1. Answer the following with suitable explanation:

(a) Compound (A) is highly unstable and it gets converted to a compound whose IR, \(^1\)H NMR and \(^{13}\)C NMR data is given below: IR: 3200-3400 (no peak of carbonyl stretching); \(^1\)H NMR: 1.11 (s, 6H), 1.46 (s, 3H), 2.0 (brs, 1H), 1.8 (s, 2H), 3.67 (s, 2H); \(^{13}\)C NMR: 23, 24, 29, 56, 75, 95 (no peak for carbonyl). Identify the product and propose suitable mechanism for its formation.
(b) Each of the following electrophiles could react with nucleophile at (at least) two different atoms. Identify these atoms in the following compounds and identify the product when a nucleophilic (Nu) reacts at each center in the following compounds. Draw suitable mechanism for each case.

(c) What factors affect the crystallinity of PET?

2. Attempt all of the following:

(a) How many non-equivalent hydrogens and carbons are present in N, N-dimethylacetamide at room temperature and high temperature. Give proper justification to your answer.
(b) Explain briefly, giving one common example as to how FMO method, PMO method and correlation diagrams can be used for analyzing a pericyclic reaction.

(c) Why Z, Z-2, 6-octadiene is not the product of pyrolysis of trans-3, 4-dimethylcyclohexadiene?

3. Answer the following:

(a) How will you differentiate ethylbenzene and n-butylbenzene by mass spectrometry.

(b) Explain why the bond angle of H-C-H in the singlet and the triplet carbenes are different?

(c) Addition of dimethylamine to the unsaturated ester (A) could give either product B or C. Draw suitable mechanism for the formation of B and C and show how you would distinguish them spectroscopically?

P.T.O.
4. Explain the following:

(a) Explain why dichlorocarbene inserts in allylic and benzylic C-H bonds and not in non-allylic primary and secondary C-H bonds?

(b) Phenols shown below have approximate pKa value of 4, 7, 9, 10 and 11. Suggest with explanation which pKa value belongs to which of the phenols.

(c) In the preparation of ester of amino acids (A) it is necessary to keep the ester as its HCl salt. What would happen if the ester is neutralized?
5. Answer all of the following:

(a) Explain why $[4+2]$ cycloaddition is photochemically forbidden.

(b) Write the products of the following reactions and propose suitable mechanism for their formation:

(i) $\text{Ketone} \xrightarrow{\text{hv}} C_6H_6 \rightarrow A + B$

(ii) $\text{Organolithium reagent} \xrightarrow{\text{heat}}$

(iii) $\text{Phenyl ester} \xrightarrow{\text{hv}} \text{EtOH} \rightarrow A + B + C$

P.T.O.
(c) Which species, Cl\(^-\) or Cl\(^+\) is formed when the compound shown below ionizes? Give a suitable reason to support your answer.

6.

6. Answer all of the following:

(a) Identify the products in the following reaction and propose suitable mechanism.

(b) Write the name and mechanism of the following transformations.
(c) Reaction between PhCl and NaOH at 300°C proceeds by a dual mechanism, what are those mechanisms and how will you demonstrate it experimentally?

7. Attempt all of the following:

(a) Explain stereoselective, stereospecific and regioselective reactions with the help of suitable examples.

(b) Draw the structures of the products formed from the syn hydroxylation of cis-2-butene and trans-2-butene in the perspective formula (wedge line structure). Discuss the chirality of the products.

(c) Identify the product in the following reaction and propose suitable mechanism for its formation.
8. Attempt all of the following:

(a) Explain why the solvolysis of 4-chlorobutanol is much faster than the solvolysis of 3-chlorobutanol in water.

(b) List the problems associated with lead and cadmium based pigments. How can these problems be resolved?

(c) Cyclobutylamine on reaction with nitrous acid gives two products, identify the products and propose suitable mechanism for their formation.