

TDP (Honours) 1st Semester Exam., 2019

CHEMISTRY

(Honours)

FIRST PAPER

Full Marks : 80

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer **eight** questions, taking **two** from each Unit

Use separate answer-script for each Unit

UNIT—I

(General Chemistry)

1. (a) How does the old classical concept of Bohr based on classical mechanics fail?
- (b) Why is the energy of an electron in an atom negative?
- (c) State the hypothesis of de Broglie. Calculate the de Broglie wavelength of the following :

A rifle bullet ($m = 2 \times 10^{-3}$ kg)
moving with a speed of 300 m s^{-1} .

(2)

- (d) Explain why orbitals like $1p$, $2d$ and $3f$ are not possible by quantum numbers.

$$2+2+(2+2)+2=10$$

2. (a) In an atom, the angular momentum of an electron is $\sqrt{6}h/2\pi$. What will be the minimum value of the principal quantum number of the electron?
- (b) Write down the differences between de Broglie's matter waves and electromagnetic waves.
- (c) Derive de Broglie's equation from Bohr's theory.
- (d) Write down the Schrödinger wave equation for H atom and explain the terms involved in it. $2+3+2+(2+1)=10$
3. (a) How is special stability of filled and half-filled configuration related to ionization energy and electron affinity?
- (b) Explain the concept of electronegativity. Is it an intrinsic property? State its usefulness in predicting the bond types, polarity of molecules and molecular association.

- (c) State the stable oxidation state of In and Tl. $3+(2+1+1+1+1)+1=10$

20M/24

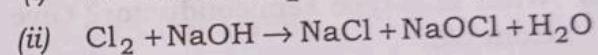
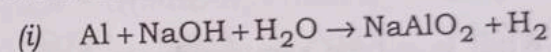
(Continued)

(3)

UNIT—II

(Inorganic Chemistry)

4. (a) Balance the following equations by ion electron method :

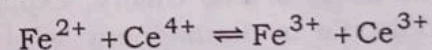


- (b) The values of

$$E^\circ_{\text{Cu}^{2+}/\text{Cu}^+} = 0.15 \text{ V and } E^\circ_{\frac{1}{2}\text{I}_2/\text{I}^-} = 0.56 \text{ V}$$

but in dil. aqueous solution of Cu^{2+} oxidizes I^- to I_2 . Explain.

- (c) Find the equilibrium constant for the reaction

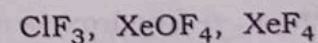


[Given, $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77 \text{ V}$ and

$$E^\circ_{\text{Ce}^{4+}/\text{Ce}^{3+}} = 1.61 \text{ V}]$$

$$(2 \times 2) + 3 + 3 = 10$$

5. (a) Predict the geometry of the following molecules :



- (b) Explain Bent's rule.

20M/24

(Turn Over)

(c) Explain the following :

- (i) Melting point of NaBr is less than that of the NaCl.
 (ii) CaCl_2 is soluble in water but CaF_2 is not. $(1 \times 3) + 3 + (2 \times 2) = 10$

6. (a) What is *n*-type semiconductor? Give one example.

(b) Draw the MO energy-level diagram for NO molecule and comment on the bond order and magnetic properties of the molecule.

(c) What is the effect of temperature on the conductivity of a semiconductor?

(d) On the basis of MO theory, explain why N_2 molecule is diamagnetic while O_2 is paramagnetic.

(e) Mention the effect of H-bonding on the structure of ice. $2 + 3 + 2 + 2 + 1 = 10$

UNIT—III

(Organic Chemistry)

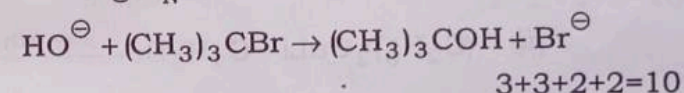
7. (a) Between *p*-dihydroxybenzene and *p*-dicyanobenzene, which one have more dipole moment and why?

(b) Compare the basicity of CH_3NH_2 , $(\text{CH}_3)_2\text{NH}$ and $(\text{CH}_3)_3\text{N}$ in aqueous solution and gas phase. Explain it.

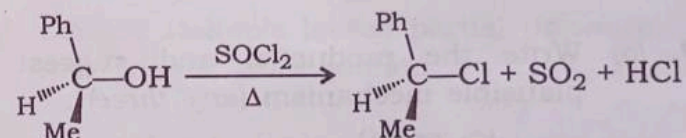
(c) Explain the following observations :

2,4,6-trinitro-*N,N*-dimethylaniline is 40000 times stronger base than 2,4,6-trinitroaniline.

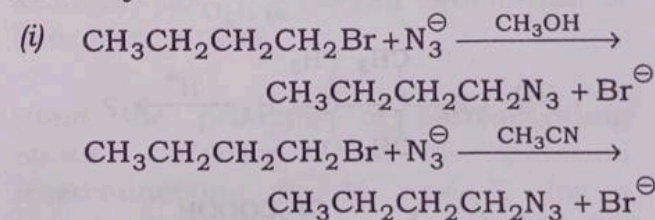
(d) Draw the energy profile diagram of the following $\text{S}_\text{N}1$ reaction :



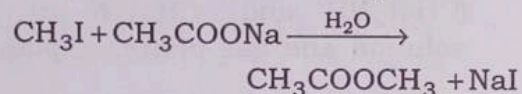
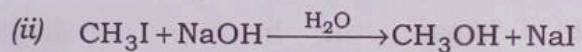
8. (a) Write the product(s) of the following reaction with plausible mechanism :



(b) Which $\text{S}_\text{N}2$ reaction of each pair is expected to take place at a faster rate and why?

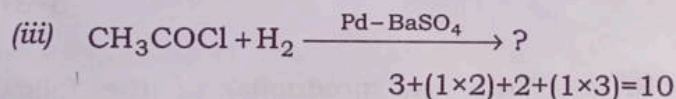
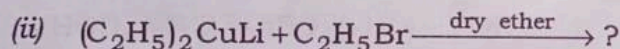
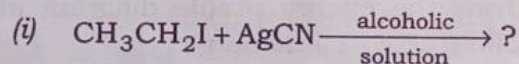


(6)

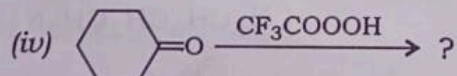
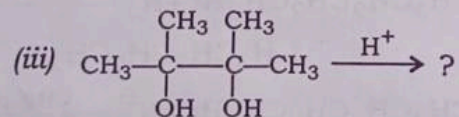
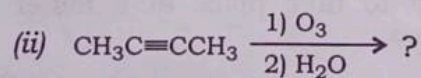
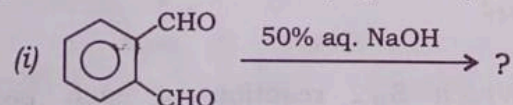


(c) Define anti-elimination and syn-elimination with example.

(d) Write the product(s) of the following reactions :



9. (a) Write the product(s) and suggest a plausible mechanism (any three) :



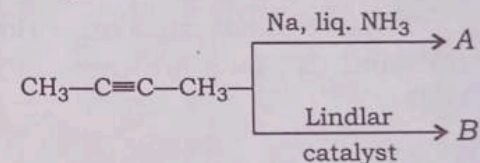
20M/24

(Continued)

(7)

(b) Explain, why peroxide effect is observed for HBr only.

(c) Identify the products A and B in the following reaction :



$$(2 \times 3) + 2 + 2 = 10$$

UNIT—IV

(Physical Chemistry)

10. (a) Deduce Dalton's law of partial pressure from kinetic gas equation.

(b) Show that for a van der Waals' gas, the Boyle temperature $T_B = a / Rb$.

(c) Calculate the temperature at which the average velocity of oxygen equals that of hydrogen at 20K.

(d) State the principle of corresponding states. Derive an expression interconnecting P_r , V_r and T_r for a van der Waals' gas.

$2 + 3 + 2 + 3 = 10$

20M/24

(Turn Over)

11. (a) Derive Born-Landé equation for the lattice energy of an ionic solid.

(b) What are colour centres? How do they arise?

(c) CsCl has a b.c.c. structure. How many Cs^+ and Cl^- ions are there in the unit cell?

(d) A metallic element exists as a cubic lattice. Each edge of the unit cell is 2.88 \AA . The density of the metal is 7.20 g cm^{-3} . How many unit cells will there be in 100 gm of the metal?

$$4 + 2\frac{1}{2} + 1 + 2\frac{1}{2} = 10$$

12. (a) Write the full form of BASIC. Write BASIC expressions for the following :

$$ax^2 + bx + c$$

(b) Convert the following decimal numbers to binary :

$$(0.6875)_{10}$$

(c) Calculate the packing efficiency in b.c.c. lattice.

(d) What are operating systems? Why do we need them?

$$(1+2)+2+3+2=10$$

★★★

TDP (Honours) 1st Semester Exam., 2018

CHEMISTRY

(Honours)

FIRST PAPER

Full Marks : 80

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer **eight** questions, taking **two** from each Unit

Use separate answer-script for each Unit

UNIT—I

(General Chemistry)

Answer *any* **two** questions

1. (a) Define electron affinity. What is the difference between electron affinity and electronegativity?
- (b) Explain Pauli's exclusion principle.

(2)

- (c) What is screening constant? How does it affect the value of ionization potential of an atom?
- (d) Calculate the effective nuclear charge on the outermost electron of vanadium ($Z = 23$).
 $(2+2)+1+(2+1)+2=10$
2. (a) Give two examples with their electronic configurations where Aufbau principle is violated in the stable electronic configuration of atoms. Mention the factors which cause such isolation.
- (b) Calculate the de Broglie wavelength of 6s electron of Hg moving with a speed nearly $\frac{1}{6}$ th that of light (velocity of light $= 3 \times 10^8$ m/s).
- (c) Explain why—
- (i) the ionization potential of Li^+ is greater than He, although these are isoelectronic;
- (ii) chlorine has higher electron affinity than that of fluorine.
 $(2+1)+3+(2+2)=10$
3. (a) What is meant by inert pair effect? Explain with a suitable example.

M9/18

(Continued)

(3)

- (b) Draw radial probability distribution curves for 3s, 3p and 3d orbitals and state the following in each case :
- (i) Number of high probability region
- (ii) Number of nodes
- (c) What is the principle of calculating electronegativity on Pauling scale?
 $(2+1)+(1+1+1)+4=10$

UNIT—II

(Inorganic Chemistry)

Answer any two questions

4. (a) What is redox potential? Explain with an example.
- (b) Calculate the equivalent weight of $\text{K}_2\text{Cr}_2\text{O}_7$ in acidic, alkaline and neutral media.
- (c) Name one suitable redox indicator which is used in the titration of Fe^{+2} ion by $\text{K}_2\text{Cr}_2\text{O}_7$ indicating structures (both oxidized and reduced forms).
- (d) Balance the following chemical reaction by ion-electron method :
- $\text{Zn} + \text{NaNO}_3 + \text{NaOH} \rightarrow \text{Na}_2\text{ZnO}_2 + \text{NH}_3 + \text{H}_2\text{O}$

$$2+3+3+2=10$$

(Turn Over)

M9/18

(4)

5. (a) What is lattice energy? Write its mathematical expression. On what factor does it depend? $1+1+1$
- (b) Starting from $M(s)$ and $X_2(g)$, construct the Born-Haber cycle for formation of $MX(s)$ and mention the meaning of terms used in it. $2+1$
- (c) Using VSEPR theory, explain the shapes of NF_3 and XeF_2 . $1+1$
- (d) What is dipole moment? Between NH_3 and NF_3 , which one has higher dipole moment? $1+1$ $3+3+2+2=10$

6. (a) What do you mean by the term π - π interaction? 2

(b) The conductivity of Ge is enhanced after adding trace amount of As to it. Why? 2

(c) On the basis of molecular orbital energy diagram, find out the bond-order and compare the magnetic properties of O_2 , O_2^+ , O_2^- and O_2^{2-} . $1+1+1$

(d) What is 'hydrogen bond'? In which of the following compounds do you expect hydrogen bonding? $1+1+1$

Water; Methane; Acetic acid;

ortho-nitrophenol

$2+2+3+3=10$

(Continued)

M9/18

(5)

UNIT—III

(Organic Chemistry)

Answer any two questions

7. (a) What is the difference between bond polarity and bond polarizability?

(b) Calculate the resonance energy of benzene. [Given heat of hydrogenation of cyclohexene to cyclohexane is $-119.7 \text{ kJ mole}^{-1}$ and that of benzene to cyclohexane is $-208.5 \text{ kJ mole}^{-1}$.]

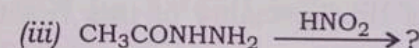
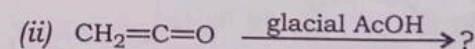
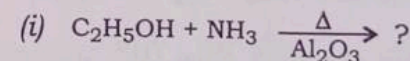
(c) How can you account for the lower strength of the O—H bond in liquid alcohols than that in the vapour phase?

(d) Dipole moment of *N,N*-dimethylaniline is 1.61 D whereas that of *O,O',N,N*-tetramethylaniline is only 0.94 D. Explain.

(e) What do you mean by activation energy and transition state of a reaction?

$2+2+2+2+2=10$

8. (a) Complete the following reactions :



M9/18

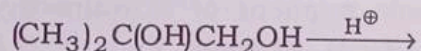
(Turn Over)

(6)

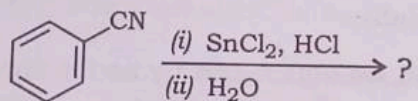
- (b) How is acetic acid prepared from acetonitrile? Give mechanism.
- (c) What is the difference in the products of S_N1 and S_N2 reactions?
- (d) When $(CH_3)_3CCl$ and $(CH_3)_3S^+(CH_3)_2$ separately treated with 80% EtOH and 20% water at $65.3^\circ C$? The ratio of S_N1 and $E1$ products of both the reactions are almost same. How can you account for this equality despite of the different substrates?

3+3+2+2=10

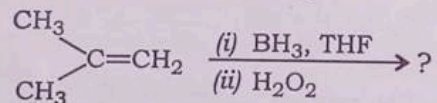
9. (a) Complete the following reaction and give reason for your answer :



- (b) Complete the following reaction :



- (c) How can propane be prepared by Corey-House synthesis?
- (d) Complete the following reaction :



What is the speciality of this reaction?

3+2+2+3=10

(Continued)

M9/18

(7)

UNIT—IV

(Physical Chemistry)

Answer any two questions

10. (a) What is meant by mean-free path? How does it depend upon temperature and pressure?
- (b) Depict Maxwell's velocity distribution curves at two temperatures T_1 and T_2 ($T_2 > T_1$). Mention two salient features of it.
- (c) What is Boyle temperature?
- (d) Calculate the root-mean-square velocity of nitrogen molecules at $27^\circ C$.

3+3+2+2=10

11. (a) What do you mean by the terms 'space lattice' and 'unit cell' of a crystal?
- (b) X-ray diffraction pattern of NaCl and KCl are different, although they have similar structures. Explain.
- (c) What do you mean by plane of symmetry? Find the number of C_2 and C_3 axes of symmetry in a simple cube.

M9/18

(Turn Over)

- (d) Evaluate the ratio of interplanar distances among (100), (110) and (111) planes of a simple cubic system.

$$3+2+2+3=10$$

12. (a) What is CPU? Mention its important functions.

- (b) Explain the following :

- (i) Source program and object program
- (ii) System software and application software

- (c) Find the value of x of the following :

(i) $(D6C1)_{16} = (x)_{10}$

(ii) $(91)_{10} = (x)_2$

- (d) Write the following expressions in BASIC :

(i) $\frac{1}{t} \log_e \frac{a}{a-x}$

(ii) $ax^2 + bx + c$

$$3+3+2+2=10$$

★ ★ ★

TDP (Honours) 1st Semester Exam., 2017

CHEMISTRY

(Honours)

FIRST PAPER

Full Marks : 80

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer **eight** questions by taking **two** from each Unit

(Use separate answer script for each Unit)

UNIT—I

(General Chemistry)

Answer *any* **two** questions

1. (a) What is Schrödinger wave equation?
Explain the significance of the wave function.
- (b) What do you mean by dual character of matter? Obtain de Broglie relation.
- (c) Using de Broglie relation, show that the angular momentum is quantised.
 $(2+2)+(2+1)+3=10$

(2)

2. (a) Define 'ionisation potential'. Discuss the factors controlling the ionisation potential values of elements.
- (b) Which is more stable between PbI_4 and PbI_2 and why?
- (c) What is the difference between electron affinity and electronegativity?
 $(2+2)+(1+2)+3=10$

3. (a) The electron affinity of chlorine is higher than that of fluorine but its electronegativity is less as compared to fluorine. Why?
- (b) Explain the radial and angular functions of an atom. How are the shapes of atomic orbitals related to these functions?
- (c) What is meant by the diagonal relationship? In what respect does lithium resemble magnesium?
 $2+(1+1+2)+(2+2)=10$

8M/25

(Continued)

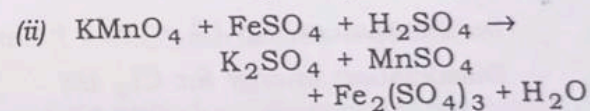
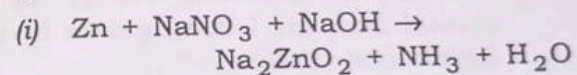
(3)

UNIT—II

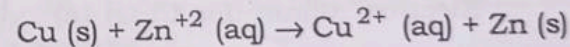
(Inorganic Chemistry)

Answer any **two** questions

4. (a) Balance the following chemical reactions by ion-electron method :



- (b) Predict whether the following redox reaction is feasible or not under standard conditions :



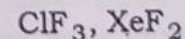
$$E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V and}$$

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

- (c) Write the difference between formal potential and standard potential.

- (d) What is electrochemical series?
 $(2+2)+3+2+1=10$

5. (a) Describe the geometries of the following molecules using VSEPR theory :



8M/25

(Turn Over)

(4)

(b) State with reason, which cation will have greater polarizing power in the following :

(i) Na^+ or Mg^{2+}

(ii) Cu^{2+} or Ca^{2+}

(iii) Pb^{2+} or Pb^{4+}

(c) Calculate the lattice energy of NaCl crystal from the following data by use of Born-Haber cycle :

Sublimation energy (S) = $108.7 \text{ kJ mol}^{-1}$

Dissociation energy for Cl_2 (D)
= $225.9 \text{ kJ mol}^{-1}$

Ionization energy for Na (g) (I)
= $489.5 \text{ kJ mol}^{-1}$

Electron affinity for Cl (g) (E)
= $-351.4 \text{ kJ mol}^{-1}$

Heat of formation of NaCl (ΔH)
= $-414.2 \text{ kJ mol}^{-1}$
(2+2)+(1+1+1)+3=10

6. (a) On the basis of MO theory, explain why—

(i) N_2 molecule is diamagnetic while O_2 is paramagnetic;

(ii) bond energy of NO is 623 kJ/mol whereas that of NO^+ is 1049 kJ/mol .

(b) What do you mean by p-type semiconductor? Give one example.

8M/25

(Continued)

(5)

(c) What is the effect of temperature on the conductivity of a semiconductor?

(d) Draw the MO energy level diagram for O_2^+ ion and comment on magnetic properties of this ion.
($1\frac{1}{2}+1\frac{1}{2}$)+3+2+2=10

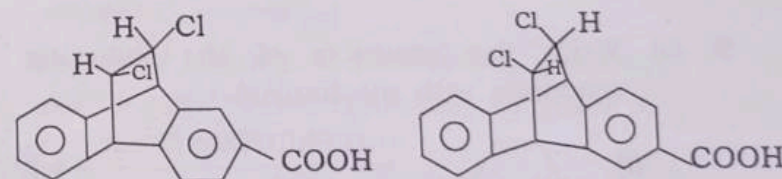
UNIT—III

(Organic Chemistry)

Answer any two questions

7. (a) What is the difference between resonance and tautomerism? Write two types of tautomerism.

(b) Which one of the following is more acidic and why?



I

II

(c) Why HCN does not undergo addition reaction to the carbonyl part of an ester?

(d) Explain that 3,5-dimethyl-4-nitroaniline is a stronger base than the corresponding 2,6-dimethyl isomer.

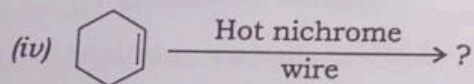
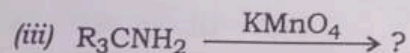
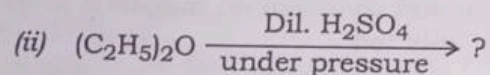
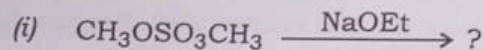
(3+1)+3+1+2=10

8M/25

(Turn Over)

(6)

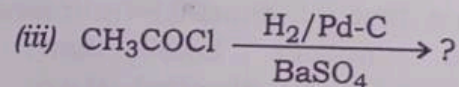
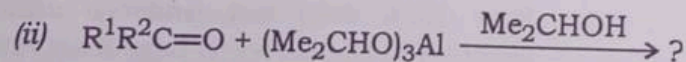
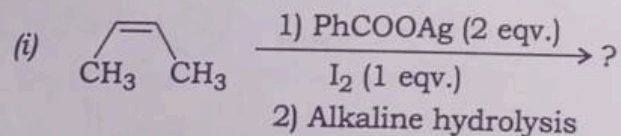
8. (a) Complete the following reactions (any three) :



- (b) Give an example of anti-elimination reaction and show the mechanism involved.

- (c) What is nucleophile? Write a reaction of nucleophilic addition. $(2 \times 3) + 2 + 2 = 10$

9. (a) Write the products of the following reactions with mechanism :

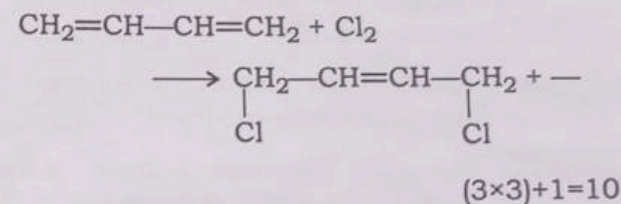


8M/25

(Continued)

(7)

- (b) Write the product(s) of the following reaction :



UNIT—IV

(Physical Chemistry)

Answer any two questions

10. (a) What are the significances of van der Waals' constants a and b ?

- (b) Derive an equation, $E = \frac{3}{2}RT$ from kinetic theory of gases (the terms have their usual meanings).

- (c) State the law of corresponding state.

- (d) van der Waals' constants for gases A, B and C are as follows :

Gas	a (atm lit ² /mole ²)	b (lit/mole)
A	4.0	0.027
B	12.0	0.030
C	6.0	0.032

Which gas has the (i) highest critical temperature and (ii) most ideal behaviour at STP?

$3 + 2 + 2 + 3 = 10$

8M/25

(Turn Over)

11. (a) State the Haüy's law of rational indices.

(b) Write a short note on n -type semiconductor.

(c) Mention the important consequences of the Schottky and Frenkel defects.

(d) Tungsten (W) has a b.c.c. lattice and each lattice point is occupied by 1 atom. Calculate the edge length of the cube. (Given density of W = 19.30 gm/cc and atomic weight of W = 183.9)

$$2+2+3+3=10$$

12. (a) Draw the block diagram of a digital computer.

(b) Distinguish between the following :

(i) RAM and ROM

(ii) Data and information

(c) Write down the following expressions in BASIC :

$$(i) \frac{J(J+1)h^2}{8\pi^2 I}$$

$$(ii) \sqrt{b^2 - 4ac}$$

(d) Evaluate the values of x of the following :

$$(i) (111011.101)_2 = (x)_{10}$$

$$(ii) (10111000)_2 = (x)_{16} \quad 3+3+2+2=10$$

★★★

TDP (Honours) 1st Semester Exam., 2016

CHEMISTRY

(Honours)

FIRST PAPER

Full Marks : 80

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

UNIT—I

(General Chemistry)

Answer *any two* questions

1. (a) State the significance of Pauli's exclusion principle.
- (b) Why is electron gain enthalpy of chlorine greater than that of fluorine?
- (c) Explain the physical significance of ψ and ψ^2 .
- (d) What characteristics of orbitals are determined by the values of quantum number n and l ?
- (e) Write a short note on screening effect of orbitals.

2+2+2+2+2=10

(2)

2. (a) What are determinate and indeterminate errors? Explain with suitable examples.

(b) State *T*-test and *F*-test. For which purpose these tests are applied in analysis of analytical data?

(c) What do you understand by the term 'significant figures'? List the proper number of significant figure in the following data :

0.312, 80.7, 900.0, 0.0570 3+4+3=10

3. (a) What is meant by diagonal relationship? Explain with suitable example.

(b) Define Pauling's scale of electronegativity. How is it related to Mulliken scale of electronegativity?

(c) Discuss the variation in atomic, ionic radii and ionization potential of elements in a group and period of the periodic table.

3+3+4=10

(3)

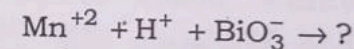
UNIT—II

(Inorganic Chemistry)

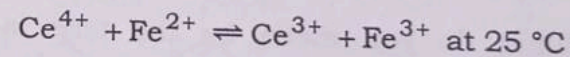
Answer any **two** questions

4. (a) What is redox potential? Explain with an example.

(b) Complete and balance the following redox reaction by ion-electron method :



(c) Calculate the equilibrium constant for the reaction



Given :

$$E^\circ_{\text{Ce}^{4+}|\text{Ce}^{3+}} = 1.44 \text{ volt and } E^\circ_{\text{Fe}^{3+}|\text{Fe}^{2+}} = 0.77 \text{ volt}$$

(d) Which indicator will you use in the titration of Fe^{2+} with $\text{K}_2\text{Cr}_2\text{O}_7$ solution in dilute H_2SO_4 medium? Why is H_3PO_4 added into the solution being titrated?

2+2+3+3=10

5. (a) What is formal charge? How would you calculate the formal charge of O_3 molecule?

(b) Explain the following using Fajans' rule :

(i) Melting point of NaBr is less than that of the NaCl.

(ii) AlCl_3 is more covalent in nature than NaCl.

(c) O_2 molecule is paramagnetic but N_2 molecule is diamagnetic in nature. Explain.

(d) Apply VSEPR theory to predict the geometry of XeOF_4 . $2\frac{1}{2}+2\frac{1}{2}+2\frac{1}{2}+2\frac{1}{2}=10$

6. (a) What is *n*-type semiconductor? Give one example.

(b) What do you mean by the term π - π interaction?

(c) Draw the MO energy-level diagram for NO molecule and comment on the bond order and magnetic properties of the molecule.

(d) How is stability of a molecule governed by H-bonding? Explain with a suitable example. $2+2+3+3=10$

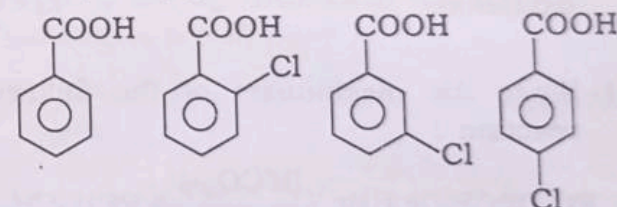
UNIT—III

(Organic Chemistry)

Answer any two questions

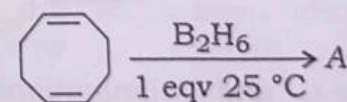
7. (a) What is resonance energy? Heat of hydrogenation of benzene and cyclohexene are $49.8 \text{ kcal mol}^{-1}$ and $28.6 \text{ kcal mol}^{-1}$ respectively. Estimate the resonance energy of benzene from these data.

(b) Arrange the following compounds in order of their increasing acid strength and justify your answer :



(c) Draw an energy profile diagram of a two-stepped exothermic reaction of which first one is endothermic. Indicate the T.S., intermediate and activation energies in the diagram.

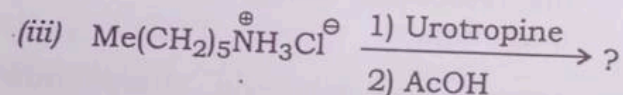
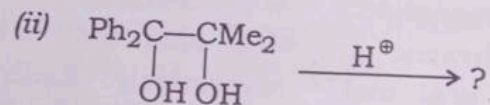
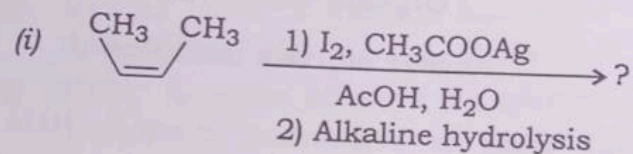
(d) Write the major product(s) in the following reaction with mechanism :



$$3+2\frac{1}{2}+2\frac{1}{2}+2=10$$

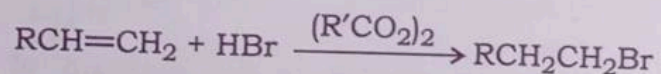
(6)

8. (a) Write the product(s) of the following reaction :

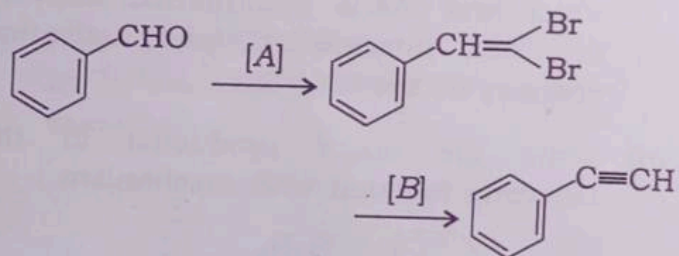


- (b) Give an example of Baeyer-Villiger oxidation.
 (3×3)+1=10

9. (a) Write the mechanism of the following reaction :



- (b) Identify [A] and [B] :



- (c) What are α - and β -eliminations? Explain with suitable examples.

(7)

- (d) In the mechanism of Cannizzaro reaction, the hydride ion is directly transferred from one molecule of aldehyde to other. Justify the statement.

$$2+2+3+3=10$$

UNIT—IV

(Physical Chemistry)

Answer any **two** questions

10. (a) Write the effect of temperature on Maxwell's distribution of velocities.
 (b) What is the significance of van der Waals' constants a and b ?
 (c) An ideal gas can never be liquified. Justify.
 (d) Deduce Dalton's law of partial pressure from kinetic gas equation.
 (e) Calculate the temperature at which hydrogen molecules will have an average speed of 176400 cm s^{-1} . $2+2+2+2+2=10$
11. (a) Derive Bragg's equation.
 (b) What is the coordination number in HCP and CCP?
 (c) Write a short note on p -type semiconductor.

- (d) A compound formed by elements X and Y arrangements. Y crystallizes in the cubic structures. X atoms are situated at the corners and Y atoms are the corners of faces. What is the formula of compound?

$$4+1+2+3=10$$

12. (a) Convert the following decimal numbers to binary :

$$(0.6875)_{10}$$

- (b) What are operating systems? Why do we need them?
- (c) Describe the structure of caesium chloride.
- (d) At what temperature the r.m.s. velocity of chlorine gas will be equal to that of SO_2 at NTP?

$$2+3+3+2=10$$

★★★

TDP (Honours) 1st Semester Exam., 2014

CHEMISTRY

(Honours)

FIRST PAPER

Full Marks : 80

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer **eight** questions, taking **two** from each Unit

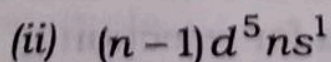
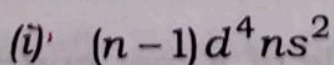
UNIT—I

(General Chemistry)

1. (a) Write down the limitations of Bohr's atomic model.

(b) Show that the Bohr's assumption of the angular momentum of electron being an integral multiple of $h/2\pi$ can be interpreted with the help of de Broglie equation.

(c) Out of the following configurations, which will be more stable one?



Justify from viewpoint of energy.

(2)

- (d) Calculate the energy of transition involving $n_1 = 6$ to $n_2 = 3$ in H-atom. Given that $R = 109737 \text{ cm}^{-1}$,
 $h = 6.63 \times 10^{-34} \text{ J-s}$.
 $2+3+2+3=10$

2. (a) Define ionization potential. What is its unit?

(b) Arrange F, Cl, Br and I in the increasing order of their electron affinity values. Give appropriate reason for your answer.

(c) State clearly the difference between electronegativity and electron affinity of an element.

(d) "Noble gases have comparatively large atomic radii than that of halogens." Explain.
 $2+3+3+2=10$

3. (a) What do you mean by significant figures?

(b) What do you mean by 'accuracy' and 'precision' of an analytical measurement?

(c) Discuss the principle of F -test and t -test, and state the criteria for rejection of data.
 $2+(2+2)+4=10$

M15-490/384

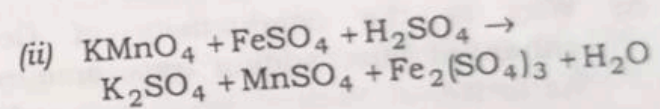
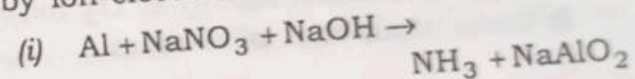
(Continued)

(3)

UNIT—II

(Inorganic Chemistry)

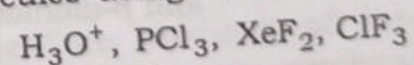
4. (a) Balance the following chemical reactions by ion-electron method :



(b) Solutions containing cupric ions readily oxidize potassium iodide to iodine though E°_{red} of $\text{Cu}^{2+}/\text{Cu}^+$ system (-0.15 V) is lower than that of the $\text{I}_2/2\text{I}^-$ system ($+0.54 \text{ V}$). Explain.

(c) Name one suitable redox indicator which is used in the titration of Fe^{2+} ion by $\text{K}_2\text{Cr}_2\text{O}_7$ indicating structures (both oxidised and reduced form).
 $(2+2)+3+(1+1+1)=10$

5. (a) Derive the shapes of the following molecules using VSEPR theory :



(b) Briefly explain Bent's rule with a suitable example.

(c) Discuss the importance of H-bonding in sustaining life.
 $(1 \times 4) + 4 + 2 = 10$

M15-490/384

(Turn Over)

(4)

6. (a) Draw the molecular orbital diagram of NO molecule.
- (b) Explain why the ionization energy of N_2 molecule is higher than that of N-atom, but the ionization energy of O_2 molecule is lower than that of O-atom.
- (c) Why is the conductivity of Ge is enhanced after adding trace amount of As to it? $4+4+2=10$

UNIT—III

(Organic Chemistry)

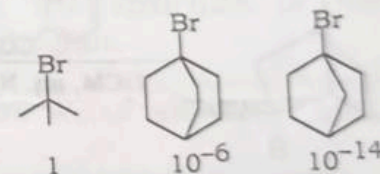
7. (a) What do you mean by tautomerism? Write down the differences between resonance and tautomerism.
- (b) Arrange the following with increasing order of dipole moment :
o-dichlorobenzene, *m*-dichlorobenzene and *p*-dichlorobenzene
- (c) Benzyl carbonium ion is more stable than allyl carbonium ion. Explain.
- (d) What is α -elimination? Give one example of such elimination. $3+2+3+2=10$

(5)

8. (a) On reductive ozonolysis, an unsaturated hydrocarbon gave (A). Write the structural formula of hydrocarbon

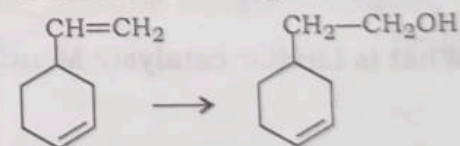


- (b) Outline the synthesis of 1-methylcyclohexane using cyclohexyl iodide as starting material.
- (c) The relative rates of solvolysis of the following three tertiary halides in 80% ethanol at 25 °C are as follows :

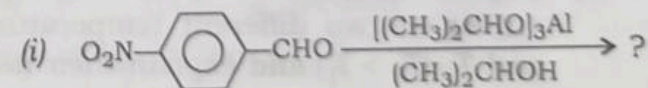


Explain the observations.

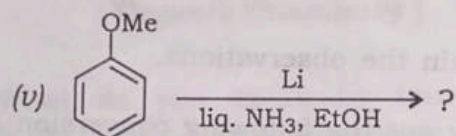
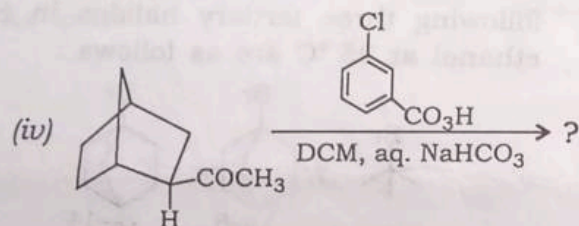
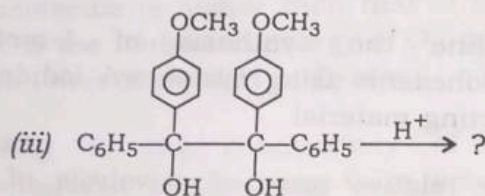
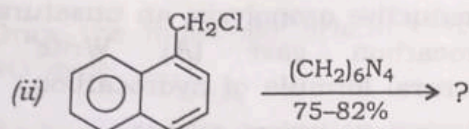
- (d) Carry out the following conversion :

 $3+2+3+2=10$

9. (a) Predict the products of the following reactions and give mechanisms (any three) :



(6)



- (b) What is Lindlar catalyst? Mention its use.
(3×3)+1=10

UNIT—IV

(Physical Chemistry)

10. (a) Depict Maxwell's speed distribution curves at two different temperatures T_1 and T_2 ($T_2 > T_1$) and explain their natures by analysing Maxwell's equation.

(7)

- (b) State law of corresponding states. What is the effect of temperature on viscosity of gases?

- (c) The mean free path of N_2 at $0^\circ C$ and 1 atm pressure is 10^{-5} cm. Calculate the collision diameter of N_2 . What will be the value of mean free path at a pressure 0.01 atm?
(2+1)+(2+2)+3=10

11. (a) What are unit cell and radius ratios? Discuss the structure of NaCl with proper diagram.

- (b) What are Weiss and Miller indices?

- (c) Potassium crystallizes with a body-centred cubic lattice and has a density of 0.856 g cm^{-3} . Calculate the length of the unit cell and the distance between (110) planes.
(2+3)+2+3=10

12. (a) What do you mean by (i) input-output devices, (ii) hardware-software and (iii) operating system of a computer?

- (b) Convert the following :

- (i) $(1000100)_2$ to decimal
(ii) $(43)_{10}$ to binary

(8)

(c) Write BASIC expression for the following :

$$\sqrt{b^2 - 4ac}$$

Also write a program in BASIC to find the roots of the quadratic equation

$$ax^2 + bx + c = 0.$$

$$3+(2+2)+3=10$$

P-1/CEMH/01/2015 (N)

2015

CHEMISTRY

(Honours)

FIRST PAPER

(Part—I / 2008 Syllabus)

Full Marks : 100

Time : 4 hours

*The figures in the margin indicate full marks
for the questions*

Write the answers to each Group in a separate book

GROUP—A

(Organic Chemistry)

(Marks : 50)

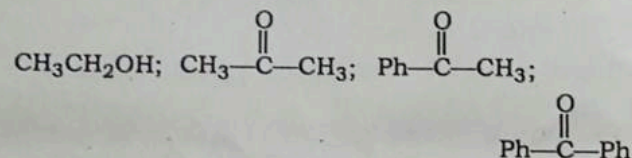
Answer Question No. 1 which is compulsory and
other **three**, taking **one** from each Unit

1. Answer any *five* of the following : 1×5=5

- (a) Boiling point of ethanol is higher than dimethyl ether though their molecular weight is same. Why?

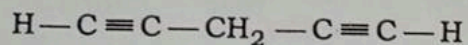
(2)

- (b) How can you synthesize alkane from alkyl halide via organometallic intermediate?
- (c) Which one of the following does not response against iodoform test?



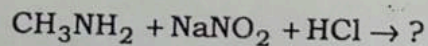
- (d) Write down the tautomeric forms of nitroso methane.

- (e) Write the IUPAC name of

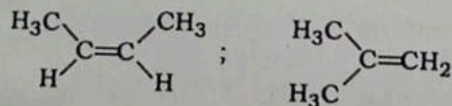
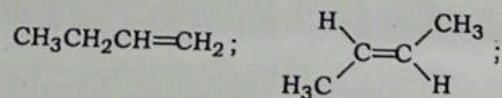


- (f) Maleic acid forms anhydride easily but fumaric acid does not. Why?

- (g) Write the product of the following reaction :



- (h) Arrange the following alkenes in ascending order of their stability :

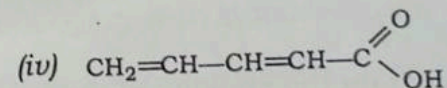
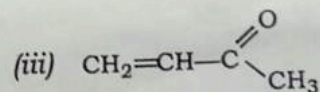
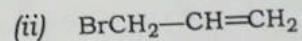
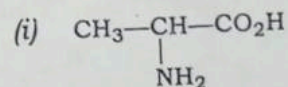


- (i) Compare the acidity of acetic acid and trifluoroacetic acid.

(3)

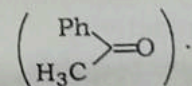
UNIT—I

2. (a) Write the IUPAC names of the following (any three) :



- (b) What are the basic differences between resonance and tautomerism? Illustrate with examples.

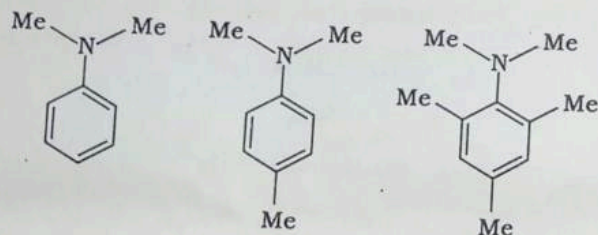
- (c) Comment on the acidity of methyl protons in acetone $\left(\begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{CH}_3 \end{array} \right)$ and acetophenone



- (d) Only one component of a mixture of salicylaldehyde and *p*-hydroxy benzaldehyde can be taken out by steam distillation. Explain.

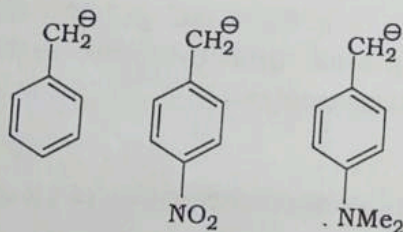
(4)

- (e) Arrange the following amines in ascending order of their basicity with reasoning :



$$3+3+3+3+3=15$$

3. (a) Comment on the stability of the following carbanions :



- (b) Arrange the following compounds in order of increasing $\text{S}_{\text{N}}1$ reactivity :

Chlorocyclopentane, Chlorocyclopropane, Chlorocyclobutane

- (c) Nitroalkanes boil at a much higher temperature than alkanes of comparable molecular weights. Explain.

(5)

- (d) 1,2-Dichloroethane has a very little dipole moment whereas ethane-1,2-diol has considerable dipole moment. Explain.

- (e) What are elimination reactions? Write examples of α - and β -eliminations.

$$3+3+3+3+3=15$$

UNIT—II

4. (a) Explain plane of symmetry and centre of symmetry with suitable examples.

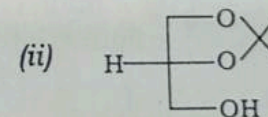
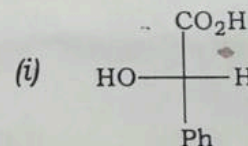
- (b) Draw Fischer projection formulae for the following :

(i) (2R, 3S)-2,3-dihydroxybutane

(ii) (4S, 3R)-4-chloro-3-hydroxy pentanoic acid

- (c) Explain the term 'racemization' with suitable example.

- (d) Label the following compounds with R- or S- notations :



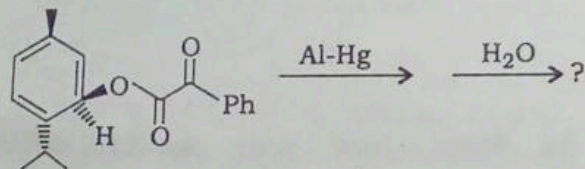
- (e) State how you would differentiate between two enantiomers. $4+4+3+2+2=15$

5. (a) Represent the *meso*-tartaric acid in Fischer projection formula. What type of conformation does it represent? Can you represent this projection formula in Newman and sawhorse projection formula? Show.

(b) Show that the enol form of ethyl acetoacetate may exist as different diastereomers. Indicate with reasons the more stable of the diastereomers.

(c) Delineate the structures of two different diastereomers having configurations (2*R*, 3*S*) and (2*R*, 3*R*) of ethyl 2-methyl-3-hydroxy-3-phenylpropanoate. How will you assign these diastereomers as *erythro*- and *threo*-forms?

(d) Which rule determines the product of the following asymmetric synthesis? Complete the reaction and designate the main product with absolute configuration :

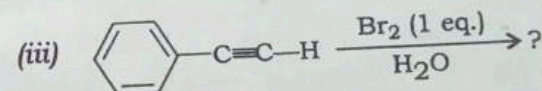
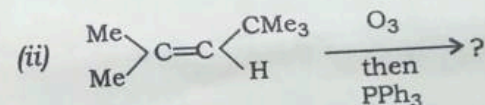
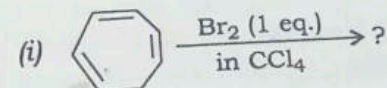


$$4+3+4+4=15$$

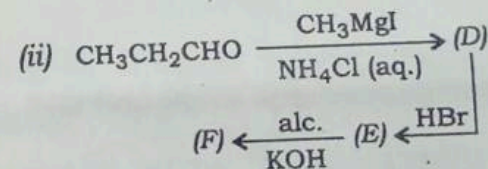
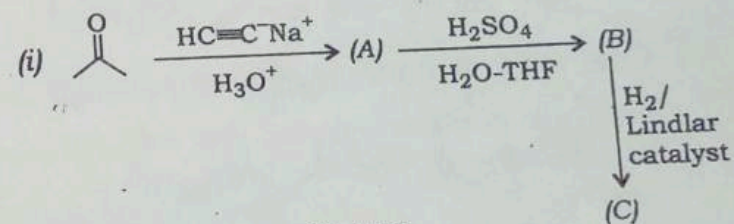
(Continued)

UNIT—III

6. (a) Predict the product(s) of the following reactions with explanation :



(b) Identify (A) to (E) :



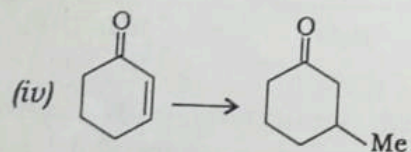
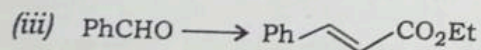
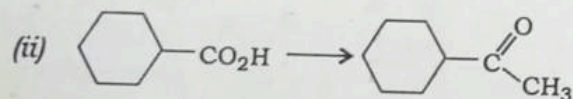
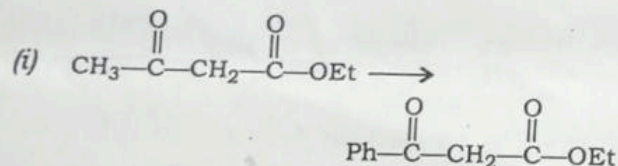
(c) How can you differentiate 1-butyne and 2-butyne chemically?

(8)

(d) What is enolate? How can you generate enolate of ethyl acetate?

$$(1\frac{1}{2} \times 3) + (1 \times 6) + 2 + 2\frac{1}{2} = 15$$

7. (a) Mention the reagents required for the following reactions and predict the mechanism (any three) :



(b) Define organometallic reagents. Why are they sensitive towards water and air?

(c) When either 1° or 2° amine is treated with HCHO and HCO_2H under reflux condition, *N*-methylated product is formed with evolution of CO_2 gas. Explain the role of HCO_2H in this reaction with mechanism. $(3 \times 3) + 3 + 3 = 15$

M15-230/682

(Continued)

(9)

GROUP—B

(Inorganic Chemistry)

(Marks : 50)

Answer Question No. 8 which is compulsory and other **three**, taking **one** from each Unit

8. Choose/Answer any *five* of the following questions : $1 \times 5 = 5$

(a) Hybridization of Xe in XeF_2 is

(i) sp^3d

(ii) sp^3d^2

(iii) sp

(iv) sp^2

(b) Which of the following statements is true?

(i) The gap between valence band and forbidden band is large for insulators.

(ii) The gap between valence band and forbidden band is small for insulators.

(iii) There is no relation between valence band and forbidden band for insulators.

(iv) None of the above

M15-230/682

(Turn Over)

- (c) LiCl is soluble in alcohol whereas NaCl is insoluble. Explain.
- (d) Write down the condition under which wave functions are said to be normalized.
- (e) The principal and azimuthal quantum numbers of electron in 4f orbitals are
- $n = 4, l = 2$
 - $n = 4, l = 4$
 - $n = 4, l = 3$
 - $n = 3, l = 4$
- (f) Draw the structure of molecule having 3e-2e bond.
- (g) When NO^+ changes to NO, the electron is added to
- σ -orbital
 - π -orbital
 - σ^* -orbital
 - π^* -orbital
- (h) Name the reagent used for detection of K^+ ion in qualitative analysis.

UNIT—I

9. (a) Describe the phenomenon of Compton effect indicating the evidence that it supports the quantum theory of radiation. Explain the term 'quantization of energy'.
- (b) State Pauli's exclusion principle. Apply the principle to predict the maximum capacity of 3rd quantum shell for accommodating electrons.
- (c) Show that Bohr's postulate of quantized angular momentum for an electron in a circular orbit can be derived by the application of de Broglie's hypothesis.
(6+2)+3+4=15
10. (a) Write the Schrödinger's three-dimensional wave equation for one-electron system and explain the terms used in it.
- (b) Draw qualitatively the radial probability distribution curves for 3s-, 3p- and 3d-orbitals.
- (c) Derive a mathematical expression for the energy of an electron in the ground state of hydrogen atom using Bohr's postulates.
- (d) Discuss Sommerfeld model of atom. How does it overcome the limitations of Bohr's atomic model?
3+3+4+5=15

UNIT—II

11. (a) State the principle of VSEPR theory for explaining shapes of molecules. Support your answer with suitable example.
- (b) Draw MO energy level diagram for NO and comment on its magnetic property. How does magnetic property change for the species NO^+ and NO^- ?
- (c) Define lattice energy. Mention the factors that influence the magnitude of lattice energy. $6+5+4=15$
12. (a) How is band theory of solids used to distinguish among insulators, semi-conductors and conductors?
- (b) Define dipole moment and mention the unit for its measurement. Gaseous HBr has dipole moment of 0.827D. Determine the percentage ionic character of the molecule if the bond distance between H and Br atom is 141.5 pm.
- (c) Draw the MO energy level diagram for CO molecule and comment on the bond order and magnetic properties. $6+4+5=15$

UNIT—III

13. (a) Name two important ores of uranium with chemical formula. Write briefly about the extraction of uranium from one of its important ore. Give the chemical reactions involved in different steps.
- (b) Write the preparation of sodium cobaltinitrite. Give equations involved in the process.
- (c) What do you mean by the term '22-carat gold'? What happens when gold is dissolved in aqua regia? Give equation. $(2+6)+3+4=15$
14. (a) Name the principal ore of silver with composition. How is pure silver obtained from this ore? Give a chemical test for silver ion with proper equation.
- (b) Discuss the redox reactions of MnO_4^- ion in acidic, neutral and alkaline mediums with suitable example.
- (c) How is nickel tetracarbonyl prepared? What is the oxidation number of nickel in the compound? $6+6+3=15$

P-1/CEMH/01/2014 (1,

2014

CHEMISTRY

(Honours)

FIRST PAPER

(Part—I / 2008 Syllabus)

Full Marks : 100

Time : 4 hours

*The figures in the margin indicate full marks
for the questions*

Write the answers to each Group in a separate book

GROUP—A

(Organic Chemistry)

(Marks : 50)

Answer Question No. 1 which is compulsory and
other **three**, taking **one** from each Unit

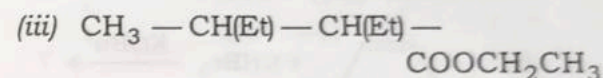
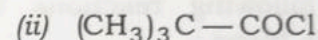
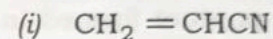
1. Answer any *five* of the following : 1×5=5

(a) Birch reduction of $RC \equiv C - R$ produces
cis-alkene. (Write True or False)

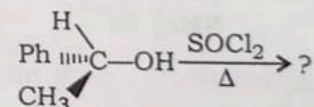
- (b) What is the major product formed when 1,3-butadiene reacts with one equivalent of bromine?
- (c) Arrange the following organometallic reagents according to their increasing order of nucleophilicity :
 CH_3MgI ; CH_3Li ; $(\text{CH}_3)_2\text{CuLi}$
- (d) Write down the Fischer projection formulae of D-glyceraldehyde.
- (e) Which excited state of methylene carbene has high energy?
- (f) Why benzaldehyde responds -ve test against Fehling's solution?
- (g) How can you convert methyl iodide to methylisocyanide?
- (h) What is arynes? Give one example.
- (i) Give one example of radical initiator with structure.

UNIT—I

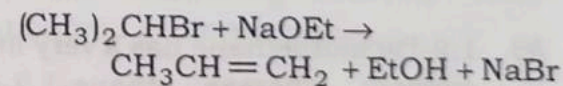
2. (a) Give the IUPAC name of the following :



- (b) Write three structures of the aliphatic compounds having the molecular formula C_6H_6 and label the state of hybridization of each carbon of these structures.
- (c) Write the difference between carbonium ion and carbenium ion. Cite examples.
- (d) Complete the following reaction and show the mechanism :



- (e) Write the mechanism of the following reaction and indicate the name of this type of mechanism :

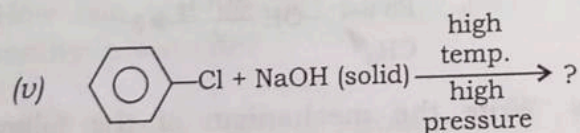
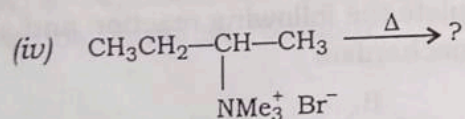
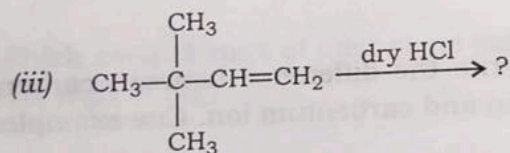
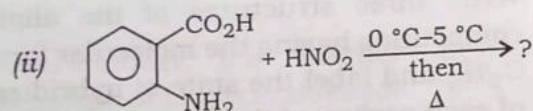
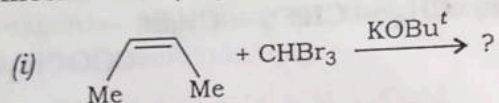


$$3+4+2+4+2=15$$

(4)

3. (a) Comment on the relative stability of PhCH_2^\oplus and PhCH_2^\ominus .

(b) Predict the major product formed in the each of the following reactions with mechanism (any three) :



(c) 1,2-Dichloroethane has a very little dipole moment whereas ethane-1,2-diol has considerable dipole moment. Explain.

(5)

(d) Aromatic rings are more susceptible towards electrophilic substitution than nucleophilic substitution. Explain.

$$3 + (2 \times 3) + 3 + 3 = 15$$

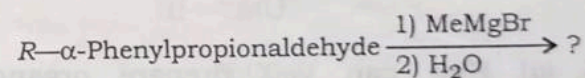
UNIT—II

4. (a) What are the differences between enantiomers and diastereomers?

(b) Draw the flying-wedge and Newman projection formulae of staggered *meso*-tartaric acid.

(c) Draw qualitative potential energy profile as a function of different conformations of cyclohexane.

(d) Write the products of the following reaction :



Write the *threo*/*erythro* designation of the major product. Write the name of the rule that governs this reaction.

$$3 + 3 + 4 + (3 + 1 + 1) = 15$$

5. (a) Write the difference between configuration and conformation.

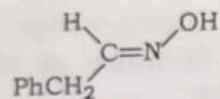
(b) All asymmetric entities are dissymmetric but the reverse is not true. Explain.

(6)

(c) Draw the Fischer projection formula of (R)-lactic acid and (2R, 3R)-2,3-dibromobutane.

(d) Draw the sawhorse formula of 2s-chlorobutanal.

(e) Designate the following molecule with E / Z as well as syn-/anti-notation :



$$3+3+(2+2)+2+3=15$$

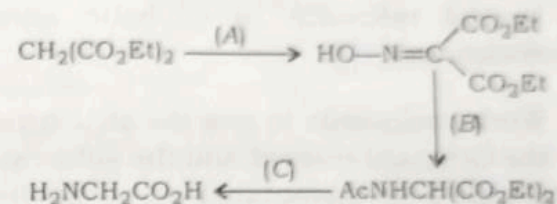
UNIT—III

6. (a) How can you prepare organolithium reagent in the laboratory? Organolithium reagents are very good nucleophile but they can also act as base. Justify the statement.

(b) Explain the stability of ethyldiazoacetate. How it reacts with benzene in presence of $h\nu$?

(7)

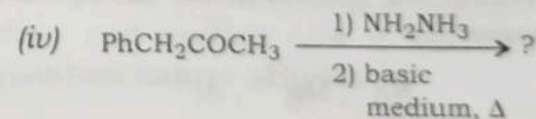
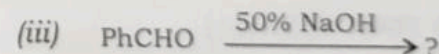
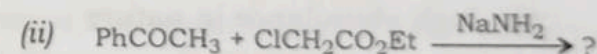
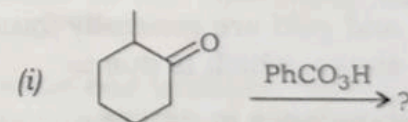
(c) Identify (A) to (C) in the following reaction :



(d) On treatment with Mg in dry ether, allyl bromide gives hexa-1,5-diene whereas n-propyl bromide forms corresponding Grignard reagent. Explain.

$$(3+3)+(2+2)+2+3=15$$

7. (a) Write down the expected major product(s) formed in each of the following reactions with mechanism (any three) :



- (b) Explain the term 'tautomerism' with special reference to aliphatic nitroso-compound.
- (c) Work backwards to give the structures of the Grignard reagent and the substrate to get the 3-methylbutan-1-ol. $(3 \times 3) + 3 + 3 = 15$

GROUP—B

(Inorganic Chemistry)

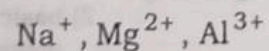
(Marks : 50)

Answer Question No. 8 which is compulsory and other **three**, taking **one** from each Unit

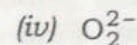
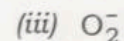
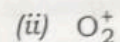
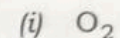
8. Choose/Answer any *five* of the following questions : $1 \times 5 = 5$

- (a) Platinum and gold are generally found in its native states, which is due to
- (i) low abundance in nature
 - (ii) high abundance in nature
 - (iii) high reactivity
 - (iv) low reactivity

- (b) Arrange the following ions in its polarizing power :



- (c) Calculate the bond order of He_2^+ ion.
- (d) Which one of the following species is diamagnetic?



- (e) The 2p and 3d orbitals have

(i) no node

(ii) one node each

(iii) two and three nodes

(iv) None of the above

- (f) What is the hybridized state of Xe in XeOF_4 ?

- (g) Name one uranium-bearing mineral and its formula.

- (h) Name the reagent that is used to detect Ni^{2+} ion qualitatively.

UNIT—I

9. (a) Discuss the phenomenon of photoelectric effect and explain how it illustrates the quantum nature of light.

- (b) Write down the important postulates of Bohr's atomic model and explain how it is used to explain atomic spectra of H-atom.
- (c) State Pauli's exclusion principle. Apply this to predict the maximum capacity of 3rd quantum shell for accommodating electrons. $5+6+4=15$
10. (a) State Heisenberg's uncertainty principle and explain its significance. Find the uncertainty in the position of an electron (mass = 9.1×10^{-28} g) moving with a velocity of 3×10^4 cm/sec accurate up to 0.011%.
- (b) Give the wave mechanical interpretation of an atomic orbital and draw the shapes of s-, p- and d-orbitals on x-, y-, z-coordinates.
- (c) In an atom, the angular momentum of an electron is $\sqrt{6} h/2\pi$. What is the minimum value of the principal quantum number of electron? $(2+2+4)+5+2=15$

UNIT—II

11. (a) State the rules for linear combination of atomic orbitals. Draw molecular orbital energy level diagram for O_2 molecule and explain its magnetic property.

- (b) What do you mean by electron deficient compound? Illustrate with an example and predict its chemical behaviours.
- (c) Using MO theory, explain the observations that bond length in N_2^+ is greater than in N_2 , while bond length in NO^+ is less than in NO. $(3+5)+4+3=15$
12. (a) State and explain the factors responsible for solubility of ionic compounds in water.
- (b) What is meant by the term 'polarisation of ions'? Discuss the factors on which the magnitude of polarising power of a cation and polarisability of an anion depend.
- (c) How is Born-Haber cycle used to calculate lattice energy of ionic solid? Discuss the factors which influence lattice energy. $4+6+5=15$

UNIT—III

13. (a) Name two important minerals of chromium and give their approximate formulae. Give flowchart with chemical reactions for isolation of pure chromium metal from one of the minerals.
- (b) How will you prepare the following?
- (i) Potassium dichromate
- (ii) Potassium permanganate $(2+5)+(4+4)=15$

14. (a) Give the names and formulae of the two important ores of nickel. Describe the extraction of nickel by Mond process with a flowchart.
- (b) What are the different types of metallurgy used in extraction of different metals? Discuss in brief the basic differences found among them.
- (c) How can you detect Mn^{2+} ion qualitatively? $7+5+3=15$
