

C9 REVISION

Do it now:

Describe the relationship between boiling point and chain length.

Longer hydrocarbon = higher boiling point (stronger intermolecular forces)

State two equations for rate of reaction. Include units.

Volume of gas \div time (cm^3/s)
Mass of reactant \div time (g/s)

What apparatus can be used to measure rate of reaction?

Gas syringe and stopwatch

OR

Mass balance and stopwatch

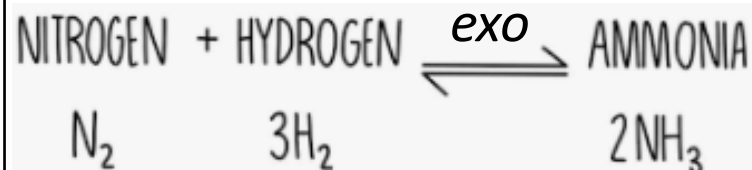
How can pure substances be distinguished from impure ones?

By looking at their melting points.

Why are large hydrocarbons cracked?

To make shorter AND MORE USEFUL alkanes (for fuel) and alkenes (for polymers)

What would happen to the yield of ammonia in the reaction below, if temperature was increased.

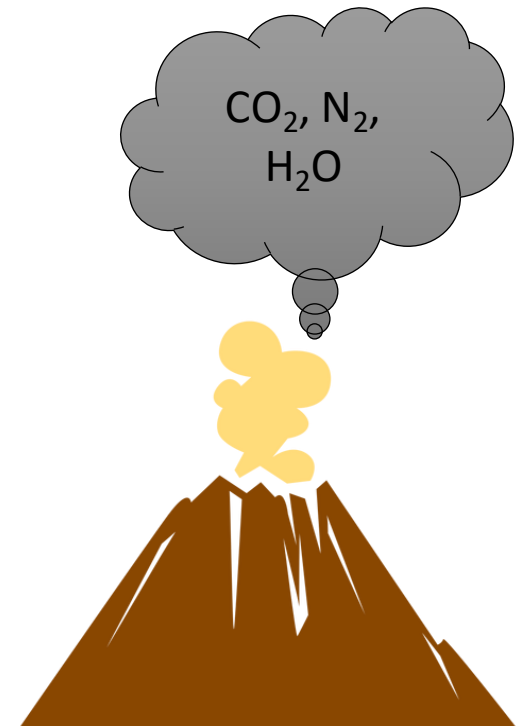


Yield of ammonia would decrease, as equilibrium would shift to the left (the endothermic direction).

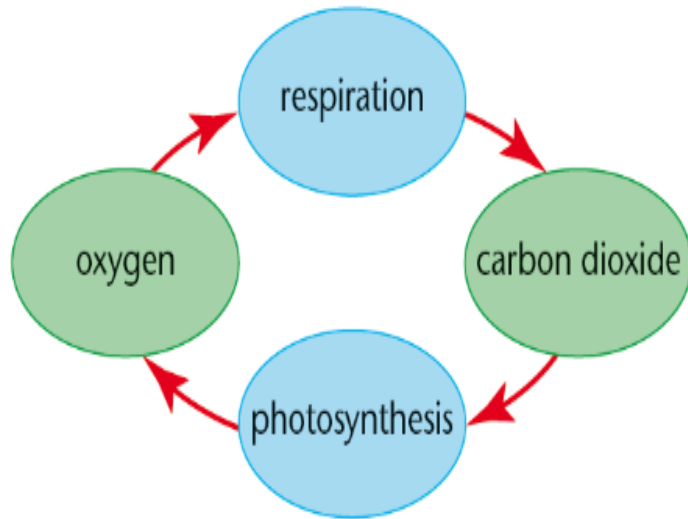
- Theories about how the Earth's early atmosphere was formed have developed over time.
- Evidence for the early atmosphere is limited because of the time scale of 4.6 billion years... there was no evidence recorded at that time!

One theory suggests that during the first billion years there was **intense volcanic activity** that **released gases** that formed the early atmosphere.

Volcanoes released mainly carbon dioxide, nitrogen and water vapour.



Gas	4.5 billion years ago	200 million years ago
Carbon dioxide	98%	0.04%
Oxygen	0	21%
Water vapour	2%	0
Nitrogen	0	78%
Argon	0	0.96%



Levels of oxygen and carbon dioxide have not changed over the last 200 million years, due to photosynthesis and respiration.

Compare the atmosphere on Earth with the atmosphere on other planets.

Venus and Mars are **rocky planets with volcanoes**. Their atmospheres are mainly made of **carbon dioxide**.



Titan (a moon of Saturn) has an **icy exterior**. Its atmosphere is mainly made of **nitrogen**.



A. The Earth's **early atmosphere** was very much like the atmosphere of Venus or Mars **today**

How can we use this information to predict future changes in the atmosphere of other planets?

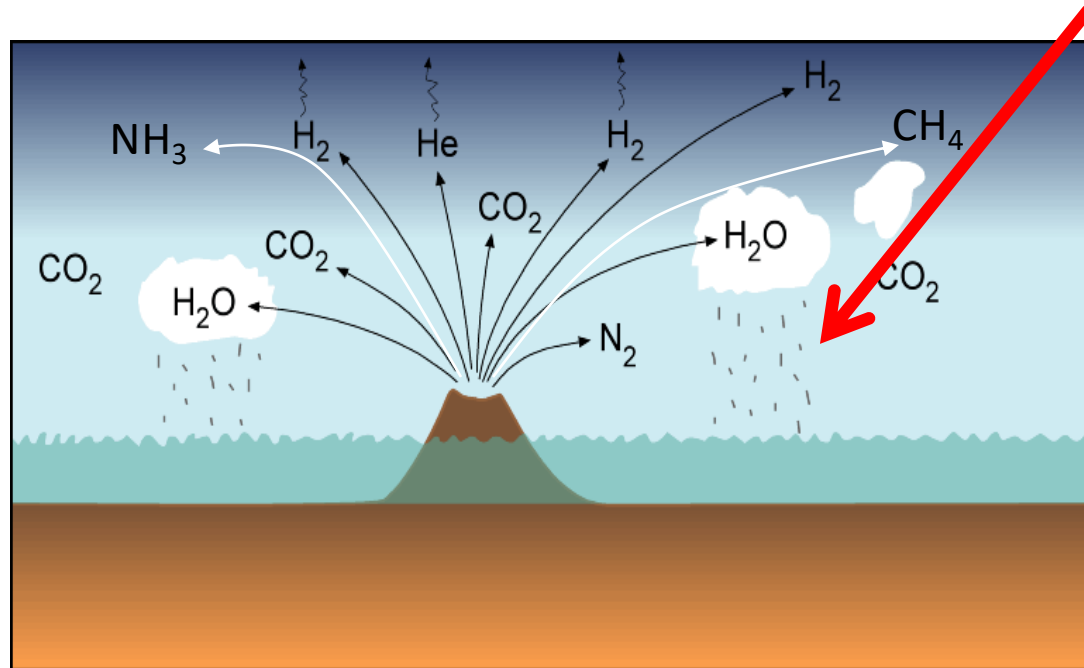
Water vapour

How?

Amount of water vapour in the atmosphere has ***decreased***.

Why?

Volcanoes released water vapour as a gas. As the earth cooled, the water vapour condensed to form the oceans.



Carbon dioxide

How?

Amount of carbon dioxide in the atmosphere has **decreased**.

Why?

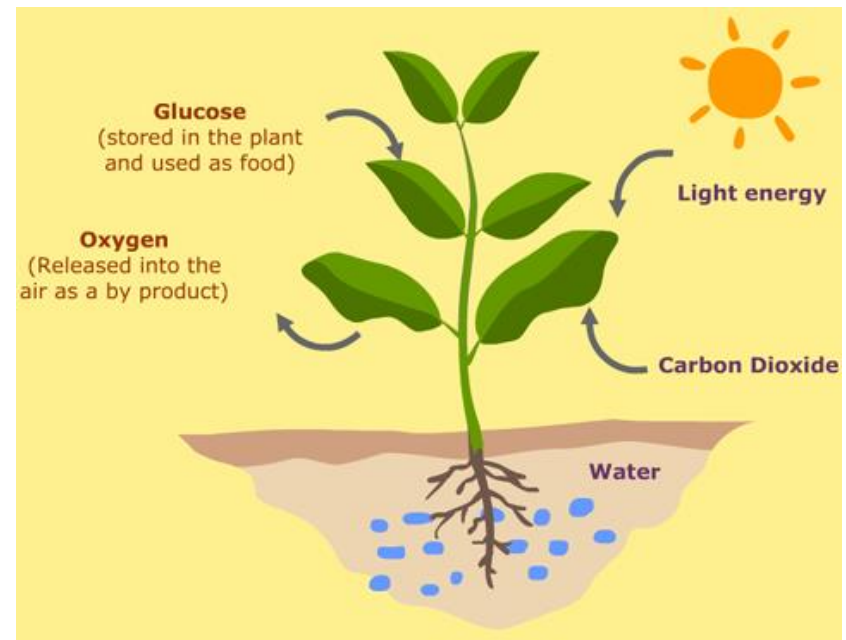
THERE ARE TWO REASONS FOR THE DECREASE IN CO₂!

1. Taken in by photosynthesis.

Plant and algae **photosynthesise**.

This takes in carbon dioxide and produces oxygen.

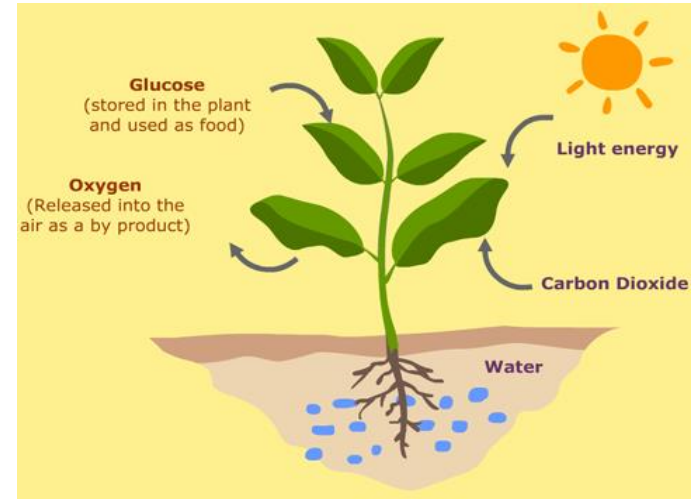
What is the word equation and the balanced symbol equation for photosynthesis?



Carbon dioxide

What is the word equation and the balanced symbol equation for photosynthesis?

YOU MUST KNOW THESE EQUATIONS!!!



carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen



Challenge – Why is light written above the arrow?

Carbon dioxide

How?

Amount of carbon dioxide in the atmosphere has **decreased**.

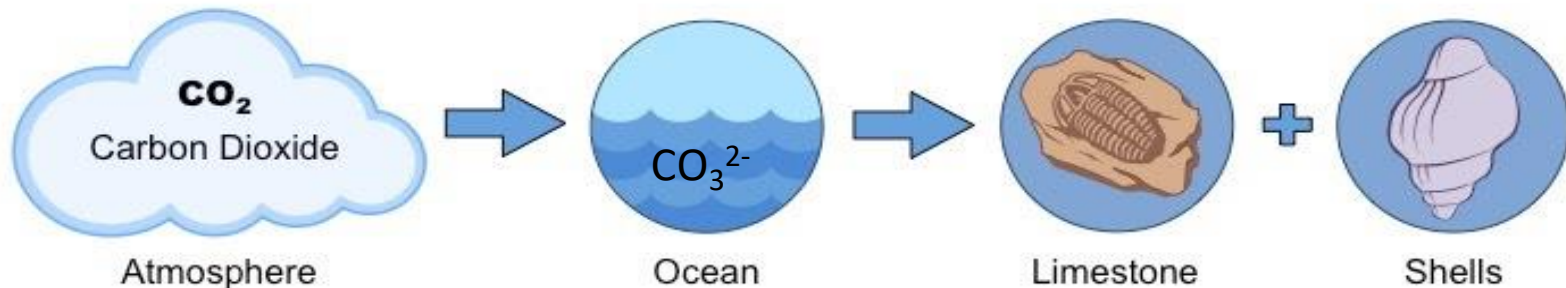
Why?

THERE ARE TWO REASONS FOR THE DECREASE IN CO₂!

2. It dissolved in the oceans

When the oceans formed, CO₂ **dissolved** in the water.

The **carbonates** precipitated out and produced sediments e.g. CaCO₃ = limestone.



Oxygen

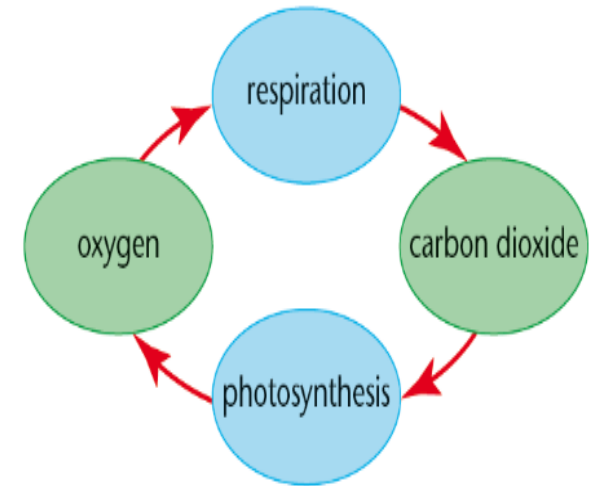
How?

Amount of oxygen in the atmosphere has **increased**.

Why?

Algae and **plants** produced the $O_2(g)$ that is now in the atmosphere by **photosynthesis**.

Algae first produced $O_2(g)$ about **2.7 billion years ago**.



<https://www.youtube.com/watch?v=GP0HT77OPYQ>



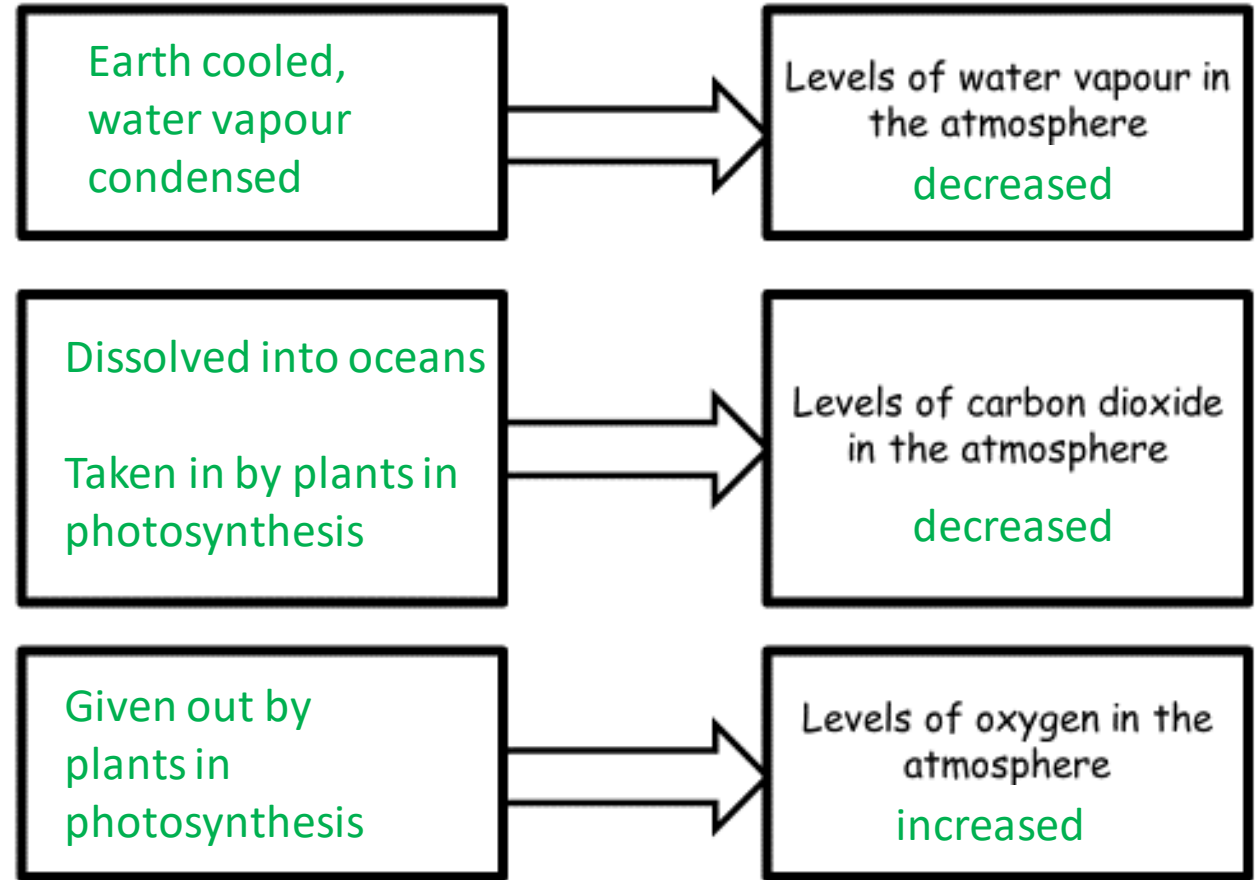
*Self
assessment*

*Earth's
surface:*

*Volcanoes ->
continents
(due to
formation of
oceans)*

Causes

Effects



Challenge – Where does evidence of the Earth's early atmosphere come from?



Q1. The table shows the gases in the Earth's atmosphere today.

Gas	Percentage (%)
N ₂	78.0
O ₂	21.0
Ar	0.9
Other gases	X

(a) What is the percentage of **X**? Tick **one** box.

0.01% 0.1% 1% 10%

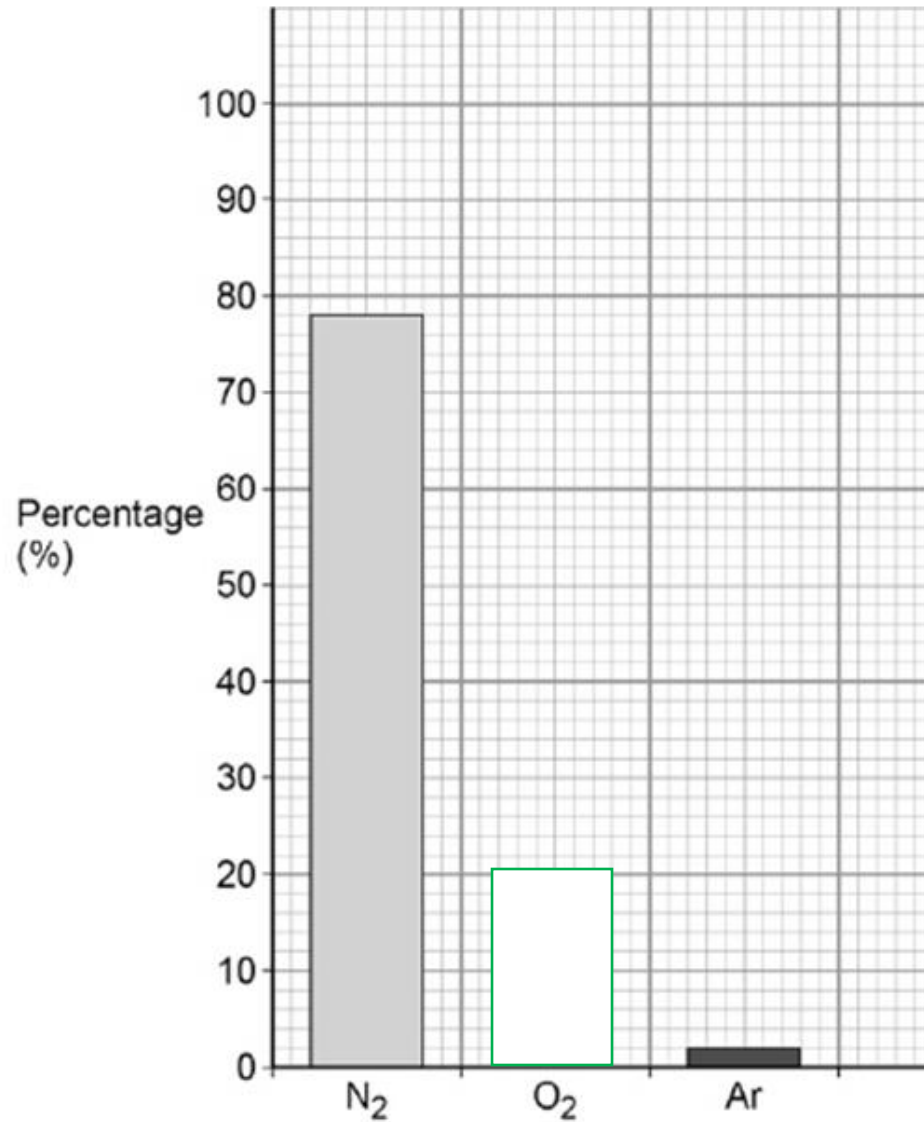
(1)

(b) Complete **Figure 1**.

Plot the data from the table on **Figure 1**.



Figure 1





(c) What is the name of the gas with symbol Ar? Tick **one** box.

Aluminium

Argon

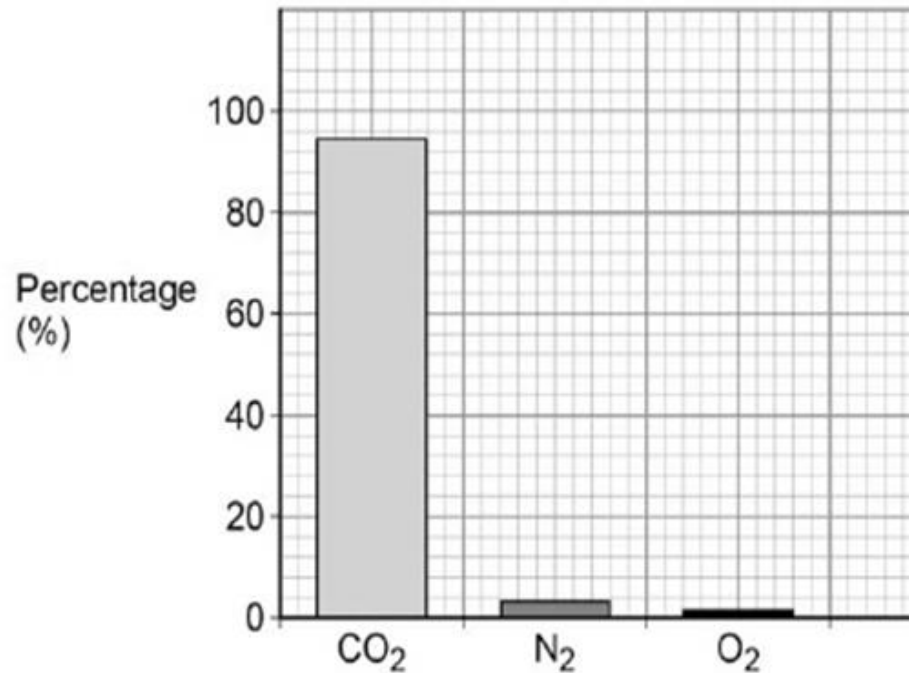
Arsenic

Astatine

(1)

(d) **Figure 2** shows the gases in the atmosphere of Mars today.

Figure 2



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

Describe the change in the percentage of oxygen from the Earth's early atmosphere to the Earth's atmosphere today. Use values from the table and **Figure 2**.

Amount of oxygen has increased (1)

Data from Figure 2 as evidence (1)

Q2. 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?

Argon

(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.

$$95.00 - 0.04 = 94.96\%$$

Decrease in percentage = _____%

(1)

Q3.

This question is about gases in the Earth's atmosphere.



- (a) Draw **one** line from each gas to the approximate percentage of the gas in the Earth's atmosphere today.

Gas	Approximate percentage of gas in the Earth's atmosphere today
Carbon dioxide	<1
	5
	10
Nitrogen	20
	50
Oxygen	80
	>90



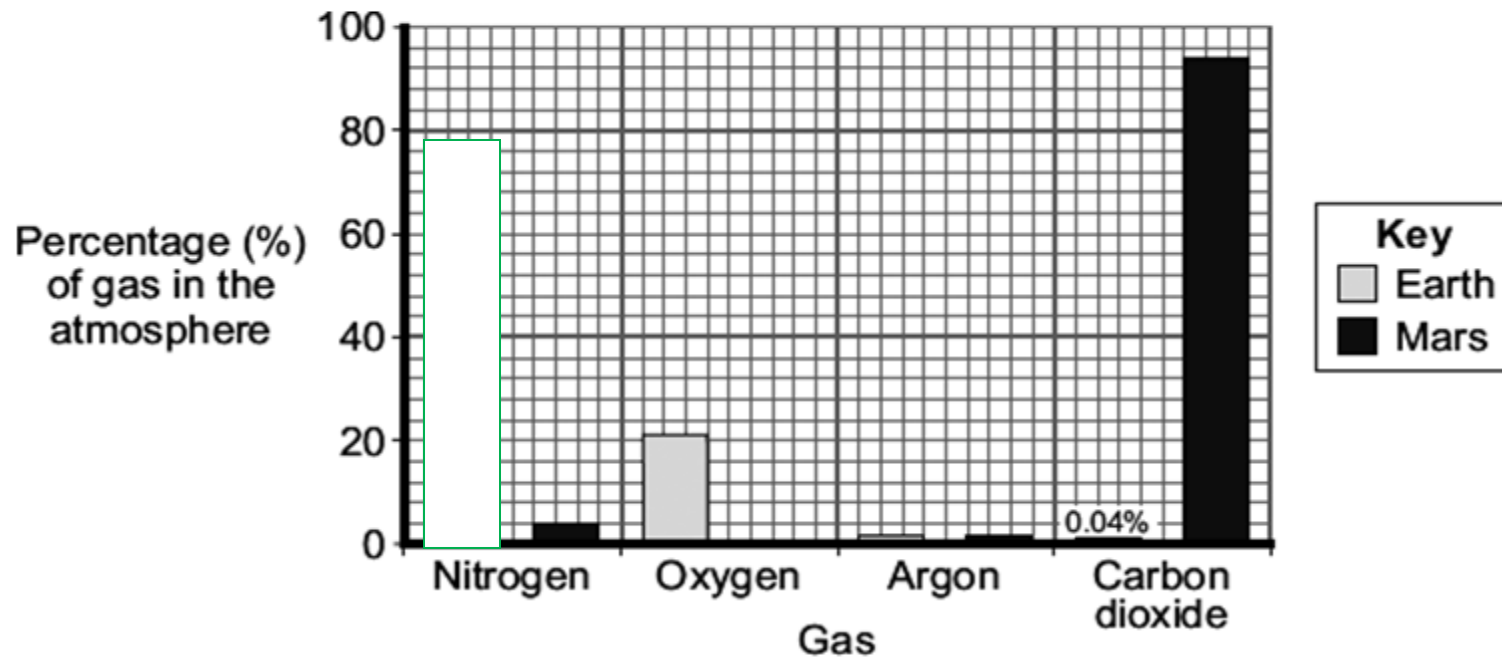
(b) Complete the word equation for photosynthesis.

carbon dioxide + water → glucose + oxygen

(1)



Q4. The bar chart shows some of the gases in the atmospheres of Earth today and Mars today.



(a) Complete the bar chart to show the percentage of nitrogen in the Earth's atmosphere today.

78%

(1)

(b) Some scientists suggest that the Earth's early atmosphere was like the atmosphere of Mars today.

(i) There is **not** much oxygen in the atmosphere of Mars.

Suggest why.

There are no plants on Mars



(1)

(ii) The percentage of argon in the Earth's atmosphere today is the same as it was in the Earth's early atmosphere.

Suggest why.

Argon is very unreactive

(1)

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

Some theories suggest that the Earth's early atmosphere was

made by

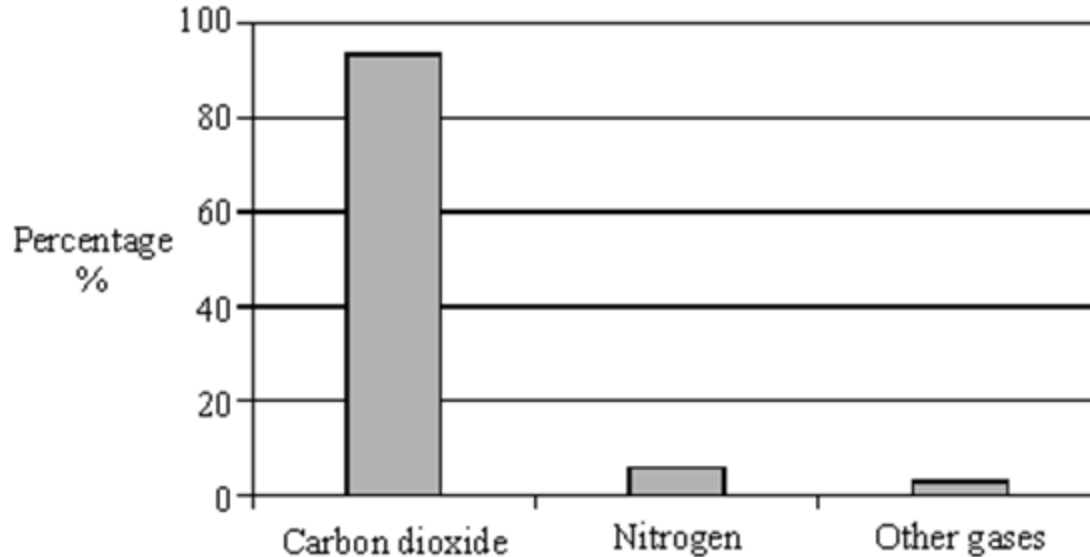
burning fossil fuels.

the formation of oceans.

the eruption of volcanoes.

(1)

Q5. The bar chart shows the percentage composition of the atmosphere on Mars.



(a) State **three** ways in which the atmosphere on Earth today is different from that on Mars.

1 less / little / not much carbon dioxide or give a %age < 1%

2 more / a lot of nitrogen or give 78-80%

3 (more) / (some) oxygen or give a %age 20-21%

Can also include: more / some water (vapour), some / 1% argon



- (b) The atmosphere on Earth may once have been like that on Mars. The evolution of green plants has changed the atmosphere on Earth.

Explain why.

Plants have taken in carbon dioxide (1)

And released oxygen (1)

(2)

- (c) The Earth's average surface temperature decreased over time. At what temperature would oceans have started to form?

Temperature = 100 °C

(1)



Q7.

There is limited evidence about the Earth's early atmosphere because of the age of the Earth.

(a) The Earth is 4.6 billion years old.

Which is the correct age of the Earth?

Tick **one** box.

4.6×10^3 years

4.6×10^6 years

4.6×10^9 years

4.6×10^{12} years

(1)



Gas	Concentration of gas in the atmosphere today in parts per million	
	Mars	Earth
Nitrogen	27 000	780 000
Oxygen	1 300	210 000
Argon	16 000	9 300
Carbon dioxide	950 000	400
Carbon monoxide	800	trace

- (b) Calculate the percentage increase in nitrogen from the Earth's early atmosphere to the atmosphere today.

Assume the Earth's early atmosphere was the same as the atmosphere today on Mars.

Give your answer to 2 significant figures.

$$\frac{780000 - 27000}{27000} \times 100 \quad (1)$$

$$= 2788.8 \quad (1)$$

$$= 2800 \quad (1)$$

Percentage increase in nitrogen = _____ %

(3)

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.

carbon dioxide has decreased due to:

• plants / microorganisms / bacteria / vegetation / trees (1)

• photosynthesis (1)

ignore respiration

(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.

Methane's boiling point is greater than the surface temperature

1

any methane that evaporates will condense

accept boils for evaporates, accept cooling and produce rain for condensing

(2) 1

- (c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene (C₂H₄) and propene (C₃H₆) from methane in Titan's atmosphere.

State the general formula for alkenes.



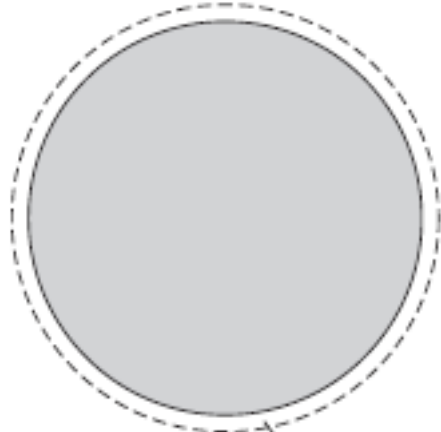
(1)

Describe how the surface of the Earth and its atmosphere have changed.

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.

The early Earth
Most of the surface was covered by volcanoes



Most of the atmosphere was carbon dioxide and water vapour

The Earth today
Most of the surface is covered by oceans



Most of the atmosphere is nitrogen and oxygen

What does this actually mean?
Can you write in bullet points?

Background information, nothing new!

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.

Describe how the surface of the Earth and its atmosphere have changed.

Recall facts AND explain why these happen or contribute.

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.

What is the difference between the first picture and the second picture?

(6)

So to conclude... for 6 marks, how has the Earth's surface and atmosphere changed, and why!

Mark scheme

Level 1 (1–2 marks)

Statements based on diagrams

Level 2 (3–4 marks)

Description of how one change occurred

Level 3 (5–6 marks)

Descriptions of how at least two changes occurred

Examples of chemistry points made in the response could include:



Main changes

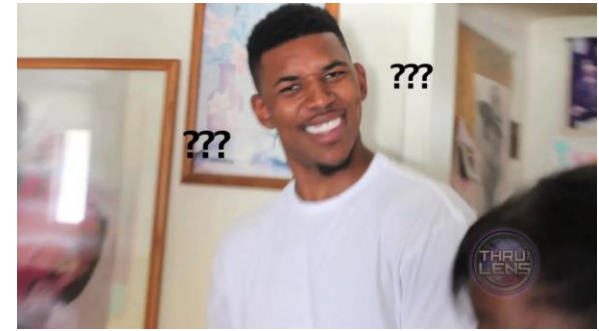
- oxygen increased because plants / algae developed and used carbon dioxide for photosynthesis / growth producing oxygen; carbon dioxide decreased because of this
- carbon dioxide decreased because oceans formed and dissolved / absorbed carbon dioxide; carbon dioxide became locked up in sedimentary / carbonate rocks and / or fossil fuels
- oceans formed because the Earth / water vapour cooled and water vapour in the atmosphere condensed
- continents formed because the Earth cooled forming a supercontinent / Pangaea which formed the separate continents
- volcanoes reduced because the Earth cooled forming a crust.

Other changes

- nitrogen has formed because ammonia in the Earth's early atmosphere reacted with oxygen / denitrifying bacteria.

IMPORTANT!!!

Don't get your key terms mixed up...



GREENHOUSE GASES

= carbon dioxide, methane and water vapour which absorb long wavelength radiation

Which causes...

GLOBAL WARMING

= the increase in temperature of the Earth's surface

Which causes...

CLIMATE CHANGE

= a resulting change in the overall climate of the Earth

Make sure you are using the correct term in your exams!

The greenhouse gases

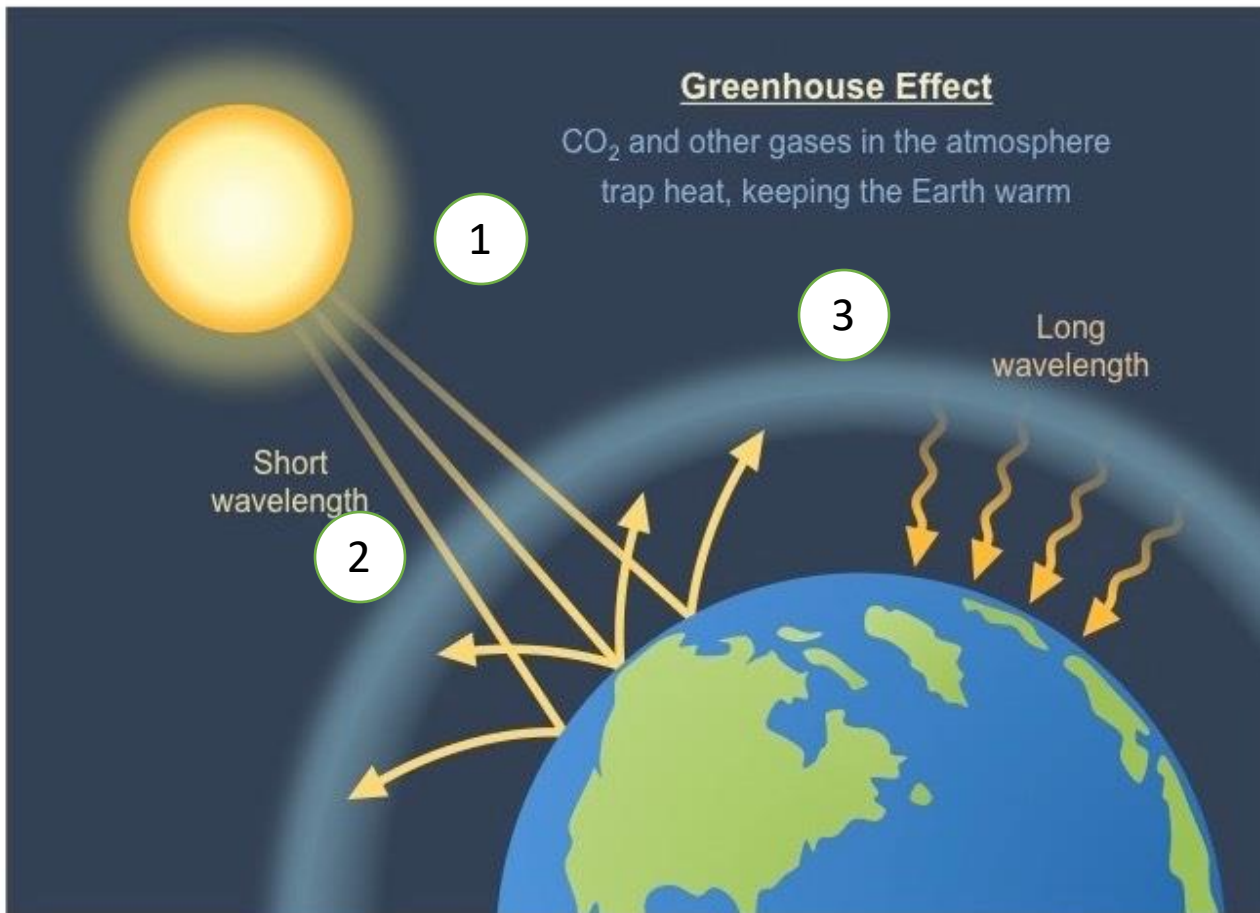
The average temperature of Earth is 14⁰C. This is because we have a blanket of greenhouse gases in our atmosphere that keep the Earth at a warm, stable temperature.

You need to know these three greenhouse gases:

- Carbon dioxide
- Water vapour
- Methane

The greenhouse effect

- 1 **Short wavelength** radiation is emitted from the sun and absorbed by the Earth
- 2 **Long wavelength** radiation is emitted from the Earth back out into the atmosphere
- 3 Greenhouse gases **absorb long wavelength radiation**
- 4 **Global temperatures rise**



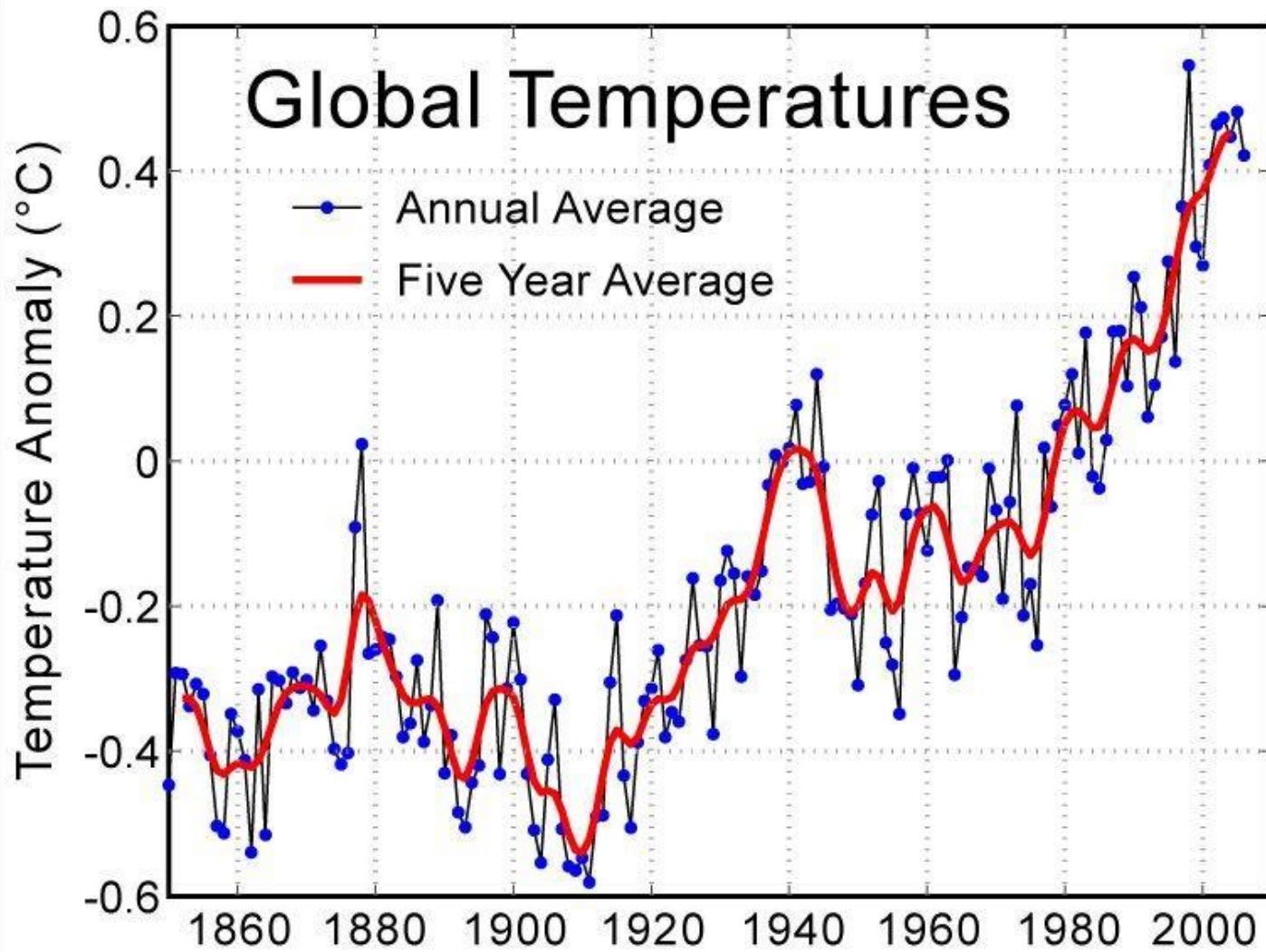
Recognise the importance of peer review of results and of communicating results to a wide range of audiences

Evidence of human impact

Most scientists agree that CO₂ levels have increased, but some scientists believe it is *part of the Earth's natural cycle*.



<https://www.youtube.com/watch?v=sG8gLt4GChg>



This is the graph Brian Cox shows in the video.

This graph **does** support human impact on global warming as the temperature started to rise rapidly at the start of the 1900s when the industrial revolution took place and we started burning lots of fossil fuel.

Describe four potential effects of global climate change



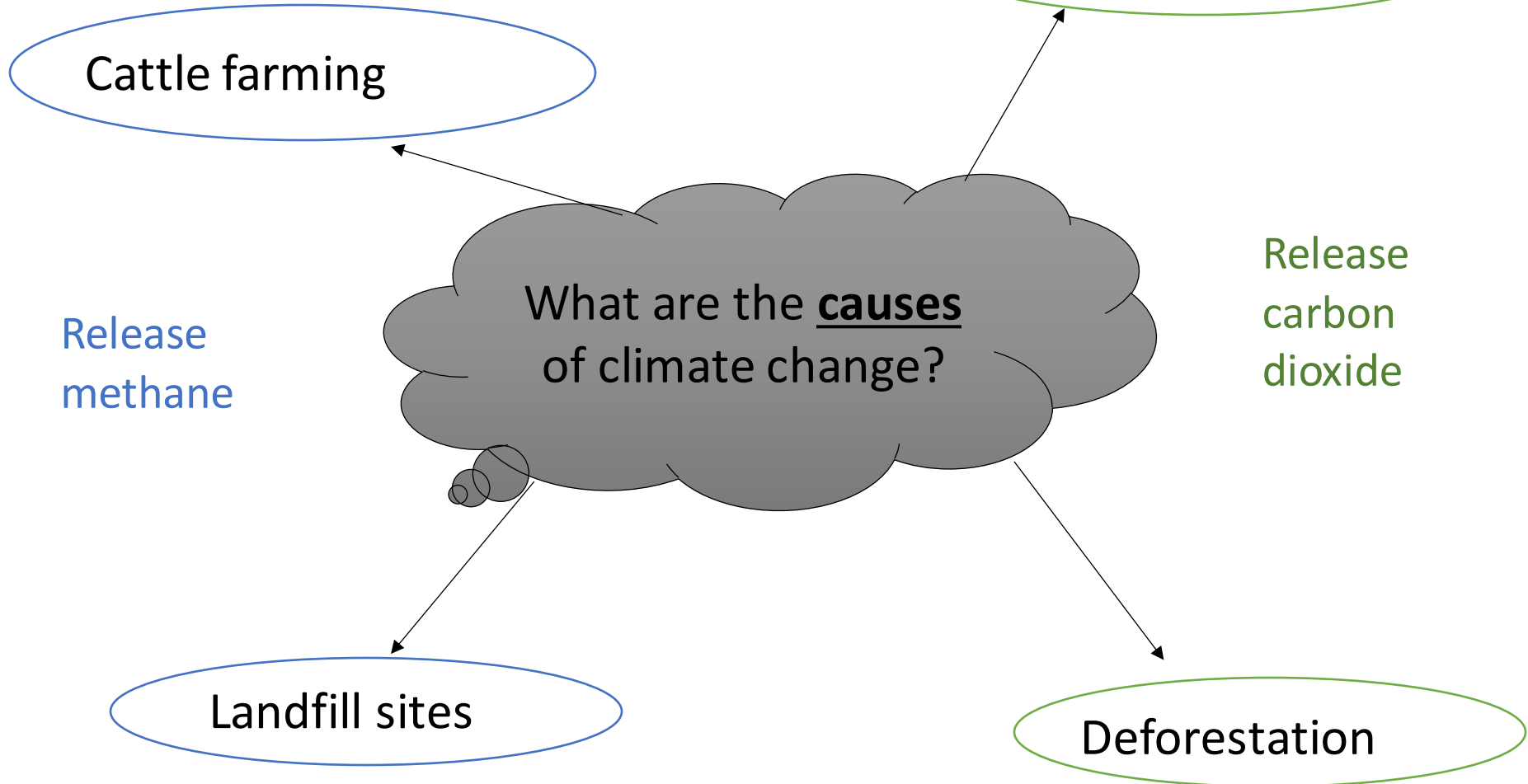
Think



Pair



Share



Burning fossil fuels

Cattle farming

Release methane

Release carbon dioxide

What are the causes of climate change?

Landfill sites

Deforestation

Describe four potential effects of global climate change

You also need to know 4 effects of climate change and the impact of each one on the planet:

Rising sea levels



Droughts



Desertification



Ice caps melting





Key definition!

A carbon footprint is the **total amount of carbon dioxide and other greenhouse gases** emitted over the **full life cycle** of a product, service or event.

All aspects from start to finish of any product must have a carbon footprint in some form or another.

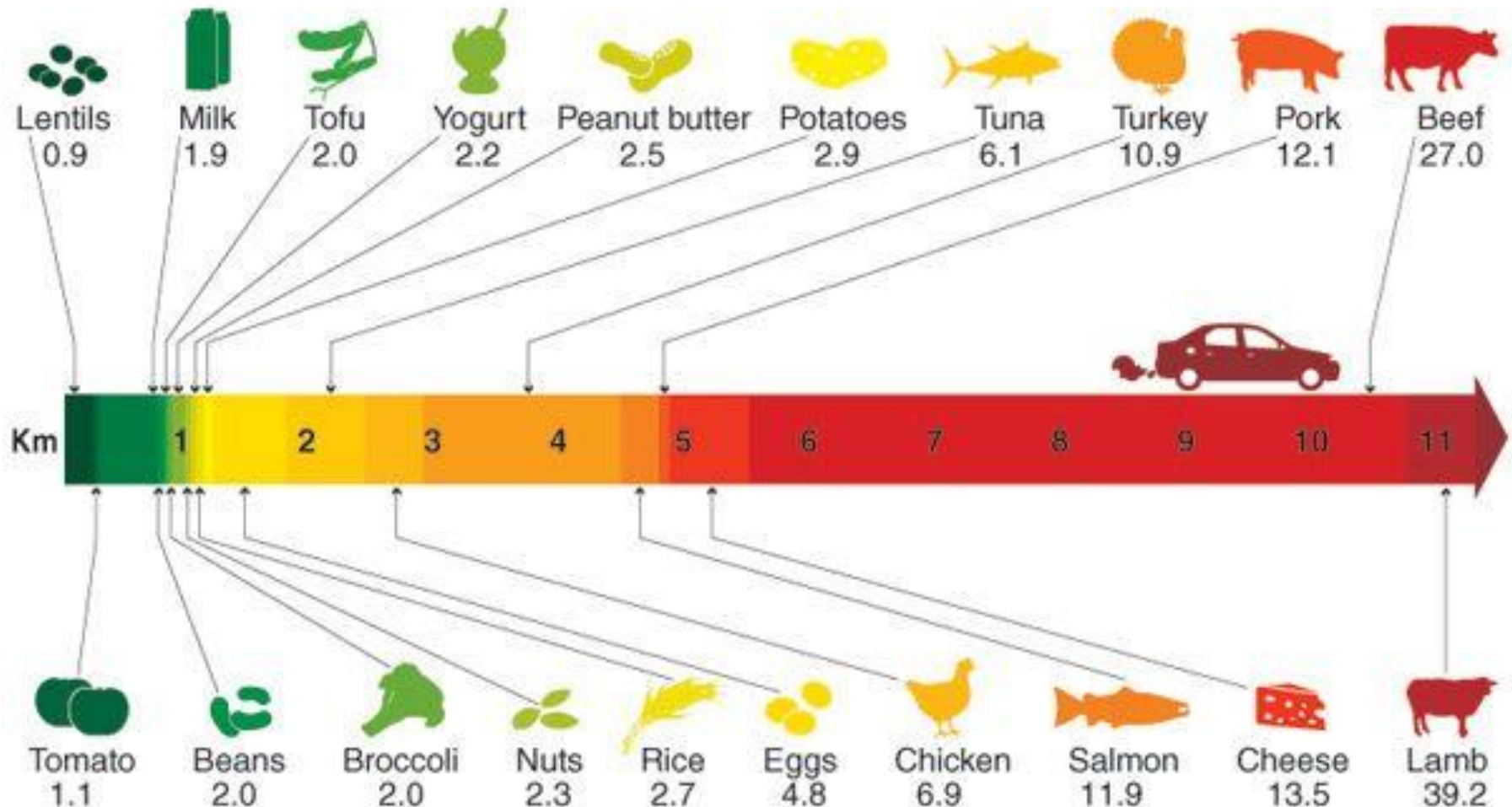
Describe what a carbon footprint is

Carbon footprint of what you eat

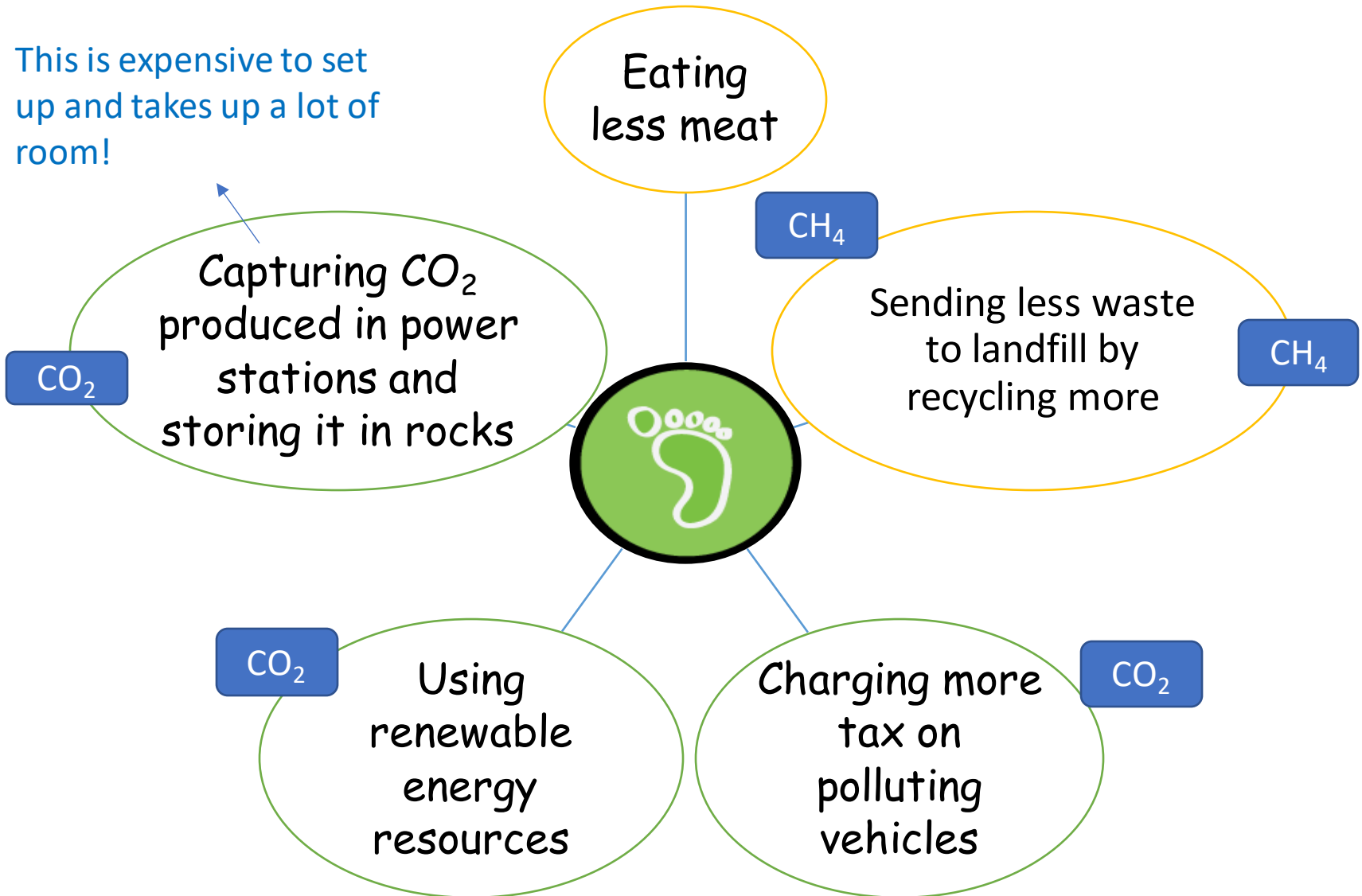
Calculations of greenhouse gas emissions from the production, processing and transportation of specific food items

■ Main chart compares 110g of food against a journey in a midsize car

■ Number shows kg of carbon dioxide equivalent produced per 1kg of food



How can we reduce our carbon footprint?

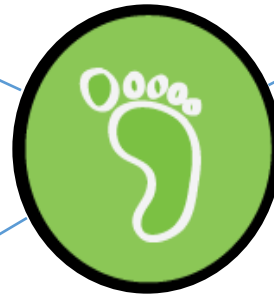


Why aren't all countries able to reduce their carbon footprint?

Their economy is built on industry and burning fossil fuels - they would lose money!

There is a lack of education about climate change

It's too expensive to set up renewable energy sources



Challenge: Fossil fuels drove the industrial revolution that led to economic growth in the West – is it fair to deny developing countries the opportunity to experience the same growth now that we know the impact of fossil fuels?

Exam practice



The area of ocean with sea ice in the arctic has changed.

Most scientists believe this is due to the activities of humans.

Explain the activities of humans that have led to the changes in sea ice from 1979 to 2016.

(6)

Task: You have 10 minutes to answer the exam question below.

The area of ocean with sea ice in the arctic has changed.

Most scientists believe this is due to the activities of humans.

Explain the activities of humans that have led to the changes in sea ice from 1979 to 2016.

(6)

Hint:

- What are our greenhouse gases?
- What human activities have increased the levels of each of these greenhouse gases?
- How does the increase of these gases cause global warming?
- How does global warming effect sea ice?

Atmospheric pollutants

Gases produced in combustion of fossil fuels:

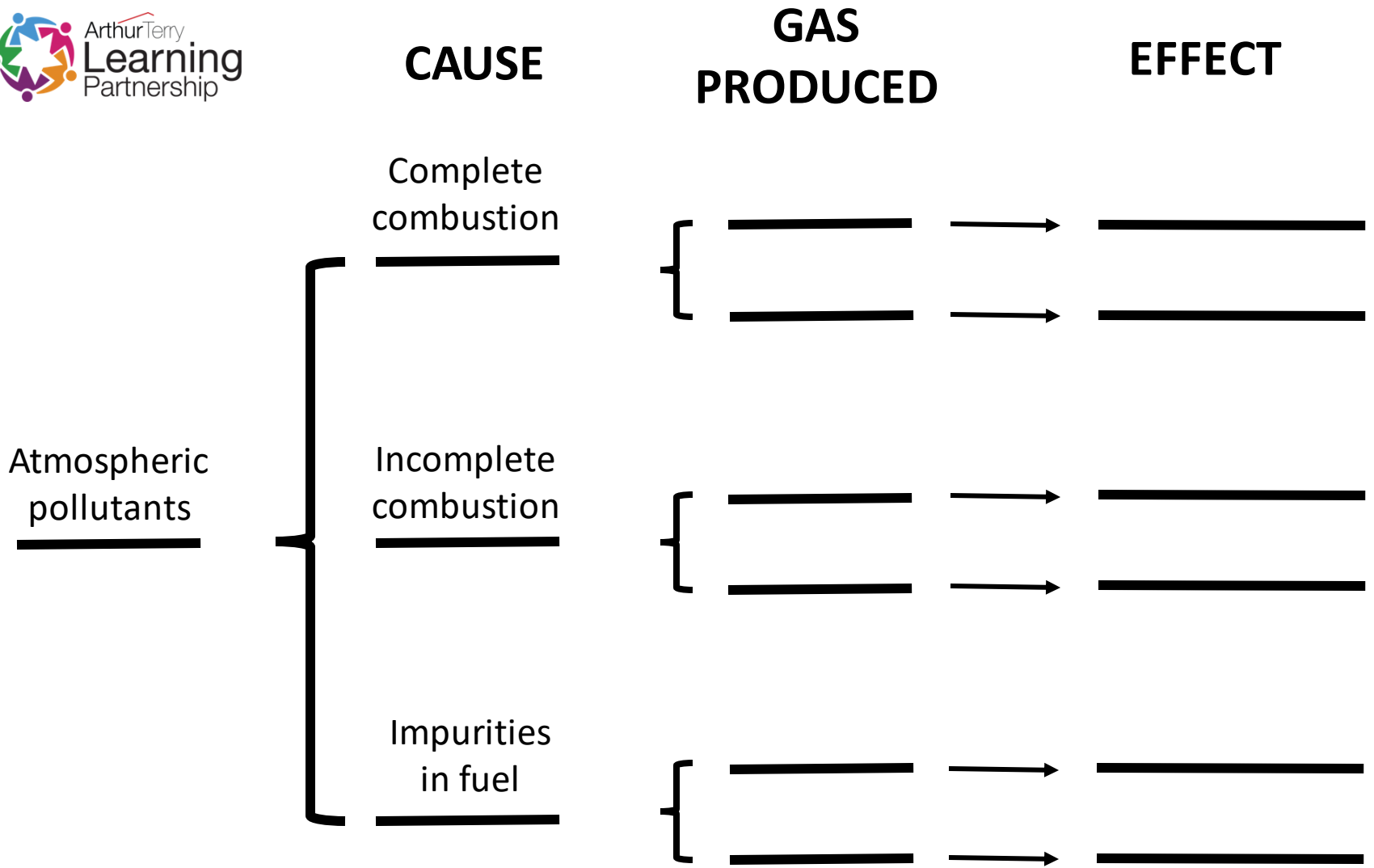
1. Carbon dioxide
2. Carbon monoxide
3. Carbon particulates
4. Water vapour
5. Sulphur dioxide
6. Nitrogen oxides

You need to know:

- How they are formed
- Their effect on the environment

LO: To explain the problems caused by increased amounts of pollutants in the air.

Task: Complete the thinking map below to show the causes and effects of each atmospheric pollutant produced from burning fuels.



1. Complete combustion

Complete combustion occurs when there is lots of oxygen available to burn the fuel in:



Task: Write a **word equation** to represent the two reactions below. Identify the reactants and products.

1. Methane (CH_4) reacts with oxygen to form carbon dioxide and water
2. Ethane (C_2H_6) reacts with oxygen to form carbon dioxide and water

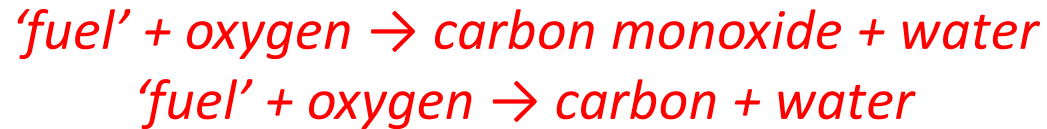
Challenge: Write a symbol equation for the two reactions above.

Hint: Oxygen exists in the air as O_2

Super Challenge!: Write a **balanced** symbol equation for the two reactions.

2. *Incomplete combustion*

Incomplete combustion occurs when there is not very much oxygen available to burn the fuel in:



Complete
Combustion
(more oxygen)



Incomplete
Combustion
(less oxygen)

Challenge: Which produces more energy?

2. Incomplete Combustion

Incomplete combustion occurs when there is not very much oxygen available to burn the fuel in.

There are two products that can be made in incomplete combustion:



= a poisonous gas



= soot



1. Carbon dioxide (CO₂)

What is the cause?

Complete combustion of fossil fuels

Occurs when there is a lot of oxygen available!



What is the effect?

Carbon dioxide causes global warming through the greenhouse effect.

Causes and effects of atmospheric pollutants



	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	→	→
	Incomplete combustion	→	→
	Impurities in fuel	→	→

2. Carbon monoxide (CO)

What is the cause?

Incomplete combustion of fossil fuels

Occurs when there is a NOT a lot of oxygen available!

Remember!
'Mono' means 'one'!

fuel + oxygen → carbon monoxide + water

What is the effect?

Carbon monoxide prevents oxygen from binding to haemoglobin in red blood cells.

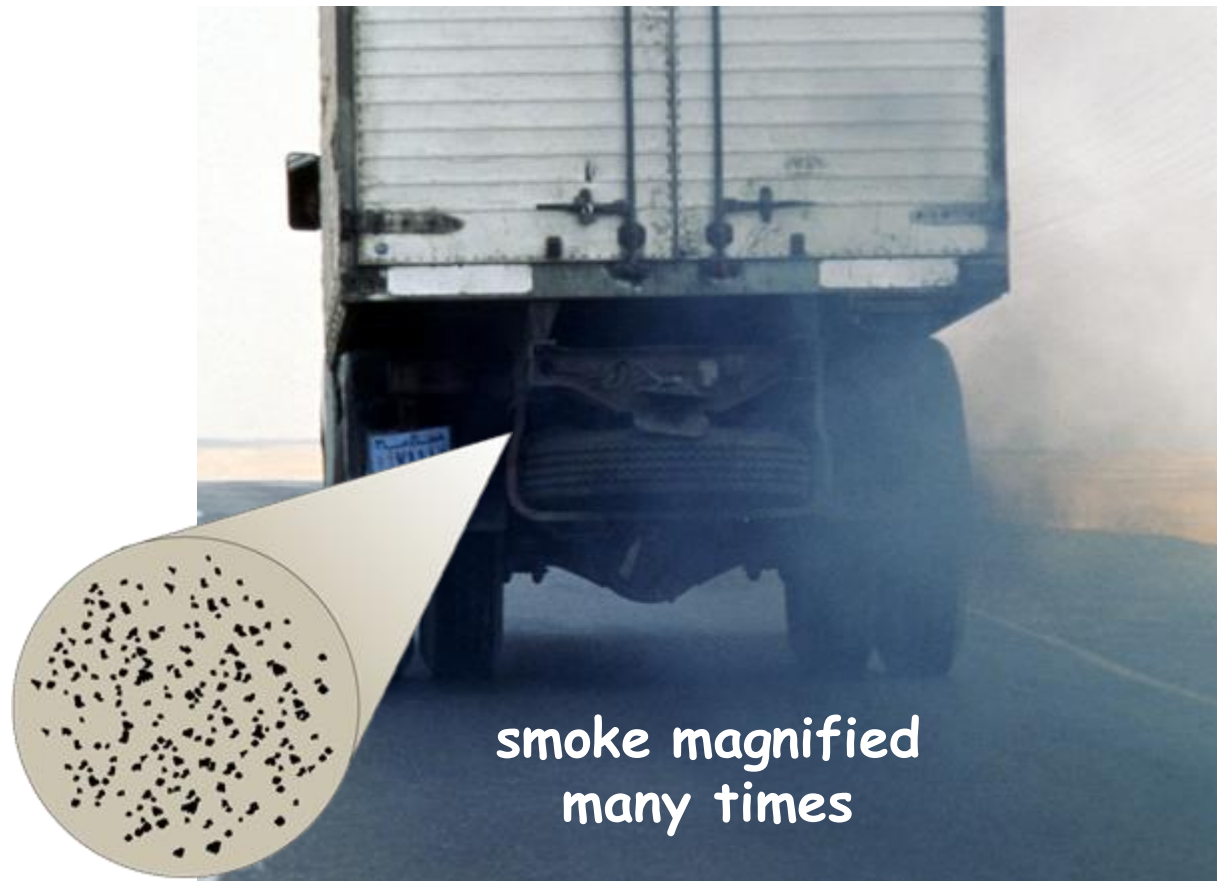
Causes and effects of atmospheric pollutants



	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	→	→
	Incomplete combustion	→	→
	Impurities in fuel	→	→

What are particulates?

If these particles get into the lungs, they can cause respiratory problems.



LO: To explain the problems caused by increased amounts of pollutants in the air.

What is global dimming?

<https://www.youtube.com/watch?v=X-bFa8pDxcl>

**Particulate
pollution seen
from space**



3. Carbon particulates (C)

What is the cause?

Incomplete combustion of fossil fuels

Carbon particulates are formed when there is even less oxygen available in combustion



What is the effect?

Carbon particulates can cause:

- global dimming
- respiratory problems.

Causes and effects of atmospheric pollutants



	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	→	→
	Incomplete combustion	→	→
	Impurities in fuel	→	→

4. Water vapour (H₂O)

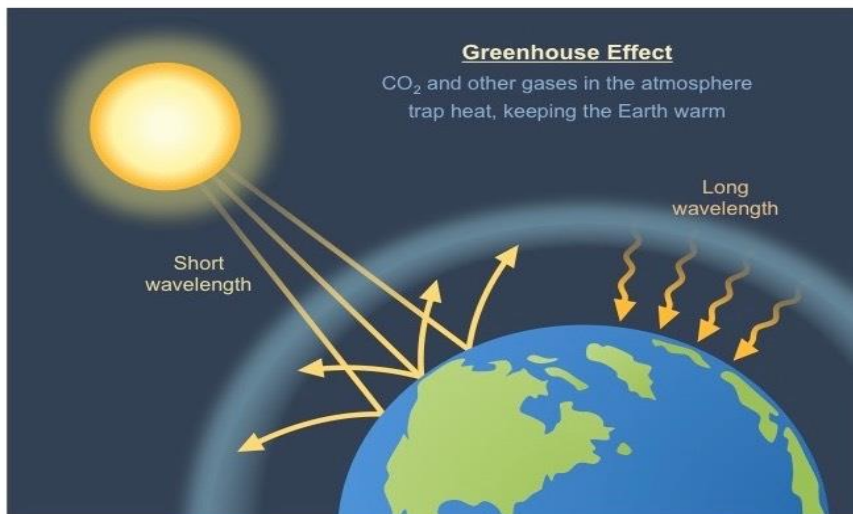
How is water vapour formed?

Complete AND incomplete combustion of fossil fuels



What is the effect of water vapour?

Water vapour causes global warming through the greenhouse effect



Causes and effects of atmospheric pollutants



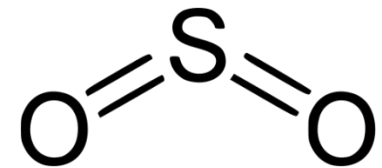
	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	→ →	→ →
	Incomplete combustion	→ →	→ →
	Impurities in fuel	→ →	→ →

5. Sulphur dioxide (SO₂)

How is sulphur dioxide formed?

Small particles of sulphur found in fuel react with oxygen in the air.

sulphur + oxygen → sulphur dioxide



(SO₂)

What is the effect of sulphur dioxide?

Sulphur dioxide can cause:

- Acid rain
- Respiratory problems in humans

Causes and effects of atmospheric pollutants



	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	{ _____ → _____ _____ → _____	_____
	Incomplete combustion	{ _____ → _____ _____ → _____	_____
	Impurities in fuel	{ _____ → _____ _____ → _____	_____

6. Nitrogen oxides (NO_x)

How are nitrogen oxides formed?

Small particles of nitrogen found in fuel react with oxygen in the air.

There is not just one formula for nitrogen oxides! They can be NO, NO₂, N₂O...

Same as sulphur dioxide!

What are the effects of nitrogen oxides?

Nitrogen oxides can cause:

- Acid rain
- Respiratory problems in humans

THIS ONLY HAPPENS AT HIGH TEMPERATURES IN CAR ENGINES!

Causes and effects of atmospheric pollutants



	CAUSE	GAS PRODUCED	EFFECT
Atmospheric pollutants	Complete combustion	→	→
	Incomplete combustion	→	→
	Impurities in fuel	→	→

Causes and effects of atmospheric pollutants



Atmospheric pollutants

CAUSE

GAS PRODUCED

EFFECT

Complete combustion

Carbon dioxide

Global warming

Water vapour

Global warming

Incomplete combustion

Carbon monoxide

Poisonous (binds to haemoglobin in RBC)

Carbon particulates

Global dimming and respiratory problems

Impurities in fuel

Sulphur dioxide

Acid rain and respiratory problems

Nitrogen oxides

Acid rain and respiratory problems

LO: To explain the problems caused by increased amounts of pollutants in the air.

THROWBACK

[Link to C4 \(acids and alkalis\)...](#)

Strong acid Weak acid Neutral Weak alkali Strong alkali



Effects of acid rain



When soil is contaminated, arable (farming) production drops.

Buildings are weathered away as the stone reacts with the acid.

Effects of acid rain



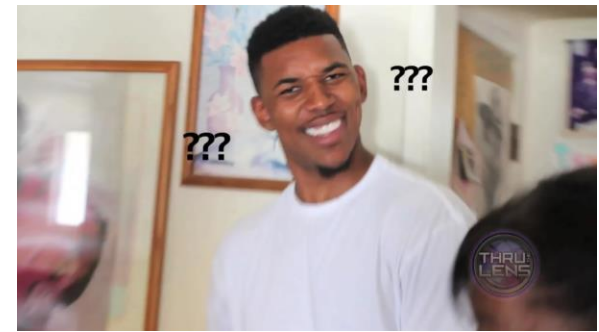
Acids pollute water. Fish die and drinking water is contaminated

Soil acidity is affected so trees die.



IMPORTANT!!!

Don't get your key terms mixed up...



GREENHOUSE GASES

= carbon dioxide, methane and water vapour which absorb long wavelength radiation

Which causes...

GLOBAL WARMING

= the increase in temperature of the Earth's surface

Which causes...

CLIMATE CHANGE

= a resulting change in the overall climate of the Earth

Make sure you are using the correct term in your exams!

The greenhouse gases

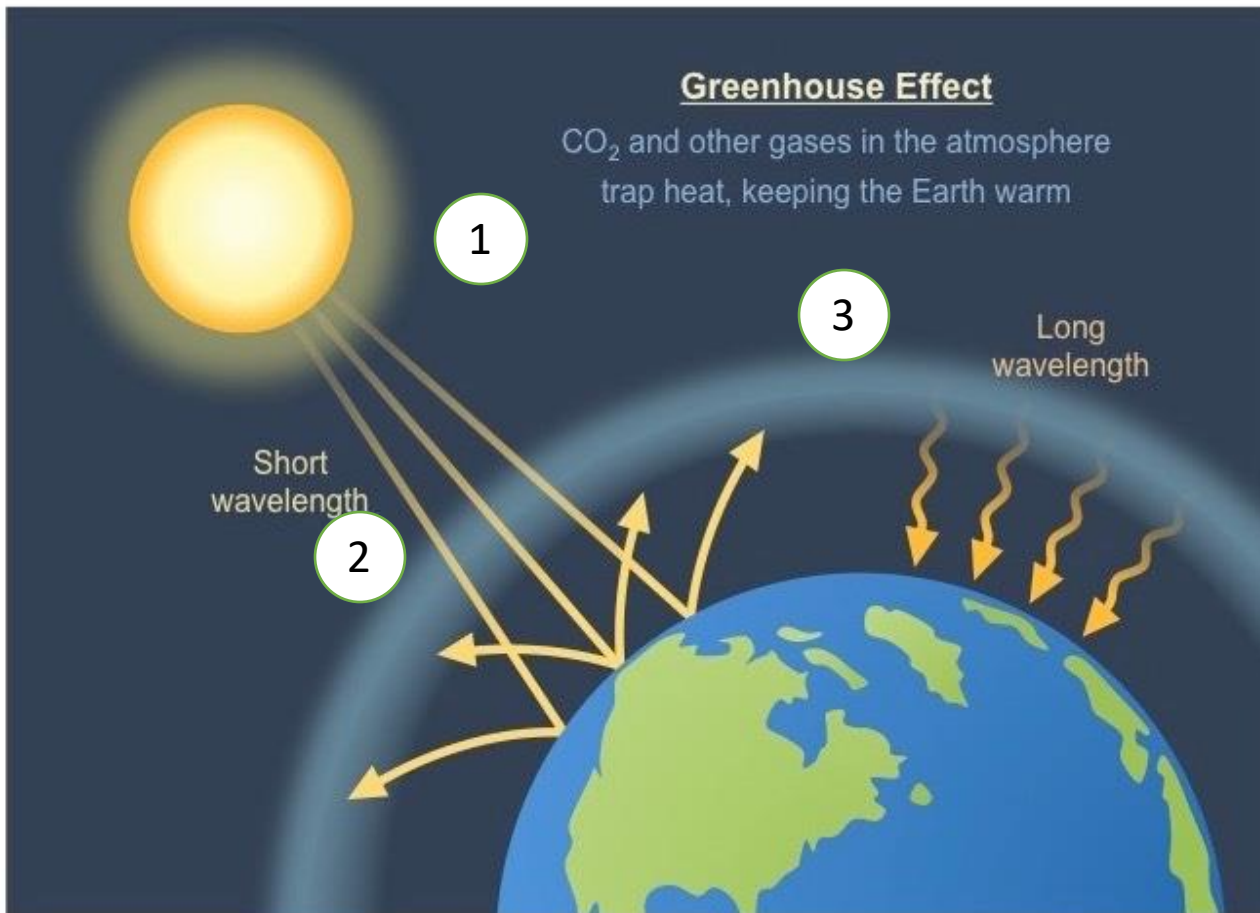
The average temperature of Earth is 14⁰C. This is because we have a blanket of greenhouse gases in our atmosphere that keep the Earth at a warm, stable temperature.

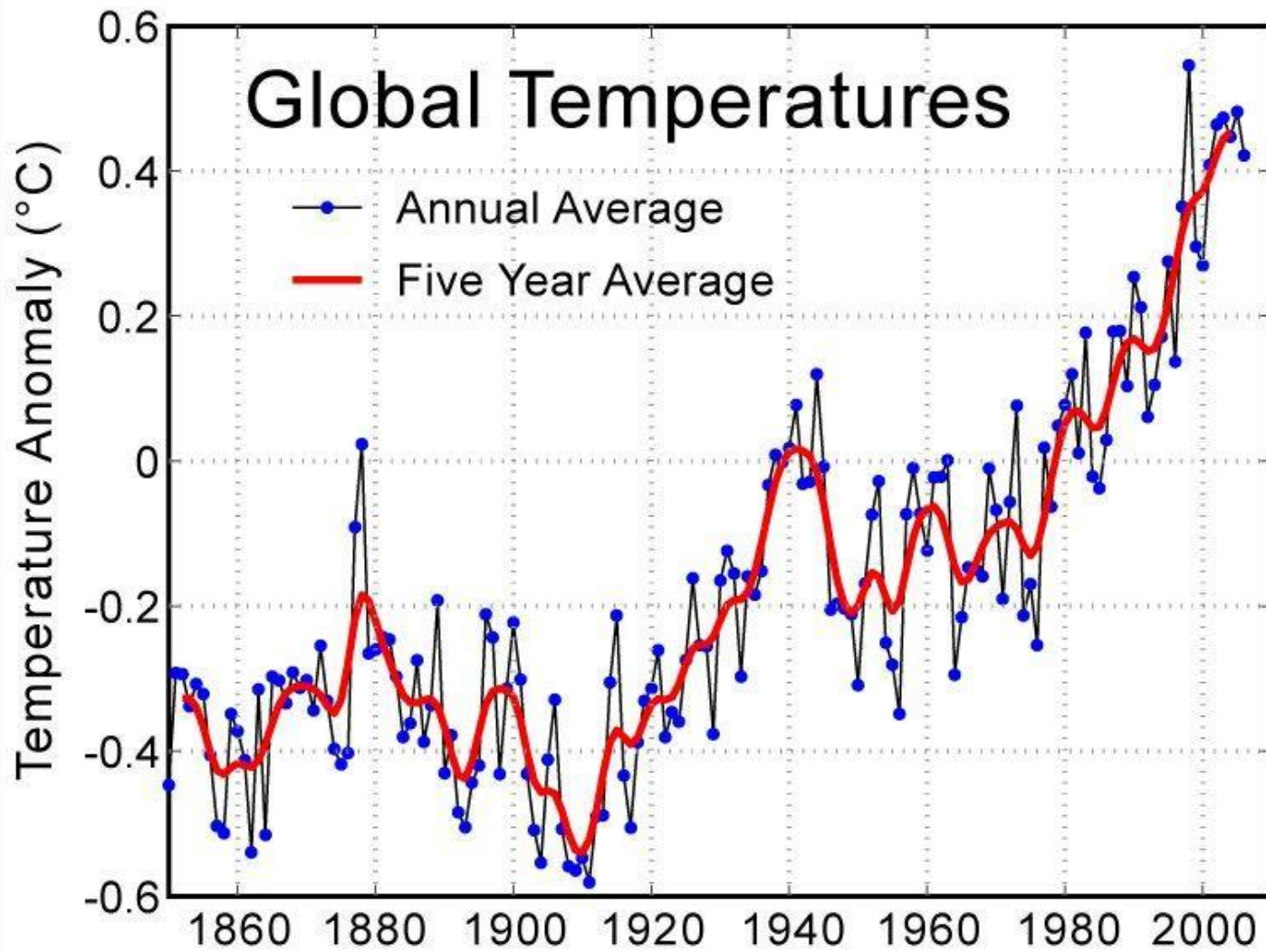
You need to know these three greenhouse gases:

- Carbon dioxide
- Water vapour
- Methane

The greenhouse effect

- 1 **Short wavelength** radiation is emitted from the sun and absorbed by the Earth
- 2 **Long wavelength** radiation is emitted from the Earth back out into the atmosphere
- 3 Greenhouse gases **absorb long wavelength radiation**
- 4 **Global temperatures rise**





This is the graph Brian Cox shows in the video.

This graph **does** support human impact on global warming as the temperature started to rise rapidly at the start of the 1900s when the industrial revolution took place and we started burning lots of fossil fuel.

Describe four potential effects of global climate change



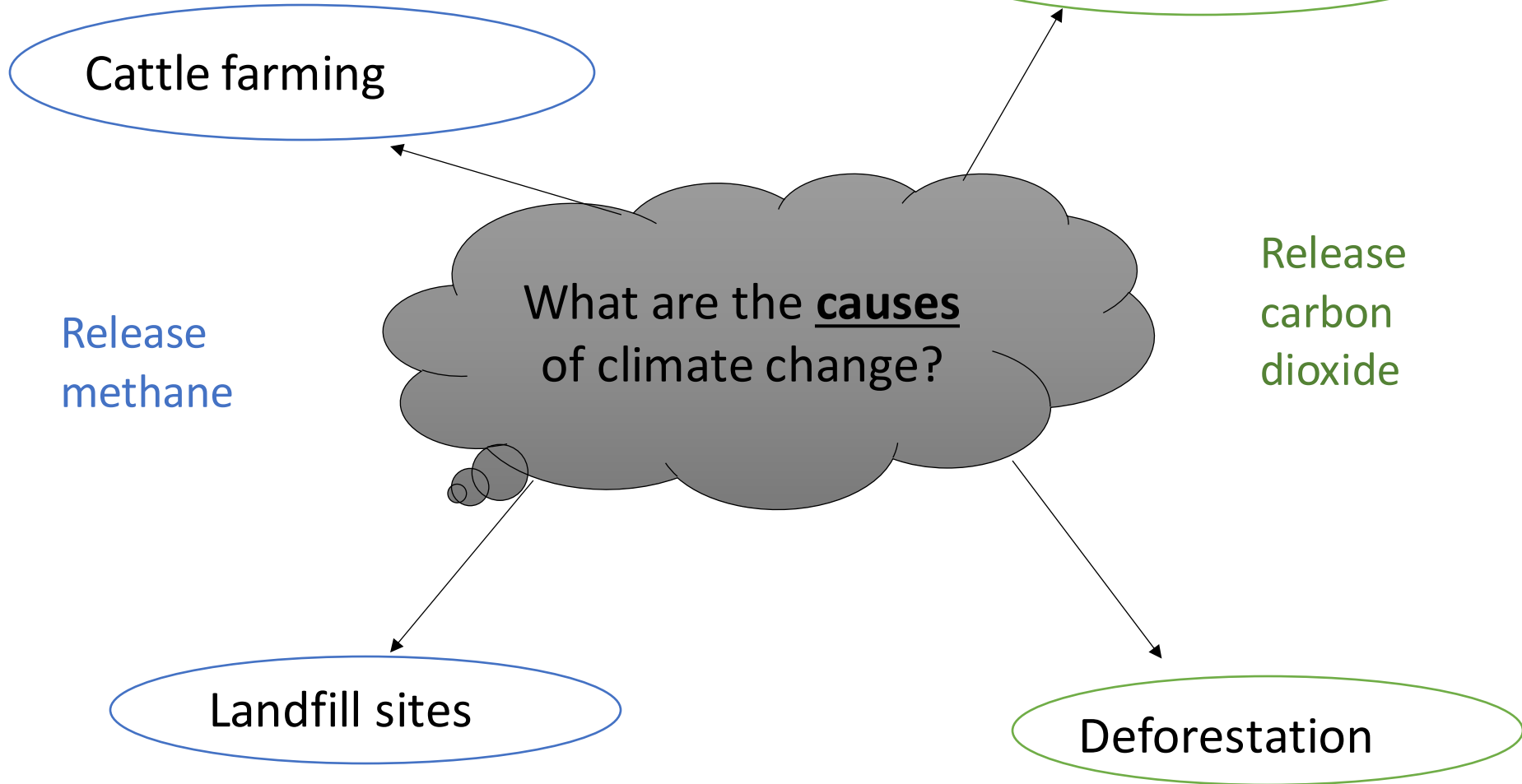
Think



Pair



Share



Describe four potential effects of global climate change

You also need to know 4 effects of climate change and the impact of each one on the planet:

Rising sea levels



Droughts



Desertification



Ice caps melting



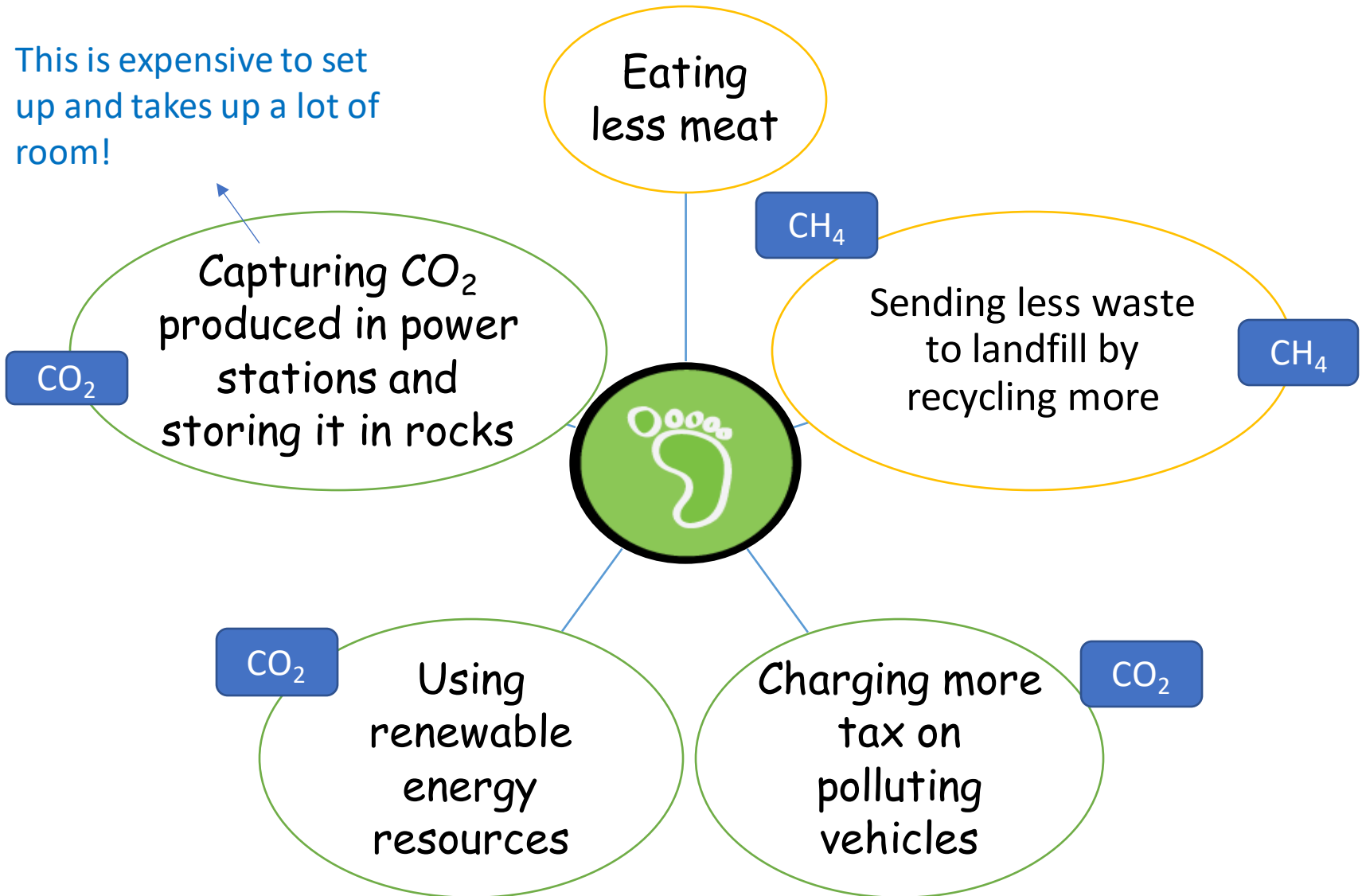


Key definition!

A carbon footprint is the **total amount of carbon dioxide and other greenhouse gases** emitted over the **full life cycle** of a product, service or event.

All aspects from start to finish of any product must have a carbon footprint in some form or another.

How can we reduce our carbon footprint?

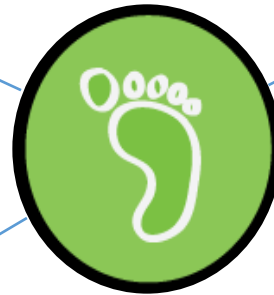


Why aren't all countries able to reduce their carbon footprint?

Their economy is built on industry and burning fossil fuels - they would lose money!

There is a lack of education about climate change

It's too expensive to set up renewable energy sources



Challenge: Fossil fuels drove the industrial revolution that led to economic growth in the West – is it fair to deny developing countries the opportunity to experience the same growth now that we know the impact of fossil fuels?

Exam practice



The area of ocean with sea ice in the arctic has changed.

Most scientists believe this is due to the activities of humans.

Explain the activities of humans that have led to the changes in sea ice from 1979 to 2016.

(6)

Atmospheric pollutants

Gases produced in combustion of fossil fuels:

1. Carbon dioxide
2. Carbon monoxide
3. Carbon particulates
4. Water vapour
5. Sulphur dioxide
6. Nitrogen oxides

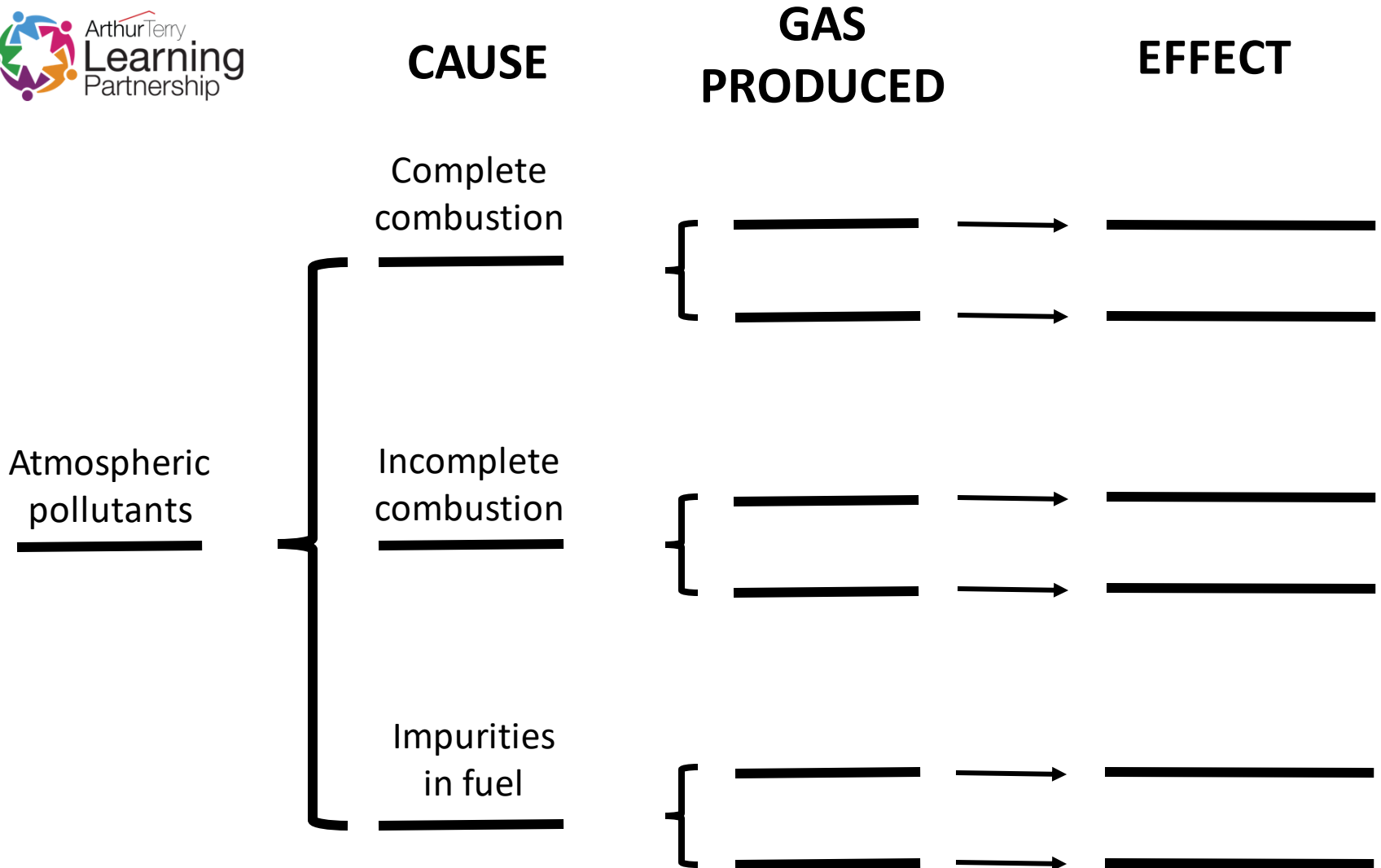


You need to know:

- How they are formed
- Their effect on the environment

LO: To explain the problems caused by increased amounts of pollutants in the air.

Task: Complete the thinking map below to show the causes and effects of each atmospheric pollutant produced from burning fuels.



Effects of acid rain



When soil is contaminated, arable (farming) production drops.

Buildings are weathered away as the stone reacts with the acid.

Effects of acid rain



Acids pollute water. Fish die and drinking water is contaminated

Soil acidity is affected so trees die.

