

1(a). Scientists think that the composition of the early atmosphere changed slowly over many billions of years.

Scientists estimated the composition of the earliest atmosphere on Earth.

**Earth's earliest atmosphere**

Gas	Percentage composition %
carbon dioxide	1.9
water vapour	95.8
other gases	2.3

Estimated surface temperature = 700 – 1100 °C

Scientists also estimated the composition of the atmosphere shortly before the first plant life existed.

**Atmosphere just before the first plant life**

Gas	Percentage composition %
carbon dioxide	89.8
water vapour	2.1
other gases	

Explain the change in the amount of water vapour shown in the tables.

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[2]

(b). Plants caused further changes to the composition of gases in the atmosphere.

Predict the effect that plants had on the percentage of carbon dioxide in the atmosphere.

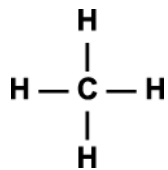
Explain your reasoning.

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[2]

2. The surface of the planet Neptune is covered with clouds of dense material. The clouds contain substances in solid, liquid and gas states.

One of the compounds in the clouds is methane.



The table shows the melting point and boiling point of methane.

melting point (°C)	-182.5
boiling point (°C)	-161.5

The temperature in the clouds is  $-218\text{ }^{\circ}\text{C}$ .

Predict the state of methane in Neptune's clouds.

----- [1]

3. Rose is a laboratory technician.

She makes up a dilute solution of lime water (calcium hydroxide).

One laboratory use of lime water is to test for a gas.

What is the name of the gas and what is the positive result of the test?

**Gas** -----

**Result** -----

[2]

4(a). A catalytic converter removes carbon monoxide and nitrogen monoxide from the exhaust gases of cars.

Complete the sentences about the chemical reaction in a catalytic converter.

Use the names of the reactants and products.

In a catalytic converter \_\_\_\_\_ is oxidised to

\_\_\_\_\_.

At the same time \_\_\_\_\_ is reduced to

\_\_\_\_\_.

[2]

(b). Diesel cars may be banned in some large cities.

Here is some data on the exhaust gases of petrol and diesel cars.

The cars are the same except for the fuel they use.

	Pollutant (grams per km travelled)			Nitrogen monoxide
	Carbon monoxide	Carbon particulates	Fuel used (litres per 100 km)	
<b>Petrol car</b>	12.0	none	6.0	5.5
<b>Diesel car</b>	0.5	0.5	9.0	4.5

Use your knowledge of these pollutants to discuss the **advantages** and **disadvantages** of diesel cars over petrol cars. Suggest reasons why diesel cars may be banned from large cities.



*The quality of written communication will be assessed in your answer.*

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**[6]**

5(a). No particulates are made during the complete combustion of hydrocarbons.

Incomplete combustion of hydrocarbons makes particulates.

Which statements, when put together, explain this difference?

Put ticks (✓) in the boxes next to the **three** correct statements.

When a hydrocarbon burns with a good supply of oxygen, carbon reacts to make carbon dioxide.

When a hydrocarbon burns in a good supply of oxygen, only the hydrogen burns.

In a limited supply of oxygen both hydrogen and carbon burn.

The hydrogen in the hydrocarbon reacts more readily with oxygen than the carbon does.

Carbon is unreactive and so does not combine with oxygen in air.

In a limited supply of oxygen some of the carbon in a hydrocarbon does not burn.

[2]

(b). Air pollutants may cause harm to people directly or indirectly.

When particulates are breathed in they may cause harm to the lungs **directly**.

Name a pollutant that causes harm to people **indirectly** and explain how it does this.

pollutant .....

explanation .....

----- [2]

(c). To reduce air pollution in this town the council introduced a charge for each vehicle entering the town centre.

Suggest **two** other things that the council could do to reduce air pollution in the town centre.

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[2]

6(a). Read the information about the atmosphere of some planets.

**Planet Atmospheres**

Other planets do not have the same atmosphere as Earth. Venus has an atmosphere that is mainly **carbon dioxide** with about 4% **nitrogen**. The atmosphere on Jupiter is mainly **hydrogen**, with about 10% **helium**. The atmospheres on both planets contain very small amounts of other gases.

Using the gases named in the information, complete the table below.

Description	Name of gas
A gas whose molecules have a relative formula mass of 2.	
A gas that is a compound.	
A gas that consists of single atoms.	

[3]



(b). The atmospheres contain molecular substances.

What are the properties of molecular substances?

Put ticks (✓) in the boxes next to the two correct answers.

They do not conduct electricity.

They all have boiling points above room temperature.

They form crystals at room temperature.

They have low melting points.

They are hard and strong.

[2]

(c). The atoms in a hydrogen molecule are held together by a covalent bond.

Which statements are **true** for the hydrogen molecule?

Put ticks (✓) in the boxes next to the **two** correct answers.

The nuclei of the two atoms are attracted together.

Electrons are attracted together to form a bond.

The nuclei of the two atoms repel each other.

The nucleus of each atom attracts the shared electrons.

The electrons repel the nuclei away from each other.

[2]

7. Sulfur dioxide does not build up in the atmosphere.

How is it removed?

Put ticks (✓) in the boxes next to the **three** statements that, when taken together, give the best explanation.

Sulfur is made.

Sulfur dioxide reacts with water vapour.

Sulfur dioxide reacts with carbon dioxide.

Sulfur dioxide reacts with oxygen.

Acid rain is made.

Sulfur dioxide reacts with nitrogen.

[2]

8(a). Lee looks up some data about gases in the air.

Gas in the air	Formula	Relative formula mass	Boiling point in °C	Percentage in air
nitrogen	N <sub>2</sub>	28	?196	78
oxygen	O <sub>2</sub>	32	?183	21
carbon dioxide	CO <sub>2</sub>	44	?57	0.04
water vapour	H <sub>2</sub> O	18	100	variable

All of the gases in the table are covalently bonded.

Which statements describe a covalent bond?

Put a tick (?) in the boxes next to the **two** correct answers.

Ions attract together due to their opposite charges.

The electrons between the atoms are attracted to each nucleus.

Electrons are shared between atoms.

The electrons of two atoms are attracted to each other.

Electrons are transferred from one atom to another.

[2]

(b). Lee looks at the data and writes down this idea.

I think that there is a correlation between the relative formula mass of a gas and its boiling point.

Does the data in the table support Lee's idea?

Explain your reasoning.

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[3]

(c). Alex also notices that there is a correlation between the relative masses of gases in the air and their percentages in air.

Gas in the air	Relative mass	Percentage in air %
nitrogen	28	78
oxygen	32	21
argon	40	1
carbon dioxide	44	0.04

Use the data in the table to explain the difference between correlation and cause.

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[2]

[Total: 7]



Question		Answer/Indicative content	Marks	Guidance
1	a	water vapour condensed / turned into a liquid / became oceans ✓  because the Earth cooled / surface temperature fell ✓	2	
	b	carbon dioxide percentage decreases ✓  plants use carbon dioxide for photosynthesis to make glucose ✓	2	
		<b>Total</b>	<b>4</b>	
2		solid ✓	1	
		<b>Total</b>	<b>1</b>	
3		carbon dioxide ✓  turns lime water milky / cloudy ✓	2	
		<b>Total</b>	<b>2</b>	
4	a	carbon monoxide_____ carbon dioxide;(1) nitrogen (mon)oxide_____ nitrogen; (1)	2	For EACH pair answers <b>MUST</b> be in the correct order <b>Allow</b> formulae <b>Reject</b> if additional reactants or products given  <b>Examiner's Comments</b>  This question discriminated well. More knew the oxidation step than the reduction step. A common wrong answer for the reduction stage was to say that nitrogen monoxide was reduced to nitrogen <b>and</b> oxygen.

Question	Answer/Indicative content	Marks	Guidance
b	<p><b>[Level 3]</b> Gives 1 advantage and 2 disadvantages or 2 advantages and 1 disadvantages of diesel and states harmful effects of 2 pollutants and relates these to why diesel cars may be banned in cities. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p><b>[Level 2]</b> Gives 1 advantage and 2 disadvantages or 2 advantages and 1 disadvantages of diesel and states harmful effect of 1 pollutant. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p><b>[Level 1]</b> Gives 1 advantage and 1 disadvantage of diesel cars. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A*</p> <p>Indicative scientific points may include:</p> <p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>diesel cars emit less carbon monoxide than petrol cars.</li> <li>diesel cars burn less fuel than petrol cars (so less carbon <b>monoxide</b> produced). / Diesel cars travel further for the same amount of fuel</li> </ul> <p><b>Disadvantages</b></p> <ul style="list-style-type: none"> <li>diesel cars emit more carbon particulates than petrol cars.</li> <li>diesel cars emit more nitrogen monoxide than petrol cars.</li> </ul> <p><b>Effects</b></p> <ul style="list-style-type: none"> <li>carbon monoxide emissions are toxic to humans.</li> <li>carbon monoxide emissions lower the amount of oxygen the blood can carry.</li> <li>carbon particulates cause breathing problems and make buildings dirty.</li> <li>carbon particulates contribute to global dimming</li> <li>nitrogen monoxide causes breathing problems and causes acid rain</li> <li>nitrogen monoxide contributes to photochemical smog and global dimming</li> </ul> <p><b>Reason why banned</b></p> <p>Diesel banned because of effects of <b>carbon particulates and/or NO only</b>. eg breathing problems, smog, dirt</p> <p>Ignore catalytic convertors Reject 'using' pollutants</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>



Question			Answer/Indicative content	Marks	Guidance
					<p><b>Examiner's Comments</b></p> <p>This first level of response question was answered well with good differentiation between the levels. Most used the data to achieve level 1. Some were vague about the effects of the pollutants, repeating ideas of fatal, harmful and polluting. More failed to comment on banning from cities or just wrote they were banned because of pollution or harmful gases which did not gain marks. Another common problem was that candidates were uncertain about the difference between using something and producing something. It was not uncommon to read that petrol cars use more carbon monoxide than diesel cars.</p>
			<b>Total</b>	<b>8</b>	

Question		Answer/Indicative content	Marks	Guidance
5	a	<p>When a hydrocarbon burns with a good supply of oxygen, carbon reacts to make carbon dioxide. <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p>The hydrogen in the hydrocarbon reacts more readily with oxygen than the carbon does. <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p>In a limited supply of oxygen some of the carbon in a hydrocarbon does not burn. <input checked="" type="checkbox"/></p>	2	<p>all three correct scores 2 marks two correct scores 1 mark</p> <p><b>Examiner's Comments</b></p> <p>Most candidates scored at least one mark, and more able candidate scored both. A significant number ticked only two of the boxes.</p>
	b	<p>sulfur dioxide / nitrogen dioxide (1) causes acid rain / damages crops / kills fish (1)</p>	2	<p><b>allow</b> correct formula <b>do not allow</b> pollutants that cause harm directly eg CO <b>allow</b> CO<sub>2</sub> (1) global warming / greenhouse effect (1) second mark cannot be scored if wrong pollutant given</p> <p><b>Examiner's Comments</b></p> <p>Only the more able candidates gave a correct example of a pollutant gas that harms people indirectly, and most of these could give a correct explanation. Many candidates suggested pollutant gases that harm people directly, and explain how they do this, which gained no credit.</p>

Question		Answer/Indicative content	Marks	Guidance
	c	<p><i>any two from:</i></p> <p>increase availability of public transport / make public transport free / introduce park and ride (1)</p> <p>have dedicated cycle lanes / routes (1)</p> <p>have no / reduced charge for cars with more than one person in / have no / reduced charge for electric vehicles (1)</p> <p>increase parking charges (1)</p> <p>only allow cars at certain times of day (1)</p> <p>make town centre traffic free (1)</p> <p>limit entry according to vehicle emissions (1)</p>	2	<p><b>allow</b> other valid answers, but they must be practical steps that the <b>council</b> could take</p> <p>answer must clearly indicate what the council can do rather than what individuals can do eg no mark for people can share cars</p> <p><b>ignore</b> vague "encourage people to ..." answers</p> <p><b>ignore</b> reduce number of parking spaces / use catalytic converters / reference to MoT testing / car tax / fuel price / insurance cost / idea of rewards for walking etc</p> <p><b>Examiner's Comments</b></p> <p>More able candidates gave valid suggestions to gain one or both marks. Many described actions that could be taken by individuals rather than actions that could be taken by the town council.</p>
		<b>Total</b>	<b>6</b>	

Question		Answer/Indicative content	Marks	Guidance
6	a	hydrogen (1) carbon dioxide (1) helium (1)	3	<b>accept</b> correct formula H <sub>2</sub> CO <sub>2</sub> and He Formula must be unambiguous and fully correct with subscripts used correctly.  <b>Examiner's Comments</b>  Many candidates started this answer incorrectly by choosing helium as the gas with a relative formula mass of 2. This led them to place hydrogen in the third row of the column, losing two marks. Almost all correctly chose carbon dioxide as the only gas that is a compound.
	b	They do not conduct electricity <input checked="" type="checkbox"/> They all have boiling points above room temperature <input type="checkbox"/> They form crystals at room temperature <input type="checkbox"/> They have low melting points <input checked="" type="checkbox"/> They are hard and strong <input type="checkbox"/>	2	<b>Examiner's Comments</b>  The properties of molecular substances were well known with almost all candidates scoring at least one mark.
	c	The nuclei of the two atoms are attracted together. <input type="checkbox"/> Electrons are attracted together to form a bond. <input type="checkbox"/> The nuclei of the two atoms repel each other. <input checked="" type="checkbox"/> The nucleus of each atom attracts the shared electrons <input checked="" type="checkbox"/> The electrons repel the nuclei away from each other <input type="checkbox"/>	2	<b>Examiner's Comments</b>  Candidates were not so sure about covalent bonds. They commonly thought that electrons or nuclei are attracted together. Few candidates gained both marks.
		<b>Total</b>	<b>7</b>	
7		ticks in boxes 2, 4 and 5	2	Three correct boxes for 2 marks Two correct boxes for 1 mark  <b>Examiner's Comments</b>  Only the weakest candidates gained no mark but few of the stronger candidates gained both marks. There was no discernible pattern to the incorrect choices.
		<b>Total</b>	<b>2</b>	

Question		Answer/Indicative content	Marks	Guidance
8	a	<p>box 2; (1)</p> <p>box 3; (1)</p>	2	<p><b><u>Examiner's Comments</u></b></p> <p>Most candidates knew that a covalent bond involves shared electrons. The effect of the attraction by the nucleus was less well known.</p>
	b	<p>as the RFM increases the BP increases;</p> <p>but this works for 3 gases / N<sub>2</sub> O<sub>2</sub> and CO<sub>2</sub>;</p> <p>water does not fit;</p> <p>(because water BP is) too high / has a higher BP (than the others) / has the lowest formula mass / has the highest BP;</p>	3	<p>Any 3</p> <p>Ignore 'yes' or 'no'</p> <p>Ignore 'correlation' (in the Q)</p> <p><b><u>Examiner's Comments</u></b></p> <p>??This type of question asks candidates to interpret information in the light of a claim made. Typically on the higher tier paper the trend in the information given is not straightforward. Some candidates identified a partial trend for the 'first three' elements, showing a good understanding of scale with respect to negative numbers, and also identified that water does not fit the trend and why. The question was very challenging, both because not all of the data fits the trend and due to the inclusion of negative numbers. These issues meant that many candidates did not score on this question.</p>

Question		Answer/Indicative content	Marks	Guidance
	c	<p>the relative masses and percentages follow a similar pattern / the bigger the mass the lower the percentage / relative masses and percentages are linked;</p> <p>but one is not a direct result of the other / it is a coincidence / no causal link / no mechanism is known;</p>	2	<p>MP1 refers to the data in the table  <b>Ignore</b> masses and percentages show a correlation (in the Q)</p> <p><b>Accept</b> one is not caused by the other / both could be caused by another (hidden) factor  <b>Allow</b> general description of 'cause' for MP2</p> <p><b>Examiner's Comments</b></p> <p>In this case the trend was more obvious, and most gained at least one mark for identifying the correlation. The question asked for an explanation for 'the DIFFERENCE between correlation and cause'. In this type of question, candidates need to make sure that they engage with what the question asks for. A basic 'dictionary' every day statement that 'cause is what makes something happen' may be a true statement but is not enough to explain the difference between correlation and cause. Answers which gained two marks gave a clear explanation that an apparent link in the data does not necessarily mean that one results directly from the other.</p>
		<b>Total</b>	<b>7</b>	

Question	Answer/Indicative content	Marks	Guidance
9	<p><b>[Level 3]</b> Compares changes in amounts of gases on Mars with the changes on Earth and states reasons for changes for two gases. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p><b>[Level 2]</b> States reasons for changes for two gases or compares changes in amounts of gases on Earth and Mars. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p><b>[Level 1]</b> States a change to the atmosphere of Mars or Earth or gives a reason how one gas has changed on Earth. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A / A*</p> <p><b>Indicative scientific points may include:</b></p> <ul style="list-style-type: none"> <li>• Percentage carbon dioxide has increased on Mars</li> <li>• Percentage water vapour has decreased on Mars</li> <li>• Some oxygen has appeared on Mars</li> <li>• Percentage carbon dioxide has decreased on Earth</li> <li>• Percentage water vapour has decreased on Earth</li> <li>• Percentage oxygen has increased on Earth</li> <li>• Water vapour has disappeared from both the atmosphere of Earth and Mars by condensation or freezing</li> <li>• Oceans have formed</li> <li>• Carbon dioxide has disappeared from Earth because it has dissolved in oceans</li> <li>• Plants have added oxygen</li> <li>• Plants have removed carbon dioxide from Earth's atmosphere</li> <li>• Lowering of amounts of carbon dioxide has given much higher proportion of nitrogen on Earth</li> </ul> <p><b>accept:</b> atmosphere on Mars very small / thin compared to that on Earth.</p> <p><b>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</b></p> <p><b><u>Examiner's Comments</u></b></p> <p>?For many candidates the answer was very confused and they need to be guided to take a moment to plan their answer to these 6 mark questions. Rather than start with a gas and describe the change on each planet, or vice versa, the answers would meander through planets and gases with no really structure. As a result of this many candidates missed marks because they simply didn't give a full answer, probably without realising it. However,</p>

Question			Answer/Indicative content	Marks	Guidance
					marks were gained by good descriptions of the role of cooling temperatures and photosynthesis, in changes to the atmosphere on Earth. A significant number of candidates gave pollution and other effects caused by man as reasons for the changes to the Earth's atmosphere. These candidates usually then said that Mars' atmosphere had not changed as much as there is no pollution on Mars.
			<b>Total</b>	<b>6</b>	