1. Fractional distillation is used to separate crude oil into a range of other substances. The process uses a fractionating column.

Which of these statements about fractional distillation is / are correct?

1 propane, C_3H_8, is found in the fraction obtained from the top of the column
2 crude oil is heated before it enters the bottom of the column

A 1 only
B 2 only
C both 1 and 2
D neither 1 nor 2

Your answer ☐

[1]

2. Old railway carriages are recycled in the same way as cars.

Write about the advantages, other than cost, of recycling metals.

---

[2]

3. This question is about crude oil.

Crude oil is separated into useful products called fractions.

(i) What is the name of the process that is used to separate crude oil?

---

[1]

(ii) Diesel is one fraction separated from crude oil.

Write down the names of **two other** fractions that are separated from crude oil.

---

[2]

4. Gas oil, paraffin, LPG and propane are all found in crude oil.

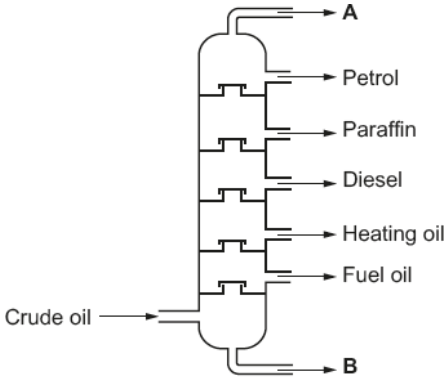
A mixture of gas oil, paraffin, LPG and propane can be separated by **fractional distillation**.

Explain why. Use ideas about molecular size and intermolecular forces.

---

[2]

5(a). Crude oil can be separated into useful substances called fractions.



Write down the name of the process that separates crude oil into fractions.

---------- [1]

(b). Name the fractions A and B.

A ----------

B ----------

[2]

(c). Here are the boiling ranges for petrol and diesel.

Fraction	Approximate boiling range (°C)	Number of carbons
Petrol	30–80	5–10
Diesel	205–290	13–17

(i) How do the sizes of molecules in petrol and diesel differ?

---

[1]

(ii) Explain why the boiling range for petrol is different from the boiling range for diesel.

---

[3]

(d). Not enough petrol is made from crude oil to meet world demand.

Oil refineries make more petrol using a process called **cracking**.

Describe how cracking makes more petrol from other hydrocarbons.

Include the conditions needed.

---

[3]

6(a). A company wants to make a glass to hold a cold drink. They are considering materials **A and B**.

Look at the life cycle assessments for a glass made out of materials **A and B**.

Process	Material A		Material B	
	Energy used (MJ)	Greenhouse gases made (g of CO_2)	Energy used (MJ)	Greenhouse gases made (g of CO_2)
Extracting the raw materials	5.0	2.2	3.8	1.4
Manufacturing of the glass from the raw materials	0.4	0.3	0.4	0.1
Transporting the glasses to the shops	1.5	1.0	3.1	2.2
Process **W**	2.0	0.6	5.0	1.7
Total	.....	.....	.....	.....

Complete the table to show the totals for each column. **[1]**

(b). Write down the name of process **W**.

..... **[1]**

7(a). The table shows some hydrocarbons from crude oil.

Name	Formula
Methane	CH_4
Propane	C_3H_8
Butane	C_4H_{10}

Nonane is another hydrocarbon from crude oil.

It contains 9 carbon atoms.

Predict the formula of nonane.

---------- [1]

(b). Write down the name of this homologous series of hydrocarbons.

---------- [1]

8. Iron can be extracted from its ore by heating it with carbon.

Which statement is the correct explanation for this?

A Iron is above carbon in the reactivity series.

B Iron is above copper in the reactivity series.

C Iron is below carbon in the reactivity series.

D Iron is below sodium in the reactivity series.

Your answer [ ] [1]

9. Which statement about the fractional distillation of crude oil is correct?

A Diesel leaves the fractionating column at the bottom.

B Petrol leaves the fractionating column at the top.

C The fractionating column is hottest at the top.

D The hydrocarbons in crude oil can be separated because they have different boiling temperatures.

Your answer [ ] [1]

10. The table shows some hydrocarbons from crude oil.

Name	Formula
Methane	CH_4
Propane	C_3H_8
Butane	C_4H_{10}

Nonane is another hydrocarbon from crude oil.

It contains 9 carbon atoms.

Predict the formula of nonane.

---

[1]

11. Which statement about extracting copper by phytoextraction is correct?

A Bacteria in the soil absorb the copper ions.

B Plant ash is equivalent to a high grade ore.

C Plant roots absorb copper metal from the soil.

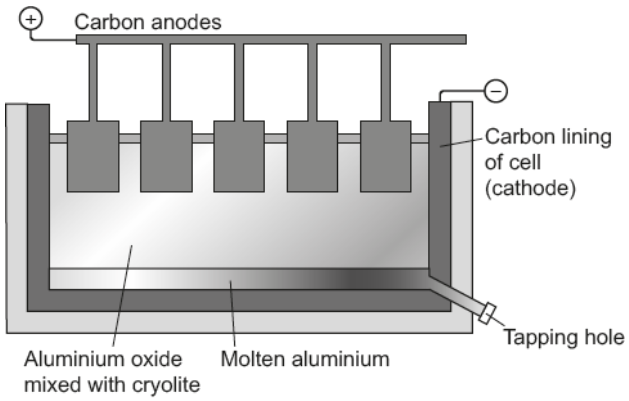
D The plants are crushed to extract the copper ions.

Your answer ☐ [1]

12(a) Aluminium is extracted from its ore by electrolysis.

.

This is an electrolysis cell.



Aluminium oxide is mixed with cryolite in the electrolysis cell.

Explain why cryolite is used.

---

[1]

(b). Aluminium is made at the negative electrode (cathode) from aluminium ions, Al^{3+}.

Write a **half equation** for this reaction. Use e^- to represent an electron.

---

[1]

(c). Oxygen, O_2, is made at the positive electrode (anode).

The anodes in the cell have to be replaced every few weeks.

Suggest why.

---

[2]

(d). Write the overall **balanced symbol** equation for the electrolytic breakdown of aluminium oxide, Al_2O_3.

---

[2]

13. The table shows some hydrocarbons from crude oil.

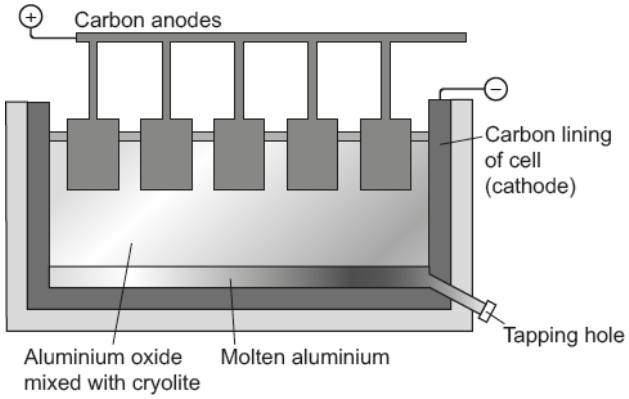
Name	Formula
Methane	CH_4
Propane	C_3H_8
Butane	C_4H_{10}

Write down the name of this homologous series of hydrocarbons.

[1]

14. Aluminium is extracted from its ore by electrolysis.

This is an electrolysis cell.



Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Explain why.

[1]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	**1**	
2			**any two from:** saves natural resources / saves a finite resource (1) saves energy (1) reduces litter / reduces disposal problems (1)	2	**ignore** saves money **allow** saves metal / material which is running out / saves mining for new metal (1) **allow** (uses less energy) so less carbon dioxide / greenhouse gasses released (1) **allow** less landfill needed (1) **Examiner's Comments** There were very few good answers to explain the advantages of recycling. Many concentrated on getting cheap spares to repair other carriages. This answer was excluded as the question clearly looked for answers other than cost.
			Total	**2**	
3		i	fractional distillation (1)	1	distillation is insufficient **allow** fractionation / fractionating (1) **ignore** fractioning **Examiner's Comments** This question focused on crude oil. cracking was often confused with fractional distillation. Many candidates were able to correctly name two fractions that are separated from crude oil
		ii	**any two from:** LPG (1) petrol (1) paraffin (1) heating oil (1) fuel oil / kerosene (1)	2	

Question			Answer/Indicative content	Marks	Guidance
		ii	bitumen (1)		**allow** tar **allow** naphtha (1) **allow** lubricating oil (1) **ignore** diesel (stem of question) **ignore** gas / oil **Examiner's Comments** This question focused on crude oil. Diesel was a common response that did not gain credit, as it was given in the stem of the question. Oil and gas were other common responses that failed to gain credit.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
4				2	comments must be comparative
			idea that smaller molecules have weaker or fewer intermolecular forces / ora (1)		allow smaller molecules have weaker forces between molecules / smaller molecules have fewer forces between molecules / ora (1) allow small molecules have weak or few intermolecular forces and large molecules have strong or many intermolecular forces(1) ignore smaller or larger intermolecular forces
			idea that smaller molecules have lower boiling points / ora (1)		allow small molecules have low boiling points and large molecules have high boiling points (1) allow weaker or fewer intermolecular forces have lower boiling point / ora (1) allow the smaller the molecules the less energy or heat is needed to break intermolecular forces / forces between molecules (1) allow IMF / intermolecular bonds / bonds between molecules not forces between atoms / in molecules / intramolecular forces ignore references to position fractions are in column
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
5	a		fractional distillation ✓	1 (AO 1.1)	ALLOW fractionation Examiner's Comments Candidates found this difficult and a significant number omitted the question. Distillation, electrolysis, filtration, cracking, fracking and chromatography were common responses.
	b		A – LPG ✓ B – bitumen ✓	2 (AO 2 × 1.1)	ALLOW petroleum gases ALLOW methane / ethane / propane / butane ALLOW tar (if blank check diagram) Examiner's Comments Few candidates gained credit. The most common incorrect response was input or in for A and output or out or exit for B. Carbon dioxide, gas and hot were also common for A and waste, oxygen and cold for B.
	c	i	Molecules in petrol are smaller (than those in diesel)/ORA ✓	1 (AO 1.1)	ALLOW (molecules in) petrol are smaller (number)/ shorter / fewer carbons / ORA IGNORE diesel is higher / petrol is lower / more in diesel / less in petrol Examiner's Comments Candidates found this difficult. Many repeated the stem of the question either saying the sizes were different or that one was larger than the other without specifying which one. Many thought that diesel had more molecules.

Question			Answer/Indicative content	Marks	Guidance
		ii	Any 3 from: Recognise intermolecular forces / intermolecular bonds are present ✓ Intermolecular forces / intermolecular bonds are smaller / weaker in petrol (molecules than in fuel molecules) ✓ Less energy / heat required to overcome forces in petrol / ORA ✓ Petrol boils at a lower temperature / has a lower boiling range / ORA ✓	3 (AO 3 × 1.1)	ALLOW bonds between molecules ALLOW bonds between molecules ALLOW bonds IGNORE doesn't boil at a high temperature Examiner's Comments A very small minority of candidates answered in terms of intermolecular forces. Many linked the sizes of the molecules to boiling faster or slower or discussed the number of molecules or discussed ease of boiling or ease of burning. A small number compared the boiling points.

Question			Answer/Indicative content	Marks	Guidance
	d		UP TO TWO FROM: (cracking) breaks large hydrocarbons / molecules into smaller ones ✓ (cracking) breaks (carbon-carbon) bonds ✓ alkene molecules also made ✓ UP TO TWO FROM: high temperature ✓ catalyst ✓	3 (AO 3 × 1.1)	ALLOW breaks up large molecules / breaks into smaller molecules IGNORE separates ALLOW range between 450 to 800oC IGNORE warm / heat/hot ALLOW named catalyst e.g. alumina / Al_2O_3 / aluminium oxide / silica / silicon dioxide / SiO_2 / zeolites / / china / broken pot / chromium oxide / Cr_2O_3 Examiner's Comments Candidates did not understand cracking and many described the process of fracking and its environmental consequences. Others repeated the stem of the question and conditions were rarely mentioned. A significant number omitted the question.
			Total	10	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>a</td><td></td><td>
<table>
<tr><th></th><th colspan="2">Material A</th><th colspan="2">Material B</th></tr>
<tr><th></th><th>Energy used in MJ</th><th>Greenhouse gases made in g of CO_2</th><th>Energy used in MJ</th><th>Greenhouse gases made in g of CO_2</th></tr>
<tr><td>Extracting the raw materials</td><td>5.0</td><td>2.2</td><td>3.8</td><td>1.4</td></tr>
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<tr><td>Total</td><td>8.9</td><td>4.1</td><td>12.3</td><td>5.4</td></tr>
</table>
</td><td>2 (AO 2 × 2.2)</td><td>All correct = 2 marks
2 or 3 correct = 1 mark
1 correct = 0 marks

IGNORE units</td></tr>
<tr><td></td><td>b</td><td></td><td>disposal (of the product) / end of life management / AW✓</td><td>1 (AO 1.1)</td><td>ALLOW recycling / reuse / melting

IGNORE use of / selling product

<u>Examiner's Comments</u>

Candidates found this difficult and many opted for a word beginning with w including waste, weighing and water. Many also discussed the next step in terms of use rather than life cycle assessment and so selling, shopping, delivering and storing were all common incorrect responses.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
7	a		C_9H_{20} ✓	1 (AO 3.1a)	ALLOW $H_{20}C_9$ Examiner's Comments Very few candidates gained credit. Higher ability candidates appreciated that nonane would contain C9 but C9H16, C9H21, and C9H, were common incorrect responses from these candidates. C5H12 was also a common response. A significant number omitted the question.
	b		alkane(s) ✓	1 (AO 1.1)	Examiner's Comments Few candidates gained credit and many omitted the question. Some named specific alkanes, homologous series and halogens were common responses.
			Total	2	
8			C ✓	1 (AO 1.1)	Examiner's Comments Most candidates correctly gave C as an answer. Some misread the answer for B and gave this instead. Candidates must ensure they take the time to read all the information carefully.
			Total	1	
9			D ✓	1 (AO 1.1)	Examiner's Comments Almost all candidates answered this correctly.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
10			C_9H_{20} ✓	1 (AO 3.1a)	ALLOW $H_{20}C_9$ Examiner's Comments Candidates could answer this question by recalling the general formula for alkanes or by using information in the table to work out the formula. This question was fairly well answered.
			Total	1	
11			B ✓	1 (AO 1.1)	Examiner's Comments Only the most able candidates answered this correctly. It is new to chemistry specifications and so it may not have been covered in the correct depth. Many candidates incorrectly chose C as they did not understand it was copper ions that are absorbed,
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
12	a		to lower the melting point (of aluminium oxide) / dissolve the aluminium oxide ✓	1 (AO 1.1)	<u>Examiner's Comments</u> Few candidates knew this. The most common incorrect answers were that cryolite behaves as a catalyst / lowers the activation energy / speeds up the electrolysis. There were some candidates who wrote about it lowering the melting point of aluminium rather than aluminium oxide. This did not gain a mark.
	b		$Al^{3+} + 3e^- \rightarrow Al$	1 (AO 2.1)	**ALLOW** any correct multiple e.g. $2Al^{3+} + 6e^- \rightarrow 2Al$ **ALLOW** $Al^{3+} \rightarrow Al - 3e^-$ **ALLOW** = for arrow **DO NOT ALLOW** 'and' or & for + <u>Examiner's Comments</u> A balanced half equation is required here. The electrons should be represented as $3e^-$. Most candidates attempted this but were unclear about how to write a half equation.
	c		oxygen reacts with the carbon anodes ✓ making carbon dioxide ✓	2 (AO 2×1.1)	<u>Examiner's Comments</u> Candidates have to apply their knowledge of the extraction of aluminium process as well as the reactions of oxygen. Few candidates gained marks here. Many suggested the anode corroded or rusted. Some suggested the anode became coated in oxygen.

Question			Answer/Indicative content	Marks	Guidance
	d		$2Al_2O_3 \rightarrow 4Al + 3O_2$ correct formulae ✓ balancing conditional on correct formulae ✓	2 (AO 2×2.1)	**ALLOW** any correct multiple e.g. $Al_2O_3 \rightarrow 2Al + 1½O_2$ **ALLOW** = for arrow **DO NOT ALLOW** 'and' or & for + **ALLOW** one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $2Al_2O^3 \rightarrow 4al + 3O_2$ Examiner's Comments Most candidates did not realise the reactant was the aluminium oxide. Many tried to write an equation to produce aluminium oxide. Many also tried to write another half equation. A few gave the formula of aluminium as Al2. Candidates need to practice writing balanced equations.
			Total	6	
13			alkane(s) ✓	1 (AO 1.1)	Examiner's Comments Relatively few candidates gave the term alkane. Common incorrect answers were "hydrocarbon chain" (or similar), "ethane" (and other named alkanes) and "alkenes", "crude oil". A few answered "reactivity series". Many candidates did not understand what is meant by a homologous series.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
14			idea that aluminium is **more** reactive than carbon / aluminium is high**er** in the reactivity series than carbon **ORA** ✓	1 (AO 1.1)	**ALLOW** carbon can't displace aluminium / carbon can't reduce aluminium oxide Assume 'it' refers to aluminium unless qualified <u>Examiner's Comments</u> Most candidates knew this was about relative reactivity. Candidates should be encouraged to compare the reactivity of the two elements. Stating aluminium is reactive does not fully answer the question.
			Total	1	