Trinity College

ATAR Chemistry 3+4
Organic Molecules Test

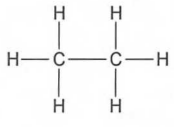
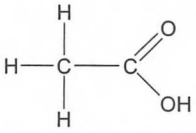
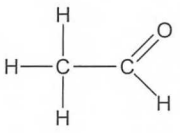
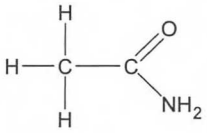
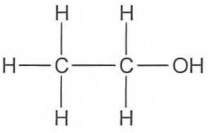
TOTAL MARKS = 51

DO NOT MARK THIS PAPER

YOU MUST SHOW ALL HYDROGEN ATOMS IN YOUR STRUCTURAL DIAGRAMS

Multiple choice 10 marks

1. Consider the following five (5) organic compounds.

(i)	(ii)	(iii)	(iv)	(v)
				
CH_3CH_3	CH_3COOH	CH_3CHO	CH_3CONH_2	CH_3CH_2OH

Which of the following lists contain compounds that **all** have the ability to form hydrogen bonds?

(a) all of (i), (ii), (iii), (iv) and (v)
(b) (ii), (iii), and (iv) only
(c) (i), (ii), (iii) and (v) only
(d) (ii), (iv) and (v) only

2. The partially completed equations below show the various chemical reactions involved in the synthesis of ethyl ethanoate.

Equation 1: $CH_2CH_2 + \mathbf{A} \overset{\mathbf{D}}{\rightleftharpoons} CH_3CH_2OH$

Equation 2: $3\ CH_3CH_2OH + \mathbf{B}\ Cr_2O_7^{2-} + 16\ H^+ \rightarrow 3\ \mathbf{C} + 4\ Cr^{3+} + 11\ H_2O$

Equation 3: $\mathbf{C} + CH_3CH_2OH \overset{\mathbf{D}}{\rightleftharpoons} CH_3COOCH_2CH_3 + \mathbf{A}$

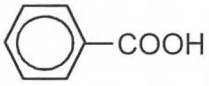
Which of the following correctly identifies the unknowns A, B, C & D?

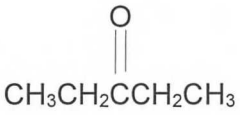
	A	B	C	D
(a)	H_2O	2	CH_3COOH	H^+
(b)	H_2O	1	CH_3COOH	catalyst
(c)	H_2O	2	CH_3CHO	H^+
(d)	H^+	4	CH_3CHO	H_2O

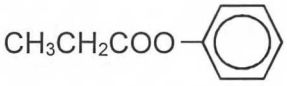
3. An organic substance has an empirical formula of $C_3H_6O_2$. Which of the following is NOT a possible identity of the substance?

(a) Propanoic acid
(b) Ethyl methanoate
(c) Methyl methanoate
(d) Methyl ethanoate

4.

i. 

ii. 

iii. 

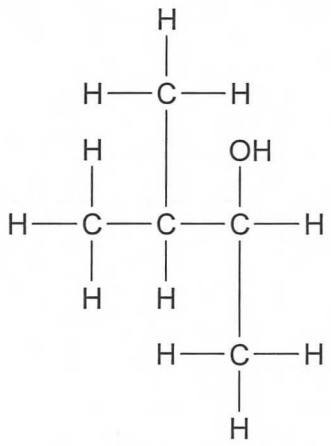
iv. CH_3CH_2CHO

Which one of the following lists places the compounds in their correct class?

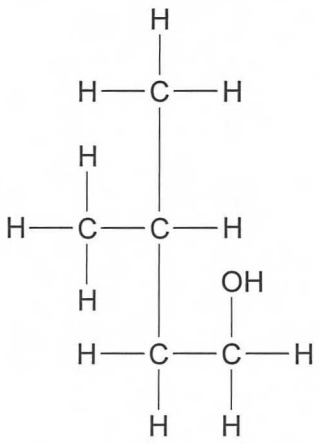
	i.	**ii**	**iii**	**iv**
(a)	Ester	Aldehyde	Ketone	Carboxylic acid
(b)	Carboxylic acid	Ketone	Ester	Aldehyde
(c)	Carboxylic acid	Ester	Ketone	Aldehyde
(d)	Aldehyde	Ketone	Carboxylic acid	Ester

Questions 5 and 6 relate to the four isomers of $C_5H_{11}OH$ shown below.

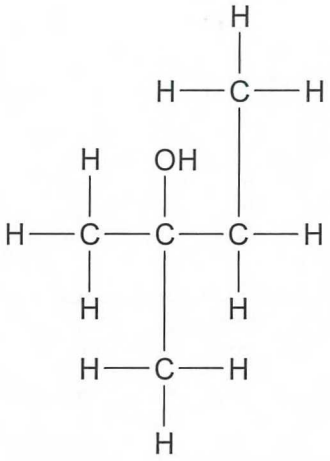
A



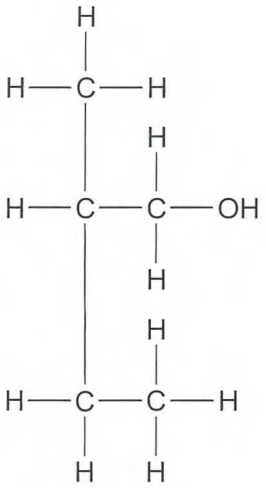
B



C



D



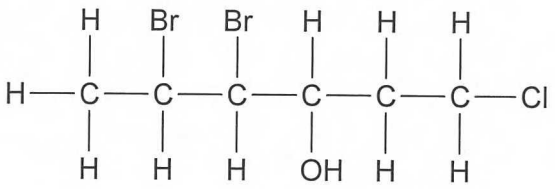
5. Which of the isomers would **not** react when mixed with acidified sodium permanganate solution?

(a) A
(b) B
(c) C
(d) D

6. Which of the following is **not** a possible organic product resulting from oxidation of the isomers above?

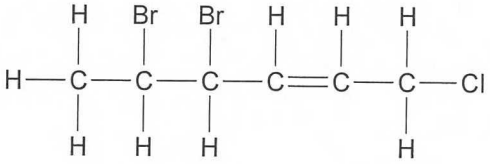
(a) 3-methylbutanoic acid
(b) 2-methylbutanoic acid
(c) 3-methylbutanone
(d) 2-methylbutanone

7. Consider the organic molecule shown below.



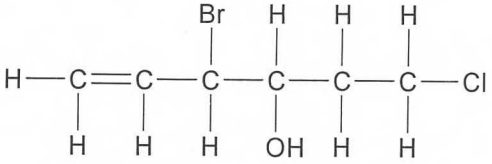
Which of the following reactions is **most likely** to produce this compound?

(a)



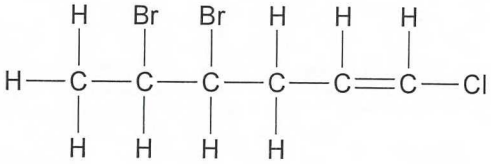
+ H_2

(b)



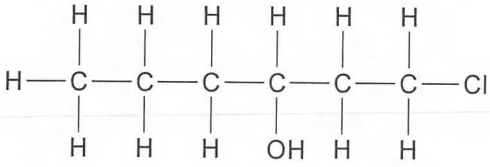
+ HBr

(c)



+ H_2O

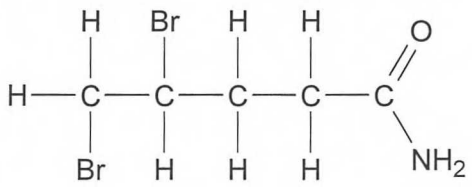
(d)



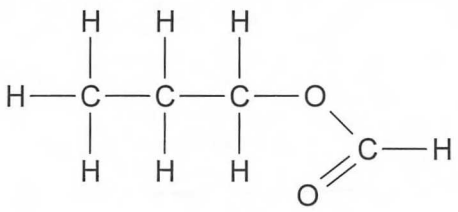
+ Br_2

8. Which of the following molecules has **not** been given the correct IUPAC name?

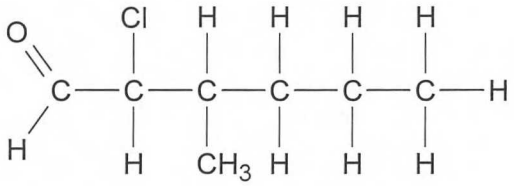
(a) 4,5-dibromopentanamine



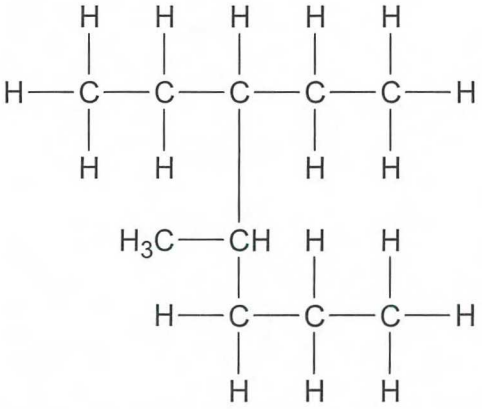
(b) propylmethanoate



(c) 2-chloro-3-methylhexanal

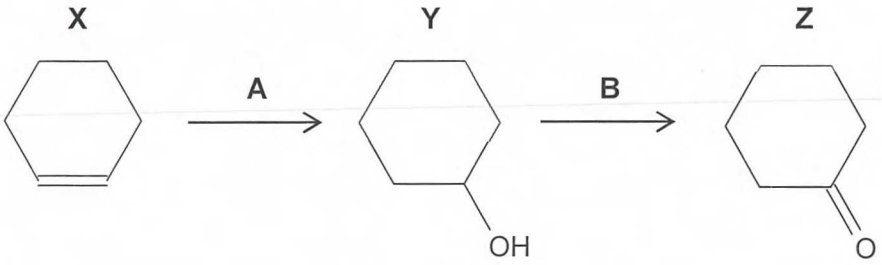


(d) 3-ethyl-4-methylheptane



Questions 9 and 10 relate to the following information.

An overview of a particular reaction sequence is shown below.



9. What functional group is present in each of the substances?

	X	Y	Z
(a)	alkene	alcohol	aldehyde
(b)	alkene	aldehyde	carboxylic acid
(c)	alkene	alcohol	ketone
(d)	alkane	ketone	ester

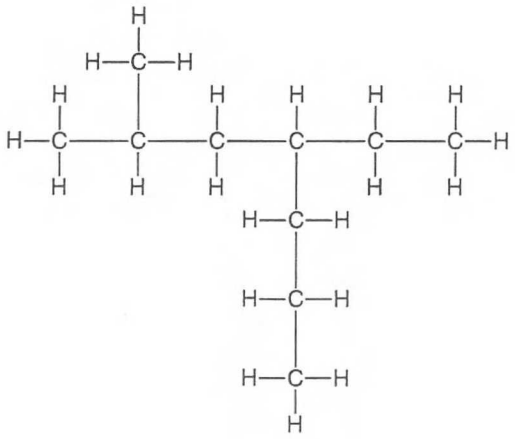
10. What reagents were **most likely** added at steps A and B?

	A	B
(a)	$O_2(g)$	$H_2(g)$
(b)	$H_2O(l)$	$O_2(g)$
(c)	NaOH(aq)	$H^+/MnO_4^-(aq)$
(d)	$H_2O(l)$	$H^+/Cr_2O_7^{2-}(aq)$

Short Answers 41 marks

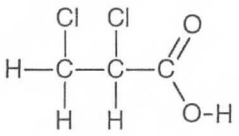
11. Give the IUPAC name of the following structures:

(a)



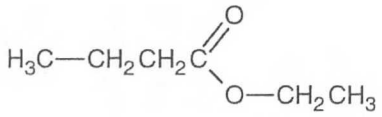
4-ethyl-2-methylheptane

(b)



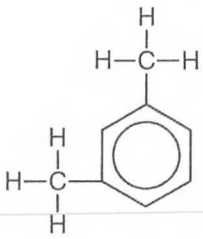
2,3-dichloropropanoic acid

(c)



ethyl butanoate

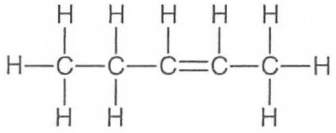
(d)



1,3-dimethylbenzene

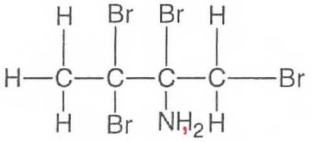
3-methyltoluene

(e)



Cis-pent-2-ene

(f)



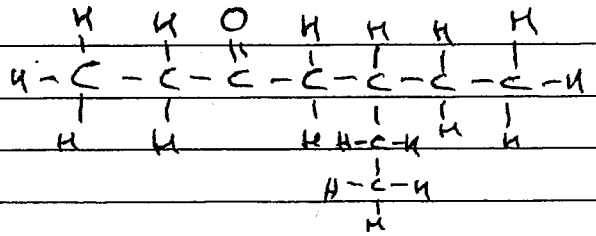
1,2,3,3 tetrabromo

butan-2-amine

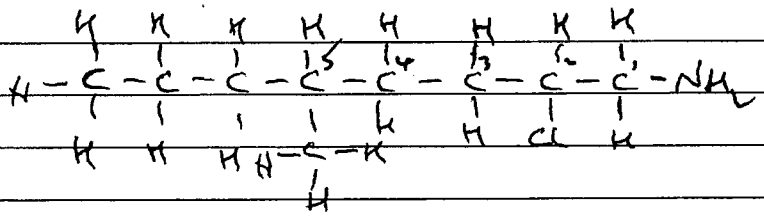
[6 marks]

Year 12 - Organic Naturals Test - SA.

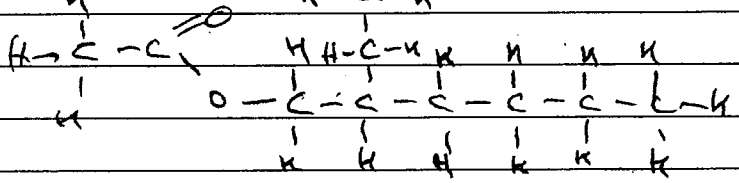
12) a)



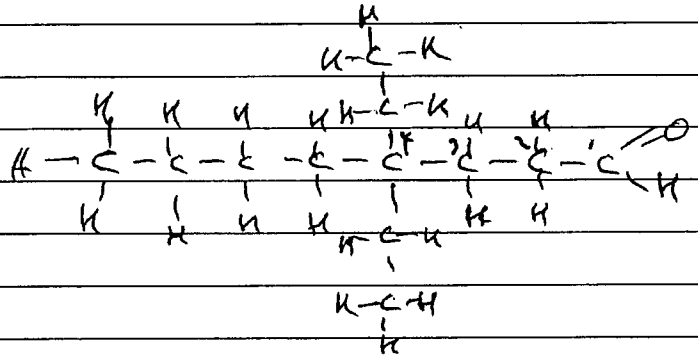
b)



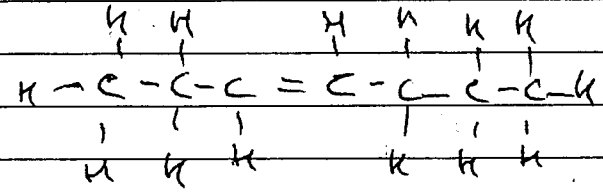
c)



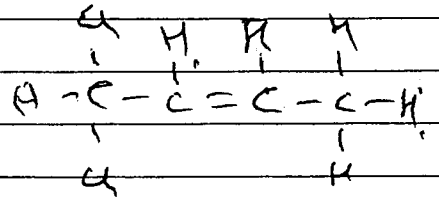
d)



e)



f)



[6 marks]

13) a) $5(CH_3CH_2OHCH_2CH_2CH_3 \longrightarrow CH_3COCH_2CH_2CH_3 + 2H^+ + 2e^-$ (1)

$2(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$5CH_3CH_2OHCH_2CH_2CH_3 + 2MnO_4^- + 6H^+ \rightarrow 5CH_3COCH_2CH_2CH_3 + 2Mn^{2+} + 8H_2O$ (2)

(1) (aq) (aq) (1) (aq) (1)

a purple solution is added to a clear colourless solution. Upon addition a bi-layer forms and after shaking the aqueous layer goes colourless/pale pink. (1)

b) $3(CH_3CH_2CH_2OH \longrightarrow CH_3CH_2CHO + 2H^+ + 2e^-$ (1)

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

$3CH_3CH_2CH_2OH + Cr_2O_7^{2-} + 8H^+ \rightarrow 3CH_3CH_2CHO + 2Cr^{3+} + 7H_2O$ (2)

(1) (aq) (aq) (2) (aq) (1)

an orange solution is added to a clear colourless solution. Upon addition the solution mix and the solution turns deep green. (1)

[8 total]

Q 14 ratio / proportional method.

$n(CO_2) = \frac{4.1}{44}$

$= 0.09318$ mols [1]

$n(CO_2) = n(C)$

$n(C) = 0.09318 = \frac{m}{12}$ [1]

$m(C) = 1.11816$ g.

ratio $\frac{1.99}{1.99} \times 1.68 = 1.68$ g of H_2O.

So $n(H_2O) = \frac{1.68}{18}$ [1]

$= 0.09333$ mols

$n(H_2O) \times 2 = n(H)$

$n(H) = 0.18666$ mols

$m(H) = 0.18666$ g. [1]

So $m(O) = 1.68 - (1.11816 + 0.18666)$

$m(O) = 0.37517$ g. [1]

$n(O) = \frac{0.37517}{16}$

$n(O) = 0.023448$ mols. [1]

C	H	O
$\frac{0.09318}{0.023448}$	$\frac{0.18666}{0.023448}$	$\frac{0.023448}{0.023448}$
3.97	7.96	1

[1]

$\therefore$ EF C_4H_8O. [1]

Question 14

Coconut oil contains an ester which gives the oil its distinctive odour. The ester was extracted and a series of experiments were carried out to determine the formula of this ester, which was known to contain only carbon, hydrogen and oxygen.

A 1.680 g sample was combusted in excess oxygen and 4.100 g of carbon dioxide was produced.

A separate 1.990 g sample was combusted in excess oxygen and 1.990 g of water was produced.

(a) Calculate the empirical formula of the ester in the coconut oil. (8 marks)

$n(CO_2)$ = m/M = 4.10/44.01 = 0.09316 mol = n(C) (1)

m(C) = nM = 0.09316 x 12.01 = 1.11885 g

%(C) = (1.11885/1.68) x 100 = 66.60% (1)

$n(H_2O)$ = m/M = 1.99/18.016 = 0.11046 mol , n(H) = 2 x 0.11046 = 0.2209 mol (1)

m(H) = nM = 0.2209 x 1.008 = 0.2227 g

%(H) = (0.2227/1.99) x 100 = 11.19% (1)

Thus %(O) = (100 – (66.60 + 11.19)) = 22.21% (1)

		C	H	O	
Mass in 100g	=	66.60	11.19	22.21	
n	=	66.60/12.01	11.19/1.008	22.21/16.00	(1)
	=	5.55	11.10	1.39	
Ratio of mol	=	5.55/1.39	11.10/1.39	1.39/1.39	
	=				
	=	4 :	8 :	1	(1)

Empirical Formula = C_4H_8O (1)

A further sample weighing 0.8100 g was vaporised and the gas produced was found to occupy a volume of 226.0 mL at 140.0 °C and a pressure of 85.20 kPa.

(b) From this information, calculate the molecular formula of the ester. (4 marks)

$$n = \frac{PV}{RT} = \frac{85.20 \times 0.2260}{8.314 \times 413.15} = 0.005606 \text{ mol} \quad (1)$$

$$M = m/n = 0.810/0.005606 = 144.49 \text{ g/mol} \quad (1)$$

Emp Formula mass (C_4H_8O) = 72.104 g/mol (1)

Thus, MF = Mol Formula mass/ Emp Formula mass x EF

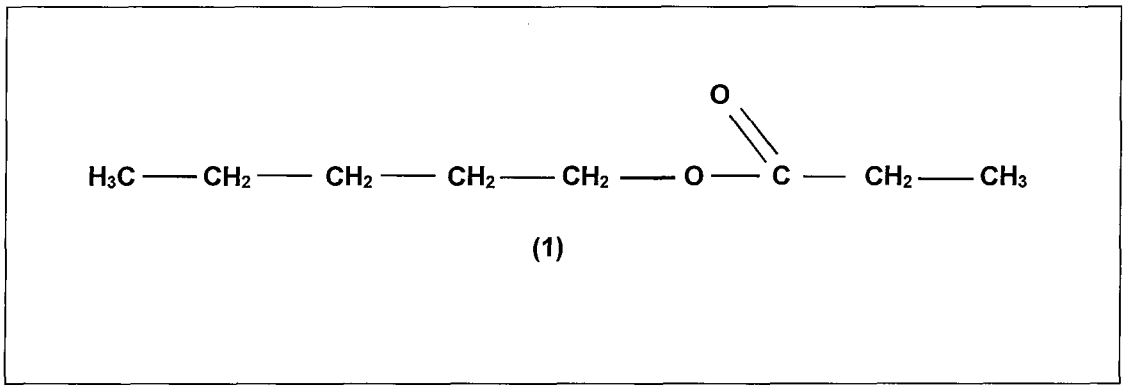
= 144.49/72.104 x C_4H_8O

= 2 x C_4H_8O

= $C_8H_{16}O_2$ (1)

(c) This same ester can also be synthesised in the laboratory by reacting pentan-1-ol and a carboxylic acid, using sulfuric acid as a catalyst.

Using this information, draw the structural formula of the ester present in coconut oil.
(1 mark)



(1)

15) a) - Large atoms have larger electron clouds which are easier to polarise (temporary dipole) (1) thermal
- ∴ Dispersion force increase with increasing molecular mass require more (1) ket energy to overcom

b) - Alkane ad alkenes are made up of only carbon ad hydrogen so do not have a big enough electronegativity difference so are non-polar, Non-polar means they only have Dispersion forces (2)
which are the weakest force and only need limited kat energy to overcome this weak intermolecular force ad so have a low bpt,

- Alcohol ad Carboxylic acid - both have hydrogen bonding ad Carboxylic acid also has dipole-dipole $-\overset{\delta+}{C}=\overset{\delta-}{O}$, As these (2)
are strong intermolecular force between both therefore they need more kat energy to overcome these force of attraction so have a relatively high bpt.

15) c) Alcohol ad Carboxylic acid are polar a explaind in part(b). They are able to easily dissolve in a polar solvent (such as H_2O) (1)
because polar solvent create area of greater negative ad positive charge (dipole-dipole), In this the solute ad solvent are attracted to one another by these partial charge ad so the resistance to mixing is (1)
overcome by the attraction to mixing.

d) Alcohol all have H bonding (dipole-dipole) ad Dispersion force,
However in small alcohol C_1-C_3 the dominant force is H-bonding ad so (1)
these alcohol are fully miscible in a polar solvent,
At about C_4 the Carbon (alkyl) chain is long enough for the dispersion force (1)
to start to dominate ad after C_5 pentan-1-ol they become the dominant force ad so become immiscible with polar solvent,