

2023

CHEMISTRY — HONOURS

Paper : CC-8

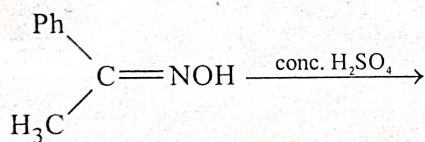
(Organic Chemistry - 4)

Full Marks : 50

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer *question no. 1* and *any eight* questions from the rest (*question nos. 2 to 12*).1. Answer *any ten* questions :

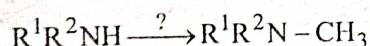
1×10

- (a) What is meant by umpolung? Give one example.
- (b) Primary aromatic amines form stable diazonium salts whereas primary aliphatic amines do not. Explain.
- (c) In the structure of aniline, point out the chromophore and auxochrome components.
- (d) Which of the following nuclei have magnetic property?
 $^{12}_6\text{C}$, $^{14}_7\text{N}$, $^{16}_8\text{O}$, $^{19}_9\text{F}$
- (e) Write down the product of the following reaction (no mechanism needed)

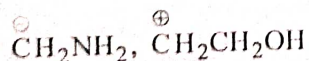


(E = Isomer)

- (f) Write down the reagents required for the following transformation :



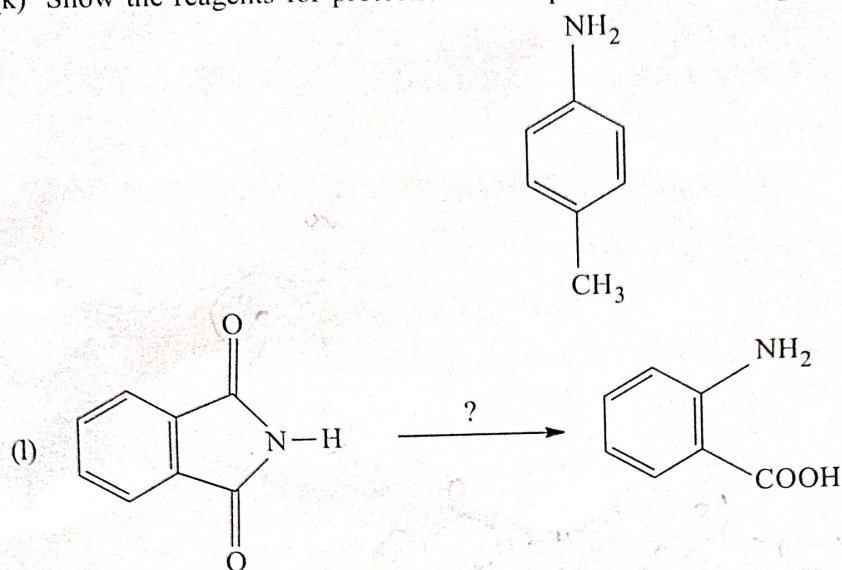
- (g) What happens to the UV absorption spectrum (λ_{max}) of aniline when HCl is added to it?
- (h) Write down the synthetic equivalents (SE) of the following synthons :



- (i) Both $\text{Ph}_2\text{C}(\text{OH})\text{C}(\text{OH})\text{CMe}_2$ and $\text{Ph}(\text{Me})\text{C}(\text{OH})-\text{C}(\text{Me})(\text{OH})\text{Ph}$ give the same ketone on separate treatment with H_2SO_4 . Write down the structure of the product.
- (j) Write down the structure of the compound $\text{C}_5\text{H}_{11}\text{Cl}$ which shows two singlets in its ^1H NMR spectrum.

Please Turn Over

(k) Show the reagents for protection and deprotection of $-NH_2$ group of the following compound :

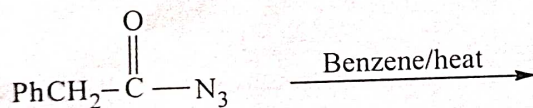


2. (a) How would you distinguish between the members of each of the following pairs by IR spectroscopy?

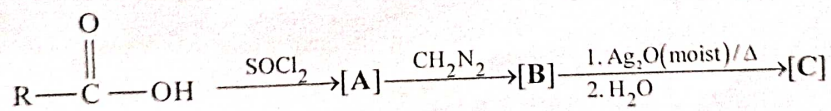
(i) Ethanol and ethylene glycol

(ii) Methyl benzoate and phenyl acetate

(b) Give the product of the following reaction along with mechanism. 3+2

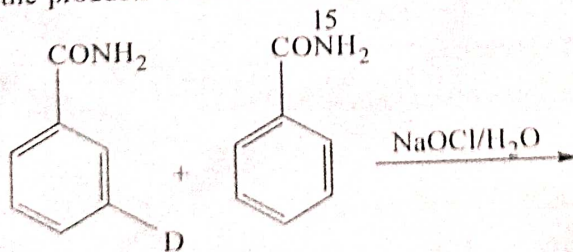


3. (a) Identify [A], [B], [C] of the following sequence of reactions :



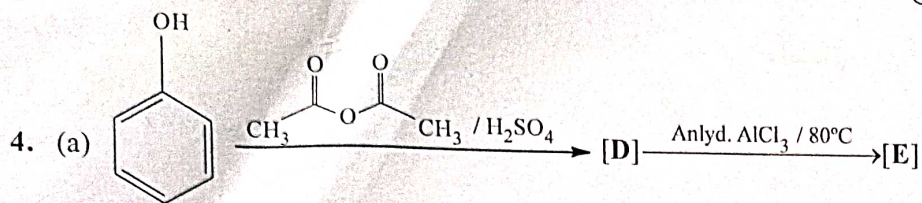
Give mechanism for the conversion of [B] to [C].

(b) Give the products of the following reaction and explain their formation. 3+2



(3)

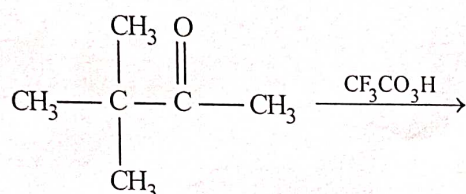
Z(4th Sm.)-Chemistry-H/CC-8/CBCS



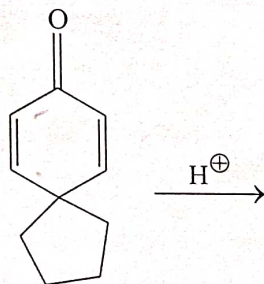
Give the structures of [D] and [E] and write down the mechanism for the conversion of [D] to [E].

(b) Arrange *E*-stilbene and *Z*-stilbene in order of their increasing λ_{\max} value and justify. 3+2

5. (a) Predict the major product and give plausible mechanism of the following reaction :



(b) Give the product of the following reaction along with mechanism : 3+2



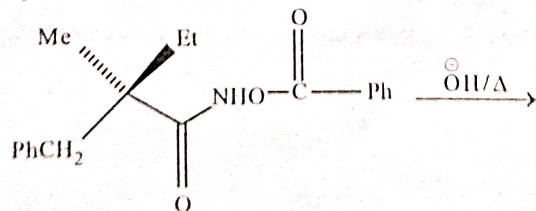
6. (a) Distinguish between the following pair of compounds with the help of spectroscopic method mentioned in the bracket and justify your answer in each case.

(i) Cyclopropanone and cyclohexanone (IR)

(ii) 1-chloropropane and 2-chloropropane (^1H NMR)

(b) Explain why alkyl isocyanides can not be hydrolysed by alkali. 3+2

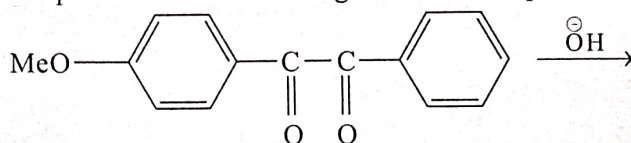
7. (a) Predict the product of the reaction below and show the mechanism involved :



(b) Why is deuterated solvent used to run ^1H NMR samples? 3+2

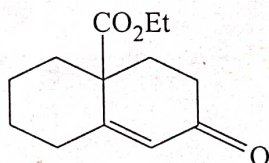
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8. (a) Predict the product of the following reaction with plausible mechanism :



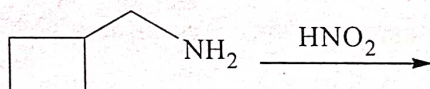
- (b) Which of the two regioisomers of dibromoethane will show a 4H,s in its ^1H NMR spectrum and why? 3+2

9. (a) Give the synthesis along with the retrosynthesis of the following target molecule :

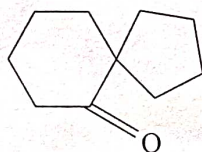


- (b) Illustrate the use of acyloin reaction for the synthesis of large rings. 3+2

10. (a) Predict the product(s) of the following reaction with plausible mechanism :

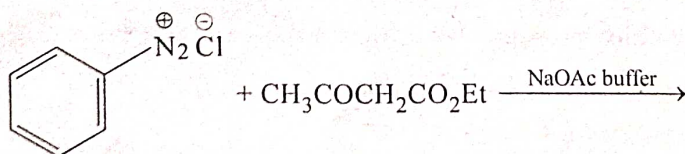


- (b) How would you synthesise the following compound using pinacol-pinacolone rearrangement? 3+2

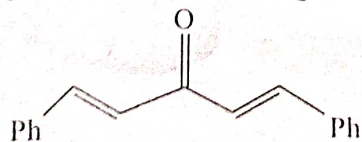


11. (a) Saturated cyclic ketones usually record three absorption bands in their UV spectra at around 160 nm, 190 nm and 280 nm. Assign them in terms of electronic transition. Predict with proper reasoning which will record the most intense absorption.

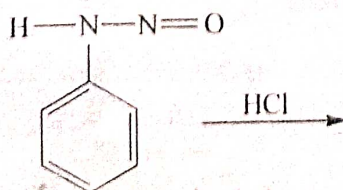
- (b) Predict the product of the following reaction with plausible mechanism : 3+2



12. (a) Describe the synthesis of the following compound with proper retrosynthetic analysis.



- (b) Give the product along with mechanism of the following reaction : 3+2



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CHEMISTRY — HONOURS

Paper : CC-9

(Physical Chemistry - 3)

Full Marks : 50

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practical be.*Answer *question no. 1* and *any eight* questions from the rest.1. Answer *any ten* questions :

1×10

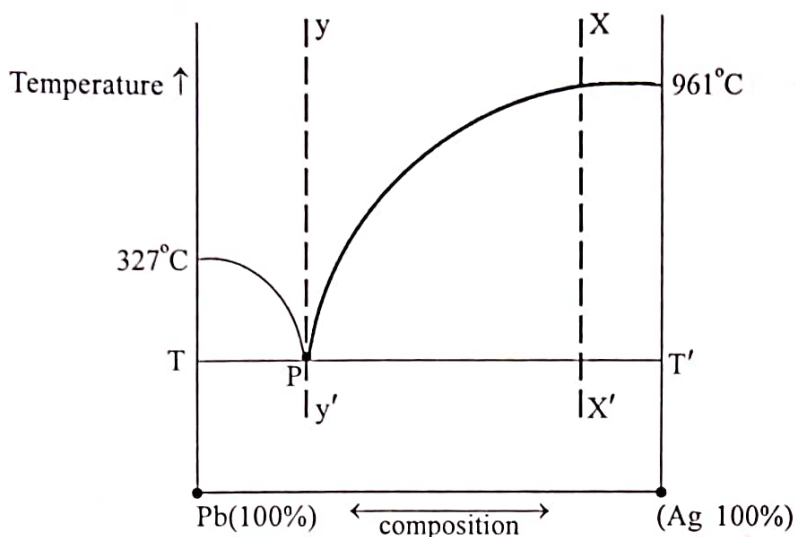
- (a) The function $f(x) = e^{-ikx}$ is an eigenfunction of an operator $\hat{A} = -i\hbar \frac{\partial}{\partial x}$. Find the eigenvalue of the eigenfunction.
- (b) Why for a two-component system, the degree of freedom (F) at the Eutectic point is zero?
- (c) A mixture of Na_2CO_3 and K_2CO_3 is used as fusion mixture. Explain.
- (d) Prove that if $\psi(x)$ is a solution to the Schrödinger equation, then any constant times $\psi(x)$ is also a solution.
- (e) Show the distance of separation of (nh, nk, nl) planes from d_{hkl} value with orthogonal axes.
- (f) "If the degree of dissociation or association of solute molecules in solvent increases, the extent of abnormality in colligative property increases." — Explain.
- (g) For a particular wavelength of X-rays, show that the highest order of reflection made by the lattice planes is directly proportional to the interplaner distance.
- (h) What is the physical significance of $|\psi|^2$?
- (i) What is the significance of normalisation constant?
- (j) What do you mean by expansion of eigenstates?
- (k) Explain Bohr's correspondence principle for particle in an one-dimensional box.
- (l) Why are the number of chemical species and number of components are equal for non-interacting constituents in equilibrium?
2. Using the concept of chemical potential, derive the van't Hoff equation, $\pi = cRT$, where the terms have usual significance. Also derive a relationship between osmotic pressure and lowering of vapour pressure of an ideal solution.

3+2

Please Turn Over

3. (a) Let $\psi_1, \psi_2, \dots, \psi_n$ be a set of linearly independent eigenfunctions.
 If $\phi = c_1\psi_1 + c_2\psi_2 + \dots + c_n\psi_n = \sum_i c_i\psi_i$, find the coefficients c_i 's? Assume that ψ_i 's are orthonormal.
- (b) A dilute solution of H_2SO_4 in water. Find its degrees of freedom and components. 3+2
4. (a) Show that the probability of finding a particle in a one-dimensional box of length a within the interval.
- $$\left(0 \leq x \leq \frac{a}{4}\right) \text{ is } \frac{1}{4}, \text{ when } n \text{ is even, and is } \left(\frac{1}{4} - \frac{(-1)^{\frac{n-1}{2}}}{2\pi n}\right) \text{ when } n \text{ is odd.}$$
- (b) Calculate the ratio of mole fraction of O_2 and N_2 dissolved in water at 25°C , if Henry's law constant for $\text{N}_2 = 6.50 \times 10^7$ torr and for $\text{O}_2 = 3.30 \times 10^7$ torr. 3+2
5. (a) If ψ_1 and ψ_2 are non-degenerate eigenfunctions of a Hermitian operator, ($\hat{\alpha}$) and given :
- $$\hat{\alpha}|\psi_1\rangle = a_1|\psi_1\rangle$$
- $$\hat{\alpha}|\psi_2\rangle = a_2|\psi_2\rangle$$
- a_1 and a_2 being the eigenvalues of ψ_1 and ψ_2 , respectively.
 show that $\langle\psi_1|\psi_2\rangle = 0$.
- (b) In a crystalline solid, anion C is arranged in cubic close packing. Cation A occupies 50% of the tetrahedral voids and cation B occupies 50% of octahedral voids. What is the formula of the solid? 3+2
6. (a) State with reasons the degree of freedom (F) inside the bound area, outside the bound area and at the C.S.T. for phenol-water system.
- (b) Evaluate the commutators of the operators A and A^\dagger , where $A = x + i\frac{h}{2\pi} \frac{d}{dx}$. 3+2
7. Consider the phase diagram (drawn here) for lead-silver system : 5
- (a) Describe the TT' line.
- (b) What are the phases present at P ?
- (c) Describe the changes which occur when the liquid mixture (melt) X (nearly 80% Ag) is cooled along the dashed line (XX').

(d) Describe the changes along the dashed line yy'



8. (a) Show that the error in the de Broglie wavelength (λ) is related to the error in velocity (v) by the relation $d\lambda = -\frac{\lambda}{v} dv$.

(b) The eigenfunction for the particle in a one-dimensional box of length a be $\psi_n(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$.

Show that the said wavefunction is an eigenfunction of \hat{p}_x^2 but not of \hat{p}_x . (The notations have their usual significance). 2+3

9. (a) State and explain Konowaloff's rule.

(b) What is the cause of positive deviations from Raoult's law? What are its consequences? 3+2

10. (a) Show that $\psi(x) = A \cdot e^{\pm 2\pi i x / \lambda}$ represents a de Broglie wave. Use this relation to derive an expression for x component of the linear momentum operator \hat{p}_x .

(b) If there exists a set of functions which are eigenfunctions of two operators \hat{A} and \hat{B} , they must commute : that is, $\hat{A}\hat{B} = \hat{B}\hat{A}$. 2½+2½

11. (a) Consider a particle in a two-dimensional box. Determine $[\hat{x}, \hat{p}_y]$, $[\hat{x}, \hat{p}_x]$. (notations have got their usual significance).

(b) Show that the length of the box is an integral multiple of $\frac{\lambda}{2}$, where λ is the wavelength associated with the particle wave. 3+2

Please Turn Over

(4)

Z(4th Sm.)-Chemistry-H/CC-9/CBCS

12. (a) KCl crystallizes as FCC. At certain temperature the density of KCl is 2gm/cc and the edge length of the unit cell is 6.3 Å. Find the number of K^+ and Cl^- ions per kg of KCl.
- (b) 'Experiment shows that KCl has a simple cubic lattice structure. However we expect that KCl should have the same structure of NaCl, that is FCC, as both of them form a continuous series of solid solution, where Na^+ replaces K^+ in any proportions.'— Comment. 3+2
13. (a) 'The void space of FCC lattice is greater than the void space of BCC lattice.'— Justify or criticize.
- (b) Debye's theory is better at predicting low temperature behaviour of heat capacity than that of Einstein's.— Why? $2\frac{1}{2}+2\frac{1}{2}$
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CHEMISTRY — HONOURS

Paper : CC-10

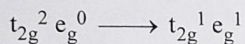
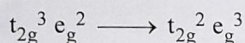
(Inorganic Chemistry - 4)

Full Marks : 50

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer **question no. 1** and **any eight** questions from the rest.1. Answer **any ten** questions :

1×10

(a) Justify whether the following transitions are spin allowed or spin forbidden.

(b) Between $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{Co}(\text{NH}_3)_5 \text{Cl}]^{2+}$, which one has intense colour?(c) Which lanthanide atom has ground state electronic configuration of $[\text{Xe}]4f^7 5d^1 6s^2$?

(d) Which ion(s) among the following will have highest tendency towards formation of tetrahedral complex— Ni(II), Co(II), Cr(III)?

(e) Arrange NO_2^- , H_2O , CO and Cl^- according to increasing *trans* effect shown by them.

(f) Give example of a transition metal complex which shows evidence of Jahn Teller distortion in its visible spectrum.

(g) Give example of a compound which shows superexchange phenomenon.

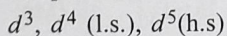
(h) What type of charge transfer spectra is observed in $\text{Fe}_4^{\text{III}}[\text{Fe}^{\text{II}}(\text{CN})_6]_3$?

(i) Cite an example of metal complex which shows spin state equilibrium.

(j) Give one example of superconducting lanthanide compound with its molecular formula.

(k) Give two uses of actinide compounds.

(l) Which electronic configuration gives orbital contribution to the overall magnetic moment of the complex?



Please Turn Over

2. (a) Stability of a distorted octahedral complex is greater than that of a perfectly octahedral complex. Explain with suitable example.
- (b) Explain why energy of ligand to metal charge-transfer bands follows the trend —
 $[\text{CoI}_4]^{2-} < [\text{CoBr}_4]^{2-} < [\text{CoCl}_4]^{2-}$. 3+2
3. (a) Show splitting pattern of d -orbitals in square planar complex. Explain why the complex $[\text{PdCl}_4]^{2-}$ adopts the square planar geometry.
- (b) Explain the fact : $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ has greater CFSE than $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ 3+2
4. (a) Metal ion having d^9 configuration preferably forms octahedral complexes whereas that with d^{10} configuration preferably forms tetrahedral complexes. Justify.
- (b) Predict the spinel nature of CuFe_2O_4 . 3+2
5. (a) Explain why *cis*-platin on reacting with excess thio urea (tu) produces $[\text{Pt}(\text{tu})_4]^{2+}$ while *trans*-platin produces *trans*- $[\text{Pt}(\text{tu})_2(\text{NH}_3)_2]^{2+}$ complex.
- (b) Explain the term 'Nephelauxetic effect' 3+2
6. (a) $[\text{V}(\text{H}_2\text{O})_6]^{3+}$ absorbs $17,200 \text{ cm}^{-1}$; $25,600 \text{ cm}^{-1}$ and $38,500 \text{ cm}^{-1}$ of light. Assign these absorptions with proper transitions involved with the help of Orgel diagram. Find out the $10 Dq$ value from the given data.
- (b) What do you mean by labile complex? Give an example. 3+2
7. (a) Identify the products A, B, C, D, E, F.
- $$[\text{PtCl}_4]^{2-} \begin{cases} \xrightarrow{\text{NH}_3} \text{A} \xrightarrow{\text{Br}^-} \text{B} \xrightarrow{\text{Py}} \text{C} \\ \xrightarrow{\text{Py}} \text{D} \xrightarrow{\text{Br}^-} \text{E} \xrightarrow{\text{NH}_3} \text{F} \end{cases}$$
- (Py = Pyridine)
- (b) $[\text{VO}_4]^{3-}$ is colourless while $[\text{CrO}_4]^{2-}$ is yellow, although both the metal ions have d^0 electronic configuration. 3+2
8. (a) Discuss the differences in spectral properties of transition metal compounds with lanthanide compounds.
- (b) In $[\text{CrF}_6]^{4-}$ four (Cr - F) bonds are long and two are short but in $[\text{MnF}_6]^{4-}$ all (Mn - F) bonds are equal in length. — Why? 3+2

9. (a) With the help of M.O. diagram, explain why halides show field strength order as —
 $\Gamma^- < \text{Br}^- < \text{Cl}^- < \text{F}^-$.
- (b) Explain why — EDTA forms a more stable complex with Lu(III) than La(III). 3+2
10. (a) Discuss the mechanistic steps involved in the base catalysed hydrolysis of $[\text{CoCl}(\text{NH}_3)_5]^{2+}$ complex.
- (b) Why tetrahedral complexes show much intense colour than octahedral complexes of same metal ion? 3+2
11. (a) Compare the magnetic moment of tetrahedral and octahedral complexes of Ni(II) with respect to spin only magnetic moment value.
- (b) Mention the lanthanide ions which are stable in +2 oxidation state. 3+2
12. (a) State the Jahn Teller theorem. Mention the electronic configurations in tetrahedral complexes which show Jahn Teller distortion.
- (b) Compare the stability of oxidation states of transition metal ions along a group. 3+2
13. (a) Show graphically how lattice energy of divalent halides, MX_2 (M = Ca to Zn) vary and also provide a proper explanation.
- (b) Calculate the OSSE value for Ni(II) ion. 3+2
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2023

CHEMISTRY — HONOURS

Paper : SEC-B-1

(Pharmaceuticals Chemistry)

Full Marks : 80

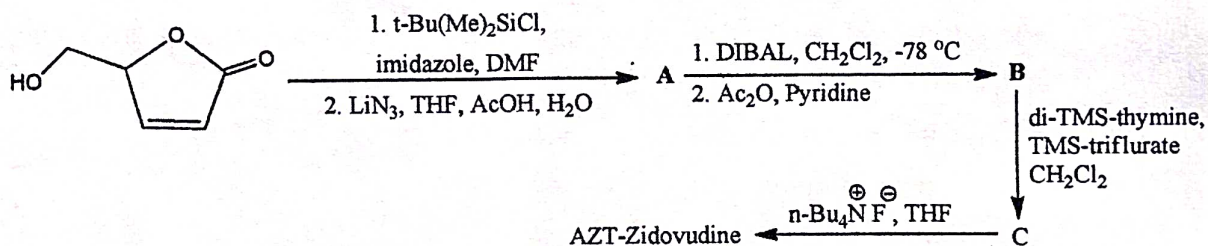
*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.**Question no. 1 is compulsory and answer any twelve questions from the rest (question nos. 2 to 15).*1. Answer *any twenty* questions :

1×20

- (a) Name two microorganisms that are capable of synthesizing Vitamin B₂.
- (b) What do you mean by therapeutic ratio or index?
- (c) Mention two serious side effects of the drug ibuprofen.
- (d) Give an example of drug which has analgesic, antipyretic and anti-inflammatory activity.
- (e) Write the structure of *L*-lysine.
- (f) Name one 'opioid' and one 'non-opioid' analgesics.
- (g) Give an example of antioxidant.
- (h) What do you mean by 'PDD' and 'TDD' in pharma industries?
- (i) What are isosteres?
- (j) Give an example of antiviral drug.
- (k) What is the full form of NSAID?
- (l) Write the number and stereochemistry of the chiral centre present in the biologically active chloramphenicol.
- (m) Which metal ion present in Vitamin B₁₂?
- (n) Name two drugs, used as antibacterial agents.
- (o) What is the medicinal use of dapsone?
- (p) What is the use of aspirin?
- (q) Write the name of an antifungal agent.
- (r) Write the difference between aerobic and anaerobic fermentation.
- (s) Give one example of antianginal drug.

Please Turn Over

- (t) What are synthons?
- (u) What are the uses of sulphacetamide?
- (v) Name two antibiotics that are produced by fermentation.
- (w) Name an anti-anxiety drug.
- (x) Which Vitamin is synthesised by Reichstein-Grussner process?
2. (a) Write down two uses of phenobarbital and its side effects.
- (b) What do you mean by 'lead compounds'? Give one example. 3+2
3. Show the retrosynthesis and forward synthesis of chloramphenicol. 3+2
4. (a) Write down the synthetic route of diazepam.
- (b) What do you mean by NOAEL (No Observed Adverse Effect Level)? 3+2
5. (a) Describe briefly the formation of ethanol from glucose by an anaerobic fermentation process using yeast.
- (b) What do you mean by agonist drugs and antagonist drugs? 3+2
6. (a) Write down the structures of 'A', 'B' and 'C' in the following reactions.



- (b) What do you mean by 'high throughput screening (HTS)' and 'cross-screening' in drug discovery? 3+2
7. Synthesis aspirin from phenol. Write two uses of it. 3+2
8. Show the retrosynthesis and forward route of acyclovir. 3+2
9. (a) Give one example of β -lactum antibiotic with structure. Why is it named such?
- (b) What do you mean by LD_{50} and ED_{50} ? 3+2
10. (a) Write the structures of 'P', 'Q' and 'R' in the following scheme of the reactions.
- $$\text{Ph-CH}_2\text{-CO}_2\text{Et} + (\text{CO}_2\text{Et})_2 \xrightarrow[\text{3. 160}^\circ\text{C}]{\text{1. NaOEt, EtOH; 2. H}_3\text{O}^+} \text{P} \xrightarrow[\text{2. EtBr}]{\text{1. NaOEt, EtOH}} \text{Q} \xrightarrow[\text{2. H}_3\text{O}^+]{\text{1. Urea, NaOEt, EtOH}} \text{R}$$
- (b) What do you mean by 'nucleocapsid'? 3+2

11. Show the retrosynthesis and forward synthesis of sulphonamide. 3+2
12. (a) How can glyceryl trinitrate be synthesized?
(b) Write down the uses and side effects of glyceryl trinitrate. 3+2
13. (a) Give two similarities and two dissimilarities between batch and continuous fermentation processes.
(b) What is meant by pharmacokinetic phase? 3+2
14. Write a short note for the formation of Vitamin B₁₂ by fermentation process. 5
15. (a) What are auxotrophic and prototrophic strains?
(b) Name two vitamins that are required for production of L-lysine in fermentation process. 3+2

Paper : SEC-B-2
(Pesticide Chemistry)

Full Marks : 80

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer *question no. 1* and answer *any twelve* questions from the rest (*question nos. 2-15*).

1. Answer *any twenty* questions :

1×20

- (a) What is Persistent Organic Pollutant (POP)?
- (b) Give two examples of synthetic pesticides.
- (c) What is a weed?
- (d) What is the starting material for the production of Lindane?
- (e) Give an example of natural pesticide.
- (f) What are microbial pesticides?
- (g) What is ovicide? Give an example.
- (h) Name two organic pesticides.
- (i) Write down the major component of Bordeaux mixture.
- (j) What is meant by 'Disease of ecotopes'?
- (k) What is the precursor for the production of malathion? Write down its structure.
- (l) Provide the name and chemical structure of a rice herbicide from the chloroacetanilide family.
- (m) What is butachlor?
- (n) Write down two examples of carbamate pesticide.
- (o) Write down the name of first bioinsecticide developed on commercial scale.
- (p) Write down the name of a cholin esterase inhibitor.
- (q) Name the pesticide that is most commonly used to protect wooden structures from termite attack.
- (r) What is Fenarimol?
- (s) Give an example of warm-blooded animal.
- (t) Why is folidol banned or restricted to use in our country?
- (u) What are zoocides?
- (v) What is the acute oral toxicity (LD_{50}) value of gammaxene for rats?

2. (a) Describe three methods of pest control.
(b) What is the difference between contact and systematic herbicides? 3+2
3. Discuss the classification of pesticides based upon chemical nature. 5
4. (a) Discuss the mode of action :
(i) Stomach poison pesticides
(ii) Fumigants.
(b) What are Nematicides? Give an example. 3+2
5. Discuss some important methods used for pesticide management. 5
6. (a) What are the differences of mechanism of action between DDT and Lindane?
(b) Write down the chemical reaction and conditions involved in the synthesis of DDT. 3+2
7. Outline different steps involved in manufacturing a pesticide. 5
8. (a) Describe briefly the synthesis of carbofuran with chemical reaction.
(b) What are the carbofuran poisoning symptoms? 3+2
9. (a) Provide the names of two agricultural fungicides from the quinone family. Write down their structures.
(b) Mention two side effects of DDT. 3+2
10. (a) Give a brief outline of the preparation of chloranil.
(b) Provide one example of each of triazolopyrimide and triketone based herbicides. 3+2
11. (a) Why are biopesticides more favourable over the chemical pesticides?
(b) Define biopesticides. 3+2
12. (a) Mention the uses and side effects of carbaryl.
(b) Write down the structures of carbaryl and its hydrolysed products. 3+2
13. (a) Explain the mode of action of α -chloroacetanilides.
(b) Mention one use and one side effect of α -chloroacetanilide. 3+2
14. (a) Briefly discuss the various uses of gammaxene.
(b) Indicate the mechanism of action of gammaxene. 3+2
15. (a) Discuss the harmful effects of butachlor.
(b) Write down any one method for the preparation of butachlor. 3+2
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