

Total number of printed pages-8

3 (Sem-5/CBCS) CHE HC 1

2022

**CHEMISTRY**

(Honours)

Paper : CHE-HC- 5016

**(Organic Chemistry-IV)**

Full Marks : 60

Time : Three hours

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

1. Answer the following questions :

**(any seven)**

1×7=7

- (a) What is the most stabilizing force for nucleic acids ?
- (b) Which property is commonly shared by GDP and AMP ?
- (c) Name *one* Ketogenic amino acid.
- (d) Which enzyme helps in the formation of phosphodiester bond ?

Contd.

- (e) Statin drug is an example of \_\_\_\_\_ inhibition. (Fill in the blank)
- (f) In which site of the cell-beta oxidation takes place ?
- (g) Give an example of complex lipid.
- (h) Through which process energy is obtained by red blood cells ?
- (i) How many chiral centres are present in Ibuprofen molecule ?
- (j) What are stop codons ?
- (k) Name one enzyme which is secreted by the pancreas.
- (l) Name what class of drug is ranitidine ?

2. Answer the following : (**any four**)  $2 \times 4 = 8$

- (a) Draw the base present in deoxyadenosine monophosphate and deoxyguanosine monophosphate.
- (b) Write the significance of base-pairing in DNA.
- (c) Give one example of biologically important peptide and write at least two functions.

- (d) What happens when an  $\alpha$ -amino acid is heated ? Write reaction.
- (e) How are lipids classified ?
- (f) What is the root cause of malaria ? Write the structure of one antimalarial drug.
- (g) Draw the structure of  $\text{NAD}^+$  and  $\text{NADH}$ .
- (h) Write one function each of  $\text{NAD}^+$  and  $\text{FAD}$ .

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

$$5 \times 3 = 15$$

- (a) Describe the double helical structure of DNA. Anticodon is present in which type of RNA ?  $4 + 1 = 5$
- (b) (i) Give the structure of Lysine. Find the isoelectric point of Lysine of which  $pK_{a1}$  is 2.18  $pK_{a2}$  is 8.95 and  $pK_{a3}$  is 10.53.
- (ii) How many tripeptide bonds are formed by various combination of Gly, Ala and Phe ? Explain.

$$3 + 2 = 5$$

- (c) Write briefly about classification of enzymes. How active sites are subdivided ?  $4+1=5$
- (d) Hydrolysis of ATP results in release of energy. Explain.
- (e) What is respiratory quotient of foodstuff ? What does it signify ?  $3+2=5$
- (f) What are narcotics and non-narcotics drugs ? Give example of each type. Write chemical name of Analgin and its uses.  $3+2=5$
- (g) What are tetracyclines ? How it is different from streptomycin ? Give an example of tetracycline.  $2+2+1=5$
- (h) (i) What happens when an  $\alpha$ -amino acid is allowed to react with formaldehyde ? What is the significance of this reaction ? 3
- (ii) What is chrome protein ? Give an example. 2

4. Answer **any three** :  $10 \times 3 = 30$

- (i) (a) Write *one* method of each synthesis of Adenine and Thymine.
- (b) Describe a method how the C-terminal residue of a poly-peptide chain can be analyzed.
- (c) Name *one* amino acid which is not found in  $\alpha$ -helix.  $5+4+1=10$
- (ii) (a) Explain the process of protein biosynthesis (Translation). 5
- (b) Describe a method of synthesis of peptides along with the different steps and reactions involved. 5
- (iii) (a) Explain competitive and non-competitive inhibition of enzyme with examples.
- (b) Name *one* metalloenzyme with its specificity.
- (c) What is special about allosteric inhibition ?  $6+2+2=10$



- (viii) (a) Write a method of synthesis of paracetamol.
- (b) Mention *four* qualities that an antibiotic must possess.
- (c) Point out the essential difference between oils and fats.
- (d) Mention *one* medicinal value of turmeric and neem.
- (e) What do you mean by rancidity? How can rancidity be minimised in foods?  $2+2+2+2+2=10$

Total number of printed pages-11

3 (Sem-5/CBCS) CHE HC 2

2022

**CHEMISTRY**

(Honours)

Paper : CHE-HC-5026

**(Physical Chemistry-V)**

Full Marks : 60

Time : Three hours

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

1. Answer **any seven** of the following as directed : 1×7=7

(a) Find the eigenvalue of the operator  $\frac{d^2}{dx^2}$  if the eigenfunction is  $\cos 2x$ .

(b) Show whether the operator  $\hat{O}$  in the equation  $\hat{O}\psi = \psi^2$  is linear or not.

Contd.

- (c) The ground state electronic configuration of  $H_2^+$  is  $(1s\sigma_g)^1$ . Write the term symbol.
- (d) The one-particle wave function  $\psi(x, y, z, t)$  has the dimensions \_\_\_\_\_ . (Fill in the blank)
- (e) A spin-orbital can accommodate a maximum of \_\_\_\_\_ electron(s). (Fill in the blank)
- (f) What is the energy (in  $kJmol^{-1}$ ) of visible rays with  $\lambda = 400nm$  ?
- (g) State which of the following will be microwave active :  
 $CH_4, CH_3Cl, SF_6, OCS$
- (h) State the basic difference between line spectrum and continuous spectrum.
- (i) State which of the normal vibrations of  $CO_2$  is Raman active.
- (j) Write the difference between chemical reaction and photochemical reaction in terms of Gibbs free energy change.

(k) State what is meant by quantum yield for photochemical reactions.

(l) In photosynthesis,  $CO_2$  reacts with water in presence of chlorophyll and other plant pigments to produce starch. State the role of chlorophyll and the other pigments in the reaction.

2. Answer **any four** of the following questions :  
2×4=8

(a) Normalise the H-like function  $\psi = e^{-n}$ .

(b) Show that the wave function for a particle in one-dimensional box of length  $a$ , where the potential energy is zero, is not an eigenfunction of the linear momentum operator in one dimension.

(c) Define complementary observable with **one** example.

(d) Show that the functions  $\sin\frac{\pi x}{a}$  and

$\cos\frac{\pi x}{a}$  are orthogonal within the limit

$0 \leq x \leq a$ .

(e) Calculate the energy difference between the two rotational levels in joule of a molecule if it absorbs a photon of wavelength  $10\text{cm}$ .

(f) The Stokes' lines are more intense than the anti-Stokes' lines. Explain.

(g) What do you mean by characteristic group frequencies in IR spectroscopy? Explain with example.

(h) A sample of gaseous  $\text{HI}$  was irradiated by light of wavelength  $253.7\text{nm}$  when  $307\text{J}$  of energy was found to decompose  $1.30 \times 10^{-3}\text{mole}$  of  $\text{HI}$ . Calculate the quantum yield for the dissociation of  $\text{HI}$ .

3. Answer **any three** questions :

(a) (i) Write down the Schrödinger equation for a particle of mass  $m$  moving in three dimensions and state the properties of wave function to have physical significance. 1+2=3

(ii) The functions  $\psi_1 = \left(\frac{1}{\pi}\right)^{1/2} \cos x$  and

$\psi_2 = \left(\frac{1}{\pi}\right)^{1/2} \sin x$  are defined in the

interval  $x=0$  to  $x=2\pi$ . Examine if the functions are orthogonal to each other. 2

(b) (i) Write down the Schrödinger equation for the hydrogen-like system in spherical polar coordinates and separate it into radial and angular equations. 3

(ii) What do you mean by orbital? State the differences between an orbit and an orbital. 2

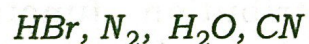
(c) Write what you mean by radial distribution function. Find an expression for the radial distribution function. Give the plot of radial distribution function against the radial distance from the nucleus for  $1s$  orbital. State how this plot differs from the plot of square of the radial function against the radial distance. 1+2+1+1=5

- (d) Show that for a rotational spectrum of a diatomic molecule, the rotational quantum number (to the nearest integer value) for the maximum populated level is given by

$$J_{\max} = \sqrt{\frac{kT}{2hcB}} - \frac{1}{2} \quad 5$$

- (e) Name the main electronic transitions observed in organic molecules. Indicate the regions of wavelengths where these transitions may take place. What types of electronic transitions are observed in carbonyl chromophore? Mention the effect of conjugation on these transitions.  $3+1+1=5$

- (f) (i) Which of the following molecules will show infrared absorption spectra?



Mention the reason of infrared absorption.  $2$

- (ii) The fundamental vibration frequency of *HCl* is  $2,890 \text{ cm}^{-1}$ . Calculate the force constant of this molecule.  $3$

- (g) Discuss the mechanism of the photochemical reaction between hydrogen and bromine and find the expressions for the reaction rate and the quantum yield for this reaction.  $5$

- (h) What do you mean by the term 'quenching of fluorescence'? Derive Stern-Volmer equation.  $2+3=5$

4. Answer **any three** questions :

- (a) (i) Using the *MO* wave function of *H<sub>2</sub>* discuss the drawback of the *MO* theory. Write how Heitler-London modified the wave function. Discuss about the correct form of the wave function for bonding in *H<sub>2</sub>* taking into account of resonance.  $3+1+3=7$

- (ii) Show that the maximum probability of finding the electron of *H*-like atom in the ground state is at a distance of  $a_0/z$  from the nucleus.  $3$

(b) (i) Derive expression for the total energy of a particle in a three-dimensional box. Explain the concept of degeneracy. 5+2=7

(ii) For a particle in a one-dimensional box of length  $a$ , find the probability of finding the particle in the region  $0 \leq x \leq a/4$  in the ground state.

3

(c) (i) What is a Hermitian operator? Show that the eigenvalue of a Hermitian operator is real.

2+3=5

(ii) Evaluate the expectation values of  $\langle x \rangle$  and  $\langle p_x \rangle$  for the ground state of the harmonic oscillator. Given normalized wave function

$$\psi = \left( \sqrt{\frac{a}{\pi}} \right) e^{-ax^2/2};$$

standard integral

$$\int_{-\infty}^{\infty} x^2 e^{-ax^2} dx = \left( \frac{1}{2a} \right) \left( \frac{\pi}{a} \right)^{1/2} \quad 5$$

(d) (i) A particle in a box cannot have zero energy quantum mechanically. Explain. 3

(ii) Find the values of momentum and energy for an electron in a box of length  $1A^\circ$  for  $n=1, 2$ . 4

(iii) Prove that  $\psi(x) = e^{iCx}$  is acceptable eigenfunction where  $C$  is finite constant. 3

(e) (i) Using the anharmonic oscillator concept, deduce expressions for the energy required for allowed vibrational transitions. Indicate fundamental absorption and overtones. 5

(ii) Write how will you distinguish between ethanol and ethanol by using IR spectra. 2

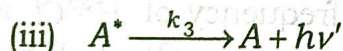
(iii) The fundamental vibrational frequency of  $H^{35}Cl$  is  $8.667 \times 10^{31} s^{-1}$ . What would be the separation between the infrared absorption lines for  $H^{35}Cl$  and  $H^{37}Cl$ , if the force constants of the bonds are assumed to be same? 3

(f) (i) Write the quantum mechanical theory of Raman effect. What do you mean by Raman shift? Explain the conditions under which Stokes and anti-Stokes lines are observed.  $2+1+2=5$

(ii) Using the Franck-Condon principle, explain why the intensities of the vibrational lines associated with electronic transitions differ. 3

(iii) Define auxochrome. What do you mean by red shift and blue shift of absorption maximum?  $1+1=2$

(g) (i) What is called photostationary state of the photochemical reaction? The following mechanism has been proposed for the dimerization of anthracene:



Show that when the reaction is at photostationary state and presence of large amount of monomer, the concentration of dimer is independent of the concentration of monomer.  $1+4=5$

(ii) Write a note on chemiluminescence. 2

(iii) For the photochemical reaction  
 $A \rightarrow B$ ;  
 $1 \times 10^{-5}$  moles of  $B$  were formed on absorption of  $6.62 \times 10^7$  ergs at  $3600 \text{ \AA}$ . Calculate the quantum yield of the reaction. 3

(h) (i) Define transition moment. What do you mean by allowed and forbidden transitions in the context of transition moment? 3

(ii) The lifetime of an excited electronic state is  $10^{-8}$  s. Calculate the width of the spectral line in Hz. 2

(iii) State and explain the factors on which the width of a spectral line depends. 3

(iv) Write the selection rules of molecular electronic transition in diatomic molecules. 2

Total number of printed pages-23

**3 (Sem-5/CBCS) CHE HE 4/HE 5/HE 6**

**2022**

**CHEMISTRY**

(Honours Elective)

**Answer the Questions from any one Option.**

**OPTION-A**

**(*Novel Inorganic Solids*)**

Paper : CHE-HE-5046

**OPTION-B**

**(*Polymer Chemistry*)**

Paper : CHE-HE-5056

**OPTION-C**

**(*Instrumental Methods of Chemical Analysis*)**

Paper : CHE-HE-5066

*Full Marks : 60*

*Time : Three hours*

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

*Contd.*

**OPTION-B**

**(Polymer Chemistry)**

Paper : CHE-HE-5056

1. Answer **any seven** of the following questions : 1×7=7

(i) Bakelite is condensation polymer of

- (a) phenol and urea
- (b) phenol and formaldehyde
- (c) urea and formaldehyde
- (d) urea and melamine

(ii) In cationic polymerization, termination occurs by

- (a) rearrangement
- (b) chain transfer
- (c) coupling
- (d) both rearrangement and chain transfer

(iii) Surfactants used in emulsion polymerization are

- (a) anionic
- (b) cationic
- (c) non-ionic
- (d) All of the above

(iv) Which of the following polymers is more amorphous ?

- (a) Isotactic
- (b) Atactic
- (c) Syndiotactic
- (d) All of the above

(v) For solubility of a polymer in a solvent  $\Delta G$  must be

- (a) positive
- (b) negative
- (c) zero
- (d) infinite

(vi) Which one of the following pairs is not correctly matched ?

- (a) Terylene-Condensation polymer of terephthalic acid and ethylene glycol
- (b) Teflon-Thermally stable cross-linked polymer of phenol and formaldehyde
- (c) Perspex-a homopolymer of methyl methacrylate
- (d) Synthetic rubber-a copolymer of butadiene and styrene

(vii) Which is/are true for elastomers ?

- (a) These are synthetic polymers possessing elasticity
- (b) These possess very weak intermolecular forces of attractions between polymer chains
- (c) Vulcanised rubber is an example of elastomer
- (d) All of the above

(viii) PDI for natural polymer is generally close to

- (a) zero
- (b) 100
- (c) 1
- (d) 50

(ix) The catalyst used in the manufacture of polythene by Ziegler method is

- (a) Titanium tetrachloride and triphenyl aluminium
- (b) Titanium tetrachloride and triethyl aluminium
- (c) Titanium oxide
- (d) Titanium isopropoxide

(x) Buna S is a natural rubber.  
(True/False)

(xi) Light scattering method is used for the determination of osmotic pressure of polymers.  
(True/False)

(xii) The Flory-Huggins theory explains the miscibility of a polymer with solvent.  
(True/False)

2. Answer **any four** of the following questions :  
2×4=8

(i) What are initiators in chain growth polymerization? Give *one* example.

(ii) What do you mean by high density polyethylene (HDPE)? Write its *one* application.

(iii) Write the brand name of polytetrafluoroethylene (PTFE). Explain its behaviour on heating.

(iv) Why are silicones called inorganic polymer?

(v) What are polycarbonates? Write *one* method of its preparation.

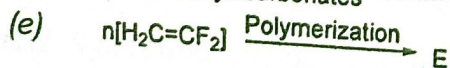
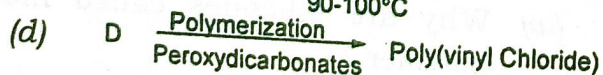
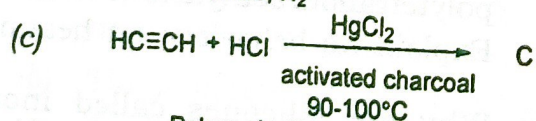
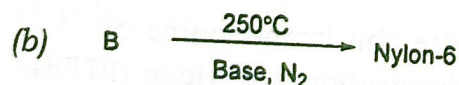
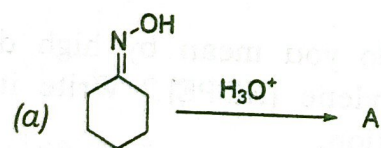
(vi) What is meant by living and dead polymer?

(vii) Define the term 'super fibre' with an example.

(viii) How do you explain functionality of a polymer?

3. Answer **any three** of the following questions:  $5 \times 3 = 15$

(i) Identify A-E in the following polymeric reactions:



(ii) Give the method of preparation of the following polymers: (**any two**)

$2.5 \times 2 = 5$

(a) Nylon 6,6

(b) Buna-S

(c) Polystyrene

(iii) Mention **two** conditions for a polymer to be conducting. Explain the conducting behaviour of polyaniline (PANI).  $2+3=5$

(iv) Explain with examples the practical significances of copolymerization. Write the differences between graft and block copolymers.  $3+2=5$

(v) Show with suitable examples the classification of polymer on the basis of tacticity. Describe briefly how crystallinity of a polymer is related to its tacticity.  $3+2=5$

(vi) Explain with suitable example the radical mechanism of chain growth polymerization.

(vii) Discuss the kinetics of condensation polymerization.

(viii) What are acrylic polymers? Give an account of different acrylic polymers, their formation, properties and uses.

2+3=5

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

10×3=30

(i) What are coordination polymers? Explain the detailed mechanism of Ziegler-Natta polymerization of propylene. How can you explain the source of stereoregularity in the formation of isotactic polypropylene using Ziegler-Natta catalyst?

2+6+2=10

(ii) Discuss the basic principle of bulk polymerization. Briefly outline the advantages and disadvantages of bulk polymerization. What are the differences between suspension and emulsion polymerization?

3+3+4=10

(iii) Differentiate between addition and condensation polymers. What are the different types of mechanism by which chain-growth polymerization proceeds? For a monomer of general structure  $CH_2 = CHX$ , complete the following table. Put '+' if the monomer can be polymerized by the method mentioned at the top of the column, and '-' if polymerization by the method is not feasible. Briefly justify your answer.

3+2+5=10

X	Free radical	Anionic	Cationic
-CN			
-Ph			
-OCH <sub>3</sub>			

(iv) What are crystalline polymers? What are the different factors which affect degree of crystallinity? Differentiate between crystalline and amorphous polymers. Define functionality of a monomer.

2+4+2+2=10

(v) What are the factors that affect the solubility of polymers? Derive an expression for enthalpy change and free energy change of mixing of polymers. What are the assumptions of Flory-Huggins theory?

3+4+3=10

(vi) Define number average molecular weight and weight average molecular weight. Explain osmotic pressure methods to determine molecular weight of the polymers. A box of mangoes contains sets A, B, and C with their numbers and weight as shown below:

Set A : 30 mangoes with weight of each mango 200gm

Set B : 20 mangoes with weight of each mango 300gm

Set C : 40 mangoes with weight of each mango 100gm

Calculate number average molecular weight ( $M_n$ ) for the mangoes.

$$2+5+3=10$$

(vii) Give a detailed account of thermal properties of polymers. Give a detailed account on preparations, properties and uses of various phenol formaldehyde resins.

$$4+6=10$$

(viii) Explain kinetic chain length in free radical polymerization and derive equation of rate of polymer formation. Discuss the effect of temperature on chain polymerization.

$$8+2=10$$

*Total number of printed pages-23*

**3 (Sem-5/CBCS) CHE HE 1/2/3**

**2022**

**CHEMISTRY**

(Honours Elective)

**Answer the Questions from any one Option.**

**OPTION-A**

***(Applications of Computers in Chemistry)***

Paper : CHE-HE-5016

**OPTION-B**

***(Analytical Method in Chemistry)***

Paper : CHE-HE-5026

**OPTION-C**

***(Molecular Modelling and Drug Design)***

Paper : CHE-HE-5036

*Full Marks : 60*

*Time : Three hours*

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

*Contd.*

## OPTION-B

### (Analytical Method in Chemistry)

Paper : CHE-HE-5026

1. Answer **any seven** of the following questions :

I×7=7

- (a) How is standard deviation related to accuracy ?
- (b) Why is IR spectrum considered 'finger print' of a molecule ?
- (c) Why is source modulation used in atomic absorption spectroscopy ?
- (d) What is potentiometry ?
- (e) What is meant by Nernstian behaviour in an indicator electrode ?
- (f) What is meant by thermogravimetric analysis ?
- (g) What is the function of Nernst glower ?
- (h) A sample exhibited an absorbance 1.0 in UV-visible spectroscopy. What will be its percentage of transmittance ?
- (i) Name the two light sources used in UV-visible spectrophotometer.
- (j) When is batch extraction used for extraction process?
- (k) Define the term 'specific rotation'.
- (l) Name the binder that is present in silica gel G.

2. Answer **any four** of the following questions :  
2×4 = 8

- (a) The standard deviation from one set of 11 determinations was 0.210, and the standard deviation from 13 determinations was 0.641. Is there any significant difference between the precision of these *two* sets of results at the 10% level? Given the value of *F* for 10 and 12 degrees of freedom at 10% probability level is 2.28.
- (b) Name different gases that can be used as fuel and oxidant in Flame-AAS.
- (c) The force constant for  $H^{35}Cl$  and  $D^{35}Cl$  are the same and both can be considered as harmonic oscillators.  $H^{35}Cl$  has a fundamental vibrational transition at  $2886\text{ cm}^{-1}$ . Calculate the ratio of the zero-point energy of  $H^{35}Cl$  to that of  $D^{35}Cl$ .
- (d) Draw a probable TG curve for  $CuSO_4 \cdot 5H_2O$ .
- (e) Describe the source of pH dependence in a glass membrane electrode.
- (f) What are the different types of paper chromatography?
- (g) What do you mean by synergistic extraction?
- (h) What is the role played by a masking agent in the extraction of metal ions?

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

- (a) What is the difference between accuracy and precision? Discuss the methods for determining the accuracy. 1+4=5
- (b) Describe briefly *two* different sample preparation methods for IR measurement.
- (c) Discuss the working principle of atomic absorption spectrometer.
- (d) Describe the basic differences between atomic emission and atomic absorption spectroscopy. Among atomic emission and atomic absorption, which one is more sensitive to flame instability and why? 2+3=5
- (e) Explain the basic working principle and the applications of the TGA technique. What are the factors that affect the TGA curve? 3+2=5
- (f) What is conductometry? How will you determine the pKa value of an acid with the help of conductometric titration? 1+4=5

(g) Discuss the factors on which conductance of a solution depends.

(h) What is chromatogram? Write shortly about *any two* chromatogram development methods? 1+4=5

4. Answer **any three** of the following questions :  
10×3=30

(a) (i) Mention *two* advantages of spectrophotometric analysis. 2

(ii) UV-visible spectroscopy can be used to distinguish keto-enol tautomers. Explain with the help of a suitable example. 3

(iii) Explain with an example how Job's method of continuous variation can be used to determine the composition of a metal complex. 5

(b) Describe the working principle of single beam and double beam UV-visible spectrophotometers. Mention *two* advantages of double beam spectrophotometer over the single beam. 8+2=10

(c) (i) Match the following : 1

(A) Near IR region (A) Rotation

(B) Middle IR region (B) Overtone

(C) Far-IR region (C) Vibration-rotation

(ii) How many stretching modes of vibration are there for  $H_2O$  and  $HCl$  molecule? 2

(iii) Diagrammatically show the bending modes of vibration for  $H_2O$  and  $CO_2$  molecule. 2

(iv) In an IR spectrophotometer, diffraction gratings have displaced prisms as the main source of monochromation. Why? 1

(v) What type of detectors is preferred in IR spectrophotometer for measurements that must be made rapidly? 1

(vi) What are the advantages of FT-IR over continuous wave spectrophotometer? 2

(vii) How will you distinguish between propanone and propan-2-ol using IR spectroscopy? 1

(d) What are the factors that influence the vibrational frequency? Discuss with the help of example. Distinguish between the two isomers having molecular formula,  $C_3H_6O$  namely  $CH_3COCH_3$  and  $CH_3CH_2CHO$  in terms of their IR frequencies. 6+4=10

(e) What is potentiometric titration? How one reveals the end point of a potentiometric titration? Describe the features of a potentiometric titration curve. Discuss the use of potentiometry in food industry and pharmaceutical industry. 1+1+3+5=10

(f) Discuss the basic features of conductometric titration curves obtained from the reactions between —

(i)  $HCl$  and  $NaOH$ ;

(ii)  $H_2C_2O_4$  and  $Na_2CO_3$ ;

(iii)  $Na_2CO_3$  and  $HCl$ ;

(iv)  $CH_3COOH$  and  $NaOH$ . 10

(g) (i) What is meant by solvent extraction? State the law on which it is based on. Define the term 'distribution ratio'. How is it different from distribution coefficient? 1+1+1+2=5

(ii) Describe briefly the continuous extraction technique used in solvent extraction. 5

(h) (i) Describe the qualitative and quantitative aspects of gas chromatography. 5

(ii) How can NMR spectroscopy be used to determine the enantiomeric composition? 5