UNIVERSITY OF ABUJA

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

2016/2017 SECOND SEMESTER EXAMINATION NOVEMBER 2017

CHM 171: FOUNDATION CHEMISTRY III UNIT: 3 TIME ALLOWED $2^{1/2}$ HRS

INSTRUCTIONS: ANSWER ALL QUESTIONS IN SECTION A AND ONE QUESTION EACH FROM SECTION B AND C

SECTION A (ANSWER ALL)

1. The general formula for the alkanes is _____
2. Alkyl groups have the general formula _____
3. Hydrocarbons are divided into two main classes, aromatic and _____
4. $-NH_2$ is called _____ functional group
5. Two liquids are said to be _____ if they form homogeneous mixture
6. Organic compounds with OH are called _____
7. The Carboxylic acid group is represented as _____
8. The formula C_nH_{2n-2} belongs to the _____
9. The simplest member of the alkene family is _____
10. SH and C≡N are called _____ and _____ respectively
11. Alkenes are isomeric with _____ molecules
12. The ability of carbon to bond with another to give chain and ring of various sizes is called:

    (a) Hybridization (b) Combination (c) Catenation (d) None of the above (e) All of the above

13. A double bond is made up of

    (a) One sigma bond and one pi bond (b) Two sigma bond and one pi bond (c) One sigma bond and three pi bond (d) Two sigma bond and two pi bond (e) one sigma bond and two pi bond

14. The reactivity of H atom in alkane is in the order

    (a) CH_4 > 1^0 hydrogen > 2^0 hydrogen > 3^0mhydrogen (b) 2^0 hydrogen > 3^0 hydrogen > 1^0 hydrogen > CH_4 (c) 3^0 hydrogen > 2^0 hydrogen > 1^0 hydrogen > CH_4 (d) 1^0 hydrogen >

3^0 hydrogen > 2^0 hydrogen > CH_4 (e) None of the Above

15. How many isomers are possible for the compound with molecular formula C_4H_8?

    (a) 2 (b) 4 (c) 6 (d) 8 (e) it has no isomers

16. Which compound is not an isomer of the other three?

    (a) N-pentane (b) 2,2, Dimethyl propane (c) 2-methyl butane (d) 2,3, dimethyl butane (e) they are all isomers.

17. One of the following pair of compounds exhibit functional group isomerism

    (a) Cis- but – 2-ene and trans-but-2-ene (b) Prop-1-en-2-ol and propanone (c) n-butane and 2-methylpropane (d) ethanol and dimethyl ether (e) hex-1-ene and hex-2-ene

18. Which of the following exist as Cis-Trans isomers?

    (a) Propene (b) Hex – 3- ene (c) Hex-2-ene (d) 2-methyl but-2-ene (e) None of the above.

19. One of the unique nature of carbon for occurrence of diversity of organic compounds is the __

    (a) Ability to form covalent bond (b) Ability to form multiple bond (c) All of the above (d) none of the above (e) ability to halogenate

20. When a carbon atom is sp hybridized in a compound, it is bonded to _____

    (a) 4 other atoms (b) 3 other atoms (c) 2 other atoms (d) 5 other atoms (e) 1 other atom

21. In stable organic compounds, Carbon will always form

    (a) 4 bonds (b) 2 bonds (c) 3 bonds (d) 5 bonds (e) 6 bonds

22. How many isomers are possible for the compound with molecular formula C_5H_{12}?

    (a) 2 (b) 3 (c) 4 (d) 5 (e) 6

23. Which molecular formula indicates 2,2,4-trimethylhexane

    (a) C_9H_{20} (b) C_9H_{18} (c) C_8H_{18} (d) C_8H_{16} (e) C_9H_{14}

24. Which of the following molecular formula will correspond to an alkene with two double bonds?

    (a) C_4H_{10} (b) C_5H_{12} (c) C_6H_{10} (d) C_8H_{16} (e) C_7H_{10}

25. Which of the following hydrocarbons have acidic hydrogens?

    (a) But-1-yne (b) But-2-yne (c) But-1-ene (d) But-2-ene (e) None of these

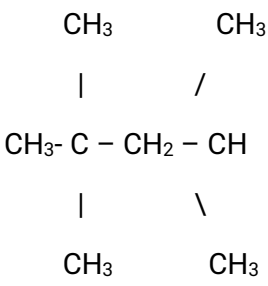
26. 0.19g of an organic compound gave on combustion 0.32g of CO_2 and 0.156g of H_2O, the percentage composition of oxygen in the compound is:

    (a) 93.46% (b) 52.60% (c) 46.90% (d) 65.20% (e) 56.60%

27. Which of the following is not a correct name according to the IUPAC rules?

    (a) 3-methyl pentane (b) 2,4, di-methyl pentane (c) 3,3 dimethyl pentane (d) 2methybutane (e) 3-methylbutane

28. What is the IUPAc name of the following compound?



    (a) 1,3-Pentamethylpropane (b) 1,1,3,3,-Tetramethylbutane (c) 2,4,4- Trimethylpentane (d) 2,2,4-Trimethylpentane (e) 2,2-Dimethylhexane

29. What is the separation technique for the mixture of Dye stuff?

30. The valency of carbon is _____

31. _____ is the art of separating the wanted substance from the unwanted ones?

Name the physical property that is considered as a basis when following separation techniques are used (32) Distillation (33) Separating funnel.

34. Fractional Distillation is different from ordinary distillation due to the presence of _____ column

35. What is the full meaning R_f?

36. the presence of cracks in a column packing can lead to _____ diffusion

37. What is the formula for calculating R_f value?

Given that distance moved by the solvent is 10cm, distance moved by compounds A=8cm, B=6cm and C=3cm. Use this information to answer 38-40

Calculate the Rf value for (38) Compound B (39) Compound A

40. Which compound will be eluted last?

SECTION B (ANSWER ANY ONE)

1. A. Differentiate between poly-functional and functional groups.
   B. Explain the main classes of organic compounds
2. Define Aromatic Hydrocarbons
   Aldehydes and ketones both have _____ as their functional group, explain

SECTION C (ANSWER ANY ONE)

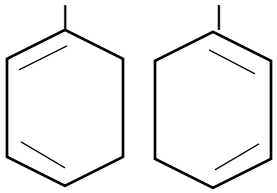
1. Distinguish between the terms empirical formula, molecular formula and structural formula of a compound
   Write down the positional, structural, geometrical and functional group isomers of

pentene (C_5H_{10})
Write the electronic configuration of carbon in Ground state and Excited state.
Fill in the blank spaces in the table below:

Type of C-C bond	**$H_3C - CH_3$**	**$H_2C = CH_2$**	**$HC \equiv CH$**
Hybridization			
Bond angle			
Geometry			

2. 0.62g of an organic compound gave on combustion 1.76g CO_2 and 0.42g H_2O. 0.232g of the same compound gave 29.5cm^3 of nitrogen measured dry at 15^{0}C and 760mmHg. Calculate the empirical formula of the compound, assuming the empirical is the same as the molecular formula, propose the structure of the compound.
   B. Give the hybridization state of each of the carbon atoms (a - e)

   a b c d e
   $CH_2 - C \equiv C - C = CH_2$



Solutions

1) C_nH_{2n+2}

2) C_nH_{2n+1}

3) Aliphatic

4) Amines

5) Miscible

6) Alcohol

7) RCOOH

8) Alkynes

9) Ethene

10) SH →Sulfhydryl group and CN(triple bond)=>Nitrile

11) Cycloalkanes

12) (C) Catenation

13) A

14) C

15) A

16) D

17) D

18) B

19) C

20) E

21) A

22) B

23) A

24) D

25) A

26) Check behind

27) B

28) D

29) Chromatography

30) 4

31) Separation techniques

32) Boiling point

33) Density

34) Fractionating column

35) Retardation factor (RF)

36) Longitudinal diffusion

37) Rf value = Distance moved by the solute/ Distance moved by the Solvent

38) Rf= Distance moved by Solute/Distance moved by solvent.
Rf of compound B=6/10=0.6cm

39) Rf of compound A=8/10 =0.8

40) A compound

(Note: compounds with low polarity have higher Rf value and low elution)

SECTION B

1a) Differences between poly functional and functional groups.

Functional group is the part of an organic compound that takes part in most of its reactions and determines the chemical properties of the compound

Poly functional: this is having repeating functional group with complicated properties which result from interconnectedness

1b) Main classes of organic compound

There are

1) Protein

2) Carbohydrates

3) Lipids

4) Nucleic acids

- Protein: It is built from building blocks called amino acids .They are the most complex of all

organic compounds, they contain Carbon, hydrogen, oxygen and nitrogen

- Carbohydrates: These include sugars starch and saccharides.They are compose of carbon,hydrogen and oxygen. Their classes are monosaccharides, disaccharides and polysaccharides. They energy providers
- Lipids: They are organic molecules composed of carbon, hydrogen and oxygen atoms.The ratio of hydrogen atoms to oxygen atom is much greater in lipids than in carbohydrates
- Nucleic acids: They are composed of nucleotides which are monomers made of three components; a 5-carbon sugar, a phosphate group and nitrogenous bases types of nucleic acids are DNA and RNA.

2a) Aromatic Hydrocarbons

They are also known as arenes, they are chemical compounds that contain conjugated d planar ring systems

with delocalized pi electron. Examples Benzene and toluene

2b) Aldehydes and ketones organic compounds both have **CARBONYL** functional group

SECTION C

1a)

- Empirical formular gives the simplest ratio between atoms in a molecule
- Molecular formular gives the actual number of atoms in the molecule
- Structural formular is the graphic representation of the molecular structure

1b)

Pentene (C_5H_{10})

a) Positional: pent-2-ene <

b) Structural: 2-Methylbut-1-ene

c) Geometrical: Cis-2-pentene and Trans-2-pentene

d) Functional group: Cyclopentane, Methylcyclobutane

1c) Carbon in Ground state

C= 1s2 2s2 2p2 or 1s2 2s2 $2p1_x$ $2p1_y$ $2p0_z$

Excited

C= 1s2 2s1 $2p_x1$ $2p_y1$ 2_pz1

1d)

Type	H_3C-CH3	H2C=CH2	HC CH
Hybridization	Sp3	Sp2	Sp
Bond angle	109.5	120	180
Geometry	Tetrahedral	Trigonal planar	Linear shape

2a) 0.62g--->sample

1.76g→ $C0_2$, 0.42g → H_2O

0.232g→ sample gave 29.5cm^3nitrogen

T=25+273=288k, P=760mmHg

44g of CO_2→12g C

1.76g of CO_2→X. X=0.48g of C

0.48/0.62×100% =77.42%

18g H_2O →2g H

0.42g of H_20 → X H X=0.046

%= 0.046/0.62×100%= 7.53%

Sec and sample 0.232g

$P_1V_1/T_1=P_2V_2/T_2$➔ $V_2=P_1V_1T_2/P_2T_1$

V_2=760×29.5×273/288×760 =27.96cm^3

From Standard 22400cm^3 of N_2 → 28g

27.96cm^3 of N_2=X. X=28×27.96/22400 =0.03495 g of N_2

%=0.03495/0.232 ×100% =15.1% {checking: 77.4+7.5.15.1}%=100%

C	H	N
77.4/12	7.5/1	15.1/14
6.45 /1.08	7.5/1.08	1.08 /1.08(divide through by the lowest)
6	7	1 ➔ **C_6H_7N Phenylamine**

2b) A=Sp_3, B=Sp, C=Sp_3, D=Sp_2 E=Sp_3

Question 26, Section A .Solution

Sample=0.19, CO_2=0.32g, H_2O=0.156g

44g of CO_2→ 12g C

0.32g of CO_2 → X X=0.32×12/44=0.0873g C

C %=0.0873/0.19×100 =45.94%

18g H_2O→2g

0.156g H_20→ 2×0.156/18 = 0.0173g

%H =0.0173/0.19×100 =9.12%

O_2% =100-(45.95+9.12)= 44.94%

Naming Substituted Alkanes and Cycloalkanes—Group C Substituents Only

1. Organic compounds containing substituents from Group C are named following this sequence

of steps, as indicated on the examples below:

•Step 1. Find the longest continuous carbon chain. Determine the root name for this

parent chain. In cyclic compounds, the ring is usually considered the parent chain, unless it is

attached to a longer chain of carbons; indicate a ring with the prefix “cyclo” before the root

name. (When there are two longest chains of equal length, use the chain with the greater number

of substituents.)

•Step 2. Number the chain in the direction such that the position number of the first

substituent is the smaller number. If the first substituents from either end have the same number,

then number so that the second substituent has the smaller number, etc.

•Step 3. Determine the name and position number of each substituent. (A substituent on

a nitrogen is designated with an “N” instead of a number; see Section III.D.1. below.)

•Step 4. Indicate the number of identical groups by the prefixes di, tri, tetra, etc.

•Step 5. Place the position numbers and names of the substituent groups, in alphabetical

order, before the root name. In alphabetizing, ignore prefixes like sec-, tert-, di, tri, etc., but

include iso and cyclo. Always include a position number for each substituent.

AREA OF CONCENTRATION

1. Separation Techniques
   i. Physical properties use in separating mixtures.
   ii. Types of Chromatography (RF value)
2. Hydrocarbon
   Carbonyl compounds,aliphatic and aromatic hydrocarbons
3. Classes of organic
   i. Properties
   ii. Reactions
   iii. Preparations
4. Naming of organic compounds
5. Aromatic hydrocarbon
6. Isomerism
   i. Functional isomerism
   ii. Structural isomerism
   iii. Positional isomerism
7. Hybridization
8. Calculations on Empirical, Molecular and structural formular