## Chemistry of the atmosphere

## Q1.

This question is about mixtures and analysis.

(a) Which **two** substances are mixtures?

Tick **two** boxes.

| | |
|---|---|
| Air | ☐ |
| Carbon dioxide | ☐ |
| Graphite | ☐ |
| Sodium Chloride | ☐ |
| Steel | ☐ |

**(2)**

(b) Draw **one** line from each context to the correct meaning.

| Context | Meaning |
|---|---|
| | A substance that has had nothing added to it |
| **Pure** substance in chemistry | A single element or a single compound |
| | A substance containing only atoms which have different numbers of protons |
| **Pure** substance in everyday life | A substance that can be separated by filtration |
| | A useful product made by mixing substances |

**(2)**

(c) What is the test for chlorine gas?

Tick **one** box.

A glowing splint relights ☐

A lighted splint gives a pop ☐

Damp litmus paper turns white ☐

Limewater turns milky ☐

**(1)**

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick **one** box.

Calcium ☐

Copper(II) ☐

Iron(II) ☐

Iron(III) ☐

**(1)**

**(Total 6 marks)**

## Q2.

Greenhouse gases affect the temperature of the Earth.

(a) Which gas is a greenhouse gas?

Tick **one** box.

Argon ☐

Methane ☐

Nitrogen ☐

Oxygen ☐

**(1)**

(b) An increase in global temperature will cause climate change.

What is **one** possible effect of climate change?

Tick **one** box.

Deforestation ☐

Global dimming ☐

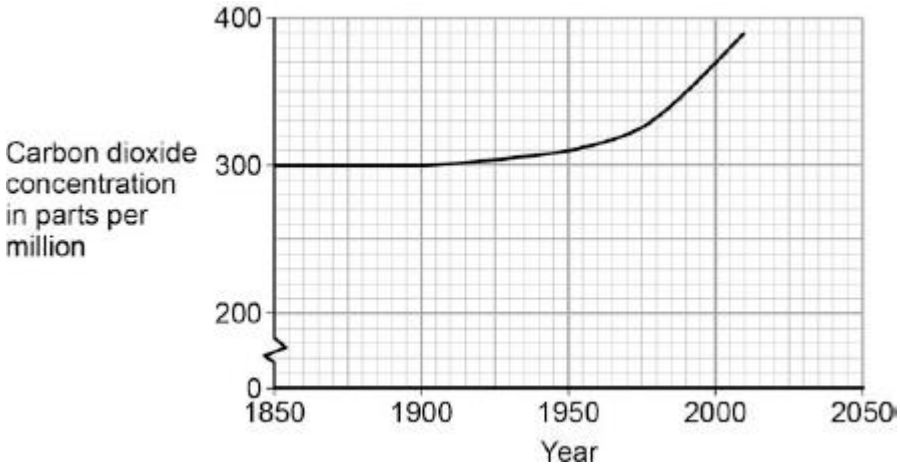
Sea levels rising ☐

Volcanic activity ☐

**(1)**

(c) Carbon dioxide is also a greenhouse gas.

The figure below shows how the concentration of carbon dioxide in the atmosphere has changed since 1850.




Which process is the reason for the change in carbon dioxide concentration shown on the figure above?

Tick **one** box.

Burning of fossil fuels ☐

Carbon capture ☐

Formation of sedimentary rocks ☐

Photosynthesis ☐

**(1)**

(d) Give **three** conclusions that can be made from the figure above.

1. _____

_____

2. _____

_____

3. _____

_____

**(3)**

**(Total 6 marks)**

## Q3.

The table below gives information about four alcohols.

| Alcohol | Formula | Melting point in °C | Boiling point in °C |
|---|---|---|---|
| Methanol | $CH_3OH$ | −94 | 65 |
| Ethanol | $CH_3CH_2OH$ | −118 | 78 |
| Propanol | $CH_3CH_2CH_2OH$ | −129 | 97 |
| Butanol | $CH_3CH_2CH_2CH_2OH$ | −89 | 118 |

(a) Which alcohol in the table is liquid over the greatest temperature range?

_____

**(1)**

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms ☐

Butanol has the highest boiling point ☐

Methanol has the largest molecules ☐

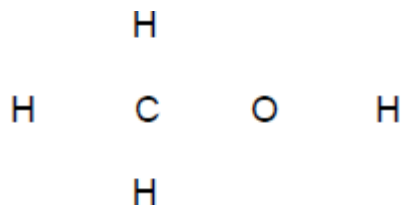
Propanol has the highest melting point ☐

**(1)**

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

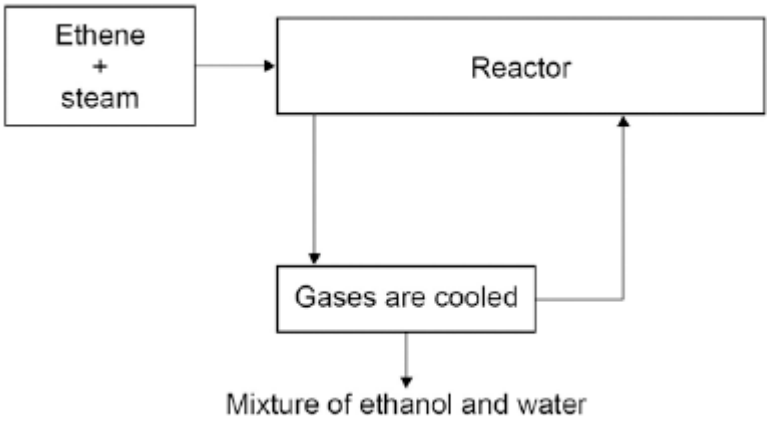
**Figure 1**




**(1)**

(d) **Figure 2** shows a flow diagram of the process to produce ethanol.

**Figure 2**




Complete the word equation for the reaction to produce ethanol.

_____ + _____ → ethanol

**(1)**

(e) What happens to the unreacted ethene?

_____

_____

**(1)**

(f) Wine contains ethanol.
A bottle of wine was left open in air.
After a few days, the wine tasted of vinegar.
Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

_____

_____

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 8 marks)**

## Q4.

This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

| | |
|---|---|
| Ethane | $C_2H_6$ |
| Propane | $C_3H_8$ |
| Butane | $C_4H_{10}$ |

The next member in the series is pentane.

What is the formula of pentane?

_____

**(1)**

(b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols ☐

Alkanes ☐

Alkenes ☐

Carboxylic acids ☐

**(1)**

(c) Propane ($C_3H_8$) is used as a fuel.

Complete the equation for the complete combustion of propane.

$C_3H_8 + 5O_2 \rightarrow 3$ _____ + 4 _____

**(2)**

(d) Octane ($C_8H_{18}$) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

_____

_____

**(2)**

(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

| **Fuel** | **Relative amounts of pollutants** | | |
|---|---|---|---|
| | **Oxides of Nitrogen** | **Particulate matter** | **Carbon dioxide** |
| Diesel | 31 | 100 | 85 |
| Petrol | 23 | 0 | 100 |

Compare the pollutants from cars using diesel with those from cars using petrol.

_____

_____

_____

_____

_____

_____

**(3)**

(f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

| **Pollutant** | **Environmental impact caused by the pollutant** |
|---|---|
| | Acid rain |
| Oxides of nitrogen | Flooding |
| | Global dimming |
| Particulate matter | Global warming |
| | Photosynthesis |

**(2)**

**(Total 11 marks)**

## Q5.

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon, $C_{18}H_{38}$

$C_{18}H_{38} \rightarrow C_6H_{14} + C_4H_8 + 2\,C_3H_6 + C_2H_4$

(a) Which product of the reaction shown is an alkane?

Tick **one** box.

$C_2H_4$ ☐

$C_3H_6$ ☐

$C_4H_8$ ☐

$C_6H_{14}$ ☐

**(1)**

(b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

| | **Boiling point** | **Flammability** | **Viscosity** |
|---|---|---|---|
| **A** | highest | lowest | highest |
| **B** | highest | lowest | lowest |
| **C** | lowest | highest | highest |
| **D** | lowest | highest | lowest |

Which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{18}H_{38}$ compare with the properties of $C_2H_4$, $C_3H_6$, $C_4H_8$ and $C_6H_{14}$?

Tick **one** box.

**A** ☐

**B** ☐

**C** ☐

**D** ☐

**(1)**

(c) The hydrocarbon $C_4H_8$ was burnt in air.

Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?

**A** $C_4H_8 + 4O \rightarrow 4CO + 4H_2$

**B** $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$

**C** $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

**D** $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

**A** ☐

**B** ☐

**C** ☐

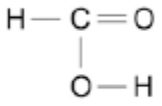
**D** ☐

**(1)**

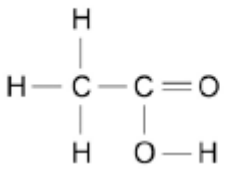
(d) Propanoic acid is a carboxylic acid.

Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?

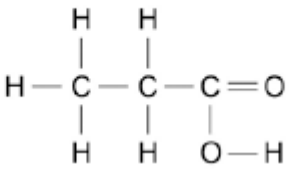
**A**



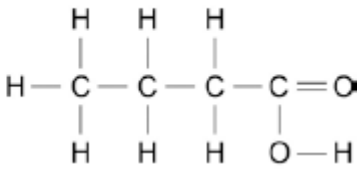
**B**



**C**



**D**



Tick **one** box.

**A** ☐

**B** ☐

**C** ☐

**D** ☐

**(1)**

(e) Propanoic acid is formed by the oxidation of which organic compound?

Tick **one** box.

Propane ☐

Propene ☐

Propanol ☐

Polyester ☐

**(1)**

**(Total 5 marks)**

## Q6.

This question is about the temperature of the Earth's atmosphere.

(a) Give **one** reason why it is difficult to produce models for future climate change.

_____

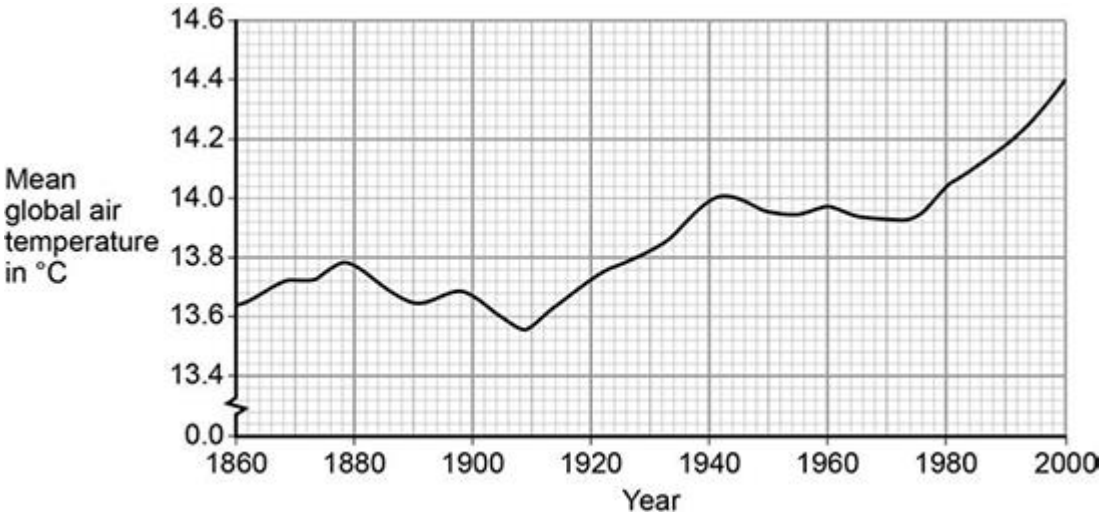
_____

**(1)**

(b) Describe how carbon dioxide helps to maintain temperatures on Earth.

**(3)**

(c) The figure below shows the change in mean global air temperature from 1860 to 2000.




Explain how human activities have contributed to the main trend shown from 1910 in the figure above.

**(3)**

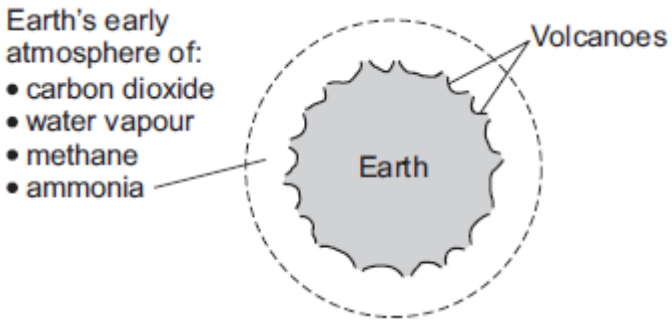
**(Total 7 marks)**

## Q7.

This question is about the Earth and its atmosphere.

(a) **Figure 1** shows the Earth and its atmosphere billions of years ago.

**Figure 1**




The boiling point of water is 100 °C.

Suggest **one** reason why there was no liquid water on the Earth's surface billions of years ago.

_____

_____

**(1)**

(b) The Earth's atmosphere today contains nitrogen, oxygen, argon, carbon dioxide and other gases.

(i) Draw **one** line from each substance to a description of the substance.

| Substance | Description of the substance |
|---|---|
| air | compound |
| carbon dioxide | element |
| argon | hydrocarbon |
| | metal |
| | mixture |

**(3)**

(ii) Which gas in the Earth's atmosphere is used when hydrocarbons burn?

Tick (✔) **one** box.

carbon dioxide ☐

nitrogen ☐

oxygen ☐

**(1)**

(iii) What percentage of the Earth's atmosphere is nitrogen?

Tick (✔) **one** box.

about 40% ☐

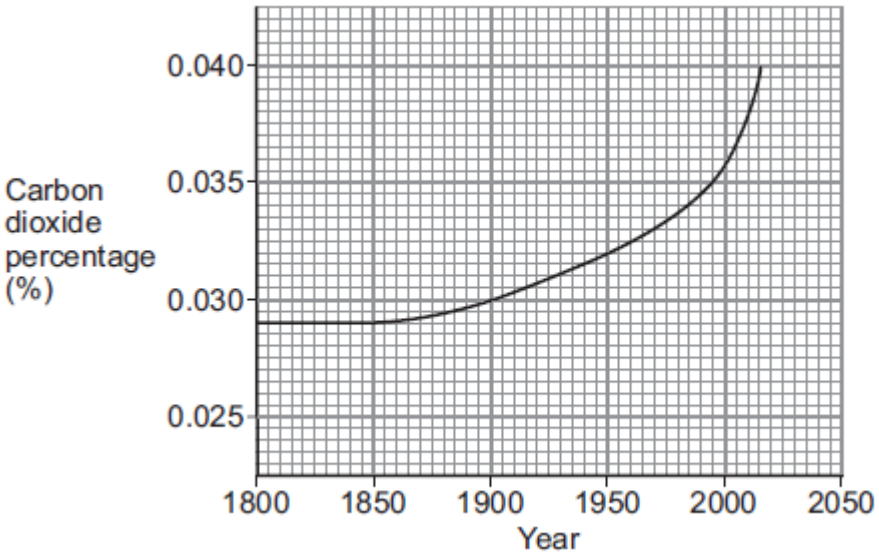
about 60% ☐

about 80% ☐

**(1)**

(c) **Figure 2** shows the carbon dioxide percentage (%) in the Earth's atmosphere since the year 1800.

**Figure 2**




(i) What was the carbon dioxide percentage in 1900?

_____ %

**(1)**

(ii) Describe, in detail, how the carbon dioxide percentage changed from 1900 to 2015.

_____

_____

_____

_____

**(2)**

(iii) Suggest **two** reasons for the change in the carbon dioxide percentage from 1900 to 2015.

1. _____

_____

2. _____

_____

**(2)**

**(Total 11 marks)**

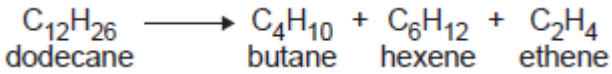
## Q8.

This question is about hydrocarbons.

(a) Most of the hydrocarbons in crude oil are alkanes.

(i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.




Give **two** conditions used to crack large alkane molecules.

1. _____

2. _____

**(2)**

(ii) The products hexene and ethene are alkenes.

Complete the sentence.

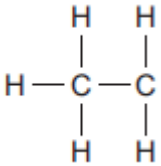
When alkenes react with bromine water the colour changes

from orange to _____ .

**(1)**

(iii) Butane ($C_4H_{10}$) is an alkane.

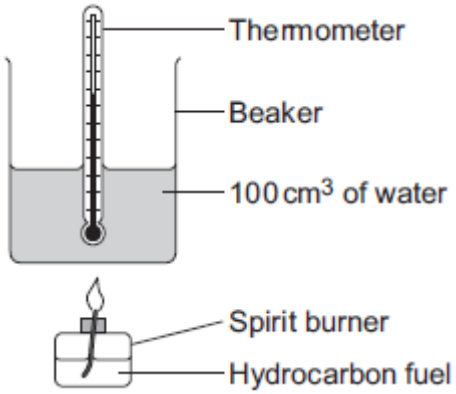
Complete the displayed structure of butane.



**(1)**

(b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

The diagram below shows the apparatus used.




Each hydrocarbon fuel was burned for two minutes.

**Table 1** shows the students' results.

**Table 1**

| | After two minutes | | | | |
|---|---|---|---|---|---|
| **Name and formula of hydrocarbon fuel** | **Mass of fuel used in g** | **Temperature increase of water in °C** | **Energy released by fuel in kJ** | **Energy released by 1.0 g of fuel in kJ** | **Relative amount of smoke in the flame** |
| Hexane, $C_6H_{14}$ | 0.81 | 40 | 16.80 | 20.74 | very little smoke |
| Octane, $C_8H_{18}$ | 1.10 | 54 | 22.68 | 20.62 | some smoke |
| Decane, $C_{10}H_{22}$ | 1.20 | 58 | 24.36 | | smoky |
| Dodecane, $C_{12}H_{26}$ | 1.41 | 67 | 28.14 | 19.96 | very smoky |

(i) Calculate the energy released by 1.0 g of decane in kJ.

_____

_____

Energy released = _____ kJ

**(2)**

(ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

_____

_____

_____

**(2)**

(iii) The students noticed that the bottom of the beaker became covered in a black

substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

_____

_____

_____

_____

**(2)**

(iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 2** support this conclusion.

1. _____

_____

2. _____

_____

**(2)**

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

**Table 2** shows information about petrol and hydrogen.

**Table 2**

| | **Petrol** | **Hydrogen** |
|---|---|---|
| State of fuel at room temperature | Liquid | Gas |
| Word equation for combustion of the fuel | petrol + oxygen ⟶ carbon dioxide + water | hydrogen + oxygen ⟶ water |
| Energy released from combustion of 1 g of the fuel | 47 kJ | 142 kJ |

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

**(6)**

**(Total 18 marks)**

## Q9.

This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

_____

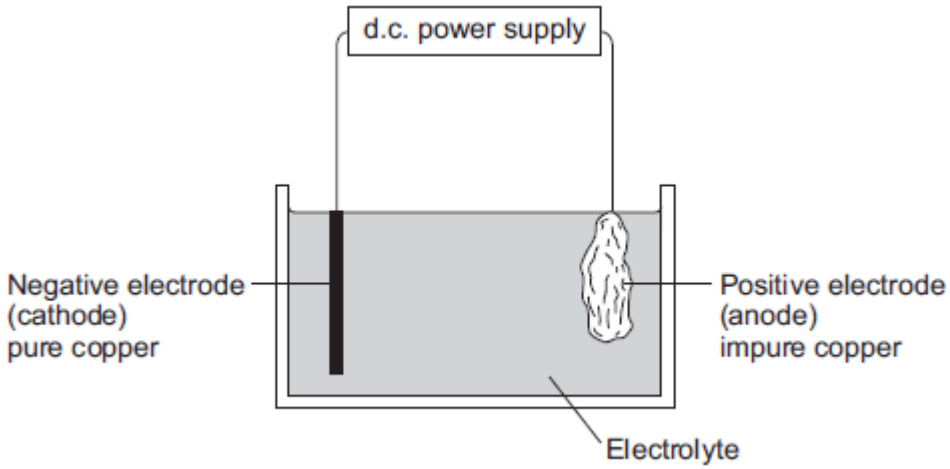
_____

_____

_____

**(2)**

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.




Copper atoms are oxidised at the positive electrode to $Cu^{2+}$ ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$$

(i) How does the half equation show that copper atoms are oxidised?

_____

_____

**(1)**

(ii) The $Cu^{2+}$ ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

_____

**(1)**

(iii) Suggest a suitable electrolyte for the electrolysis.

_____

**(1)**

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

_____

_____

_____

_____

_____

_____

**(3)**

(e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses ($A_r$): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

Empirical formula = _____

**(4)**

**(Total 16 marks)**

## Q10.

This question is about ethanol.

(a) Ethanol can be made by fermentation of sugars from plants.

(i) What is a suitable temperature for fermentation?

Draw a ring around the correct answer.

**0 °C** **25 °C** **450 °C**

**(1)**

(ii) Fermentation produces a dilute solution of ethanol in water.

Name the process used to obtain ethanol from this dilute solution.

_____

**(1)**

(b) Ethanol made by fermentation can be used as a biofuel.

(i) Explain why increasing the use of biofuels may cause food shortages.

_____

_____

_____

_____

**(2)**

(ii) Explain why burning biofuels contributes less to climate change than burning fossil fuels.

_____

_____

_____

_____

_____

**(2)**

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate**.

Ethanol can also be made by reacting ethene with steam in the presence of a catalyst.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

**Figure 1** shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

**Figure 1**

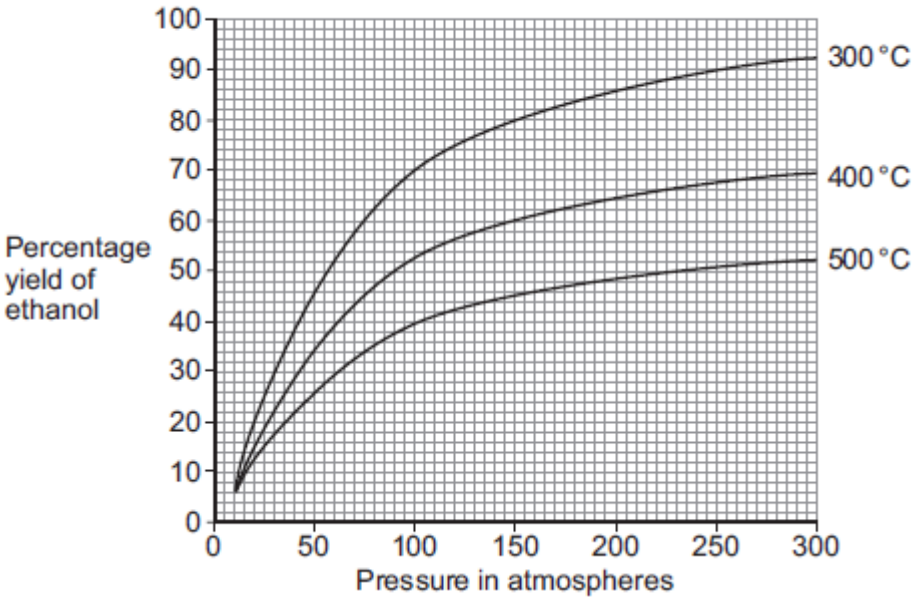
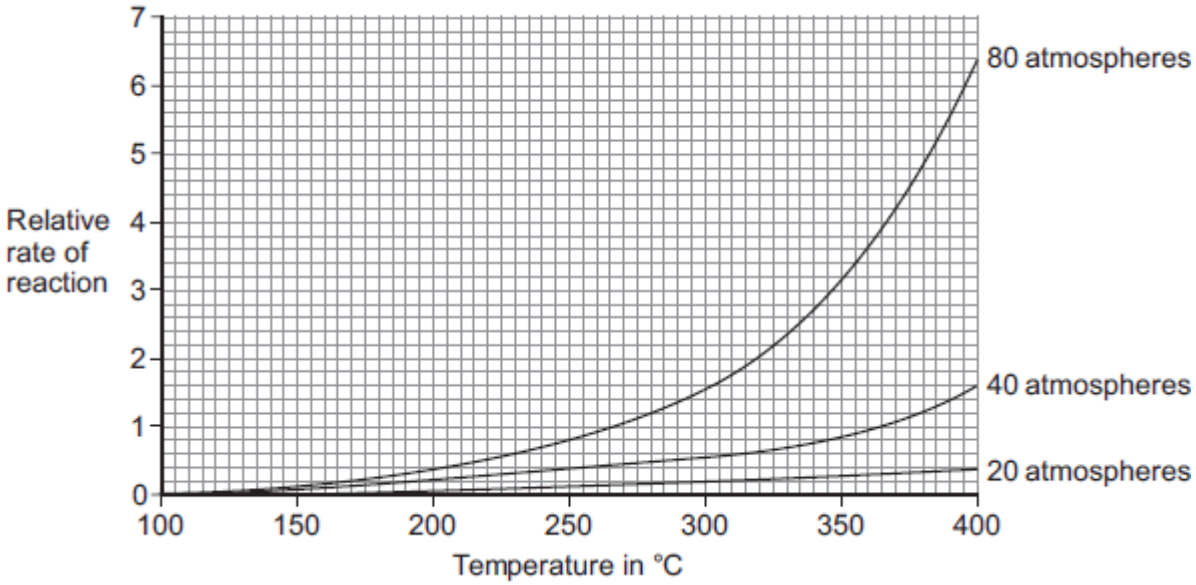



**Figure 2** shows how the rate of reaction changes as the temperature changes at three different pressures.

**Figure 2**




In one process for the reaction of ethene with steam the conditions are:

- 300 °C
- 65 atmospheres
- a catalyst.

Use the information in **Figure 1** and **Figure 2**, and your own knowledge, to justify this choice of conditions.

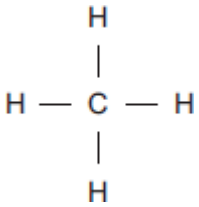
**(6)**

**(Total 12 marks)**

## Q11.

Methane ($CH_4$) is used as a fuel.

(a) The displayed structure of methane is:



Draw a ring around a part of the displayed structure that represents a covalent bond.

**(1)**

(b) Why is methane a compound?

Tick (✓) **one** box.

Methane contains atoms of two elements, combined chemically. ☐

Methane is not in the periodic table. ☐

Methane is a mixture of two different elements. ☐

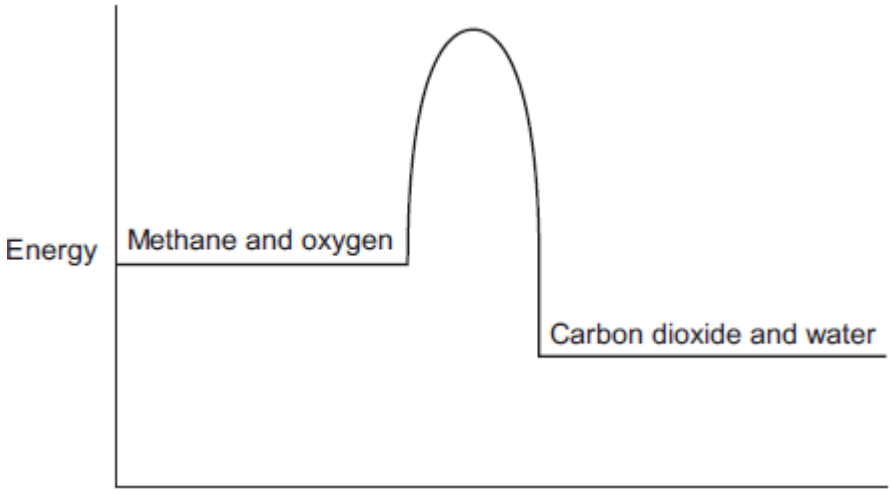
**(1)**

(c) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, *ΔH*.




**(2)**

(ii) Complete and balance the symbol equation for the complete combustion of methane.

$$CH_4 + \_\_\_\_\_ \longrightarrow CO_2 + \_\_\_\_\_$$

**(2)**

(iii) Explain why the **incomplete** combustion of methane is dangerous.

**(2)**

(iv) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

**(3)**

(d) Methane reacts with chlorine in the presence of sunlight.

The equation for this reaction is:

Some bond dissociation energies are given in the table.

| **Bond** | **Bond dissociation energy in kJ per mole** |
|---|---|
| C−H | 413 |
| C−Cl | 327 |
| Cl−Cl | 243 |
| H−Cl | 432 |

(i) Show that the enthalpy change, $\Delta H$, for this reaction is −103 kJ per mole.

_____

_____

_____

**(3)**

(ii) Methane also reacts with bromine in the presence of sunlight.

This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change, $\Delta H$, is −45 kJ per mole.

What is a possible reason for this?

Tick (✓) **one** box.

| | |
|---|---|
| $CH_3Br$ has a lower boiling point than $CH_3Cl$ | ☐ |
| The C−Br bond is weaker than the C−Cl bond. | ☐ |
| The H−Cl bond is weaker than the H−Br bond. | ☐ |
| Chlorine is more reactive than bromine. | ☐ |

**(1)**

**(Total 15 marks)**

## Q12.

Crude oil is a fossil fuel.

(a) To make crude oil more useful it is separated into fractions.

Use the correct word from the box to complete each sentence.

| | | | |
|---|---|---|---|
| **boiling** | **compound** | **decomposition** | **distillation** |
| | **filtration** | **mixture** | **molecule** |

(i) Crude oil is a _____ of different substances.

**(1)**

(ii) The substances in crude oil have different

_____ points.

**(1)**

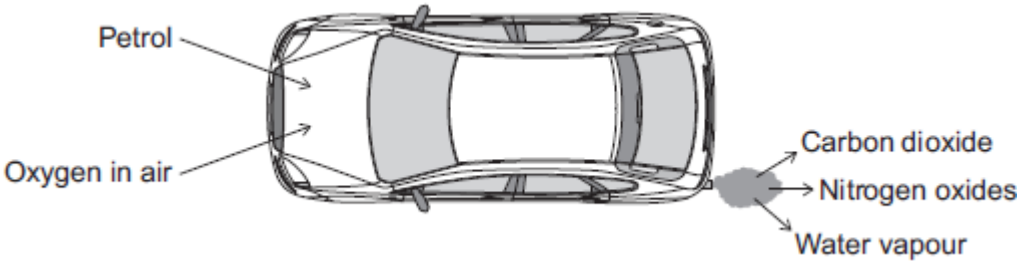
(iii) Crude oil is separated by fractional _____ .

**(1)**

(b) Petrol is one of the fractions produced from crude oil.

Car engines use a mixture of petrol and air.

The diagram shows some of the gases produced.




(i) What type of reaction happens to petrol in a car engine?

Tick (✓) **one** box.

combustion ☐

decomposition ☐

neutralisation ☐

**(1)**

(ii) Petrol contains octane ($C_8H_{18}$).

Complete the word equation for the reaction of octane with oxygen.

octane + _____ ⟶ _____ + _____

**(2)**

(iii) Cars use sulfur-free petrol as a fuel.

Describe why sulfur should be removed from petrol.

_____

_____

_____

_____

**(2)**

(c) Some fractions from crude oil contain large hydrocarbon molecules.

These molecules can be cracked to produce smaller, more useful molecules.

An equation for cracking decane is:

| | | | | | | |
|---|---|---|---|---|---|---|
| $C_{10}H_{22}$ | ⟶ | $C_3H_8$ | + | $C_2H_4$ | + | $C_5H_{10}$ |
| decane | | propane | | ethene | | pentene |

(i) Why is propane useful?

Tick (✓) **one** box.

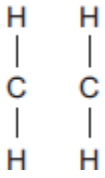
Propane is a polymer. ☐

Propane is an alloy. ☐

Propane is a fuel. ☐

**(1)**

(ii) Draw bonds to complete the displayed structure of ethene.



**(1)**

(iii) What is the colour change when bromine water reacts with ethene?

Tick (✓) **one** box.

Orange to colourless ☐

Orange to green ☐

Orange to red ☐

**(1)**

(iv) Complete the sentence.

Pentene is useful because many pentene molecules can join together to form _____ .

**(1)**

**(Total 12 marks)**

## Q13.

This question is about life, the Earth and its atmosphere.

(a) There are many theories about how life was formed on Earth.

Suggest **one** reason why there are many theories.

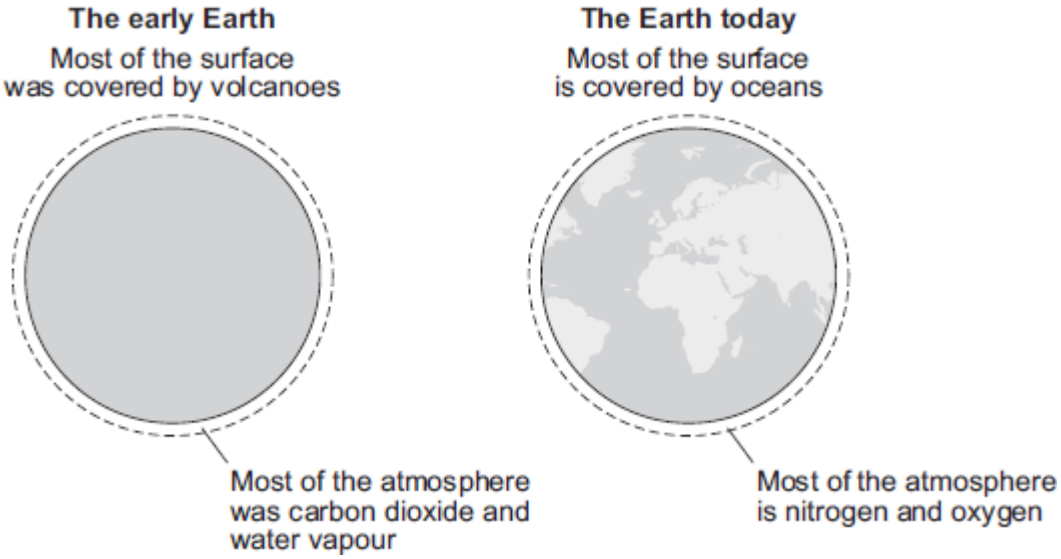
_____

_____

**(1)**

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

This Earth and its atmosphere today are not like the early Earth and its atmosphere.




Describe and explain how the surface of the early Earth and its atmosphere have changed to form the surface of the Earth and its atmosphere today.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**
**(Total 7 marks)**

## Q14.

Crude oil is a fossil fuel.

(a) Describe how crude oil is separated into fractions.

**(4)**

(b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

**(3)**

(c) Some fractions from crude oil contain large hydrocarbon molecules.

(i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller,

more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

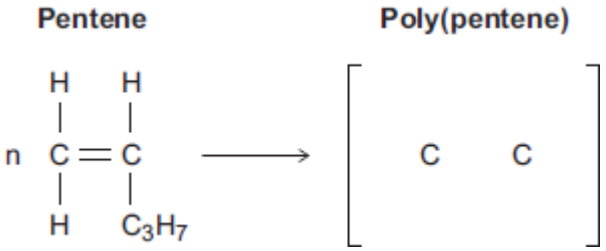
$C_{10}H_{22}$ ⟶ $C_5H_{10}$ + $C_3H_8$ + _____

decane pentene propane

**(1)**

(ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).




**(3)**

(iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

_____

_____

**(1)**

**(Total 12 marks)**

## Q15.

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, $SO_2$

(a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✔) **one** box.

Sulfur dioxide causes acid rain. ☐

Sulfur dioxide causes global dimming. ☐

Sulfur dioxide causes global warming. ☐

**(1)**

(b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?
Give a reason for your answer.

**(2)**

(c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.

**(3)**

(d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (**W**)
- dry gas desulfurisation (**D**)
- seawater gas desulfurisation (**S**).

Information about the three methods is given in the bar chart and in **Table 1** and **Table 2**.

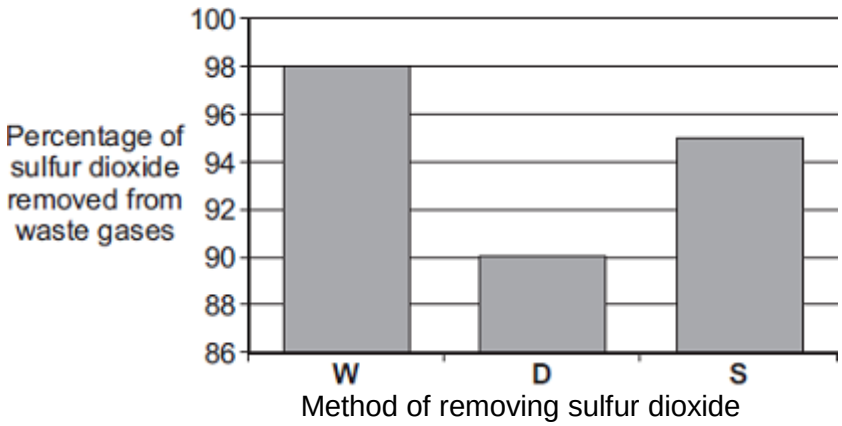



**Table 1**

| Method | Material used | How material is obtained |
|---|---|---|
| **W** | Calcium carbonate, $CaCO_3$ | Quarrying |
| **D** | Calcium oxide, CaO | Thermal decomposition of calcium carbonate:<br>$CaCO_3 \longrightarrow CaO + CO_2$ |
| **S** | Seawater | From the sea |

**Table 2**

| Method | What is done with waste material |
|---|---|
| **W** | Solid waste is sold for use in buildings.<br>Carbon dioxide is released into the atmosphere. |
| **D** | Solid waste is sent to landfill. |
| **S** | Liquid waste is returned to the sea. |

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

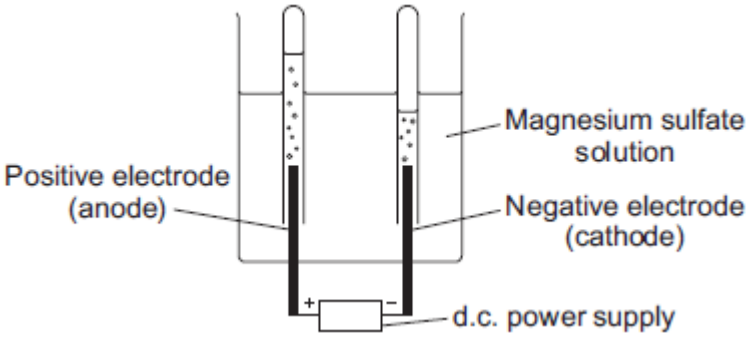
**(6)**

**(Total 12 marks)**

## Q16.

**Diagram 1** shows the apparatus used to electrolyse magnesium sulfate solution.

**Diagram 1**




Gases were given off at both electrodes.

(a) The gas collected at the anode was oxygen.

Draw **one** line from the test for oxygen to the correct result.

| Test | Result |
|---|---|
| | The splint relights |
| Place a glowing splint in the tube of the gas | The splint goes out |
| | There is a squeaky pop |

**(1)**

(b) (i) The gas collected at the cathode was hydrogen.

Describe how to test the gas to show that it is hydrogen.

Test _____

_____

Result _____

_____

**(2)**

(ii) Why is hydrogen, and **not** magnesium, produced at the cathode?

_____

_____

**(1)**

(c) A student wanted to use electrolysis to silver plate a metal spoon.

(i) Give **one** reason why metal spoons are sometimes silver plated.

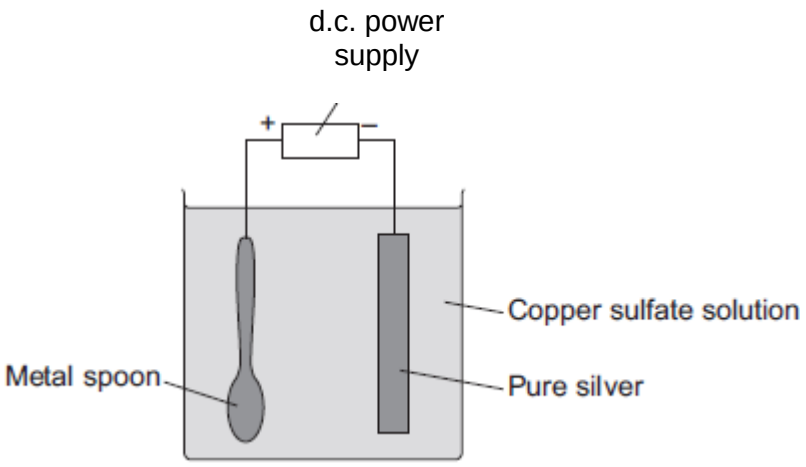
_____

_____

**(1)**

(ii) **Diagram 2** shows the apparatus the student used. The student did **not** set the apparatus up correctly.

**Diagram 2**




The student found that the metal spoon eroded and a thin layer of copper formed on the pure silver electrode.

Suggest **two** changes that the student must make to his apparatus to be able to silver plate the metal spoon. Give a reason for each change.

_____

_____

_____

_____

_____

_____

_____

**(4)**

(iii) Why is it difficult to electroplate plastic spoons?

_____

_____

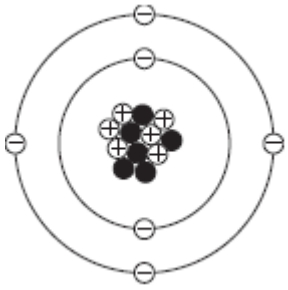
**(1)**

**(Total 10 marks)**

## Q17.

Fossil fuels contain carbon.

(a) The figure below represents a carbon atom.



Draw a ring around the correct answer to complete each sentence.

(i) The name of the particle with a positive charge is

| |
|---|
| an electron. |
| a neutron. |
| a proton. |

**(1)**

(ii) The centre of the atom is called the

| |
|---|
| energy level. |
| molecule. |
| nucleus. |

**(1)**

(iii) Use the Chemistry Data Sheet to help you to answer this question.

Use the correct number from the box to complete each sentence.

| | | | | |
|---|---|---|---|---|
| **4** | **6** | **8** | **10** | **12** |

The mass number of this carbon atom is ☐

In the periodic table, carbon is in Group ☐

(b) Coal is a fossil fuel.

A piece of coal contains:

- 80% carbon
- 9% oxygen
- 1% sulfur
- 5% hydrogen.

The rest of the coal is other elements.

(i) What is the percentage of other elements in this piece of coal?

_____ %

**(1)**

(ii) Coal burns in air to produce carbon dioxide, sulfur dioxide and water.

Draw **one** line from each product to the type of pollution caused by each product.

| Product | Type of pollution |
|---|---|
| Carbon dioxide | Acid rain |
| Sulfur dioxide | Global dimming |
| Water | Global warming |
| | No pollution |

**(3)**

**(Total 8 marks)**

## Q18.

Some theories suggest that the Earth's early atmosphere was the same as Mars' atmosphere today.

The table below shows the percentage of four gases in the atmosphere of Mars today and the atmosphere of Earth today.

| **Gases** | **The atmosphere of** | |
|---|---|---|
| | **Mars today** | **Earth today** |

| | | |
|---|---|---|
| Carbon dioxide | 95.00% | 0.04% |
| Nitrogen | 3.50% | 78.00% |
| Argon | 1.00% | 0.96% |
| Oxygen | 0.50% | 21.00% |

(a) Which **one** of the gases in the table is a noble gas?

_____

**(1)**

(b) Draw a ring around the correct answer to complete each sentence.

(i) Noble gases are in Group

0

1

7

**(1)**

(ii) Noble gases are

slightly reactive.

unreactive.

very reactive.

**(1)**

(c) The percentage of carbon dioxide in the Earth's early atmosphere was 95.00%. It is 0.04% in the Earth's atmosphere today.

(i) Calculate the decrease in the percentage of carbon dioxide in the Earth's atmosphere.

_____

_____

Decrease in percentage = _____%

**(1)**

(ii) Give **two** reasons for this decrease.

_____

_____

_____

_____

**(2)**

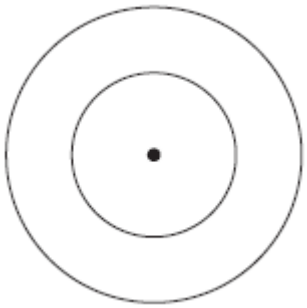
**(Total 6 marks)**

## Q19.

Fossil fuels contain carbon and hydrogen.

(a) (i) Use the Chemistry Data Sheet to help you to answer this question.

Complete the figure below to show the electronic structure of a carbon atom.



**(1)**

(ii) Complete the word equation for the oxidation of hydrogen.

hydrogen + oxygen ⟶ _____

**(1)**

(b) Coal is a fossil fuel.

Coal contains the elements hydrogen, sulfur, oxygen and carbon.

Name **two** products of burning coal that have an impact on the environment.

What impact does each of the products you named have on the environment?

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

**(Total 6 marks)**

## Q20.

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

(a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmosphere of Mars and Earth today.

| Mars today | | Earth today | |
|---|---|---|---|
| nitrogen | 3% | nitrogen | 78% |
| oxygen | trace | oxygen | 21% |
| water | trace | water | trace |
| Carbon dioxide | 95% | Carbon dioxide | trace |
| Average surface temperature −23°C | | Average surface temperature 15°C | |

The percentages of some gases in the Earth's atmosphere of millions of years ago have changed to the percentages in the Earth's atmosphere today.

For **two** of these gases describe how the percentages have changed **and** suggest what caused this change.

**(2)**

(b) Titan is the largest moon of the planet Saturn.
Titan has an atmosphere that contains mainly nitrogen.
Methane is the other main gas.

| Main gases in Titan's atmosphere | Percentage (%) | Boiling point in °C |
|---|---|---|
| Nitrogen | 95 | −196 |
| Methane | 5 | −164 |
| Average surface temperature −178°C | | |

When it rains on Titan, it rains methane!

Use the information above and your knowledge and understanding to explain why.

**(2)**

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene ($C_2H_4$) and propene ($C_3H_6$) from methane in Titan's atmosphere.

State the general formula for alkenes.

_____

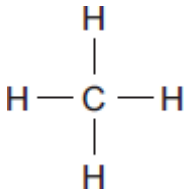
**(1)**

**(Total 5 marks)**

## Q21.

Saturated hydrocarbons, for example methane and octane, are often used as fuels.

(a) Methane can be represented as:



(i) The formula of methane is _____ .

**(1)**

(ii) Draw a ring around the correct answer to complete the sentence.

In a saturated hydrocarbon molecule all of the bonds are

| |
|---|
| double. |
| ionic. |
| single. |

**(1)**

(iii) Draw a ring around the correct answer to complete the sentence.

The homologous series that contains methane and octane is called the

| |
|---|
| alcohols. |
| alkanes. |
| alkenes. |

**(1)**

(b) (i) The complete combustion of petrol produces carbon dioxide, water vapour and sulfur dioxide.

Name **three** elements petrol must contain.

1. _____

2. _____

3. _____

**(3)**

(ii) The exhaust gases from cars can contain oxides of nitrogen.

Complete the sentence.

Nitrogen in the oxides of nitrogen comes from _____ .

**(1)**

(iii) The sulfur dioxide and oxides of nitrogen from cars cause an environmental problem.

Name the problem and describe **one** effect of the problem.

Name of problem _____

Effect of problem _____

_____

**(2)**

(c) When a fuel burns without enough oxygen, there is incomplete combustion.

One gaseous product of incomplete combustion is carbon monoxide.

Name **one** solid product of incomplete combustion.

_____

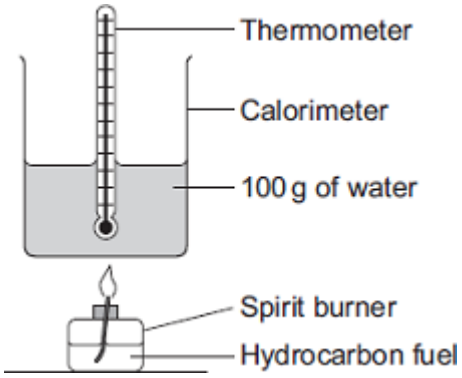
**(1)**

(d) A student investigated how well different hydrocarbon fuels would heat up 100 g of water.

Her hypothesis was:

| **The more carbon atoms there are in a molecule of any fuel, the better the fuel is.** |
|---|

The apparatus the student used is shown in the diagram.




She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

| **Name of hydrocarbon fuel** | **Number of carbon atoms in a molecule of hydrocarbon fuel** | **Temperature change of water in °C after 2 minutes** | **Temperature change per g of fuel burned** | **Observations** |
|---|---|---|---|---|
| | | | | |

| | | | | |
|---|---|---|---|---|
| Pentane | 5 | 30 | 60 | no smoke |
| Hexane | 6 | 40 | 57 | very small amount of smoke |
| Octane | 8 | 55 | 55 | small amount of smoke |
| Decane | 10 | 57 | 52 | large amount of smoke |
| Dodecane | 12 | 60 | 43 | very large amount of smoke |

The student investigated only hydrocarbons.

Look carefully at her results.

How well do the student's results support her hypothesis?

**The more carbon atoms there are in a molecule of any fuel, the better the fuel is.**

Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(e) A 0.050 mol sample of a hydrocarbon was burned in excess oxygen.

The products were 3.60 g of water and 6.60 g of carbon dioxide.

(i) Calculate the number of moles of carbon dioxide produced.

Relative atomic masses: C = 12; O = 16.

_____

_____

Moles of carbon dioxide = _____

**(2)**

(ii) When the hydrocarbon was burned 0.20 mol of water were produced.

How many moles of hydrogen atoms are there in 0.20 mol of water?

_____

Moles of hydrogen atoms = _____

**(1)**

(iii) The amount of hydrocarbon burned was 0.050 mol.

Use this information and your answers to parts **(e) (i)** and **(e) (ii)** to calculate the molecular formula of the hydrocarbon.

If you could not answer parts **(e) (i)** or **(e) (ii)** use the values of 0.20 moles carbon dioxide and 0.50 moles hydrogen. These are **not** the answers to parts **(e) (i)** and **(e) (ii)**.

_____

_____

_____

_____

Formula = _____

**(2)**

**(Total 19 marks)**

## Q22.

Crude oil is a mixture of many different chemical compounds.

(a) Fuels, such as petrol (gasoline), can be produced from crude oil.

(i) Fuels react with oxygen to release energy.

Name the type of reaction that releases energy from a fuel.

_____

**(1)**

(ii) Fuels react with oxygen to produce carbon dioxide.
The reaction of a fuel with oxygen can produce a different oxide of carbon.

Name this different oxide of carbon and explain why it is produced.

_____

_____

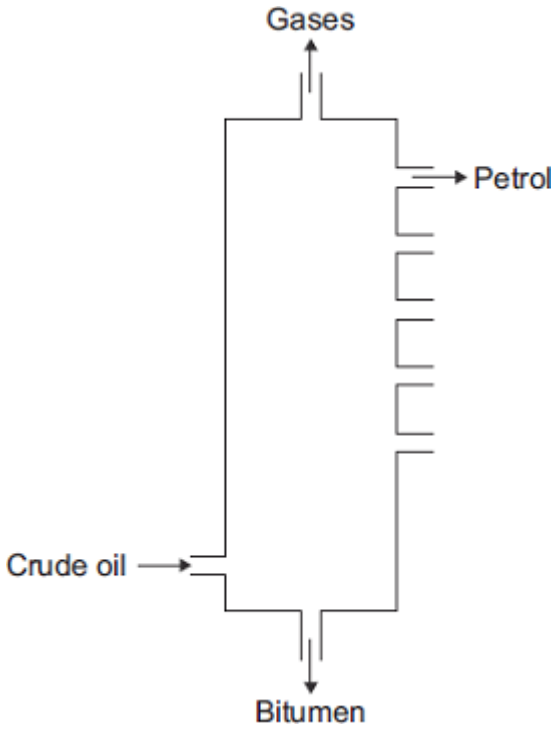
_____

_____

**(2)**

(b) Most of the compounds in crude oil are hydrocarbons.

Hydrocarbons with the smallest molecules are very volatile.




*In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

Use the diagram and your knowledge to answer this question.

**(6)**

**(Total 9 marks)**

## Q23.

The amount of carbon dioxide in the Earth's atmosphere has changed since the Earth was

formed.
The amount of carbon dioxide continues to change because of human activities.

(a) Cement is produced when a mixture of calcium carbonate and clay is heated in a rotary
kiln. The fuel mixture is a hydrocarbon and air.

Hydrocarbons react with oxygen to produce carbon dioxide.
Calcium carbonate decomposes to produce carbon dioxide.

(i) Complete each chemical equation by writing the formula of the other product.

$$CH_4 + 2O_2 \longrightarrow 2 \text{.....} + CO_2$$

$$CaCO_3 \longrightarrow \text{.....} + CO_2$$

**(2)**

(ii) Hydrocarbons and calcium carbonate contain *locked up* carbon dioxide.

What is *locked up* carbon dioxide?

_____

_____

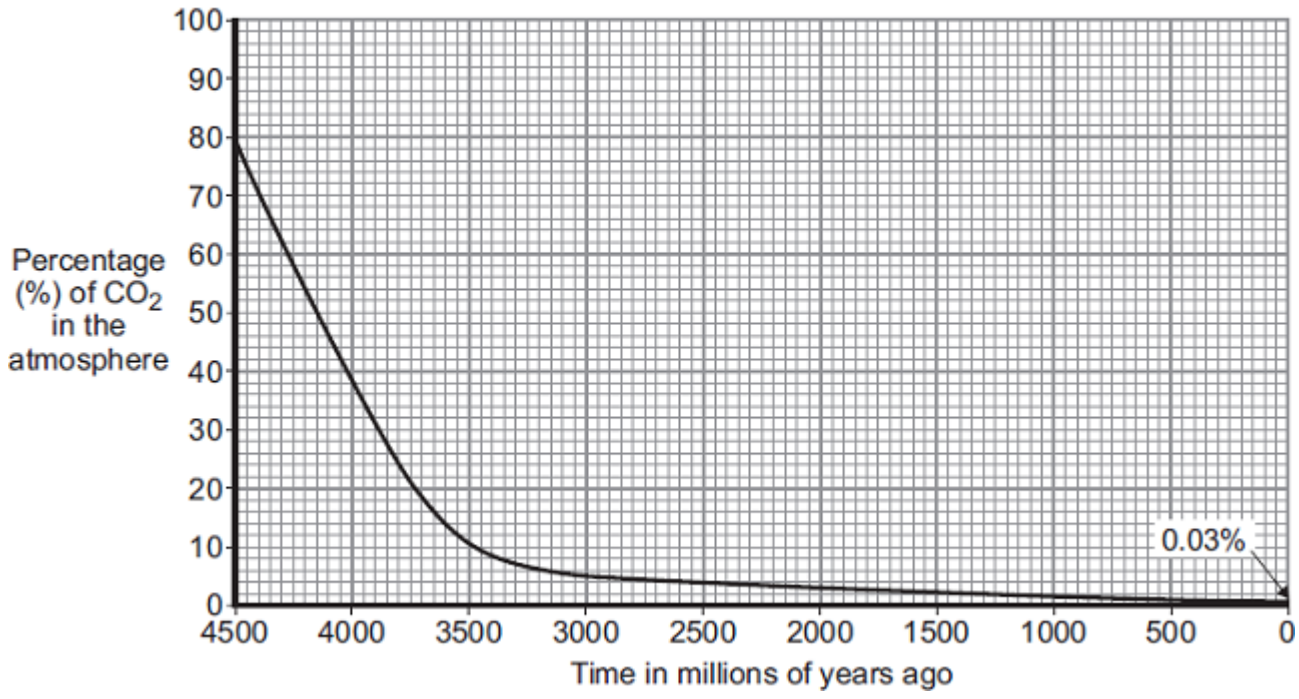
_____

_____

**(2)**

(b) **Graph 1** shows how the percentage of carbon dioxide in the atmosphere changed in the last 4500 million years.

**Graph 1**




Use information from **Graph 1** to answer these questions.

(i) Describe how the percentage of carbon dioxide has changed in the last 4500 million years.

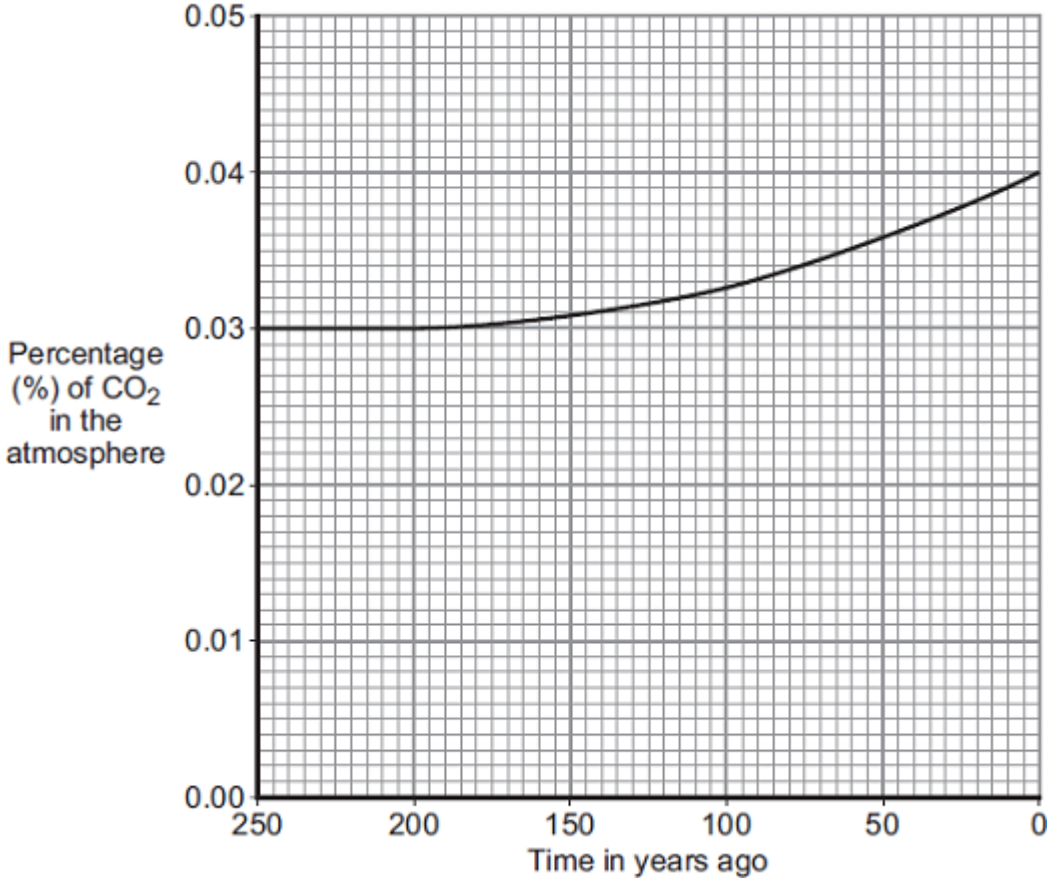
**(2)**

(ii) Give **two** reasons why the percentage of carbon dioxide has changed.

**(2)**

(c) **Graph 2** shows how the percentage of carbon dioxide in the atmosphere changed in the last 250 years.

**Graph 2**




Should we be concerned about this change in the percentage of carbon dioxide?

Explain your answer.

_____

_____

**(2)**

**(Tota 10 marks)**