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 : 1×7=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 ?

(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 : 2×4=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

(a) $XeF_4(s) + Pt(s) \rightarrow$

(b) $XeF_2(s) + SbF_5(l) \rightarrow$

(c) $Li_3N + H_2O \rightarrow$

(d) $Li(s) + N_2(g) \rightarrow$

(e) $B_2H_6 + 2NH_3 \rightarrow$

(iii) Applying Wade's rule, rationalize why the cage structure of $C_2B_4H_6$ 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

Contd.

4. Answer ***any three*** of the following questions : 10×3=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 : 1×7=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 : 2×4=8

(a) How can you prepare lactic acid from propanoic acid?

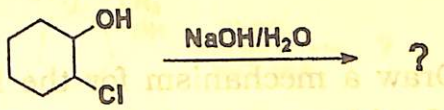
(b) Why is Ethylacetoacetate (EAA) called an active methylene compound?

(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?

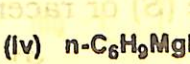
3. Answer ***any three*** of the following questions : 5×3=15

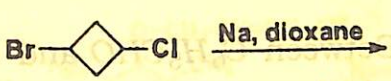
(a) Predict the major product in each of the given reactions : 1×5=5

(i) 

(ii) $CH_3SCH_3 + CH_3I \longrightarrow$?

(iii) $(C_6H_5)_3P + C_6H_5CH_2Br \longrightarrow$?

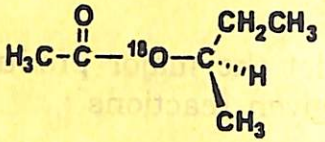
(iv) $n\text{-}C_6H_9MgBr +$  $\xrightarrow[\text{II) } H_3O^+]{\text{I) } Et_2O}$?

(v) 

(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

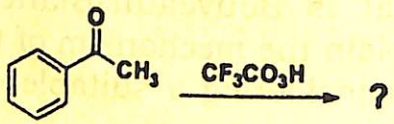
(d) Suppose we have some optically pure (*R*)-2-butyl acetate that has been 'labeled' with the heavy ^{18}O isotope at one oxygen atom as shown.



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

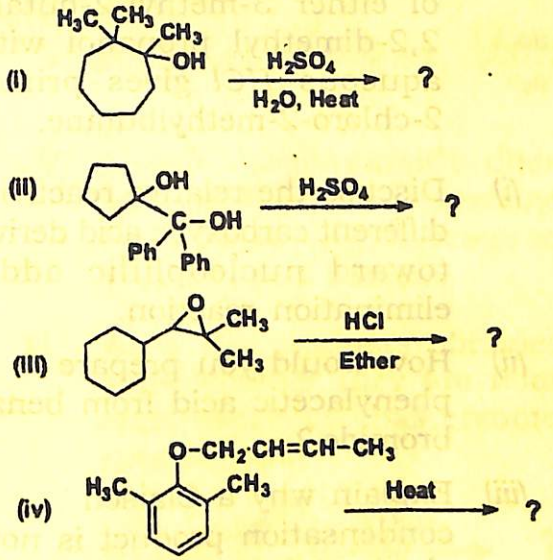
(e) (i) Between C_6H_5CHO and CH_3CHO, which one is less reactive towards nucleophiles and why? 2

(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

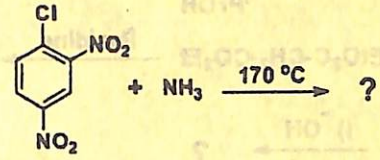
(d) (i) Compare S_N1 and S_N2 reactions with regard to

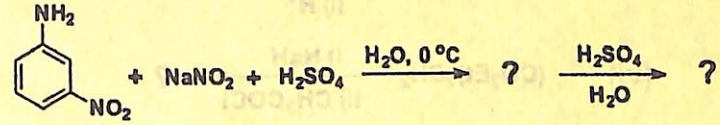
(1) stereochemistry ;

(2) kinetic order ;

(3) occurrence of rearrangements. 2+2+1=5

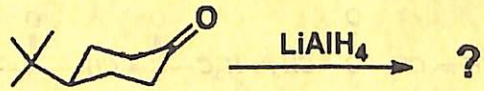
(ii) Complete the following reaction and write the mechanism : ***(any one)*** 3

(a) 

(b) 

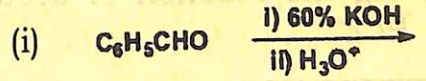
(iii) *N*-Methylpropanamide does not undergo Hofmann rearrangement when treated with aqueous sodium hypobromite. Explain. 2

(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

(i) 

(ii) $C_6H_5CHO \xrightarrow{KCN} ?$

(iii) $CH_3\text{-}CH{=}CH\text{-}CHO \xrightarrow[{}^{i}PrOH]{Al(O^{i}Pr)3} ?$

(iv) $CH_3CHO + EtO_2C\text{-}CH_2\text{-}CO_2Et \xrightarrow{Pyridine} ?$

(v) $Ph\text{-}\overset{O}{\overset{\|}{C}}\text{-}\overset{O}{\overset{\|}{C}}\text{-}Ph \xrightarrow[ii)\ H^+]{i)\ ^-OH} ?$

(vi) $(CO_2Et)_2CH_2 \xrightarrow[ii)\ CH_3COCl]{i)\ NaH} ?$

(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 :

$$H_3C{-}CH{=}CH{-}\overset{O}{\overset{\|}{C}}{-}CH_3 + H_3C{-}\overset{O}{\overset{\|}{C}}{-}CH_2{-}\overset{O}{\overset{\|}{C}}{-}OEt \xrightarrow{NaOEt} ?$$

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

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 : 1×7 =7

(i) A triple point is —

(a) trivariant

(b) bivariant

(c) univariant

(d) invariant

(Choose the correct option)

(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 : 2×4=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 : 10×3=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. Water $\rightleftharpoons$ water vapour
2. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
3. $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$

(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

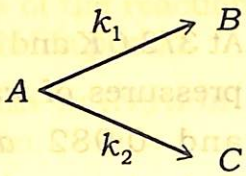
(iii) Define critical solution temperature (CST). Sketch and explain the curves showing upper CST and lower CST. Give suitable examples. 5

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

Consider the initial concentrations of A and B be a and b $mol\,L^{-1}$ 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 isoterm be tested ? 1+2+2=5