VCE CHEMISTRY 2008

YEAR 12 UNIT 3

Organic Chemical Pathways

Time allowed: 50 minutes
Total marks: 47

SECTION A
Contains 12 Multiple Choice Questions
13 minutes, 12 marks

SECTION B
Contains 4 Extended Response Questions
37 minutes, 35 marks

To download the Chemistry Data Book please visit the VCAA website:
http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf *Page 20*

Learning Materials ***by Lisachem***
PO Box 2018, Hampton East, Victoria, 3188
Ph: (03) 9598 4564 Fax: (03) 8677 1725
Email: orders@learningmaterials.com.au or orders@lisachem.com.au
Website: www.learningmaterials.com.au

Student Name....………………………...

VCE Chemistry 2008 Year 12 – Organic Chemical Pathways

Student Answer Sheet

Instructions for completing test. Use only an HB pencil. If you make a mistake erase and enter the correct answer. Marks will not be deducted for incorrect answers.
Write your answers to the Short Answer Section in the space provided directly below the question. There are 12 Multiple Choice questions to be answered by circling the correct letter in the table below.

Question 1	A	B	C	D	*Question 2*	A	B	C	D
Question 3	A	B	C	D	*Question 4*	A	B	C	D
Question 5	A	B	C	D	*Question 6*	A	B	C	D
Question 7	A	B	C	D	*Question 8*	A	B	C	D
Question 9	A	B	C	D	*Question 10*	A	B	C	D
Question 11	A	B	C	D	*Question 12*	A	B	C	D

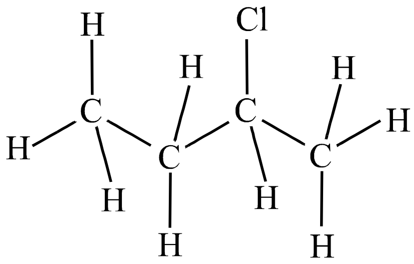
VCE Chemistry 2008 Year 12 – Organic Chemical Pathways

Multiple Choice Section

Section A – (12 marks, 13 minutes)

For each question choose the response that is correct or best answers the question.   *Circle the chosen response on this answer sheet.*   *Only circle **one** response for each question.*

Question 1
Which one of the following compounds would be an isomer for the compound whose structure is shown below?



A. 3-chlorobutane.
B. 2-methyl-1-chloropropane.
C. 2-chlorobutane.
D. 1-chloropropane.

Question 2
Bioethanol can be produced by the fermentation of sugars. The chemical equation that best represents the fermentation of glucose would be

A. $C_6H_{12}O_6(aq) \rightarrow 2C_2H_6O(aq) + 2CO_2(g)$
B. $C_6H_{12}O_6(aq) + 3H_2O(l) \rightarrow 3C_2H_6O(aq) + 3O_2(g)$
C. $C_6H_{12}O_6(aq) \rightarrow C_2H_6O(aq) + 4CO(g) + 6H^+(aq)$
D. $C_6H_{12}O_6(aq) \rightarrow C_2H_6O(aq) + C_4H_6O_5(aq)$

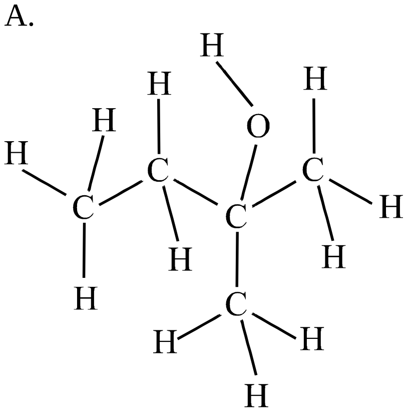
Question 3
During the fractional distillation of a liquid hydrocarbon mixture in a fractionating tower the

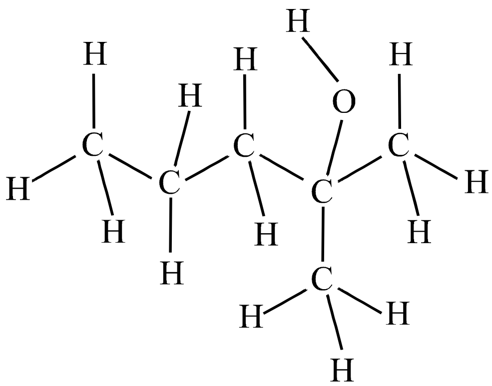
A. lightest hydrocarbons will condense at the bottom of the tower because these have the lowest boiling temperatures.
B. heaviest hydrocarbons which have the highest boiling temperatures will condense at the top of the tower.
C. lightest hydrocarbons which have the lowest boiling temperatures will condense at the top of the tower.
D. heaviest hydrocarbons will condense at the bottom of the tower because these have the lowest boiling temperatures.

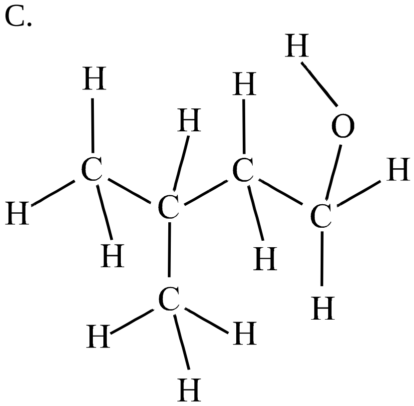
Question 4
When glucose molecules undergo a chemical reaction to form cellulose in plants
A. two hydroxyl groups undergo a condensation reaction to form an ester linkage and water.
B. two hydroxyl groups undergo a condensation reaction to form an ether linkage and water.
C. two hydroxyl groups undergo an addition reaction to form an ether linkage and water.
D. two hydroxyl groups undergo an oxidation reaction to form an ester linkage and water.

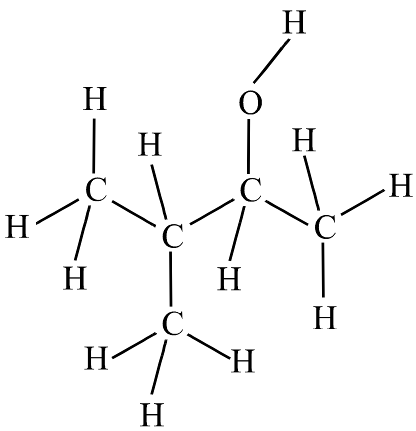
Question 5
When salicylic acid, $C_6H_4(OH)COOH$, is converted to aspirin, $C_6H_4(OCOCH_3)COOH$, the ester is formed by a condensation reaction between
A. the hydroxyl group on the salicylic acid and ethanol.
B. the carboxyl group on the salicylic acid and ethanol.
C. the carboxyl group on the salicylic acid and ethanoic acid.
D. the hydroxyl group on the salicylic acid and ethanoic acid.

Question 6
The structure for 3-methylbutan-2-ol is

A.


B.


C.


D.


Question 7
The main type of bonding interaction that contributes to the secondary structure of a protein molecule is
A. covalent bonding between the atoms in the protein.
B. hydrogen bonding between the atoms in the protein.
C. hydrogen bonding between oxygen atoms on one amide group and hydrogen atoms on adjacent amide groups in the protein chain.
D. hydrogen bonding between oxygen atoms and hydrogen atoms on amide groups in the protein chain.

Question 8
The main product that would be produced when bromine reacts with but-2-ene is
A. 1,2-dibromobutane.
B. 2,3-dibromobutane.
C. 2-bromobutene.
D. 1-bromobutene.

Question 9
An enzyme will **not**
A. be denatured by heating it in boiling water.
B. catalyse a reaction at a much higher rate compared with most inorganic catalysts.
C. bind to the reacting substrate during the reaction process.
D. catalyse a wide variety of different chemical reactions.

Question 10
In the DNA molecule the bases are covalently bonded
A. to the sugar units in the molecular backbone.
B. to the phosphate units in the molecular backbone.
C. to the bases on the other strand of the DNA molecule.
D. between the sugar and phosphate units along the molecular backbone.

Question 11
Which one of the following semi-structural formulae would represent the compound produced when pentan-1-ol reacts with an acidic aqueous solution of potassium dichromate?
A. $CH_3CH_2CH_2CH_2COOH$.
B. $CH_3CH_2CH_2CH_2CHO$.
C. $CH_3CH_2CH_2COOH$.
D. $CH_3CH_2CH_2CH_2CH_2COOH$.

Question 12
Why are some proteins useful as indicators for the presence of certain diseases?
A. All diseases will increase the amounts of proteins in the body fluids, such as blood or urine, to levels that they can be detected.
B. Certain diseases will cause different types of proteins to be synthesised by the body and these can be detected.
C. Certain diseases will cause the amount of a specific protein in a body fluid, such as blood or urine, to change dramatically and this change can be detected.
D. Diseases cause cells to malfunction and produce proteins that will not normally be present in the body and these can be detected.

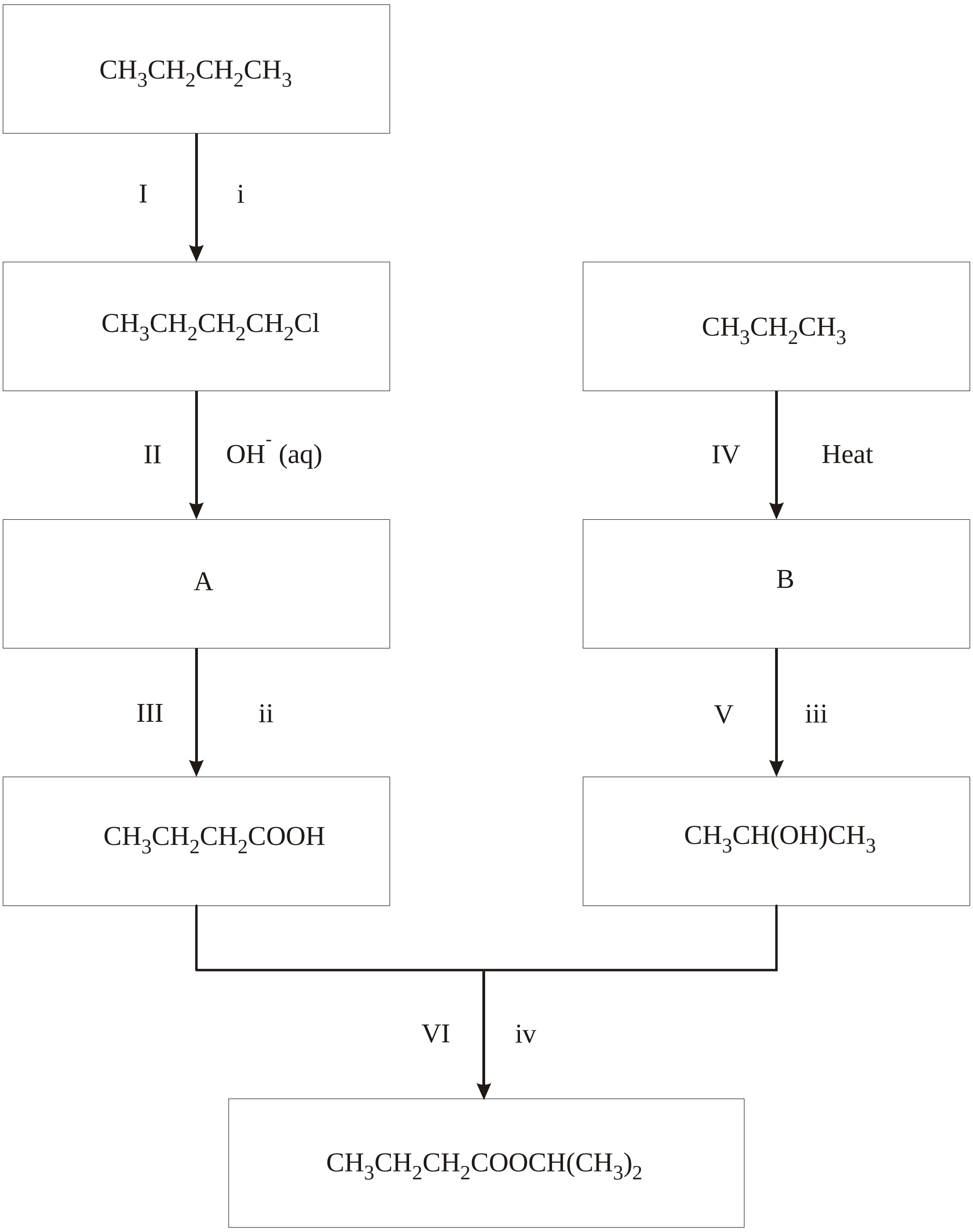
End of Section A

VCE Chemistry 2008 Year 12 – Organic Chemical Pathways

Section B - (35 marks, 37 minutes)

This section contains four questions, numbered 1 to 4.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 - (16 marks, 17 minutes)
Below is a reaction scheme using butane and propane as starting materials to produce isopropylbutanoate, $CH_3CH_2CH_2COOCH(CH_3)_2$.



a. What are the semistructural formulae for the compounds labelled A and B?

A:

B:

(2 marks)

b. What are the additional reactants identified as i, ii, iii, and iv required?

i:

ii:

iii:

iv:

(4 marks)

c. What types of chemical reaction occur in the following steps?

Step II:

Step III:

Step IV:

Step V:

Step VI:

(5 marks)

d. What are the systematic names for the compounds produced in the following steps?

Step III: ($CH_3CH_2CH_2COOH$)

Step V: ($CH_3CH(OH)CH_3$)

(2 marks)

e. What are the by-products of the reaction in steps II, IV and VI?

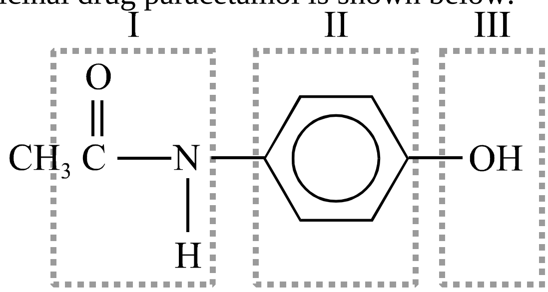
Step II:

Step IV:

Step VI:

(3 marks)

Question 2 - (5 marks, 5 minutes)
The structure for the medicinal drug paracetamol is shown below.



a. Identify each of the parts of the structure labelled I, II and III above.

I:

II:

III:

(3 marks)

b. If this compound could be prepared from ethanoic acid and another compound.
 i. Draw the structure for this compound.

(1 mark)

 ii. What type of chemical reaction would occur during the synthesis reaction?

(1 mark)

Question 3 - (7 marks, 8 minutes)

a. i. What are the two functional groups that all amino acids contain?

(1 mark)

ii. Explain the difference in the acid-base properties of these two functional groups.

(1 mark)

b. Draw the two structural forms that the amino acid cysteine can have at neutral pH.

(1 mark)

c. Draw the structures for the two dipeptides that can be formed when cystine reacts with glycine.

(2 marks)

d. i. What type of bonds can be formed between two cystine units in a protein chain?

(1 mark)

ii. What aspect of the protein structure does this type of bonding contribute to?

(1 mark)

Question 4 - (7 marks, 7 minutes)
Palm oil is used as the feedstock for a biodiesel plant that has been established in Malaysia. The two main fatty acids found in palm oil are oleic acid, $C_{18}H_{34}O_2$, and palmitic acid, $C_{16}H_{32}O_2$.

a. Apart from the length of the carbon atom chain, what is a key structural difference between these two fatty acids?

(1 mark)

b. i. Use one of the fatty acids mentioned to draw the structure of a molecule that could be present in palm oil.

(1 mark)

ii. What is the key functional group that is present in this molecule?

(1 mark)

c. i. What would be the by-product produced when palm oil is converted into biodiesel?

(1 mark)

ii. What are the two type of chemical reaction that will take place during the conversion of palm oil into biodiesel?

(2 marks)

iii. Write an appropriate chemical equation to show how the fatty acid, selected in b. above, is converted into the compound that would be present in the biodiesel.

(1 mark)

End of Section B

End of Trial Exam

Suggested Answers

VCE Chemistry 2008 Year 12 – Organic Chemical Pathways

Multiple Choice Section

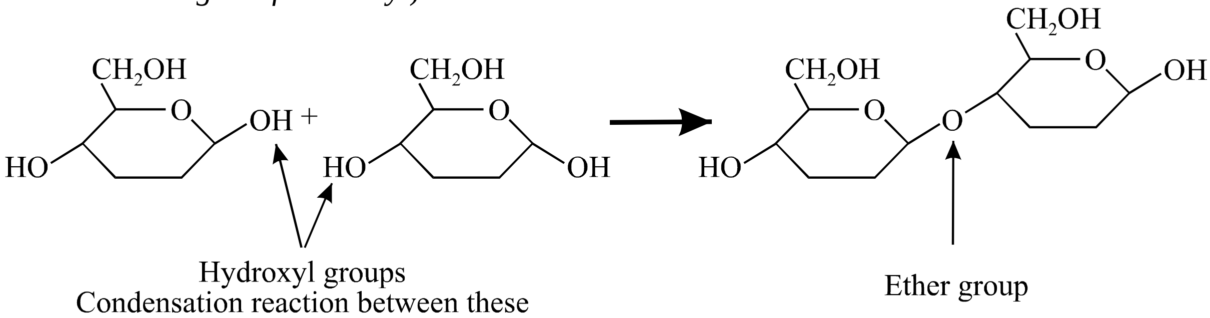
Section A - (1 mark per question)

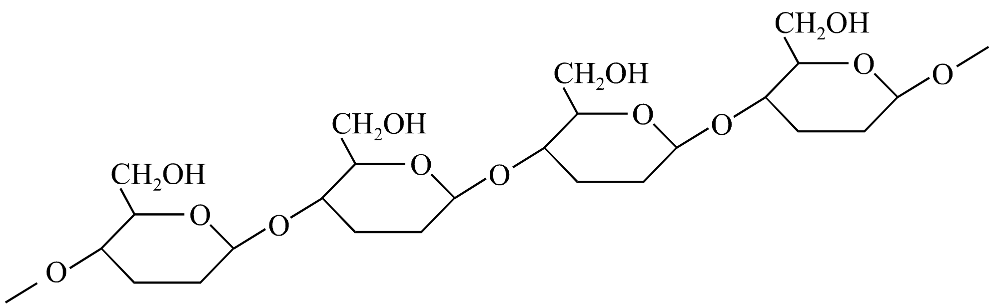
Q1 **B** **An isomer is a compound with the same molecular formula but a different chemical structure**. The compound shown is 2-chlorobutane, C_4H_9Cl. Response A, 3-chlorobutane, $CH_3CH_2CHClCH_3$, is not a correct systematic name as this is the same structure as 2-chlorobutane, $CH_3CHClCH_2CH_3$.

Q2 **A** Glucose, $C_6H_{12}O_6$, will produce ethanol, CH_3CH_2OH, and carbon dioxide, CO_2, when it undergoes a fermentation reaction.

Q3 **C** During **fractional distillation compounds are separated using their different boiling temperatures**. In large scale fractional distillation of hydrocarbons, the hydrocarbon mixture is vaporised and feed into the bottom of the fractionating tower. As the vapour moves up the tower it cools down, therefore the compounds with the **higher boiling temperatures, which will also be the heaviest molecules, having highest molecular masses, will condense close to the bottom**, while the **lightest molecules, with lower boiling temperatures, will condense further up the tower**.

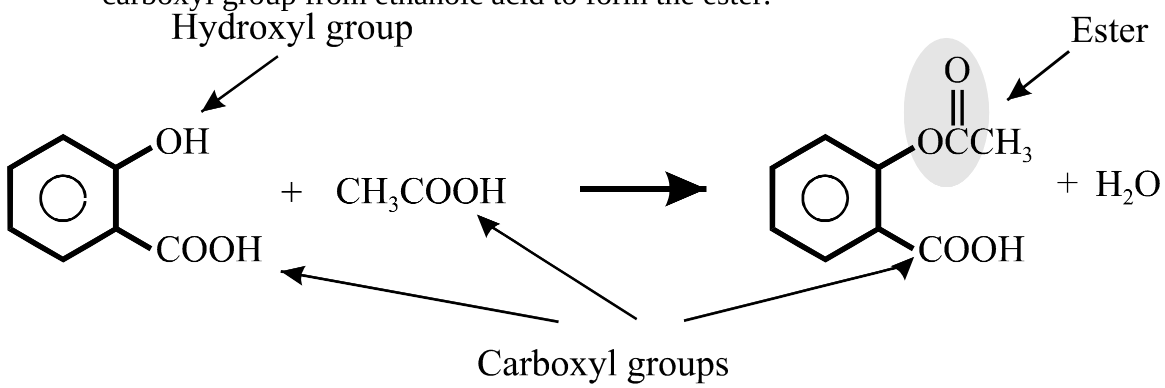
Q4 **B** Cellulose is a condensation polymer of glucose. In this process the hydroxyl groups on two different glucose molecules (or terminal units already in chains) react to form an ether group and water. The diagram below shows the formation of an ether group during the condensation reaction and part of the structure for cellulose. (*Some hydrogen atoms and hydroxyl groups have been omitted from the diagram for clarity*.)



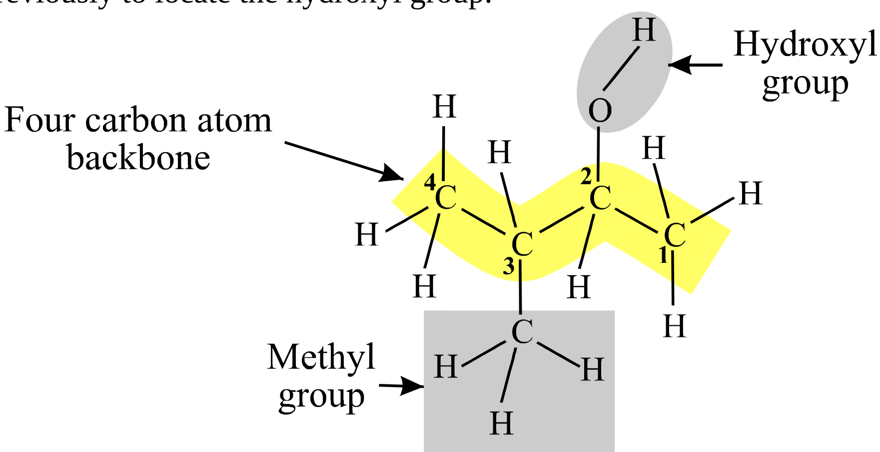


Cellulose

Q5 D The carboxyl group, -COOH, is present in both the structures of salicylic acid and aspirin, therefore the hydroxyl group, -OH, on the salicylic acid must react with a carboxyl group from ethanoic acid to form the ester.



Q6 D The chemical structure can be deduced from the name:
butan – four carbon atom backbone with single carbon-carbon bonds.
-2-ol – an hydroxyl group, -OH, attached to the second carbon atom from one end of the backbone.
3-methyl – a methyl, $-CH_3$, group attached to the third carbon atom from the end used previously to locate the hydroxyl group.



Q7 C The secondary structure is determined by **hydrogen bonding** between the **oxygen atom** on one amide group and the **hydrogen atom on an adjacent amide group**. This type of bonding influences the three-dimensional structure of the protein, resulting in the coiling, folding or pleating of parts of the molecular structure.

Q8 B But-2-ene is an alkene with a carbon-carbon atom double bond. When alkenes react with bromine, Br_2, **an addition reaction occurs** and the bromine atoms are added across the double bond. The product would be **2,3-dibromobutane**.

$$CH_3CH = CHCH_3(g) + Br_2(l) \rightarrow CH_3CHBrCHBrCH_3(l)$$

Q9 D Enzymes are readily denatured by both heat and changes in pH. Generally enzymes catalyse reactions at significantly higher rates compared to most inorganic catalysts. The reactant substrate actually binds to the enzyme as part of the reaction process. Enzymes generally only catalyse specific reactions, for example amlyase will catalyse the hydrolysis of starch to maltose but not the hydrolysis of maltose to glucose nor the hydrolysis of cellulose.

Q10 A The DNA molecule has a sugar-phosphate backbone and the various bases, adenine, cytosine, guanine and thymine are covalently bonded to the sugar units in the backbone.

Q11 A The dichromate ion is a strong oxidant and primary alcohols will be oxidised to their corresponding carboxylic acids by aqueous solutions of potassium dichromate, therefore pentan-1-ol will be oxidised to pentanoic acid.

$$CH_3CH_2CH_2CH_2CH_2OH(l) \xrightarrow{Cr_2O_7^{2-}(aq)/H^+(aq)} CH_3CH_2CH_2CH_2COOH(aq)$$

Q12 C Certain diseases can cause specific protein levels in a body fluid to alter dramatically from the normal and this change in amount of the protein can be used to indicate the likelihood of a specific disease. For example, there is only a trace amount of the protein serum albumin present in normal urine, however in the urine samples from people who suffer from the renal disease proteinuria there are large amounts of serum albumin present.

Section B

Question 1 – (16 marks, 17 minutes)
The fully annotated reaction scheme is shown below with the inclusion of the by-products shown in italics.

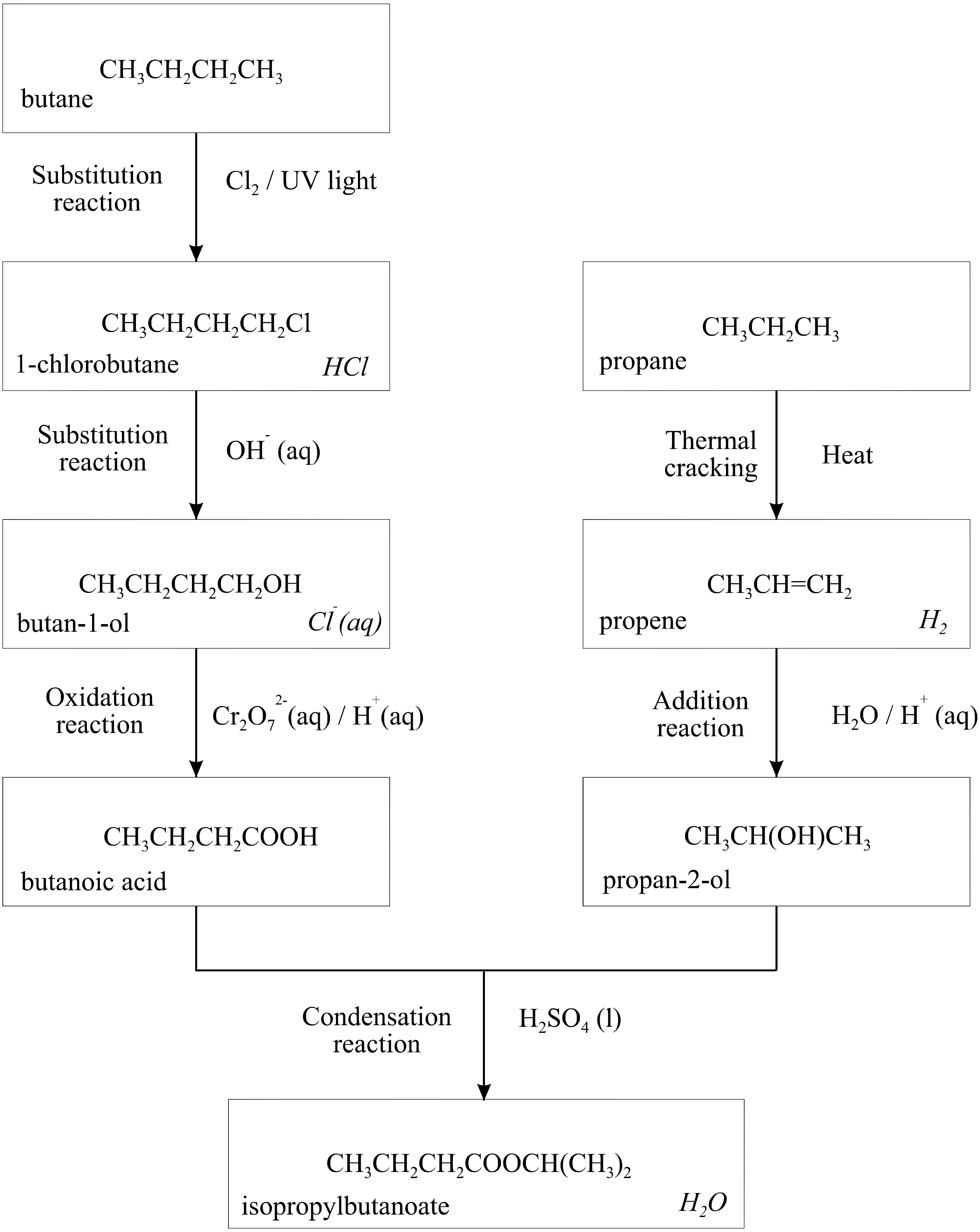
a. A: $CH_3CH_2CH_2CH_2OH$ **(1 mark)**
B: $CH_3CH{=}CH_2$ **(1 mark)**

b. i. **Cl_2(g)/UV light**. Chlorine in the presence of UV light. **(1 mark)**
ii. **$Cr_2O_7^{2-}$(aq) / H^+(aq)** (or other suitable oxidant) **(1 mark)**
iii. **H_2O / H^+(aq) (1 mark)**
iv. **H_2SO_4(l) (1 mark)**

c. Step II: **Substitution reaction**. **(1 mark)** The chlorine atom in the 1-chlorobutane is being replaced by (substituted with) the hydroxyl, -OH, functional group.
Step III: **Oxidation reaction. (1 mark)** The primary alcohol is being oxidised to the carboxylic acid.
Step IV: **Thermal cracking. (1 mark)** The alkane is being converted into the unsaturated alkene.
Step V: **Addition reaction. (1 mark)** Water is being added across the carbon-carbon double bond.
Step VI: **Condensation reaction. (1 mark)** Water is being eliminated as the two reactants form the ester.

d. $CH_3CH_2CH_2COOH$
Longest carbon chain: 4 ⇒ **but**
Bonds between carbon atoms in chain: All single carbon-carbon bonds ⇒ **an**
Functional group: -COOH carboxyl ⇒ **oic acid**
Location of functional group: part of carbon backbone
Substituent groups: none
butanoic acid (1 mark)
Step V: ($CH_3CH(OH)CH_3$)
Longest carbon chain: 3 ⇒ **prop**
Bonds between carbon atoms in chain: All single carbon-carbon bonds ⇒ **an**
Functional group: -OH hydroxyl ⇒ **ol**
Location of functional group: carbon atom 2 ⇒ **-2-**
Substituent groups: none
propan-2-ol (1 mark)

e. Step II by-product: **Cl^-**(aq) **(1 mark)**
Step IV by-product: **H_2 (1 mark)**
Step VI by-product: **H_2O (1 mark)**



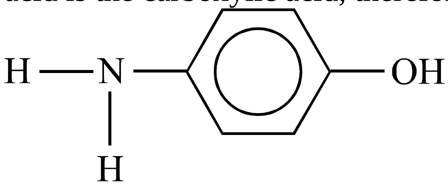
Question 2 - (5 marks, 5 minutes)

a. I **Amide functional group**. **(1 mark)**

II **Benzene ring, C_6H_4 in this structure**. **(1 mark)**

III **Hydroxyl functional group**. **(1 mark)**

b. i. An amide is formed by the reaction of an amine with a carboxylic acid. Ethanoic acid is the carboxylic acid, therefore the structure of the amine will be;



(1 mark)

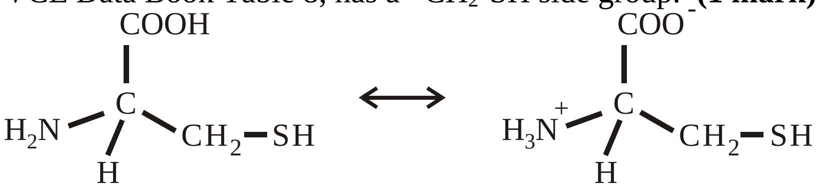
ii. The reaction between an amine and a carboxyl group to form an amide is a **condensation reaction**. **(1 mark)**

Question 3 - (7 marks, 8 minutes)

a. i. All amino acids contain an **amine** functional group, **$-NH_2$**, and a **carboxyl** functional group, **-COOH**. **(1 mark)**

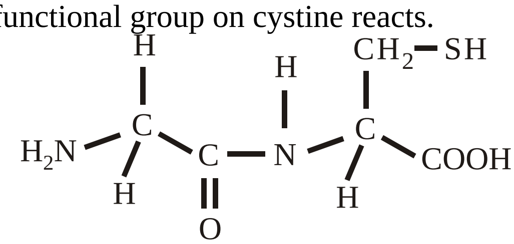
ii. The **amine** functional group can act as a **base** and accept a proton to form the **$-NH_3^+$**, ion, while the **carboxyl** functional group can act as an acid and donate a proton to form the **$–COO^-$** ion. **(1 mark)**

b. At neutral pH the amino acid can exist molecular or zwitterion forms. Cystine, from the VCE Data Book Table 8, has a $–CH_2$-SH side group. **(1 mark)**

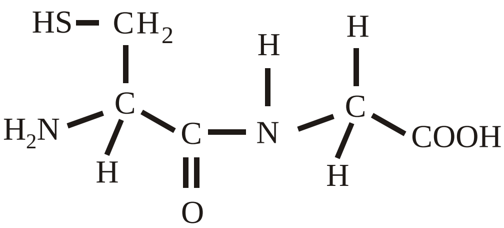


zwitterion

c. Two dipeptides can be formed when cystine reacts with glycine depending on which functional group on cystine reacts.



(1 mark)



(1 mark)

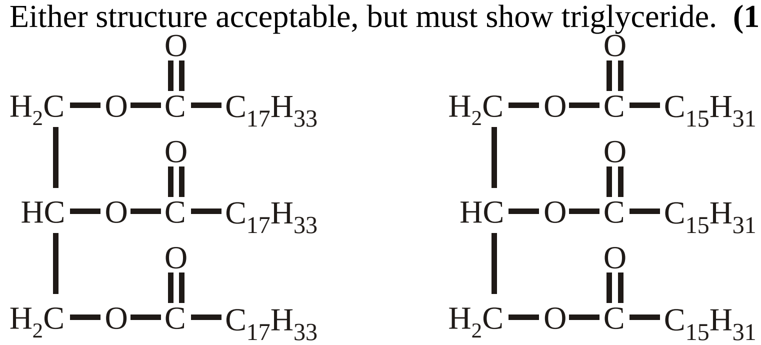
d. i. Disulfide linkages, C-S-S-C. **(1 mark)**

ii. Disulfide linkages contribute to the **tertiary structure of the protein**. **(1 mark)**

Question 4 - (7 marks, 7 minutes)

a. Oleic acid, $C_{18}H_{34}O_2$, $C_{17}H_{33}COOH$.
Palmitic acid, $C_{16}H_{32}O_2$, $C_{15}H_{31}COOH$.
A saturated C_{17} hydrocarbon will have $C_{17}H_{36}$, while a C_{15} will be $C_{15}H_{32}$.
From this it can be seen that oleic acid is an unsaturated fatty acid where as palmitic acid is a saturated fatty acid. Therefore the key structural difference will be the **presence of a carbon-carbon double bond in the hydrocarbon chain in oleic acid**. **(1 mark)**
Oleic acid: $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$
Palmitic acid: $CH_3(CH_2)_{14}COOH$

b. i. Either structure acceptable, but must show triglyceride. **(1 mark)**



ii. The **ester functional group**. **(1 mark)**

c. i. **Glycerol, $CH_2(OH)CH(OH)CH_2(OH)$**. **(1 mark)**

ii. **Hydrolysis** reaction as the triglyceride is converted to its fatty acids. **(1 mark)**
Condensation reaction as the methyl ester is formed. **(1 mark)**
The conversion of the oil into biodiesel is a **transesterification** reaction.

iii. The equations for the reactions for oleic and palmitic acid with methanol to form their methyl esters are: **(1 mark)**
Oleic acid:
$C_{17}H_{33}\,COOH\,(l) + CH_3\,OH\,(l) \Rightarrow C_{17}H_{33}\,COOCH_3\,(l) + H_2O\,(l)$
Palmitic acid:
$C_{15}H_{31}\,COOH\,(l) + CH_3\,OH\,(l) \Rightarrow C_{15}H_{31}\,COOCH_3\,(l) + H_2O\,(l)$

End of Suggested Answers