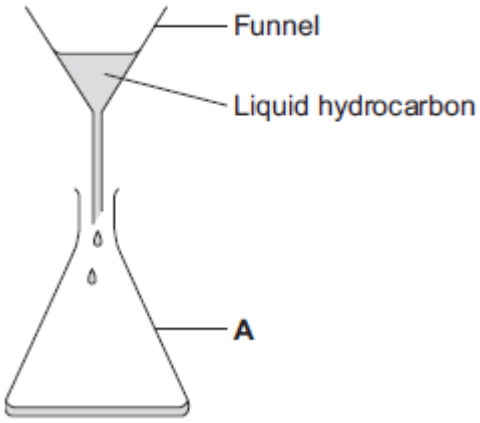
4-7 Organic Chemistry – Chemistry

1.0 A student investigated the viscosity of liquid hydrocarbons.

The student used this method:

1. Measure 40 cm^3 of the liquid hydrocarbon.
2. Pour the liquid hydrocarbon into the funnel.

Figure 1



3. Time how long it takes for all of the liquid hydrocarbon to run out of the funnel.
4. Repeat the experiment for the other liquid hydrocarbons.

1.1 Give the name of apparatus **A** in **Figure 1.**

[1 mark]

_____

1.2 Name the apparatus that could be used to measure 40cm^3 of liquid hydrocarbon.

[1 mark]

_____

The student's results for six liquid hydrocarbons are shown in **Table 1**.

Table 1

Formula of liquid hydrocarbon	Time for liquid hydrocarbon to run out of the funnel in seconds			Mean time in seconds
	Experiment 1	Experiment 2	Experiment 3	
C_6H_{14}	12.2	11.8	12.0	12.0
C_7H_{16}	14.7	15.2	15.4	15.1
C_8H_{18}	18.7	19.9	18.9	
$C_{10}H_{22}$	27.6	26.8	28.2	27.5
$C_{12}H_{26}$	48.3	48.5	48.1	48.3
$C_{14}H_{30}$	65.9	67.1	69.0	67.3

1.3 Explain how the data show that the student's results are **precise**.

[1 mark]

_____

_____

1.4 Describe the pattern shown on **Table 1** between the number of carbon atoms in a molecule of liquid hydrocarbon and the time taken for the liquid hydrocarbon to run out of the funnel.

[1 mark]

_____

_____

1.5 Identify the anomalous result on the table.
Suggest **one** error the student may have made to get this anomalous result.

[2 marks]

Anomalous result: _____

Error: _____

1.6 Use the data in **Table 1** to calculate the mean time in seconds for C_8H_{18}.
Give your answer to an appropriate number of significant figures.

[1 mark]

Mean time = _____s

1.7 Give **one** safety precaution the student should take when carrying out this experiment.

[1 mark]

_____

_____

2.0 This question is about organic molecules.

2.1 Large hydrocarbon molecules can be broken into smaller molecules by heating with a catalyst.
The equation shows **one** example of this type of reaction.

$$C_{11}H_{24} \rightarrow 2C_3H_6 + C_5H_{12}$$

Which word describes this type of reaction?

[1 mark]

Tick **one** box.

Cracking ☐

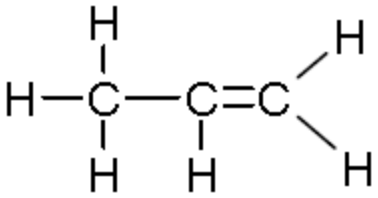
Polymerisation ☐

Precipitation ☐

Reduction ☐

2.2 **Figure 2** shows propene as a displayed structure.

Figure 2



Draw a ring around the part of the molecule which makes propene unsaturated.

[1 mark]

2.3 Bromine water changes colour when mixed with an unsaturated compound like propene.
Complete the sentences.
Use words from the box.

[2 marks]

Blue	**Colourless**	**Green**	**Orange**	**Red**

Before mixing with propene, bromine water is _____.

After mixing with propene, bromine water is _____.

2.4 Propene reacts with steam to produce an alcohol, propanol.
Complete the equation for the reaction.

[1 mark]

$C_3H_6 + H_2O \rightarrow$ _____

2.5 Which **two** statements are true about propanol?

[2 marks]

Tick **two** boxes.

Propanol can be oxidised to propanoic acid ☐

Propanol mixes with water to form a solution ☐

Propanol is a hydrocarbon ☐

Propanol reacts with sodium carbonate to make carbon dioxide ☐

Propanol is a strong acid ☐

3.1 Propane reacts with oxygen in the air.
Complete and balance the chemical equation for the complete combustion of propane in oxygen.

[3 marks]

$C_3H_8(g)$ + ...(g) → .....(g) + ...(l)

3.2 Which one of the following is **not** an alkane?

[1 mark]

Tick **one** box.

C_8H_{15} ☐

$C_{12}H_{26}$ ☐

$C_{16}H_{34}$ ☐

$C_{24}H_{50}$ ☐

3.3 Which has the **highest** boiling point?

Draw a ring around the correct answer.

[1 mark]

C_3H_6 **C_5H_{12}** **$C_{10}H_{22}$** **C_8H_{18}**

3.4 **Table 2** shows some information about alkanes.

Table 2

Name	Formula	Relative formula mass	Boiling point in °C
methane	CH_4	16	–160
ethane	C_2H_6	30	–90
propane	C_3H_8	44	–40
butane	C_4H_{10}	58	–1
pentane	C_5H_{12}	72	
hexane	C_6H_{14}	86	68

What is the formula of heptane, the next member of the series?

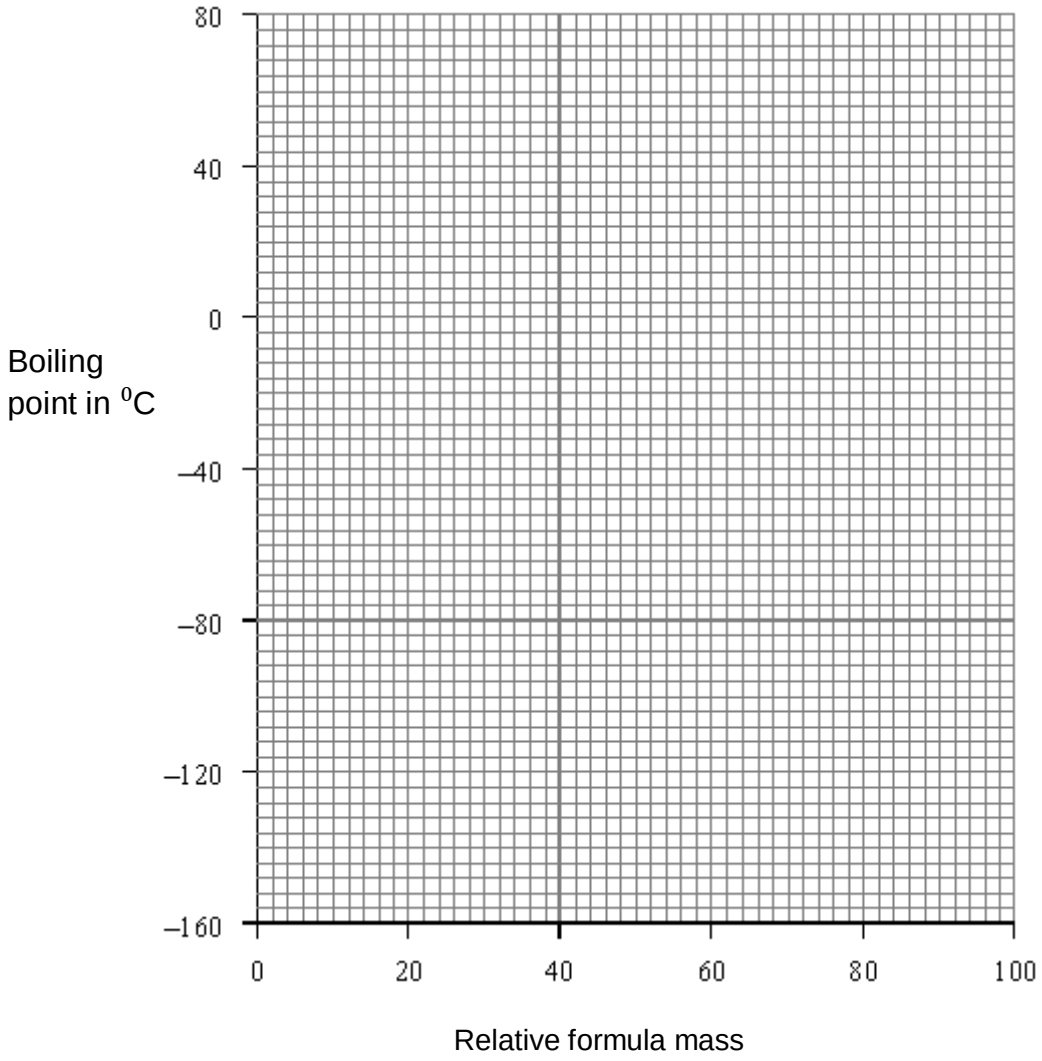
[1 mark]

3.5 Draw a graph of relative formula mass against boiling point.

On the graph:

- plot the points
- draw a line of best fit.

[3 marks]



3.6 Give **two** conclusions you can make from your graph.

[2 marks]

4.1 Propanoic acid (CH_3CH_2COOH) can be produced from propanol.

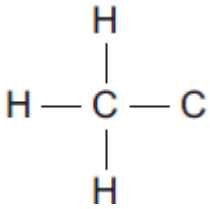
What type of reaction produces propanoic acid from propanol?

[1 mark]

_____

4.2 Complete the displayed structure of propanoic acid.

[1 mark]



4.3 Solutions of propanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of propanoic acid has a higher pH than the solution of hydrochloric acid.

[2 marks]

_____

_____

_____

_____

5.1 Draw the displayed structure of a butene (C_4H_8) molecule.

[1 mark]

5.2 Name the polymer that can be formed from butene molecules

[1 mark]

_____

5.3 Explain how butene molecules form a polymer.

[3 marks]

_____

_____

_____

_____

_____

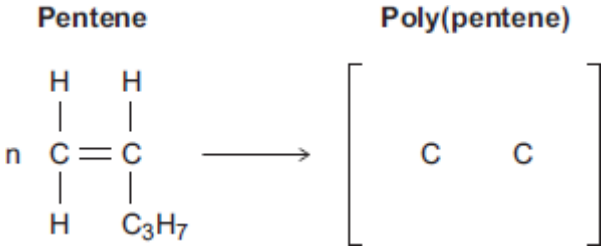
_____

_____

5.4 Pentene is used to produce poly(pentene).

Complete the equation to show the polymerisation reaction.

[3 marks]



6.0 Crude oil contains a mixture of hydrocarbons.

The table below shows the relative market demand and available supply of each fraction.

Fraction	Boiling point in °C	Relative % supply in crude oil	Relative % demand
Liquid Petroleum Gas	Less than 30	2	5
Gasoline (petrol)	30-160	15	30
Kerosene (paraffin)	160-250	10	20
Diesel	220-350	20	25
Fuel and Heavy oils	Greater than 350	53	20

6.1 Describe how **fractional distillation** and **cracking** are used so that sufficient petrol is produced from crude oil to meet demand.

Use the information in the table, and your own knowledge.

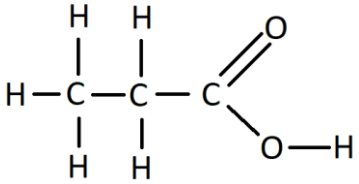
[6 marks]

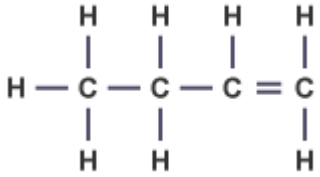
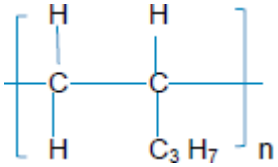
MARK SCHEME

Qu No.		Extra Information	Marks
1.1	(conical) flask		1
1.2	measuring cylinder / pipette / burette		1
1.3	(for each hydrocarbon there is) Little difference from mean between the repeats / little spread about the mean		1
1.4	As the number of carbon atoms increases, the time taken for the hydrocarbon to run out of the funnel increases		1
1.5	C_8H_{18} Trial 2 any **one** from: • longer hydrocarbon used • volume of hydrocarbon too great • started timing early • stopped timing too late	Allow 19.9; or this result circled on table must indicate why the result is **higher** than the others. allow the temperature was lower **or** the students used a thinner funnel.	1 1
1.6	$\frac{18.7 + 18.9}{2}$ 18.8	 An answer of 18.8 without working gains 2 marks Allow 19.2 for one mark	1 1
1.7	Wear safety glasses	allow any suitable safety precaution	1

Qu No.		Extra Information	Marks
2.1	Cracking		1
2.2	Ring drawn around the functional group	Minimum to enclose C=C Must not enclose any of the atoms of the methyl group	1
2.3	Orange Colourless		1 1
2.4	C_3H_8O	Allow any order of elements. Allow any structural/display formula with atomic ratio 3:8:1	1
2.5	Propanol can be oxidised to propanoic acid Propanol mixes with water to form a solution		1 1

Qu No.		Extra Information	Marks
3.1	$C_3H_8(g) + O_2(g)$ $CO_2(g) + .H_2O(l)$ Correct balancing of equation	 Allow correct multiples An answer of $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ gains 3 marks	1 1 1
3.2	C_8H_{15}		1
3.3	$C_{10}H_{22}$		1
3.4	C_7H_{16}		1
3.5	All points plotted correctly Best fit straight line	± ½ small square Allow 1 mark for 5/6 plotted correctly	2 1
3.6	As the relative formula mass increases the higher the temperature of the boiling point non-linear/not proportional or change gets smaller as relative formula mass gets higher		1 1

Qu No.		Extra Information	Marks
4.1	oxidation		1
4.2	Correct structure drawn: 		1
4.3	propanoic acid is a weak / weaker acid because propanoic acid does not completely ionise.	 allow because propanoic acid does not completely dissociate allow propanoic acid has a lower concentration of hydrogen ions allow converse for hydrochloric acid answers must be clear whether they are referring to propanoic acid or hydrocholoric acid	1 1

Qu No.		Extra Information	Marks
5.1	displayed structure of butene drawn: 		1
5.2	poly(butene)		1
5.3	many monomers **or** many butane molecules double bond breaks / opens up **or** double bond forms a single bond form chains **or** very large molecules		1 1 1
5.4	a single bond between carbon atoms other four bonds linking hydrogen atoms and C_3H_7 group plus two trailing / connecting bonds n at the bottom right hand corner of the bracket	An answer of  Would score 3 marks	1 1 1

Qu No.		Extra Information	Marks
6.1			
Level 3:	A detailed and coherent description is given for both processes, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.		5-6
Level 2:	A description is given which demonstrates a reasonable understanding of the key scientific ideas. Links are made but may not be fully articulated and / or precise.		3-4
Level 1:	Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.		1-2
	No relevant content		0
Indicative content			
Fractional distillation • Crude oil heated / evaporated • Vapours enter column • Vapours condense and are collected at different levels • Each fraction has different boiling / condensing point • Each fraction has different size molecules *Cracking* • Large molecules heated / evaporated / vaporised • Molecules cracked / broken/ decomposed • Passed over hot catalyst at ~450-550°C *or*			

• Heated with water/steam at ~800-900°C • Smaller molecules are produced • Products contain alkenes and alkanes • Alkenes used for making polymers or alcohols • Alkanes used for fuels	