Total No. of Printed Pages—7

3 SEM TDC CHMH (CBCS) C 5

2024

(Nov/Dec)

CHEMISTRY

(Core)

Paper : C–5

(Inorganic Chemistry)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×6=6

(a) The number of terminal hydrogens present in B_2H_6 is

(i) 4

(ii) 2

(iii) 3

(iv) 6

(b) The semiconductors are refined by

(i) distillation

(ii) solvent extraction

(iii) zone refining

(iv) electro-refining

(c) The conjugate base of H_2O is

(i) H_3O^+

(ii) OH^-

(iii) O^{2-}

(iv) None of the above

(d) The type of hybridization in NH_4^+ ion is

(i) sp^2

(ii) sp^3

(iii) sp

(iv) dsp^3

(e) The shape of XeF_2 molecule is

(i) tetrahedral

(ii) square planar

(iii) linear

(iv) octahedral

(f) The formula of inorganic benzene is

(i) B_6H_6

(ii) $B_3N_3H_6$

(iii) Al_6H_6

(iv) $B_3Al_3H_6$

2. Write short notes on the following (any *two*) : 2×2=4

(a) Zone refining

(b) Hydrometallurgy

(c) Carbon reduction process

3. Answer the following questions (any *two*) : 3×2=6

(a) What are hard and soft acids and bases (HSAB)? Mention one application of HSAB principle. 2+1=3

(b) What are Lewis bases? Classify different types of Lewis bases. Give example. 2+1=3

(c) What is conjugate acid-base pair? Write the conjugate acids of $OH^{\ominus}$, $HCO_3^{\ominus}$, $NH^{\ominus}$, $HS^{\ominus}$ ions. 1+2=3

4. Answer the following questions (any *five*) : 2×5=10

(a) What is inert-pair effect?

(b) Explain the term 'diagonal relationship' with a suitable example.

(c) $AlCl_3$ is less covalent than AlI_3. Why?

(d) Write the name and formula of oxyacids of phosphorus.

(Continued)

(e) What are pseudohalogens? Give example.

(f) What are silanes? Give examples.

5. Answer the following questions (any *five*) : 3×5=15

(a) Write one method of preparation and one use of boric acid. 2+1=3

(b) Draw the electronic structures of HNO_3, N_2O_4 and HNO_2. 1+1+1=3

(c) What are interhalogen compounds? Predict the geometry of ClF_3 and PCl_5. 1+1+1=3

(d) Explain the (3*c*–2*e*) bond in diborane. 2+1=3

(e) What are carboranes? Give one example and structure of carborane. 1+1+1=3

(Turn Over)

(f) Name the allotropes of sulphur and draw their structures. 1+1+1=3

6. Answer the following questions (any *two*) : 3×2=6

(a) Give one method of preparation and chemical property of XeF_6.

(b) Applying VSEPR theory, explain the geometry of XeF_4.

(c) What are clathrates? Give one example of clathrates of noble gases.

7. Answer the following questions (any *two*) : 3×2=6

(a) What are phosphazenes? Give a method of preparation of trimeric phosphonitrilic chloride. What happens when triphosphazene chloride is hydrolysed? 1+1+1=3

(b) Give one method of preparation and bonding structure of borazine. 1+2=3

(c) Give one method of preparation of linear, cross-linked and cyclic silicones. 1+1+1=3

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CHEMISTRY

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(Organic Chemistry)

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1. Select the correct answer : 1×5=5

(a) Tertiary alkyl halides are practically inert to substitution by S_N2 mechanism due to

(i) insolubility

(ii) unstability

(iii) steric hindrance

(iv) inductive effect

(b) The electrophile involved in the Reimer-Tiemann reaction is

(i) $:CCl_2$

(ii) $\overset{\oplus}{C}HCl_2$

(iii) $\overset{\oplus}{C}HO$

(iv) $\overset{\ominus}{C}Cl_3$

(c) Lucas reagent is a mixture of

(i) $ZnCl_2 + HCl$

(ii) $Zn + HBr$

(iii) $Pd + HCl$

(iv) $Zn\text{-}Hg + Cl$

(d) Which of the following compounds will give Cannizzaro's reaction?

(i) CH_3CHO

(ii) $(CH_3)_3C—CHO$

(iii) $C_6H_5CH_2CHO$

(iv) CH_3CH_2CHO

(Continued)

(e) Arrange the following in order of increasing acidity :

(i) $ClCH_2COOH$

(ii) $Cl_2CHCOOH$

(iii) Cl_3CCOOH

(iv) $HCOOH$

UNIT—I

2. Answer any *five* of the following questions : 2×5=10

(a) What is S_Ni mechanism? Explain with the help of an example.

(b) Give the elimination-addition mechanism of conversion of chloro-benzene into aniline.

(c) Why are the aryl halides less reactive towards nucleophilic substitution reaction than alkyl halides?

(d) Complete the following reactions :

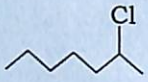
(i) $H_2C—CH_2$ (epoxide, O) $\xrightarrow{HCN}$?

(ii) $(CH_3)_3C—MgX \xrightarrow[Ether]{O_2}$? $\xrightarrow[H_2O]{H^{\oplus}}$?

(Turn Over)

(e) Discuss the relative reactivity of alkyl, allyl and aryl halides towards nucleophilic substitution reactions.

(f) Which one of the following reacts faster in S_N1 reaction and why?

(i) 

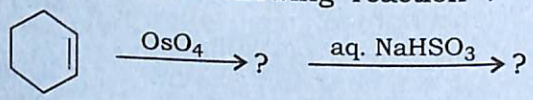
(ii) 

UNIT—II

3. Answer any *three* of the following questions : 2×3=6

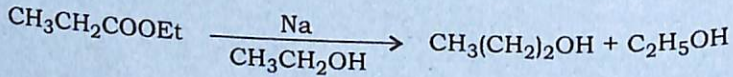
(a) How will you distinguish between 1°, 2° and 3° alcohols by Lucas test?

(b) Complete the following reaction :



(c) How would you synthesize α, β-unsaturated aldehyde from glycerol?

(d) Give the mechanism of the following reaction :



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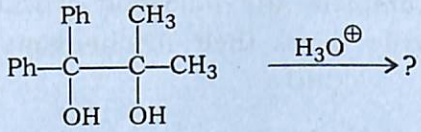
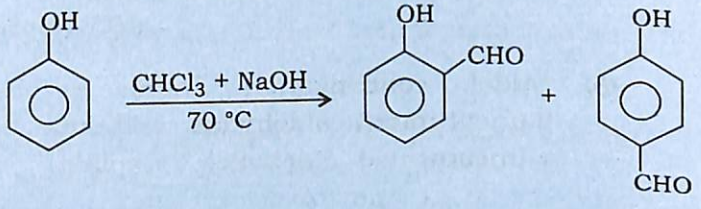
4. Answer any *two* of the following questions : 3×2=6

(a) Complete the following reaction and write down the possible mechanism :

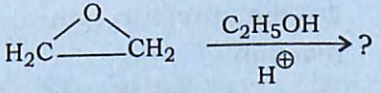


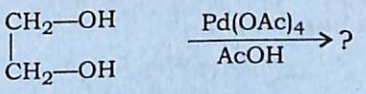
(b) (i) How can you prepare phenol from cumene? Give the mechanism.

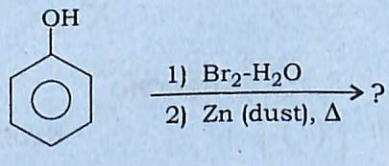
(ii) Give the mechanism of the following reaction :



(c) Complete the following reactions :

(i) 

(ii) 

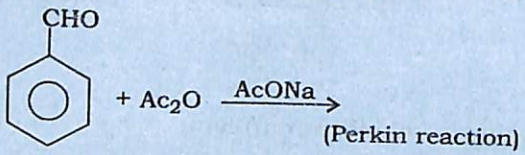
(iii) 

(Turn Over)

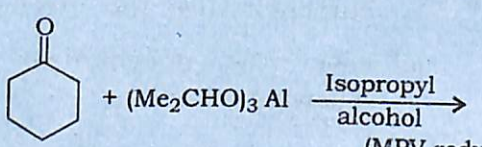
UNIT—III

Answer *either* Q. No. **5** *or* Q. No. **6**

5. *(a)* Complete the following reactions and write down their mechanisms : 3×2=6

(i) 

(Perkin reaction)

(ii) 

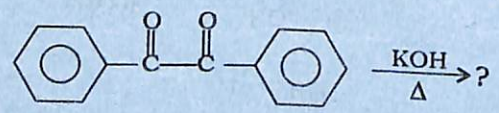
(MPV reduction)

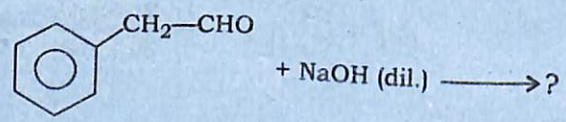
(b) "Aldol condensation leads to α, β-unsaturated aldehydes and not β, γ-unsaturated aldehydes." Explain. 2

6. *(a)* Synthesize the following : 2

2,3-dimethylbut-2-ene by Wittig reaction

(b) Complete the following reactions with mechanisms : 3×2=6

(i) 

(ii) 

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7. Answer any *two* of the following questions : 2×2=4

(a) Mention the synthetic applications of the following reagents (any *two*) : 1×2=2

(i) HIO_4

(ii) $LiAlH_4$

(iii) SeO_2

(b) What is active methylene compound? Show the keto-enol tautomerism in ethyl acetoacetate. 1+1=2

(c) What is Michael reaction? Explain with a suitable reaction. 2

8. Synthesize methyl vinyl ketone from acetone. 1

Or

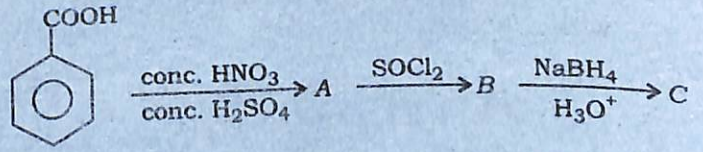
How is barbituric acid prepared using malonic ester?

UNIT—IV

Answer *either* Q. No. **9** *or* Q. No. **10**

9. *(a)* "Carboxylic acids have higher boiling point than the alcohols." Explain. 2

(b) Identify *A*, *B* and *C* in the following reactions : 3



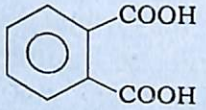
(Turn Over)

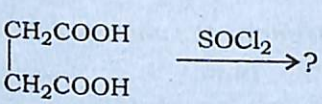
(c) Synthesize the following : 2×2=4

(i) Cinnamic acid from benzaldehyde by using Knoevenagel reaction

(ii) Propanoic acid to ethanoic acid by Hofmann degradation

10. (a) Complete the following reactions : 1×2=2

(i) 

(ii) 

(b) Discuss the mechanism of acid-catalyzed hydrolysis of ester. 3

(c) (i) How would you synthesize lactic acid from propene? 2

(ii) Justify the observation that o-hydroxybenzoic acid is a stronger acid than a methoxybenzoic acid. 2

UNIT—V

11. What are thioethers? How do you obtain diethyl thioether from ethyl mercaptan? What happens when a thioether is oxidized with H_2O_2? ½+½+1=2

12. Which is the stronger acid, ROH or RSH? Give reason for your answer. 1+1=2

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CHEMISTRY

(Core)

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(Physical Chemistry)

Full Marks : 53
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The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×5=5

(a) The unit of rate constant of a zero-order reaction is

(i) $dm^6 mol^{-2} s^{-1}$

(ii) s^{-1}

(iii) $dm^{-3} mol\ s^{-1}$

(iv) $dm^3 mol^{-1} s^{-1}$

(b) For a reaction, if the plot of ln k versus $1/T$ gives a straight line, then

(i) $E_a = (\text{slope}) \times R$

(ii) $E_a = -(\text{slope}) \times R$

(iii) $E_a = (\text{slope}) \times 1/R$

(iv) $E_a = -(\text{slope}) \times 1/R$

(c) The reduced phase rule for a condensed system is

(i) $F = C - P + 2$

(ii) $F = C + 2 + P$

(iii) $F' = C + 1 - P$

(iv) $F' = C + 1 + P$

(d) The number of phases, number of components and degrees of freedom corresponding to the triple point of sulphur system are

(i) (3, 2, 1)

(ii) (3, 1, 0)

(iii) (4, 2, 0)

(iv) (2, 2, 0)

(e) The adsorption theory explains the

(i) acid-base catalysis

(ii) homogeneous catalysis

(iii) heterogeneous catalysis

(iv) enzyme catalysis

2. Answer any *five* questions from the following : 2×5=10

(a) What is triple point? Write its significance.

(b) Show that half-life period of a second-order reaction is inversely proportional to the initial concentration of the reactant.

(c) The reaction, $2A + B \rightarrow$ products; is first-order with respect to A and second-order with respect to B. Write down its differential rate equation and rate law.

(d) Find out the number of components and degrees of freedom for the following equilibrium :

$$CaCO_3(s) = CaO(s) + CO_2(g)$$

(e) "Adsorption is exothermic in nature." Explain.

(f) What are catalytic promoters? Give one example.

3. Answer any *three* questions from the following : 4×3=12

(a) Derive the phase rule thermodynamically.

(b) Write the Clapeyron equations for the three-phase transition equilibria of water system. Predict the slope of the P vs. T curves of water system from the Clapeyron equations.

(c) Construct the phase diagram for Zn-Mg from the following data :

Melting point of Zn = 420 °C

Melting point of Mg = 650 °C

A congruently melting stable compound Mg_xZn_y is formed at 15% by mass of Mg; the congruent melting point of which is 599 °C. The lowest freezing point of zinc observed is 370 °C at 4% by mass of Mg. The lowest freezing point of magnesium observed is 350 °C at 50% by mass of Mg. Determine the molecular formula of the stable compound Mg_xZn_y. 3+1=4

(Continued)

(d) Draw and discuss the phase diagram of lead-silver system.

(e) Write short notes on any *two* of the following : 2×2=4

(i) Azeotropes

(ii) Steam distillation

(iii) Eutectic point

(iv) CST

4. Answer any *three* questions from the following : 4×3=12

(a) What is meant by the rate and order of a reaction?

For the reaction

$$A + 2B + C \rightarrow D + 2E$$

the rate of formation of D is found to be

(i) doubled when $[A]$ is doubled keeping $[B]$ and $[C]$ constant

(ii) doubled when $[C]$ is doubled keeping $[A]$ and $[B]$ constant

(iii) unchanged when $[B]$ is doubled keeping $[A]$ and $[C]$ constant

Write the rate equation for the reaction. 2+2=4

(Turn Over)

(e) What is half-life period of a reaction? Deduce a relationship between half-life period and order of a reaction. 1+3=4

5. Answer any *three* questions from the following : 3×3=9

(a) What are homogeneous and heterogeneous catalysis? Give one example of each. 2+1=3

(b) The following mechanism is proposed for an acid-catalyzed reaction :

$$S + AH^+ \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} SH^+ + A$$

$$SH^+ + H_2O \xrightarrow{k_2} P + H_2O^+$$

where S is the substrate, AH^+ is an acid and P is the product. Under what conditions, the reaction becomes *(i)* general acid-catalyzed and *(ii)* specifically hydrogen ion-catalyzed reaction? 1½+1½=3

(c) Discuss the effect of pH on enzyme catalysis.

(d) Write a short note on any *one* of the following :

(i) Nanomaterials as catalyst

(ii) Autocatalysis

6. Answer any *one* question from the following : 5

(a) Show that the Freundlich adsorption isotherm is a special case of Langmuir adsorption isotherm.

(b) *(i)* What are physical adsorption and chemisorption? Write four differences between physical adsorption and chemisorption. 2+2=4

(ii) Finely divided solid materials are better adsorbents than their compact solid. Why? 1

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