NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

ORGANIC CHEMISTRY (PST2042)

Special Examination Paper

AUGUST 2024

This Examination Paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph Paper

Internal Examiner: Ms I Mpofu

External Examiner: Dr S.J. Mpofu

INSTRUCTIONS

1. Section A: Answer two (2) questions.
2. Section B: Answer any three (3) questions.
3. Each question carries 20 marks
4. Use curved arrows to show mechanisms or reaction steps.

MARK ALLOCATION

QUESTION	MARKS
1	20
2	20
3	20
4	20
5	20
6	20
TOTAL	100

SECTION A: Answer two questions. [40]

Question 1

Explain clearly what is meant by each of the following types of organic reactions.
a) electrophilic addition. [10]
b) nucleophilic substitution. [10]
Illustrate your answer by describing the mechanism of one example of each type of reaction.

Question 2

a) Explain what you understand by the term structural isomerism. [2]

b) Draw the full structural formulae and give the IUPAC names of all the compounds of molecular formula C_6H_{14}. [10]

c) Name the homologous series to which each of these compounds belong.
(i) CH_3OH. (ii) CH_3CHO. (iii) CH_3COOH. (iv) CH_3COCH_3. [2x4]

SECTION B: Answer any three questions. [60]

Question 3

a) Draw the full structural formula of each of the organic products, D, E, F, G and H.

(i) $CH_3CH_2CH_2OH$ + conc H_2SO_4 + Heat→ D:
D + Br_2 → E. [4]

(ii) $CH_3CH_2CH_2OH$ + $Na_2Cr_2O_7$ + dil. H_2SO_4 and distil → F:
F + $Na_2Cr_2O_7$ + dil. H_2SO_4 and reflux → G. [4]

(iii) CH_3CO_2H + PCl_5 + Heat → H. [2]

b) Three compounds of molecular formula C_4H_9Br are described below.
Identify each of the compounds A, B and C.
(i) A reacts with aqueous sodium hydroxide to give a compound, $C_4H_{10}O$ which on oxidation gives a compound, C_4H_8O. On warming C_4H_8O with iodine and aqueous sodium hydroxide a yellow precipitate is produced. [4]
(ii) B reacts with aqueous sodium hydroxide to give a compound that does not react with aqueous potassium manganite (VII). [2]
(iii) C reacts with concentrated sodium hydroxide in ethanol on boiling to give C_4H_8. C_4H_8 undergoes oxidation under certain conditions to give methanol and a compound, C_3H_6O. C_3H_6O gives a silver mirror on warming with Tollens' reagent. [4]

Question 4

a) Describe and explain what would happen in each of the following experiments. Write balanced equations for any reactions that occur.
(i) Benzene is gradually added to a cooled mixture of concentrated sulphuric acid and the product is then poured into water. [5]
(ii) Methylbenzene is boiled under reflux with aqueous acidified potassium permanganate(VII). [5]

b)(i) Compare and contrast the behaviours of butan-1-ol, butan-2-ol and 2-methylpropan-2-ol with acidified aqueous potassium dichromate(VI). [6]
(ii) Identify the alcohol above that exists as a pair of optical isomers. Explain your answer. [4]

Question 5

a)(i) Draw the structure of pentanone. [3]
(ii) Draw the structure of an aldehyde that is isomeric with pentanone. [3]

(iii) Show one reaction (reagents, conditions and products) that pentanone can undergo. [5]

b)(i) Copy and complete the table below.

Compound	2,2-dimethylbutane	2-methylpentane	hexane
Molecular Formula			
Structural Formula			

[6]
(ii) State with reason which compound in (i) above you expect to have the lowest boiling point. [3]

Question 6

a) Write equations for the following reactions:
(i) the complete combustion of hexane. [3]
(ii) the reaction of ethanoic acid with ethanol in the presence of a catalyst. [3]

b) Write the structural formulae for: (i) 2.4.5-trimethylheptane (ii) 2-chloro-3-methylhexane (iii) butanoic acid. [9]

c) Heating butan-2-ol with excess concentrated sulphuric acid produces two isomeric alkene products A and B. (i) Write the structures for A and B. [4]
(ii) State which will be the major product. [1]

Ptable

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.00794	Atomic Sym Weight																2 He 4.00260
2	3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
3	11 Na 22.9897	12 Mg 24.305											13 Al 26.9815	14 Si 28.0855	15 P 30.9737	16 S 32.065	17 Cl 35.453	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.845	27 Co 58.9331	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.798
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9058	40 Zr 91.224	41 Nb 92.9063	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.904	54 Xe 131.293
6	55 Cs 132.905	56 Ba 137.327	57–71	72 Hf 178.49	73 Ta 180.947	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.084	79 Au 196.966	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89–103	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

C Solid
Hg Liquid
H Gas
Rf Unknown

Metalloids

Nonmetals
- Other nonmetals
- Halogens
- Noble gases

Metals
- Alkali metals
- Alkaline earth metals
- Lanthanoids
- Actinoids
- Transition metals
- Post-transition metals

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

57 La 138.905	58 Ce 140.116	59 Pr 140.907	60 Nd 144.242	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.5	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.054	71 Lu 174.966
89 Ac (227)	90 Th 232.038	91 Pa 231.035	92 U 238.028	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)