
- (e) Why *o*-nitrophenol is more acidic than phenol ?
- (f) What is the product formed when 1-butene reacts with HBr ?

(2)

SECTION-B

Answer all questions :

2. (a) What do you understand by the term 'quantum number'? How many quantum numbers has an electron in an orbital? Explain the significance of each quantum number. 3+2+5
- (b) Derive de Broglie's wave equation. 2

OR

- (c) What is Hund's rule of maximum multiplicity? 2
- (d) Write short notes on the following: 10

- (i) Aufbau principle
- (ii) Pauli's exclusion principle
3. (a) Draw the molecular orbital diagram for oxygen molecule. 5
- (b) Predict the structures of  $\text{CO}_2$  and  $\text{NH}_3$  molecules by using VSEPR theory. 7

OR

- (c) Give a brief account of VSEPR theory. 7
- (d) What is the difference between VBT and MOT? 5

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(3)

4. (a) Write short notes on the following: 8
- (i) Carbocations
- (ii) Huckel's rules of aromaticity
- (b) Write down the difference between configurational and conformational isomers. 4

OR

- (a) What are R and S configurations? State and explain the rule with example. 8
- (b) Explain optical activity. 4
5. (a) How acetylene can be prepared from calcium carbide? By using acetylene how can you synthesize 1-propyne? 6
- (b) Write down the two methods of preparation of alkane from Grignard reagents. 6

OR

- (c) Explain Saytzeff's rule. What is the major product formed when 2-bromobutane is treated with alc. KOH? 6
- (d) Write short note on Kolbe's reaction. 6

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