

90309

Level 2 Chemistry, 2008

90309 Describe the structural formulae and reactions of compounds containing selected organic functional groups

Interactive paper

Credits: Four

You should answer ALL the questions in this paper.

Show all working for all calculations.

A periodic table is provided at the end of this paper.

Type your answers in the fields provided. Copy and paste any special characters needed from the box at the top of each page. Use the *Comment and Markup* tools to draw diagrams, circle options and so on. When you have finished, click the Mark Answers button at the end of the paper. This will reveal the answers and marking schedule, and boxes for you to enter the grades (N, A, M or E). As you mark the paper your totals and overall performance will appear in the boxes below.

Achievement Criteria		
Achievement	Achievement with Merit	Achievement with Excellence
Describe structures and reactions of organic compounds.	Link structure and reactivity of organic compounds.	Discuss reactivity and structure of organic compounds.
Overall Level of Performance (all criteria within a column are met)		

Achievement	Achievement with Merit	Achievement with Excellence
Total of FIVE opportunities answered at Achievement level or higher $5 \times A$	Total of at least SEVEN opportunities answered with FOUR at Merit level or higher. $4 \times M + 3 \times A$	Total of at least SEVEN opportunities answered with TWO at Excellence level and THREE at Merit level or higher. $2 \times E + 3 \times M + 2 \times A$

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You are advised to spend 45 minutes answering the questions in this booklet.

QUESTION ONE

Complete the following table to show the structural formula and IUPAC (systematic) name for each of the organic compounds.

Compound	Structural formula	IUPAC name
A		pentan-2-ol
B	$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{Cl} \\ \\ \text{Cl} \end{array}$	
C		4-methylpent-2-yne
D	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C} \\ \\ \text{O}-\text{CH}_2-\text{CH}_3 \end{array}$	

1	<p>A</p> $\begin{array}{c} \text{OH} \\ \\ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}-\text{CH}_3 \end{array}$ <p>B 1,2-dichlorobutane</p> <p>C</p> $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}\equiv\text{C}-\text{C}-\text{CH}_3 \\ \\ \text{H} \end{array}$ <p>D ethyl butanoate</p>	A Three correct answers.
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QUESTION TWO

The compound below has been named **incorrectly**.

- (a) Draw the structure implied by the name.
- (b) Explain why the given name is incorrect.
- (c) Write the correct IUPAC name.

Compound: **2-chloro-4-ethylpentane**

- (a) Implied structure:

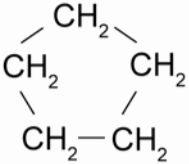
- (b) The given name is incorrect because:

- (c) The correct IUPAC name is: _____

2	<p>a $\text{CH}_3\text{-CH(Cl)-CH}_2\text{-CH(CH}_2\text{CH}_3\text{)-CH}_3$</p> <p>b The longest chain contains 6 C atoms, not 5.</p> <p>c 2-chloro-4-methylhexane</p>	<p>A Implied structure drawn correctly, OR Explanation correct, OR Corrected name.</p> <p>M Any two correct.</p> <p>E All three correct.</p>
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QUESTION THREE

Four different molecules with the molecular formula C₅H₁₀ are given below.

$\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}_3$	$\begin{array}{c} \text{CH}_3-\text{CH}=\text{C}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$
	$\begin{array}{c} \text{CH}_2=\text{C}-\text{CH}_2-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$

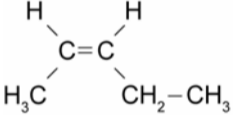
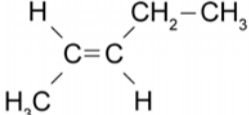
(a) Describe why these molecules are **structural isomers**.

3 a	Structural isomers have the same molecular formula but they differ in the sequence in which the atoms are joined together.	A Correct
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(b) One of the molecules shown above may exist as **cis-trans isomers**.

- (i) Identify this molecule using the **bold** letter from the above table. _____
- (ii) Draw the *cis* and *trans* isomers of the molecule identified in (i).

<i>cis isomer</i>	<i>trans isomer</i>
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3 b	<p>i A identified</p> <p>ii <i>cis</i>-pent-2-ene</p>  <p><i>trans</i>-pent-2-ene</p> 	A Correct molecule A , AND <i>cis-trans</i> isomers drawn correctly, AND drawn in correct box.
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(c) Discuss why the molecule you selected in (b)(i) may exist as *cis-trans* isomers, while the other three isomers cannot.

3 c	<p><i>Cis-trans</i> isomers can occur in molecules that have double bonds, because rotation of the atoms about the axis of the carbon-to-carbon double bond is restricted.</p> <p>They must also have two different groups attached to each of the carbons involved in the double bond.</p> <p>Molecule A (pent-2-ene) has a double bond, and each carbon involved in the double bond has two different groups attached to them. Hence Molecule A can exist as <i>cis-trans</i> isomers.</p> <p>Molecule C has no double bonds, so cannot exist as <i>cis-trans</i> isomers.</p> <p>Molecule B and Molecule D have double bonds. However each carbon involved in the double bond does not have 2 different groups attached.</p>	<p>A One of the two requirements for <i>cis-trans</i> isomers described. (Doesn't need to refer to Molecule A.)</p> <p>M Both of the requirements for <i>cis-trans</i> isomers described. (Reference to molecule A / pent-2-ene.)</p> <p>E Requirements described AND Reference to all molecules in box.</p>
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QUESTION FOUR

For each of the THREE following reactions:

- (i) Write the **IUPAC name** or the **structural formula** of the product formed.
 (ii) State the type of reaction occurring. Choose from the box below.

acid-base	addition	elimination	esterification
hydrolysis	oxidation	polymerisation	substitution

(a) Ethanol is heated with a catalyst (either concentrated sulfuric acid or aluminium oxide).

(i) Product:

(ii) Type of reaction: _____

(b) Propanoic acid is reacted with sodium hydroxide solution.

(i) Product:

(ii) Type of reaction: _____

(c) Propene is reacted with hydrogen in the presence of a nickel catalyst at 150°C.

(i) Product:

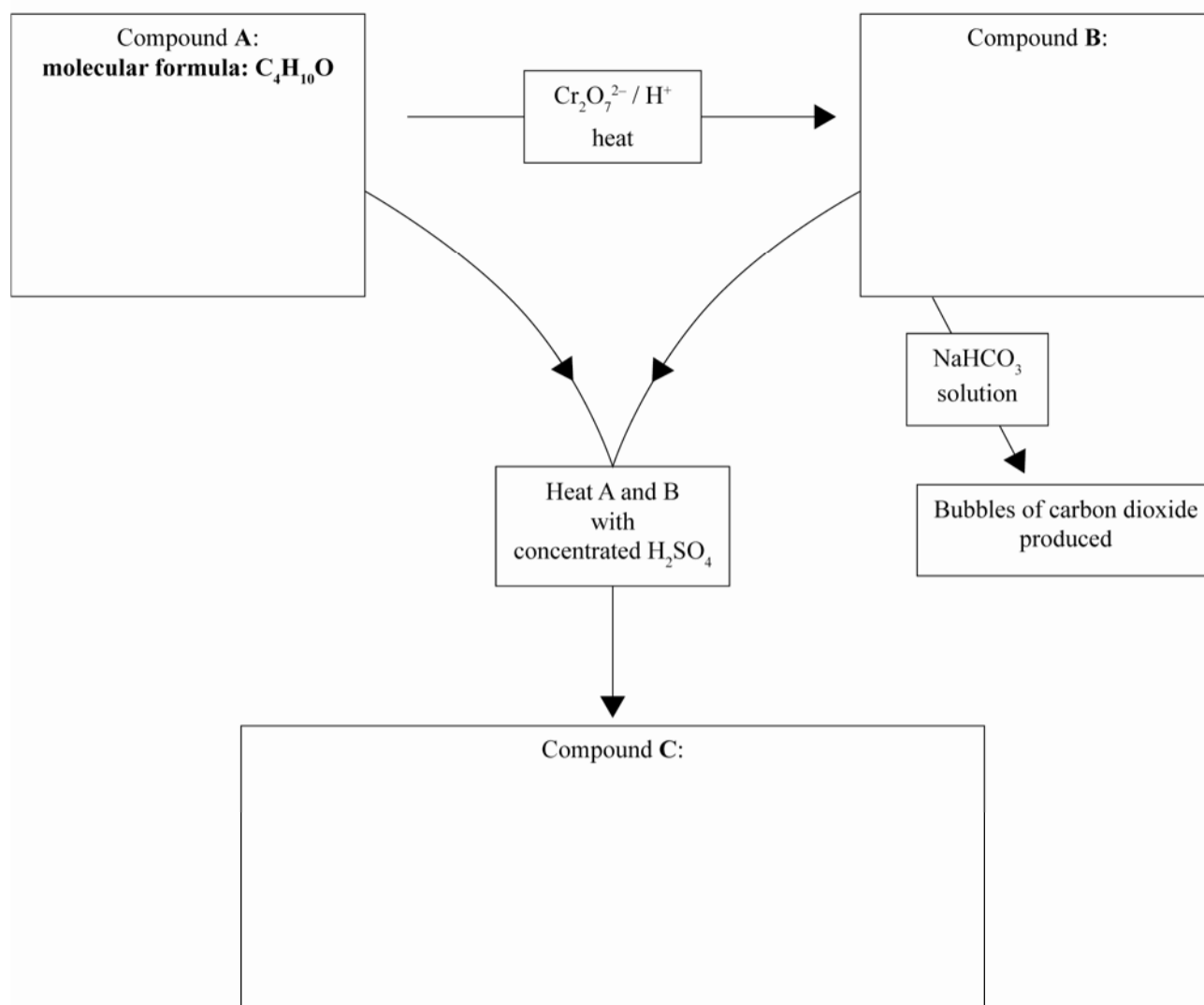
(ii) Type of reaction: _____

4	<p>a i</p> $\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	OR ethene	<p>A Two products identified.</p> <p>M Two products identified AND linked to corresponding reaction type.</p>
	<p>ii elimination</p>		
	<p>b i</p> $\text{CH}_3-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{ONa}$	OR sodium propanoate	
	<p>ii acid-base</p>		
	<p>c i</p> $\text{CH}_3-\text{CH}_2-\text{CH}_3$	OR propane	
	<p>ii addition</p>		

QUESTION SIX

The flow diagram below shows some reactions involving organic substances.

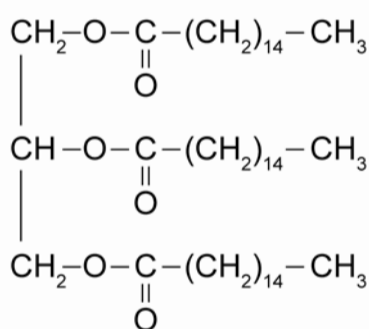
Complete the diagram by drawing **structural formulae** for the compounds **A**, **B** and **C**.



6	<p>A $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$ butan-1-ol</p> <p>B $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-C(=O)OH}$ butanoic acid</p> <p>C $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-C(=O)O-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_3$ butyl butanoate</p>	<p>A Either A or B correct.</p> <p>M All correct.</p>
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QUESTION SEVEN

The triglyceride shown below was heated with aqueous sodium hydroxide, NaOH.



Draw the structural formulae of the two products formed in this reaction.

7	<p>i $\text{CH}_2\text{(OH)CH(OH)CH}_2\text{(OH)}$ propan-1,2,3-triol</p> <p>ii $\text{CH}_3\text{(CH}_2\text{)}_{14}\text{COONa}$</p>	<p>A One correct.</p> <p>M Both correct.</p>
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PERIODIC TABLE OF THE ELEMENTS

		Atomic Number																	
		Molar Mass/g mol ⁻¹																	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18																	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18																	
		H 1.0																	
		He 4.0																	
		Li 6.9 Be 9.0																	
		Na 23.0 Mg 24.3																	
		K 39.1 Ca 40.1 V 50.9 Cr 52.0 Mn 54.9 Fe 55.9 Co 58.9 Ni 58.7 Cu 63.6 Zn 65.4 Ga 69.7 Ge 72.6 As 74.9 Se 79.0 Br 79.9 Kr 83.8																	
		Rb 85.5 Sr 87.6 Y 88.9 Zr 91.2 Nb 92.9 Mo 95.9 Tc 98.9 Ru 101 Rh 103 Pd 106 Ag 108 Cd 112 In 115 Sn 119 Sb 122 Te 128 I 127 Xe 131																	
		Cs 133 Ba 137 Lu 175 Hf 179 Ta 181 W 184 Re 186 Os 190 Ir 192 Pt 195 Au 197 Hg 201 Tl 204 Pb 207 Bi 209 Po 210 At 210 Rn 222																	
		Fr 223 Ra 226 Lr 262 Rf 261 Db 262 Sg 263 Bh 264 Hs 265 Mt 268																	
		La 139 Ce 140 Pr 141 Nd 144 Pm 147 Sm 150 Eu 152 Gd 157 Tb 159 Dy 163 Ho 165 Er 167 Tm 169 Yb 173																	
		Ac 227 Th 232 Pa 231 U 238 Np 237 Pu 239 Am 241 Cm 244 Bk 249 Cf 251 Es 252 Fm 257 Md 258 No 259																	