NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

SCHOOL OF NATURAL AND APPLIED SCIENCES

DEPARTMENT OF BIOLOGY, CHEMISTRY AND PHYSICS

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE CODE: ORC601S	**COURSE NAME:** ORGANIC CHEMISTRY 1
SESSION: JUNE 23	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR. MPINGANA AKAWA
MODERATOR:	PROF. HABAUKA KWAAMBWA

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly.

PERMISSIBLE MATERIALS

1. Non-programmable Calculators

THIS QUESTION PAPER CONSISTS OF 13 PAGES (Including this front page)

SECTION A [50]

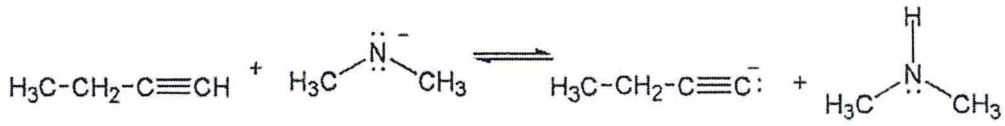
QUESTION 1: Multiple Choice Questions

- There are 25 multiple choice questions in this section. Each question carries 2 marks.
- Answer ALL questions by selecting the letter of the correct answer.

1.1 Which of the following alkanes would have the lowest boiling point?

A. $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
B. $(CH_3)_3CCH(CH_2)_2$
C. $CH_3CH_2CH_2CH_2CH(CH_3)_2$
D. $(CH_3)_2CHCH_2CH(CH_2)_2$

1.2 Consider the following acid-base reaction. The equilibrium for this reaction lies to the:



A. Left
B. Right
C. It cannot be determined
D. The forward and reverse reactions are equally favoured

1.3 Which of the following is not a nucleophile?

A. ^-CN
B. CH_3NH_2
C. CH_3O^-
D. H_2O
E. $^+NO_2$

1.4 Consider the three isomeric alkanes n-hexane, 2, 3-dimethylbutane, and 2-methylpentane. Which of the following correctly lists these compounds in order of increasing boiling point?

A. 2, 3-dimethylbutane < 2-methylpentane < n-hexane
B. 2-methylpentane < n-hexane < 2, 3-dimethylbutane
C. 2-methylpentane < 2, 3-dimethylbutane < n-hexane
D. n-hexane < 2-methylpentane < 2, 3-dimethylbutane

1.5 Among the butane conformers, which occur(s) at energy minima on a graph of potential energy versus dihedral angle?

A. gauche only
B. eclipsed and totally eclipsed
C. gauche and anti
D. eclipsed only

1.6 Which of the following compounds in the product of catalytic hydrogenation of 2,3-Dimethyl-2-butene?

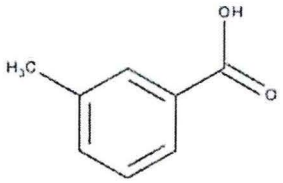
A. 2,3-Dimethylbutane
B. 2-Methylpentane
C. 2,2-Dimethylbutane
D. 3-Methylpentane

1.7 What is the IUPAC name of the following compound?

$$CH_3C \equiv CCH_2C(CH_3)_3$$

A. 4,4-dimethyl-2-hexyne
B. 5,5-dimethyl-2-hexyne
C. 5,5-dimethyl-3-hexyne
D. None of the above

1.8 What is the correct name of the following compound?

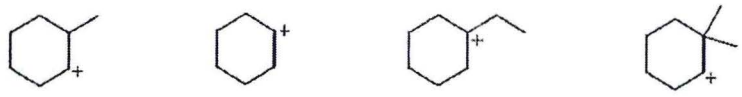


A. 3-methylbenzoic acid
B. m-methylbenzoate
C. tolylcarboxylate
D. methylbenzoate

1.9 Markovnikov addition of HBr to 1-propene involves:

A. Initial attack of bromide ion
B. Initial attack of bromine radical
C. Formation of a secondary carbocation
D. Formation of a primary carbocation

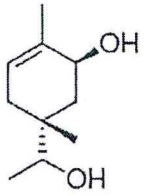
1.10 Which of the following carbocations is the most stable?



A B C D

A. A
B. B
C. C
D. D

1.11 How many stereogenic centres are present in the following compound?



A. 0
B. 1
C. 3
D. 4
E. 5

1.12 Which of the following is a product of the acid-catalyzed hydration of 3-methyl-2-pentene?

A. 2-methylpentane
B. 3-methyl-1-pentanol
C. 3-methyl-3-pentanol
D. 2-methyl-2,3-pentadiol

1.13 What is the molecular geometry of the central atom in CH_3OCH_3?

A. Trigonal planar
B. Trigonal pyramidal
C. Tetrahedral
D. Bent

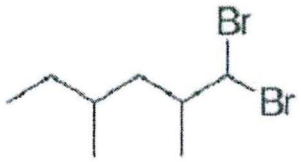
1.14 Which of the following statements is true in comparing ethane, ethene and ethyne to one another?

A. Ethyne is the weakest acid and has the longest C-H bond distance.
B. Ethyne is the strongest acid and has the shortest C-H bond distance.
C. Ethane is the strongest acid and has the longest C-H bond distance.
D. Ethene is the strongest acid and has the shortest C-H bond distance.

1.15 Which of the following anions is the best leaving group?

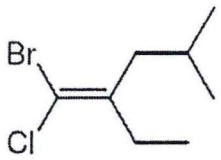
A. NH_2^-
B. Cl^-
C. CH_3^-
D. OH^-

1.16 What is the condensed formula of the compound below?



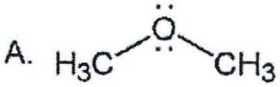
A. $CH_3CH_2CH(CH_3)CH_2CH(CH_3)CHBr_2$
B. $CH_3CH_2CH_2(CH_3)CH_2CH(CH_3)CHBr_2$
C. $CH_3CH_2CH(CH_3)CH(CH_3)CH_2CHBr_2$
D. None of the above

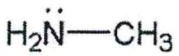
1.17 Give the IUPAC name for the following compound.



A. (Z)-1-bromo-2-chloro-2-ethyl-4-methyl-1-pentene
B. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-2-pentene
C. (Z)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene
D. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene

1.18 What is the nucleophilic site in each of the following molecules?

A. 

B. 

C. 

A. A: hydrogen; B: nitrogen; C: 2 electrons in bond
B. A: oxygen: B: nitrogen: C: carbon
C. A: oxygen; B: nitrogen; C: 2 electrons in bond
D. A: oxygen: B: carbon; C: 7 electrons in bond

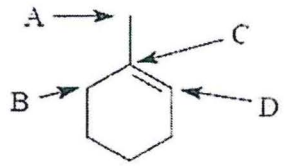
1.19 The formal charge on the nitrogen atom in the nitrate ion, NO3-, is [2]

A. -3
B. 0
C. +1
D. +3
E. +5

1.20 Which molecule has a nonzero dipole moment?

A. Cl_2
B. CO_2
C. CCl_4
D. $CHCl_3$

1.21 Using Markovnikov's rule, predict the position of the Cl atom in the major product from the reaction of 1-methylcyclohexene with HCl.



A. A
B. B
C. C
D. D

1.22 Which of the following reagents must be used with HBr to convert 1-hexene to 1-bromohexane?

A. HSO_3^-
B. $NaBH_4$
C. ROOR
D. Pd/C
E. no other reagent is necessary

1.23 Which of the following compounds consists of only sp^3 hybrid carbon orbitals?

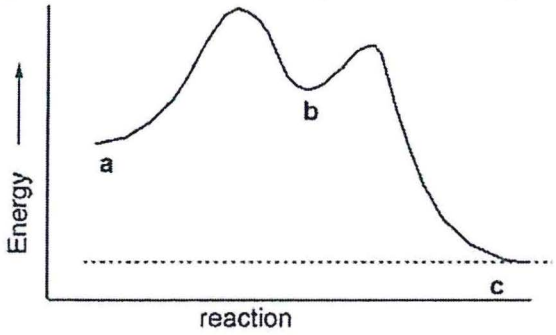
A. $CH_3CH_2CH_3$
B. $CH_3C{\equiv}CH$
C. $CH_3CH{=}CH_2$
D. $CH_2{=}CH{-}CH{=}CH_2$

1.24 Give the IUPAC name of the following compound.

$CH_3C(CH_3)_2CH_2C{\equiv}CCH_2CH(CH_2CH_2CH_3)CH_3$

A. 2,2,7-trimethyl-4-nonyne
B. 2,2,7-trimethyl-4-decyne
C. 3,3,7-trimethyl-4-decyne
D. 2,2,6-trimethyl-4-undecyne

25. Which of the following statements is (are) true about the energy diagram drawn below?



A. The reaction mechanism has two steps
B. b labels a transition state.
C. The overall reaction is endothermic
D. The conversion of a to b is faster than the conversion of b to c.

SECTION B [50]

- There are SIX questions in this section. Answer all Questions.

QUESTION 2 [3]

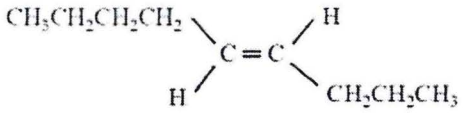
2.1 Which of the following alkanes would have the lowest boiling point? Explain.

A. $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
B. $(CH_3)_3CCH(CH_3)_2$
C. $CH_3CH_2CH_2CH_2CH(CH_3)_2$
D. $(CH_3)_2CHCH_2CH(CH_3)_2$

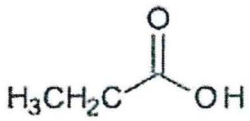
QUESTION 3 [10]

3.1 Give systematic IUPAC names or draw the skeletal structures of the following organic compounds

a) 5,5-dimethyl-2-hexyne
b) 3-ethyl- 4-methyl-2-pentene
c) 1,6,6-trimethylcylcohexa-1,4-diene
d)



e)



QUESTION 4

[6]

4.1 The names of the following compounds are not correct. Point out the errors and correct them.

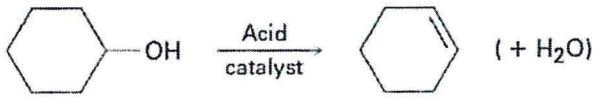
a) 2,2-dimethyl-6-ethylheptane
b) 4-ethyl-5,5-dimethylhexane
c) 5,5,6-trimethyloctane

QUESTION 5 [4]

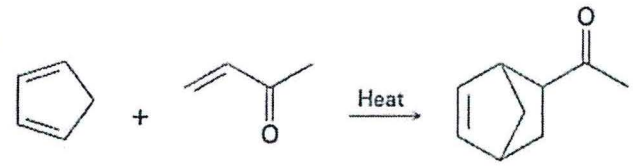
5.1 Classify each of the following reactions as addition, elimination, substitution or rearrangement.

(a) $CH_3CH_2Br + NaCN \longrightarrow CH_3CH_2CN\ (+ NaBr)$

(b)



(c)

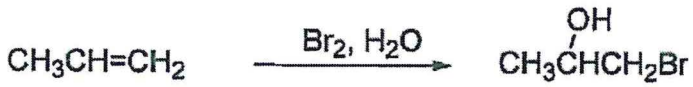


(d)

QUESTION 6

6.1 The below equation shows the bromination of methane. Propose a radical reaction mechanism to account for the product formation. [7]

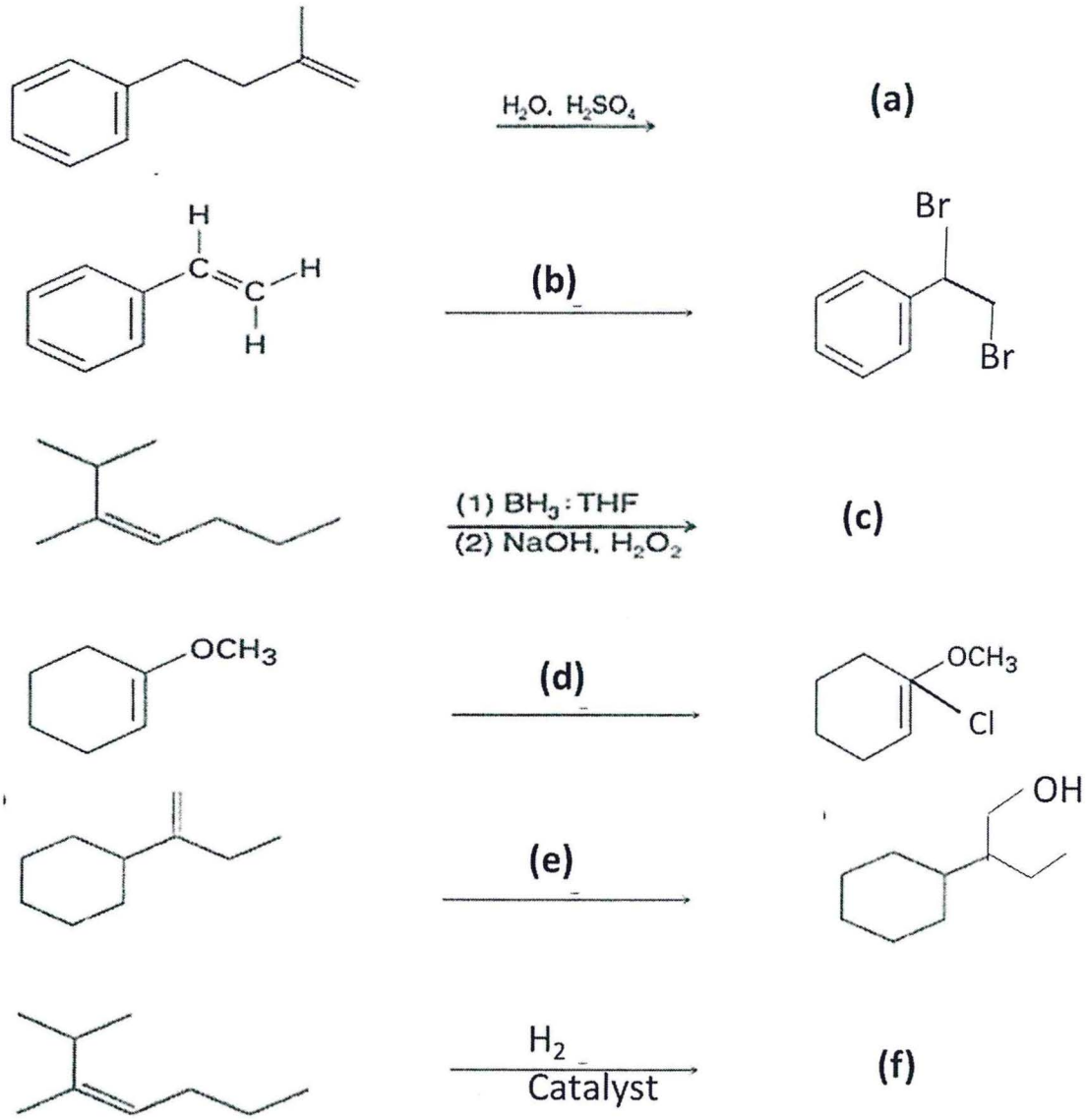
6.2 Consider the following equation: [8]



Explain how the product is formed by showing a complete mechanism (show with arrows). Is this a Markovnikov or Anti-Markovnikov product? Explain

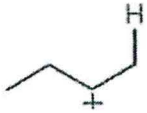
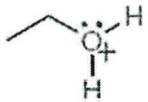
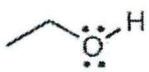
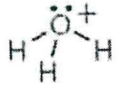
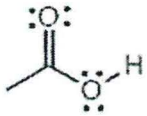
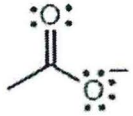
QUESTION 7 **[12]**

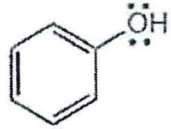
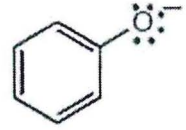
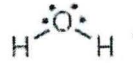
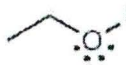
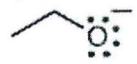
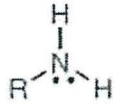
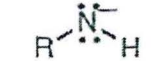
7.1 Predict the product(s) or the conditions of the following reaction

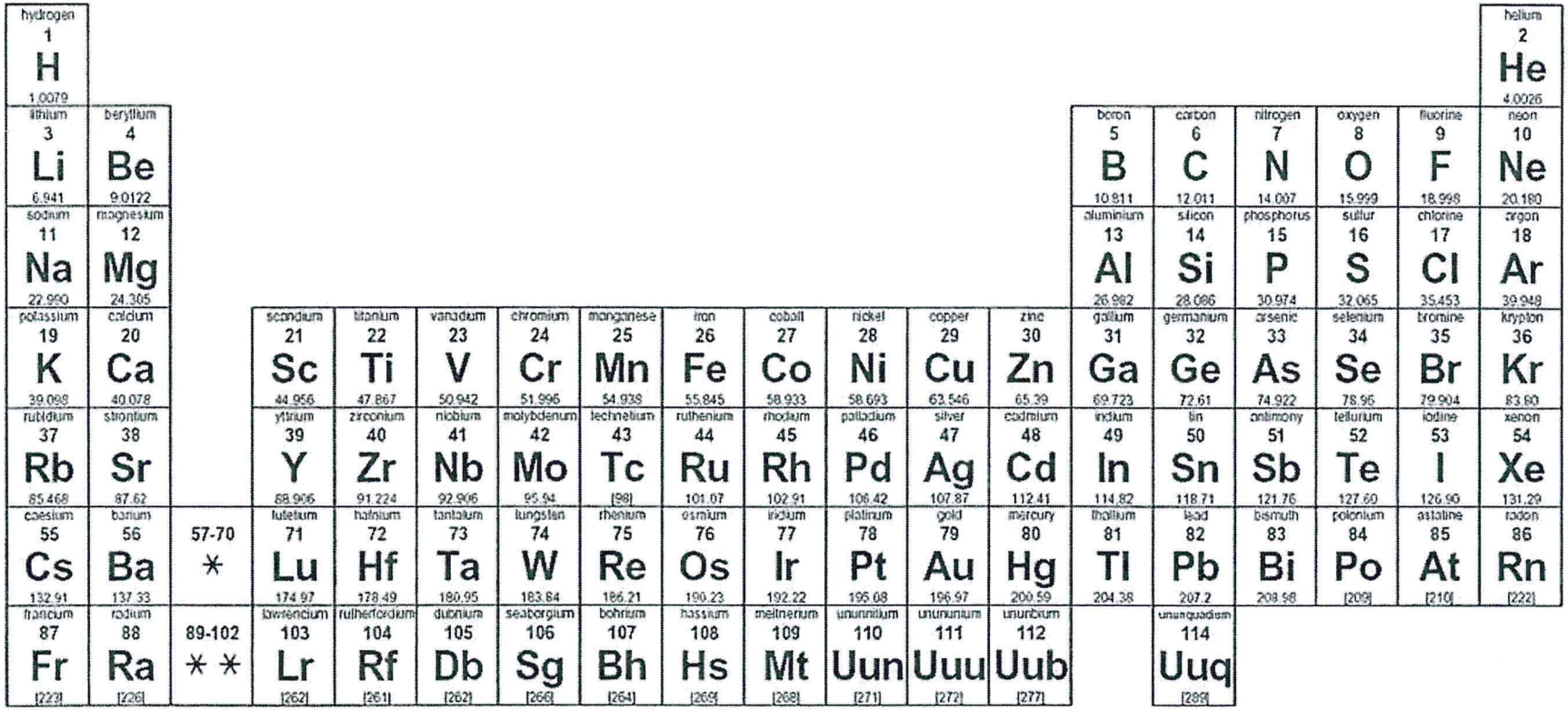


END OF EXAMINATION QUESTIONS

pKa Chart

conjugate acid		conjugate base	
sulfuric acid	H_2SO_4	HSO_4^-	-10
hydroiodic acid	HI	I^-	-9
hydrobromic acid	HBr	Br^-	-8
hydrochloric acid	HCl:	:Cl:$^-$	-7
carbocations			-3
protonated alcohol			-2.4
hydronium ion			-1.7
nitric acid	HNO_3	NO_3^-	-1.3
hydrofluoric acid	HF	F^-	3.2
carboxylic acids			4.8

conjugate acid		conjugate base	
hydrogen cyanide	H—C≡N:	:C≡N:$^-$ (cyanide)	9.1
phenols			10
water		(hydroxide)	15.7
primary alcohols		 (alkoxides)	16
alkynes	C≡C—H	C≡C:$^-$ (acetylide anions)	26
hydrogen	H—H	:H$^-$ (hydride)	35
ammonia/amines		 (amide bases)	36
alkanes			~60



*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]