Organic Chemistry 5

Name: _____

Class: _____

Date: _____

Time: **88 minutes**

Marks: **83 marks**

Comments:

1. This question is about crude oil and alkanes.

(a) Describe how crude oil is formed.

(3)

(b) Describe how crude oil is separated into fractions by fractional distillation.

(4)

The table below shows the boiling points of three alkanes.

Alkanes	**Boiling point in °C**
C_5H_{12}	36
$C_{10}H_{22}$	174
$C_{15}H_{32}$	271

(c) What is the general formula for alkanes?

(1)

(d) Explain the trend in the boiling points of the alkanes.

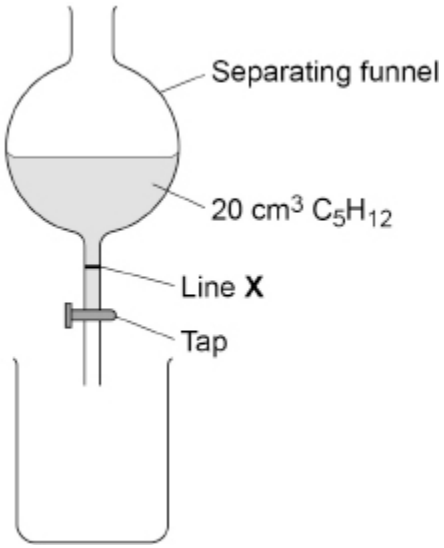
(3)

(e) A student investigated one property of the alkanes C_5H_{12}, $C_{10}H_{22}$ and $C_{15}H_{32}$

This is the method used.

1. Pour 20 cm^3 of C_5H_{12} into a separating funnel.
2. Open the tap of the separating funnel and start a timer.
3. Stop the timer when the level of C_5H_{12} reaches line **X**.
4. Repeat steps 1 to 3 with $C_{10}H_{22}$ and $C_{15}H_{32}$

The diagram below shows the apparatus used.



The level of C_5H_{12} takes 6.4 seconds to reach line **X**.

Predict the trend in times for the other two alkanes.

Give **one** reason for your answer.

Trend _____

_____

Reason _____

_____

(2)

(Total 13 marks)

2. Large hydrocarbon molecules can be cracked to produce smaller, more useful molecules.

Alkanes and alkenes are produced when hydrocarbons are cracked.

(a) Give **two** conditions used for cracking.

1 _____

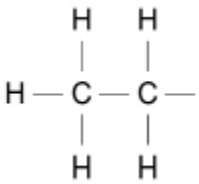
2 _____

(2)

(b) Butane (C_4H_{10}) is an alkane.

The figure below shows part of the displayed structural formula of butane.

Complete the displayed structural formula of butane in the figure.



(1)

(c) Butane burns in oxygen.

Complete the word equation for the complete combustion of butane.

butane + oxygen ⟶ _____ + _____

(2)

(d) Ethene is an alkene.

Give a test for alkenes.

Give the result of the test if an alkene is present.

Test _____

Result _____

_____

(2)

(e) Each year many tonnes of crude oil are extracted from the Earth.

It took millions of years for the crude oil to be formed.

What do we call development that meets the needs of current generations without compromising the resources for future generations?

Tick (✓) **one** box.

Finite development ☐

Global development ☐

Natural development ☐

Sustainable development ☐

(1)

(Total 8 marks)

3. This question is about the Earth's resources.

When most fuels burn carbon dioxide is produced.

Propane (C_3H_8) is a fuel.

(a) Balance the equation for the combustion of propane.

$$C_3H_8 + \_\_\_\_\_ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

(1)

(b) Describe the test for carbon dioxide.

Give the result of the test.

Test _____

Result _____

_____

(2)

(c) Propane can be cracked to produce propene and hydrogen.

Complete the symbol equation for the reaction.

$$\underset{\text{propane}}{C_3H_8} \rightarrow \underset{\text{propene}}{\_\_\_\_\_} + \underset{\text{hydrogen}}{H_2}$$

(1)

(d) Describe the test for hydrogen.

Give the result of the test.

Test _____

Result _____

_____

(2)

(e) Propene is an alkene.

Describe the test for alkenes.

Give the colour change in the test.

Test _____

Colour change _____ to _____

(3)

(Total 9 marks)

4. This question is about hydrocarbons and crude oil.

(a) Hydrocarbon fuels are produced from crude oil.

Describe how crude oil is separated into fractions.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Butane is a hydrocarbon.

(b) Two equations for the combustion of butane are:

- $2\ C_4H_{10} + 13\ O_2 \longrightarrow 8\ CO_2 + 10\ H_2O$
- $2\ C_4H_{10} + 5\ O_2 \longrightarrow 8\ C + 10\ H_2O$

Why are different products formed?

_____

_____

_____

(1)

(c) One other product of the combustion of butane is carbon monoxide.

Balance the equation.

$$\_\_\_\_\ C_4H_{10} + \_\_\_\_\ O_2 \rightarrow \_\_\_\_\ CO + \_\_\_\_\ H_2O$$

(1)

(d) Carbon dioxide is a greenhouse gas.

Describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.

(4)

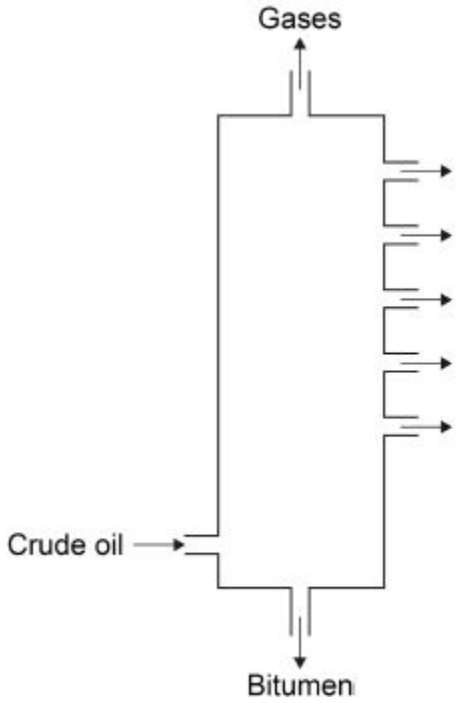
(Total 10 marks)

5. Crude oil is a mixture of hydrocarbons.

(a) The hydrocarbons in crude oil are separated into fractions by fractional distillation.

Figure 1 shows a fractional distillation column.

Figure 1



Crude oil vapour passes up the column.

Complete the sentence.

Choose the answer from the box.

condenses	**dissolves**	**freezes**	**melts**

Each fraction _____ at a different level.

(1)

(b) Why do the fractions separate?

Tick **one** box.

The fractions have different boiling points. ☐

The fractions have different flammability. ☐

The fractions have different melting points. ☐

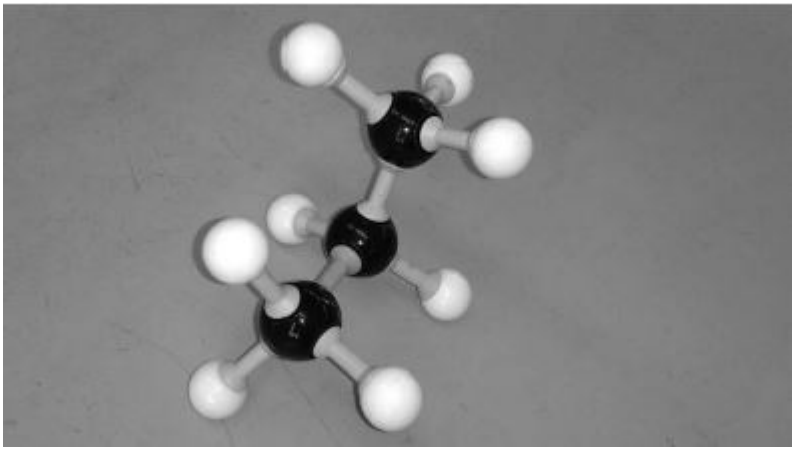
The fractions have different viscosity. ☐

(1)

Most of the hydrocarbons in crude oil are alkanes.

(c) **Figure 2** represents an alkane molecule.

Figure 2



Name the alkane.

_____

(1)

(d) Methane (CH_4) is an alkane.

What is the general formula for alkanes?

Tick **one** box.

C_nH_n ☐

C_nH_{2n} ☐

C_nH_{2n-2} ☐

C_nH_{2n+2} ☐

(1)

(e) Alkanes burn in oxygen.

Balance the equation for methane burning.

$$\_\_\_\_\_CH_4 + \_\_\_\_\_O_2 \rightarrow \_\_\_\_\_CO_2 + \_\_\_\_\_H_2O$$

(1)

(f) Ethene is an alkene.

Which reagent is used to test for alkenes?

Tick **one** box.

Anhydrous copper sulfate ☐

Bromine water ☐

Damp litmus paper ☐

Limewater ☐

(1)

The table below shows data from a life cycle assessment (LCA) for the disposal of 10 000 biodegradable plastic bags.

	Burning and using the energy to generate electricity	**Landfill**
Mass of carbon dioxide produced in kg	25	15
Mass of solid residue in kg	0.050	0.070
Mass of sulfur dioxide produced in kg	0.20	0.30

(g) Why are life cycle assessments (LCA) done?

_____

_____

(1)

(h) Compare the **two** methods for the disposal of biodegradable plastic bags.

Use information from the table above.

_____

_____

_____

_____

_____

_____

_____

_____

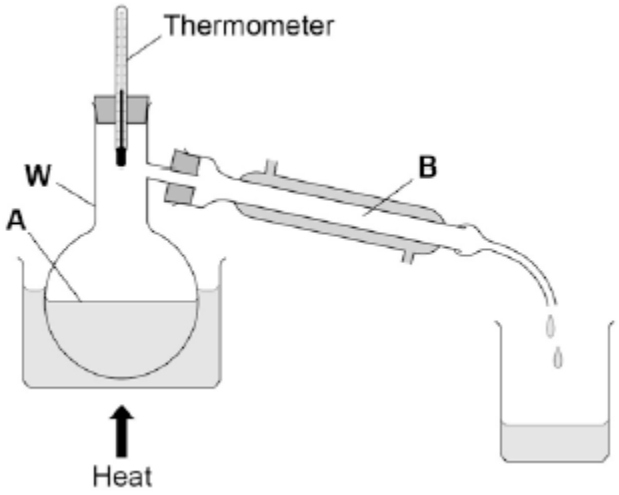
_____

_____

(4)

(Total 11 marks)

6. The apparatus in the figure below is used to separate a mixture of liquids in a fuel.



(a) What is apparatus **W** on above the figure above?

Tick **one** box.

Beaker ☐

Boiling Tube ☐

Flask ☐

Jug ☐

(1)

(b) What is the name of this method of separation?

Tick **one** box.

Crystallisation ☐

Electrolysis ☐

Filtration ☐

Distillation ☐

(1)

(c) Name the changes of state taking place at **A** and **B** in the figure above.

Use words from the box.

boiling	**condensing**	**freezing**	**melting**

Change of state at **A**: _____

Change of state at **B**: _____

(2)

(d) **Table 1** shows the boiling points of the hydrocarbons in the fuel.

Table 1

Hydrocarbon	Boiling point in °C
Pentane	36
Hexane	69
Heptane	98
Octane	125

Which hydrocarbon will be the last to collect in the beaker?

Tick **one** box.

Pentane ☐

Hexane ☐

Heptane ☐

Octane ☐

(1)

(e) The fuel is a mixture of liquids that has been designed as a useful product.

What name is given to this type of mixture?

Tick **one** box.

- Catalyst ☐
- Formulation ☐
- Polymer ☐
- Solvent ☐

(1)

(f) Describe how this fuel is different from crude oil.

_____

_____

_____

_____

(2)

(g) A student measured the melting point of a solid hydrocarbon four times.

The student's results are in **Table 2**.

Table 2

	Trial 1	Trial 2	Trial 3	Trial 4
Melting point in °C	35	48	37	37

Calculate the mean melting point of the hydrocarbon, leaving out any anomalous result.

Give your answer to two significant figures.

_____

_____

Mean melting point = _____ °C

(2)

(Total 10 marks)

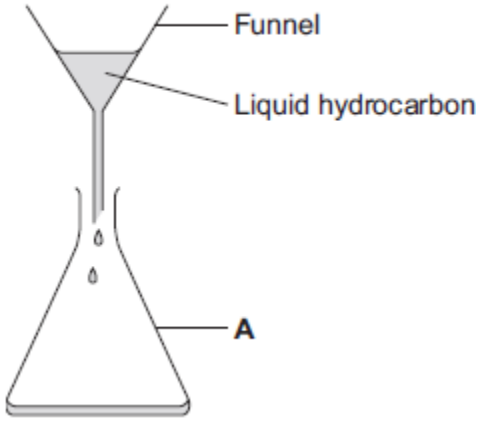
7. A student investigated the viscosity of liquid hydrocarbons.

A viscous liquid is a liquid that flows slowly.

The student used this method.

- Measure 50 cm^3 of the liquid hydrocarbon.
- Pour the liquid hydrocarbon into the funnel, as shown in **Figure 1**.

Figure 1



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

(a) (i) Give the name of apparatus **A** in **Figure 1**.

_____

(1)

(ii) Name the apparatus that could be used to measure 50 cm^3 of liquid hydrocarbon.

_____

(1)

(b) 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_5H_{12}	12	11	13	12
C_6H_{14}	14	15	15	15
C_7H_{16}	19	20	18	
C_8H_{18}	27	26	28	27
$C_{10}H_{22}$	46	48	24	47
$C_{12}H_{26}$	65	67	69	67

(i) The student did the experiment three times with each liquid hydrocarbon.

Give **two** reasons why.

_____

_____

_____

_____

(2)

(ii) Use the data in **Table 1** to calculate the mean time, in seconds, for C_7H_{16}

_____

_____

Mean time = _____ seconds

(1)

(iii) Complete the sentence.

As the number of carbon atoms in a molecule of liquid hydrocarbon increases, the time taken for the liquid hydrocarbon to run out of the funnel

_____ .

(1)

(iv) A ring has been drawn around one result in **Table 1**.

This result has **not** been used to calculate the mean time for $C_{10}H_{22}$

Suggest why this result was not used.

_____

_____

(1)

(v) Suggest **one** error the student may have made to get the ringed result.

_____

_____

_____

(1)

(c) The student investigated the effect of temperature on the viscosity of one of the liquid hydrocarbons.

The liquid hydrocarbon he was using had the hazard symbols shown in **Figure 2**.

Figure 2

(i) Suggest why the student warmed the liquid hydrocarbon using warm water and **not** a Bunsen flame.

_____

_____

(1)

(ii) The student wore safety glasses.

Give **one** other safety precaution the student should take, and give a reason for this safety precaution.

Safety precaution _____

Reason _____

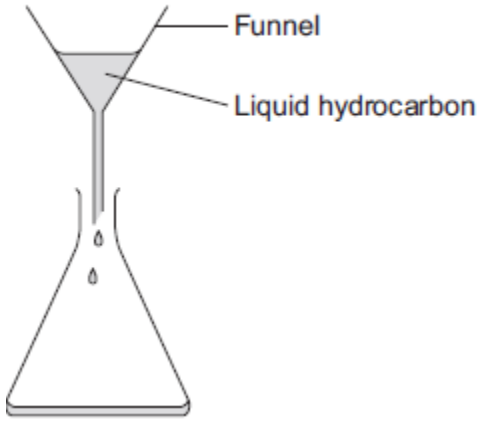
_____

(2)

(d) This is the method the student used to investigate the effect of temperature on the viscosity of one of the liquid hydrocarbons.

- Measure 50 cm^3 of the liquid hydrocarbon and pour it into a beaker.
- Stand the beaker of liquid hydrocarbon in a heated water bath.
- Leave for a few minutes.
- Measure the temperature of the liquid hydrocarbon.
- Pour the liquid hydrocarbon into the funnel, as shown in **Figure 3**.

Figure 3



- Time how long it takes for all of the liquid hydrocarbon to run out of the funnel.
- Repeat the experiment at different temperatures.

(i) The student's results are shown in **Table 2**.

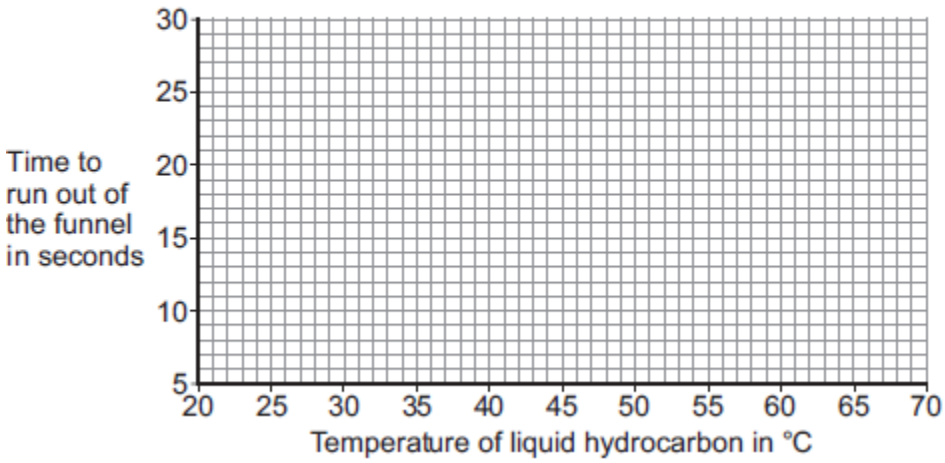
Table 2

Temperature of liquid hydrocarbon in °C	Time to run out of the funnel in seconds
23	27
30	21
37	17
46	16
55	11
65	9

Plot the results shown in **Table 2** on the graph in **Figure 4**.

Draw a curve of best fit.

Figure 4



(3)

(ii) One of the points is anomalous.

Draw a ring around the anomalous point on your graph.

(1)

(iii) Predict how long it will take the liquid hydrocarbon to run through the funnel at 70 °C.

Show your working on your graph.

Time = _____ seconds

(2)

(iv) Describe the relationship between the temperature of the liquid hydrocarbon and the viscosity of the liquid hydrocarbon.

(3)

(v) The apparatus the student used in **Figure 2** could lead to a systematic error in the results.

Identify **one** source of systematic error, and describe how the student could avoid or reduce the error.

(2)

(Total 22 marks)

1.

(a) plankton

allow biomass
allow (marine) animals / organisms
ignore plants

1

buried in mud

allow compressed under mud
allow compressed in sedimentary rock
ignore fossilised

1

over a long period of time
or
over millions of years

1

(b) crude oil heated

1

(hydrocarbons / liquids) evaporate

allow (hydrocarbons / liquids) vaporise / boil

1

vapours / gases condense

1

fractions have different boiling points
or
fractions collect at different levels depending upon boiling point

1

(c) C_nH_{2n+2}

1

(d) *max **2** marks for incorrect reference to particles **/** bonds*

allow converse

the boiling point increases as the number of (carbon) atoms increases

1

(because the weak) intermolecular forces increase
or
(because the weak) forces between the molecules increase

1

(and these intermolecular forces increase) as the size of the molecules increases

1

(e) *MP2 dependent on correct response in MP1*

(as number of carbon atoms increase) the time increases

1

(because) the viscosity increases

1

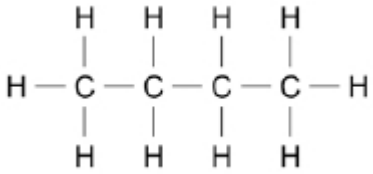
[13]

2. (a) any **two** from:

- high temperature
  ignore heat / hot
  allow a temperature between 400 °C and 900 °C
- catalyst
  allow aluminium oxide, alumina, porous pot, zeolites
- steam
- high pressure
- low oxygen atmosphere

2

(b)



all bonds and atoms must be present

1

(c) carbon dioxide

allow CO_2

1

water

allow H_2O

1

(d) bromine (water)

*do **not** accept bromide*

1

turns (from orange / brown / yellow to) colourless

MP2 is dependent on MP1
allow decolourises
ignore clear

1

(e) sustainable development

1

[8]

3.

(a) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

allow multiples

1

(b) *MP2 is dependent upon correct response in MP1*

(bubble gas through) lime water

allow (bubble gas through) calcium hydroxide (solution)

1

turns milky / cloudy / white
or
white precipitate forms

1

(c) C_3H_6

1

(d) *MP2 is dependent upon correct response in MP1*

burning / lit splint

allow flame
*do **not** accept glowing splint*

1

burns with a (squeaky) pop sound

allow pops

1

(e) bromine (water)

*do **not** accept bromide*

1

(colour change) orange*

1

(to) colourless*

**allow 1 mark for colourless (to) orange*
ignore clear

1

[9]

4. (a)

*maximum of **3** marks if incorrect reference made to cracking*
ignore fractional distillation
ignore fracking

heat or vaporise (oil)

1

temperature gradient in column

allow column is cooler at the top
or
allow column is hotter at the bottom

1

(vapour) condenses (into fractions)

1

depending on boiling point of fraction

allow at different levels

1

(b) different amounts of oxygen available

*allow complete combustion **and** incomplete / partial combustion*

1

(c) $2\ C_4H_{10} + 9\ O_2 \longrightarrow 8\ CO + 10\ H_2O$

allow correct multiples / halves

1

(d) short wavelength radiation which enters the atmosphere

because uv / ultra violet radiation which enters the atmosphere

1

is absorbed by materials **and** re-emitted

1

as a longer wavelength radiation

as ir / infrared radiation

1

(the longer wavelength radiation is trapped by) a greenhouse gas / carbon dioxide / methane which stops radiation escaping (from the atmosphere)

allow so temperature increases

1

[10]

5. (a) condenses

1

(b) the fractions have different boiling points

1

(c) propane

*do **not** accept propene*

1

(d) C_nH_{2n+2}

1

(e) $CH_4 + \mathbf{2}\ O_2 \longrightarrow CO_2 + \mathbf{2}\ H_2O$

allow multiples

1

(f) bromine water

1

(g) to assess the environmental impact (of the stages in the life of a product)

allow to see the effect / harm / damage on the Earth / environment / planet

ignore references to energy, pollution, carbon footprint, carbon dioxide, sustainability

1

(h) **Level 2:** Scientifically relevant features are identified; the ways in which they are similar / different is made clear and the magnitude of the similarity / difference noted.

3–4

Level 1: Relevant features are identified and differences noted.

1–2

No relevant content

0

Indicative content

- burning 10 000 bags produces 10 kg more of carbon dioxide than landfill
- putting 10 000 bags in landfill produces 0.02 kg more of solid residue than burning
- putting 10 000 bags in landfill produces 50% more sulfur dioxide than burning
- burning 10 000 bags produces 25 kg of carbon dioxide, but landfill only produces 15 kg
- putting 10 000 bags in landfill produces 0.07 kg of solid residue but burning only produces 0.05 kg
- landfill produces less carbon dioxide than burning
- landfill produces more solid residue than burning
- burning produces less sulfur dioxide than landfill

[11]

6.

(a) Flask

1

(b) Fractional distillation

1

(c) **A** – boiling

in this order

1

B – condensing

1

(d) Octane

1

(e) Formulation

1

(f) the fuel is a pure compound

1

and crude oil is a mixture

or

the fuel is made up of four hydrocarbons

allow crude oil contains a large number of compounds and the fuel contains four

and crude oil could have many more

1

(g) (35 + 37 + 37 / 3) = 36.33

1

36

1

*allow (35 + 48 + 37 + 37 / 4 =) 39(.25) for **1** mark*

[10]

7. (a) (i) (conical) flask

1

(ii) measuring cylinder / pipette / burette

1

(b) (i) any **two** from:
- so anomalous results could be identified / ignored
- so a mean / average could be taken
- (to improve) accuracy

2

(ii) 19

1

(iii) increases / gets longer / gets bigger

1

(iv) anomalous / does not agree with other times for $C_{10}H_{22}$

1

(v) any **one** from:
- shorter hydrocarbon used
- volume of hydrocarbon too small
- started timing late
- stopped timing too early / when liquid left in funnel

*must suggest why the result is **lower** than the others.*

*allow the temperature was higher **or** the students used a wider funnel.*

1

(c) (i) flammable

1

(ii) suitable safety precaution

1

reason that links the safety precaution to the hazard symbols

eg:
- *wear gloves*
- *(because) it is hazardous to health / harmful / toxic / irritant*

or
- *do not pour down sink **or** dispose of properly*
- *(because) it is harmful to the environment / kills fish*

or
- *wear a mask or do it in the fume cupboard or a well-ventilated area*
- *respiratory irritant*

1

(d) (i) points plotted correctly (within half small square)

*all six points correct scores **2***

*3, 4 or 5 points correct scores **1***

2

smooth curve of best fit

1

(ii) point at 46 °C circled

allow point furthest from the line as drawn

1

(iii) working shown on graph

1

value read from graph line drawn (within half small square)

1

(iv) the higher the temperature the lower the viscosity

*allow the higher the temperature the lower / shorter the time taken for **1** mark*

2

non-linear **or** change gets smaller as temperature gets higher

*answer relating temperature to time taken can score a maximum of **2** marks.*

1

(v) identifying source of the error

1

method of avoiding the error

eg:

- *the temperature will drop*
- *insulate the funnel*

or

- *runs out before all added*
- *put a tap on the funnel*

1

[22]