Air and water – 2021/20 GCSE 21st Chemistry B

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

Water evaporates from lakes and oceans. It forms clouds of gaseous water.

In the right conditions the water falls as rain, as shown by the equation:

$H_2O(g) \rightarrow H_2O(l)$

(a) Which **two** processes does this equation show?

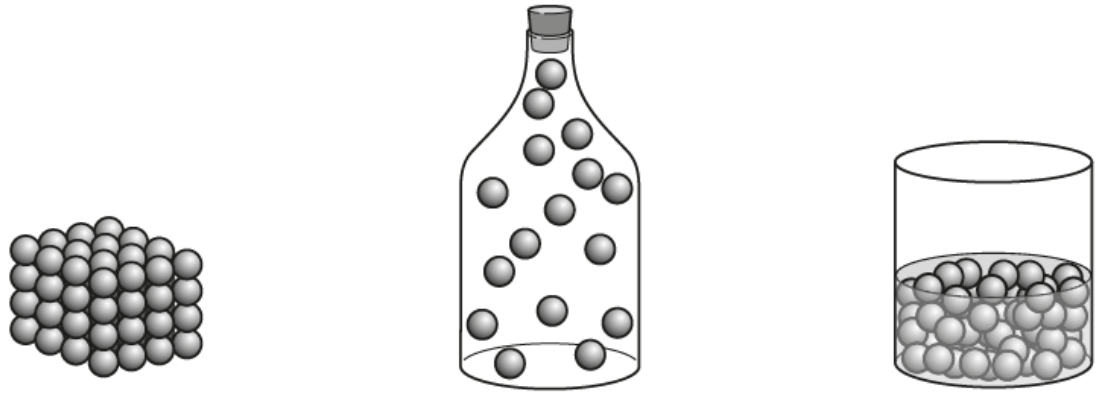
Tick (✓) **two** boxes.

Condensation	☐
Chemical change	☐
Evaporation	☐
Physical change	☐
Melting	☐
Combustion	☐

[2]

(b) **Fig. 2.1** represents the three states of matter: **solid**, **liquid** and **gas**.

(i) Write the word for the correct state under each model.



....

[1]

Fig. 2.1

(ii) **Fig. 2.2** shows a molecule of oxygen, O_2.

O=O

Fig. 2.2

Draw a similar diagram to show a molecule of water, H_2O.

[1]

(c) The table shows the percentage of nitrogen and carbon dioxide in air:

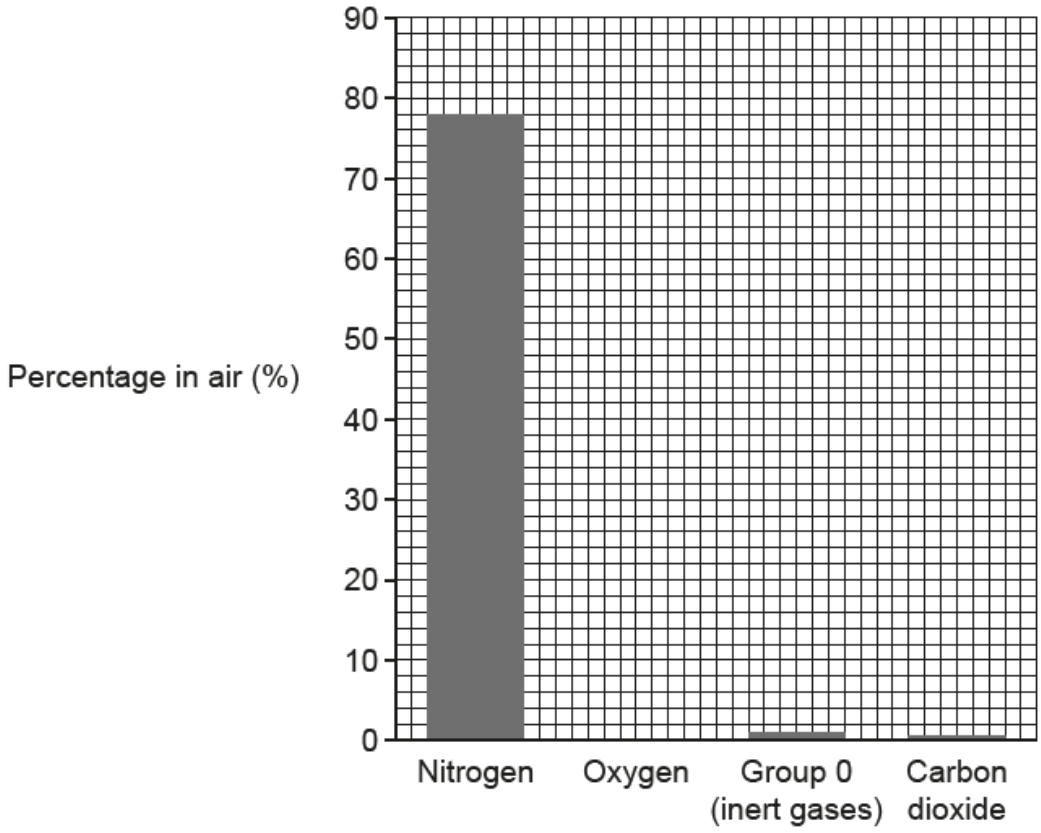
Gas	Percentage (%)
Nitrogen	78
Carbon dioxide	0.04

(i) Calculate how many times more nitrogen there is than carbon dioxide in air.

..... times more nitrogen than carbon dioxide **[2]**

(ii) Oxygen is 21% of air.

Plot the data for oxygen on the bar chart.



[1]

(iii) Draw lines to connect each **gas** with its correct **property**.

Gas	**Property**
	Unreactive.
Group 0 (inert gases)	Relights a glowing splint.
Carbon dioxide	Turns limewater milky.
Oxygen	Turns litmus blue.

[3]

2. Nov/2021/Paper_J258/01/No.8(a)

Chlorine is used to make water safe to drink.

(a) How does chlorine make water safe to drink?

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

3. Nov/2021/Paper_J258/02/No.1

The exhaust gases from diesel car engines contain nitrogen oxides.

(a) Complete the sentences about nitrogen oxides.

Put a (ring) around the correct answers.

Nitrogen oxides form in the engine when nitrogen from the **air** / **fuel** reacts with oxygen.

This happens because in car engines the gases are very **concentrated** / **hot**.

Nitrogen oxides are harmful because they cause **acid rain** / **particulates**.

[2]

(b) Urea is used in the exhausts of some diesel cars to remove nitrogen oxides from the exhaust gases.

Urea reacts with nitrogen oxide (NO) and oxygen to make three new gases.

Substances used in the reaction		**New gases formed**
Urea		CO_2
Nitrogen oxide (NO)	----------→	H_2O
Oxygen		N_2

(i) Amir says that nitrogen oxides are reduced during the reaction.

Give **one** reason why Amir is correct.

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

(ii) Jamal says that the reaction also involves oxidation.

Give **one** reason why Jamal is right.

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

(iii) Complete the table by giving the name of each new gas formed in the reaction.

Gas	Name
CO_2	
H_2O	
N_2	

[3]

(iv) Amir says that the three new gases formed are **not** harmful to health or to the environment.

Do you agree with Amir?
Explain your answer.

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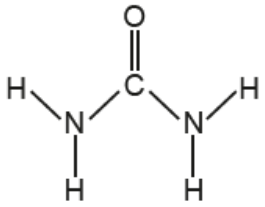
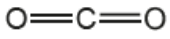
..... **[2]**

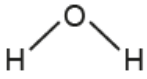
(c) Amir draws the structures of urea and of the gases involved in the reaction.



Urea



CO_2



H_2O

N_2

Amir looks at the number of bonds formed by carbon, oxygen, nitrogen and hydrogen atoms. He says that each type of atom has the same number of bonds in every molecule shown.

Do you agree with Amir?
Explain your answer.

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

4. Nov/2020/Paper_J258/01/No.2

Fig. 2.1 shows how the average world temperature has changed since 1880.

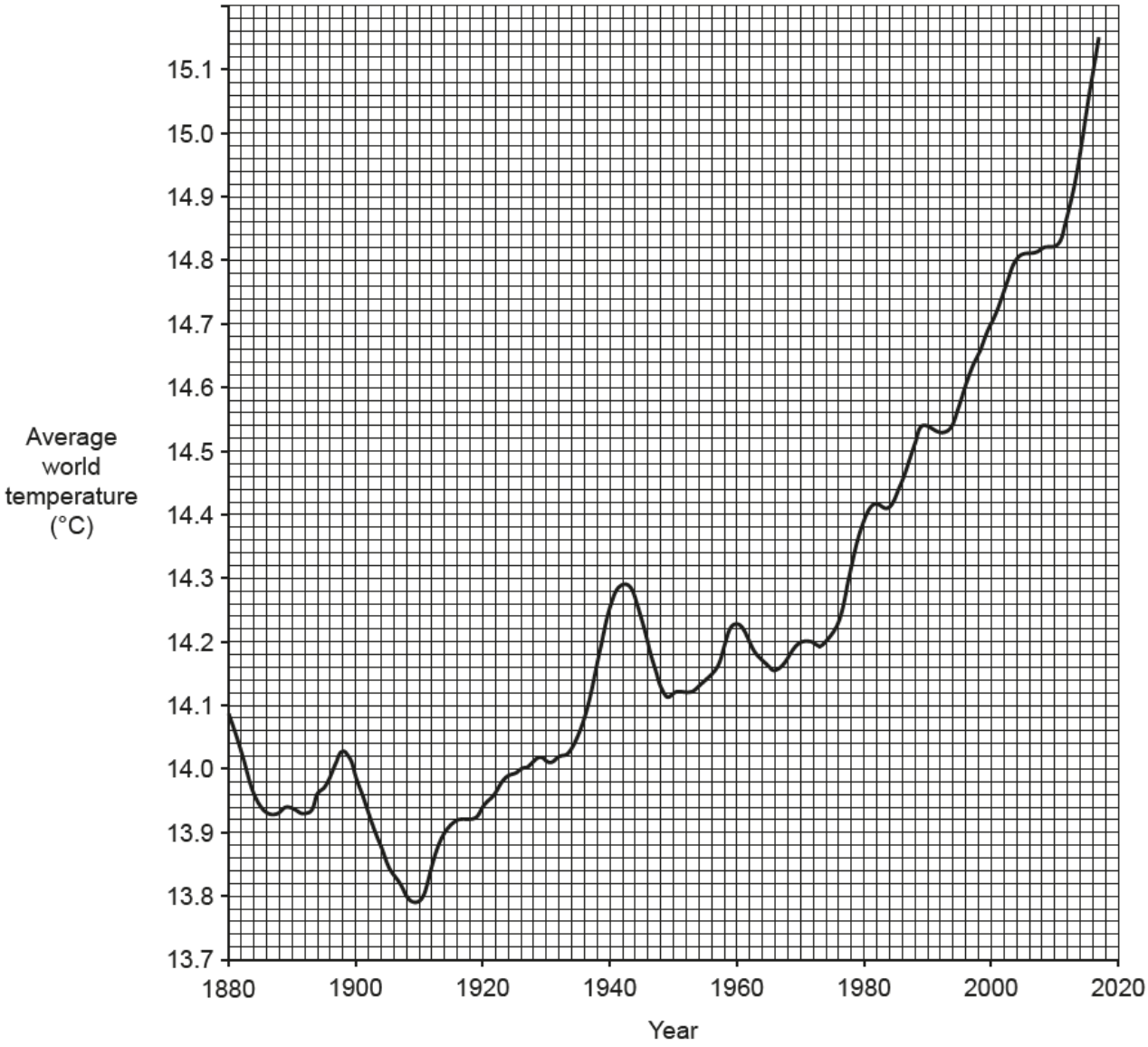


Fig. 2.1

(a) (i) Using **Fig. 2.1**, what was the temperature in 1910?

Temperature = ...°C **[1]**

(ii) Using **Fig. 2.1**, calculate the temperature rise between 1980 and 2000.

Temperature rise = ...°C **[2]**

(iii) Using **Fig. 2.1**, which **two** time periods show the **greatest** temperature rises?

Tick (✓) **two** boxes.

1890–1900 ☐

1910–1920 ☐

1920–1940 ☐

1980–2000 ☐

[2]

(b) Some scientists believe that world temperatures have increased due to increased amounts of greenhouse gases in the air.

(i) How do greenhouse gases increase world temperatures?

Tick (✓) **one** box.

They block out visible light from the Sun. ☐

They form a cover around the Earth. ☐

They absorb infrared radiation and re-emit it. ☐

They absorb visible light from the Earth. ☐

[1]

(ii) Carbon dioxide is a greenhouse gas.

Draw lines to connect **each** question with **one** correct answer.

Question	**Answer**
	People burning more fossil fuels.
What can directly increase the amount of carbon dioxide in the air?	People recycling less.
What can reduce the amount of carbon dioxide emissions into the air?	People changing to electric cars.
	People throwing away plastics.

[2]

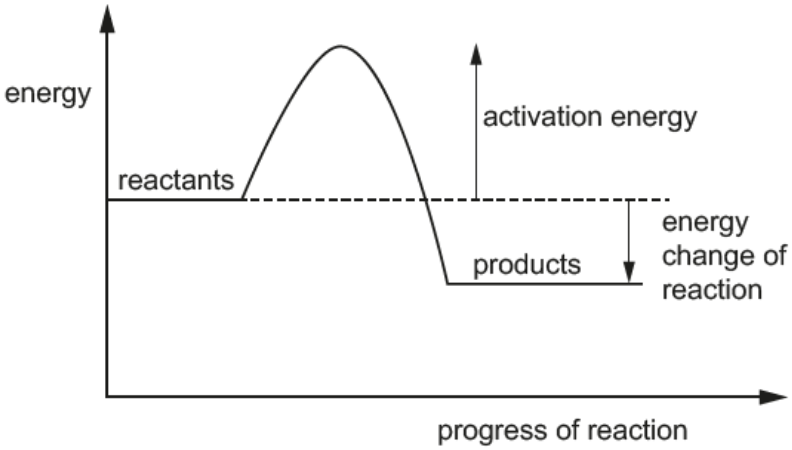
5. Nov/2020/Paper_J258/02/No.7

Drain cleaner removes blockages in shower drains.

Drain cleaner contains solid sodium hydroxide.

An exothermic reaction happens when the solid sodium hydroxide dissolves in water in the drain. This helps to clear the blockage.

The diagram shows the energy change of the reaction when solid sodium hydroxide dissolves in water.



(a) How does the diagram show that this reaction is **exothermic**?

Tick (✓) **two** boxes.

- Energy is taken in at the start of the reaction. ☐
- The activation energy is very large. ☐
- The energy change of the reaction is negative. ☐
- The energy change of the reaction is small. ☐
- The reactants have more energy than the products. ☐

[2]

(b) (i) Kai does an experiment to prove that when solid sodium hydroxide dissolves in water, an **exothermic** reaction happens.

Write an outline plan for Kai's experiment.

The plan should include:
- what Kai should **do**
- what **measurements** he should make
- what **results** he should expect.

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

(ii) This is the hazard warning symbol for solid sodium hydroxide.

Kai wears gloves and goggles when he does his experiment.

Explain why these are necessary.

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

6. Nov/2020/Paper_J258/02/No.8

A company sets up three monitoring stations to measure the concentration of sulfur dioxide in the air around a coal-fired power station.

(a) Why does the company set up three monitoring stations rather than only one?

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

(b) There is a motorway with a lot of traffic near the power station.

The company makes sure that the monitoring stations are **not** set up near the motorway.

(i) Explain **one** reason why this is important.

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

(ii) Suggest **one other** factor the company should consider when deciding where to set up the monitoring stations.

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

(c)* The power station burns the same amount of coal every day.

The table shows the mean concentration of sulfur dioxide in the air and the weather conditions near the power station over 6 days.

Day	Mean concentration of sulfur dioxide in the air (g/m^3)	Weather conditions
Monday	24	dry, sunny, no wind
Tuesday	24	dry, cloudy, no wind
Wednesday	13	dry, windy
Thursday	15	light rain, no wind
Friday	9	light rain, windy
Saturday	3	heavy rain

Describe how the concentration of sulfur dioxide in the air changes over the week, and suggest reasons for the changes.

Use the information in the table to support your answer.

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

7. Nov/2021/Paper_J258/03/No.3

In very cold conditions, hand warmers can be used inside gloves. One type of hand warmer uses a chemical reaction to give off heat.

Iron powder inside the hand warmer reacts with oxygen to make iron oxide.
An exothermic reaction starts when the iron powder comes into contact with the air.

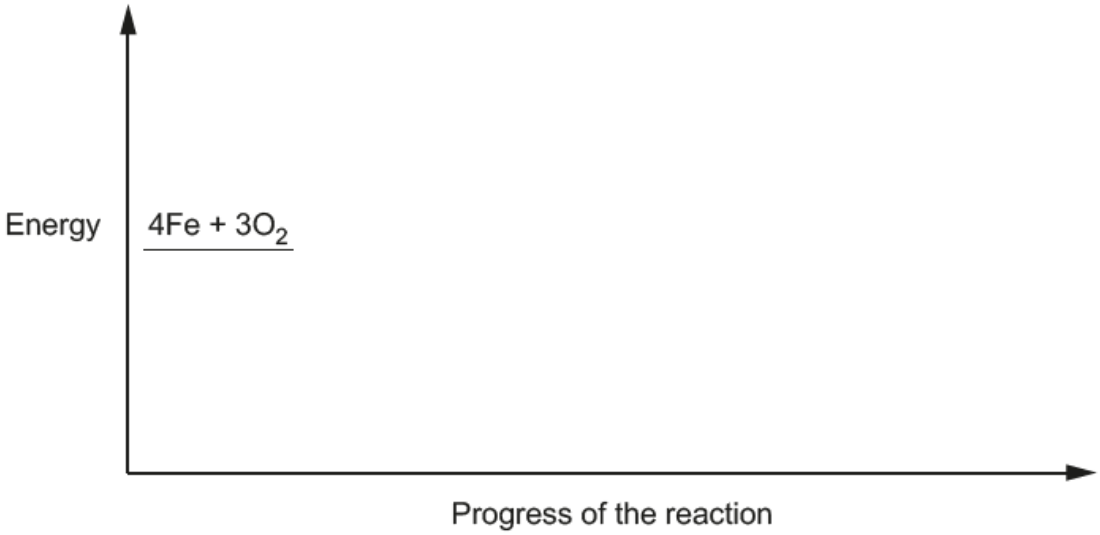
(a) Iron oxide, Fe_2O_3, contains O^{2-} ions.

What other ion does iron oxide, Fe_2O_3, contain?

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

(b) Draw and label the reaction profile for this reaction.

Label the activation energy 'AE'.



[3]

(c) Carbon is used as a catalyst in the hand warmer.

(i) Suggest why a catalyst is added to the hand warmer.

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

(ii) Why does the catalyst have the effect identified in **(c)(i)**?

Use ideas about energy in your answer.

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

(d) The iron is in powdered form.

Explain why this makes the reaction go quickly.

Use ideas about particles in your answer.

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

8. Nov/2021/Paper_J258/04/No.6

Some diesel cars have a system which uses a solution of urea, $(NH_2)_2CO$, to remove nitrogen oxides from their exhaust gases.

(a) Urea solution reacts in a two stage process.

Stage 1: At temperatures above 100 °C, urea solution breaks down to make ammonia.

$(NH_2)_2CO(aq) + H_2O(g) \longrightarrow CO_2(g) + 2NH_3(g)$

Stage 2: Ammonia then reacts with nitrogen oxide.

$4NO(g) + 4NH_3(g) + O_2(g) \longrightarrow 4N_2(g) + 6H_2O(g)$

(i) The overall reaction that happens in Stage 1 and Stage 2 produces **three waste** gases which leave the exhaust.

Name these **three** gases.

1. .....

2. .....

3. .....

[1]

(ii) The urea solution is sprayed into the hot exhaust gases before they leave the car.

Explain why the **two** equations show the state symbol for water as (g) rather than (l).

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

(iii) In the car, the urea solution is stored in a tank. The tank is kept cool by being kept far away from the hot engine.

Why is it important to keep the urea solution cool?

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

(iv) A redox reaction happens when oxidation and reduction happen in the same equation.

Explain why the reaction in **Stage 2** is a redox reaction.

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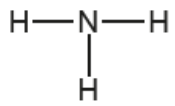
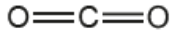
..... **[3]**

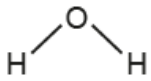
(b) Amir draws the displayed formulae of some of the substances involved in the reactions.



NH_3



CO_2



H_2O

N_2

Amir says that the number of bonds formed by each element can be calculated by using this equation:

Number of bonds formed = (18 – x)

where x = group number of the element shown on the Periodic Table.

(i) Show that this equation works for the number of bonds formed by nitrogen and oxygen.

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

(ii) Suggest **one** reason why this equation **cannot** be used for hydrogen.

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

(iii) Urea, $(NH_2)_2CO$, contains one double bond.

Draw the displayed formula of urea.

[2]

9. Nov/2020/Paper_J258/03/No.4

Fig. 4.1 shows how the average world temperature has changed since 1880.

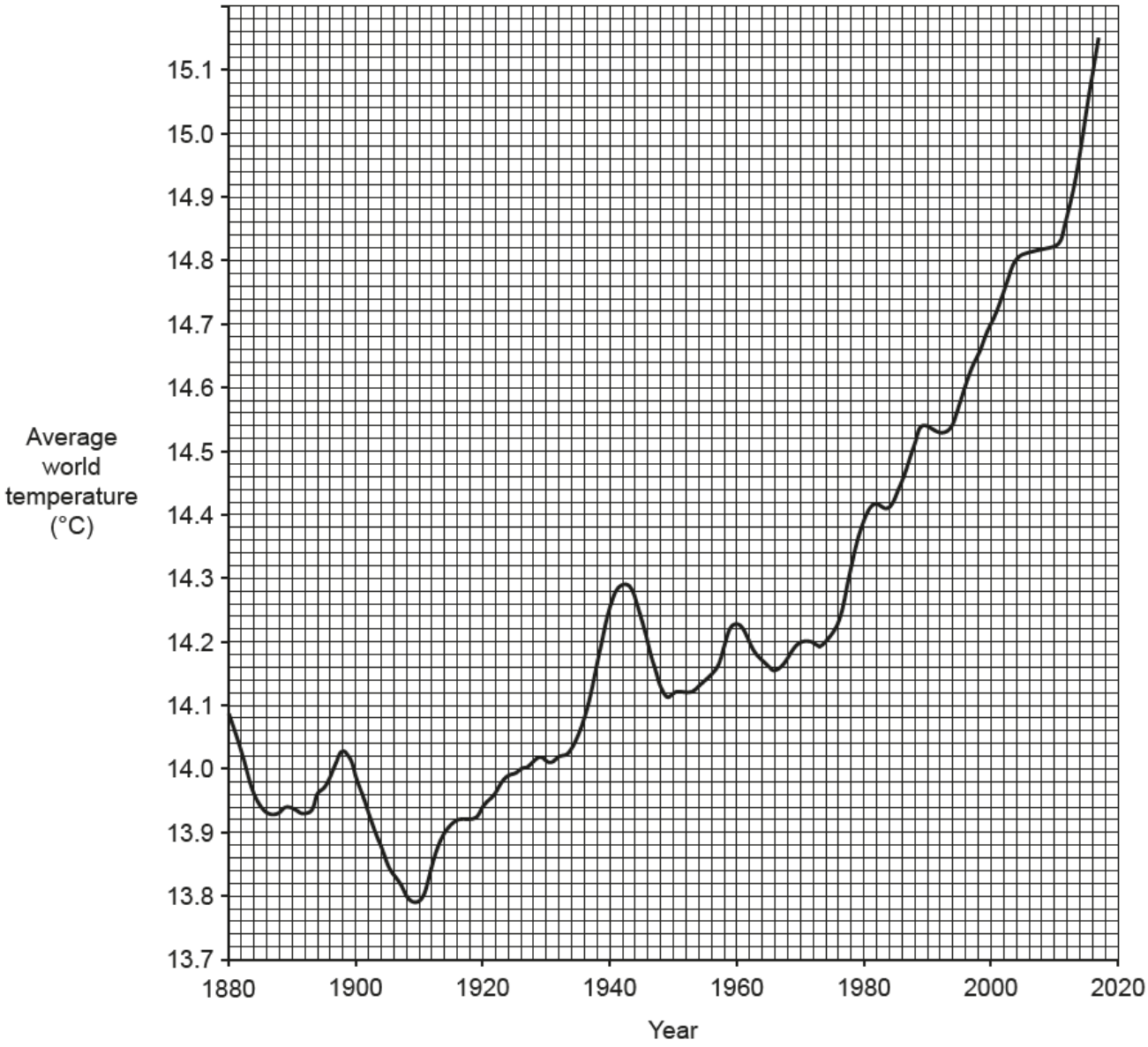


Fig. 4.1

(a) (i) Using **Fig. 4.1**, describe how the average world temperature changed from 1910–1930.

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

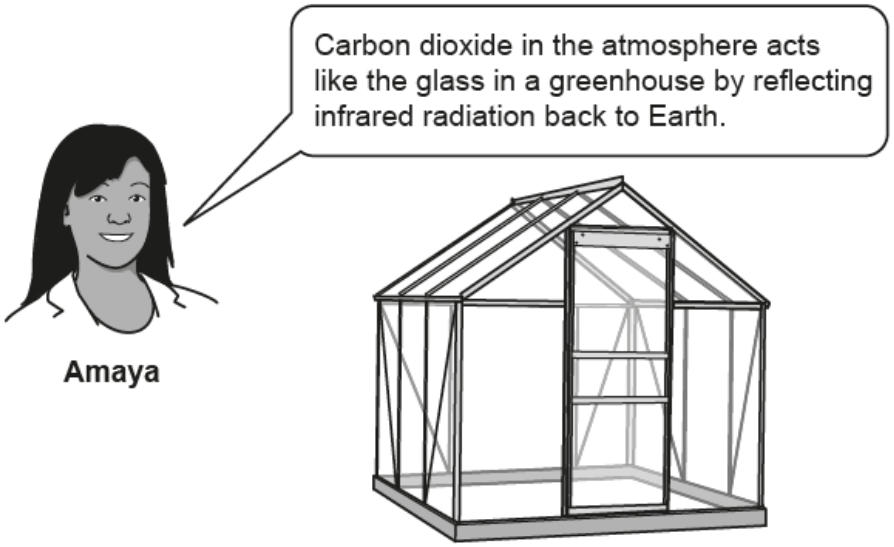
(ii) Between which **two** years was there the largest **continuous** temperature rise?

Between ..... and ..... **[1]**

(b) (i) Some scientists believe that average world temperatures have increased due to increased amounts of greenhouse gases in the air.

Carbon dioxide is a greenhouse gas.

Amaya says,



Explain what is **incorrect** about Amaya's statement.

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

(ii) State **one** suitable way in which we can lower our carbon dioxide emissions.

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

(c) State **one** effect of increasing average world temperatures on the Earth's climate.

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

10. Nov/2020/Paper_J258/04/No.7(b)

(b)* The energy changes that happen when solid fertilisers dissolve in water are related to bond-breaking and bond-making.

Fig. 7.2 shows the process of a solid ionic compound dissolving in water, in terms of bond-breaking and bond-making.

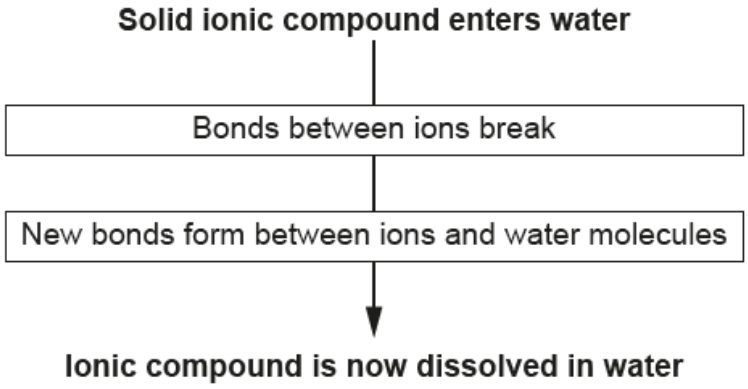

Fig. 7.2

Fig. 7.3 shows the energy changes when calcium nitrate and ammonium nitrate dissolve in water.

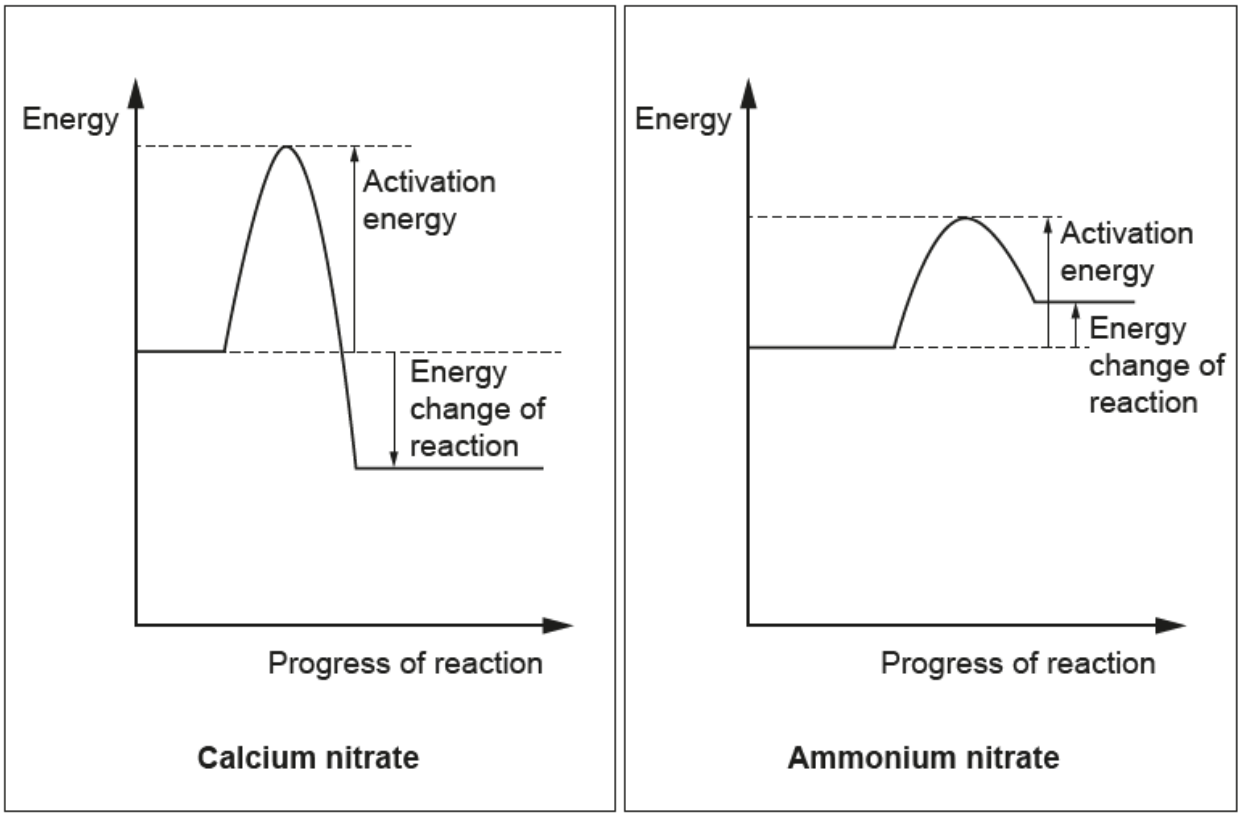

Fig. 7.3

Using **Fig. 7.2** and **Fig. 7.3**, describe and explain the differences in the energy changes when calcium nitrate and ammonium nitrate dissolve in water.

Use ideas about bond-breaking and bond-making in your answer.

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

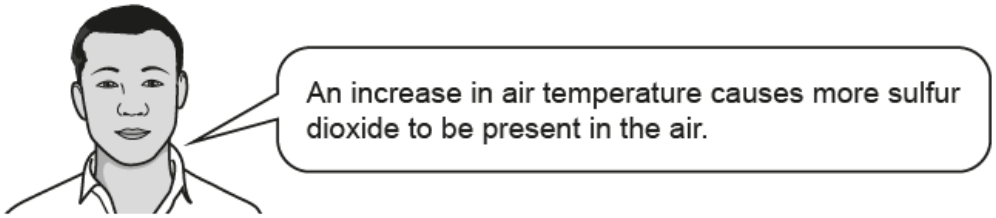
11. Nov/2020/Paper_J258/04/No.9

A monitoring station collects data about the weather and the concentration of sulfur dioxide, SO_2, near a power station.

The table shows some data collected at 12.00 midday each day for 7 days.

Day	Air temperature (°C)	Weather conditions	Concentration of SO_2 (mg/m^3)
Mon	24	no rain, no wind	25.0
Tues	20	light rain, windy	8.0
Thurs	16	heavy rain, no wind	3.5
Wed	21	light rain, no wind	16.2
Fri	19	light rain, windy	9.4
Sat	15	heavy rain, windy	
Sun	22	no rain, windy	

(a) Ali looks at the data from the monitoring station and says:



Discuss why this idea is **incorrect**.

Use data from the table to support your answer.

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

(b) Use the table to predict the concentration of sulfur dioxide, SO_2, for Saturday and Sunday.

Explain your answers.

Concentration of SO_2 on Saturday ..... mg/m^3

Explanation .....

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.....

Concentration of SO_2 on Sunday ..... mg/m^3

Explanation .....

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[4]

(c) The power station agrees to these targets for sulfur dioxide concentration in the air near the power station.

Targets
Sulfur dioxide concentration must be below….
• 200 mg/m^3 averaged over a 1-hour period
• 80 mg/m^3 averaged over a 24-hour period
• 20 mg/m^3 averaged over a one year period.

Jane is a scientist and wants to use the monitoring station to check whether the power station is meeting these targets.

Describe an outline plan for Jane.

Your plan should include:
- the frequency of measurements she needs to make,
- how she needs to process her results,
- how she can judge whether the targets are being met.

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