

Total number of printed pages-4

3 (Sem-3/CBCS) CHE HC 1

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-3016

(Inorganic Chemistry-II)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed: $1 \times 7 = 7$

(i) F^- is a hard base.

(State True or False)

(ii) Predict the shape of XeF_2 with the help of the VSEPR model.

(iii) Why does nitrogen not form any pentahalide in contrast to phosphorus ?

Contd.

- (iv) Why is the dipole moment of NF_3 very low compared to that of NH_3 ?
- (v) $NaCl$ and KCl are anhydrous whereas $MgCl_2 \cdot 6H_2O$ and $CaCl_2 \cdot 6H_2O$ have water of crystallization. Give a reason.
- (vi) $MgSO_4$ is soluble in water but $BaSO_4$ is insoluble. Why ?
- (vii) FeS is much less soluble than $Fe(OH)_2$. Explain.

2. Answer the following questions : $2 \times 4 = 8$

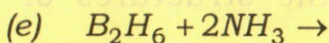
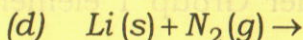
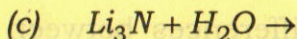
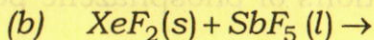
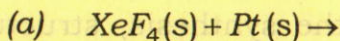
- (i) Briefly discuss the structural differences of BeH_2 and CaH_2 .
- (ii) What are pseudohalogens ? Write two similar properties of CN^- and Cl^- .
- (iii) Arrange the following molecules in increasing order of their acid strengths and give reasons for your choice :
 BBr_3, BF_3, BCl_3
- (iv) What happens when sodium hydrogencarbonate ($NaHCO_3$) is heated ? Why is it used as the fire extinguisher ?

3. Answer **any three** of the following questions : 5×3=15

(i) Define Lewis base. Lewis acids may be classified into four categories. Discuss these four categories of Lewis acids.

1+4=5

(ii) Identify the products : 1×5=5



(iii) Applying Wade's rule, rationalize why the cage structure of $\text{C}_2\text{B}_4\text{H}_6$ is an octahedron. How many cage isomers are possible for it ? 3+2=5

(iv) Write the preparation method, structure and application of polysiloxanes.

2+2+1=5

(v) What is inert-pair effect ? Give *two* examples where the inert-pair effect is seen. 1+2+2=5

4. Answer **any three** of the following questions : $10 \times 3 = 30$

(i) Discuss the Ellingham diagram. 10

(ii) Discuss the layer structure of boron nitride. Write *one* method for the preparation of boron nitride. Write *two* dissimilarities between the boron nitride and the graphite. $7 + 1 + 2 = 10$

(iii) Discuss the synthesis, structure and applications of phosphazene polymers. 10

(iv) Write the differences between lithium and the other Group 1 elements. 10

(v) Discuss the structures of various silicates. 10

(vi) Write about — $5 + 5 = 10$

(a) the allotropes of phosphorus and

(b) the structure of carbon nanotubes.

Total number of printed pages-8

3 (Sem-3/CBCS) CHE HC 2

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-3026

(Organic Chemistry-II)

Full Marks : 60

Time : Three hours

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

1. Answer the following questions : $1 \times 7 = 7$

(a) Write the name of a thiol compound that can be used as an antidote for mercury poisoning.

(b) Arrange the following compounds in order of reactivity toward S_N2 reaction :

1-Bromobutane,

1-Bromo-2,2-Dimethylpropane

1-Bromo-2-Methylbutane

1-Bromo-3-Methylbutane

Contd.

- (c) With increasing temperature, elimination is favoured over substitution. Why?
- (d) What is meant by cine-substitution?
- (e) Name a reagent used to convert cyclohexylmethanol to cyclohexanecarboxaldehyde.
- (f) Give *two* ways in which you can convert the poor leaving group in ROH to a good leaving group.
- (g) What happens when diethylsulfide reacts with hydrogen peroxide and acetic acid?

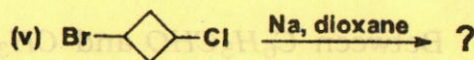
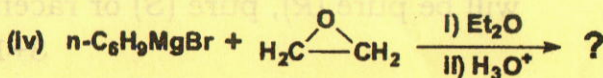
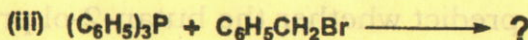
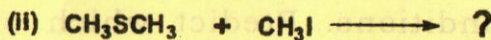
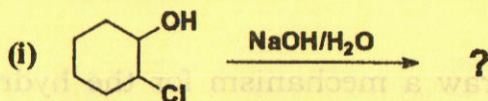
2. Answer the following questions : $2 \times 4 = 8$

- (a) How can you prepare lactic acid from propanoic acid?
- (b) Why is Ethylacetoacetate (EAA) called an active methylene compound?
- (c) Explain why the boiling point of ethylene glycol is much lower than that of glycerol.

(d) Between thiol and alcohol, which one is more acidic and why?

3. Answer **any three** of the following questions : 5×3=15

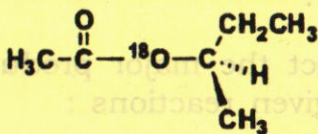
(a) Predict the major product in each of the given reactions : 1×5=5



(b) What product(s) is/are obtained when *m*-chlorotoluene is treated with sodium amide in liquid NH_3 ? Propose a mechanism to justify the product(s) formed. 1+4=5

(c) What is Bouveault-Blanc reaction? Explain the mechanism of the reaction by considering a suitable example. 1+4=5

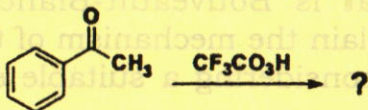
- (d) Suppose we have some optically pure (*R*)-2-butyl acetate that has been 'labeled' with the heavy ^{18}O isotope at one oxygen atom as shown.



Draw a mechanism for the hydrolysis of this compound under basic conditions. Predict which of the products will contain the ^{18}O label. Also predict whether the butan-2-ol product will be pure (*R*), pure (*S*) or racemized.

$$3+1+1=5$$

- (e) (i) Between $\text{C}_6\text{H}_5\text{CHO}$ and CH_3CHO , which one is less reactive towards nucleophiles and why? 2
- (ii) Predict the product and propose a mechanism of the following reaction: 3

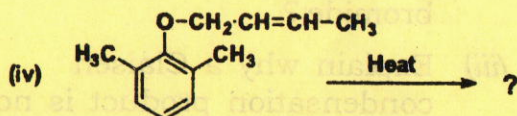
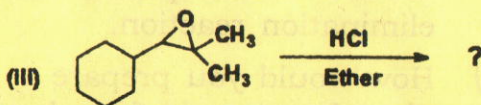
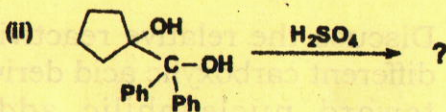
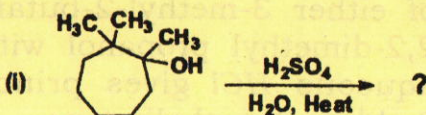


4. Answer **any three** of the following :

10×3=30

(a) Predict the product and propose mechanisms of the following reactions :

3+3+2+2=10



(b) (i) 2,3-Epoxypropane when reacts with methanol under acidic conditions yield 2-Methoxy-propan-1-ol as major product, but under basic conditions yield 1-Methoxy-propan-2-ol. Explain.

5

(ii) Explain why the acid-catalyzed condensation is a poor method for the synthesis of an unsymmetrical ether such as ethyl methyl ether. 2

(iii) Provide a mechanistic explanation for the observation that treatment of either 3-methyl-2-butanol or 2,2-dimethyl propanol with hot aqueous HCl gives principally 2-chloro-2-methylbutane. 3

(c) (i) Discuss the relative reactivities of different carboxylic acid derivatives toward nucleophilic addition-elimination reaction. 5

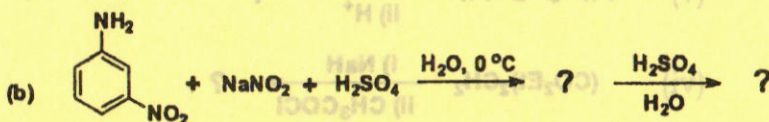
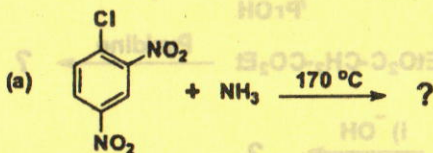
(ii) How would you prepare phenylacetic acid from benzyl bromide? 2

(iii) Explain why a Claisen condensation product is not obtained from ester such as ethyl 2-methylbutanoate. 3

(d) (i) Compare S_N1 and S_N2 reactions with regard to

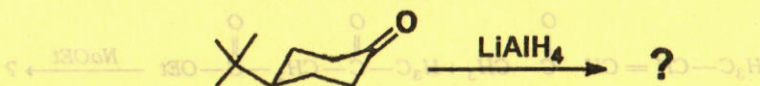
- (1) stereochemistry ;
 - (2) kinetic order ;
 - (3) occurrence of rearrangements.
- 2+2+1=5

- (ii) Complete the following reaction and write the mechanism :
(any one) 3



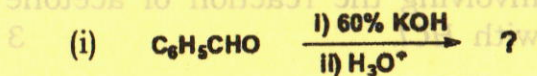
- (iii) N-Methylpropanamide does not undergo Hofmann rearrangement when treated with aqueous sodium hypobromite. Explain. 2

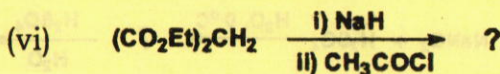
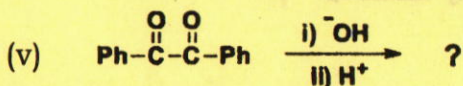
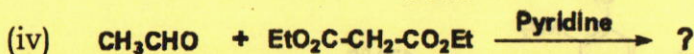
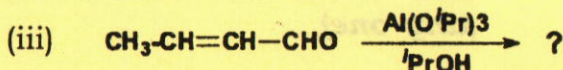
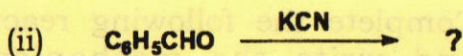
- (e) (i) Write the products obtained and state whether they are related to each other as diastereomers or enantiomers. 2



- (ii) How can you convert cyclohexanone to nylon? Write the reaction. 2

- (iii) Predict the products formed :
1×6=6

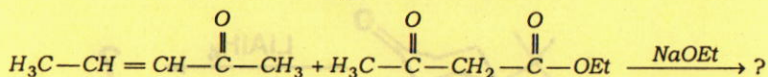




(f) (i) What are ylides? How can you prepare methylenecyclohexane using Wittig reaction? Propose a mechanism for the reaction clearly stating the steps involved.

1+1+3=5

(ii) Identify the product in the following reaction :



In this reaction which substrate is the Michael acceptor and which one is the Michael donor? 2

(iii) Propose a mechanism for acid-catalysed aldol condensation involving the reaction of acetone with HCl . 3

Total number of printed pages-7

3 (Sem-3 /CBCS) CHE HC 3

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-3036

(Physical Chemistry III)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed : $1 \times 7 = 7$

(i) A triple point is —

(a) trivariant

(b) bivariant

(c) univariant

(d) invariant

(Choose the correct option)

Contd.

- (ii) A compound with a congruent melting point melts into a liquid of _____ composition as the solid.

(Fill in the blanks with suitable word)

- (iii) The minimum number of independent variables required to characterize the composition of each phase in a system is called degrees of freedom.

(State True or False)

- (iv) Write the differential rate law for a zeroth order reaction.

- (v) Give *one* example of a consecutive reaction.

- (vi) Give *one* example of homogeneous catalysis.

- (vii) What are adsorption isotherms ?

2. Answer the following questions : $2 \times 4 = 8$

- (a) State and explain the phase rule for a non-reactive system.

- (b) Distinguish between order and molecularity of a reaction.

- (c) For the reaction $A + B \rightarrow C$, when the concentration of A is doubled, the rate of the reaction is doubled. But doubling the concentration of B does not change the rate of the reaction. Calculate the order of the reaction.
- (d) In a reaction catalysed by metal, fine division of the metal increases the catalytic action. Explain.
3. Answer **any three** questions from the following : 5×3=15
- (a) Discuss the application of phase rule to the water system. 5
- (b) (i) Explain what is meant by azeotropic mixture. 2
- (ii) Explain the principle of steam distillation. 3
- (c) (i) Derive an expression for rate constant of a zero-order reaction. 3
- (ii) Give the characteristics of zero-order reaction. 2

(d) (i) Show that in a first order reaction the time required for completion of 99.9% of the reaction is ten times its half-life period. 3

(ii) Explain activation energy of a reaction. 2

(e) (i) What is catalysis ? 1

(ii) Depending on the role and nature of the catalyst used in a reaction, classify catalysts and give suitable examples for each of them. 4

4. Answer **any three** questions from the following : $10 \times 3 = 30$

(a) (i) Discuss the application of phase rule to the sulphur system. 5

(ii) Explain the term 'component'. How many components are present in the following systems ? $2 + 3 = 5$

1. $\text{Water} \rightleftharpoons \text{water vapour}$

2. $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$

3. $\text{NH}_4\text{Cl}(s) \rightleftharpoons \text{NH}_3(g) + \text{HCl}(g)$

(b) (i) Define the terms congruent and incongruent melting points. 2

(ii) At 373.6 K and 372.6 K the vapour pressures of water are 1.018 atm and 0.982 atm respectively. Calculate the enthalpy of vapouration of water. 3

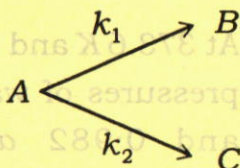
(iii) Define critical solution temperature (CST). Sketch and explain the curves showing upper CST and lower CST. Give suitable examples. 5

(c) (i) Derive the integrated rate law for the 2nd order reaction $A + B \rightarrow \text{products}$.

Consider the initial concentrations of A and B be a and $b\text{ mol L}^{-1}$ respectively. 4

(ii) Define activation energy. Give the significance of activation energy. Explain an experimental method to determine activation energy of a reaction. 1+2+3=6

- (d) (i) Find the integrated rate law for the reaction



5

- (ii) Explain the Lindemann mechanism of unimolecular gaseous decomposition reaction and find an expression for the rate of the reaction.

5

5. (a) Give the criteria of a catalyst. 4

- (b) Give *one* example of heterogeneous catalysis. Describe the mechanism of the heterogeneous catalysis.

1+5=6

6. (a) Distinguish between physisorption and chemisorption. Give *one* example of each of the physisorption and the chemisorption.

3+2=5

(b) What is adsorption isotherm ? Write the Freundlich adsorption isotherm indicating different terms involved in it. How can the Freundlich isotherm be tested ? 1+2+2=5
