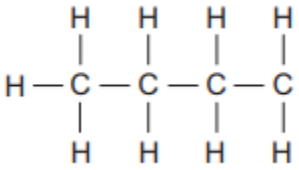
HYDROCARBONS 3

Q1. Crude oil is a mixture of hydrocarbons. Most of these hydrocarbons are alkanes.

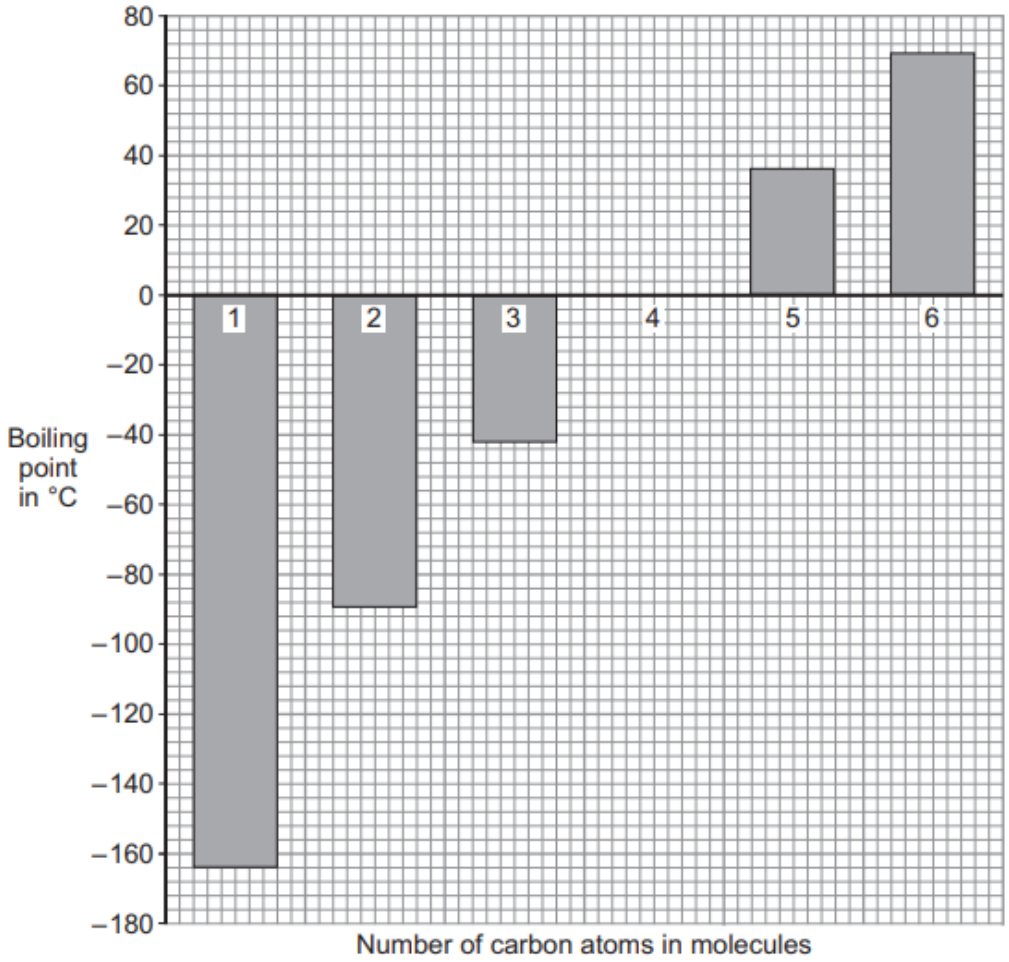
(a) The general formula of an alkane is C_nH_{2n+2}

Complete the structural formula for the alkane that has six carbon atoms in its molecules.



(1 mark)

(b) The boiling points of alkanes are linked to the number of carbon atoms in their molecules.



(i) Describe the link between the number of carbon atoms in an alkane molecule and its boiling point.

_____

_____

(1 mark)

(ii) Suggest two reasons why all of the alkanes in the bar chart are better fuels than the alkane with the formula $C_{30}H_{62}$.

_____

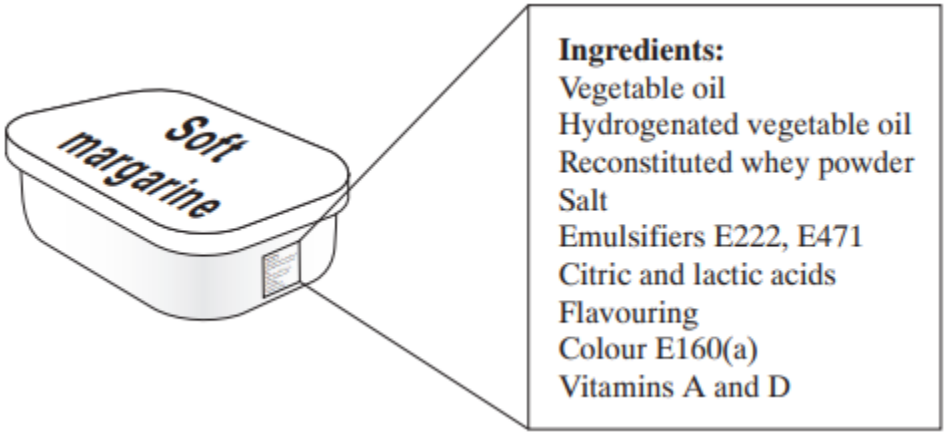
_____

_____

_____

(2 marks)

Q2. Processed food may contain additives. These additives are listed in the ingredients.



The ingredients of soft margarine include hydrogenated vegetable oil.

(i) Why is hydrogenated vegetable oil used in soft margarine?

_____

_____

(1 mark)

(ii) Describe how vegetable oils are hydrogenated.

_____

_____

_____

_____

(2 marks)

Q3. Draw the structure of propene, C_3H_6, to show the covalent bonds.

(1 mark)

Q4. The table shows information about four fuels, **A**, **B**, **C** and **D**.

	Fuel	Type of substance	Number of carbon atoms per molecule	Energy per g of fuel	Mass of carbon dioxide per g of fuel
A	LPG	Alkanes	3 or 4	50 kJ	3.0 g
B	Diesel	Alkanes	16–20	53 kJ	3.1 g
C	Ethanol	Alcohol	2	30 kJ	1.9 g
D	Hydrogen	Element	0	118 kJ	0.0 g

Match fuels, **A**, **B**, **C** and **D**, with the numbers **1**– **4**.

1 This fuel has the lowest boiling point of the fuels that are alkanes.

2 This fuel does not produce carbon dioxide when burned.

3 This fuel gives the least amount of energy per gram when burned.

4 This fuel has the most carbon atoms in its molecules.

(4 marks)

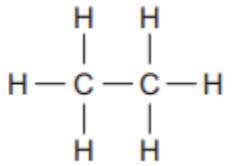
Q5. This question is about four alkanes, A, B, C and D.

	Alkane	Formula	Boiling point in °C
A	Methane	CH_4	−162
B	Ethane	C_2H_6	−89
C	Butane	C_4H_{10}	0
D	Nonane	C_9H_{20}	+150

Match alkanes, A, B, C and D, with the numbers 1– 4 in the sentences.

The alkane with the lowest boiling point is . . . 1 . . . .

The alkane with 14 atoms in each molecule is . . . 2 . . . .

The alkane with the structural formula  is . . . **3** . . . .

The alkane which is least flammable is . . . 4 . . . .

(4 marks)

Q6. Crude oil is a mixture made up mainly of alkanes.

(a) The alkanes are a series of hydrocarbons . . .

1 all of which are gases at room temperature (20°C).

2 that have the general formula CnH2n.

3 in which the molecules have a carbon : hydrogen ratio of 1 : 4.

4 that are saturated.

(1 mark)

Crude oil can be separated into fractions by fractional distillation.

(b) In the fractionating column, the crude oil separates into fractions because . . .

1 the crude oil changes from a liquid into a vapour.

2 the alkanes condense at different temperatures.

3 the crude oil decomposes when it is heated.

4 the alkanes have different densities.

(1 mark)

(c) The petrol fraction has a boiling range from 40°C to 70°C.

The fraction does not have a fixed boiling point because it . . .

1 contains only one alkane.

2 contains several alkanes.

3 collects near the top of the column.

4 decomposes at 40°C.

(1 mark)

(d) The petrol fraction is used as a fuel. Ethanol (C_2H_5OH), made from plant material, can be used as a fuel instead of petrol.

One advantage of ethanol over petrol is that ethanol . . .

1 does not produce carbon dioxide when it burns.

2 is a renewable fuel.

3 produces only water when it burns.

4 is a compound, not a mixture

(1 mark)

Q7. This question is about four carbon compounds that burn in air. Match compounds, A, B, C and D, with the numbers 1– 4 in the table.

A CO

B CS_2

C C_2H_4

D C_3H_8

1	It burns to form carbon dioxide only.
2	It is a hydrocarbon but it is not an alkane.
3	It is in the series with the general formula C_nH_{2n+2}
4	It burns to form carbon dioxide and sulfur dioxide.

.

(4 marks)

Q8. This question is about alkanes.

Alkane	Melting point in °C	Boiling point in °C
Methane, CH_4	−183	−164
Ethane, C_2H_6	−183	−89
Propane, C_3H_8	−190	−42
Butane, C_4H_{10}	−138	−0.5
Pentane, C_5H_{12}	−130	+36

(a) Which of the following is correct?

1 Butane is liquid at room temperature (20°C).

2 These alkanes will be collected separately during the fractional distillation of crude oil.

3 The boiling points of the alkanes decrease as the size of their molecules increases.

4 Pentane is liquid over the greatest range of temperature.

(1 mark)

(b) In the alkane series, which one of the following changes from one alkane to the next?

1 the general formula

2 the number of bonds on each carbon atom

3 the ratio of carbon atoms to hydrogen atoms in each molecule

4 the number of double carbon carbon bonds in each molecule

(1 mark)

(c) The general equation below represents the burning of an alkane in excess of oxygen.

$$C_wH_x + (w + \frac{x}{y})O_2 \rightarrow wCO_2 + (\frac{x}{2})H_2O$$

The value of y is . . .

1 1

2 2

3 4

4 8

(1 mark)

(d) The complete combustion of a molecule of propane . . .

1 produces less carbon dioxide than the complete combustion of a molecule of butane.

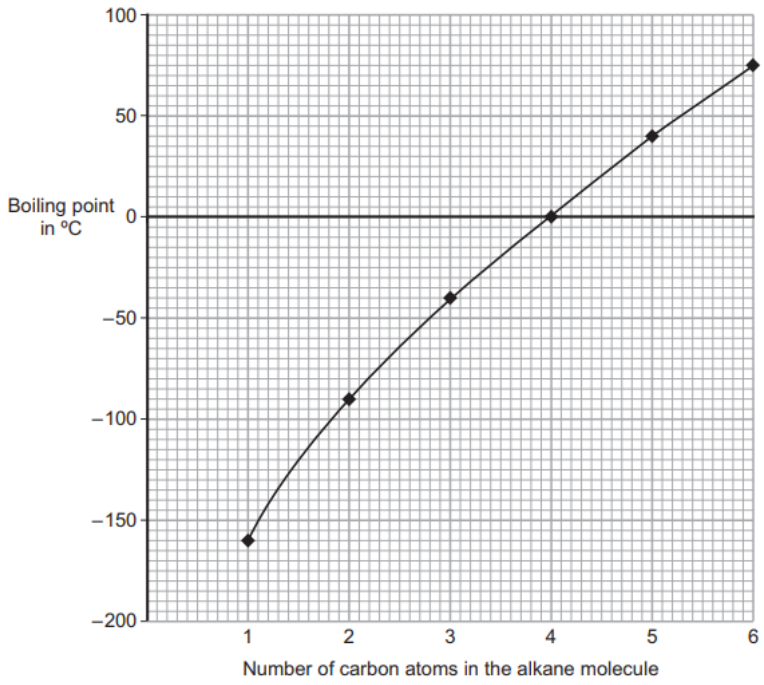
2 requires more oxygen than the complete combustion of a molecule of pentane.

3 produces the same ratio of carbon dioxide molecules to water molecules as pentane.

4 requires less oxygen than the complete combustion of a molecule of methane.

(1 mark)

Q9. The general formula for the alkanes is C_nH_{2n+2}. The graph shows the boiling points of six alkanes.



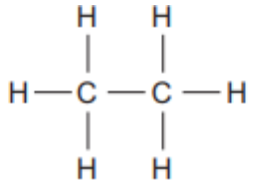
Match values, A, B, C and D, with the numbers 1– 4 in the sentences.

A 0

B 6

C 12

D −90

The alkane with the structural formula  has a boiling point of . . . **1** . . . °C.

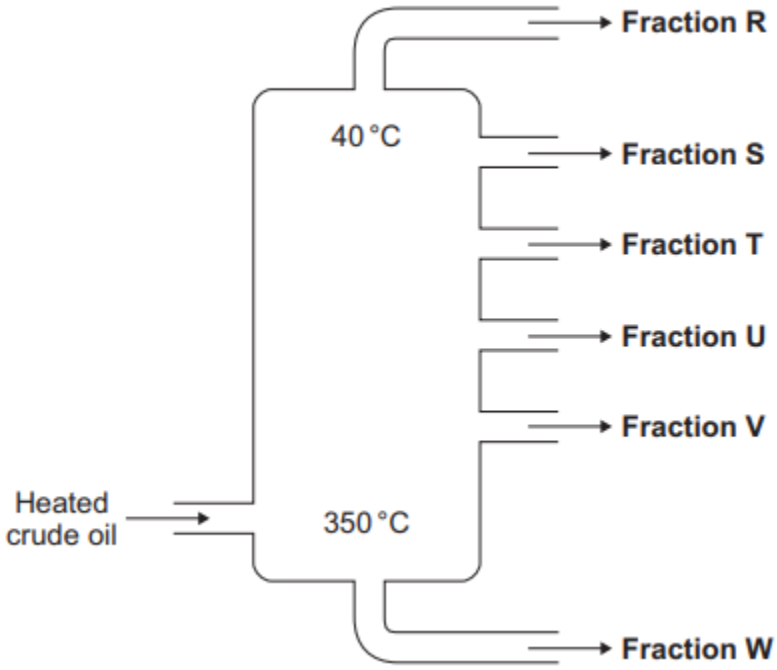
The boiling point of the alkane with four carbon atoms in each molecule is . . . 2 . . . °C.

The alkane that is a liquid at 50 °C has . . . 3 . . . carbon atoms in each molecule.

The alkane with five carbon atoms has . . . 4 . . . hydrogen atoms in each molecule.

(4 marks)

Q10. The diagram shows a fractionating column.



(a) Each fraction collected is . . .

1 a single alkane.

2 a mixture of alkanes with similar boiling points.

3 a mixture of alkanes with the same chemical formula.

4 a mixture of alkanes that are liquids.

(1 mark)

(b) Which row in the table describes the alkanes in Fraction R?

1	small molecules	are gases
2	small molecules	are liquids
3	large molecules	are gases
4	large molecules	are liquids

(1 mark)

(c) Which statement is correct for the alkanes in Fraction W?

1 they are compounds of carbon, hydrogen and oxygen

2 they have the general formula C_nH_{2n-2}

3 they have boiling points below 100 °C

4 they are saturated compounds

(1 mark)

(d) Fraction T is used to make diesel fuel.

Why are fuel companies producing low-sulfur diesel fuel for use in vehicles?

1 to increase the miles per litre vehicles will travel

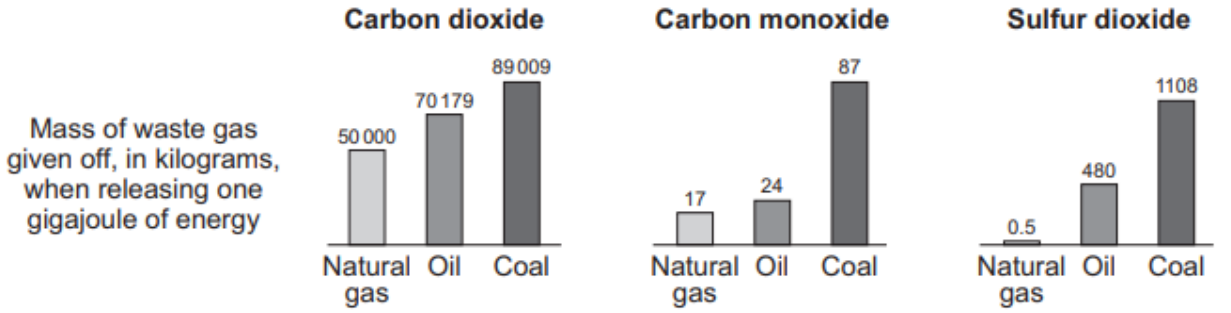
2 to reduce the amount of acid rain

3 to reduce global warming

4 to increase levels of oxygen in the atmosphere

(1 mark)

Q11. Natural gas (mainly methane), oil and coal are burned in power stations. The quantities of the waste gases, carbon dioxide, carbon monoxide and sulfur dioxide produced by burning these fuels are shown in the bar charts.



(a) From the information in the bar charts a correct conclusion is that . . .

1 oil and coal contain hydrocarbons with larger molecules than natural gas.

2 coal undergoes complete combustion but natural gas and oil do not.

3 coal burns to release more energy than oil or natural gas.

4 small volumes of natural gas occur in coal seams.

(1 mark)

Research continues into the use of natural gas in power stations.

The following is an extract from an article in a science journal:

> One potential option for gas-fired power stations is to capture the carbon before the fuel is burned. Natural gas is converted to carbon monoxide and hydrogen. The carbon monoxide is converted to carbon dioxide, which is then removed. The hydrogen is burned in the power station.

The equations below show two reactions that take place:

$CH_4 + H_2O \rightarrow CO + 3H_2$

$CO + H_2O \rightarrow CO_2 + H_2$

(b) Which substances are oxidised in these reactions?

1 carbon monoxide and water

2 carbon monoxide and carbon dioxide

3 methane and carbon monoxide

4 methane and carbon dioxide

(1 mark)

(c) One reason why hydrogen is preferred to the other fuels is that . . .

1 when hydrogen burns there are no waste products.

2 when hydrogen burns only water is produced.

3 hydrogen is very flammable and can burn in the absence of oxygen.

4 hydrogen reacts with carbon monoxide to produce carbon dioxide.

(1 mark)

Total marks (39)