Question bank

Subject: ***Chemistry-1***
Subject code: ***BTCH-101-18***

UV and IR Spectroscopy

1. Which of the following molecules will show IR spectra?
   H_2, HCl, CH_4, CO_2 and H_2O

2. Why electronic bands are broader than IR spectra?

3. Explain the following:

a) Bathochromic shift

b) Hypochromic shift

c) Hyperchromic shift

d) Hypsochromic shift

4. Calculate the number of vibrational degree of freedom in the following compounds.

   i. CO_2 ii. SO_2 iii. CH_4

5. Arrange the following in increasing order of absorption maxima.

6. Calculate the fundamental vibrational frequency of HCl and DCl^{35} is 2080 cm^{-1} .Assume the force constant of HCl and DCl to be same.

7. What selection rules for IR and UV spectroscopy?

8. What are the different types of electronic transitions? Explain auxochromes and Chromophores?

9. Give the applications of UV and IR spectroscopy.

10. Arrange the following compounds in increasing order of their UV absorption maxima: ehtylene, Naphthalene, anthracene and 1, 3- butadiene.

11. How will you distinguish between 1, 3 pentadiene and 1'4 pentadiene on the basis of UV spectroscopy.

12. What is the importance of IR spectroscope in finger print region?

13. Discuss the factors contributing to the broadening of spectral lines.

14. Explain phosphorescence and Fluorescence on the basis of Jablonski diagram.

15. What is zero point energy?

16. How will you distinguish between CH_3CHO and CH_3COCH_3 by IR.?

Periodic Properties

Q_1. What are isoelectronic ions? Arrange the following ions in the order of their increasing ionic radius. N^{3-}, Na^{+}, Mg^{2+}, Al^{3+}, O^{2-} and F^{-}.

Q_2. What is meant by first ionization energy and second ionization energy? Why second ionization energy is much higher than first ionization energy.

Q_3. Define Electron affinity. Why electron affinities of the halogens are so high?

Q_4. Predict which element in each of the following pair has higher ionization energy and why?

i. S, P ii. Be, B iii. N, C iv. Ne, F v. F, Cl vi. Na, K

Q_5. Give reasons for the following.

a. The second ionization energy of Na is very high.
b. Electron affinity of F is less than that of Cl.
c. Electron affinity of N is almost zero while that of F is very high.
d. Size of Na is greater than Na^{+} and that of Cl^{-} greater than Cl.

Q_6. Which of the following will have greatest and lowest electron affinity value?

i. (Ne) $3s^2$, $3p^3$ ii. (Ne) $3s^2$ $3p^4$, iii. (Ne) $3s^2 3p^5$ iv. (Ne) $3s^1$

Q_7. On the basis of VSEPR theory determine the shape of following molecules.

a. BeF_2 ii. BF_3 iii. PCl_5 iv. XeF_4

Q_8. Predict which direction the following reactions will go.

$$HI + NaF \rightarrow HF + NaI$$
$$AlF_3 + 3NaF \rightarrow AlF_3 + 3NaI$$
$$CaS + H_2O \rightarrow CaO + H_2S$$

$$TiF_4 + 2TiI_2 \rightarrow TiI_4 + 2TiF_2$$
$$CoF_2 + HgBr_2 \rightarrow CoBr_2 + HgF_2$$
$$HgO + H_2S \rightarrow HgS + H_2O$$

Q_9. Differentiate between electron affinity and electronegativity.

Q_{10}. Explain why ionization energy of N is higher than that of oxygen.

Q_{12}. Define the terms. A. Hard acid and hard base b. Soft acid and soft base

Q_{13}. Explain their trends in a period and in a group.

a. Electron affinity b. Electronegativity c. Atomic radius d. Ionisation Energy

Q_{14}. Define effective nuclear charge.

Stereochemistry

Q1. Write the structures of all the isomeric alcohols and ethers having molecular formula, $C_5H_{12}O$.

Q2. Describe functional isomerism? Illustrate with suitable example.

Q3. Write the Fisher, Newman and Wedge and Dash projection of 2-aminopropanoic acid.

Q4. Write the meso form of 2, 3-dichlorobutane.

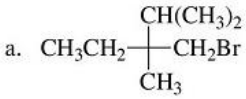
Q5. Two carboxylic acids having molecular formulae $C_3H_5O_2Br$ and $C_5H_{10}O_2$ are optically active. Draw their structural formulae.

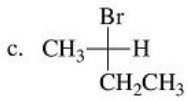
Q6. Employing Cahn-Ingold- Prelog rules indicate priority sequence for $–CH_3$, $-CH_2CH_3$, $-C(CH_3)_3$ and $–CH(CH_3)_2$.

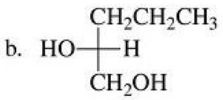
Q7. Write the geometrical isomers of 1, 2-dichlorocyclopropane and find out which isomer is optically active and why?

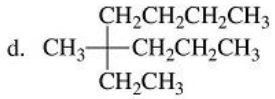
Q8. Assign R and S Configuration to following molecules.

Indicate whether each of the following structures has the *R* or the *S* configuration:

a. 

c. 

b. 

d. 

Q9. How many chiral carbon atoms are present in the following molecule?
$HOCH_2$-CHOH-CHOH-CHOH-CH_2OH

Q10. Write the different Configurational isomers of Tartaric acid.

Q11. An acid having molecular formulae $C_3H_6O_3$ is optically active. Write its structure and name.

Q12. Give one example of each:

i. Ionisation Isomers ii. Hydrate isomers iii. Linkage isomers

Q13. Write the electronic configurations of Cu and Cr. Why their electronic configurations are not according to normal rules.

Q14. Define the term Enantiomer, Diastereomers and Meso compounds with examples.

Q15. Give extreme confirmations of n-Butane.

Q16. What are enantiomers? Write their main characteristics.

Q17. Does the absence of chiral carbon atoms always make a molecule inactive? Explain.

Q18. Differentiate between the terms configuration and confirmation.

Q19. What is tautomerism? Give one example.

Q20. Explain the geometrical isomerism of transition metal complexes with suitable examples.

Atomic and Molecular Structure

Q_1. Give the shape of molecular orbitals obtained by linear combination of atomic orbitals.

I. 1s + 1s ii. $2p_z + 2p_z$ iii. $2p_y - 2p_y$ iv. $2p_x + 2p_x$

Q_2. Calculate the bond order in the following molecules. CO, CN^-, NO^+, HCl, H_2^+

Q_3. Arrange the molecules in the increasing order of bond length. N_2, N_2^+, N_2^-

Q_4. Calculate the magnetic moment of oxygen molecule.

Q_5. Why do transition metals form coloured complexes.

Q_6. Explain why $CuCl_2$ is paramagnetic whereas CuCl is diamagnetic.

Q7. Why pi-bond is weaker than sigma-bond.

Q_8. What is Huckel's rule? Predict out the following compounds which will show aromatic character.

(i) Cycloheptatrienyl cation (ii) Cyclopentadienyl cation

(iii) Cyclopentadienyl anion (iv) Cyclooctatetraene

Q_9. Derive Schrödinger wave equation. What is the significance of Ψ and Ψ^*?

Q_{10}. What do you understand by 'Node'? Calculate the number of nodes present in 2s, 3s, 3p, 4d, 4s.

Q_{11}. Which one is more stable and why? O_2, O_2^-, O_2^+

Q_{12}. Draw the molecular energy diagram of NO molecule.

Q_{13}. What are intrinsic and extrinsic semi-conductors?

Q_{14}. What are n-type and p-type semiconductors? Explain giving examples. What are current carriers in these semi-conductors?

Q_{15}. How conductivity of a semi-conductor does varies with temperature.

Q_{16}. Why Germanium dopped with antimony is called n-type semiconductor.

Q_{17}. On the basis of band theory differentiate between conductor, semiconductor and insulator.

Q_{18}. What is meant by doping?

Q_{19}. Benzene gives substitution reaction rather than addition reactions.

Q_{20}. What are the conditions for normalization and orthogonality of wave functions?

Spectroscopic techniques, stereochemistry and synthesis

Q1. What are the selection rules for Rotational and pure-vibrational spectroscopy?

Q2. How will you determine the bond length from rotational spectroscopy?

Q3. What is intersystem crossing?

Q4. Indicate diagrammatically the splitting of signals in NMR spectra of following compounds.

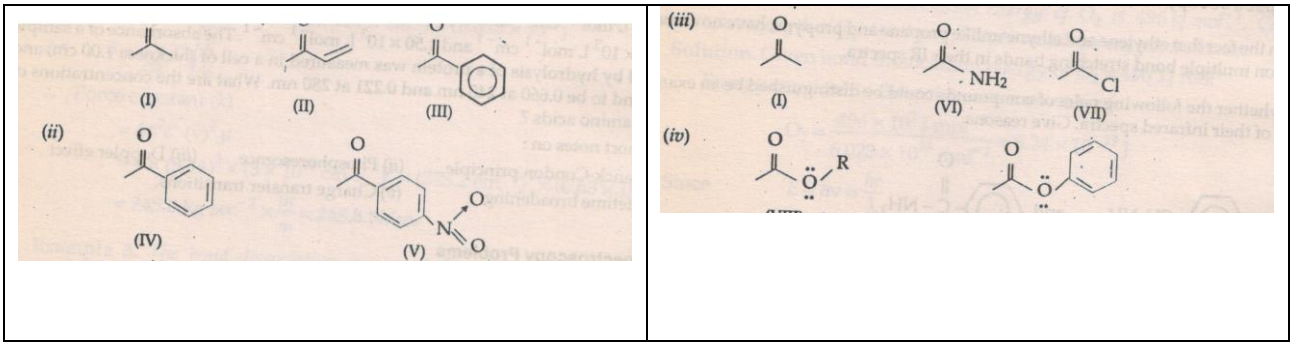
i. CH_3CH_2Br ii. CH_3CHBr_2 iii. $CH_2Br\text{-}CHBr_2$

Q5. An organic compound with molecular formula $C_3H_3Cl_5$ shows one triplet ($\delta = 4.52$, 1H) and one doublet

($\delta = 6.07$, 2H). Assign suitable structure of the compound.

Q6. Write the possible isomers corresponding to the following molecular formulae and give NMR signals. i. C_4H_{10} ii. C_3H_6O iii. C_2H_6O

Q7. Which will absorb at a higher wave number due to C=O



Q8. Which of the following molecules will show IR spectrum and why?

H_2, HCl, CH_4, CO_2, H_2O

Q9. List all electronic transitions possible for; CH_4, CH_3Cl, HCHO.

Q10. Differentiate between solubility product and ionic product.

Q11. What is common ion effect? Give its significance in qualitative analysis.

Q12. A copper equipment should not possess a small steel bolt.

Q13. Bolts and nuts made of same material are prefferd in practice. Explain?

Q14. Write all the possible structural isomers having molecular formula $C_4H_{10}O$ and give their IUPAC name.

Q15. Distinguish between meso and racemic forms of tartaric acid.

Free energy and Chemical equilibrium

Q1. Define enthalpy and show that $\Delta H = q_{p.}$

Q2. Calculate the equilibrium constant, K for the following reaction at 400K.

$$2\ NOCl_{(g)} \rightarrow 2NO + Cl_{2(g)}$$

$\Delta H = 80$ kJ/mol $\Delta S = 120$ KJ/mol

Q3. Define Free energy. The emf of the cell reaction

$3Sn^{4+} + 2\ Cr \rightarrow 3Sn^{2+} + 2Cr^{3+}$ is 0.89 V Calculate the free energy change.

Q4. What is Lewis concept of acids and bases?

Q5. The standard reduction potential, E^o of copper is 0.34V and concentration of Cu^{2+} ion is 0.015M. Find the reduction potential of copper and free energy change of electrode reaction.

Q6. The value of free energy of formation of Cr_2O_3 is − 540 $kJmol^{-1}$ and that of $Al_2\ O_3$ is – 827 $kJmol^{-1}$. Is the reduction of Cr_2O_3 possible with Al?

Q7. Define chemical corrosion and electrochemical corrosion.

Q8. Write the chemical reaction to show the amphoteric nature of water?

Q9. Distinguish between:

i. Hard Water and Soft Water ii Heavy Water and Solid CO_2

Q10. The solubility of $Mg(OH)_2$ is 1.518×10^{-4} moles per litre at 285 K. Calculate its solubility product at this temperature.

Organic Synthesis

Q1. Define Electrophile and nucleophile giving examples.

Q2. Mention the different types of reactive intermediates formed in organic reactions and also draw their orbital picture.

Q3. Why do alkyl halides undergo nucleophilic substitution reactions?

Q4. Classify the following solvents as Protic or aprotic: formic acid, acetone, acetonitrile formamide, ammonia, trimethyl amine and ethylene glycol.

Q5. Would you expect the reaction of propyl bromide with (NaCN):

$CH_3CH_2CH_2Br + NaCN \rightarrow CH_3CH_2CH_2CN + NaBr$

to occur faster in DMF or in ethanol. Explain your answer.

Q6. Explain the factors affecting the rate of SN^1 and SN^2 reactions.

Q7. Explain the Markovnikov's rule and peroxide effect with suitable examples.

Q8. Arrange the following towards SN1 reactions: CH_3F, CH_3I, CH_3Cl, CH_3Br.

Q9. Give the product and mechanism involved in the following reactions.

A. $CH_3CH_2CH_2Br + CH_3O^- \rightarrow$ in the presence of CH_3OH at 50^oC

B. $CH_3CH_2CH_2Br + (CH_3)_3CO^- \rightarrow$ in the presence of $(CH_3)_3OH$ at 50^oC

C. $(CH_3CH_2)_3Br + OH^- \rightarrow$ in the presence of CH_3OH at 50^oC

D. $(CH_3CH_2)_3CBr + CH_3OH \rightarrow$ at 50^oC

Q10. Give the mechanism of the reaction of benzene with n-Propyl Chloride in the presence of $FeCl_3$.

Q11. Why do aromatic compounds undergo electrophilic substitution reaction instead of addition reactions?

Q12. Why do Alkenes undergo addition reactions instead of substitution reaction?

Q13. Explain the reactivity of Different alkyl halides towards SN^1, SN^2, E_1 and E_2 Reactions.

Q14. Which of the following species, H_2O, SO_3, NH_3, $AlCi_3$, and ROH are electrophiles?