

0 7

Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

Table 4 shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Table 4

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16–24	0.30	0.02
3–16	0.20	0.02

0 7 . 1

Explain how carbon monoxide is produced when petrol is burned in car engines.

[2 marks]

0 7 . 2

Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

[2 marks]

1

2

Turn over ►



0 7 . 3

Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

[1 mark]

Oxides of nitrogen are also pollutants contained in exhaust fumes.

0 7 . 4

Describe how oxides of nitrogen are produced when petrol is burned in car engines.

[2 marks]

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

0 7 . 5

Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

[2 marks]

0 7 . 6

Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

[2 marks]

1 _____

2 _____

0 7 . 7

The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

[1 mark]

Tick **one** box.

Alkali metals

Halogens

Noble gases

Transition metals

12

Turn over ►

6 Crude oil is a complex mixture of substances.

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

Figure 7 shows a fractional distillation column and the fractions produced when a sample of crude oil is distilled.

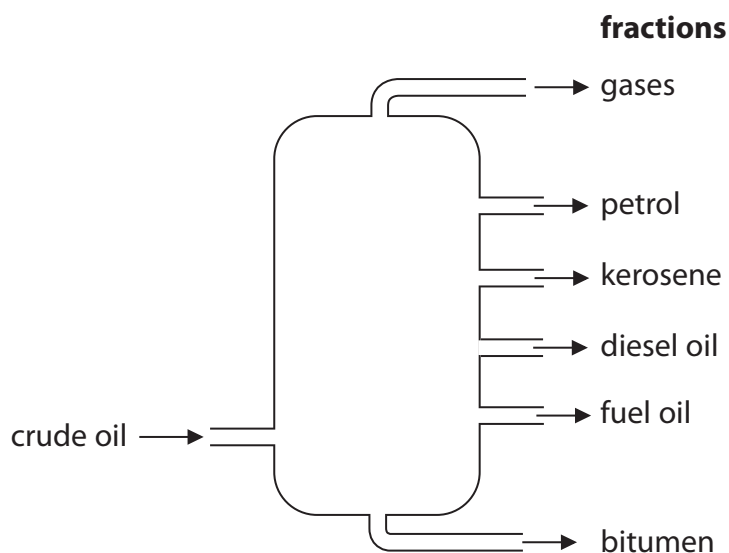


Figure 7

The properties of these fractions vary from the top of the column to the bottom of the column.

Which of the following is a trend in a property of the fractions obtained from the top of the column to those obtained from the bottom?

(1)

- A the average number of carbon atoms in molecules present decreases
- B the ease of ignition increases
- C the boiling points decrease
- D the viscosities increase

(b) 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)

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

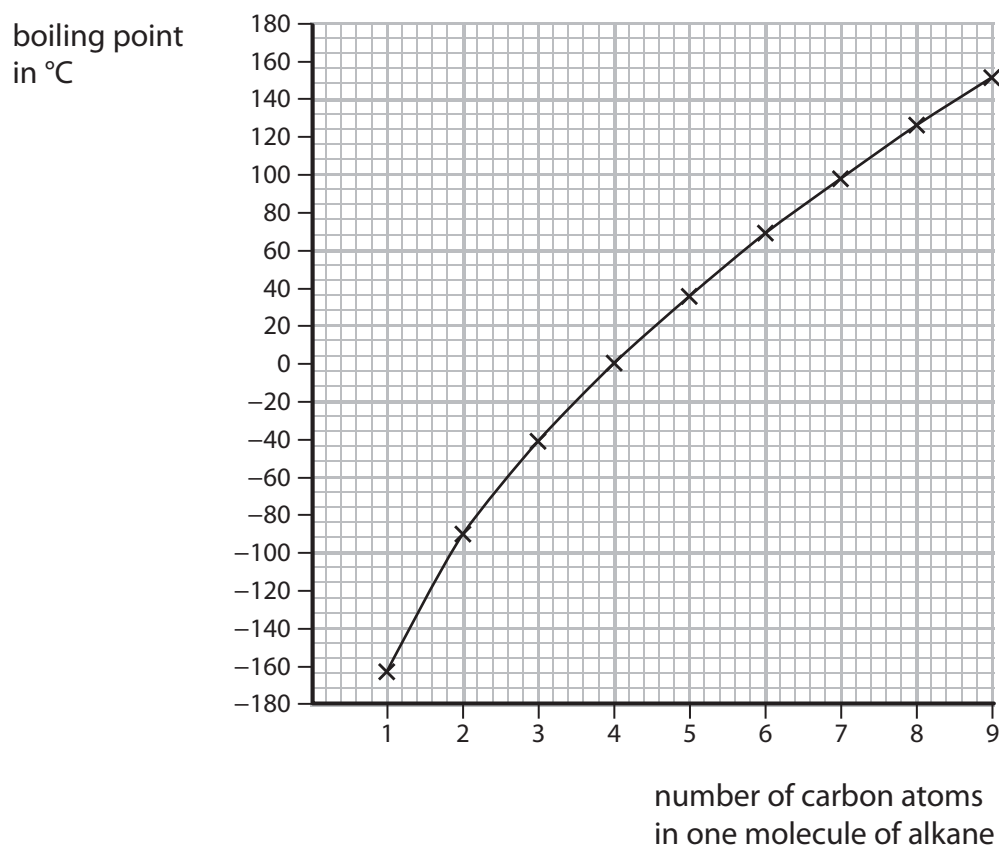


Figure 8

Explain the pattern shown by this graph.

(2)

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- (d) 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.

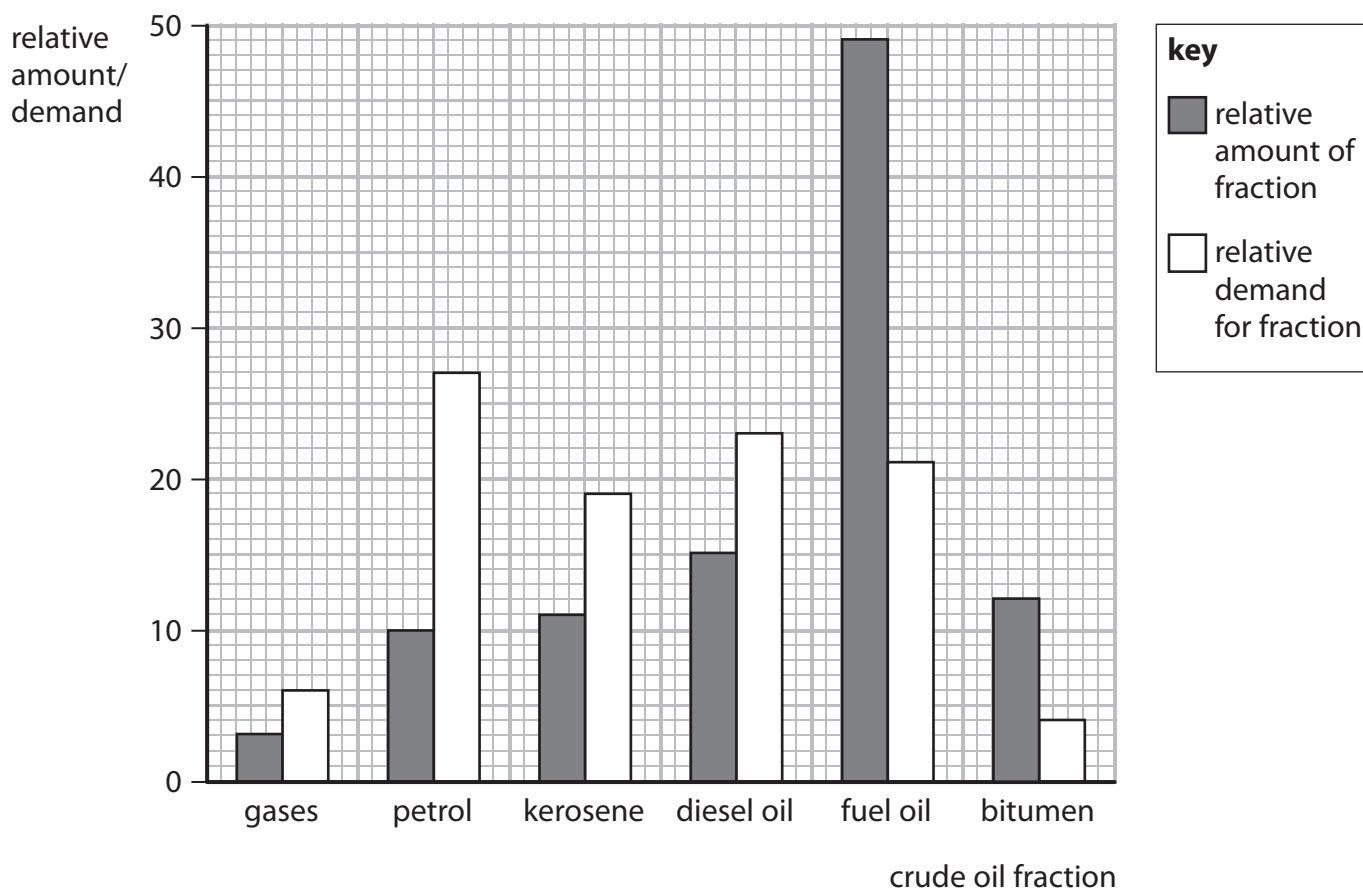


Figure 9

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.

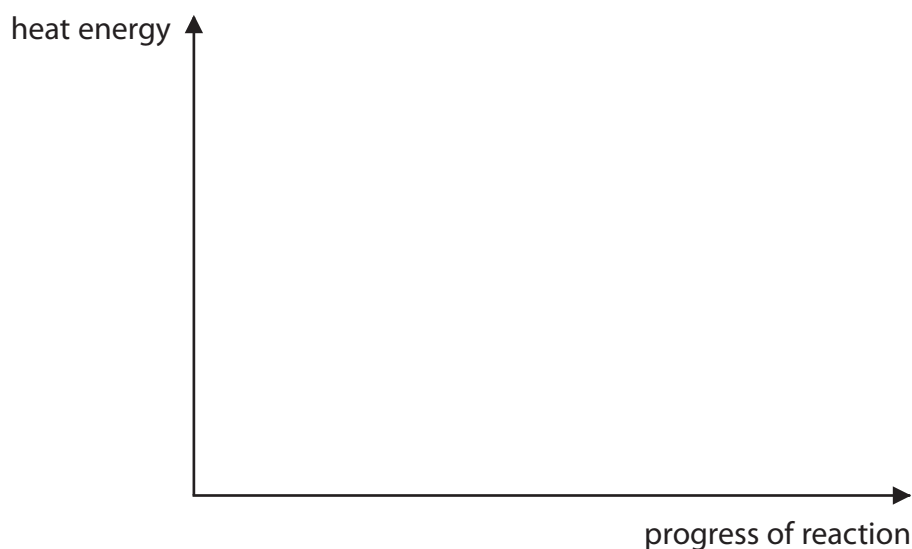
(1)



- (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 6 = 11 marks)

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SECTION B

Answer **all** the questions.

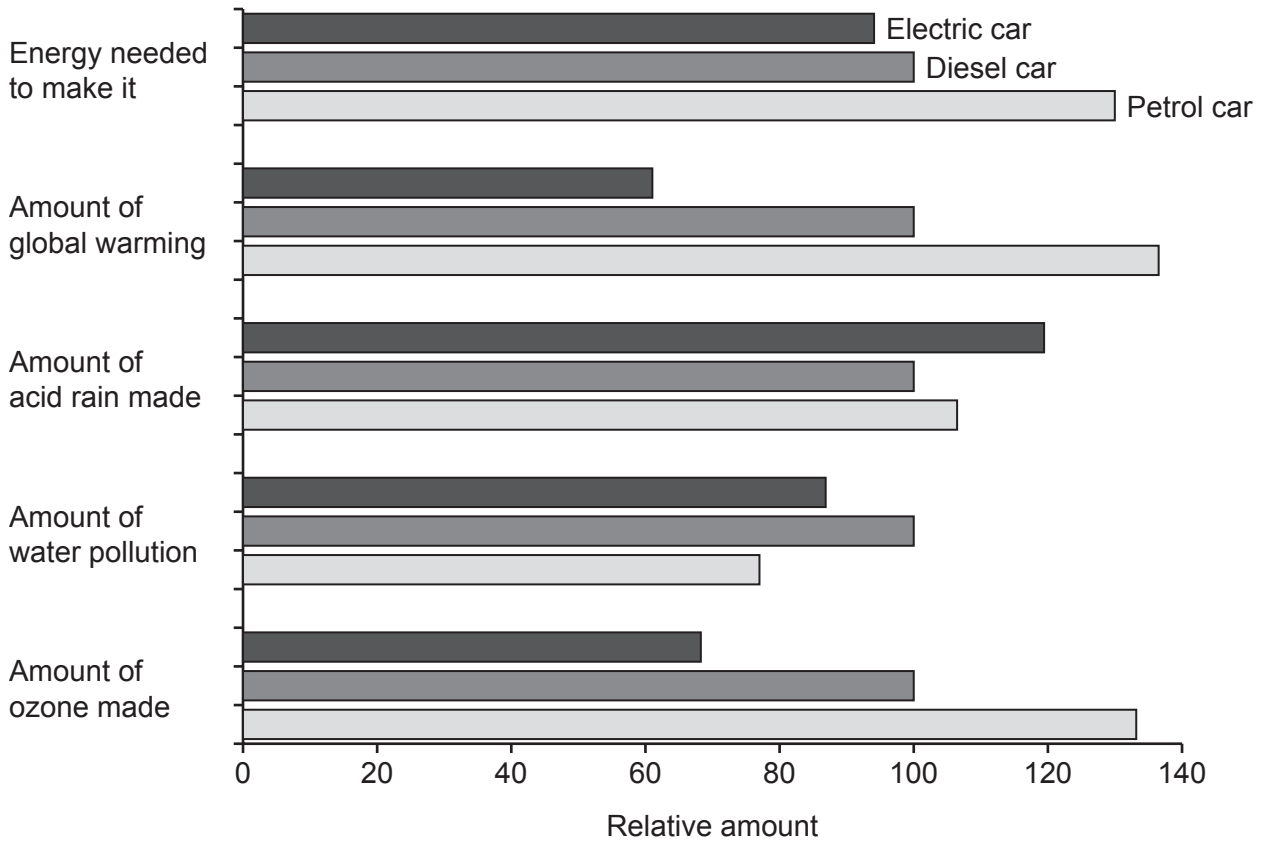
16 This question is about life-cycle assessment.

(a) A car company is developing three new cars:

- A petrol car
- A diesel car
- An electric car.

They do a life-cycle assessment of each car.

Look at the information about the life-cycle assessment of each car.



The company decides to manufacture and sell the electric car.

Explain why they make this choice.

Use the information from the life-cycle assessment to help you.

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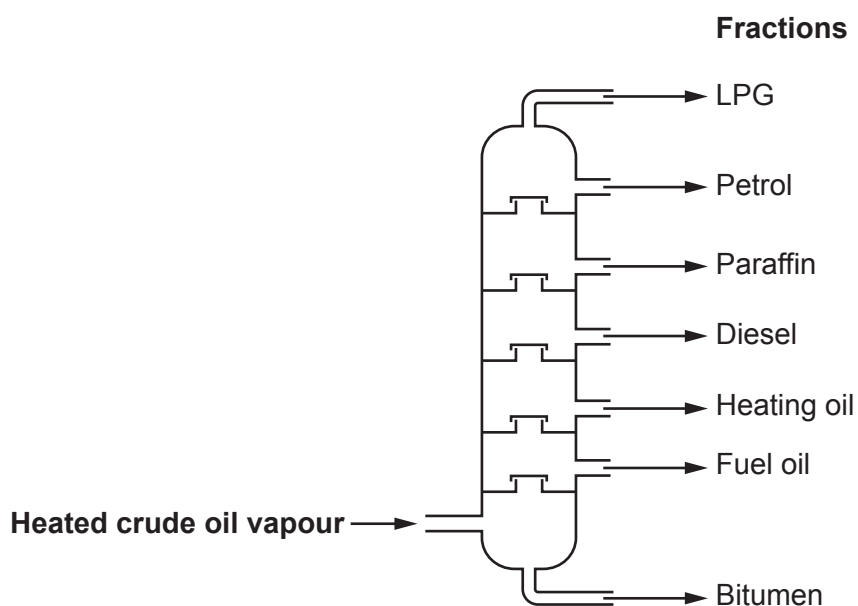
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[3]

(b) The fuels for the petrol and diesel cars are made from crude oil.

Crude oil is separated into different parts by **fractional distillation**.

The diagram shows a fractionating column.



Explain why crude oil **vapour** can be separated by fractional distillation.

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..... [3]

- (c) The table shows the boiling points of molecules present in different crude oil fractions.

Molecule	Boiling point (°C)
A	-2
B	125
C	216
D	502

Which molecule, **A**, **B**, **C** or **D** is in the **LPG fraction**?

Explain your decision.

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 [2]

- (d) Car manufacturers are developing cars that are powered by hydrogen/oxygen fuel cells.

The table shows some information about a 200 km journey using an electric car and a car using a fuel cell.

Feature	Electric	Fuel cell
Refuelling time (minutes)	360	4
Cost of refuelling (£)	3.20	4.20
CO₂ emitted (kg)	48	36
Mass of car (kg)	1550	1200

Evaluate the **advantages** and **disadvantages** of using a car powered by a fuel cell, rather than an electric car for the 200 km journey.

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 [3]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	incomplete combustion (because) insufficient / limited oxygen supply		1 1	AO1 4.9.3.1
07.2	any two from: <ul style="list-style-type: none"> carbon monoxide toxic / poisonous greater public concern / awareness about pollution more cars so otherwise there would be more carbon monoxide entering atmosphere improved engine technology catalytic converters have been introduced 	allow description of how carbon monoxide is toxic / poisonous ignore carbon monoxide is harmful / dangerous / deadly ignore comments about the effects of other pollutants ignore unspecified comments about carbon monoxide pollution	2	AO1 AO3 4.9.3.2
07.3	any one from: <ul style="list-style-type: none"> (to reduce) health problems (to reduce) global dimming 	allow (to reduce) specified health problems eg breathing difficulties, asthma, lung cancer allow (to reduce) the effects of global dimming eg reduced light levels allow (to reduce) smog allow (to reduce) the formation of particulates ignore global warming do not accept to reduce soot	1	AO1 4.9.3.1 4.9.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	nitrogen (from atmosphere) reacts with oxygen (from atmosphere)		1	AO1 4.9.3.1
	at high temperature (in engine) or with a spark (from spark plug)	ignore heat / hot	1	
07.5	$2 \text{NO}_2 \rightarrow \text{N}_2 + 2 \text{O}_2$	allow multiples if incorrect, allow N_2 for 1 mark	2	AO2 4.1.1.1 4.3.1.1
07.6	any two from: <ul style="list-style-type: none"> • acid rain • respiratory problems • carbon monoxide • global dimming or smog 	max 1 mark if global warming mentioned allow specific effects of acid rain allow specific respiratory problems eg breathing difficulties, asthma	2	AO1 4.9.3.2
07.7	transition metals		1	AO2 4.1.3.2
Total			12	

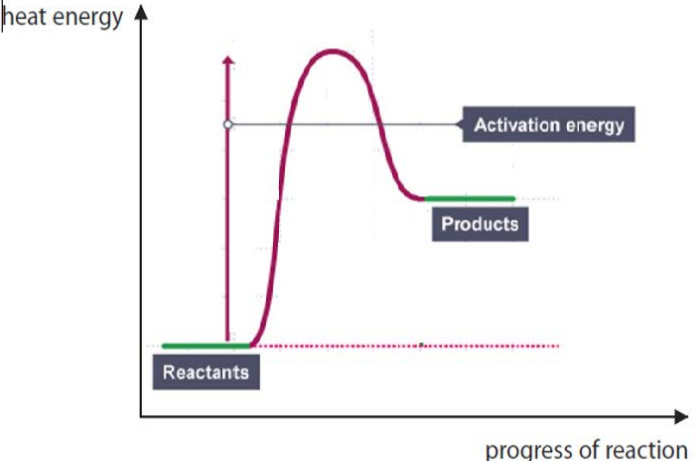
Question Number	Answer	Mark
6(a)	<p>D the viscosities increase</p> <p>The only correct answer is D</p> <p><i>A is not correct because average number of carbon atoms increases</i></p> <p><i>B is not correct because ease of ignition decreases</i></p> <p><i>C is not correct because boiling points increase</i></p>	(1) AO 1 1

Question Number	Answer	Mark
6(b)(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
6(b)(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 of carbon and hydrogen</p> <p>ignore symbols C and H</p>	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
6(c)	<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>

Question Number	Answer	Mark
6(d)(i)	fuel oil	<p>(1) AO 3 2a</p>

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

Question		Answer	Marks	AO element	Guidance
16	(a)	<p>(Electric car) uses Less energy (needed to make it) ✓</p> <p>Causes less global warming / less greenhouse gases produced ✓</p> <p>Causes less ozone ✓</p>	3	3 x 3.1b	<p>IGNORE just a restatement of the data; must be a comparison</p> <p>IGNORE references to carbon footprint DO NOT ALLOW eg less greenhouses gases so less acid rain</p> <p>ALLOW less water pollution than (making) a diesel car / produces the second least water pollution</p> <p>IGNORE less (water) pollution</p>

Question	Answer	Marks	AO element	Guidance
(b)	<p>MAX TWO FROM: Idea that (fractionating) column has a temperature gradient ✓</p> <p>Idea that crude oil contains a range of molecular sizes ✓</p> <p>Idea that molecules or fractions or hydrocarbons or alkanes have different boiling points ✓</p> <p>Idea that molecules or fractions or hydrocarbons or alkanes condense at different levels (in the fractionating column) ✓</p> <p>PLUS AT LEAST ONE FROM: Larger molecules have higher boiling points / ORA ✓</p> <p>Intermolecular forces between larger molecules are strong(er) / ORA / larger molecules have more intermolecular forces / ORA ✓</p> <p>The stronger the intermolecular forces the higher the boiling point or more energy is required to break these forces / ORA ✓</p> <p>During boiling intermolecular forces are broken ✓</p>	3	3 x 1.1	<p>DO NOT ALLOW just idea that molecules or fractions have different melting points</p> <p>NB This marking point gains TWO MARKS as it also includes M3 above ALLOW longer chains molecules for larger molecules ALLOW bitumen or fuel oil as a named large molecule / LPG or petrol as a named small molecule</p> <p>ALLOW bonds between molecules for forces between molecules</p> <p>ALLOW heat for energy</p> <p>BUT the larger the molecule the stronger the intermolecular forces therefore the higher the boiling point scores 3 / ORA</p>

Question		Answer	Marks	AO element	Guidance
	(c)	<p>A ✓</p> <p>Idea that (LPG fraction) has the lowest boiling point ✓</p>	2	<p>3.2b</p> <p>1.1</p>	<p>Second mark is dependent on correct choice of A ALLOW -2(°C)</p> <p>ALLOW A / LPG is a gas at room temperature ALLOW idea that LPG is collected at the top of the tower so must have the lowest (boiling) temperature IGNORE just quoting data from the table</p>
	(d)	<p>ANY TWO Advantages of fuel cell:</p> <p>Refuelling time (for a fuel cell) is less / ORA ✓</p> <p>Fuel cell emits less CO₂ / ORA ✓</p> <p>Mass (of car) is less (with fuel cell) / ORA ✓</p> <p>AND Disadvantage of fuel cell: Cost of refuelling is more / ORA ✓</p>	3	3 x 3.1b	<p>Assume unqualified answer refers to fuel cell IGNORE just a restatement of the data; must be a comparison</p> <p>ALLOW fuel cell takes 356 minutes less to refuel / ORA ALLOW fuel cell only takes 4 minutes to refuel</p> <p>ALLOW fuel cell emits 12kg less CO₂ / ORA ALLOW fuel cell only emits 36 kg CO₂</p> <p>ALLOW mass of car with fuel cell is 350(kg) less than electric car / ORA ALLOW mass of car with fuel cell is only 1200(kg) IGNORE electric car is faster</p> <p>ALLOW cost of refuelling car with fuel cell is £1 more than an electric car / ORA ALLOW cost of refuelling electric car is only £3.20 ALLOW costs more to run</p>