

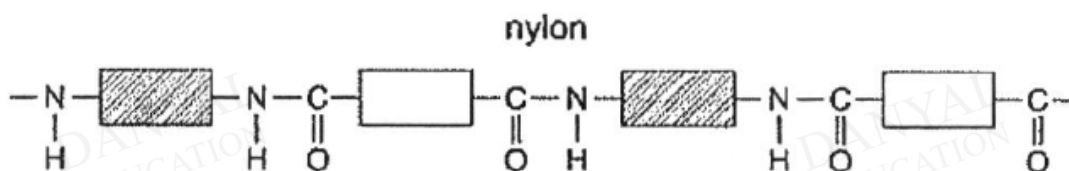
## O Level Pure Chemistry Structured

### Organic Chemistry Test 7.0

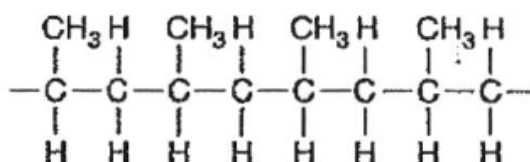
Q1

Use the following polymers to answer questions.

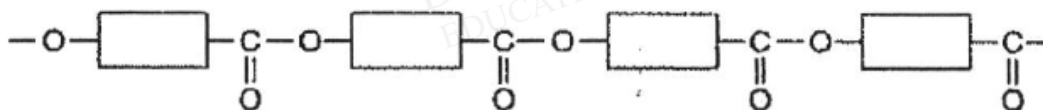
Their structures are as shown below.



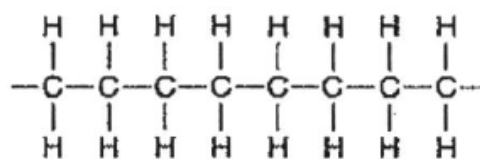
poly(propene)



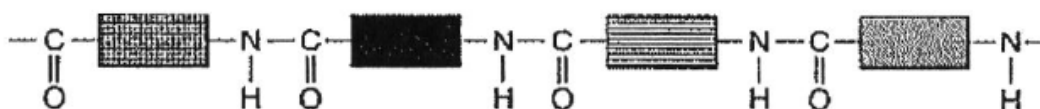
polyester



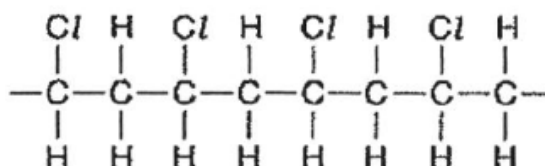
poly(ethene)

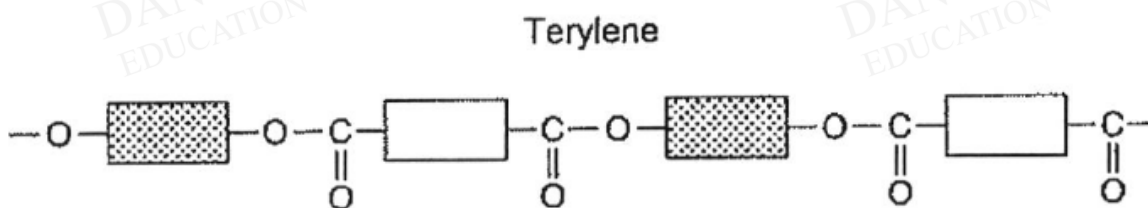
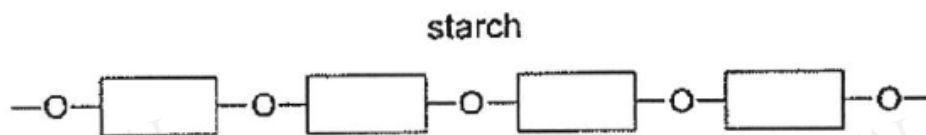
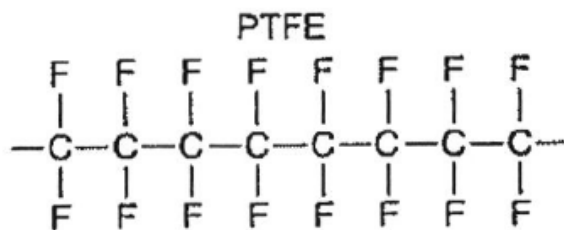


protein



PVC





Each polymer can be used once, more than once or not at all.

Which is a polymer that

- (a) is made from propene
- (b) will form hydrogen chloride when combusted?
- (c) is used to manufacture clingfilm and plastic bags?
- (d) is a condensation polymer?
- (e) is a saturated hydrocarbon?

Q2

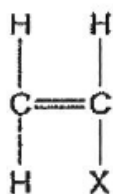
Scientists have been researching the possibility of using liquid petroleum gas (LPG) and ethanol as fuels in cars. Unlike natural gas, LPG contains mainly propane. The table below shows information about propane and ethanol.

name	formula	boiling point / °C	physical state at r.t.p	enthalpy change of combustion / kJ per mol	method of manufacture
ethanol	<input type="text"/>	78	liquid	-1367	<input type="text"/> ..... of sugar cane
propane	C <sub>3</sub> H <sub>8</sub>	-42	<input type="text"/>	-2220	<input type="text"/> ..... of crude oil

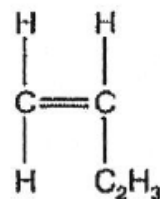
- (a) Complete the table by filling up the table.
- (b) Show by calculation, that 50455 kJ of energy is given out when 1 kg of propane burns.
- (c) Show by calculation that ethanol gives out less energy per kg than propane.
- (d) Using the information provided, suggest two advantages of using ethanol than propane as fuel for cars.

Q3

Styrene-butadiene rubber is a synthetic rubber. It is made by polymerising a mixture of the monomers butadiene and styrene.



styrene



butadiene

One possible structure for the polymer is as shown below.



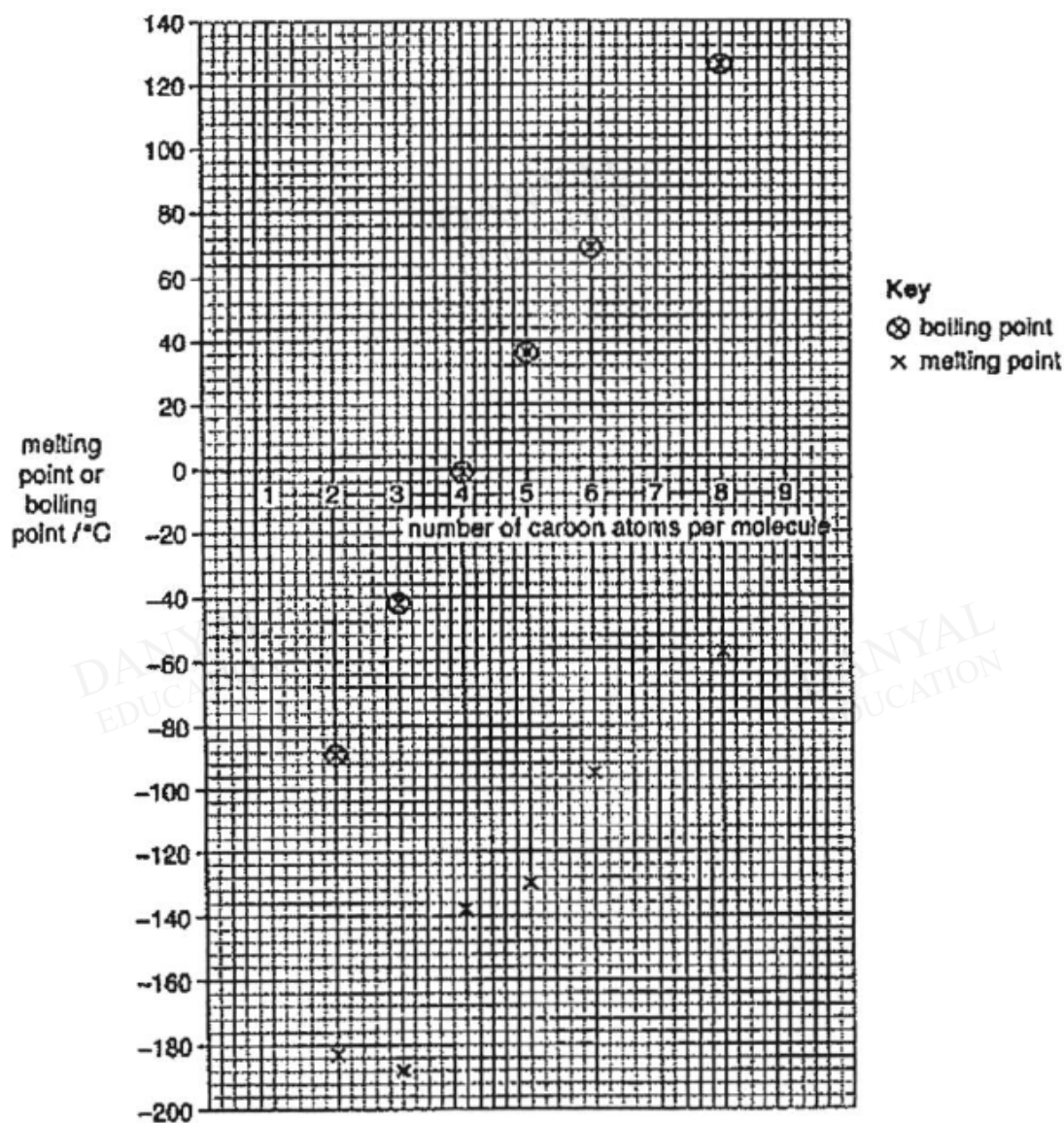
- (a) Draw the structural formula of the repeating unit in this polymer structure.
- (b) When the mixture of styrene and butadiene polymerises, the polymer is unlikely to contain only of this regular, repeating pattern. Explain why.

Q4

The following table shows the melting and boiling points of some alkanes.

name	formula	melting point / °C	boiling point / °C
ethane	C <sub>2</sub> H <sub>6</sub>	-183	-89
propane	C <sub>3</sub> H <sub>8</sub>	-188	-42
butane	C <sub>4</sub> H <sub>10</sub>	-138	-1
pentane	C <sub>5</sub> H <sub>12</sub>	-130	36
hexane	C <sub>6</sub> H <sub>14</sub>	-95	69
octane	C <sub>8</sub> H <sub>18</sub>	-57	126

The graph below shows the melting and boiling points of the alkanes plotted against the number of carbons in each alkane molecule.



- (a) What are the trends shown by the data in the table and the graph?
- (b) The melting point of one of the alkanes appears to be different from the expected value.

Name the alkane and explain your choice.

- (c) Predict the melting point of heptane,  $C_7H_{16}$ .
- (d) Crude oil contains a mixture of hydrocarbons. The mixture contains straight chain and branched chain alkanes.

In a refinery, isomerisation is used to convert straight chain alkanes into branched chain alkanes to be used as fuels.

The table below shows the boiling and melting points of some branched chain alkanes.

	no. of carbon atoms	structural formula	melting point / °C	boiling point / °C
Branched alkane 1	6	$\begin{array}{ccccccc} & & & CH_3 & & & \\ & & &   & & & \\ CH_3 & - & CH_2 & - & CH & - & CH_2 - CH \end{array}$	-153	60
Branched alkane 2	6	$\begin{array}{ccccccc} & & CH_3 & & H & & H \\ & &   & &   & &   \\ H_2C & - & C & - & C & - & C & - & H \\ & &   & &   & &   \\ & & CH_3 & & H & & H \end{array}$	-101	50

- (i) How is boiling point of a straight chain alkane affected by isomerisation?

Use evidence from the information to explain your reasoning.

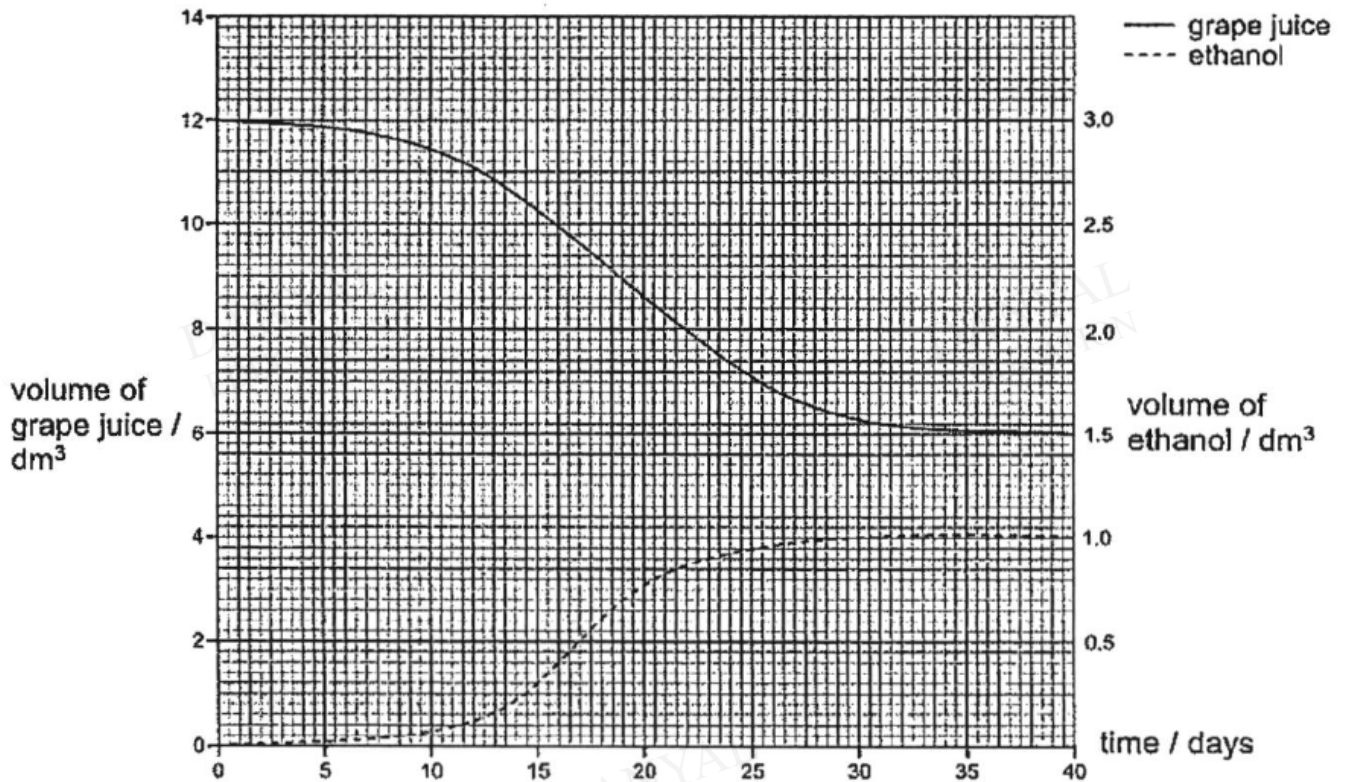
- (ii) Branched chain alkanes is preferred over straight chain alkanes as fuel because they have been found to burn more smoothly in engines.

However, in countries with a warm climate, straight chain alkanes is mixed with branched chain alkanes in petrol. This is said to reduce the amount of petrol lost if the petrol tank is vehicles is not air tight.

Explain why the addition of large amount of straight chain alkanes to branched chain alkanes can reduce the amount of petrol lost.

Q5

Ethanol can be produced from the action of yeast on sugars found in grapes to produce wine in 40 days. The graph shows how the composition of ethanol and grape juice changes.



- (a) Grape juice is known to contain glucose. With the help of a chemical equation, explain [3] the changes in composition of ethanol and grape juice as shown in the graph.

.....

.....

.....

.....

.....

.....

- (b) Using information from the graph, calculate the percentage of ethanol, by volume, [2] present in wine.

**Answers**

**Organic Chemistry Test 7.0**

Q1

(a) is made from propene

**Polypropene** [1]

(b) will form hydrogen chloride when combusted?

**PVC** [1]

(c) is used to manufacture clingfilm and plastic bags?

**Poly(ethene)** [1]

(d) is a condensation polymer?

**Nylon / Terylene / Polyester / Proten / Starch** [1]

(e) is a saturated hydrocarbon?

**Poly(ethene) / poly(propene)** [1]



Q2

name	formula	boiling point / °C	physical state at r.t.p	enthalpy change of combustion / kJ per mol	method of manufacture
ethanol	C <sub>2</sub> H <sub>5</sub> OH	78	liquid	-1367	Fermentation of sugar cane
propane	C <sub>3</sub> H <sub>8</sub>	-42	gas	-2220	fractional distillation of crude oil

(a) Complete the table by filling up the table.

[1] per correct blank

(b) Show by calculation, that 50455 kJ of energy is given out when 1 kg of propane burns.

$$\text{No. of moles of propane} = 1000 / 44 = 22.7 \text{ mol}$$

$$\text{Energy given out} = 1000 / 44 \times 2220 = 50454.54 = \underline{50455 \text{ kJ}} [1]$$

(c) Show by calculation that ethanol gives out less energy per kg than propane.

$$\begin{aligned} \text{Amount of energy given out by 1 kg of ethanol when burnt.} \\ = 1367 / 46 \times 1000 \\ = \underline{29717 \text{ kJ}} [1] \end{aligned}$$

(d) Using the information provided, suggest two advantages of using ethanol than propane as fuel for cars.

Ethanol is a **renewable** fuel such that more can be manufactured by **fermentation of sugar cane** after it is used whereas propane is a **non-renewable** fuel that cannot be manufactured. [1]

or

Ethanol **burns more cleanly in air**, producing **less soot and carbon monoxide**. [1]

OR

**No special equipment is needed for the storage of ethanol in cars whereas propane requires an air-tight gas tank. [1]**

Accept:

Ethanol is a safer fuel than propane because it exists as a **liquid state at r.t.p** whereas propane is a **gaseous state at r.t.p.** Therefore, ethanol is **less likely to escape and combust than propane.** [1]

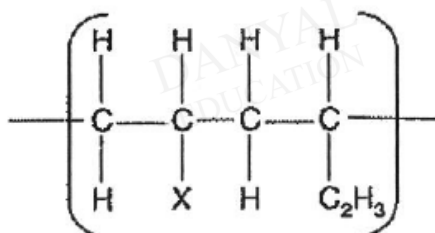
Or

Ethanol exists as a **liquid at r.t.p** therefore it is **easier to transport [less preferred]** / **requires a smaller volume of storage space** than propane, which is a **gas at r.t.p.**

Accept: ethanol renewable and propane is non-renewable fuel.

Q3

(a) Draw the structural formula of the repeating unit in this polymer structure.



[1] repeating unit

(b) When the mixture of styrene and butadiene polymerises, the polymer is unlikely to contain only of this regular, repeating pattern. Explain why.

Addition polymerisation **can also occur between styrene monomers** as well as **between butadiene monomers.** [1]

Q4

- (a) What are the trends shown by the data in the table and the graph?

**As the number of carbon in the alkanes increases, the melting and boiling point of the alkane increases.** [1]

- (b) The melting point of one of the alkanes appears to be different from the expected value.

Name the alkane and explain your choice.

**Propane.** [1]

From the graph, the **melting point of propane** ( $-184^{\circ}\text{C}$ ) is **lower** than the melting point of ethane ( $-181^{\circ}\text{C}$ ). However, the melting point of propane is expected to be higher than that of ethane because **propane has one more carbon atom.** [1]

- (c) Predict the melting point of heptane,  $\text{C}_7\text{H}_{16}$ .

**$-72^{\circ}\text{C}$  (+/-  $2^{\circ}\text{C}$ )** [1]

- (i) How is boiling point of a straight chain alkane affected by isomerisation?

Use evidence from the information to explain your reasoning.

Isomerisation **lowers the boiling point** of an alkane. [1]

The boiling point of a six carbon straight chain alkane, hexane ( **$69^{\circ}\text{C}$** ) is **higher** than that of 6-carbon branched chain alkanes 1 and 2 with a boiling point of  **$60^{\circ}\text{C}$**  and  $50^{\circ}\text{C}$  respectively. [1]

**The more branched the alkane, the lower the boiling point.** [1]

Branched alkane 2 has **more branches** than branched alkane 1. Branched alkane 2 has a lower boiling point of  **$60^{\circ}\text{C}$**  whereas the less branched alkane 1 has a boiling point of  **$50^{\circ}\text{C}$** . [1]

- (ii) Branched chain alkanes is preferred over straight chain alkanes as fuel because they have been found to burn more smoothly in engines.

However, in countries with a warm climate, straight chain alkanes is mixed with branched chain alkanes in petrol. This is said to reduce the amount of petrol lost if the petrol tank is vehicles is not air tight.

Explain why the addition of large amount of straight chain alkanes to branched chain alkanes can reduce the amount of petrol lost.

The addition of large amounts of straight chain alkanes will increase the boiling point of the petrol. [1]

Therefore, the petrol is less likely to vapourise / become gas under hot weather conditions, escape from the petrol tank, resulting in less petrol loss. [1]

Q5		
(a)	$C_6H_{12}O_6 \rightarrow 2 C_2H_5OH + 2 CO_2$	1
	Glucose in the grape juice undergoes fermentation in the presence of yeast to produce ethanol resulting in a drop in volume of grape juice and a rise in volume of ethanol.	1
	After 30 days, fermentation stops as the concentration of ethanol kills the yeast resulting in a constant volume of ethanol of $1.0 \text{ dm}^3$ .	1
(b)	Volume of ethanol = $1.0 \text{ dm}^3$	1
	Volume of wine = $6 + 1 = 7 \text{ dm}^3$	
	% of ethanol = $1.0 / 7 \times 100\% = 14.3\%$	1