Organic Chemistry 3

Name: _____

Class: _____

Date: _____

Time: **70 minutes**

Marks: **64 marks**

Comments:

1. Crude oil is a resource found in rocks.

(a) What is crude oil produced from?

Tick (✓) **one** box.

Microbes ☐

Plankton ☐

Water ☐

(1)

(b) Most of the compounds in crude oil are made of carbon and hydrogen atoms only.

What name is given to compounds made of carbon and hydrogen atoms only?

Tick (✓) **one** box.

Fertilisers ☐

Halogens ☐

Hydrocarbons ☐

(1)

(c) Crude oil found in different areas has different compositions.

Table 1 shows the percentage (%) composition of crude oil from two different areas.

Table 1

	Percentage (%) of component	
Component	**Area A**	**Area B**
Diesel oil	18	13
Heavy fuel oil	32	60
Kerosene	12	10
Petrol	38	17

Give **three** differences between the composition of crude oil from area **A** and crude oil from area **B**.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

Table 2 shows the percentage (%) composition of crude oil from area **C**.

Table 2

Component	**Percentage (%) of component from area C**
Diesel oil	15
Heavy fuel oil	42
Kerosene	12
Petrol	31

(d) Calculate the volume of **kerosene** in 160 dm^3 of crude oil from area **C**.

Give your answer to 2 significant figures.

Use **Table 2**.

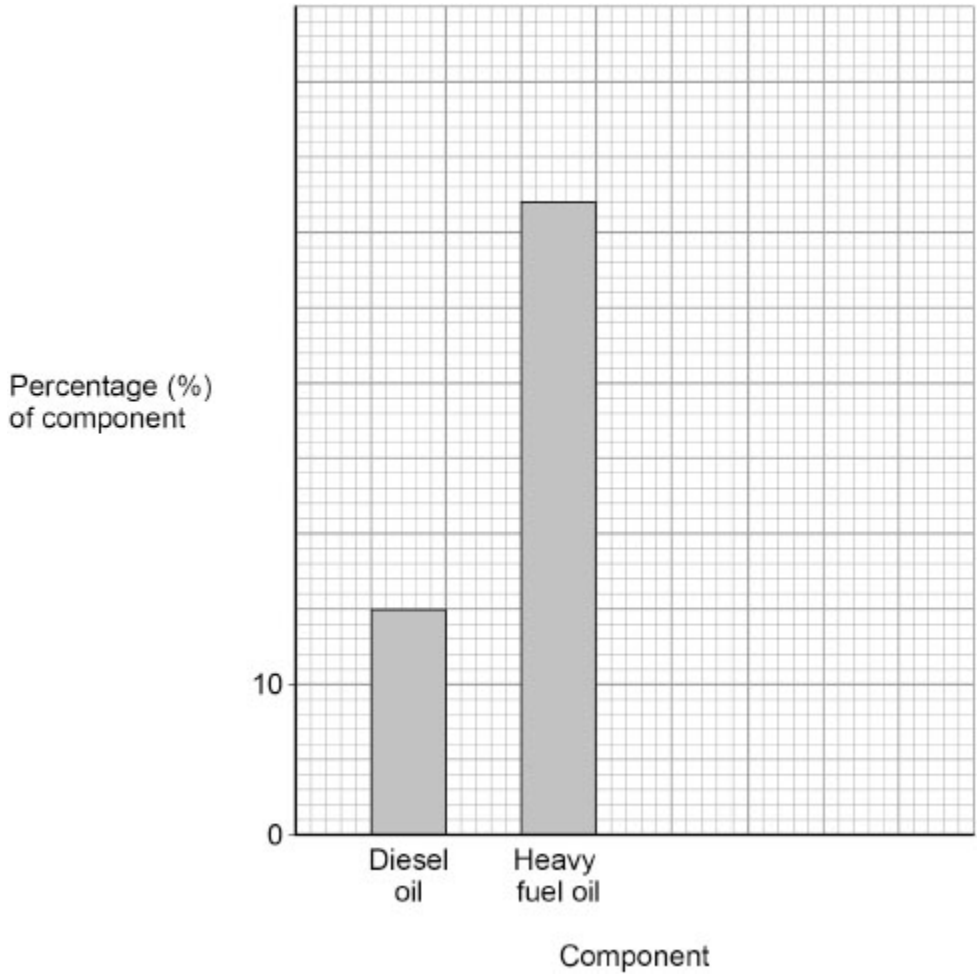
Volume (2 significant figures) = _____ dm^3

(3)

(e) Complete the figure below.

You should:

- complete the scale for the *y*-axis
- plot the data for kerosene and for petrol from **Table 2**
- label the bars for kerosene and for petrol.



(3)

(Total 11 marks)

2. Alkanes and alkenes are hydrocarbons.

(a) Define the term ‘hydrocarbon’.

_____

_____

(1)

(b) The general formula for alkanes is C_nH_{2n+2}

Determine the formula of the alkane with 10 carbon atoms.

_____

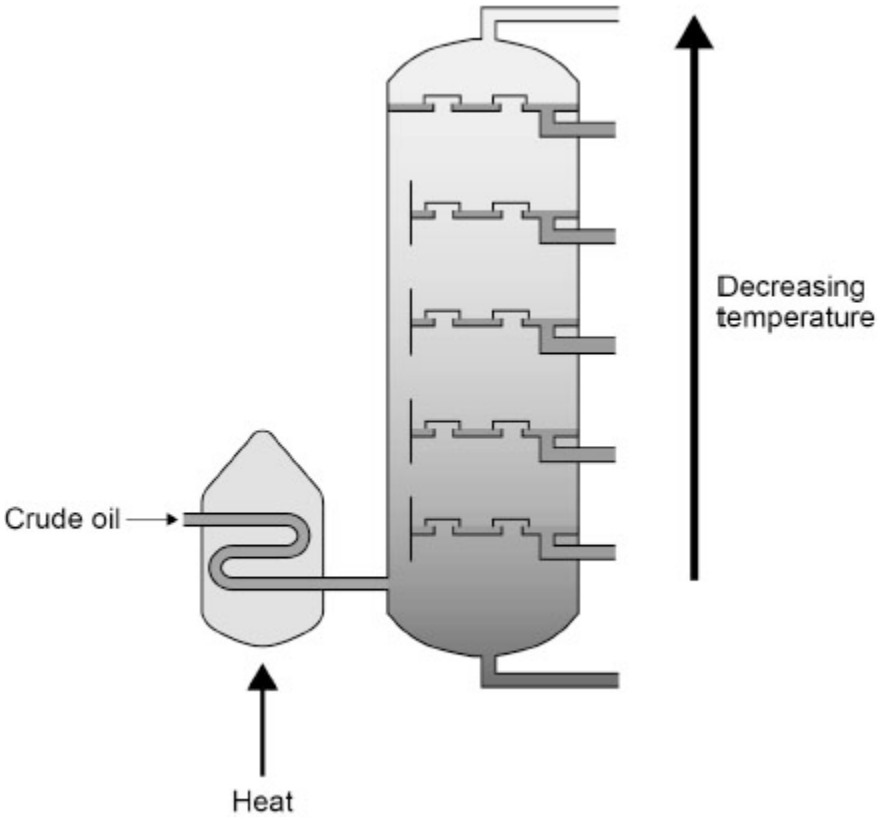
Formula = _____

(1)

(c) Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

(4)

(d) The alkane molecule $C_{14}H_{30}$ can be cracked to produce smaller molecules.

Balance the equation for the reaction.

$$C_{14}H_{30} \rightarrow C_8H_{18} + \_\_\_\_\_ C_3H_6$$

(1)

Propene (C_3H_6) is an alkene.

(e) Describe the test for alkenes.

Give the result.

Test _____

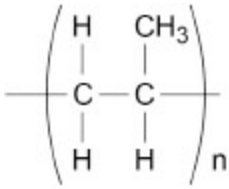
Result _____

(2)

(f) Poly(propene) is made from propene.

Figure 2 represents the repeating unit of poly(propene).

Figure 2



What type of substance is poly(propene)?

_____

(1)

(Total 10 marks)

3. Humans use many different resources.

Water is an important natural resource.

(a) What is meant by 'potable water'?

Tick (✓) **one** box.

Water from the ground ☐

Water that is pure ☐

Water that is safe to drink ☐

(1)

(b) Waste water needs treatment before the water is put back into rivers and the sea.

The first stage of waste water treatment is to pass the waste water through metal grids.

Why is the waste water passed through metal grids?

Tick (✓) **one** box.

To remove dissolved salts	☐
To remove large solid objects	☐
To remove microbes	☐
To remove oxygen gas	☐

(1)

Clothes can be made from different materials.

Some clothes are made from wool and some clothes are made from poly(propene).

(c) One sheep produces 4.5 kg of wool.

50 g of wool is needed to make a hat.

Calculate the number of hats that can be made from the wool of one sheep.

1 kg = 1000 g

_____

_____

_____

_____

_____

Number of hats = _____

(3)

(d) The table below gives information about poly(propene) and wool.

	Poly(propene)	**Wool**
Source of material	Crude oil	Sheep
Level of insulation	High	Medium
Cost	Low	High
Durability	High	Medium

Explain the advantages of using poly(propene) and of using wool for clothing.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e) After being used, clothes can be:

- given to other people to wear
- used to make insulation blocks for buildings.

Complete the sentences.

Choose answers from the box.

recycled	**reduced**	**released**	**reused**	**reversed**

When clothes are given to other people to wear,

the clothes are _____.

When clothes are used to make insulation blocks for buildings,

the clothes are _____.

(2)

Poly(propene) is made from an alkene.

Alkenes are produced by cracking alkanes.

(f) A high temperature is used for cracking alkanes.

Which **two** of the following can also be used to crack alkanes?

Tick (✓) **two** boxes.

A catalyst ☐

A solvent ☐

Carbon dioxide ☐

Steam ☐

Sulfuric acid ☐

(2)

(g) Which chemical is used to test for alkenes?

Tick (✓) **one** box.

Ammonia ☐

Bromine water ☐

Copper sulfate ☐

Nitrogen ☐

(1)

(Total 14 marks)

4. Dodecane is an alkane.

(a) The general formula for alkanes is C_nH_{2n+2}

A molecule of dodecane has 12 carbon atoms.

Complete the formula of dodecane.

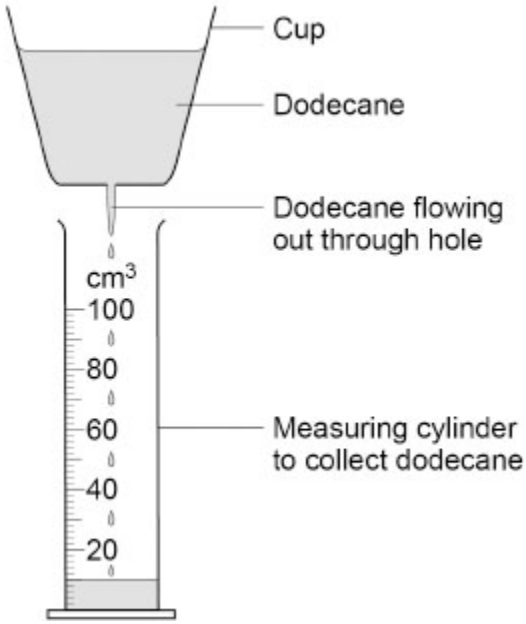
C_____ H_____

(1)

A student investigated the effect of changing the temperature on the viscosity of dodecane.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Add 100 cm^3 of dodecane at 25 °C to the cup.
2. Immediately start a timer.
3. Stop the timer when 40 cm^3 of dodecane has been collected in the measuring cylinder.
4. Record the time taken.
5. Repeat steps 1 to 4 using dodecane at different temperatures.

(b) The student used a water bath to heat the dodecane.

Suggest **one** reason why the student used a water bath instead of a Bunsen burner to heat the dodecane.

_____

_____

(1)

(c) Give **one** control variable used in the investigation.

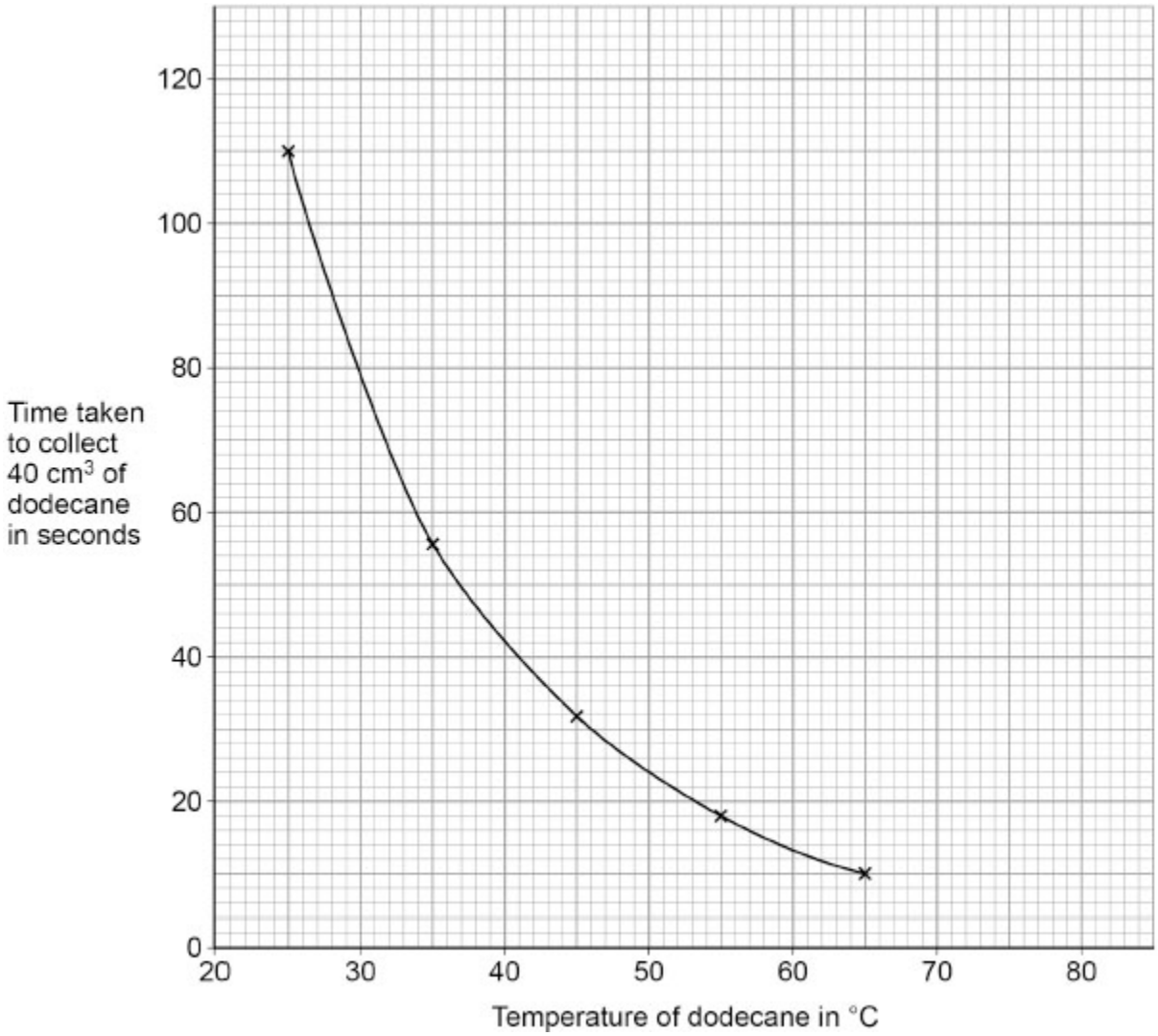
_____

_____

(1)

Figure 2 shows the results.

Figure 2



(d) Predict the time taken to collect 40 cm^3 of dodecane at 75 °C.

You should extend the line of best fit on **Figure 2**.

Time taken = _____ s

(2)

(e) The higher the viscosity, the slower dodecane flows.

Explain how the trend in **Figure 2** shows the effect of an increase in temperature on the **viscosity** of dodecane.

_____

_____

_____

_____

(2)

(Total 7 marks)

5. Some fractions of crude oil are processed to produce fuel for transport.

(a) Describe how crude oil was formed.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Transport is a source of atmospheric pollutants.

(b) Suggest how sulfur dioxide can be produced by transport.

_____

_____

_____

_____

(2)

(c) Give **two** problems caused by sulfur dioxide as an atmospheric pollutant.

1 _____

_____

2 _____

_____

(2)

(d) Describe how carbon monoxide can be produced by transport.

_____

_____

_____

_____

(2)

(e) Catalytic converters are fitted to car exhausts to reduce the amount of pollution from cars.

Carbon monoxide and nitrogen dioxide (NO_2) react in a catalytic converter.

Nitrogen and carbon dioxide are produced.

Write a balanced equation for the reaction.

_____ + _____ → _____ + _____

(2)

(Total 12 marks)

6. Crude oil contains a large number of hydrocarbons.

(a) Crude oil is a finite resource.

What is a finite resource?

Tick (✓) **one** box.

A limited resource ☐

A renewable resource ☐

A sustainable resource ☐

(1)

(b) What is crude oil formed from?

Tick (✓) **one** box.

Plankton ☐

Volcanoes ☐

Water ☐

(1)

(c) What type of substance is crude oil?

Tick (✓) **one** box.

Compound ☐

Element ☐

Mixture ☐

(1)

(d) The hydrocarbons in crude oil are separated into fractions using fractional distillation.

Complete the sentences.

Choose answers from the box.

condense	**evaporate**	**freeze**	**melt**

In fractional distillation the crude oil is heated so

the hydrocarbons _____.

The fractions collect as the hydrocarbons cool and _____.

(2)

Hydrocarbons can be cracked to produce more useful molecules.

(e) Complete the sentence.

Choose the answer from the box.

alloys	**fertilisers**	**fuels**

Some products of cracking are useful as _____.

(1)

(f) Hydrogen gas is a product of cracking.

What is used in the test for hydrogen gas?

Tick (✓) **one** box.

Burning splint ☐

Glowing splint ☐

Limewater ☐

(1)

(g) 5.20 kg of crude oil contains 1.53 kg of LPG (Liquefied Petroleum Gas).

Calculate the percentage (%) of LPG in 5.20 kg of crude oil.

Give your answer to 3 significant figures.

Percentage (3 significant figures) = _____ %

(3)

(Total 10 marks)

1.

(a) plankton

1

(b) hydrocarbons

1

(c) any **three** from:
(crude oil from area **A** contains)
- more diesel (oil)
- less heavy fuel oil
- more kerosene
- more petrol

*allow converse if clearly stated as referring to area **B***

*allow the highest percentage in area **A** is petrol and in area **B** is heavy fuel oil*

3

(d) (volume of kerosene =)
$\frac{12}{100} \times 160$

1

= 19.2

1

= 19 (dm^3)

allow an answer correctly rounded to 2 significant figures from an incorrect calculation which uses 160 dm^3 and a component percentage

1

(e) (*y*-axis 0, 10) 20, 30, 40 (50)

ignore intermediate values

1

bar correctly plotted and labelled for kerosene

allow a tolerance of ± ½ a small square

1

bar correctly plotted and labelled for petrol

*if both bars incorrectly / not labelled allow **1** mark for both bars correctly plotted*

1

[11]

2.

(a) (molecules) made up of carbon and hydrogen (atoms only)

1

(b) $C_{10}H_{22}$

1

(c) (crude oil) is heated

1

(so some of the hydrocarbons) vaporise

1

the column has a temperature gradient

allow the column gets cooler going up

1

(so) the hydrocarbons / fractions condense at different heights / temperatures in the column
or
(and) the hydrocarbons / fractions condense at their boiling points

1

(d) $C_{14}H_{30} \rightarrow C_8H_{18} + \mathbf{2}\ C_3H_6$

1

(e) add bromine (water)

1

(bromine water) changes (from orange) to colourless

allow (bromine water) decolourises

ignore clear

MP2 is dependent on MP1 being awarded

1

(d) polymer

allow plastic

allow hydrocarbon

1

[10]

3. (a) water that is safe to drink

1

(b) to remove large solid objects

1

(c) (conversion 4.5 kg =) 4500 (g)

1

$$\text{(number of hats =)}\ \frac{4500}{50}$$

allow correct use of incorrect / no conversion

1

= 90

alternative approach

(conversion 50 g =) 0.05 (kg) (1)

$$\text{(number of hats =)}\ \frac{4.5}{0.05}\ (1)$$

allow correct use of incorrect / no conversion

= 90 (1)

1

(d) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account

3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1-2

No relevant content

0

Indicative content

(poly(propene) has)

- higher level of insulation
  - (so) keeps the wearer warmer
- lower cost
  - (so) the clothes are cheaper
- higher durability
  - (so) the clothes last longer

(wool is)

- sheep are a renewable resource
  - so are sustainable

for **Level 2** there must be an advantage for both poly(propene) and wool plus a linked explanation

(e) reused

1

recycled

1

must be in this order

(f) a catalyst

1

steam

1

(g) bromine water

1

[14]

4. (a) $C_{12}H_{26}$

1

(b) any **one** from:

- (a water bath) will control the temperature
- (a water bath) will not set dodecane on fire

allow dodecane is flammable

1

(c) volume of dodecane

1

(d) line extrapolated to 75 °C

1

value at 75 °C read from extrapolated line

allow a tolerance of ± ½ a small square

1

(e) as the temperature increases the time taken decreases

ignore references to rate

1

(so) the viscosity decreases

1

[7]

5. (a) plankton (died)

allow (remains of) ancient biomass

1

and were buried (in mud)

allow and were buried (by sediments)

1

and were compressed

1

over millions of years

1

(b) (some) fuels contain sulfur

allow a named fossil fuel for fuels

1

(which) reacts with oxygen to produce sulfur dioxide

1

(c) acid rain

allow a specific effect of acid rain

1

respiratory problems (in humans)

allow named respiratory problem eg asthma

1

(d) fuels are burnt

allow a named fossil fuel for fuels

1

in insufficient / limited oxygen

allow (carbon monoxide is) produced by incomplete combustion

1

(e) $4\ CO + 2\ NO_2 \rightarrow N_2 + 4\ CO_2$

*allow for **1** mark*

$CO + NO_2 \rightarrow N_2 + CO_2$ with no / incorrect balancing numbers

2

[12]

6. (a) a limited resource

1

(b) plankton

1

(c) mixture

1

(d) evaporate

1

condense

1

(e) fuels

1

(f) burning splint

1

(g) (percentage =)

$$\frac{1.53 \times 100}{5.20}$$

1

= 29.42

1

= 29.4 (%)

allow a correctly calculated answer to 3 significant figures from an incorrect calculation which uses values given in the question

1

[10]