UNIVERSITY OF SWAZILAND

SUPLLEMENTARY EXAMINATION 2005

TITLE OF PAPER : Introductory Organic Chemistry.

COURSE NUMBER : C203.

TIME : Three (3) Hours.

INSTRUCTIONS : Answer any Four (4) Questions.
Each Question carries 25 Marks.

You must not open this paper until the Chief Invigilator has so granted permission to do.

Question 1:

a) Write the ground state electron configuration of the following elements, most commonly associated with the majority of organic compounds:

i. Carbon (2 Marks)

ii. Nitrogen (2 Marks)

iii. Oxygen (2 Marks)

iv. Sulfur (2 Marks)

b) With the aid of appropriate illustrations, explain the following terms and concepts in relation to chemical bonds:

i. Lewis Model of the nature of the chemical bond (3 Marks)

ii. The Molecular Orbital Theory (VSEPR) of chemical bonding (3 Marks)

iii. The Orbital Hybridization Model of bonding (3 Marks)

iv. Write a complete Lewis structure and the corresponding equivalent resonance structure for: each of the following chemical species.

(a) The chlorate ion (ClO_3^-) (2 Marks)

(b) Isocyanic acid (OCNH) (2 Marks)

(c) Nitrylchloride (NO_2Cl) (2 Marks)

(d) Methyl nitrite CH_3NO_2 (2 Marks)

Question 2:

a) Briefly describe the structure and bonding characteristics in BF_3 molecule in terms of the following:

i. Lewis Model (4 Marks)

ii. Valence Shell Electron Pair Repulsion Theory (VSEPR) (4 Marks)

iii. Orbital Hybridization (5 Marks)

b) On the basis of the Valence Shell Electron Pair Repulsion Theory of bonding, predict and draw the shape of the following molecules:

i. Methyl Cation CH_3^+ (4 Marks)

ii. Phosphorous trichloride PCl_3 (4 Marks)

iii. The Carbonate ion CO_3^{2-} (4 Marks)

Question 3:

a) Briefly explain the following terms and concepts and give suitable examples in each case to illustrate your answers.

i. Meso form (2 Marks)

ii. Racemic mixture (2 Marks)

iii. Diastereoisomerism (2 Marks)

iv. Optical activity (2 Marks)

b) The following sequence of reactions describes a synthesis of 2-hydroxy butanoic acid II through cyanohydrin 1. The sequence is an efficient method for generating a chiral centre in the molecule. Study the sequence and answer the following questions

$$CH_3CH_2CHO \xrightarrow[Ether/H_2O;\ HCl]{NaCN} CH_3CH_2CH(OH)CN \xrightarrow[Heat]{dil\ H_2SO_4} CH_3CH_2CH(OH)COOH$$

I II

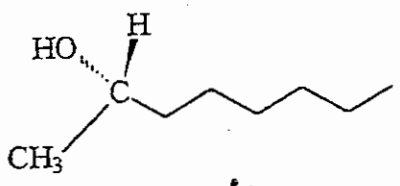
Synthesis scheme for 2-hydroxy butanoic acid (II)

i. In what stereochemical form is the 2-hydroxy butanoic acid product (2 Marks)

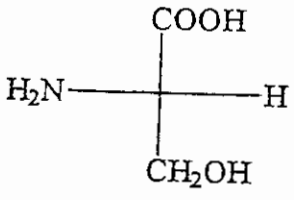
ii. Why is the product II obtained in the form identified above? (2 Marks)

iii. Write a three dimensional structure and the equivalent Fisher projection formula of (R) -2-hydroxy butanoic acid. (4 Marks)

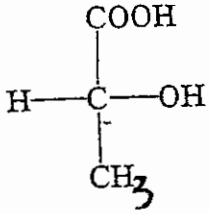
c) Specify the configuration as (R) and (S) in each stereogenic centre in the following molecules: (9 Marks)



(i)



(ii)



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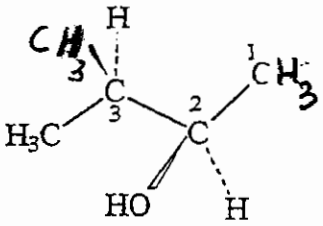
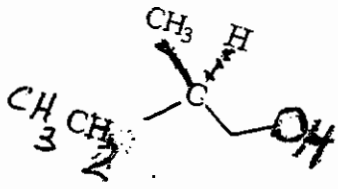
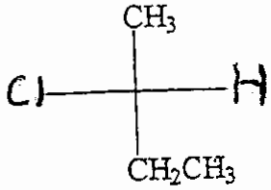


(IV)



(V)



(VI)

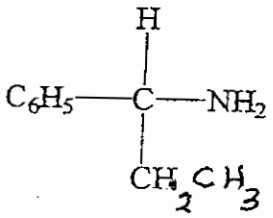
Question 4:

a) The structure of tartaric acid, an important compound in the history of stereochemistry is: HOOC-CH(OH)-CH(OH)-COOH

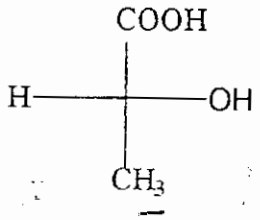
i. State the number of all the possible stereoisomers of tartaric acid, and draw the Fisher projection structure of each stereoisomer. (8 Marks)

ii. There are two naturally occurring forms of tartaric acid that are both optically inactive. Name the forms. (4 Marks)

b) Enantiomerically pure amines such as pure (S)-1- phenylpropylamine are often used to resolve racemic forms of acidic compounds such as (±) lactic acid II.



I



II

i. Briefly describe how (S)-1- phenylpropylamine (I) may be used to resolve the racemic form of lactic acid (II) into enantiomerically pure acids. (10 Marks)

ii. In the resolution of lactic acid using (S)-1- phenylpropylamine as the resolving agent, the compound obtained by re-crystallization of the mixture of diastereomeric salts is (S)-1- phenylpropylammonium (R) lactate. Name the other component of the mixture that (being more soluble) remains in solution in the re-crystallization solvent. (3 Marks)

Question 5:

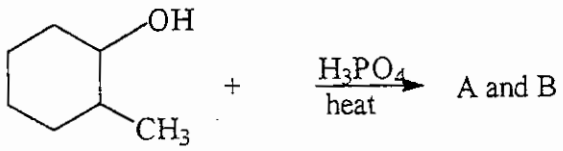
a) Briefly explain the following terms. Give an appropriate example in each case to illustrate your answer:

i. Chemical reaction (4 Marks)

ii. Reaction coordinate (4 Marks)

iii. Reaction Mechanism (4 Marks)

b) Heating 2-methylcyclohexanol (1) in phosphoric acid (H_3PO_4) is known to convert compound (1) into two isomeric products A and B (see reaction below)

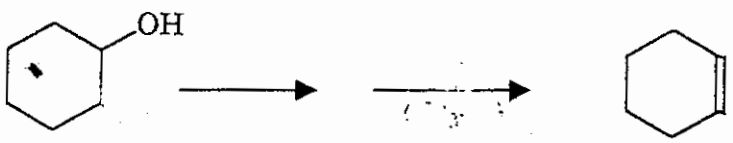


1

i. Write the correct structures for A and B. (4 Marks)

ii. Write a suitable mechanism for the conversion of 2-methylcyclohexanol to the isomeric products A and B (4 Marks)

iii. Write the sequence of reactions that describe a possible synthesis of cyclohexene in a laboratory using cyclohexanol, sodium metal and methanol among other reagents. (5 Marks)



Question 6:

a) Using suitable examples give an outline of one general laboratory method for preparing

i. Alkylhalides $(CH_3CH_2)_2CHCH_2X$ (6 Marks)

ii. Alkylamine $(CH_3\ CH_2\ CH_2\ NH_2)$ (6 Marks)

b) Write the sequence of reactions and show the products when:

i. Aqueous solution of sodium nitrite ($NaNO_2$) is acidified with dilute hydrochloric acid. (4 Marks)

ii. Butylamine is treated with acidified solution of sodium nitrite in water (5 Marks)

iii. Iso propylamine $(CH_3\ CH(CH_3)\ NH_2)$ reacts with acidified solution of sodium nitrite at 0°C (4 Marks)

PERIODIC TABLE OF ELEMENTS

PERIODS	GROUPS 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.007 **N** 7	15.999 **O** 8	18.998 **F** 9	20.180 **Ne** 10
3	22.990 **Na** 11	24.305 **Mg** 12											26.982 **Al** 13	28.086 **Si** 14	30.974 **P** 15	32.06 **S** 16	35.453 **Cl** 17	39.948 **Ar** 18
4	39.098 **K** 19	40.078 **Ca** 20	44.956 **Sc** 21	47.88 **Ti** 22	50.942 **V** 23	51.996 **Cr** 24	54.938 **Mn** 25	55.847 **Fe** 26	58.933 **Co** 27	58.69 **Ni** 28	63.546 **Cu** 29	65.39 **Zn** 30	69.723 **Ga** 31	72.61 **Ge** 32	74.922 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
5	85.468 **Rb** 37	87.62 **Sr** 38	88.906 **Y** 39	91.224 **Zr** 40	92.906 **Nb** 41	95.94 **Mo** 42	98.907 **Tc** 43	101.07 **Ru** 44	102.91 **Rh** 45	106.42 **Pd** 46	107.87 **Ag** 47	112.41 **Cd** 48	114.82 **In** 49	118.71 **Sn** 50	121.75 **Sb** 51	127.60 **Te** 52	126.90 **I** 53	131.29 **Xe** 54
6	132.91 **Cs** 55	137.33 **Ba** 56	138.91 ***La** 57	178.49 **Hf** 72	180.95 **Ta** 73	183.85 **W** 74	186.21 **Re** 75	190.2 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.97 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.2 **Pb** 82	208.98 **Bi** 83	(209) **Po** 84	(210) **At** 85	(222) **Rn** 86
7	223 **Fr** 87	226.03 **Ra** 88	(227) ****Ac** 89	(261) **Rf** 104	(262) **Ha** 105	(263) **Unh** 106	(262) **Uns** 107	(265) **Uno** 108	(266) **Une** 109	(267) **Uun** 110								

Atomic mass → 10.811
Symbol → **B**
Atomic No. → 5

TRANSITION ELEMENTS

***Lanthanide Series**	140.12 **Ce** 58	140.91 **Pr** 59	144.24 **Nd** 60	(145) **Pm** 61	150.36 **Sm** 62	151.96 **Eu** 63	157.25 **Gd** 64	158.93 **Tb** 65	162.50 **Dy** 66	164.93 **Ho** 67	167.26 **Er** 68	168.93 **Tm** 69	173.04 **Yb** 70	174.97 **Lu** 71
****Actinide Series**	232.04 **Th** 90	231.04 **Pa** 91	238.03 **U** 92	237.05 **Np** 93	(244) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(260) **Lr** 103

( ) indicates the mass number of the isotope with the longest half-life.