The Earth's Atmosphere

Why did it take so long before life existed on the Earth?

2/3: Identify the current gases in the Earth's atmosphere and their compositions

3: Describe the processes that affects the Earth's atmosphere

4/5: Explain how the Earths atmosphere has changed over time

6/7: Analyse data on the Earth's atmosphere

8/9: Link the impact of human activities on the atmosphere

Starter:

What gases are currently in the Earth's atmosphere and what are their percentages?

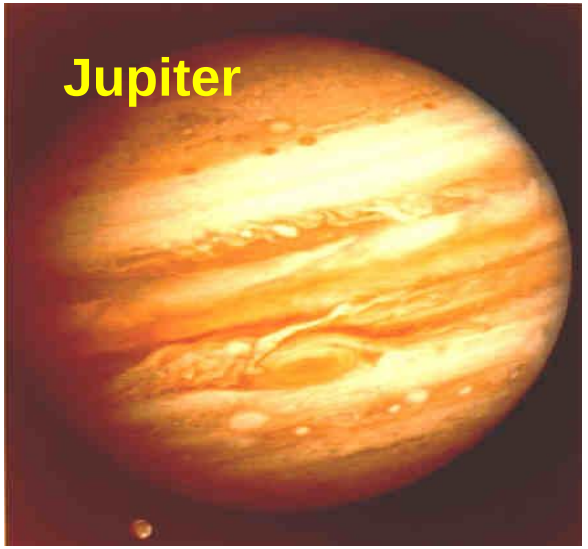
What processes affect our atmosphere?

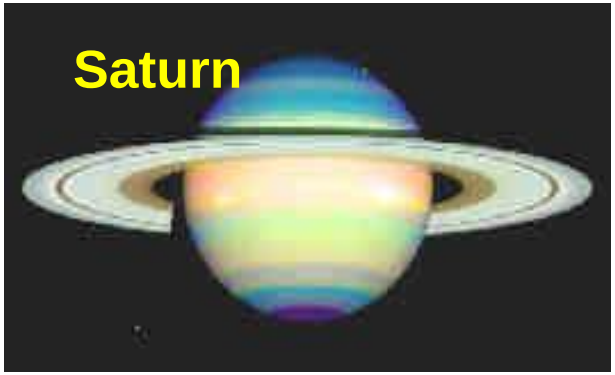
- Photosynthesis
- Respiration
- Combustion
- Carbon dioxide dissolving into oceans
- Volcanic eruptions
- Decay

The Atmosphere

In the beginning -

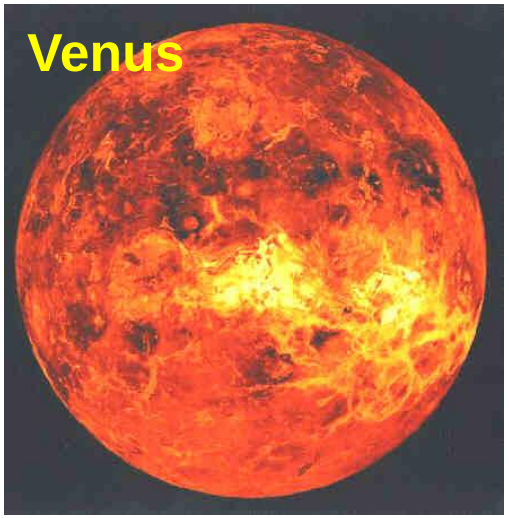
- The Earth was formed about 4500 million years ago.
- The very first atmosphere mainly consisted of hydrogen and helium gases.
- Frozen giant planets like Saturn and Jupiter still have atmospheres like this but on the warmer, smaller Earth these light gases were largely lost into space.





The early atmosphere

- During the first billion years on Earth there was intense volcanic activity. This produced the next early atmosphere.
- It would have contained large quantities of carbon dioxide (CO_2), along with methane (CH_4) , and ammonia (NH_3).
- This is rather like the atmosphere on Mars and Venus today.
- The Earth's atmosphere would also have contained water vapour which condensed to form the oceans.



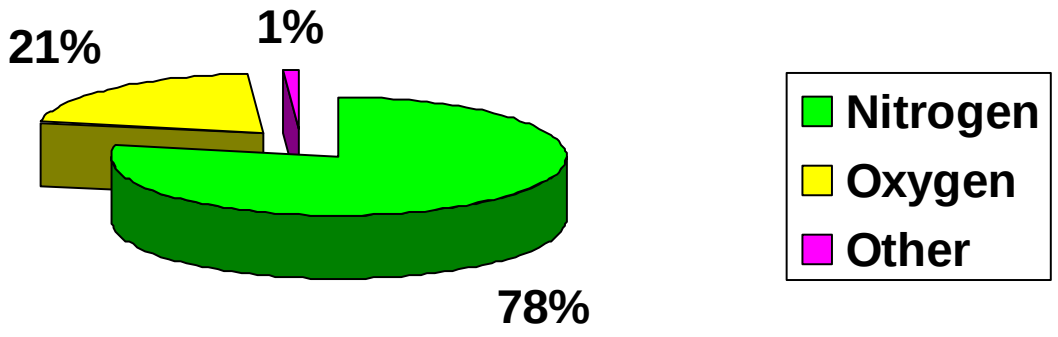
Oxygen levels increase

- Carbon dioxide reacted with rocks and much became trapped in them.
- The evolution of algae some 3000 million years ago, and subsequently plants which successfully colonised the Earth's surface, led us towards the present atmosphere.
- Their photosynthesis replaced carbon dioxide with oxygen.
- Over a period of time billions of tonnes of carbon dioxide became locked up in fossil fuels.

Photosynthesis increased oxygen levels

Nitrogen makes an appearance

- As oxygen levels rose atmospheric ammonia (NH_3) reacted with oxygen(O_2) to form water(H_2O) and nitrogen (N_2)
- Also, living organisms, including denitrifying bacteria, broke down nitrogen compounds releasing more nitrogen into the atmosphere.
- And so the atmosphere headed towards a composition that has remained fairly constant for the last 200 million years.

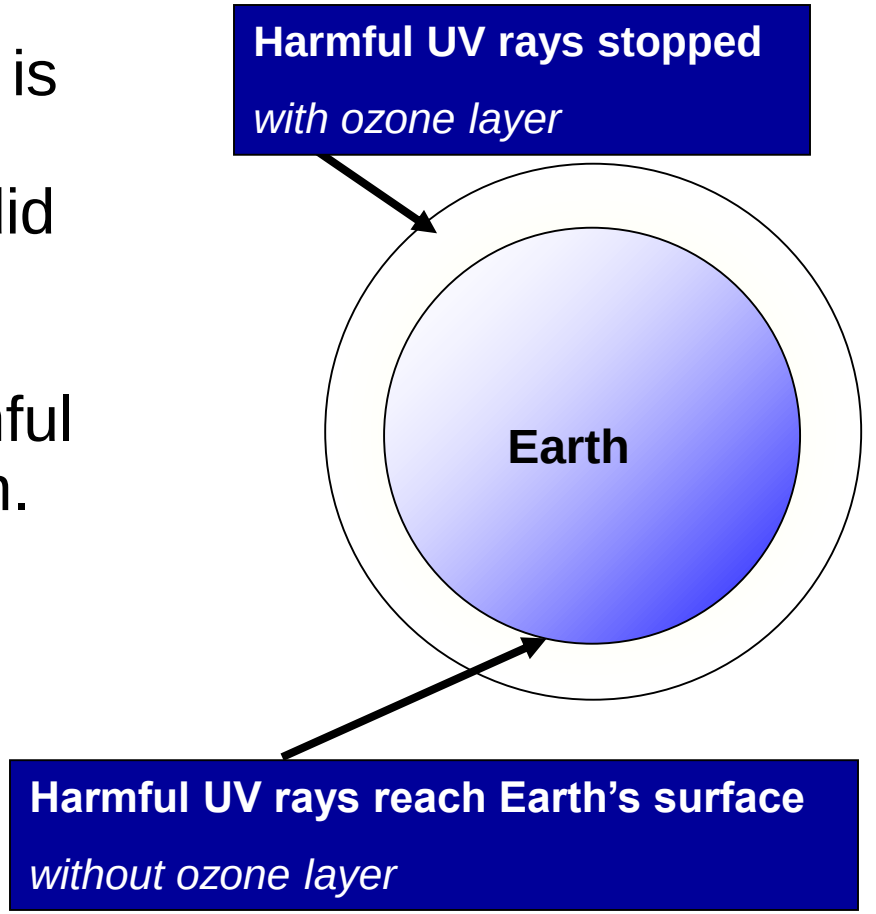


Ozone – a vital filter

- Oxygen normally exists as pairs of atoms ($O_{2)}$.
- Oxygen can, however, turn into another form that has three atoms joined together. This is ozone (O_3).
- As oxygen levels rose, so did the amount of ozone.
- This layer of ozone in the atmosphere filters out harmful ultraviolet rays from the sun. This will have allowed new organisms to evolve and survive.

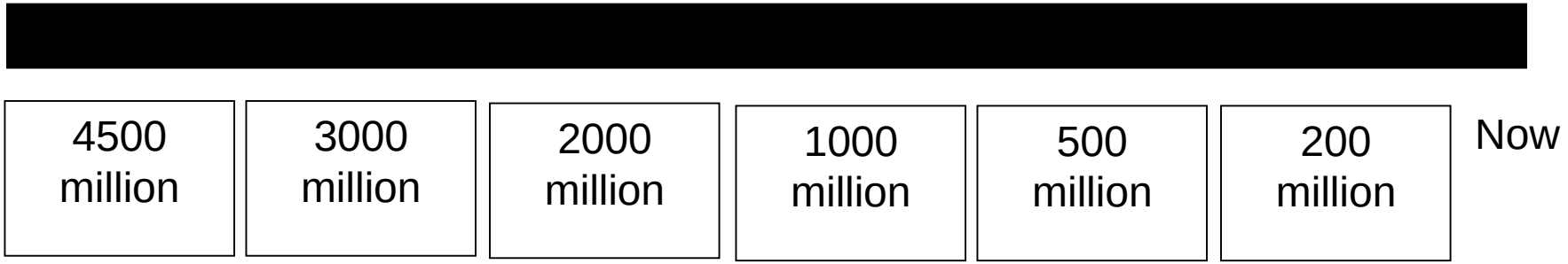
$3O_2 \leftrightarrows 2O_3$

Oxygen ozone



Activity

Copy the timeline and arrange the blue boxes in appropriate places along the line.



No gases

H_2O N_2 O_2

CO_2 NH_3 CH_4

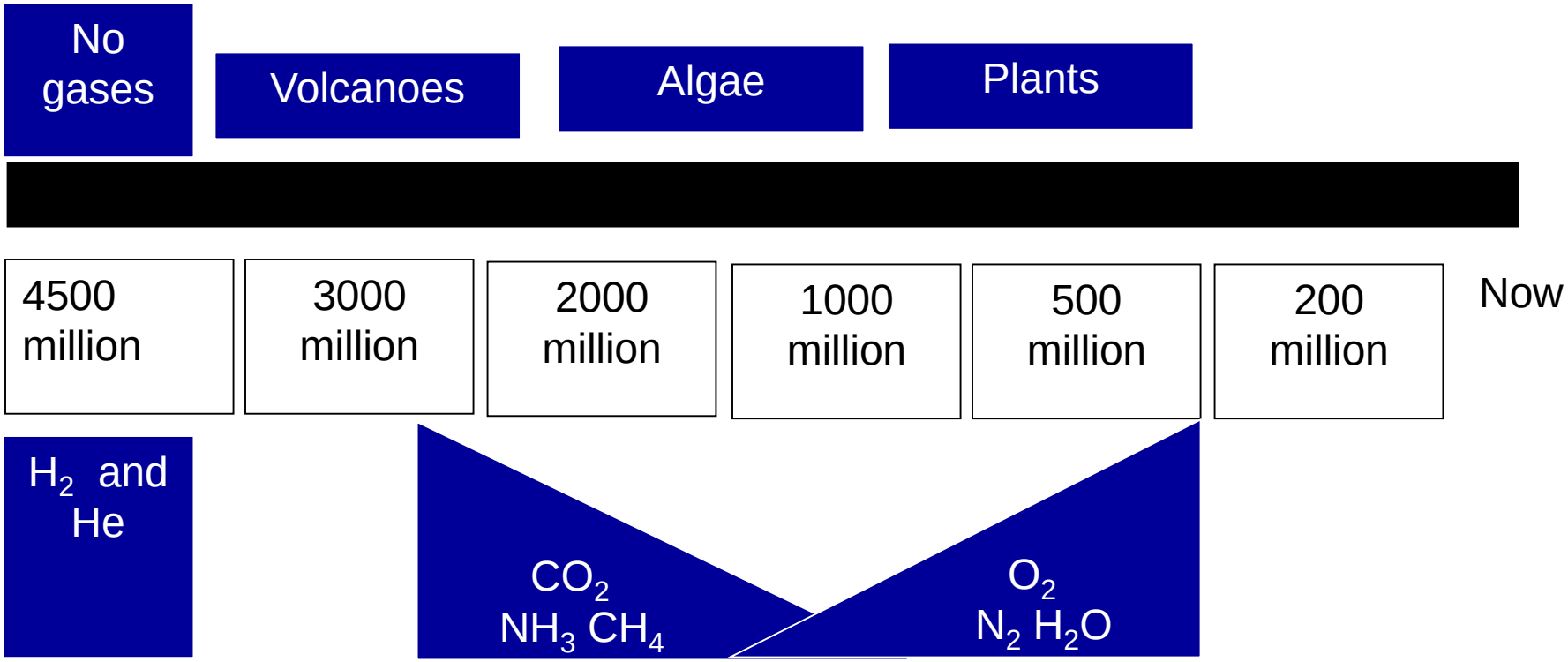
Volcanoes

Algae

H_2 and He

Plants

Answer



All positions are approximate

Activity

1. What was the main gas in the atmosphere around 3500M years ago?

   Carbon dioxide

2. Where did this gas come from?

   Volcanoes

3. What process led to reduction in CO_2 levels?

   Photosynthesis

4. What gas protects life from harmful UV radiation?

   Ozone

5. What % of the present atmosphere is oxygen?

   21%

Activity

Use the graph to estimate the answers.

1. How long ago was the atmosphere 75% CO_2?

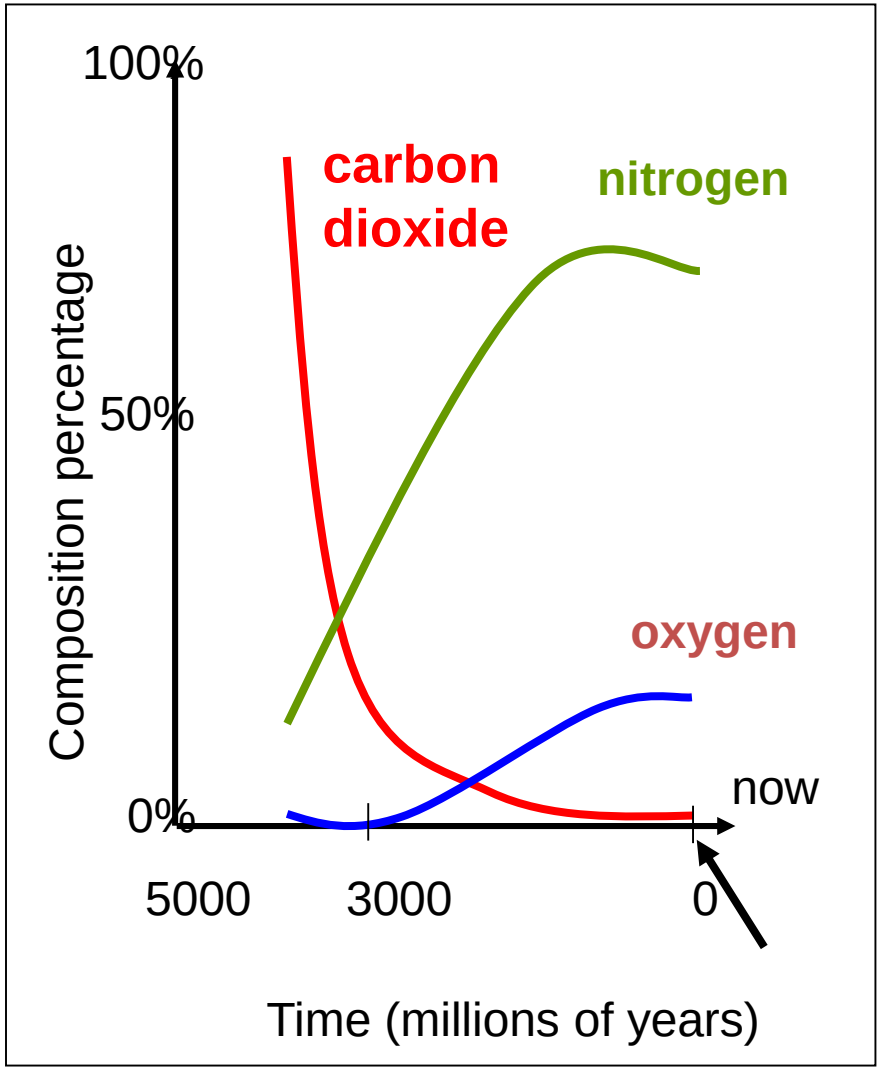
   Approx 4,000M

2. How long ago were the CO_2 and N_2 levels in the atmosphere equal?

   Approx 3,300M

3. How long ago was the atmosphere 50% nitrogen?

   Approx 2,000M



Activity

Find the words in the word-search
Write a sentence about how each has played a part in the evolution of the Earth's atmosphere.

P	Z	K	P	A	G	T	U	N	A	T	G	N	R	E
D	H	J	F	N	E	L	N	J	M	M	E	V	D	Q
E	E	O	X	Y	G	E	N	R	M	G	A	I	Z	R
C	L	I	T	O	G	F	M	T	O	W	X	U	V	X
O	I	Q	W	O	Z	K	I	R	N	O	V	M	P	W
I	U	E	R	T	S	O	D	O	I	K	W	Y	V	K
T	M	T	M	Q	C	Y	N	D	A	I	O	B	K	O
R	I	M	E	T	H	A	N	E	K	J	B	N	M	N
N	O	Q	Y	X	C	O	S	T	J	Q	Z	E	W	Z
A	J	X	Z	L	B	M	E	W	H	S	V	L	W	B
F	W	Z	O	R	U	X	U	Z	Y	E	W	F	R	P
V	M	V	A	Q	Q	Y	Y	Q	W	B	S	J	D	I
Q	B	C	H	L	G	O	O	P	M	R	T	I	R	P
M	B	B	K	C	R	T	E	E	X	E	H	H	S	K

Ammonia

Carbon dioxide

Helium

Hydrogen

Methane

Nitrogen

Oxygen

Ozone

Photosynthesis

Volcano

Carbon dioxide and temperature

Over millions of years the carbon cycle has maintained a constant, low percentage (approx. 0.03%) of carbon dioxide in the atmosphere.

In 1860, the CO_2 level was about 289 ppm (parts per million).

Here is a table showing the CO_2 levels over a recent 10 year period.

Year	Carbon Dioxide (ppm)
1979	333.68
1980	335.55
1981	337.14
1982	338.38
1983	340.25
1984	341.82
1985	343.18
1986	344.26
1987	345.99
1988	347.96

What percentage change is this and does it matter?

Greenhouse effect

From air trapped in Antarctic ice, we have a good idea of CO_2 concentrations going back 160,000 years.

We also know the temperatures over the same period.
The very warm interglacial period of 130,000 years ago was accompanied by CO_2 levels of around 300 ppm.
The previous great Ice Age had CO_2 levels around 200 ppm.

200ppm CO_2

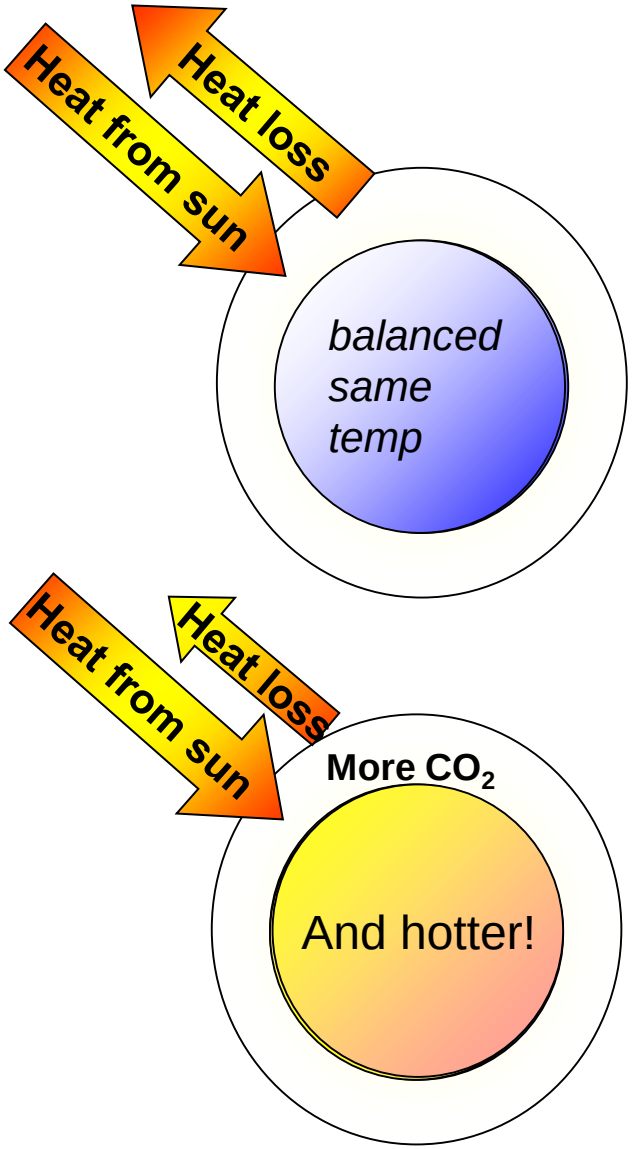
300ppm CO_2

Which label goes with each picture?

Greenhouse effect

Normally the Earth absorbs heat and emits heat at the same rate. Because of this the temperature remains constant.

Certain gases, like CO_2 and methane, act like a greenhouse. They let heat in but do not let it out.
This means: the more CO_2 there is, the hotter planet Earth is!



What gases would have formed the original atmosphere around planet Earth?

1. Hydrogen and helium
2. Oxygen and nitrogen
3. Methane and ammonia
4. Carbon dioxide and water

What gases form the majority of the present atmosphere around planet Earth?

1. Hydrogen and helium
2. Oxygen and nitrogen
3. Methane and ammonia
4. Carbon dioxide and water

What gas protects us against dangerous UV radiation?

1. Sulphur dioxide
2. Nitrogen oxide
3. Methane
4. Ozone

What gas is a major cause of the greenhouse effect?

1. Sulphur dioxide
2. Nitrogen oxide
3. Carbon dioxide
4. Chlorine dioxide

What process increases atmospheric carbon dioxide levels?

1. Photosynthesis
2. Respiration
3. Formation of Fossil fules
4. Formation of carbonate rocks