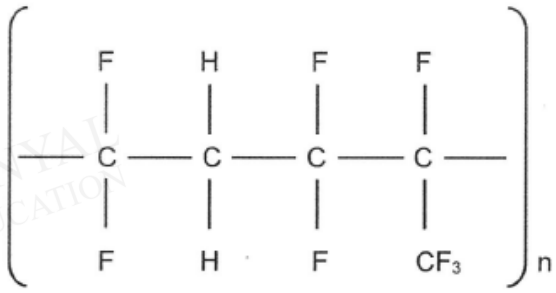
O Level Pure Chemistry Structured

Organic Chemistry Test 3.0

Q1

A *copolymer* is formed from more than one type of monomer unit.
Viton elastomer is a copolymer used in fuel injection seals. The following shows the structure of a *copolymer*, *Viton*, showing one repeat unit. There is **no** by-product formed.



(a) (i) What type of polymerisation does it undergo?

.....

[1]

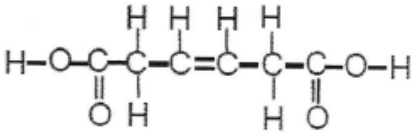
(ii) Draw the structures of the monomers that react to form this polymer.

[2]

(iii) The relative molecular mass of the *Viton* molecule is about 500 000.
Calculate the minimum number of monomers in one *Viton* molecule.

[2]

(b) Polyesters are polymers used in the manufacture of numerous products such as fabrics and eyeglass lenses. The starting material of one such polyester is compound **P** which has the structural formula shown below:



compound **P**

(i) State the observation when compound **P** reacts with aqueous bromine and with aqueous sodium carbonate

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..... [2]

(ii) Draw the full structural formula when compound **P** reacts with excess ethanol.

[2]

(iii) State the condition for the reaction in **(ii)** above.

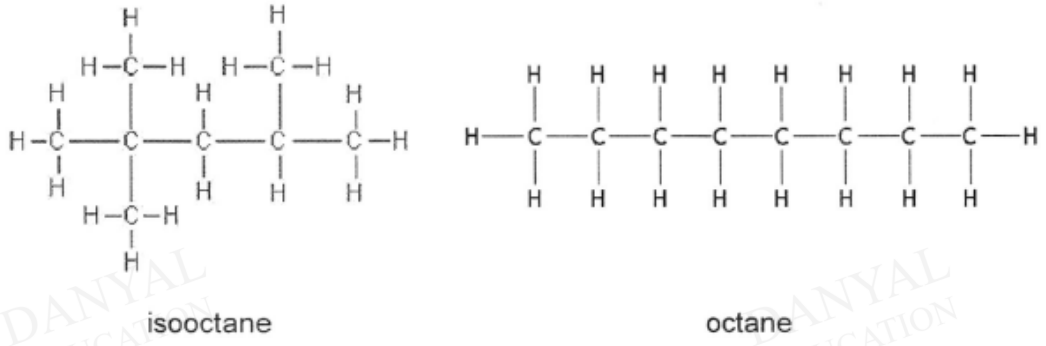
..... [1]

[Total: 10 marks]

Q2

(a) 2,2,4-trimethylpentane, also known as isooctane, is an isomer of octane C_8H_{18}.

The structures of isooctane and octane are shown in Fig. 7.1.



isooctane octane

Fig. 7.1

The enthalpy changes of combustion and boiling points for isooctane and octane are given in the Table 7.1.

Table 7.1

hydrocarbon	enthalpy change of combustion/ kJ mol^{-1}	boiling point/ °C
isooctane	- 5460	99.3
octane	- 5460	126.1

(i) Write a balanced equation for the complete combustion of isooctane.

.....[1]

(a) (iii) Suggest why the boiling points for isooctane and octane are different.

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.....[2]

(b) Spider silk is composed of polyamide chains mainly made from amino acids. Fig. 7.2 shows the structural formula of the three main amino acids, glycine, alanine and serine, found in spider silk.

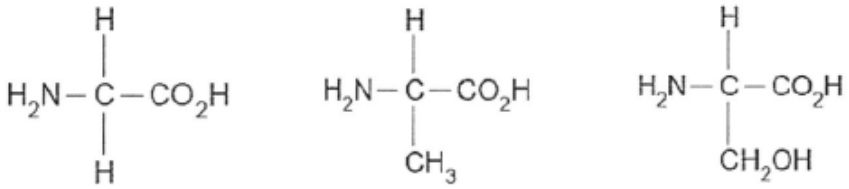

Fig. 7.2

(i) Assuming spider silk is made from repetitive sequences of –glycine–alanine–serine–, draw the structural formula of the repeat unit of the polyamide chain.

[2]

(ii) The M_r of each polyamide chain is about 600 000.

Assuming the polyamide chain is made from equal amounts of the above three amino acids, calculate the average number of amino acids monomers in each polyamide chain.

[3]

Q3

Perfumes usually contain three classes of compounds called top notes, middle notes and end notes.

(a) Top notes consist of small, light molecules that evaporate quickly. An example of a top note is styrallyl acetate as shown in Fig. 10.1.

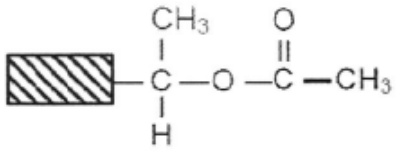

Fig. 10.1

(i) With reference to its structure, explain why the compound is likely to have a pleasant smell.

.....

.....[1]

(ii) Draw the structural formulae of the two compounds that are needed to form styrallyl acetate.

[2]

(b) Middle notes vapourise less readily than the top notes. A typical middle note is 2-phenylethanol. The structure of 2-phenylethanol is as shown in Fig. 10.2.

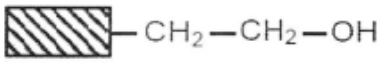

Fig. 10.2

Describe a chemical test to distinguish between styrallyl acetate and 2-phenylethanol.

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.....[3]

(c) End notes of a perfume are responsible for the long lasting odour which stays with the user. The structural formula of a typical end note is as shown in Fig. 10.3.

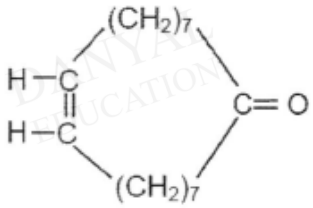

Fig. 10.3

(i) Explain why the end note is an unsaturated compound.

.....

.....[1]

(ii) Draw the structural formula of the product formed when the end note undergoes hydrogenation.

[1]

(c) (iii) Iodine value is a measure of how unsaturated a compound is. It is the mass, in grams, of iodine that reacts with 100 g of the compound.

Calculate the iodine value for the end note.

DANYAL EDUCATION

[2]

[Total: 10]

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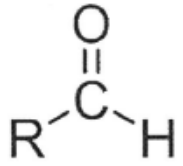
Q4

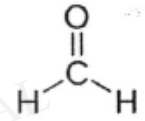
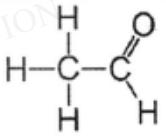
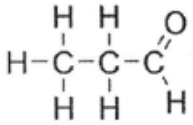
An aldehyde is an organic compound containing a formyl functional group. This functional group, with the structure – CHO, consists of a carbonyl centre (a carbon double bonded to oxygen) bonded to hydrogen.



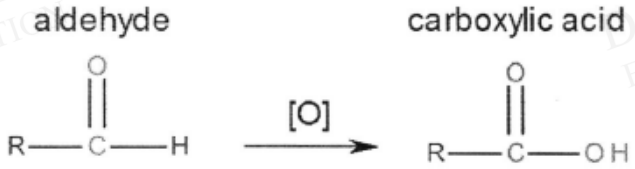
R group - generic alkyl or side chain

Table 6.1 shows some properties of aldehydes.

Table 6.1

chemical name	chemical formula	structural formula	boiling point/°c
methanal	CH_2O		−19
ethanal	CH_3CHO		20
propanal	CH_3CH_2CHO		50

Due to the high reactivity of aldehyde, it can be oxidised easily to form carboxylic acid as shown below.



Possibly because of the high reactivity of the formyl group, aldehydes are not commonly found in nature's building blocks such as amino acids, nucleic acids and lipids. Amino acids are monomers that form protein polymers. Proteins have the same linkage as nylon. An amino acid contains an amine functional group and a carboxyl functional group. These two groups can react to form a condensation polymer.

(a) Use the information above to give two pieces of evidence that suggest that the aldehydes are a homologous series.

.....

..... [2]

(b) Deduce the general formula of the aldehydes and hence predict the formula of the aldehyde that contains 8 carbon atoms.

..... [2]

(c) Draw the structural formula of butanal.

[1]

(d) When propanal is reacted with potassium manganate (VII), product **A** is formed.
Product **A** can also be formed by reactant **B** via a two-step process.
Reactant **B** undergoes addition polymerisation to form a polymer.
Name product **A** and draw the polymer of **B**, showing 2 repeat units.

Product **A**: ..... [1]

Polymer **B**:

[2]

Protein is a condensation polymer. Polymer **B** is an addition polymer.
Fig. 6.2 shows a section of a protein structure.

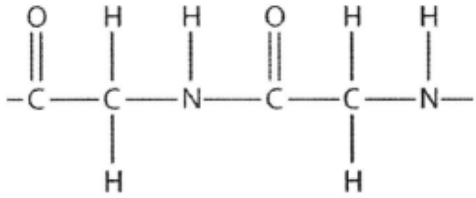


Fig. 6.2

(e) Draw the amino acid that forms this protein structure.

[1]

[Total: 9 marks]

Q5

Nylon and Terylene are condensation polymers.

Fig. 3.1 and Fig. 3.2 show the structures of Nylon and Terylene respectively.

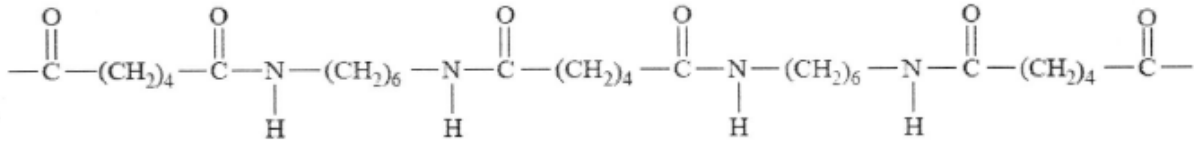


Fig. 3.1

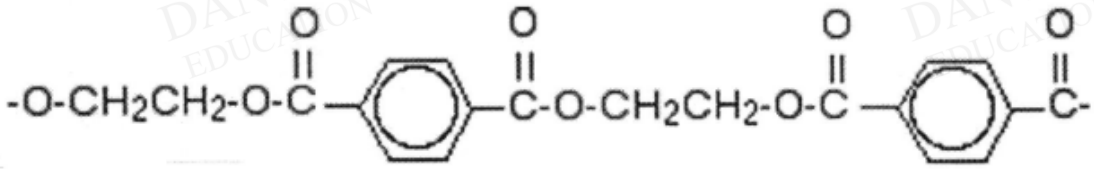


Fig. 3.2

(a) Compare and contrast the two polymers in terms of the following:

- The type of linkage present
- The monomers used in each polymer
- The side product when the polymer forms

.....

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..... [3]

(b) Both Nylon and Terylene are condensation polymers.
Explain what condensation polymers are.

.....

..... [1]

(c) These condensation polymers are non-biodegradable.
Explain why being non-biodegradable is both an advantage and a disadvantage.

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.....

..... [2]

(d) The combustion of these condensation polymers produce a much larger amount of carbon monoxide and soot as compared to the combustion of their respective monomers. Explain the phenomena.

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.....

..... [2]

(e) Lactic acid can be made from corn starch. It polymerises to form the polymer, poly(lactic acid) (PLA).
Suggest two advantages that PLA has compared with a polymer made from petroleum.

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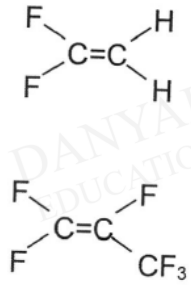
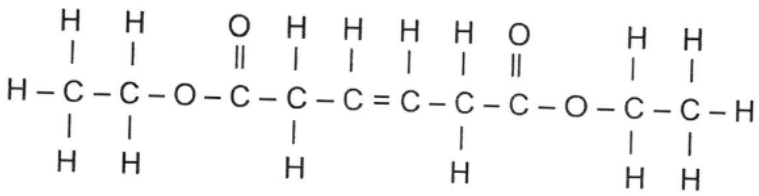
..... [2]

[Total: 10 marks]

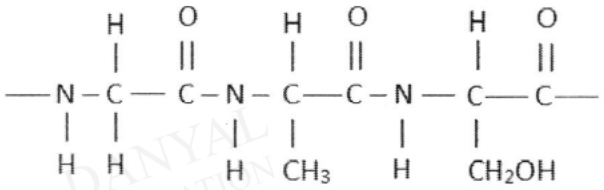
Answers

Organic Chemistry Test 3.0

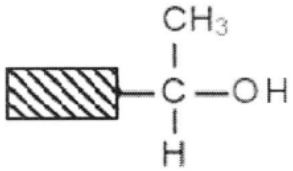
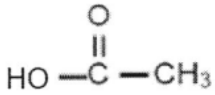
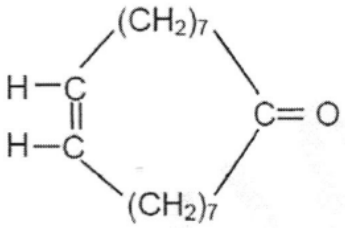
Q1

(a)	(i)	Addition polymerization	1
	(ii)		1 1
	(iii)	Mr of repeating unit = 214 No. of repeating units = 500 000 ÷ 214 = 2336 No. of monomers = 2336 × 2 = 4672 (or 4673)	1 1
(b)	(i)	Aq bromine: Reddish brown aqueous bromine is rapidly decolourised/turned colourless. Aq sodium carbonate: Effervescence occurs/ colourless gas produced/ bubbling.	1 1
	(ii)		1: 1 ethyl on left 1: 1 ethyl on right
	(iii)	Warming with concentrated sulfuric acid	1

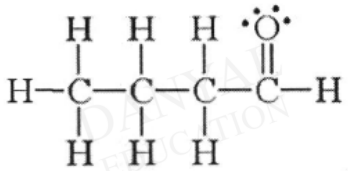
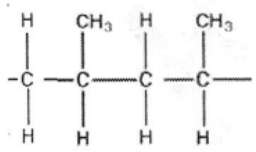
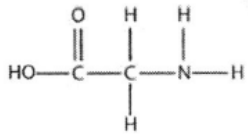
Q2

(a)(i)	$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$;	[1]
(a)(iii)	Less intermolecular forces of attraction between isooctane molecules; Less energy needed to overcome the intermolecular forces; R: weaker intermolecular forces of attraction	[1] [1]
(b)(i)	 [1]: 2 proper amide linkages [1]: consists of 1 glycine, 1 alanine, 1 serine	if polymer -1m
(b)(ii)	Mr of repeat unit = 215; Number of repeat units = 600 000/215; Number of amino acids = 2790.7 x 3 = 8372.1 = 8372; R: 8373	[1] [1] [1] allow ECF

Q3

(ai)	It has the ester functional group; A: ester linkage	[1]
(aii)	Alcohol  Carboxylic acid 	[1] [1]
(b)	Add acidified potassium manganate(VII) to both solutions; If purple solution turns colourless, the sample is middle note/2-phenylethanol; If purple solution remains purple, the sample is top note/styrallyl acetate; OR Add acidified potassium dichromate(VI) solution to each sample, if the solution turned from orange to green, the sample is middle note or if the solution remained orange, the sample is top note.	[1] [1] [1]
(ci)	It has a carbon-carbon double bond;	[1]
(cii)		[1]
(ciii)	1 mol of end note reacts with 1 mol of iodine. No. of mole of end note = 100/250 = 0.4 mol; No of mole of iodine = 0.4 mol Mass of iodine =0.4 x 2 x 127 =101.6 g; R: missing unit	[1] [1]

Q4

A6	As the number of carbon atom increases/As the molecules get larger, the boiling point	1
(a)	increases. They share the same general formula. OR The consecutive members of the group differ by $-CH_2$ OR They have the same functional group.	1
(b)	$C_nH_{2n+1}CHO$ where n = 0 for first member / $C_nH_{2n}O$ where n= 1	1
	$CH_3CH_2CH_2\ CH_2CH_2CH_2CH_2CHO$ OR $C_7H_{15}CHO$ OR $C_8H_{16}O$	1
(c)		1
(d)	Product **A**: Propanoic acid [1]	1
	Polymer **B**: 	2
(ii)		2

Q5

(a)	The linkage present in nylon is amide linkage. The one in terylene is ester linkage.	1
	Nylon is made up of dicarboxylic acid monomers and diamine monomers while terylene	1
	is made up of dicarboxylic acid monomers and diols monomers	1
	The side products from formation of both polymers are water molecules.	
(b)	Condensation polymers are **macromolecule** made from combining many **monomers**, with an **elimination of a small molecule like water**.	1
(c)	Being non-biodegradable will allow the polymer to be durable and resistant to corrosion.	1
	However, being non-biodegradable will also create more landfills when the polymer is disposed off and thus, causing land pollution.	1
(d)	The polymer has **much higher carbon content** than its monomers thus are **less flammable** and would **undergo incomplete combustion** with oxygen to form carbon monomers and soot. In contrast, its monomers have lower carbon content and is more flammable and undergoes complete combustion to form carbon dioxide.	1 1
(e)	It is biodegradable and thus does not take up landfill space and reduce land pollution.	1
	It is carbon neutral as the same amount of carbon dioxide that is used to grow the corn plant is released upon decomposition/combustion of PLA.	1