Chemicals of the natural environment – 2021/20 GCSE 21st Chemistry Combined Science B

1. Nov/2021/Paper_J260/02/No.3

Crude oil is a mixture of hydrocarbons.

(a) How is crude oil separated into fractions?

Put a (ring) around the correct answer.

Cracking **Crystallisation** **Filtration** **Fractional distillation** **Titration**

[1]

(b) The fractions in crude oil are needed for fuels and other uses.

Some fractions are needed in larger amounts than other fractions.

The table gives information about the percentage of each fraction in crude oil and the percentage of each fraction needed. It also shows the number of carbon atoms in each fraction.

Fraction	Percentage in crude oil (%)	Percentage of fraction needed (%)	Number of carbon atoms in the fraction
Gas	2	4	1–4
Petrol	6	22	5–10
Naphtha	10	5	8–12
Paraffin	13	8	9–16
Diesel	19	23	15–25
Fuel oil	50	38	20–30

(i) Name **two** fractions where the percentage of fraction needed is greater than the percentage in crude oil.

..... and .....**[2]**

(ii) Which **three** fractions in the table contain $C_{10}H_{22}$?

Put a (ring) around the correct answers.

Diesel **Fuel oil** **Gas** **Naphtha** **Paraffin** **Petrol**

[1]

(iii) A process is used to break down larger molecules into smaller molecules.

What is the name of this process?

Put a (ring) around the correct answer.

Cracking **Crystallisation** **Filtration** **Fractional distillation** **Titration**

[1]

(iv) The process in **(b)(iii)** is used to break down naphtha to make petrol.

Give **two** reasons why naphtha is broken down to make petrol.

Use data from the table to support your answer.

1 .....

.....

2 .....

.....

[2]

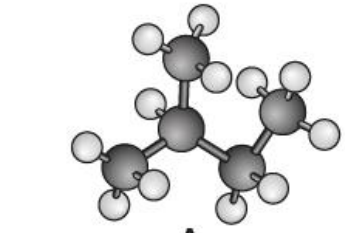
(v) A molecule with ten carbon atoms can be broken down into a molecule with eight carbon atoms and one other molecule.

Complete the symbol equation to show the formula of the other molecule formed.

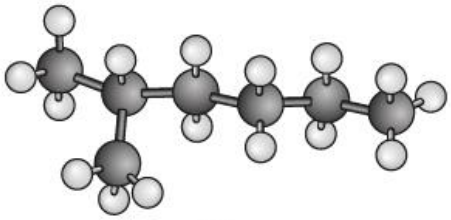
$C_{10}H_{22} \rightarrow C_8H_{18} + ...$

[2]

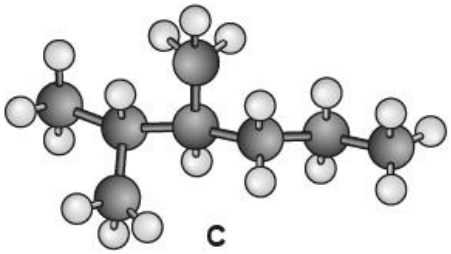
(c) The diagrams show 3D models of the structures of five hydrocarbons in crude oil.



A



B



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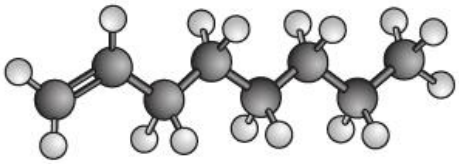
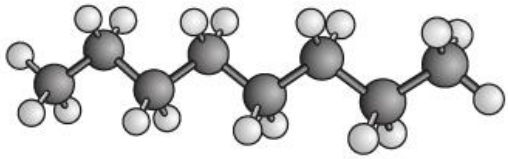


D



E

(i) Which **two** structures have the formula C_8H_{18}?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

E ☐

[2]

(ii) Which structure is an alkene?

Give **one** reason for your answer.

Structure .....

Reason .....

.....

[2]

d) Crude oil is a finite source of hydrocarbons.

Define **finite**.

.....

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

2. Nov/2021/Paper_J260/02/No.7

Magnesium and sodium are reactive metals.

(a) Magnesium reacts very slowly with cold water.

(i) Write the balanced symbol equation for this reaction.

magnesium	+	water	→	magnesium oxide	+	hydrogen
.....	+	.....	→	.....	+	.....

[3]

(ii) How does the equation show that magnesium is **oxidised** in this reaction?

.....

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

(b) Sodium reacts quickly with cold water to form hydrogen gas and sodium hydroxide solution.

Sodium hydroxide solution is an alkali.

(i) What tests can be used to show that an alkali and hydrogen gas are formed?

Draw lines to connect each **product** with its correct **test**.

Product	**Test**
	Pops a lighted splint
Hydrogen gas	
	Relights a glowing splint
	Turns universal indicator blue
Alkali	
	Turns universal indicator red

[1]

(ii) Why does sodium react **more** quickly with cold water than magnesium?

.....

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

(c) Magnesium and sodium are extracted from their compounds by electrolysis.

Electrolysis does not work if ionic solids are used. The ionic solids must be melted before electrolysis.

(i) Explain why solid ionic compounds must be melted before electrolysis.

.....

.....

.....

..... **[2]**

(ii) Give the name of the product formed at each electrode when molten sodium chloride is electrolysed.

Positive electrode .....

Negative electrode .....

[1]

3. Nov/2021/Paper_J260/04/No.9(b)

(b) Crude oil is a mixture of hydrocarbons. The mixture can be separated into fractions.

The table shows the number of carbon atoms in the hydrocarbon chains of three fractions of crude oil.

Fraction	Number of carbon atoms in hydrocarbon chains
Diesel oil	16–20
Kerosene	10–16
Petrol	5–8

Fractional distillation is used to separate the different fractions of crude oil.

(i) Complete **Fig. 9.2** to show where the three fractions **diesel oil**, **kerosene** and **petrol** would be collected in the fractionating tower.

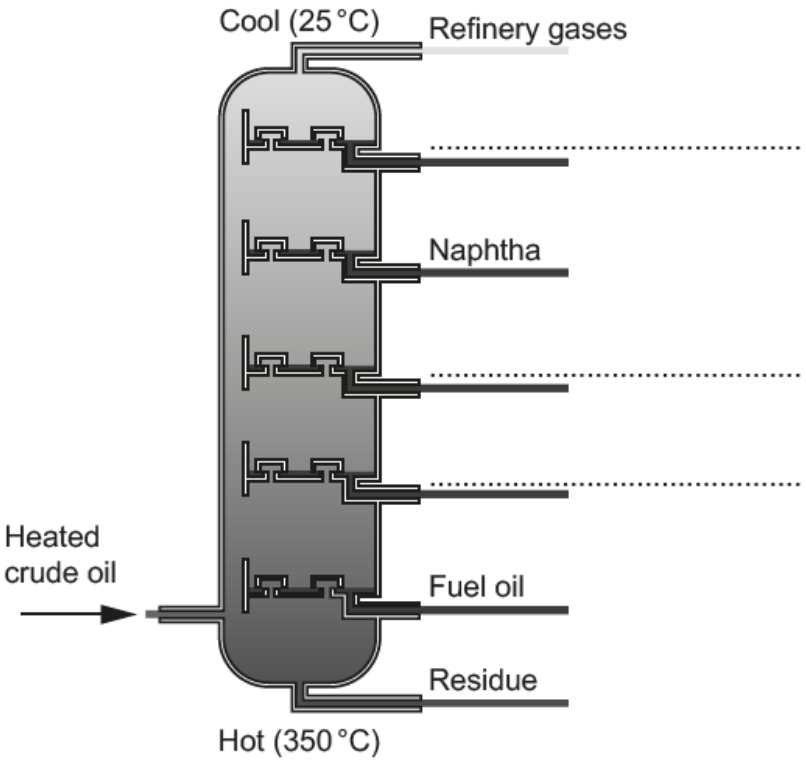


Fig. 9.2 **[2]**

(ii) Explain why naphtha is collected above fuel oil in the fractionating tower.

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..... **[2]**

4. Nov/2020/Paper_J260/02/No.7

Crude oil is a mixture of hydrocarbons.

(a) (i) Hydrocarbons contain carbon and one other element.

What is the name of the other element?

Put a (ring) around the correct answer.

bromine **chlorine** **hydrogen** **oxygen** **nitrogen**

[1]

(ii) Most hydrocarbons in crude oil are in the alkanes homologous series.

Which properties of the members in a homologous series are **true** and which are **false**?

Tick (✓) **one** box in each row.

Property	**True**	**False**
They have the same molecular formula.		
They have the same general formula.		
They have the same boiling points.		
They show a trend in physical properties.		

[4]

(iii) Why is crude oil an important resource for the chemical industry?

Tick (✓) **two** boxes.

- It is a black, sticky liquid. ☐
- It can be made into lots of other chemicals. ☐
- It will never run out. ☐
- It is a source of fuels. ☐
- It contains many ionic compounds. ☐

[2]

5. Nov/2021/Paper_J260/06/No.6

Fig. 6.1 shows the structures of diamond and methane.

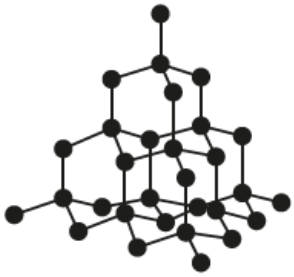
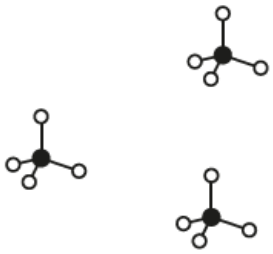
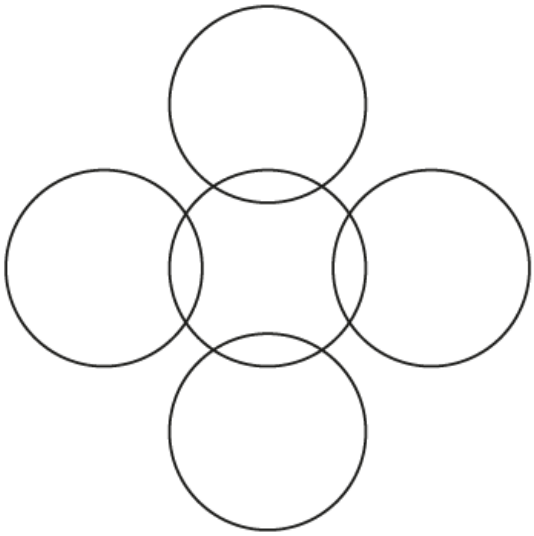
	Diamond	Methane
Diagram of structure		

Fig. 6.1

(a) (i) Complete the dot and cross diagram for methane.

Show outer electrons only, and label each atom.



[1]

(ii) Complete the table by giving the type of bonds and type of structure for diamond and methane.

Use **Fig. 6.1**.

	Type of bonds	Type of structure
Diamond		
Methane		

[2]

(iii) Explain why diamond is a solid and methane is a gas at room temperature and pressure.

Use ideas about bonds and attractions between molecules in your answer.

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..... **[3]**

(b) Diamond is an allotrope of carbon.

Fig. 6.2 shows the structure of graphite, another allotrope of carbon.

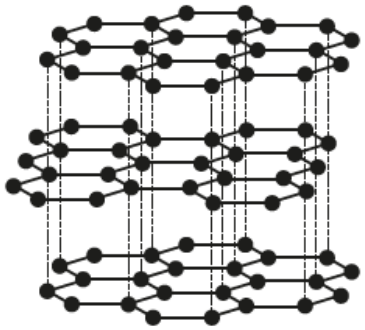

Fig. 6.2

(i) Graphite conducts electricity, but diamond does not.

Explain this statement.

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..... **[2]**

(ii) Diamond is a very hard material, but graphite is soft and slippery.

Explain this statement.

.....

.....

.....

..... **[2]**

6. Nov/2021/Paper_J260/06/No.8

Aluminium is extracted from aluminium oxide by electrolysis.

(a) Solid aluminium oxide is dissolved in a hot, molten compound called cryolite and then electrolysed.

(i) Explain why solid aluminium oxide cannot be electrolysed.

Use ideas about ions in your answer.

.....

.....

..... **[2]**

(ii) The melting point of pure aluminium oxide is 2072 °C. Aluminium oxide dissolved in cryolite melts at approximately 900 °C.

Explain **one** advantage of electrolysing aluminium oxide dissolved in cryolite instead of pure molten aluminium oxide.

.....

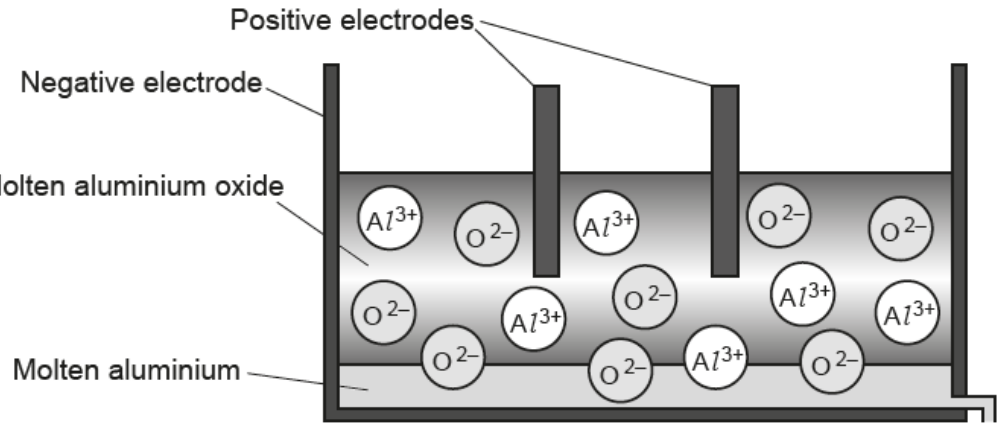
..... **[1]**

(b) The diagram shows the tank used for the electrolysis of aluminium oxide.

Positive electrodes dip into the molten solution of aluminium oxide.

The casing of the tank acts as the negative electrode.

Molten aluminium metal collects at the bottom.



Describe what happens at each electrode during electrolysis of aluminium oxide.

Use ideas about ions and electrons in your answer.

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..... **[4]**

(c) Copper is extracted by heating copper oxide (CuO) with carbon to form copper and carbon dioxide.

(i) Write a **balanced symbol** equation for this reaction.

..... **[2]**

(ii) Explain why copper can be extracted by this method but aluminium cannot.

.....

.....

.....

..... **[2]**

(d) Bioleaching and phytoextraction are new biological methods of extracting metals from waste heaps around old mines.

Bioleaching uses bacteria on waste heaps. The waste heaps need to be first sprayed with dilute acid. The bacteria then produce a dilute solution of metal ions which can be collected.

Phytoextraction uses plants to absorb metal ions from the waste heaps and store them in their leaves. Some plants can even absorb metals which are toxic to other plants and animals.

Traditional methods of extracting metals use electrolysis or heating with carbon.

Give **two** advantages and **one** disadvantage of using biological methods of extracting metals instead of traditional methods.

Advantage 1 .....

.....

Advantage 2 .....

.....

Disadvantage .....

.....

[3]

7. Nov/2021/Paper_J260/08/No.2(b)

(b) Crude oil is a mixture of hydrocarbons. The mixture can be separated into fractions.

The table shows the number of carbon atoms in the hydrocarbon chains of three fractions of crude oil.

Fraction	Number of carbon atoms in hydrocarbon chains
Diesel oil	16–20
Kerosene	10–16
Petrol	5–8

Fractional distillation is used to separate the different fractions of crude oil.

(i) Complete **Fig. 2.2** to show where the three fractions **diesel oil**, **kerosene** and **petrol** would be collected in the fractionating tower.

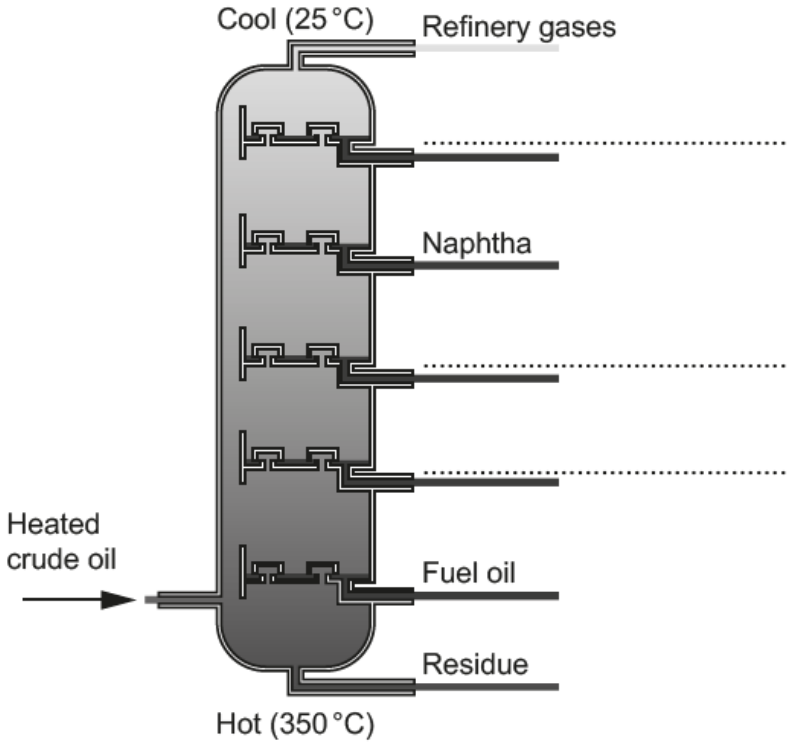

Fig. 2.2 **[2]**

(ii) Explain why naphtha is collected above fuel oil in the fractionating tower.

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..... **[2]**

8. Nov/2020/Paper_J260/06/No.5

Carbon compounds form molecules of many different shapes and sizes.

(a) (i) How many bonds does carbon form when it makes molecules?

.....

[1]

(ii) Give **two** reasons why carbon forms molecules of many different shapes and sizes.

1 .....

.....

2 .....

.....

[2]

(b) Carbon compounds are grouped into families called homologous series.

(i) Members of the alkane homologous series all have the general formula, C_nH_{2n+2}.

What is the formula of the alkane with 6 carbon atoms?

.....

[1]

(ii) Give **two other** properties of a homologous series.

1. .....

.....

2. .....

.....

[2]

9. Nov/2020/Paper_J260/06/No.10

Electrolysis of molten sodium chloride produces sodium metal and chlorine gas.

These are the half equations for the reaction at each electrode.

Positive electrode: $2Cl^- \longrightarrow Cl_2 + 2e^-$

Negative electrode: $Na^+ + e^- \longrightarrow Na$

(a) Explain the reactions at each electrode when molten sodium chloride is electrolysed.

Use ideas about oxidation, reduction, and electrons in your answer.

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..... **[3]**

(b) Alex electrolyses a **solution** of sodium chloride.

(i) Draw a fully labelled diagram in the box to show how he does this.

[2]

(ii) Sodium chloride solution contains sodium and chloride ions dissolved in water.

Give the **names** and **formulae** for the ions that come from the **water**.

Names: ..... **and** .....

Formulae: ..... **and** .....

[2]

(iii) When Alex passes electricity through the sodium chloride solution, he sees bubbles of hydrogen gas forming at the negative electrode.

Explain why, at the negative electrode, **sodium** metal is produced when molten sodium chloride is electrolysed but **hydrogen** gas is produced when sodium chloride solution is electrolysed.

Use ideas about reactivity in your answer.

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..... **[3]**

(iv) Suggest what Alex could do to test for the presence of chlorine gas at the positive electrode, and what the test will show if chlorine gas is present.

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..... **[2]**