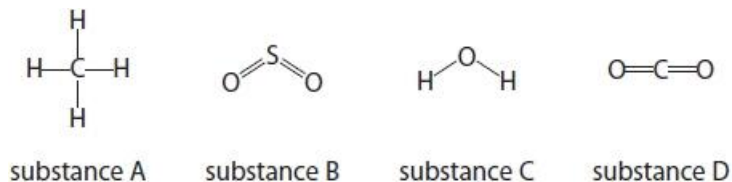


Questions

Q1.

Figure 8 shows one molecule of each of four different substances, **A**, **B**, **C** and **D**.**Figure 8**(i) Substance **C** can be formed by burning an element in oxygen.

Write the word equation for this reaction.

(1)

.....

(ii) Consider substances **A**, **B**, and **D**.

Give the letters of the two substances that can be formed by burning an element in oxygen.

(1)

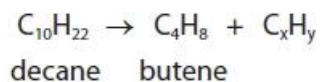
.....

(Total for question = 2 marks)

Q2.

Propene can be produced by the cracking of some hydrocarbons obtained from crude oil.

The equation shows the cracking of one molecule of decane to produce one molecule of butene and one molecule of another product.



(i) Calculate the values of x and y in C_xH_y .

(2)

x = , y =

(ii) State the total mass of products formed if 25 g of decane is cracked in this way.

(1)

.....

(Total for question = 3 marks)

Q3.

Crude oil is found in the Earth's crust.

In January 2015 the United Kingdom produced 850 000 barrels of crude oil per day. 45% of this crude oil was fuel oil.

Calculate the number of barrels of fuel oil present in the 850 000 barrels of crude oil.

Give your answer to two significant figures.

(3)

.....

.....

..... barrels

(Total for question = 3 marks)

Q4.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

(i) Which statement about the members of the alkane homologous series is correct?

(1)

- A they show a trend in chemical properties
 B their boiling point decreases as the molecules get larger
 C the molecular formula of neighbouring compounds differs by CH_3
 C their viscosity increases as the molecules get larger

(ii) Which one of the following hydrocarbons belongs to the same homologous series as octane, C_8H_{18} ?

(1)

- A C_4H_6
 B C_4H_8
 C C_4H_{10}
 D C_4H_{12}

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18} .

(3)

.....
.....

(Total for question = 5 marks)

Q5.

1 mole of pentadecane can be cracked to form 1 mole of octane, C_8H_{18} , and 1 mole of propene, C_3H_6 , and 2 moles of another product.

Complete the balanced equation for this reaction by adding the formula of the missing product.

(1)



(Total for question = 1 mark)

Q6.

When fuels such as diesel oil are burned, the high temperatures produced can cause nitrogen and oxygen in the air to form the pollutant nitrogen dioxide.

Complete the balanced equation for the reaction.

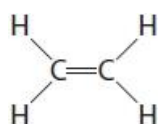


(2)

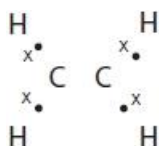
(Total for question = 2 marks)

Q7.

The structure of a molecule of ethene is shown in Figure 8.

**Figure 8**

(i) Figure 9 shows the incomplete dot and cross diagram for a molecule of ethene.

**Figure 9**

Complete Figure 9 to show the electrons of the $\text{C}=\text{C}$ double bond.

(1)

(ii) The incomplete combustion of ethene in air produces water as one of the products.

Give the name of another product of the incomplete combustion of ethene.

(1)

.....

(Total for question = 2 marks)

Q8.

Methane is a hydrocarbon fuel.

(i) Complete the word equation for the **complete** combustion of methane in oxygen.

(2)

methane + → water +
.....

(ii) The **incomplete** combustion of methane can produce carbon and carbon monoxide.

Give the reason why carbon and carbon monoxide are produced in the **incomplete** combustion of methane.

(1)

.....
.....

(Total for question = 3 marks)

Q9.

Crude oil is a complex mixture of substances.

When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 9 shows the relative amounts of six of the fractions present in a crude oil and the relative demand for each of these fractions.

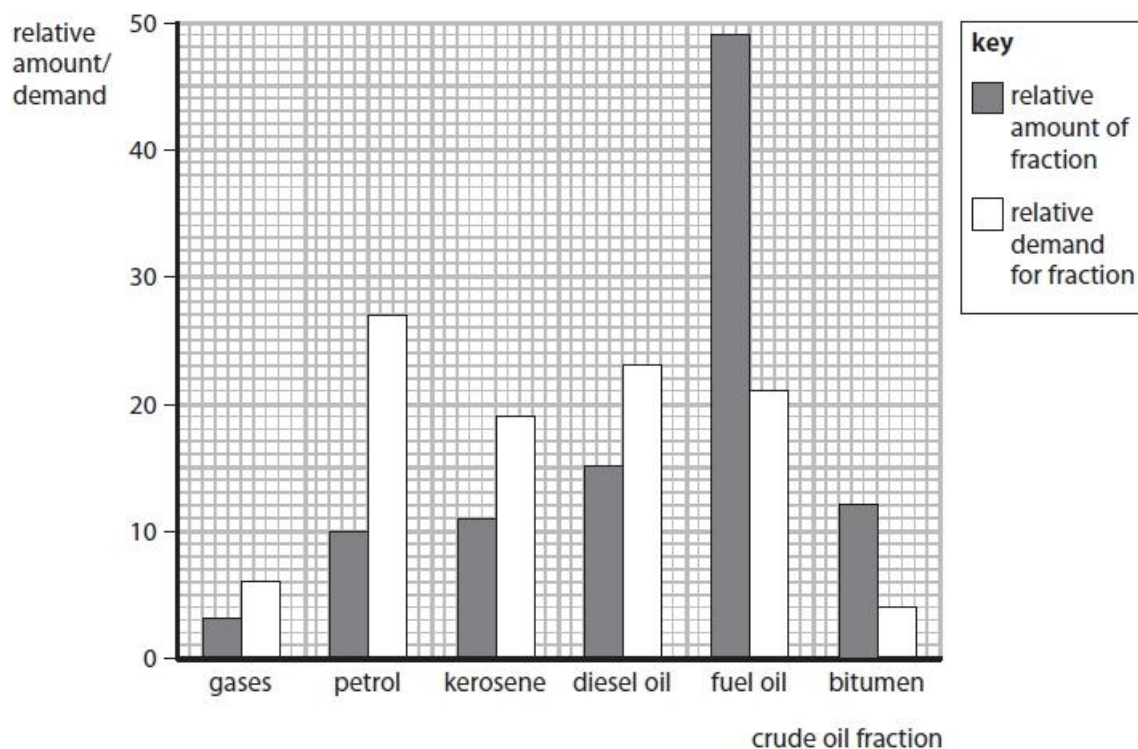


Figure 9

Cracking is used to match the relative amount of a fraction of crude oil to the demand for that fraction.

(i) Use the information in Figure 9 to give the name of the fraction that is most likely to need to be cracked.

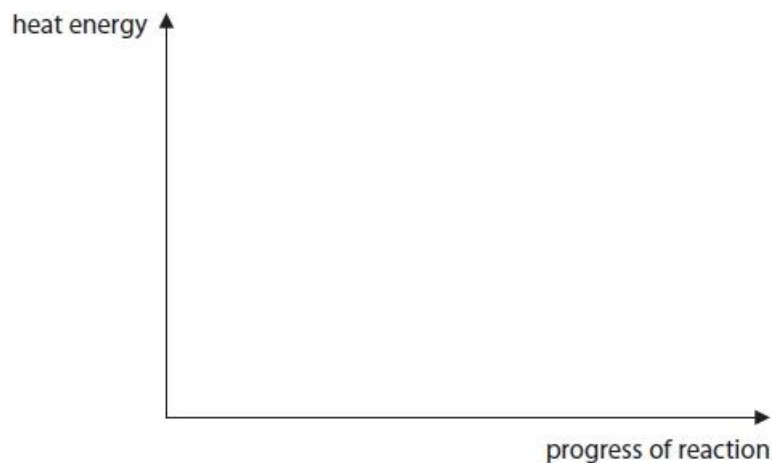
(1)

.....

- (ii) In a cracking reaction, reactants are heated to form products.
This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction.
Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



- (iii) Dodecane, $C_{12}H_{26}$, can be cracked to form useful products.

Complete the equation for the cracking of dodecane by filling in the formula of the single molecule needed to balance the equation.

(1)



(Total for question = 5 marks)

Q10.

Crude oil is found in the Earth's crust.

When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 7 shows the relative amounts of four of the fractions obtained from a crude oil and the relative demand for each of these fractions.

fraction	relative amount obtained from the crude oil	relative demand
gases	5	5
petrol	10	25
kerosene	20	25
fuel oil	45	5

Figure 7

State the fraction for which the relative amount obtained exceeds the relative demand.

(1)

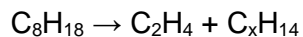
.....

(Total for question = 1 mark)

Q11.

Cracking involves the breaking down of large hydrocarbon molecules into smaller hydrocarbon molecules.

(i) Octane, C_8H_{18} , can be cracked to produce one molecule of ethene, C_2H_4 , and one molecule of C_xH_{14} .



Determine the value of x in the molecule of C_xH_{14} .

(1)

x =

(ii) Dodecane is a large hydrocarbon molecule.

When one molecule of dodecane is cracked the products are one molecule of octane and one molecule of butene.



Calculate the maximum mass of octane that could be produced when 340 g of dodecane is cracked in this reaction.

(relative formula masses: dodecane = 170, octane = 114)

(2)

.....
.....
.....
.....
.....
.....

mass of octane = g

(Total for question = 3 marks)

Q12.

*Petrol and diesel are used as fuels for cars.

The emissions from three similar sized cars were investigated.

The first car was the oldest, had no catalytic converter and used petrol.

The other two cars were only a few years old.

One of these was fitted with a catalytic converter and used petrol and the other car used diesel.

Figure 9 shows the emissions in grams for each kilometre travelled by these three cars.

	emissions in g km ⁻¹			
	carbon monoxide	nitrogen oxides	carbon dioxide	carbon particulates
car with no catalytic converter using petrol	1.60	0.09	180	0.00
car with catalytic converter using petrol	0.67	0.02	180	0.00
car using diesel	0.05	0.19	130	0.02

Figure 9

Discuss and compare the impact on the environment of the emissions from these three cars using the information from Figure 9.

(6)

(Total for question = 6 marks)

Q13.

Crude oil can be separated into different fractions.

Draw **one** straight line from each fraction to a use of that fraction.

(3)

fraction	use
petrol	fuel for aircraft
kerosene	fuel for ships
bitumen	fuel for cars
	making plastic
	extracting iron
	making road surfaces

(Total for question = 3 marks)

Q14.

* Diesel oil can contain impurities of sulfur.

Burning diesel oil containing impurities of sulfur can result in acid rain.

Acid rain is harmful to the environment.

Explain how acid rain is formed and the harm it can do.

(Total for question = 6 marks)

Q15.

Explain how the greenhouse effect is caused by the gases produced by the complete combustion of diesel oil.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q16.

A student carried out an experiment to prove that candle wax, a hydrocarbon, produces carbon dioxide and water vapour when it burns.

The equipment used is shown in Figure 11.

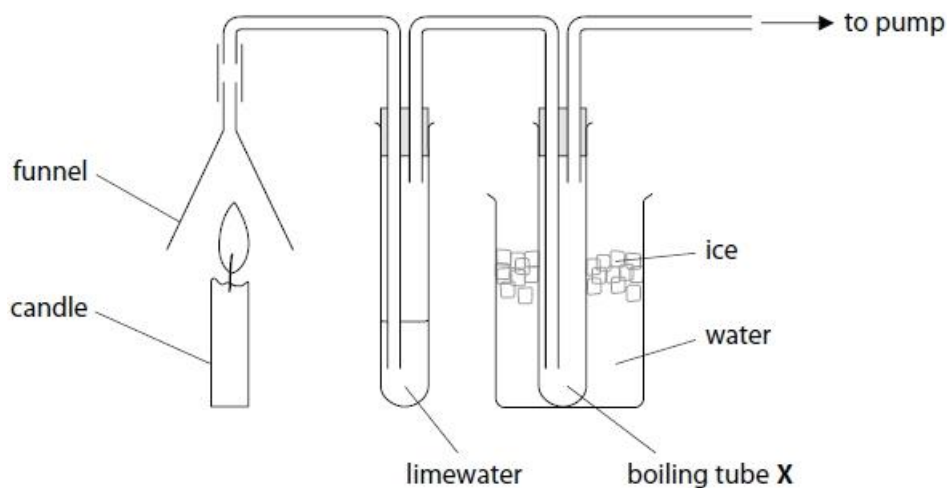


Figure 11

The gas produced from the burning candle is drawn through the apparatus. The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube X. The student claimed that this proved that burning candle wax produced water. The teacher said the apparatus had been set up incorrectly and therefore this conclusion about water was not valid.

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q17.

An impure hydrocarbon fuel is burned in the apparatus in Figure 7.

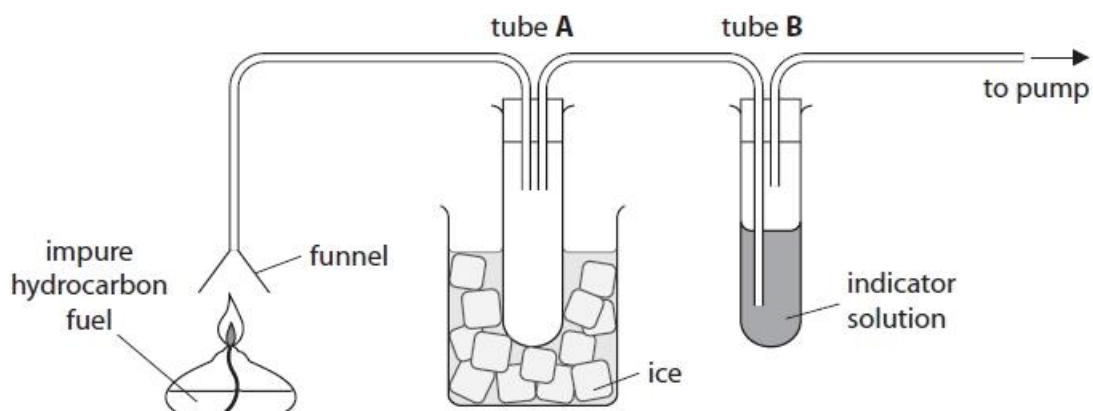


Figure 7

When the fuel is burned

- the funnel becomes hot
- a colourless liquid forms in tube A
- the indicator in tube B changes colour to show an acidic gas. Explain these observations.

(3)

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q18.

Pentadecane, $C_{15}H_{32}$, is a hydrocarbon and is used as a fuel.

The incomplete combustion of pentadecane produces carbon monoxide.
Carbon monoxide is a toxic gas.

(i) Explain why the incomplete combustion of pentadecane can produce carbon monoxide as one of the products.

(2)

.....

.....

.....

.....

(ii) Explain how carbon monoxide behaves as a toxic gas.

(2)

.....

.....

.....

.....

(Total for question = 4 marks)

Q19.

Methane gas, CH_4 , was burned using the apparatus shown in Figure 13.

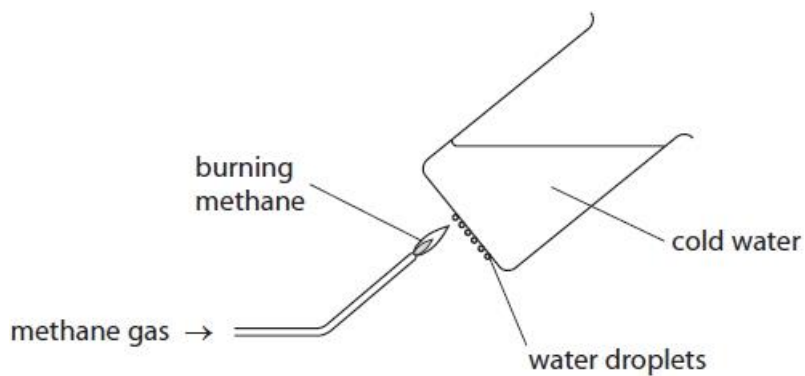


Figure 13

Explain why water droplets form on the bottom of the beaker of cold water.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q20.

Crude oil is found in the Earth's crust.

Which of the statements about crude oil is correct?

- A** crude oil is a finite resource
- B** crude oil is a mixture of the elements hydrogen and carbon
- C** all of the molecules in crude oil contain rings of carbon atoms
- D** crude oil is used in cars as a fuel

(1)

(Total for question = 1 mark)

Q21.

Figure 8 shows one molecule of each of four different substances, **A**, **B**, **C** and **D**.

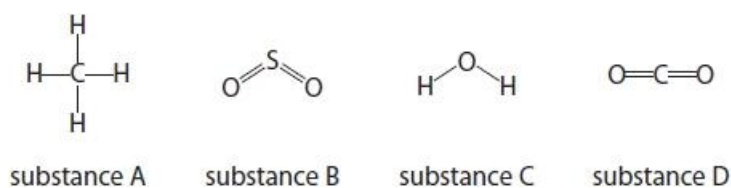


Figure 8

State the formula of a molecule of substance **B**.

(1)

.....

(Total for question = 1 mark)

Q22.

Crude oil is found in the Earth's crust.

(i) Use a word from the box to complete each of the sentences about the fractional distillation of crude oil.

condensed	heated	melted	solidified	stirred
-----------	--------	--------	------------	---------

Each word may be used once, more than once, or not at all.

The separation of crude oil into fractions occurs in a fractional distillation column. (2)

Before crude oil is passed into the column it is

During the distillation, vapour rises up the column until it is cold enough for the vapour to form a liquid. The vapour has been

(ii) Complete this sentence by underlining the correct answer in the box. (1)

Compared with the fraction from the top of the column,

the fraction from the bottom of the column

has more carbon atoms per molecule.
has a lower viscosity.
is easier to ignite.

(Total for question = 3 marks)

Q23.

Crude oil is a complex mixture of substances.

Most of the substances in crude oil are alkanes.

(i) Which of the following is the general formula of an alkane?

(1)

- A** C_nH_{2n}
- B** C_nH_{2n+1}
- C** C_nH_{2n-1}
- D** C_nH_{2n+2}

(ii) Explain why alkanes are described as hydrocarbons.

(2)

.....

.....

.....

.....

(Total for question = 3 marks)

Q24.

Figure 8 shows some information about the composition of pollutant exhaust gases from the engines of two different vehicles.

pollutant	mass of pollutant given out in g per kilometre driven	
	petrol engine	diesel engine
carbon dioxide	210	180
carbon monoxide	1.5	0.10
unburnt hydrocarbons	0.13	0.020
nitrogen oxides	0.36	2.0
particulates	0.0060	0.046
sulfur dioxide	0.0089	0.0037

Figure 8

(i) Give **two** ways in which the data in Figure 8 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

(2)

.....

.....

.....

(ii) Explain, using information from Figure 8, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

.....

.....

.....

(Total for question = 4 marks)

Q25.

Some questions must be answered with a cross in a box () . If you change your mind about an answer, put a line through the box () and then mark your new answer with a cross () .

Figure 8 shows one molecule of a compound obtained from crude oil.

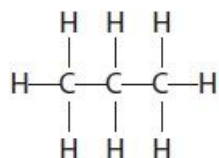


Figure 8

(i) Give the names of the two elements in this molecule.

(2)

.....
.....

(ii) What is the molecule in Figure 8?

(1)

- A an oxide
 B a chain molecule
 C a fullerene
 D a ring molecule

(iii) What is the relative formula mass of the compound in Figure 8?

(relative atomic masses: H = 1.0, C = 12)

(1)

- A 13
 B 42
 C 44
 D 96

(Total for question = 4 marks)

Q26.

Crude oil is a complex mixture of hydrocarbons.

Crude oil can be separated into useful fractions by fractional distillation.

Figure 10 shows a fractional distillation column and the fractions produced when crude oil is distilled.

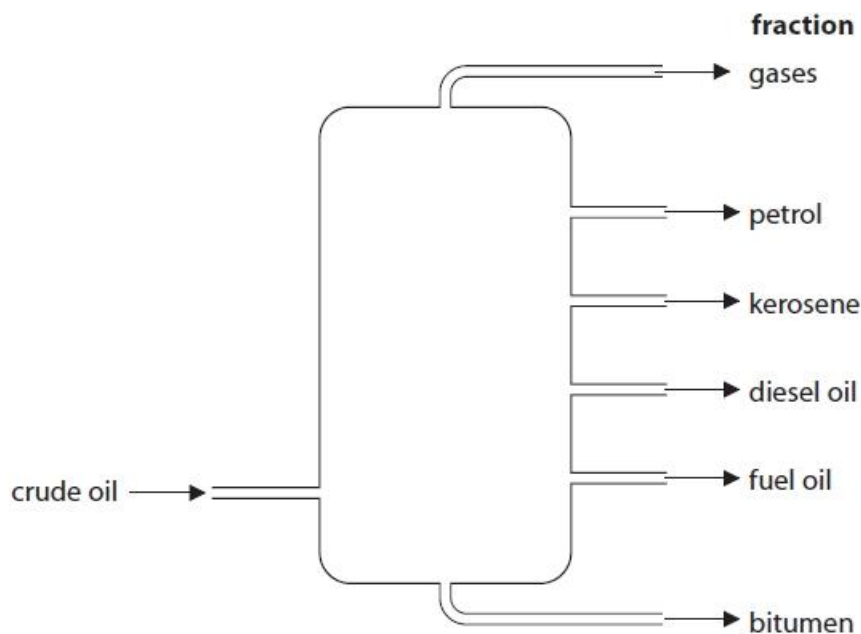


Figure 10

(i) Name the fraction in Figure 10 that is used to surface roads.

(1)

.....

(ii) Name the fraction in Figure 10 that contains hydrocarbons with the lowest boiling point.

(1)

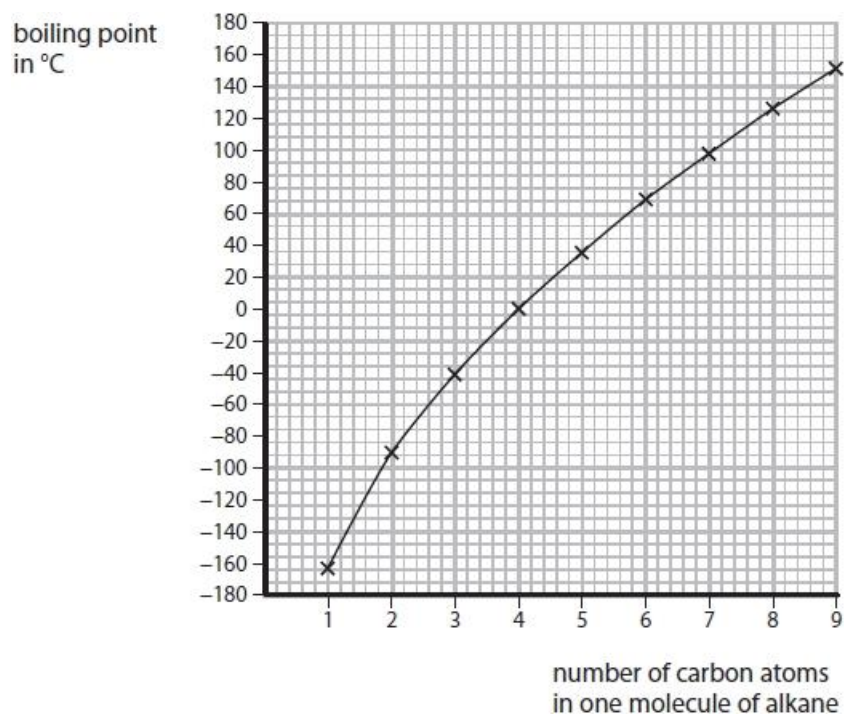
.....

(Total for question = 2 marks)

Q27.

Crude oil is a complex mixture of substances.

Figure 8 shows a graph of the boiling points of some alkanes against the number of carbon atoms in one molecule of each alkane.

**Figure 8**

Explain the pattern shown by this graph.

(2)

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q28.

Diesel oil is a mixture of hydrocarbons that can be obtained from crude oil.

State the name of the process used to separate diesel oil from crude oil.

(1)

.....

(Total for question = 1 mark)

Q29.

Most of the fuels used today are obtained from crude oil.

Figure 14 shows the formulae of a molecule of butane and of a molecule of pentane. Butane and pentane are neighbouring members of the same homologous series.

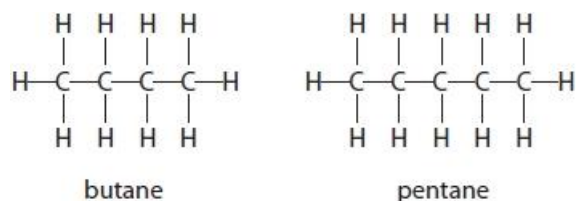


Figure 14

(i) Explain, using these formulae, why butane and pentane are neighbouring members of the same homologous series.

(2)

.....

.....

.....

.....

(ii) Butane has the formula C_4H_{10} .

Calculate the mass of carbon in 100 g of butane.

Give your answer to three significant figures.

(relative atomic masses: $\text{H} = 1.00$, $\text{C} = 12.0$;

relative formula mass: $\text{C}_4\text{H}_{10} = 58.0$)

You must show your working.

(3)

.....

.....

.....

mass of carbon = g

(iii) Butane burns completely in air to form carbon dioxide and water.

Write the word equation for this reaction.

(2)

.....

.....

(Total for question = 7 marks)

Q30.

Most of the fuels used today are obtained from crude oil.

Crude oil is separated into several fractions by fractional distillation.
Two of these fractions are kerosene and diesel oil.

(i) State a use for each of these fractions.

(2)

kerosene

.....

diesel oil

.....

(ii) Figure 13 shows where the fractions kerosene and diesel oil are produced in the fractionating column.

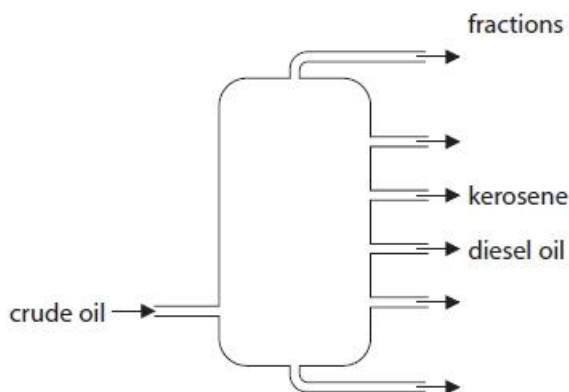


Figure 13

Kerosene is obtained higher up the column than diesel oil.
Kerosene and diesel oil fractions have slightly different properties.
Choose a property.
State how this property for kerosene compares with the property for diesel oil.

(1)

property

.....

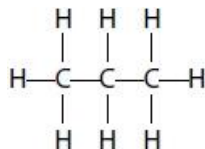
comparison

.....

(Total for question = 3 marks)

Q31.

The structure of a molecule of propane is shown as



Propane can burn completely in oxygen to form carbon dioxide and water.

(i) Write the word equation for this reaction.

(2)

.....

(ii) Propane is a fuel.

Give the reason why fuels are burned.

(1)

.....

.....

(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(i)	hydrogen + oxygen → water	allow $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$: this must be fully correct and balanced with correct subscripts reject 'hydrogen and oxygen', hydrogen oxide, hydrogen hydroxide if word and symbol equation given or mixture of symbols and words, ignore all symbols allow = for →	(1) AO 2 1
Question Number	Answer	Additional guidance	Mark
(ii)	B and D	For B allow SO_2 For D allow CO_2 reject answers containing any other letters/ names	(1) AO 3 2a

Q2.

Question number	Answer	Mark
(i)	$x = 6$ (1) $y = 14$ (1)	(2)
(ii)	25 (g)	(1)

Question number	Answer	Additional guidance	Mark
(iii)	$2 \text{C}_8\text{H}_{18} + 25 \text{O}_2 \rightarrow 16 \text{CO}_2 + 18 \text{H}_2\text{O}$ LHS formulae → (1) → RHS formulae (1) balancing correct formulae (1)	allow multiples including halves ignore any state symbols	(3) AO2 1

Q5.

Question number	Answer	Additional guidance	Mark
	C_2H_4	Allow H_4C_2	(1) AO2

Q6.

Question number	Answer	Additional guidance	Mark
	$\text{N}_2 + 2\text{O}_2 \rightarrow 2\text{NO}_2$ (2) or NO_2 (1)	other incorrect balancing max 1	(2) AO2

Q7.

Question number	Answer	Additional guidance	Mark
(i)	4 electrons shown between the 2 carbon atoms	electrons may be shown as dots, crosses or as a mixture	(1)
(ii)	carbon monoxide / carbon / soot	allow CO / C ignore carbon dioxide	(1)

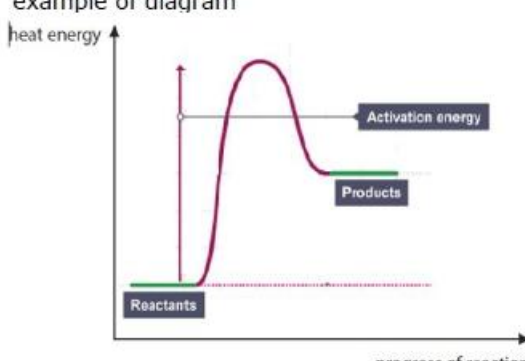
Q8.

Question number	Answer	Additional guidance	Mark
(i)	methane + oxygen (1) → water + carbon dioxide (1)	ignore symbols reject other substances on either side for that mark	(2)

Question number	Answer	Additional guidance	Mark
(ii)	limited supply of oxygen	ignore air	(1)

Q9.

Question Number	Answer	Mark
(i)	fuel oil	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> reactant(s) and product(s) labelled in their correct positions (1) activation energy labelled (1) energy of reactants lower than energy of products (1) 	<p>example of diagram</p>  <p>ignore arrow heads</p> <p>allow unlabelled diagram of an endothermic reaction showing the basic outline shape</p> <p>if exothermic reaction profile shown, allow (1) for reactants and products in correct position and (1) for correct labelling of activation energy</p>	(3) AO 1 1

Question Number	Answer	Additional guidance	Mark
(iii)	C ₆ H ₁₄		(1) AO 2 1

Q10.

Question Number	Answer	Mark
	fuel oil	(1) AO 3 2b

Q11.

Question number	Answer	Mark
(i)	x = 6	(1)

Question number	Answer	Additional guidance	Mark
(ii)	allow 2 for correct answer with or without working 170 (g) dodecane forms 114 (g) octane 1 (g) dodecane forms $\frac{114}{170}$ (g) octane (1) 340 (g) dodecane forms $\frac{114}{170} \times 340$ (1) (= 228(g))	OR $\frac{340}{170}$ (1) (= 2) 2 x 114 (1) (= 228 (g))	(2)

Q12.

Question number	Indicative content	Mark
	<p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic markscheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Pollutants</p> <ul style="list-style-type: none"> • carbon monoxide combines with haemoglobin so is toxic • nitrogen oxides are acidic / toxic • nitrogen oxides lead to acid rain • references to effects of acid rain – e.g. damages buildings/kills plants etc • carbon dioxide is a greenhouse gas • greenhouse gases cause global warming • references to effects of global warming – e.g sea levels rising etc • particulates cause breathing difficulties/ make buildings dirty <p>Petrol/diesel comparison</p> <ul style="list-style-type: none"> • compared to diesel, petrol: <ul style="list-style-type: none"> -releases less nitrogen oxides -releases less particulates • compared to diesel, petrol: <ul style="list-style-type: none"> -releases more carbon monoxide -releases more carbon dioxide <p>Catalytic converter</p> <ul style="list-style-type: none"> • reduces carbon monoxide • reduces nitrogen oxides <p>Overall comparison</p> <ul style="list-style-type: none"> • Petrol car improved with catalytic converter as two pollutants reduced • Diesel better than petrol for carbon oxides • Diesel is worse for particulates and nitrogen oxides 	<p>(6) EXP A03 (6)</p>

Level	Mark	Descriptor	Example responses
	0	No rewardable material.	
Level 1	1-2	Demonstrates elements of chemical knowledge some of which is inaccurate. Presents a discussion with some structure and coherence. States differences between engines using information from the table or explains the problem of one of the pollutants.	e.g. The diesel engine gives off the least carbon dioxide (1) carbon dioxide causes the greenhouse effect (1) the diesel engine only gives off particulates which cause breathing problems (2)
Level 2	3-4	Demonstrates elements of chemical knowledge and understanding some of which is mostly relevant but which may contain some inaccuracies. Presents a discussion that has structure and is mostly coherent. Describes two or three differences between engines using information from the table and explains the problems of some of the pollutants.	e.g. the petrol engines give off carbon dioxide but the one with a catalytic converter gives off less nitrogen oxides. The carbon dioxide is a greenhouse gas which causes global warming and the nitrogen oxide cause acid rain (4)
Level 3	5-6	Demonstrates accurate and relevant chemical knowledge and understanding. Presents a discussion and comparison with some structure and coherence. Describes three or four differences between engines using information from the table and explains the problem of some of the pollutants. Explains why one of the engines causes the least/ most damage to the environment.	e.g. the petrol engines give off carbon dioxide but the one with a catalytic converter gives off less nitrogen oxides. The diesel engine gives off less carbon dioxide but more nitrogen oxides. The carbon dioxide is a greenhouse gas which causes global warming and the nitrogen oxide cause acid rain. The diesel engine gives off the least carbon monoxide which is toxic. Overall the petrol car with no catalytic converter because it gives off the a lot of carbon dioxide and more carbon monoxide so it would cause the most global warming and breathing problems from the CO (6)

Q13.

Question number	Answer	Additional guidance	Mark
		reject more than one line from each fraction	(3) AO1 1

Q14.

Question num	Indicative content	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>AO1 (3 marks) AO2 (3 marks)</p> <ul style="list-style-type: none"> • sulfur burns at the same time as the hydrocarbon • sulfur reacts with oxygen • sulfur dioxide gas is formed • sulfur dioxide is an acidic gas • sulfur dioxide dissolves in clouds • to form sulfurous acid • which is then oxidised to form sulfuric acid • rain water becomes acidic • acid rain damages buildings / statues • damages plants/trees • runs into rivers / waterways • makes rivers/waterways acidic • kills fish/insects/waterlife • increases corrosion of metals 	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	acid rain damages plants and erodes buildings
Level 2	3–4	sulfur dioxide is formed which dissolves in clouds and then acid rain runs into waterways and kills fish
Level 3	5–6	sulfur burns to form sulfur dioxide which dissolves in clouds to form sulfuric acid, the acid rains can erode limestone statues and will increase corrosion of metals making them weaker.

Q15.

Question number	Answer	Additional guidance	Mark
	<p>An explanation linking</p> <ul style="list-style-type: none"> • {carbon dioxide / water} produced (1) • (the gases) absorb heat radiated from earth (1) • re-radiate heat back into the atmosphere (1) 	<p>allow formula</p> <p>allow traps the heat</p>	(3)

Q16.

Question number	Answer	Mark
	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): <ul style="list-style-type: none"> reverse the boiling tubes/pass gas through the tube in ice water first (1) so that if any liquid condenses in the tube it must have come from the burning wax (and not from the limewater) (1) 	(2)

Q17.

Question number	Answer	Additional guidance	Mark
	<ul style="list-style-type: none"> (funnel) heat (energy) released in reaction/ exothermic reaction (1) (liquid) water (1) (gas) sulfur dioxide / carbon dioxide (1) 	ignore NO _x	(3)

Q18.

Question number	Answer	Mark
(i)	An explanation linking <ul style="list-style-type: none"> insufficient oxygen (1) to oxidise all carbon to carbon dioxide (1) 	(2) A01

Question number	Answer	Mark
(ii)	An explanation linking <ul style="list-style-type: none"> carbon monoxide reacts with {haemoglobin (in blood) / blood / red blood cells} (1) stops oxygen being carried by {haemoglobin / blood / red blood cells} / so less oxygen reaches brain (1) 	(2) A01

Q19.

Question number	Answer	Mark
	An explanation to include <ul style="list-style-type: none"> • water vapour forms during combustion (1) • (water vapour) condenses on cold surface (1) 	(2) AO2

Q20.

Question Number	Answer	Mark
	<p>A crude oil is a finite resource</p> <p>The only correct answer is A</p> <p><i>B is not correct because crude oil is a mixture of compounds</i></p> <p><i>C is not correct because most molecules are chains</i></p> <p><i>D is not correct because crude oil must be fractionated first</i></p>	(1) AO 1 1

Q21.

Question Number	Answer	Additional guidance	Mark
	SO ₂	allow O ₂ S reject SO ₂ , SO ²	(1) AO 2 1

Q22.

Question Number	Answer	Mark	
(i)	<ul style="list-style-type: none"> • heated (1) • condensed (1) 	(2) AO 1 1	
Question Number	Answer	Additional guidance	Mark
(ii)	has more carbon atoms per molecule	allow any way of indicating answer e.g. circling reject any answer with two or more underlinings	(1) AO 1 1

Q23.

Question Number	Answer	Mark
(i)	<p>D C_nH_{2n+2}</p> <p>The only correct answer is D</p> <p><i>A is not correct because this is the general formula of an alkene</i></p> <p><i>B is not correct because this is not the general formula of an alkane</i></p> <p><i>C is not correct because this is not the general formula of an alkane</i></p>	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking</p> <ul style="list-style-type: none"> (compounds) containing hydrogen and carbon (atoms) (1) only (1) <p>MP2 is dependent on MP1</p>	<p>reject carbon molecules and hydrogen molecules /mixtures</p> <p>of carbon and hydrogen</p> <p>ignore symbols C and H</p>	(2) AO 1 1

Q24.

Question number	Answer	Additional guidance	Mark
(i)	<p>diesel releases more (nitrogen oxides / NO_x) (per km driven) / ORA (1)</p> <p>diesel releases more particulates (per km driven) / ORA (1)</p>	<p>ignore just quoting numbers from the table</p> <p>answer does need to make comparison – can be shown by statements about diesel and petrol</p> <p>ignore any effect of pollutants ignore anything about rights and wrongs of either NO_x or particulates</p>	(2) AO3 1

Question number	Answer	Additional guidance	Mark
(ii)	<p>an explanation linking</p> <ul style="list-style-type: none"> diesel releases less carbon dioxide (1) which is a greenhouse gas/contributes to global warming (1) <p>OR</p> <ul style="list-style-type: none"> diesel releases less sulfur dioxide (1) which causes acid rain (1) 	<p>vague references to pollution / harms environment do need to be qualified for any MP2</p> <p>allow climate change ignore effects of climate change</p> <p>ignore carbon monoxide / unburnt hydrocarbons ignore ozone / ozone layer / effects of acid rain</p> <p>reject particulates</p> <p>MP2 depends on MP1</p>	(2) AO3 2

Q25.

Question number	Answer	Additional guidance	Mark
(i)	carbon (1) hydrogen (1)	allow answers in either order ignore C and H alone	(2) AO1 1

Question number	Answer	Mark
(ii)	<p>B a chain molecule is the only correct answer.</p> <p>A, C and D are incorrect because propane is a not an oxide, a fullerene or a ring molecule</p>	(1) AO1 1

Question number	Answer	Mark
(iii)	<p>C 44 is the only correct answer.</p> <p>A, B and D are incorrect because $3 \times 12 + 8 \times 1 = 44$</p>	(1) AO2 1

Q26.

Question number	Answer	Additional guidance	Mark
(i)	bitumen	reject other fractions	(1)

Question number	Answer	Additional guidance	Mark
(ii)	gases	reject other fractions	(1)

Q27.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation including</p> <ul style="list-style-type: none"> boiling points increase as the number of carbon atoms (per molecule) increases (1) because {stronger forces between molecules / (increased / more) intermolecular forces (1) 	<p>ignore {positive correlation alone / proportional} allow 'longer chain' for more C atoms</p> <p>reject any reference to 'bonds' for MP2 allow van der Waals' forces/London forces</p>	<p>(2) AO 3 1a AO 3 1b</p>

Q28.

Question number	Answer	Mark
	fractional distillation / fractionation (1)	(1) AO1

Q29.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking <ul style="list-style-type: none"> they differ by CH₂ / differ by one carbon atom / pentane has one more carbon (1) they have the same general formula / C_nH_{2n+2} / both alkanes (1) 	ignore: similar chemical properties, quoting the two molecular formulae, they are both saturated, both have single bonds (only) reject carbon or hydrogen molecules for MP1 ignore same pattern of formula / similar general formula reject same {chemical / molecular} formula	(2)
(ii)	82.8 with or without working scores 3 correct answer but incorrectly rounded or not to 3sf scores 2 4 x 12 (1) (= 48) OR $\frac{100}{58}$ (= 1.724...) (1) $\frac{48 \times 100}{58}$ (= 82.759) = 82.8 (g) (1)	allow ecf but calculation must use 12, 58, 100 if working rounded to 1dp and carried forward, allow full marks eg 1.72 x 48 = 82.56 (2) or 82.6 (3) allow $\frac{100}{58}$ (1) (= 1.72414) = 1.72 (1) (to 3 sf) OR $\frac{100}{58}$ (1) x 12 (= 20.68966) = 20.7 (1) (to 3 sf) OR 4 x 12 (1) x 100 (= 4800) = 4.80 x 10 ³ (1) (to 3 sf)	(3)

Question number	Answer	Additional guidance	Mark
(iii)	butane + oxygen → carbon dioxide + water (2) butane + oxygen → (1) → carbon dioxide + water (1)	allow C ₄ H ₁₀ + 6.5 O ₂ → 4CO ₂ + 5H ₂ O (2) allow multiples correct formulae no balancing (1) allow hydrogen oxide for water allow reactants and products in either order ignore state symbols allow = for →	(2)

Q30.

Question number	Answer	Additional guidance	Mark
(i)	kerosene: (fuel for) aircraft / jets / lamps / cooking / heaters / fire lighters / rocket fuel (1) diesel oil: (fuel for) cars / trains / trucks / lorries / vehicles / tractors / generators / boats (1)	Ignore generic uses such as factories / machines / engines / fuel reject trains, boats allow ships	(2)
(ii)	any one of <ul style="list-style-type: none"> • boiling point: low(er) • melting point: low(er) • ignition: easy / easier • viscosity: low(er) / {runny / runnier} / thin(ner) • flammability: high(er) • volatility: high(er) • density: low(er) 	Note : unless otherwise stated, comparison is kerosene with diesel oil ignore lower number of carbons and hydrogens: lower length of chain: lower /shorter molecule / colour sootiness: diesel has sootier flame accept reverse argument for diesel oil note: property may be implicit in comparison	(1)

Q31.

Question number	Answer	Mark
(i)	propane + oxygen → carbon dioxide + water <ul style="list-style-type: none"> • LHS (1) • RHS (1) 	(2)
(ii)	to {release/produce} {heat/energy}	(1)