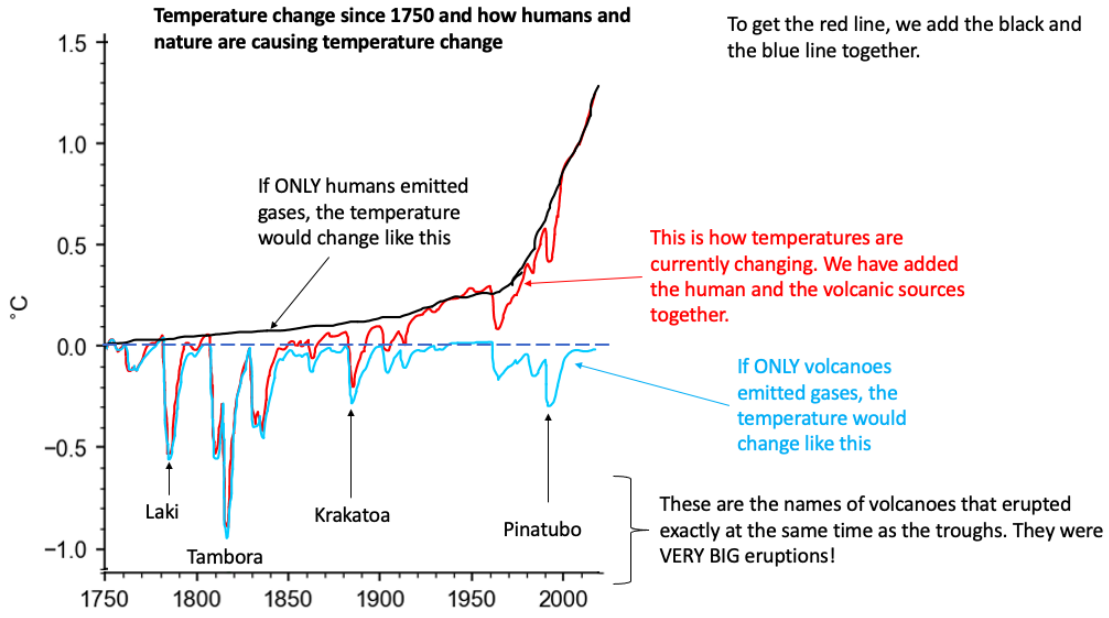
Volcanic Plumes

Investigate the gases that are emitted by volcanoes, their properties, and whether they contribute to climate change.

Volcanic Gases

- When volcanoes erupt, they release a cloud of ash and various gases called a volcanic plume.
- The gases released by volcanoes include carbon dioxide and sulphur dioxide.
- Some of these gases warm the Earth – they are called greenhouse gases.
- Others cool the Earth.
- There has been an increase in global temperatures over the past 100 years.
- The graph below is taken from the Intergovernmental Panel on Climate Change. It shows how the global temperature has changed since 1750.
- The black line shows the increase in temperature due to human activity.
- The blue line shows changes in temperature due to big volcanic eruption – these actually caused the temperature to decrease.
- And the red line is the overall change if we add together the black and blue lines.

The cloud of gas and ash erupting from a volcano is called a volcanic plume.
(Image: Unsplash, Photo by Gary Saldana)



Activity

- *In this activity you will investigate whether the changes in global temperature could be due to volcanic eruptions.*
- *You will compare the make-up of gases from volcanoes with the make-up of the Earth's atmosphere.*
- *You can look at the properties of the different gases, and see which contribute to climate change.*

This activity has been put together by the Earth and Solar System and Volcanology teams at the University of Manchester.

Volcanic Plumes

You'll need:

- About 10 different colour crayons or colouring pencils.

(Image: Unsplash, Photo by Ramakant Sharda)

- Printouts of the pie charts, graph, and cards on the next 6 pages.
- If you don't have a printer, you could draw your own pie chart, draw a grid of 100 squares, or use some squared paper. You could use some squared paper to draw your own graph. And you could also draw and colour in your own cards of gas properties – make your own pictures to show the smells, properties and effects on humans.
- Scissors.

Questions to think about:

- Are any of the gases emitted from volcanoes the same as the gases in air?
- Which gases in air and from volcanoes are greenhouse gases?
- Do humans or volcanoes make the most carbon dioxide (CO_2)?
- Have volcanoes released more or less carbon dioxide over time?
- Have humans made more or less carbon dioxide over time?
- What are the main ways humans produce greenhouse gases?
- How do greenhouse gases harm the environment?
- Do you think volcanoes are a major contributor to current climate change?

How to investigate volcanic gases:

1. Choose a different colour crayon or pencil for each different gas.
2. Colour the pie charts on the next page to show how much of each of the gases listed is in Earth's air and the gas emitted from a typical volcano. The pie charts are divided into 100 segments. If the gas is divided into 100 parts, colour the number of segments to show how many parts there are of each different gas.
3. Use the table to plot the graph to show how much carbon dioxide was released into the air by volcanoes and how much by humans, from 1800 to 2020. Draw points for the amount of gas from volcanoes at the different times, and then join the points together with a line. Do the same for the gas from human activity in a different colour.
4. Carefully cut out the cards of appearance, smell, effect on humans, and effect on the environment. Match each gas with its properties. Tip – some gases have more than one effect on humans and plants.

Be Safe:

- Be very careful and ask an adult for help using scissors to cut out the cards

Did you know…?
The word volcano comes from '*Vulcan*', the Roman god of fire.

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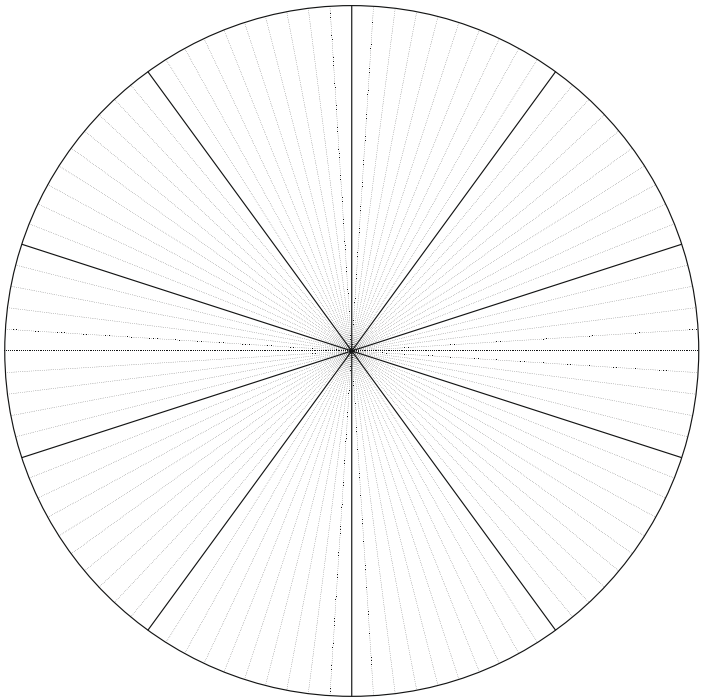
Volcanic Plumes

Air (Earth's atmosphere)

The gases in air are:

- Argon (Ar)
- Carbon dioxide (CO_2)
- Nitrogen (N_2)
- Oxygen (O_2)
- Other gases

The pie chart is divided into 100 segments called percent or %. If the gas is divided into 100 parts, colour in the pie chart to show what fraction of air you think is made of each gas.

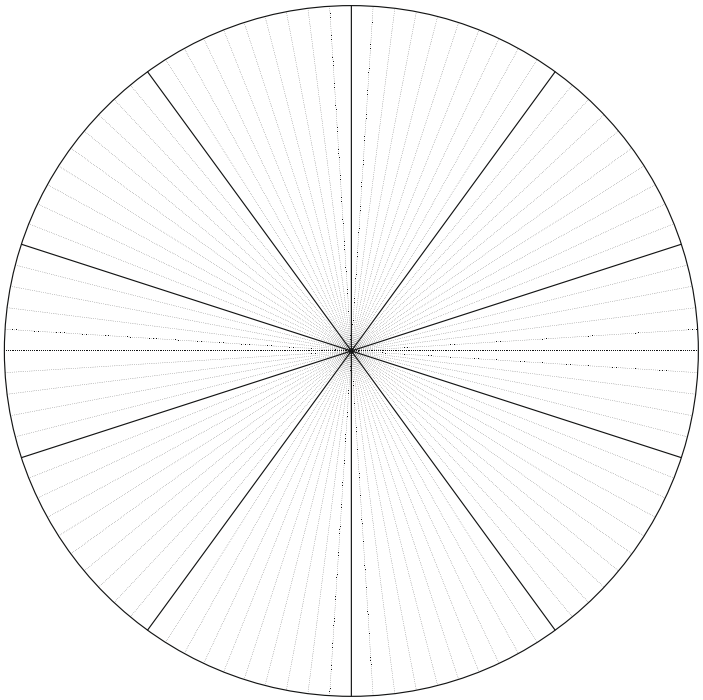


Volcanoes

The gases that are released by volcanoes are:

- Carbon dioxide (CO_2)
- Sulphur dioxide (SO_2)
- Water (H_2O)
- Other gases

The pie chart is divided into 100 segments called percent or %. If the gas is divided into 100 parts, colour in the pie chart to show what fraction of air you think is made of each gas.



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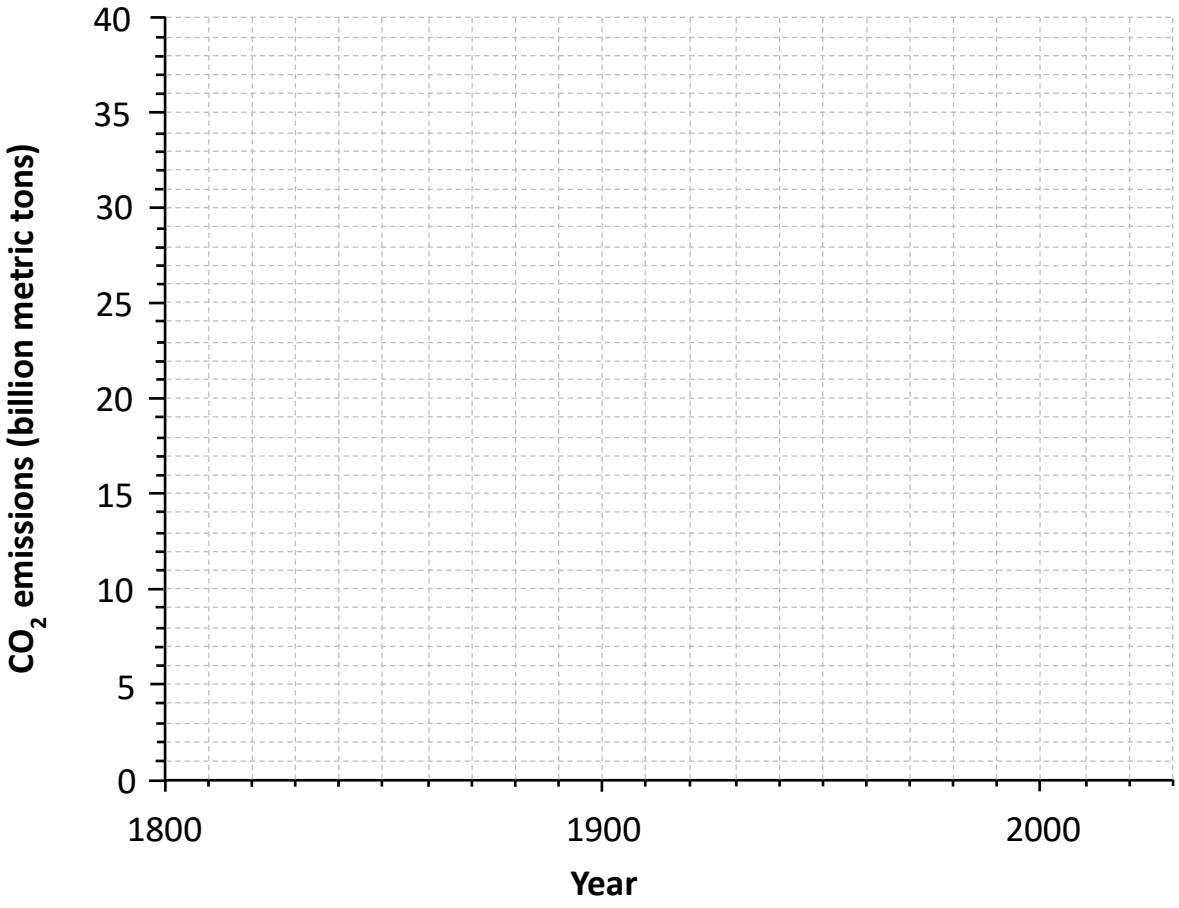
Volcanic Plumes

Climate change is caused by high amounts of greenhouse gases in the Earth's atmosphere (air). A very common greenhouse gas is carbon dioxide (CO_2). Carbon dioxide is released by volcanoes, and is also made by humans when we burn fossil fuels to power our cars and homes.

Pick a different colour for volcanoes and humans. Use the numbers in the table to draw points on the graph below to show how much carbon dioxide is produced by humans and volcanoes. Join the points for each with a line to see how the amount of carbon dioxide in the Earth's atmosphere has changed over time.

Year	Volcanoes	Humans
1800	0.9 Gt	0.2 Gt
1850	0.9 Gt	0.5 Gt
1900	0.9 Gt	3 Gt
1950	0.9 Gt	5 Gt
2000	0.9 Gt	25 Gt
2010	0.9 Gt	35 Gt
2020	0.9 Gt	40 Gt

1Gt = 1,000,000,000 tons
(That's 170 million elephants!)



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Volcanic Plumes

Cut out the cards of appearance, smell, and effects on humans and the environment from the next two pages, and try to match them with the gases.

Gas	Appearance	Smell	Effect on humans and plants	Effect on Environment
Water vapour H_2O				
Carbon dioxide CO_2				
Sulphur dioxide SO_2				
Hydrogen sulphide H_2S				
Carbon monoxide CO				
Chlorine Cl_2				
Fluorine F_2				
Nitrogen N_2				

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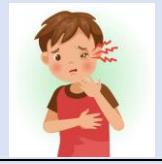
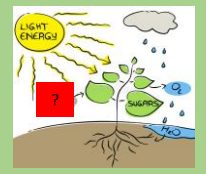
Volcanic Plumes

Cut out these cards of appearance, smell, and effects on humans and the environment, and try to match them with the gases in the table on the previous page.

GAS	APPEARANCE	SMELL	EFFECT ON HUMANS & PLANTS		EFFECT ON ENVIRONMENT	
CARBON DIOXIDE (CO_2)	COLOURLESS	NO SMELL	HARMLESS!	EYE IRRITATION 	GREENHOUSE GAS - WARMS EARTH	
CHLORINE (Cl_2)	COLOURLESS	NO SMELL	HARMLESS - 78% OF AIR WE BREATHE!	EYE IRRITATION 	GREENHOUSE GAS - WARMS EARTH	NO HARM TO EARTH AS A WHOLE
HYDROGEN SULPHIDE (H_2S)	COLOURLESS	NO SMELL	WE BREATHE IT OUT 	EYE IRRITATION 	GREENHOUSE GAS - WARMS EARTH	
CARBON MONOXIDE (CO)	COLOURLESS	NO SMELL		EYE IRRITATION 	FORMS SULPHUR DIOXIDE & SULPHURIC AICD AFTER ABOUT 18 HOURS - ACID RAIN	

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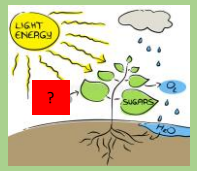
Volcanic Plumes

Cut out these cards of appearance, smell, and effects on humans and the environment, and try to match them with the gases in the table on the previous page.

WATER VAPOUR (H_2O)	**COLOURLESS**			**EYE IRRITATION** 	**ACID RAIN** - **DAMAGES PLANTS & DECREASES GROWTH** - **DEFORESTATION**	
NITROGEN (N_2)	COLOURLESS	SMELLS LIKE BLEACH 		KILLS FISH 	COOLS EARTH	
FLUORINE (F_2)	PALE YELLOW	PUNGENT SMELL		KILLS FISH 	HARMS PLANT GROWTH	
SULFUR DIOXIDE (SO_2)	YELLOW-GREEN	SMELLS LIKE BURNT MATCHES 			TOO MUCH OF IT LEADS TO ALGAL BLOOM	

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Volcanic Plumes

Information for teachers, parents and carers

Activity Summary:

- This activity aims to investigate the composition of gases emitted from volcanoes, and how that differs from the composition of air.
- It also looks at how much carbon dioxide is emitted by volcanoes compared to how much originates from human activity, i.e. from anthropogenic processes.

Answers

- Air is made of 78 % nitrogen (N_2), ~20 % oxygen (O_2), ~1 % argon (Ar), ~0.05 % carbon dioxide (CO_2), and ~0.95 % of other gases including water vapour (H_2O), neon (Ne), helium (He), methane (CH_4), and krypton (Kr).
- The composition of gas emitted by volcanoes varies, the exact composition depends on the tectonic setting of the volcano. A typical composition is ~69 % water vapour (H_2O), ~29 % carbon dioxide (CO_2), 1 % sulphur dioxide (SO_2), and 1 % other gases including hydrogen sulphide (H_2S), carbon monoxide (CO), chlorine (Cl_2), fluorine (F_2), nitrogen (N_2).
- Volcanoes release ~0.9 billion tons (900,000,000 tons) of carbon dioxide every year, creating a straight line across the bottom of the graph. Each year humans produce more carbon dioxide, with an upwards trend from ~0.2 billion tons (200,000,000 tons) in 1800 to 40 billion tons (40,000,000,000 tons) in 2020.
- So although a volcanic plume contains a larger percentage of carbon dioxide than air does, the total amount of carbon dioxide released from volcanoes each year is only about 1/40th the present-day amount of carbon dioxide produced by human activity.
- The properties of the gases are summarised in the table on the next two pages.

Links to curriculum:

Primary School

- Science – Seasons and weather, concepts of gases.
- Maths – percentages, plotting and interpreting graphs

Secondary School

- Chemistry – the composition of Earth's atmosphere, production of carbon dioxide by human activity and the impact on climate.
- Geography – climate in different parts of the world.
- Maths – percentages, plotting and interpreting graphs

GCSE or equivalent

- Geography – weather hazards, climate change
- Chemistry – chemistry of the atmosphere

A-Level or equivalent

- Geography – climate change and human impact

Uniform Groups:

- This may be suitable for Cubs or Scouts working towards their Scientist Activity badges.

Further Information:

For further information or to contact us please visit our social media accounts.

Earth and Solar System Blog
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Volcanic Plumes

Information for teachers, parents and carers

Answers for matching gas properties (Page 1 of 2).

GAS	APPEARANCE	SMELL	EFFECT ON HUMANS & PLANTS			EFFECT ON ENVIRONMENT	
CARBON MONOXIDE (CO)	COLOURLESS	NO SMELL		EYE IRRITATION 		GREENHOUSE GAS - WARMS EARTH	
CHLORINE (Cl_2)	YELLOW-GREEN	SMELLS LIKE BLEACH 		EYE IRRITATION 	KILLS FISH 	NO HARM TO EARTH AS A WHOLE	
FLUORINE (F_2)	PALE YELLOW	PUNGENT SMELL		EYE IRRITATION 		HARMS PLANT GROWTH	
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Volcanic Plumes

Information for teachers, parents and carers

Answers for matching gas properties (Page 2 of 2).

GAS	APPEARANCE	SMELL	EFFECT ON HUMANS & PLANTS			EFFECT ON ENVIRONMENT	
WATER VAPOUR (H_2O)	COLOURLESS	NO SMELL	HARMLESS!			GREENHOUSE GAS - WARMS EARTH	
CARBON DIOXIDE (CO_2)	COLOURLESS	NO SMELL	WE BREATHER IT OUT 			GREENHOUSE GAS - WARMS EARTH	
SULFUR DIOXIDE (SO_2)	COLOURLESS	SMELLS LIKE BURNT MATCHES 		EYE IRRITATION 		ACID RAIN - DAMAGES PLANTS & DECREASES GROWTH - DEFORESTATION	COOLS EARTH
HYDROGEN SULPHIDE (H_2S)	COLOURLESS			EYE IRRITATION 		FORMS SULPHUR DIOXIDE & SULPHURIC ACID AFTER ABOUT 18 HOURS - ACID RAIN	

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