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

1. Nov/2021/Paper_J258/01/No.5(e)

(c) **Fig. 5.2** shows a model of an ethanol molecule and a methane molecule:

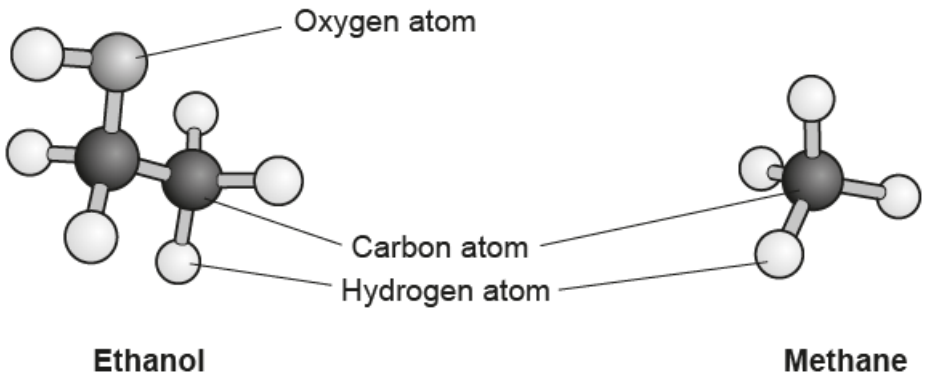


Fig. 5.2

(i) The formula of methane is CH_4.

What is the formula of ethanol?

Use **Fig. 5.2** to help you.

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

(ii) Which **two** statements do the models in **Fig. 5.2** accurately show?

Tick (✓) **two** boxes.

The number of electrons in each atom. ☐

The number of atoms in each molecule. ☐

The 3D shape of each molecule. ☐

The actual size of the atoms. ☐

[2]

2. Nov/2021/Paper_J258/01/No.7

Crude oil contains many compounds that are used as fuels.

The table shows some of these compounds:

Name	Formula	Relative formula mass	Boiling point (°C)
Methane	CH_4		–162
Butane	C_4H_{10}	58	–1
Benzene	C_6H_6	78	80
Octane	C_8H_{18}	114	126
Hexadecane	$C_{16}H_{34}$	226	287

(a) Which word describes crude oil?

Put a (ring) around the correct answer.

Chemical **Compound** **Element** **Mixture**

[1]

(b) **(i)** Name the **two** compounds in the table that are gases at 25 °C.

Compound 1 .....

Compound 2 .....

[1]

(ii) Explain your answer to **(b)(i)**.

.....

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

(c) Calculate the relative formula mass of methane.

Use the Data Sheet.

Relative formula mass = ... **[1]**

(d) Describe the relationship between relative formula mass and boiling point for the compounds in the table.

.....

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

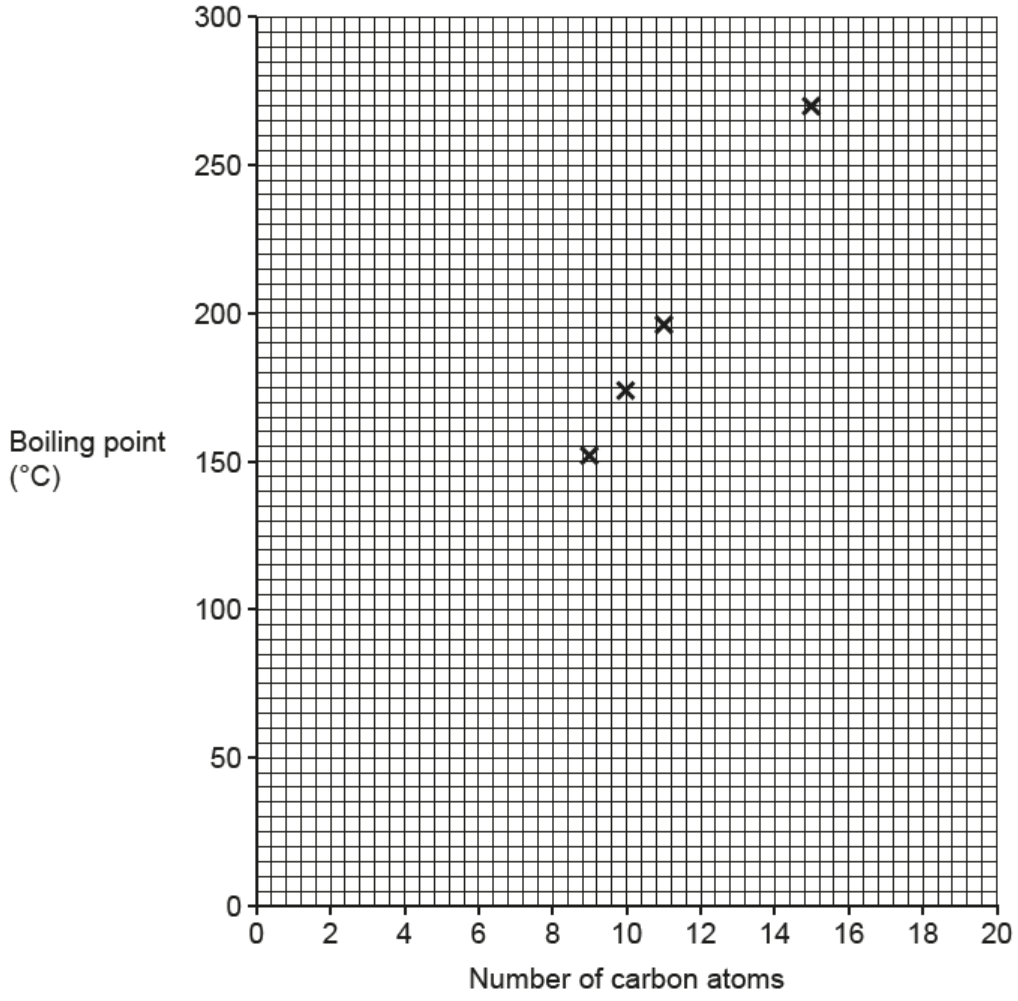
(e) Benzene has six carbon atoms but is **not** an alkane.

Alkanes have the general formula C_nH_{2n+2}.

Give the formula of the alkane with **six** carbon atoms.

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

(f) The graph shows the boiling point and the number of carbon atoms for some alkanes.



(i) Hexadecane has 16 carbon atoms. The boiling point of hexadecane is 287 °C.

Plot the point for hexadecane on the graph. **[1]**

(ii) Draw a line of best fit. **[1]**

(iii) Estimate the boiling point of the alkane with the formula $C_{12}H_{26}$.

Show your working on the graph.

Boiling point = ... °C **[1]**

(g) Fractional distillation is used to separate the compounds in crude oil.

Which property is used to separate compounds in fractional distillation?

Tick (✓) **one** box.

Boiling point	☐
Density	☐
Formula	☐
Melting point	☐

[1]

(h) **(i)** The formula for butane is C_4H_{10}.

Draw the displayed formula for butane.

[1]

(ii) What is the **simplest** ratio of carbon atoms to hydrogen atoms in butane?

Ratio of carbon atoms : hydrogen atoms = ... : ..... **[1]**

(iii) State the empirical formula of butane.

Empirical formula = ... **[1]**

3. Nov/2021/Paper_J258/02/No.3

Layla heats a small piece of sodium. She then puts it in a jar of chlorine gas, as shown in **Fig. 2.1**.

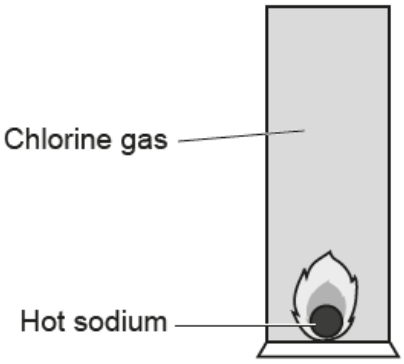


Fig. 2.1

Layla observes that the sodium burns quickly with a bright flame and forms a white solid.
The white solid is sodium chloride.

(a) Layla repeats the experiment. This time she uses lithium.

(i) What is the name of the salt that forms when lithium reacts with chlorine?

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

(ii) How would Layla's observations be different when she uses lithium?

Put a (ring) around the correct answer.

Reaction is slower **Reaction is faster** **Reaction takes same amount of time**
[1]

(iii) Give **one** reason for your answer to **(a)(ii)**.

.....

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

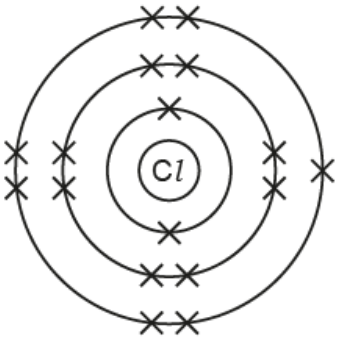
(b) Layla does experiments with other Group 1 and Group 7 elements.

Complete the table of information about each element.

Element	Group number	Solid, liquid or gas at room temperature?	Colour at room temperature
Sodium	1	Solid	Silver
Chlorine	7	.....	.....
Potassium	.....	.....	.....
Iodine	.....	Solid	.....

[3]

(c) **Fig. 2.2** shows the arrangement of electrons in a chlorine atom.



Chlorine (atomic number 17)

Fig. 2.2

(i) Complete **Fig. 2.3** to show the arrangement of electrons in a sodium atom.

Sodium (atomic number 11)

Fig. 2.3

[2]

(ii) Chlorine forms chloride ions, Cl^-.

Complete the sentence to explain why chloride ions have a charge of –1.

Use the words.

You can use each word once, more than once, or not at all.

eight **gain** **lose** **seven** **two**

Chlorine has ..... electrons in the outer shell, so it needs to

..... one electron to give a full outer shell.

[2]

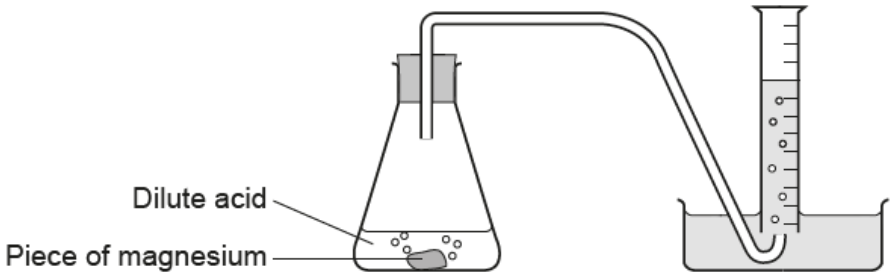
4. Nov/2021/Paper_J258/02/No.7

Kareem finds this table of information about the reactivity of some metals with dilute acids.

Metal	Reactivity with dilute acids
Copper	Does not react
Zinc	Metals become more reactive ↓
Magnesium	
Calcium	

He does some experiments to show that the reactivity of these metals is correct.

He uses the apparatus shown in the diagram.



Kareem finds that it takes **45 seconds** for magnesium to make 10 cm^3 gas.

Describe how Kareem should use the same apparatus to do experiments to show that the reactivity of the metals shown in the table is correct.

Include in your answer what he should control and what results he should expect.

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..... **[6]**

5. Nov/2020/Paper_J258/01/No.1(b, c)

(b) Aluminium has a metallic structure.

(i) Label the metallic structure shown in **Fig. 1.2** by completing the boxes.

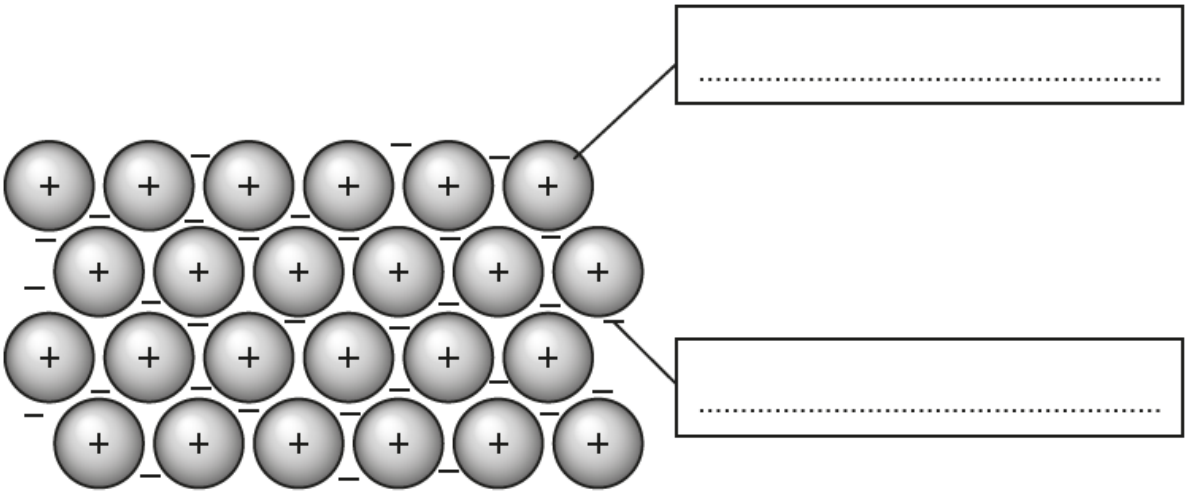


Fig. 1.2

[2]

(ii) Complete the sentence to explain why aluminium conducts electricity.

Aluminium conducts electricity because it contains .....
which can move. **[1]**

(c) Apart from cost, suggest **one** advantage of poly(propene) plastic drinking cups instead of aluminium metal drinking cups.

.....

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

6. Nov/2020/Paper_J258/01/No.3

Ethene is a gas.

The formula of ethene is C_2H_4.

(a) Name the **two** elements in ethene.

1 .....

2 ..... **[1]**

(b) What is the **empirical** formula of ethene?

Put a ring around the correct answer.

CH **CH_2** **C_2H_2** **C_2H_4**

[1]

(c) Which homologous series does ethene belong to?

Put a ring around the correct answer.

acids **alcohols** **alkanes** **alkenes**

[1]

(d) Ethene reacts with bromine water to make dibromoethane.

$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

Complete the sentences below to describe this reaction.

Use words from the list.

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

addition	**colourless**	**single**
displacement	**oxidised**	**double**

This type of reaction is called ..... .

The bromine water becomes ..... .

Ethene reacts because it contains a ..... bond.

[3]

7. Nov/2020/Paper_J258/02/No.10

Sundip passes electricity through solutions of some ionic compounds and finds out what products are formed at the positive and negative electrodes.

(a) Here are Sundip's results.

Solution	Product at positive electrode	Product at negative electrode
concentrated sodium chloride	chlorine gas	hydrogen gas
dilute sodium chloride	oxygen gas	hydrogen gas
dilute copper chloride	chlorine gas	copper metal
concentrated copper sulfate	oxygen gas	copper metal
concentrated copper chloride	.....	.....
dilute sodium sulfate	.....	.....

(i) Complete the table by predicting the products formed at each electrode when electricity is passed through concentrated copper chloride and dilute sodium sulfate. **[3]**

(ii) Sundip uses tests to identify the gases formed in her experiments.

Draw lines to connect each **gas** to its correct **test and result**.

Gas	Test and result
	relights a glowing splint
chlorine	makes a lighted splint go 'pop'
oxygen	turns lime water milky
hydrogen	turns blue litmus red and then bleaches it
	turns red litmus blue and then bleaches it

[2]

(iii) Explain why, at the negative electrode:

- **copper** metal is formed when electricity is passed through dilute copper chloride, **but**
- **hydrogen** gas is formed when electricity is passed through dilute sodium chloride.

.....

.....

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

(b) This is a list of apparatus Sundip uses to pass electricity through the solution of dilute sodium chloride:

- electrodes
- leads and clips
- a battery
- a beaker
- the solution of sodium chloride.

Draw a labelled diagram in the **box** to show how Sundip sets up her experiment to pass electricity through the solution of dilute sodium chloride.

[2]

8. Nov/2021/Paper_J258/03/No.5

Crude oil contains many compounds that are used as fuels.
The table shows information about some of these compounds:

Name	Formula	Relative formula mass	Melting point (°C)	Boiling point (°C)
Methane	CH_4	16	–182	–162
Pentane	C_5H_{10}	70	–130	36
Nonane	C_9H_{20}	128	–54	151
Dodecane	$C_{12}H_{26}$	170	–10	
Hexadecane	$C_{16}H_{34}$	226	18	287
Icosane	$C_{20}H_{42}$	282	37	343
Benzene	C_6H_6	78	6	80

(a) All the compounds in the table are alkanes, except benzene.

Explain how the formula of benzene shows it is **not** an alkane.

.....

.....

.....

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

(b) **(i)** Name **one** compound from the table which is a solid at 25 °C.

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

(ii) Give **one** reason for your answer to **(b)(i)**.

.....

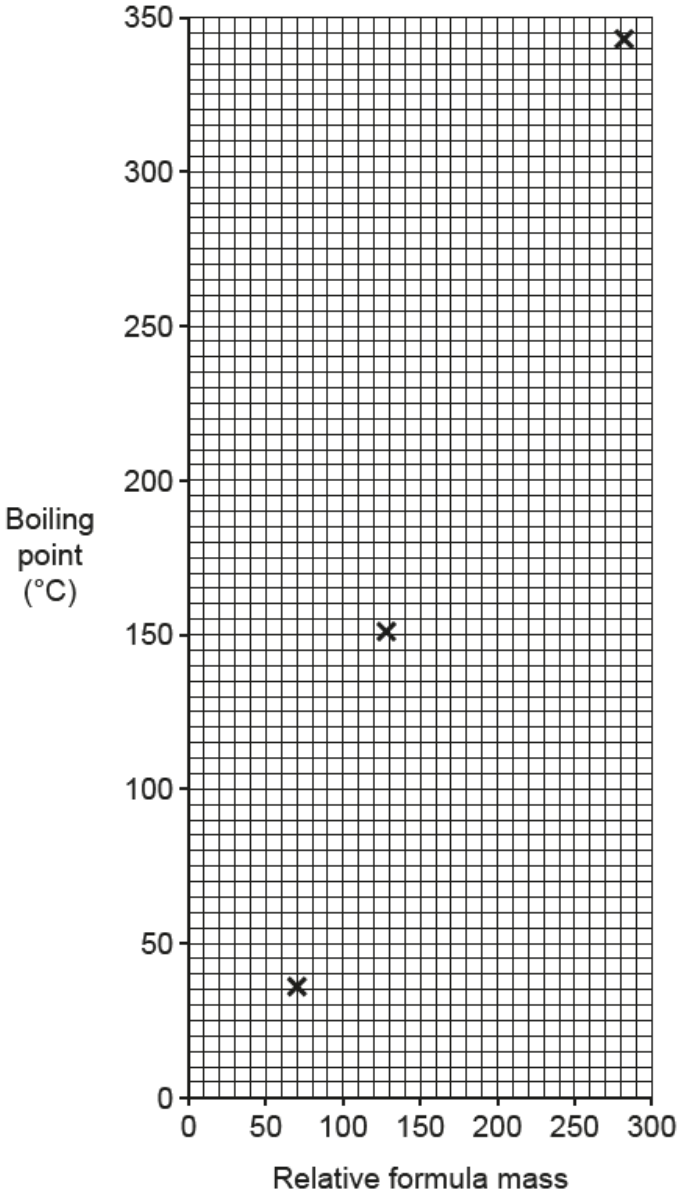
..... **[1]**

(c) Describe the relationship between melting point and boiling point for the alkanes in the table.

.....

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

(d) The graph shows the boiling point and relative formula mass for some alkanes.



(i) Hexadecane, $C_{16}H_{34}$, boils at 287 °C.
Plot the point for hexadecane on the graph.

Use data from the table. **[1]**

(ii) Draw a line of best fit. **[1]**

(iii) Estimate the boiling point of dodecane, $C_{12}H_{26}$.

Show your working on the graph.

Boiling point = ... °C **[1]**

(e) Fractional distillation is used to separate the compounds in crude oil.

Which property of the compounds is used to separate them?

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

(f) **(i)** Describe how carbon monoxide forms when alkanes burn in vehicle engines.

.....

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

(ii) Why is it important to decrease the amount of carbon monoxide entering the air?

.....

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

(iii) The formula of carbon monoxide is CO.
One mole of carbon monoxide contains 6.02×10^{23} molecules.

Calculate the mass of one carbon monoxide molecule.

Use the Data Sheet and the relationship: number of moles = $\frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

Give your answer to **3** significant figures.

Mass of one carbon monoxide molecule = ... g **[3]**

(g) Nitrogen oxides are also formed in vehicle engines.

Describe how nitrogen oxides form in vehicle engines.

.....

.....

.....

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

9. Nov/2021/Paper_J258/03/No.6(c)

(c) **Fig. 6.2** shows a model of a molecule of butane:

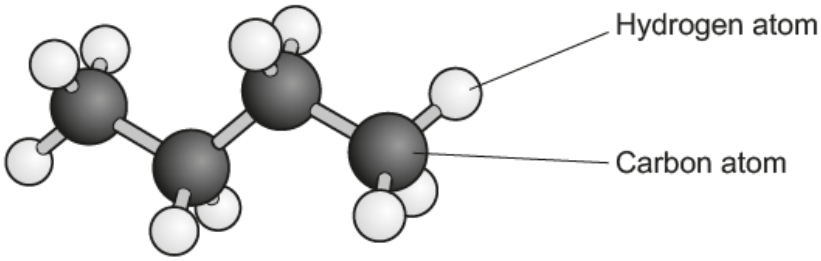


Fig. 6.2

(i) Which **two** features are shown by the model in **Fig. 6.2**?

Tick (✓) **two** boxes.

The number of electrons in the atoms. ☐

The 3D shape of the molecule. ☐

The number of atoms in the molecule. ☐

The actual size of the atoms. ☐

The length of the bonds between the atoms. ☐

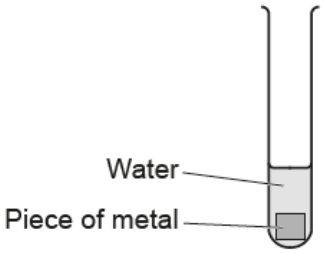
[2]

(ii) State the **empirical** formula of butane.

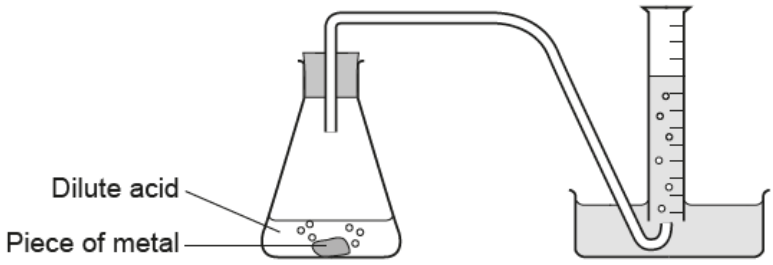
..... **[1]**

10. Nov/2021/Paper_J258/04/No.7

Kareem investigates the order of reactivity of five metals, aluminium, magnesium, calcium, copper and zinc. He does two experiments, as shown.



Experiment 1



Experiment 2

In **experiment 1** he puts small pieces of each of the metals into water.
He observes the metals over five minutes.

In **experiment 2** he puts small pieces of each metal into dilute acid.
He measures the time taken to collect 10 cm^3 of gas.

Table 7.1 and **Table 7.2** show Kareem's results.

Experiment 1	
Metal	**Observations**
Aluminium	No bubbles seen
Magnesium	Bubbles appear on surface of metal
Calcium	Rapid fizzing
Copper	No bubbles seen
Zinc	Bubbles appear on surface of metal

Table 7.1

Experiment 2	
Metal	**Time taken to collect 10 cm^3 gas (s)**
Aluminium	30
Magnesium	45
Calcium	5
Copper	No gas collected
Zinc	70

Table 7.2

(a)* Explain what conclusions can be made about the reactivity of the five metals from Kareem's experiment.

Include any uncertainties in your conclusions.

Use information from **Table 7.1** and **Table 7.2** to support your answer.

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..... **[6]**

(b) Which **two** statements explain why some metals are more reactive than others?

Tick (✓) **two** boxes.

Some metals form positive ions more easily. ☐

Some metals have lower melting points. ☐

Some metals are oxidised more easily. ☐

Some metals conduct electricity more easily. ☐

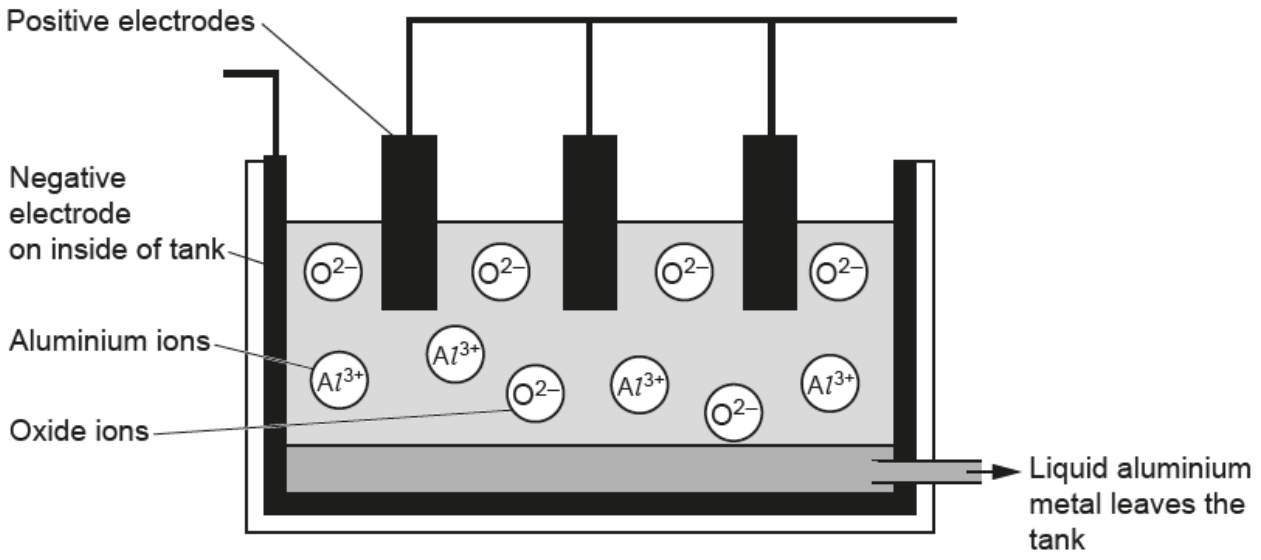
Some metals form ions with higher charges. ☐

[2]

11. Nov/2021/Paper_J258/04/No.8

Aluminium is extracted from aluminium oxide by electrolysis.

The diagram shows the tank used to electrolyse aluminium oxide.



(a) (i) Before electrolysis, solid aluminium oxide is dissolved in a hot, molten compound called cryolite.
The formula for cryolite is Na_3AlF_6.

Explain why the formula for cryolite contains six fluoride ions.

Use ideas about charges in your answer.

.....

.....

.....

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

(ii) The hot cryolite dissolves the aluminium oxide to form a molten solution.

Explain why solid aluminium oxide has to be made into a molten solution before electrolysis.

.....

.....

.....

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

(b) (i) Describe what happens at each electrode during the electrolysis.

.....

.....

.....

.....

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.....

.....

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

(ii) The melting point of aluminium metal is 660 °C.

What temperature should the inside of the tank be to make sure that aluminium leaves the tank as a liquid?

Put a (ring) around the correct answer.

<< 660 °C **> 660 °C** **< 660 °C** **~ 660 °C**

[1]

(c) Aluminium is used to make overhead cables. Copper is used to make underground cables.

The table shows some properties of each metal.

Metal	Electrical conductivity (MS / m)	Density (g/cm^3)
Copper	58	9.0
Aluminium	35	2.7

Explain why the metals are used in different ways.

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.....

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

12. Nov/2020/Paper_J258/03/No.3

Fig. 3.1 shows the displayed formula of ethene.

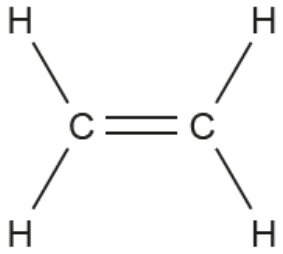


Fig. 3.1

(a) Ethene has some reactions that are different from those of ethane. These reactions are caused by its functional group.

Put a ring around the functional group of ethene in **Fig. 3.1**. **[1]**

(b) 1 mole of ethene contains 6.0×10^{23} molecules.

How many hydrogen atoms are there in one mole of ethene?

Put a ring around the correct answer.

1 **4** **6** **6.0×10^{23}** **2.4×10^{24}**

[1]

(c) **(i)** Ethene (**Fig. 3.1**) reacts with **Substance D** to give the compound shown in **Fig. 3.2**.

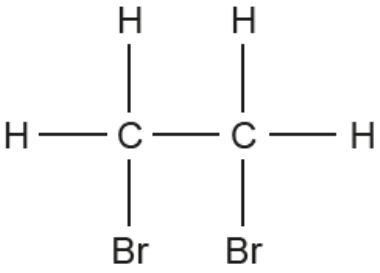


Fig. 3.2

Name **Substance D**.

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

(ii) Ethene also reacts with hydrogen.

Draw the displayed formula of the compound formed.

13. Nov/2020/Paper_J258/04/No.2

Sundip passes electricity through solutions of some ionic compounds and finds out what products are formed at the positive and negative electrodes.

(a) Here are Sundip's results.

Solution	Product at positive electrode	Product at negative electrode
concentrated sodium chloride	chlorine gas	hydrogen gas
dilute sodium chloride	oxygen gas	hydrogen gas
dilute copper chloride	chlorine gas	copper metal
concentrated copper sulfate	oxygen gas	copper metal
concentrated copper chloride	.....	.....
dilute sodium sulfate	.....	.....

(i) Complete the table by predicting the products formed at each electrode when electricity is passed through concentrated copper chloride and dilute sodium sulfate. **[3]**

(ii) Sundip uses tests to identify the gases formed in her experiments.

Draw lines to connect each **gas** to its correct **test and result**.

Gas	Test and result
	relights a glowing splint
chlorine	makes a lighted splint go 'pop'
oxygen	turns lime water milky
hydrogen	turns blue litmus red and then bleaches it
	turns red litmus blue and then bleaches it

[2]

(iii) Explain why, at the negative electrode:

- **copper** metal is formed when electricity is passed through dilute copper chloride, **but**
- **hydrogen** gas is formed when electricity is passed through dilute sodium chloride.

.....

.....

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

(b) This is a list of apparatus Sundip uses to pass electricity through the solution of dilute sodium chloride:

- electrodes
- leads and clips
- a battery
- a beaker
- the solution of sodium chloride.

Draw a labelled diagram in the **box** to show how Sundip sets up her experiment to pass electricity through the solution of dilute sodium chloride.

[2]

14. Nov/2020/Paper_J258/04/No.3

Crude oil is a source of useful chemicals.

(a) Which **two** statements about crude oil are correct?

Tick (✓) **two** boxes.

Crude oil contains hydrocarbons which are used as fuels. ☐

All crude oil compounds have the same empirical formula. ☐

Most compounds in crude oil are alkenes. ☐

Crude oil is a renewable resource. ☐

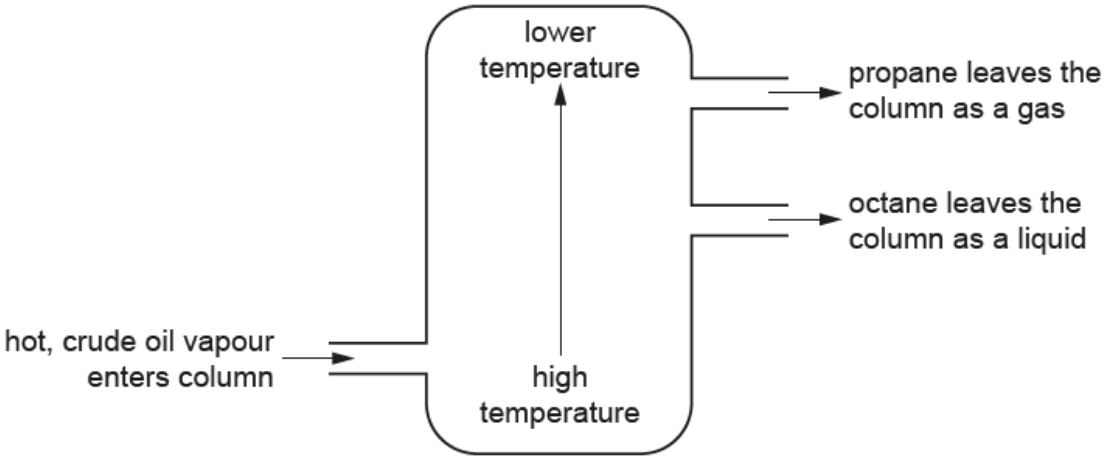
Compounds from crude oil are used as a feedstock for petrochemicals. ☐

[2]

(b) Crude oil is separated using fractional distillation.

Two compounds in crude oil are propane, C_3H_8, and octane, C_8H_{18}.

The diagram shows where hot, crude oil vapour enters and where propane gas and octane liquid leave the fractionating column.



Explain how propane and octane are separated in the column.

Use ideas about boiling points and intermolecular forces in your answer.

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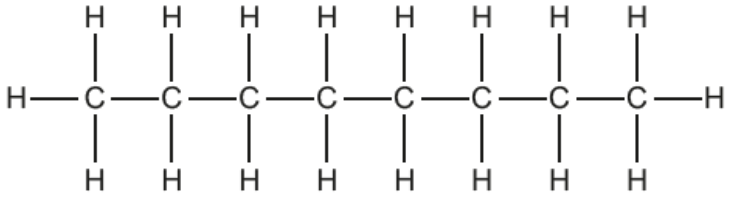
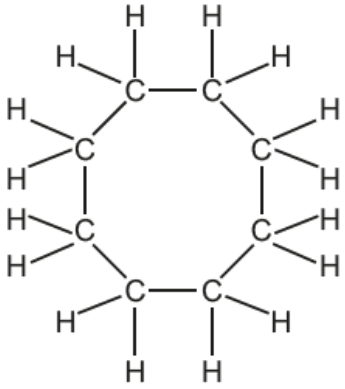
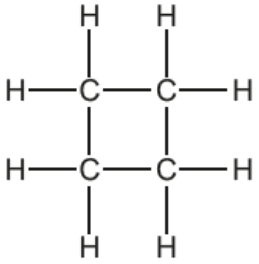
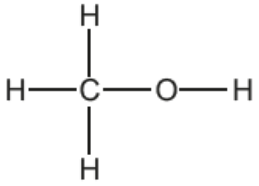
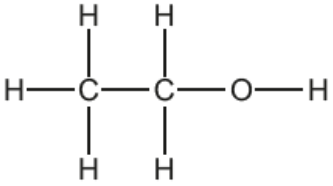
..... **[3]**

(c) Petrol contains octane, C_8H_{18}, mixed with other carbon compounds.

The table shows octane and some other compounds in petrol.

Type of compound	Example	
alkane	 **Name:** octane	
cycloalkane	 **Name:**	 **Name:** .....
alcohol	 **Name:** methanol	 **Name:** ethanol

(i) Complete the table by suggesting the names for each cycloalkane. **[2]**

(ii) The general formula for alkanes is C_nH_{2n+2}.

Suggest the general formulae for cycloalkanes and alcohols.

Use the examples in the table to help you.

General formula of cycloalkanes C_n .....

General formula of alcohols C_n .....

[2]

(iii) Carbon makes a greater range of different compounds than any other element.

Which **two** statements explain why?

Tick (✓) **two** boxes.

Carbon has a total of four electrons. ☐

Carbon forms four covalent bonds. ☐

Carbon forms compounds with oxygen and hydrogen. ☐

Carbon atoms can join together in chains and rings. ☐

Carbon is very abundant on Earth. ☐

[2]