

CHM 102

(GENERAL CHEMISTRY)

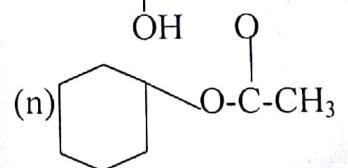
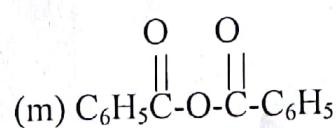
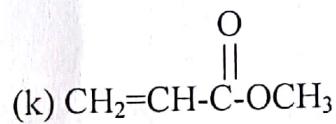
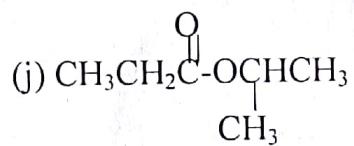
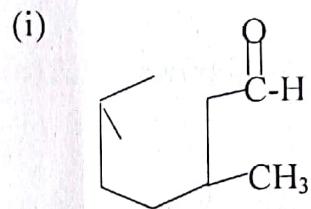
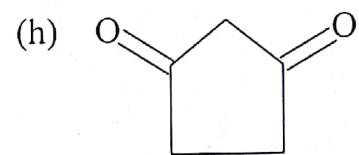
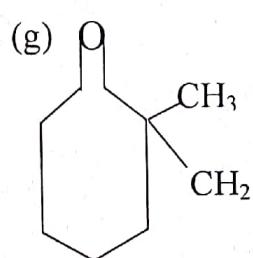
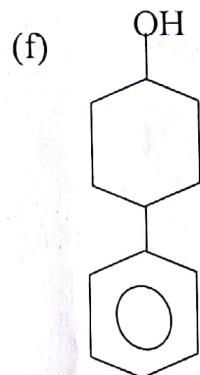
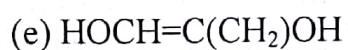
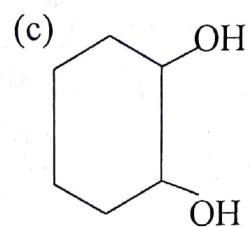
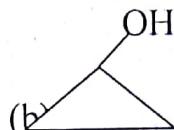
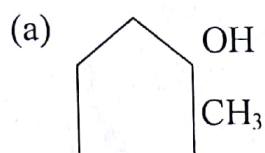
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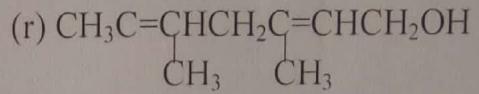
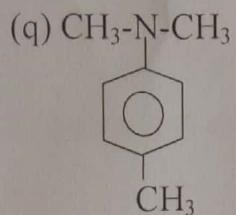
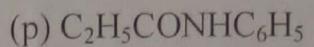
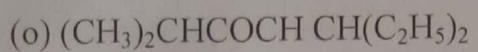
DEPARTMENT OF INDUSTRIAL CHEMISTRY

FEDERAL UNIVERSITY OYE-EKITI, NIGERIA



1. Give the IUPAC name of the followings





2. Give the structures of the following:

(a) N,N,2,6 tetramethyl aniline.

(b) 5-chloropent-3-enoylchloride

(c) N-phenylethanamide

|

(d) 4-chloropent-2-enoylchloride

(e) 3,3-dimethylpenta-4- ene-2-one

(f) 2-methyl-2-propylpropene-1,3-diol

(g) 2-isopropyl-5-methylcyclohexanol

(h) 2-ethylcylohexanol

(i) 3-phenyl-2-propanal

(j) 2-methyl-3-hexenoic acid

(k) penta-2,-4-dione

(l) 2,3,4-trimethylnonane

(m) ethane-1,2-diol

(n) toluene

(o) anisole

(p) picric acid

(q) phenol

3. (a) Name and draw the structural formula of isomers of pentanol.

(b) Calculate the molecular weight of dimethyl ether and ethanol. Deduce what you observe

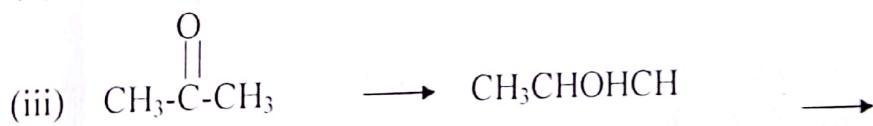
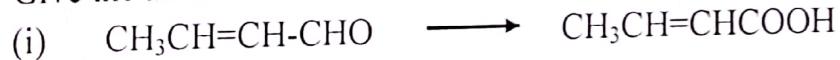
4. (a) Name the two factors responsible for electro negativity differences in atoms

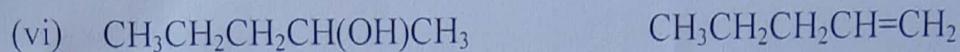
(c) What is inductive effect and explain how it changes with Carbon length

5. (i) How would you obtain absolute alcohol from pine apple juice

(ii) Describe the behaviour of primary, secondary and tertiary monohydric alcohols on oxidation with acidified KMnO_4

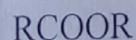
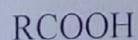
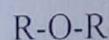
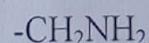
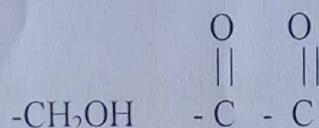
6. Give the accurate conditions for the reactions listed below



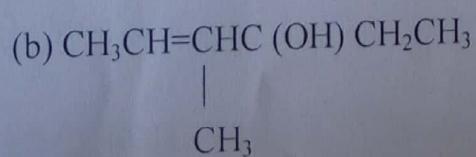


(vii) Give another product formed in (vi) above and Explain

7. Describe in each case two properties associated with the presence of the following groups in the molecules of organic compounds

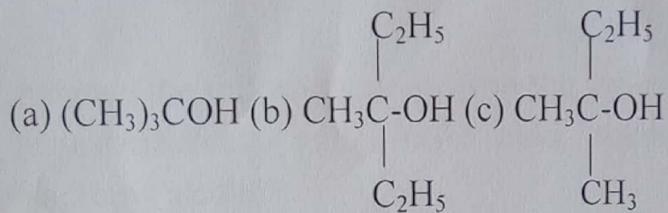


8. 3-pentene-2-one reacts with ethyl magnesium bromide (molar ratio 1:1) with subsequent hydrolysis to give a mixture of two compounds
(a) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{COCH}_2$



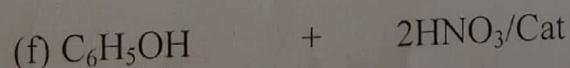
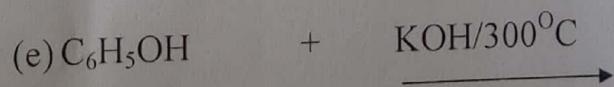
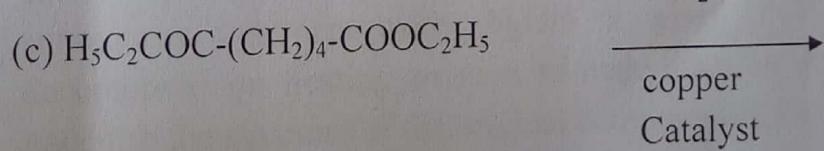
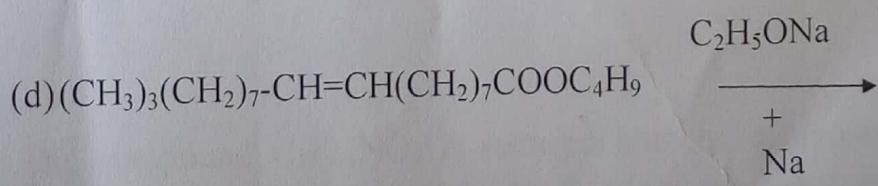
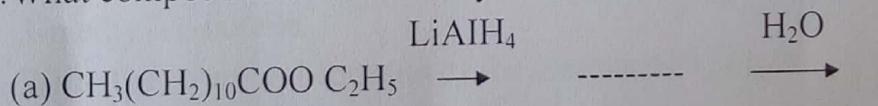
Explain the results

9. Which of the following alcohols can be obtained by the Grignard reaction from carboxylate esters.



Write Equations for the Synthesis

10. What compounds are formed by the following reactions



(g) Using electron movement structures explain the resonance effect in phenol which makes it acidic.

11. Arrange the following alcohols in the order of their increasing susceptibility to esterification with acetic acid, methyl alcohol, tert-butyl alcohol, isopropyl alcohol

12. A compound having the composition $C_6H_{15}N$ has the following properties:

- (1) When acted upon with HNO_2 it gives $C_6H_{14}N_2O$
- (2) When treated with excess CH_3I then with $AgOH$, finally heated it gives 3-methyl-1-butene.

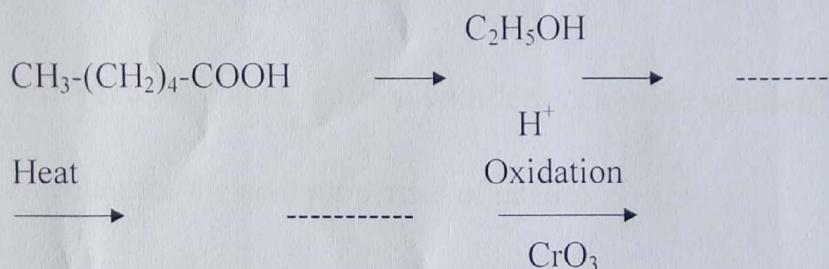
Write the structural formula of the compound $C_6H_{15}N$

13. The compound $C_5H_{11}NO_2$ is reduced into the compound $C_5H_{13}N$ that is soluble in acids. When $C_5H_{13}N$ is acted upon by excess CH_3I , with subsequent treatment with $AgOH$ it gives $C_8H_{21}NO$. The latter is decomposed on heating to give trimethyl amine and 2-methyl-1-butene. Establish the structure of the original compound $C_5H_{11}NO_2$.

14. Write the reactions of acetone and also propionaldehyde with HCN. Consider the reaction mechanism, which of the two compounds will easily, react with HCN? Explain why the formation of cyanohydrin is accelerated by adding bases and retarded by acids.

15. Indicate the active hydrogen atom in the following aldehydes (a) CH_3CHO (b) $\text{CH}_3\text{CH}=\text{CHCHO}$ (c) $\text{CH}_3\text{CH}=\text{CH-CH-CH}_2\text{-CHO}$,
Write the reactions of the aldol condensation of these aldehydes.

16. What compound will be obtained by the following transformation?



17. Arrange the following acids in the order of their increasing acid properties:

(a) CH_2ClCOOH , CH_3COOH and CCl_3COOH

(b) $\text{CH}_3\text{CHBrCH}_2\text{COOH}$, $\text{CH}_2\text{BrCH}_2\text{CH}_2\text{COOH}$ and $\text{CH}_3\text{CH}_2\text{CHBrCOOH}$

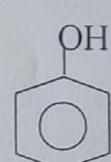
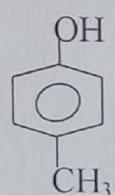
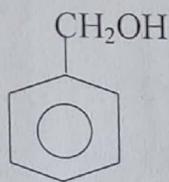
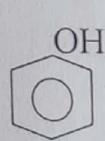
(c) CH_2ClCOOH , CH_2BrCOOH , CH_2FCOOH , CH_2ICOOH

18. Write the reactions characterizing the amphoteric properties of amino acids

19. A substance having the composition $\text{C}_6\text{H}_{13}\text{NO}_2$ does not react with sodium bicarbonate or nitrous acid, but easily reacts with hydrochloric acid to give a salt. When heated with an aqueous solution of alkali, it turns into a salt

having the composition $C_4H_8NO_2Na$. Determine the structure of the test substance.

20. Which of the following compound

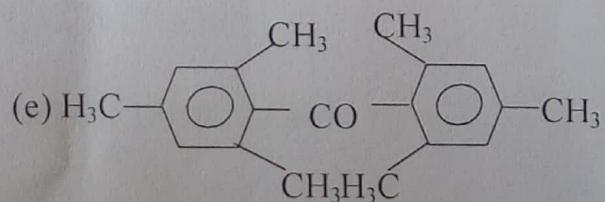


Will give the colour reaction with ferric chloride solution?

21. Account for the acid properties of phenol

22. Arrange the following aldehydes and ketones in the order of their increasing reactivity in nucleophilic addition reactions.

- (a) C_6H_5CHO (b) $C_6H_5COCH_3$ (c) $C_6H_5COC_6H_5$ (d) CH_3CHO

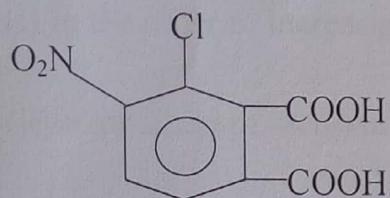


Indicate the compound in which steric hindrance are of the greatest importance

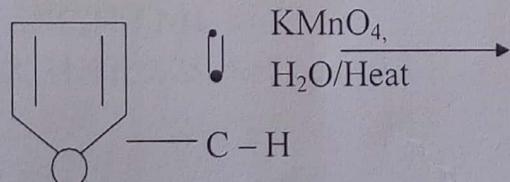
23. Write the structural formula of the substance $C_{14}H_{12}O_2$ having the following properties

- (A) it reacts with NH_2OH to give an oxime
- (b) reacts with $C_6H_5NHNH_2$ to give phenylhydrazone and with its excess it gives phenylozazone
- (c) is reduced with sodium borohydride to give $C_{14}H_{14}O_2$.

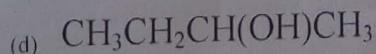
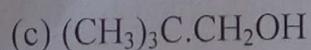
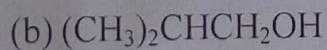
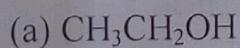
24. Write the structural formula of the compound $C_{18}H_6ClNO_2$, the oxidation of which gives 3-chloro-4-nitrophthalic acid

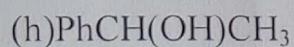
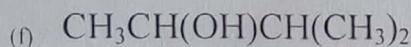
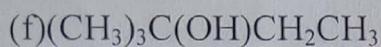
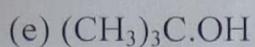


25. Accomplish the following conversions



26. Name and classify each of the following alcohols

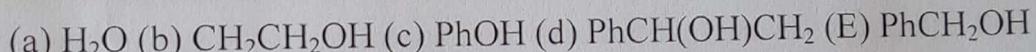




27. Arrange the compound below:

(i) in the order of increasing acid strength

(ii) in the order of increasing rapidity of reaction with sodium



(iii) Match each of the following compounds against its most probable pKa compounds NH_3 , $C_6H_5NH_2$, $(CH_3CH_2)_2NH$, CH_3NH_2 and $(C_6H_5)_2NH$.

Pka: 8.8, 11.11, 9.25, 4.58 and 10.3

(iv) Explain the following experimental facts

(i) aniline is insoluble in water but readily soluble in aqueous mineral acids

(ii) triphenyl amine is an amine and yet shows little or no basic properties.

(ii) triethyl amine readily turns moist red litmus blue

(iii) A compound of molecular formula C_4H_8O gave a yellow crystalline product with phenylhydrazine. On treatment with ammoniacal silver

oxide formation of silver mirror is observed. What is the structure and IUPAC name of the compound?

- (iv) What chemical reactions take place when:
- (h) Hydrogen gas is burbled into palm oil which contains a suspension of finely divided Nickel?
- (ii) a solution of palm oil in ether is heated under reflux lithium aluminium hydride?
- (iii) palm oil refluxed with concentrated aqueous sodium hydroxide
Discuss the importance of each of the above reactions.
- (v) Write down the structure and name of the ester of molecular formula $C_4H_8O_2$ if:
- (a) on hydrolysis it gives an alcohol which not only gives a positive iodoform reaction but also, on controlled oxidation gives a compound that reduces ammoniacal silver oxide.
 - (b) on reduction with $LiAlH_4$, it gives only one type of alcohol.
 - (c) on hydrolysis it gives an alcohol which responds positively to the iodoform reaction and an acid with reducing properties.
 - (d) on reduction it gives propan-1-ol
 - (e) on hydrolysis it gives an alcohol which on oxidation gives an acid with reducing properties
 - (f) on hydrolysis it gives an alcohol which responds negatively to the iodoform reactions and an acid with reducing properties.

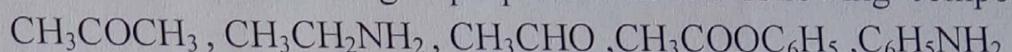
(vi) What functional group are present in the building blocks (hydrolytic products) of the macromolecules

- (a) starch
- (b) protein
- (c) palm oil?

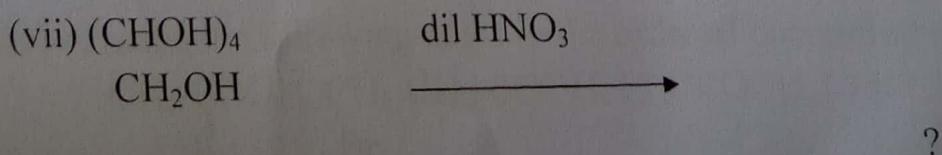
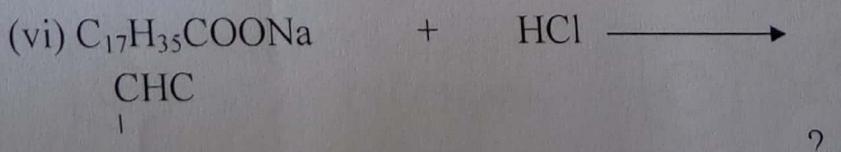
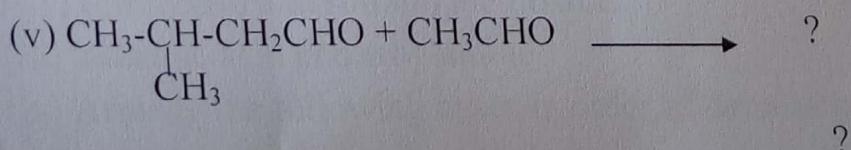
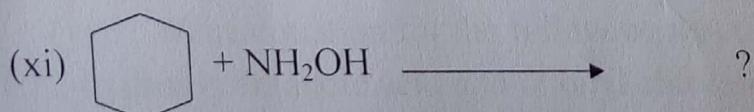
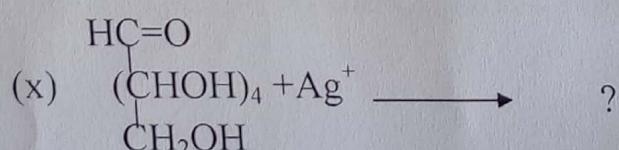
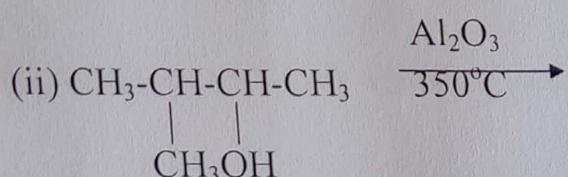
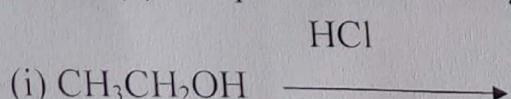
(vii) Arrange the following in order of increasing boiling points

- (i) hexane (ii) butanone (iii) 1-decanol (iv) 1-pentanol

(viii) Name the functional groups present in the following compounds:

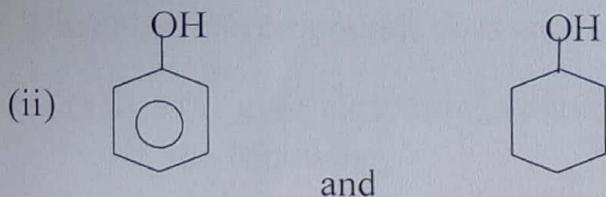


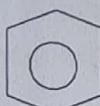
(ix) (a) complete the following equations:



(b) give one chemical test that will distinguish between the following pairs of compounds

(i) $\text{CH}_3\text{CH}_2\text{CHO}$ and CH_3COCH_3



(iii) $\text{CH}_3\text{-CO-}$  and $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$

(iv) a monosaccharide and a polysaccharide

(v) $\text{CH}_2\text{-CH-CH}_3$ and $\text{CH}_3\text{-CH-CH}_2\text{-OH}$

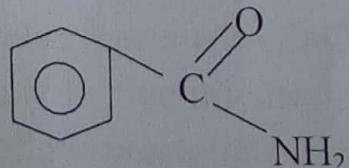
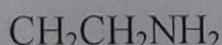
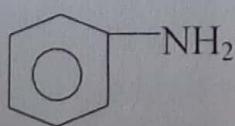
(vi) Write equation for the following reactions:

(i) 2-hydroxypentanoic acid and thionyl chloride

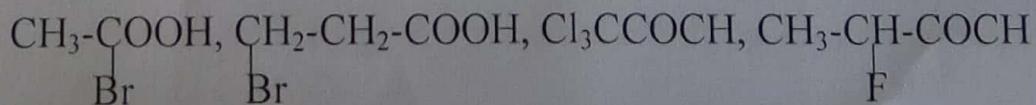
(ii) Formic acid and sodium methoxide

(iii) butanoic acid and ethylamine

(iv) Arrange the following bases in order of decreasing base strength



(v) Arrange the following acids in the order of decreasing acid strength



(vi) Write structures for the following:

N-methylaniline, succinic acid, terephthalic acid, trimethylammonium chloride, propanoyl chloride.

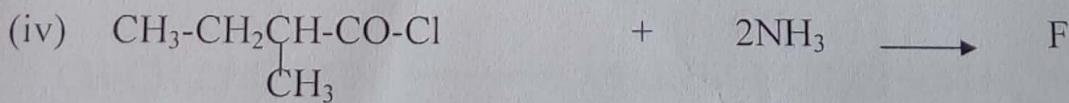
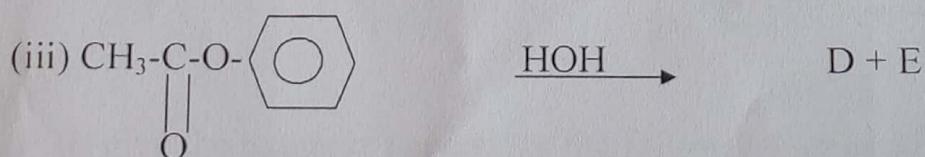
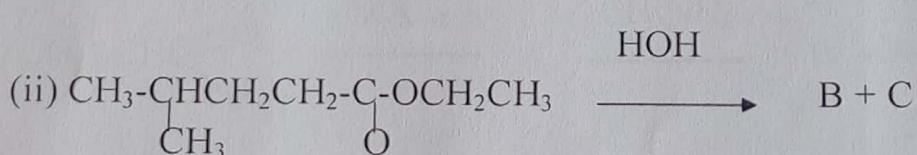
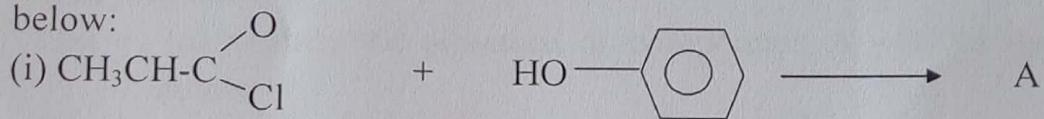
What class of compounds does each of these belong to.

(vii) (a) give clear brief definitions with one example in each case of the following

- (i) nucleophiles
- (ii) inductive effect
- (iii) hydrogen bonding

(viii) carbocations (carbonium ions or carbenium)

(b) write down the structures of compounds A, B, C, D, E and F shown below:



(ix) Two liquid position isomers A and B have the same molecular formula $\text{C}_4\text{H}_{10}\text{O}$. A is not affected by $\text{K}_2\text{Cr}_2\text{O}_7$ but B reacts with it to give a volatile liquid C. B also reacts with ZnCl_2/HCl to give D which turns the solution cloudy in five minutes. C does not react with Na_2CO_3 but forms a yellow precipitate E with I_2/NaOH to give a yellow solid F, which is used medicinally. A reacts with ethanoic acid to give a pleasant smelling liquid with a molecular formula $\text{C}_6\text{H}_{12}\text{O}_2$

(a) deduce structures for compounds A-G with reasonable inferences

(b) write equations for the conversion of

(i) A to G

(ii) B to C

(iii) C to F

(x) Given a tuber of yam, how would you make the following compounds?

(i) vinegar (ethanoic acid)

(ii) ethanol

(iii) ethyl ethanoate

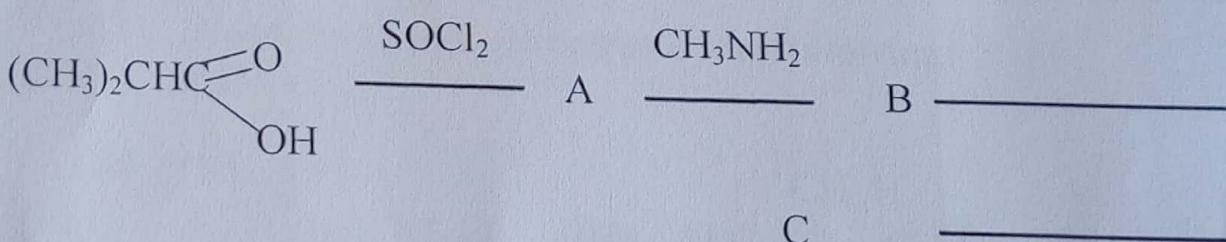
(b) define the following terms giving one example:

(i) disaccharide

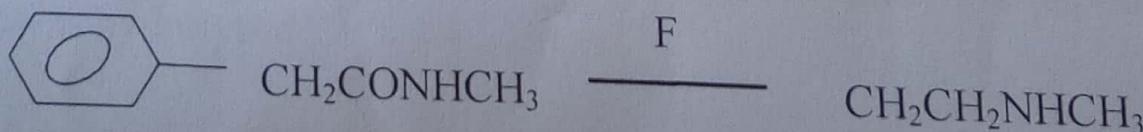
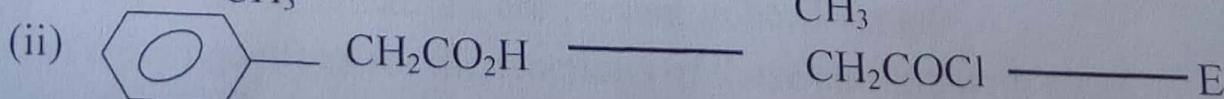
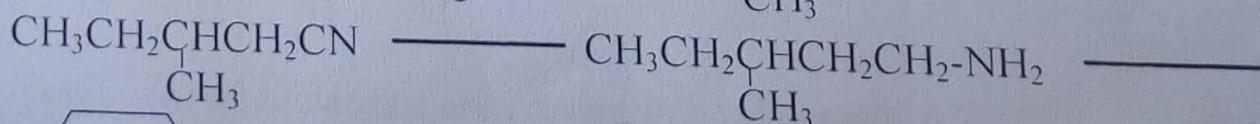
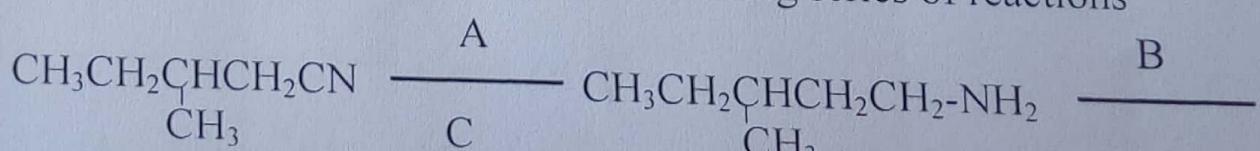
(ii) soap

(iii) drying oils

(xi) (a) written the structure or compounds A - C in the equation below



(i) (i) give the reagents needed for the following series of reactions



(xii) Distinction between $\text{CH}_3\text{CH}_2\text{CHO}$ and CH_3COCH_3
Any of the following tests is correct

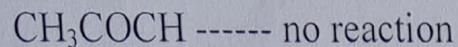
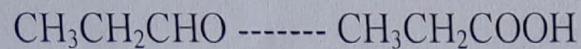
Oxidation with KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$

Oxidation with Fehling's solution

Oxidation with Benedict's solution

Oxidation with Tollen's reagent

For any of the tests correct reagent



Or oxidation with I_2/NaOH

(xiii) Write structure of the following compounds:

(i) 4-nitrobenzyl alcohol

(ii) 2-amino-2-methylpropane

(iii) 3-butan-2-ol

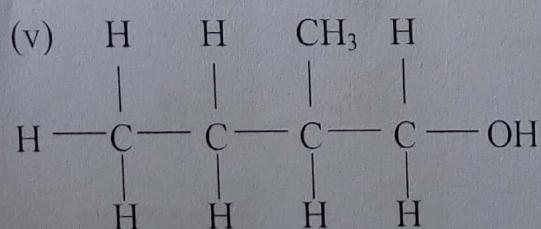
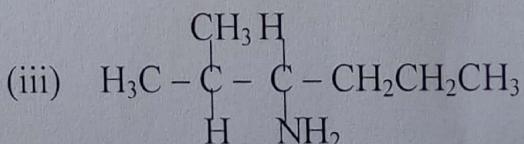
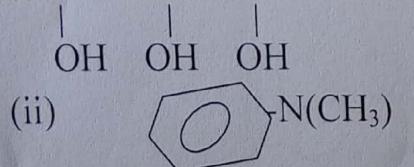
(iv) acetophenone

(v) 2-methylpentanal

(xiv) Compare the acidic strength of phenol, n-Hexyl alcohol and Hexanoic acid

(xv) Write the systematic names of the following:

(i) $\begin{array}{c} \text{CH}_2 - \text{CH} - \text{CH}_2 \\ | \quad | \quad | \\ \text{OH} \quad \text{OH} \quad \text{OH} \end{array}$



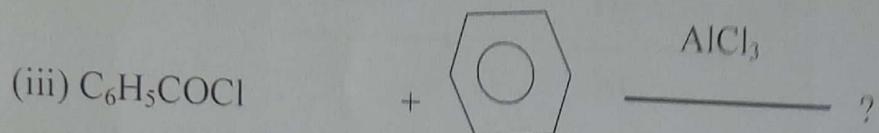
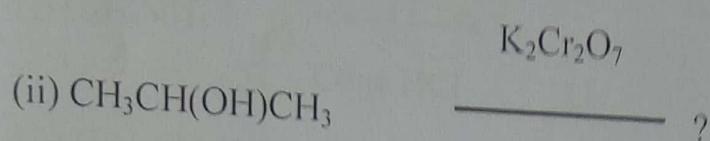
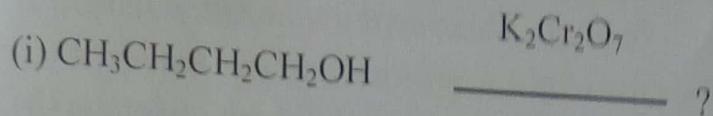
(xvi) (a) what cations are present in hard water?

(b) write equations for the reactions of these cations with soap

(c) list the names of the amino acids produced when the peptide shown below is hydrolyzed

(xvii) () write the structure of 1-phenyl-propnone and 1, 3-diphenyl-2-propen-1-one

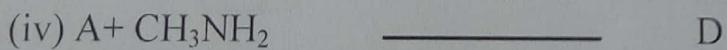
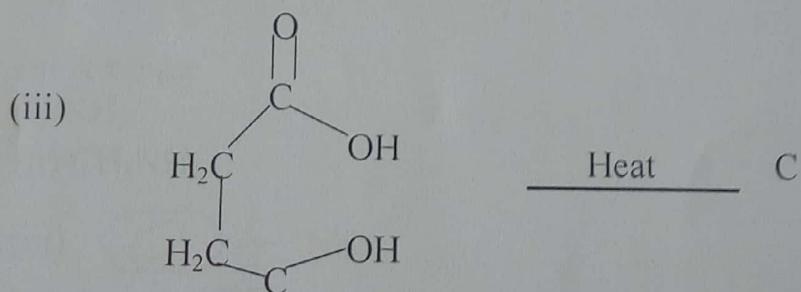
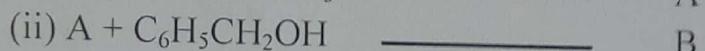
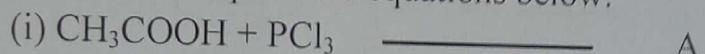
(b) Complete the following equations:



(xviii)(a) Write a chemical equation that could be used to distinguish an aldehyde from a ketone.

(b) Why is the boiling point of 1-butanol lower than that of propanoic acid?

(xix) Complete the equations below:



(xx) (a) arrange the following in order of decreasing boiling points

(i) hexane

(ii) butanone

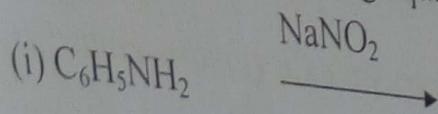
(iii) 1-decanol

(iv) 1-pentanol

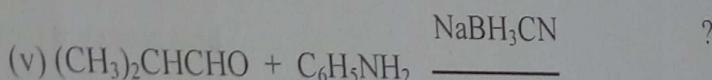
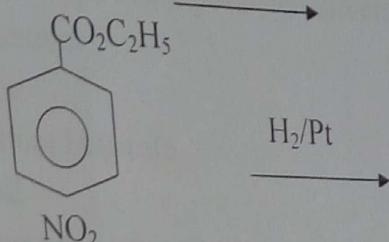
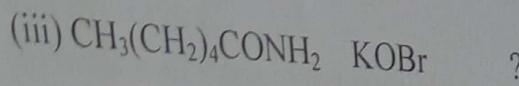
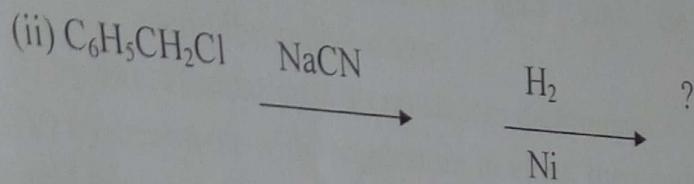
(b) what do you understand by the term essential amino acid? Give 4 examples

(xxi) (a) distinguish between fats and oils

- (b) what is a triglyceride and what products are formed when a triglyceride is treated with sodium hydroxide solution?
 (c) name the reaction between a triglyceride and sodium hydroxide solution
 (d) complete the following equations



Conc HCl



(e) Arrange:

(i) NH_3

(ii) CH_3NH_2

(iii) -NH₂

(iv) $\text{O}_2\text{N}-\text{C}_6\text{H}_4-\text{NH}_2$ in order of decreasing basicity

(xxii) (a) write the structures of the following amino acids

(i) proline

(ii) cysteine

(iii) serine

(iv) aspartic acid

(v) methionine

(b) give the systematic name of the amino acid threonine

(c) write the structure of threonine

- (i) at its isoelectric pH
- (ii) under strongly acidic conditions
- (iii) under strongly alkaline condition

(xxiii)(a) what carboxylic acid can be prepared from 4-methylbromobenzene

- (i) by direct oxidation with potassium dichromate
- (ii) by treatment with magnesium in ether, then carbon dioxide followed by acid hydrolysis?

(b) outline all steps in the possible conversion of 1-butanol to

- (i) 1-bromobutane
- (ii) 1-butene
- (iii) potassium butoxide
- (iv) butanal
- (v) 4-octanone
- (vi) butanoic acid

(c) write the structure of β -D-Glucopyranose and α -D-Gluocpyranos

(d) what is mutarotation?

(xxiv)(a) what is reducing sugar? Give 1 example

(b) arrange the following compounds in order of decreasing reactivity

- (i) $(RCO_2)_2O$ (ii) RCO_2R (iii) $RCOCl$ (iv) $RCONH_2$

(c) explain the following terms using two examples each

- (i) prostaglandins (ii) terpenoid (iii) steroid (iv) alkaloid

(xxv) (i) what do you understand by the term functional group?

(ii) give the functional group and IUPAC ending present in the following families of compounds.

Alcohols, aldehydes, ketones, carboxylic acids, acid chloride, esters, amines and amides

(b) draw the structures of:

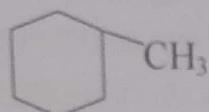
- (i) 1, 6-diphenylhexa-1, 5-diene-3-one
- (ii) 2-methylhex-2-enial
- (iii) 4-chloropent-2-enoyl chloride

(iv) 2,7-dimethyl-3,5-octadiyne-2,7-diol

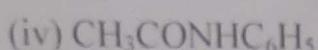
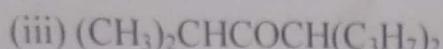
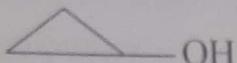
(v) propane-1, 2,3-triol

(c) give the IUPAC of the following

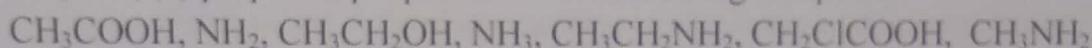
(i)



(ii)



(xxvi)(a) propose a pH profile for the following compounds



Explain your order.

(b) Explain the acidic behaviour of Ethanol and phenol in water illustrate with structures and equations where necessary

(c) Baba Angelina works in a Brewery plant in Benin City. His ride on motor bike home at the close of the day has been suspected. The traffic monitor stopped him one evening and asked him to blow into a bag containing certain chemical. The original yellow colour of the bag turns green. He was arrested and charged to court for an offence against the state.

(i) Explain the chemistry of the test carried out.

(ii) Write out a balance equation for the reaction that took place.

(iii) What offence was Baba Angelina charged for?

(d) consider the molecular formula C₄H₁₀O which has a number of isomeric alcohols. Obtain the structures of these alcohols together with their names and the names of their mild oxidation products. Where there is no oxidation, put "N.R".

(xxvii) (a) you are given 4 sample bottles known to contain aqueous solution of the following compounds:

Propanone, propanal, propanol, propanoic acid.

How would you label the bottles?

(b) It is proposed to convert the acid RCOOH into the amine R₂NH₂ by the following steps:

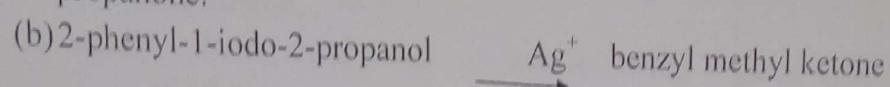
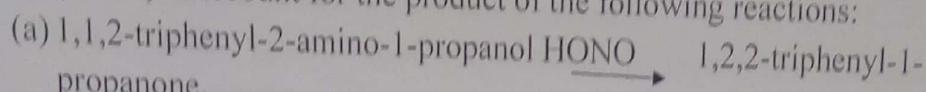
(i) RCOOH to RCOOCH₃

(ii) RCOOCH₃ to RCONH₂

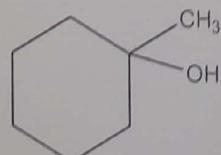
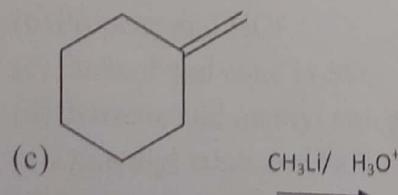
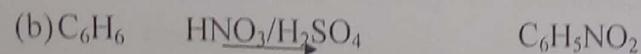
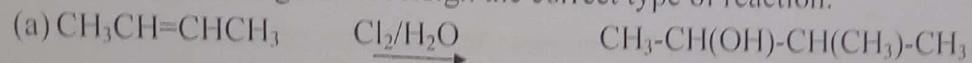
(iii) RCONH₂ to R₂NH₂

State the reagents, conditions required for these steps. What is the name of the reaction taking place in the steps?

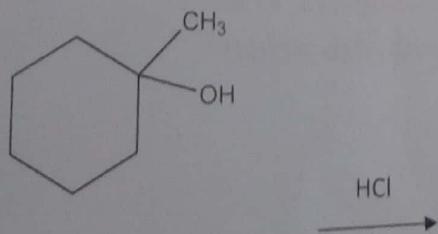
(xxviii) Account for the product of the following reactions:

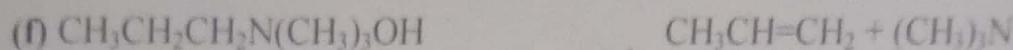


(xxix) Each of the following reactions is elimination, addition, substitution or rearrangement. Assign the correct type of reaction.



(e)





(xxx) Adding HBr to 2-butene produces a single product with molecular formula C₄H₉Br. Adding HBr to 1-butene can produce two different products depending on the reaction conditions. This also has same molecular formula, Suggest structures for each of the reaction products for 1 and 2 -butene.

(xxxi) Define hybridization and describe the type found in ethane,ethane and ethyne.

(xxxii) Write short notes on the following organic reactions using suitable examples.

(a) Elimination

(b) Addition

(c) Substitution

(d) Rearrangement

(xxxiii) Write the equations of reaction and products for the following reactions and classify as elimination, addition, substitution or rearrangement.

(a) Ethyne and H₂

(b) Propene and HCl

(c) Ethanol and conc H₂SO₄

(d) Benzene and methyl chloride

(e) Dimethyl ether and HCl

(f) Ethanol and HCN

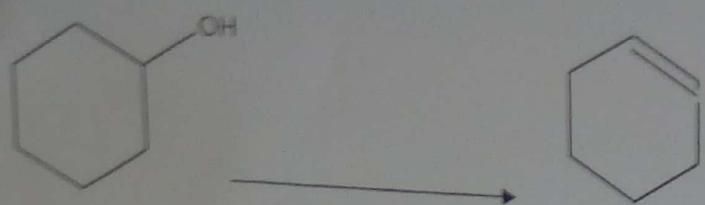
(g) Ethanoic acid and ethanol

(h) Pinacol with dilute acid H⁺

(i) Toluene with Cl₂

(j) Phenol with Cl₂

(xxxiv) When heated in the presence of a catalyst amount of phosphoric acid cyclohexanol loses water to form cyclohexene. This is a typical dehydration reaction as shown below.



- (a) What type of process is this
- (b) Write mechanism for the process
- (c) What is the function of H_3PO_4 in the reaction

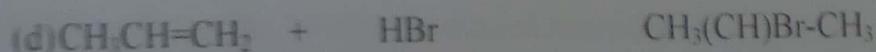
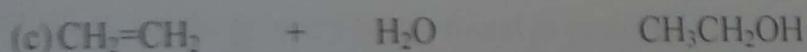
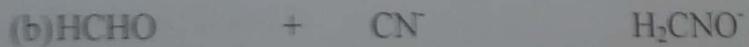
(xxxv) 1-Methyl cyclohexene reacts with HCl to form 1-chloro -1-methylecyclohexene compound C ($C_7H_{13}Cl$). When compound C reacts with water the compound D ($C_7H_{14}O$) slowly forms.

- (a) Propose structure for C and D
- (b) Write equation for the reaction
- (c) Classify each step of the reaction into appropriate reaction type.

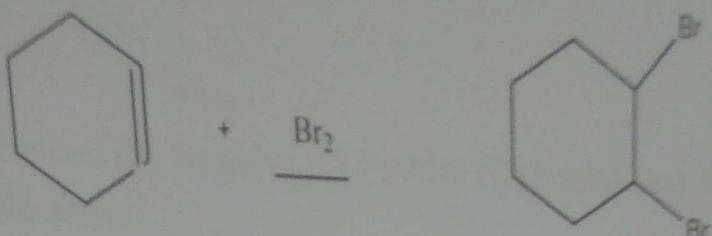
(xxxvi) An unknown alcohol E (C_3H_8O) produces a compound F when heated with an acid. Compound F produces a different alcohol G, when reacted with an aqueous acid. Bromine adds to compound F to produce compound H (C_3H_6Br)

- (a) Write the structures of compound E TO H
- (b) Write balanced equation for the reactions
- (c) Classify each step as substitution, addition or elimination.

(xxxvii) Classify each of the following reactions into the major organic reaction type and use curved arrows to show the movement of electrons as the starting materials are converted to products.



(e)



(xxxviii) List six reactions of alcohols and mention the type of each reaction

(xxxix) List four reactions each of ethanoic acid, ethyl ethanoate, acetone and acetaldehyde using suitable equations.

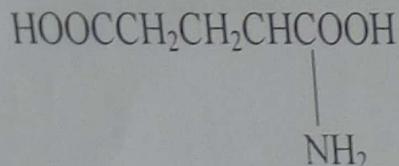
(xl) With the aid of chemical equations give six different methods of the synthesis of the following compounds from named starting materials.

- (a) Ethanol
- (b) Ethanoic acid
- (c) Ethanol
- (d) Propanone
- (e) Propyl amine
- (f) Propanamide.

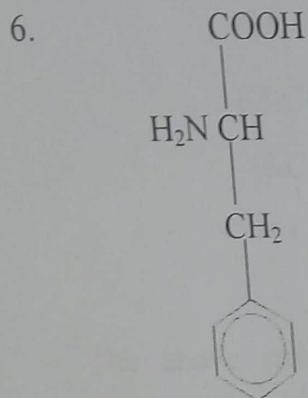
SECTION B

1. Denaturation involves the loss of what types of structure?
(A) Primary (B) Secondary (C) Tertiary (D) Both A and B (E) Both B and C
2. Beside peptide bond, what other covalent bonds are commonly found in peptides?
(A) Hydrogen bond (B) Ether bonds (C) Disulphide bonds (D) Hydrophobic bonds (E) B and D
3. All of the following statements concerning peptide bonds are true EXCEPT
(A) Their formation involves reaction between amine and a carboxyl group
(B) They are the primary bonds found in proteins
(C) They have partial double bond character
(D) Their formation involves hydration reactions

- (E) Their formation involves condensation reactions
4. What would be the charge of the following amino acid at pH 7



- (A) Neutral (B) Negative (C) Positive (D) Neutral and Negative (E) None of the above
5. $\text{NH}_2\text{CH}_2\text{COOH} + ? \longrightarrow \text{CH}_2\text{COOH CH}_2\text{CONHCH}_2\text{COOH}$
The other reactant in the above reaction is? (A) Ethanol (B) Ethanoic acid
(C) Secondary amine (D) Acetic anhydride (E) None of the above

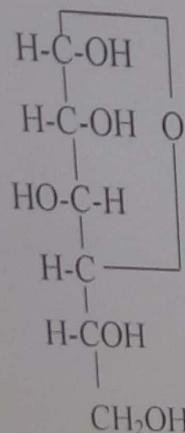


The above is the structure of:

- (A) L-tryptophan (B) D-tryptophan (C) L-tyrosine (D) D-tyrosine (E) None of the above
7. If the following amino acid (iso-electric point-9.74) in acidic solution is completely titrated with sodium hydroxide, what will be its charge at pH 3, 7 and 11
(A) Positive, neutral, negative (B) Negative, neutral, positive (C) Neutral, positive, positive (D) Positive, positive, negative (E) positive, positive, positive
8. In a neutral solution, most amino acids exist as:
(A) Positively-charged compounds (B) Zwitterions (C) Negatively charged compounds (D) Hydrophobic molecules (E) All of the above
9. Which of the following can be used to elongate a sugar?
(A) NH_2OH (B) HCN (C) NaBH_4 (d) A-C (E) All of the above
10. Which of the following is involved in the conversion of glucose to sorbitol?

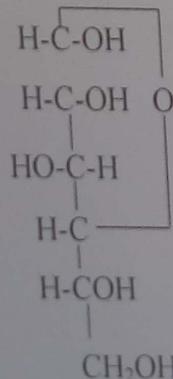
(A) Addition reaction (B) substitution reaction (C) Oxidation of the glucose (D) Reduction of the glucose (E) Reduction and oxidation of the glucose

11.



The above structure is that of: (A) β -D-glucopyranose (B) α -D-fructofuranose (C) α -D-manno furanose (D) β -D-manno furanose (E) None of the above.

12.



The number asymmetric carbon atoms in the above structure is:

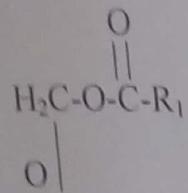
(A) =2 (B) =3 (C) =4 (D) =5 (E) =6

13. Which of the following statements about α -D-galactose pyranose is NOT correct? (A) it is monosaccharide (B) it is cyclic sugar (C) it is dextro-

rotatory (D) it contains a six membered ring (E) it will give a positive test with Fehling's solution

14. The reaction between glucose and cone HNO_3 will yield (A) gluconic acid
(B) glucitol (C) α -D-glucosone (D) an aldaric acid (E) None of the above
15. The reaction between galactose and cone HNO_3 involves (A) dehydration
(B) hydration (C) rehydration (D) hydrolysis (E) all of the above

16.



To form this compound you would start out with (A) an alkanol and an ester (B) an ester and a carboxylic acid (C) an