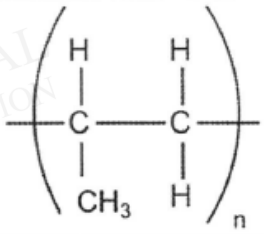
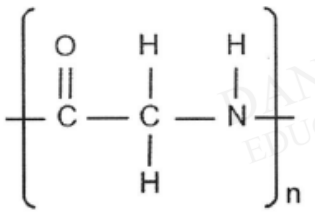
O Level Pure Chemistry Structured

Organic Chemistry Test 1.0

Q1

Polymers have several uses, and can be found almost everywhere.

Some information about two polymers are shown below.

name of polymer	polypropene	polyglycine
structural formula		
name of monomer	propene	glycine
average M_r	2000 – 4000	2000 – 5000

(a) Polyglycine is a polyamide, which is made by the condensation polymerization of the amino acid monomer, glycine.

(i) Draw the full structural formula of the monomer, glycine.

[1]

(ii) Describe one similarity and one difference between the **structures** of the addition polymer, polypropene, and the condensation polymer, polyglycine.

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.....[2]

(iii) The condensation polymerization of glycine to produce one molecule of polyglycine eliminates 990 g of water.

Calculate the relative molecular mass of this molecule of polyglycine, showing all your working (M_r of glycine is 75).

[2]

(b) Propene is the monomer used to prepare polypropene, which is widely used to make plastics.

(i) In terms of bonding and structure, explain why propene is a gas but polypropene is a solid at room temperature.

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(ii) Explain how aqueous bromine can be used to monitor the conversion of propene to polypropene.

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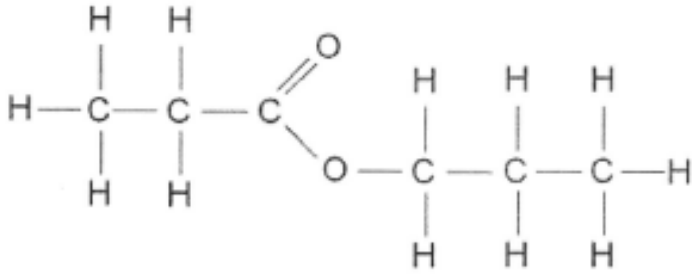
.....[2]

[total = 9 marks]

Q2

The structure of an ester that is commonly found in pineapples is shown below.



(a) Draw the full structural formulae of the alcohol and carboxylic acid used to make this ester.

full structural formula of alcohol:

full structural formula of carboxylic acid:

[2]

(b) Besides using litmus or universal indicator, describe another test you could carry out in the laboratory to distinguish the alcohol from the carboxylic acid.

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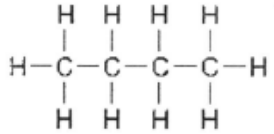
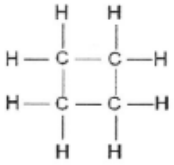
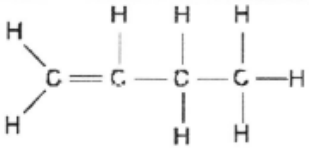
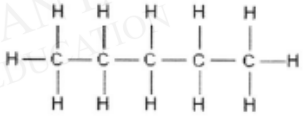
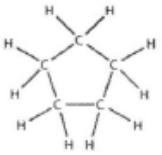
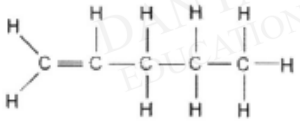
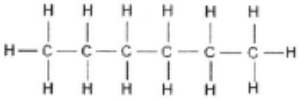
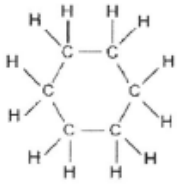
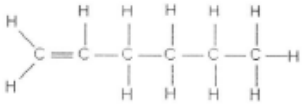
.....[2]

Q3

B9. The table below shows the names and structural formulae of some hydrocarbons.

number of carbon atoms	alkane	cycloalkane	alkene
4	 butane	 cyclobutane	 butene
5	 pentane	 cyclopentane	 pentene
6	 hexane	 cyclohexane	 hexene

(a) Explain why pentene and cyclopentane are isomers, but pentane and cyclopentane are not.

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.....[2]

(b) Do pentene and cyclohexane belong to the same homologous series? Explain your reasoning.

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.....[1]

(c) A cyclic alkene has the molecular formula of C_6H_6. Deduce how many carbon-carbon double bonds C_6H_6 has, showing your working clearly.

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.....[2]

(d) One mole of cyclobutane undergoes an endothermic reaction with one mole of chlorine gas in the presence of UV light.

(i) Write the chemical equation for this reaction, showing all the structural formulae of the reactants and products.

[2]

(ii) How would you expect the rate of reaction to change if cyclobutane was reacted with bromine instead? Explain your reasoning.

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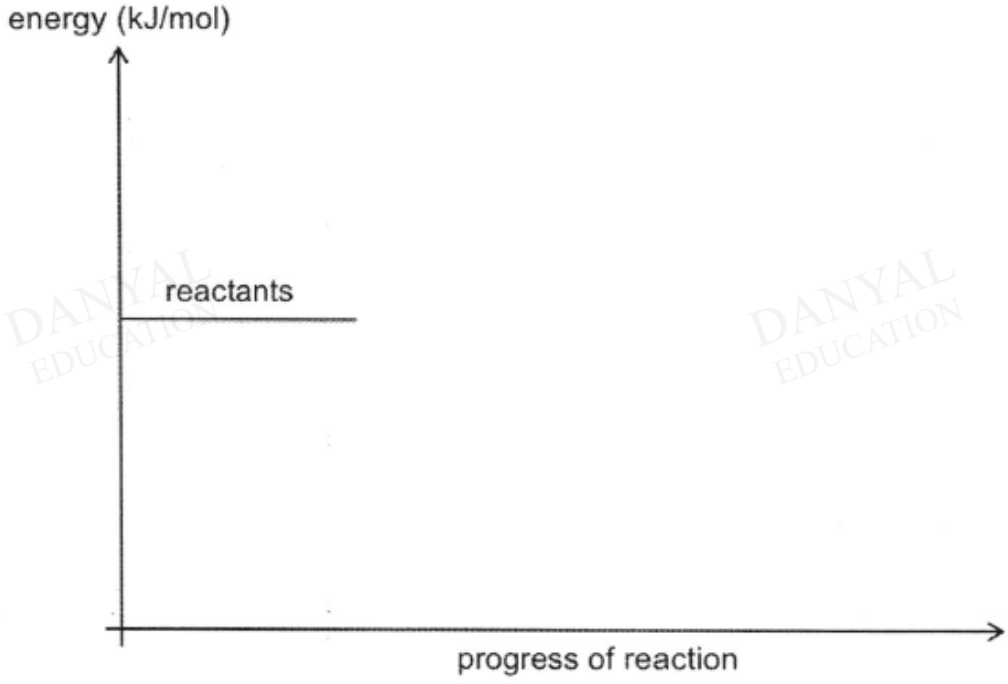
.....[1]

(iii) Draw the energy profile diagram for reaction of cyclobutane and chlorine, labelling the activation energy and enthalpy change for the reaction.



[2]

[total = 10 marks]

Q4

Alkenes are unsaturated hydrocarbons. They contain one or more carbon-carbon double bonds. Alkenes can exist as branched or unbranched hydrocarbons. Short-chain alkenes such as ethene and propene are used as starting materials for making ethanol and plastics.

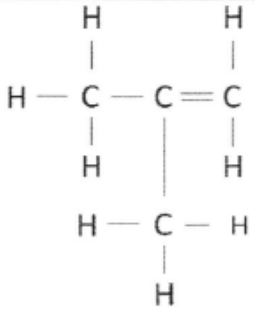
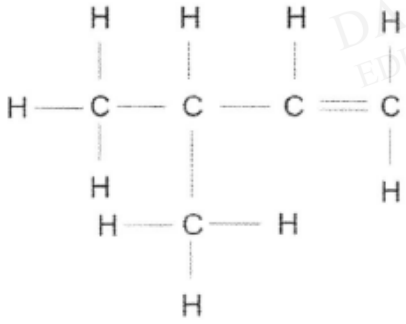
Table 1 shows the boiling points of some straight chain alkenes.

Table 1

name	formula	boiling point / °C
ethene	C_2H_4	-104
propene	C_3H_6	- 47
butene	C_4H_8	- 6
pentene	C_5H_{10}	30
hexene	C_6H_{12}	63

Table 2 shows properties of branched isomers of some of the alkenes.

Table 2

	number of carbon atoms in molecule	formula	boiling point / °C
branched alkene 1	4		-7
branched alkene 2	5		20

(a) How is the boiling point of a straight chain alkene affected by branching in isomerism?
Use evidence from **Table 1** and **Table 2** to explain your reasoning.

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.....[3]

(b) **X** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and pressure.

(i) Calculate the relative molecular mass of **X**.

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.....[1]

(ii) Hence, identify **X**. Explain your reasoning.

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.....[2]

(c) Both ethene and ethane can react with chlorine to form dichloroethane.
Give **two** differences between the two reactions.

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.....[2]

(d) Alkynes are hydrocarbons containing carbon-carbon triple bond (C≡C). **Table 3** shows some properties of the first four members of the alkyne homologous series.

Table 3

alkyne	molecular formula	boiling point / °C
ethyne	C_2H_2	- 84
propyne	C_3H_4	- 23
butyne	C_4H_6	8
pentyne	C_5H_8	40

(i) Draw the full structural formula of the alkyne with 6 carbon atoms.

[1]

(ii) Do alkenes or alkynes burn with a smokier flame? Explain your answer.

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.....[1]

(e) A Chemistry book has the following line.

.....in general, the higher the relative molecular mass of the molecule, the higher the melting and boiling points of the compound due to the higher intermolecular forces of attraction.

Use the data in **Table 1** and **Table 3** to justify whether the statement is valid.

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.....[2]

[Total: 12]

Q5

A2 **X**, **Y** and **Z** are organic compounds from three homologous series.

X can be converted to **Y** by oxidation.
Z and water are produced when **X** and **Y** react together.
Z is an isomer of ethanoic acid.

M_r of compound **X** = 32

M_r of compound **Y** = 46

M_r of compound **Z** = 60

(a) Using the information provided, complete the boxes by drawing the structures of **X**, **Y** and **Z**. [3]

(b) Suggest a reagent in the laboratory that can be used to convert compound **X** to compound **Y**.

.....

[1]

(c) Draw a 'dot-and-cross' diagram for compound **X**. Show the outer shell electrons only.

[2]

(d) The reaction mole ratio for **X** : **Y** : **Z** = 1 : 1 : 1.

Calculate the mass of **Z** produced when 100 kg of **X** reacts with 100 kg of **Y**.

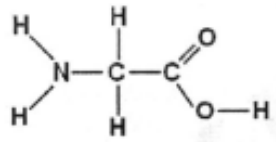
[3]

[Total 9 marks]

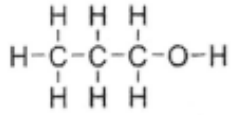
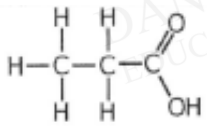
Answers

Organic Chemistry Test 1.0

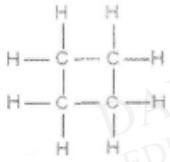
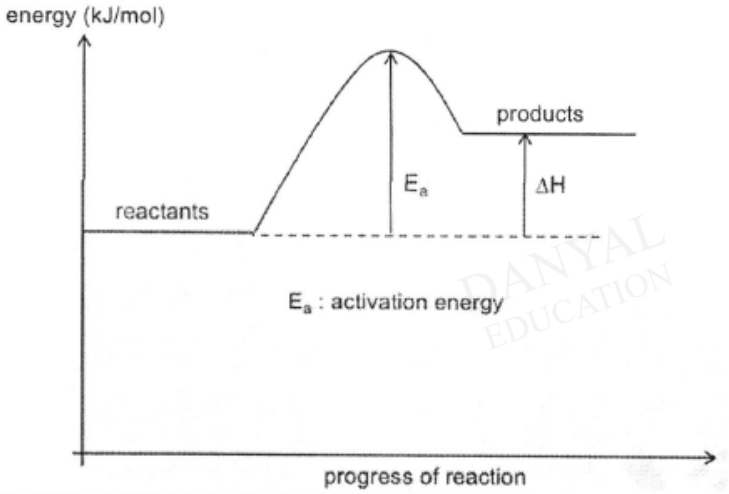
Q1

(a)(i)		[1]
(a)(ii)	**Similarity:** both polymers only require one type of monomer / both polymers have giant molecular structures [1] **Difference:** polypropene is a hydrocarbon while polyglycine is not / polyglycine is contains the amide linkage while polypropene is held together by C-C single bonds. [1]	[2]
(a)(iii)	no. of moles of H_2O = 990 g ÷ 18 = 55 mol [1] each glycine monomer will produce one small molecule when bonded to another glycine monomer, therefore 55 glycine monomers are needed. M. of polyglycine = 55 · 57 = 3135 [1] *(students who write units, penalize one mark overall from Paper 2)*	[2]
(b)(i)	Propene consists of small molecules held together by weak intermolecular forces, [1] which require much less energy to overcome compared to the strong covalent bonds in the giant molecular structure of polypropene. [1]	[2]
(b)(ii)	Propene will decolourise the reddish-brown aqueous bromine. [1] When the reaction is complete, there is only polypropene left, which will have no effect on aqueous bromine. [1] *(answers that simply give two separate outcomes without the idea of monitoring the progress of reaction will get max. 1 mark)*	[2]

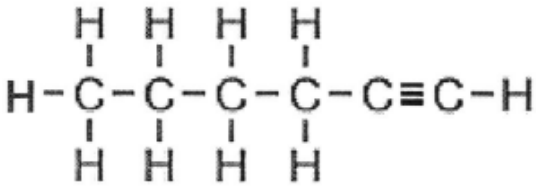
Q2

(a)	alcohol:  acid: 	[2]
(b)	Add the acid and alcohol to separate samples of acidified potassium manganate(VII). [1] The acid will have no effect on the potassium manganate(VII), but the alcohol will cause the potassium manganate(VII) to change from purple to colourless. [1] OR Add sodium carbonate or magnesium to separate samples of the alcohol and carboxylic acid. [1] The acid will have effervescence observed while the alcohol will have no visible change. [1]	[2]

Q3

(a)	Pentene and cyclopentane have the same chemical/molecular formula of C_5H_{10}, but different structural formula, so they are isomers. [1] Pentane and cyclopentane are not isomers because they do not have the same molecular formula. [1]	[2]
(b)	No they do not belong to the same homologous series as pentene has the C=C functional group while cyclopentane does not.	[1]
(c)	From hexane to hexene, molecular formula changes from C_6H_{12} to C_6H_{10}. Every increase in C=C bond results in 2 less H atoms. So from C_6H_{10} to C_6H_8, there are 4 less H atoms, so there should be 2 more C=C bonds. Total is 3 C=C double bonds.	[2]
(d)(i)		[2]
(d)(ii)	The rate of reaction between would be slower with bromine because bromine is less reactive than chlorine.	[1]
(d)(iii)		[2]

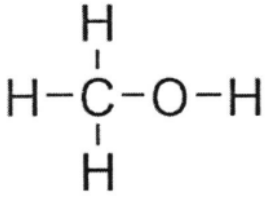
Q4

B7a	Branching in isomerism <u>decreases</u> the boiling point of straight chain alkenes. From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C). The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C).	1 1 1
b(i)	M_r = density × 24 dm^3 = 1.75 × 24 = 42	1
(ii)	X is propene / C_3H_6 with M_r of propene = (12×3) + (1×6) = 42. As X decolourises aqueous bromine, it is unsaturated / an alkene with general formula C_nH_{2n}.	1 1
c	differences: any two - substitution in ethane requires UV light whereas addition in ethene does not. - substitution in ethane involves breaking of C-H bond whereas addition in ethene involves breaking of C=C bond. - substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). - substitution in ethane produces a by-product (HCl) whereas addition in ethene does not.	1m – each difference
d(i)		1
(ii)	Alkynes burn with a smokier flame because they have a higher percentage of carbon compared to alkenes.	1
e	Although ethyne (M_r = 26) has a relative molecular mass smaller than ethene (M_r = 28), the boiling point of ethyne is -84 °C whereas the boiling point of ethene is lower at -104 °C. The statement is invalid as alkynes have higher boiling points even though they have smaller relative molecular mass.	1 1

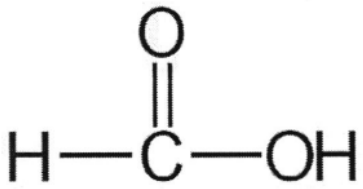
Q5

(a) Structural formula for

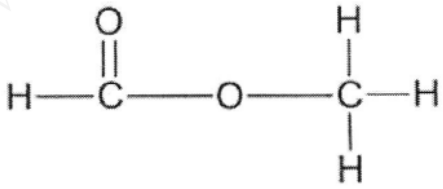
compound **X** (methanol)



compound **Y** (methanoic acid)



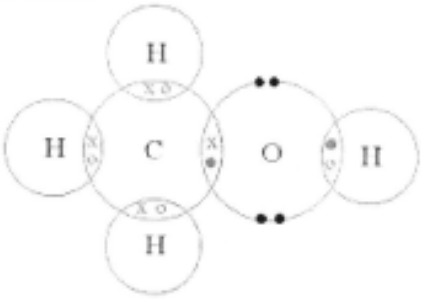
compound **Z** (methyl methanoate)

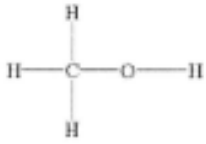


Award 1m for each correct structural formula drawn.
*Naming of compound **X**, **Y** and **Z** is not required.* [3]

(b) *Award 1m for any oxidising agent found in chemistry lab.*
E.g. <u>acidified</u> potassium manganate(VII) / <u>acidified</u> potassium dichromate (VI) / hydrogen peroxide [1]

(c) 'Dot-and-cross' diagram for X: [2]





Award 1m for correct pairs of shared electrons.
Award 1m for octet for O atom.

(d) 100 kg of **X** = 3.125×10^3 moles
100 kg of **Y** = 2.174×10^3 moles
Limiting reagent is **Y** (or that **X** is in excess)
Mass of **Z** produced = $(2.174 \times 10^3) \times 60$ = **130 kg** (to 3 s.f.)

*Award 1m for calculating number of moles in 100 kg of **X** or **Y**.*
*Award 1m for correctly identified which reagent (**X** or **Y**) is in excess / is the limiting reagent.*
Award 1m for final answer. [3]

[9 marks]