

5

The gaseous part of the Earth



In this unit you will find out the answers to these questions:

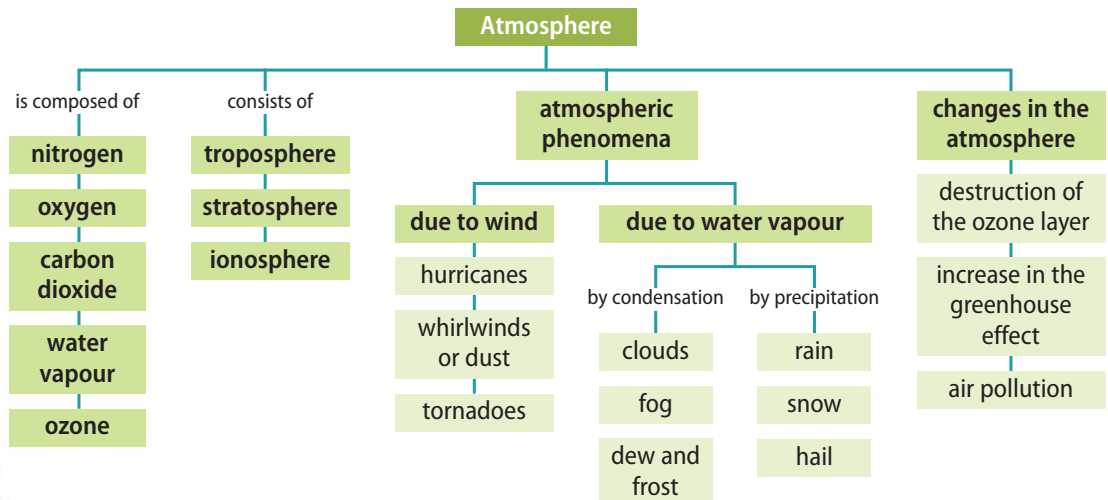
- Why is the **atmosphere** important for our planet?
- What is air and what **properties** does it have? Why is it important for living things?
- What are the main atmospheric **phenomena**?
- What is the difference between **weather** and **climate**?
- What is the **greenhouse effect**?

Before you start, check you understand the meaning of the words in blue.

KEY WORDS

- atmosphere:** the mixture of gases that surrounds the Earth
- property:** characteristic
- phenomenon:** something that happens in science or nature and is studied
- weather:** the temperature, sunshine, rain, and wind affecting an area
- climate:** the typical weather conditions in an area
- greenhouse effect:** the gradual warming of the air around the Earth

Unit summary



KEY WORDS

photosynthesis: when green plants use sunlight to synthesise nutrients from carbon dioxide and water, and produce oxygen

combustion: burning

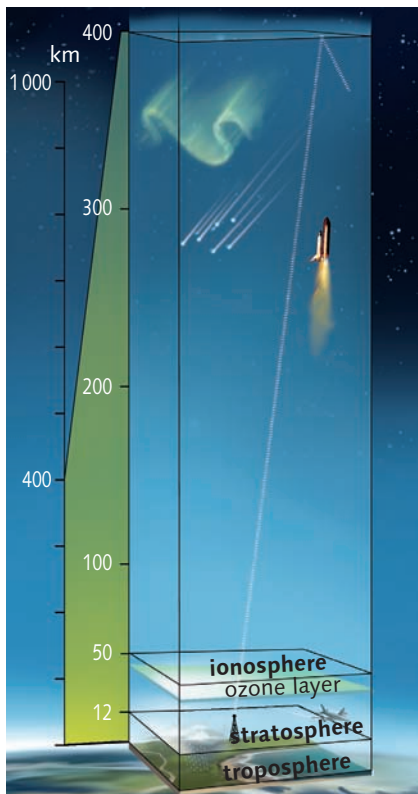
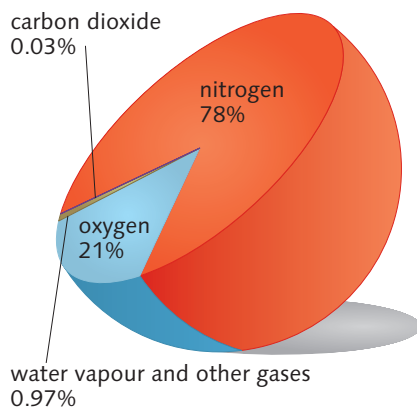
respiration: breathing

evaporation: when a liquid changes into a gas

transpiration: loss of water vapour by plants into the atmosphere

meteorological: relating to weather conditions

harmful: dangerous



The layers of the atmosphere. This picture is not drawn to scale. The correct scale is on the left of the picture.

1 The Earth's atmosphere

When the Earth first formed, the atmosphere was composed of dust clouds, gases, and water vapour from volcanic eruptions. Later, the atmosphere also included oxygen from **photosynthesis**.

Composition

The Earth's atmosphere is now a mixture of gases called **air**.

The main gases in air are:

- **Nitrogen** (N_2): this gas has no colour, no smell, and no taste.
- **Oxygen** (O_2): plants produce oxygen during photosynthesis. It is in the air and water, and it is necessary for **combustion** and **respiration**.

Air also includes:

- **Carbon dioxide** (CO_2): this gas has no colour or smell, and is soluble in water. It is produced by plant and animal respiration and the combustion of certain substances. It is essential for photosynthesis.
- **Water vapour** (H_2O): this comes from the **evaporation** of oceans, lakes, and rivers and also from plant **transpiration**.
- **Ozone** (O_3): this is a pale blue gas with a strong smell. It is made from three oxygen atoms.

Nowadays, the air we breathe is composed of the original natural components and additional gases and smoke from industry, cars, central heating, etc.

Air is also in the ground, and some gases are dissolved in water.

Structure

The atmosphere has three main layers:

- **Troposphere:** this is the nearest layer to the Earth. It is 12 km thick and contains most of the atmospheric gases. Most **meteorological** phenomena occur here.
- **Stratosphere:** this has horizontal layers of gas, including the ozone layer that protects us from **harmful** solar radiation.
- **Ionosphere:** this layer does not contain many gases. It reflects radio and television waves back to the Earth.

Atmospheric pressure



The weight of the atmosphere on the Earth is called **atmospheric pressure**. It decreases with altitude and varies with temperature (hot air is denser).

The international unit for pressure is the **pascal** (Pa). When we refer to atmospheric pressure we normally use the **atmosphere (atm)**, the **millibar (mb)** or the **hectopascal (hPa)**.

$$1 \text{ atm} = 1013 \text{ hPa} = 1013 \text{ mb}$$

Normal pressure is the pressure at sea level (1 atm). Pressure above this is **high pressure**; pressure below this is **low pressure**.

Activities

- 1  Listen and repeat the names of the gases. Listen again and write the symbols for the gases in your exercise book.
- 2 What differences are there between the original composition of the atmosphere and its composition today? Write them down in your exercise book.
- 3  Copy the words below into your exercise book. Then listen, repeat, and underline the stressed syllables.

atmosphere

photosynthesis

evaporation

respiration

combustion


transpiration

- 4 Working in pairs, take turns to explain the following to your partner in your own words. What process is your partner describing?
 - a) photosynthesis
 - b) evaporation
 - c) transpiration
 - d) condensation
 - e) combustion

Example:

A: *This when green plants use sunlight to synthesise nutrients from carbon dioxide and water, and produce oxygen.*

B: *Photosynthesis*

- 5 Where does atmospheric oxygen come from?
- 6  Copy and complete the sentences with the correct words in your exercise book. Listen and check.
 - a) The ionosphere *reflects/absorbs* _____ radio waves back to Earth.
 - b) The stratosphere contains *horizontal/vertical* _____ layers of gas.
 - c) The ozone layer *retains/protects* _____ us from harmful solar radiation.
 - d) The layer *furthest/nearest* _____ to the Earth is the troposphere.
 - e) There *aren't many/are lots of* _____ gases in the ionosphere.

- 7 In which layer of the atmosphere do meteorological phenomena take place?
- 8 Where is the ozone layer? Why do we say that this layer protects living things?
- 9 Describe one of the layers of the atmosphere to your partner. Which layer is it?

Example:

A: *This layer contains the ozone layer.*

B: *It's the stratosphere.*

- 10 Read the text about atmospheric pressure and answer the questions in your exercise book.
 - a) What is atmospheric pressure?
 - b) Why does atmospheric pressure decrease when we climb a mountain?
 - c) How does temperature affect atmospheric pressure?
 - d) What measurement do we use to refer to atmospheric pressure?
 - e) Where do we find normal pressure? What is its value?

- 11  Listen and repeat the equation.

$$1 \text{ atm} = 1\,013 \text{ hPa} = 1\,013 \text{ mb}$$

KEY WORDS

solar radiation: energy from the Sun

heat up: become warmer

average: the sum of a number of quantities divided by their number, e.g. for 2, 3, and 7, the average is 4:
 $2 + 3 + 7 = 12$
 $12 \div 3 = 4$

unequal: not the same

latitude: the distance north or south of the Equator, measured in degrees

Sun's rays: straight, narrow beams of light from the Sun

2 The atmosphere regulates temperature

During the day:

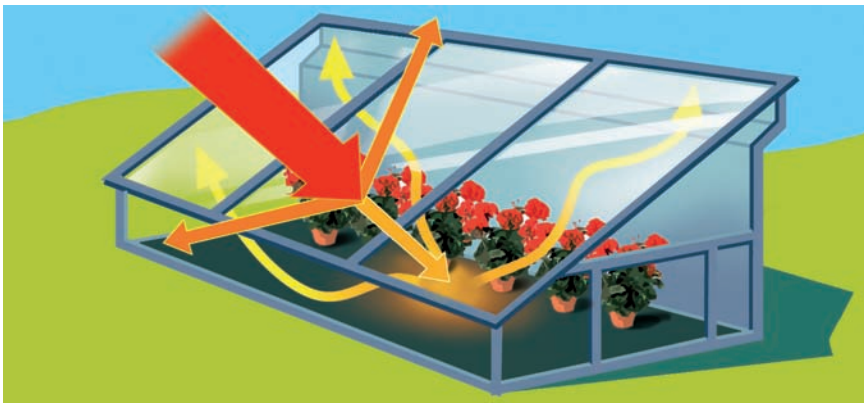
- The Earth's surface absorbs some **solar radiation** and **heats up**.
- The warm surface heats the nearest layers of air.
- The radiation that is not absorbed by the ground is reflected and escapes from the atmosphere.
- Not all the excess radiation reaches outer space. Carbon dioxide and water vapour reflect some back to the Earth's surface.
- The Earth's surface heats up again.

During the night:

- The atmosphere stops the surface heat escaping into space. The Earth's **average** temperature is 15°C because it retains heat.

This means that the lower part of the atmosphere is heated from below. The temperature in the troposphere decreases the higher you go —around 5°C per 1000 m.

Water vapour and **carbon dioxide** retain heat like the glass in a greenhouse. This causes the **greenhouse effect**. Without a natural greenhouse effect the Earth's average temperature would be -18°C .



The greenhouse effect. The glass allows the Sun's radiation to enter. It does not release the radiation reflected from the ground inside.

Unequal warming of the planet

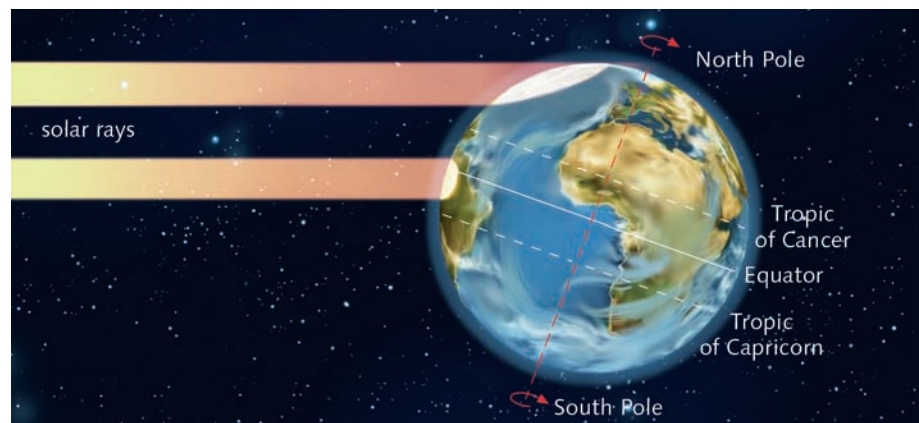
The average temperature of the Earth is 15°C , but the temperature varies depending on the **latitude**.

The Equator is warmer because the **Sun's rays** hit the ground at 90° .



Towards the North and South Poles the Sun's rays become more inclined so there is less warmth and also lower air temperatures.

The temperature of the atmosphere also varies depending on the latitude.

Air is thicker at the North and South Pole: the Sun's rays travel through more air so there is more heat loss.



Activities

- 12 Do the following occur during the day or during the night or both?
- a) Solar radiation heats the Earth.
 - b) There is no solar radiation.
 - c) The warm Earth heats the air.
 - d) The average temperature of the Earth is 15 °C.
 - e) Excess radiation escapes from the atmosphere.
- 13 Does all the excess radiation reach outer space? Why?
- 14  Say these figures. Then listen and check: 5 °C, –18 °C, 1 000 m, 12 km.
- 15 In your exercise book, write the measurements below out in words. Use the following terms: *kilometres, hundred, degrees, minus, thousand, centigrade, metres.*
- a) 2 300 m
 - b) 308 km
 - c) –16 °C
 - d) 60 °C
 - e) 40 °C
 - f) 14 °C
- 16 Which gases produce the greenhouse effect? Why?
- 17  Copy and complete the following in your exercise book. Listen and check.
The Earth's _____ temperature would be _____ without a _____ greenhouse effect. Heat is retained by _____ and _____, like the glass in a greenhouse. This causes the _____ effect.
- 18 When is the Earth's surface cooler: on a clear night or on a night when the sky is very cloudy? Give reasons for your answer.
- 19 Why is the maximum temperature during the day different at the Equator from other latitudes?
- 20 What would happen if the Earth lost its atmosphere? Give reasons for your answer.
- 21 Look at this diagram. Why is it summer in one hemisphere but winter in the other?



- 22 Choose the correct word. Write out the sentences in your exercise book.
- a) The Sun's rays are *more/less* _____ inclined at the North or South Pole than they are at the Equator.
 - b) At the North and South Poles air is *thicker/thinner* _____ than at the Equator.
 - c) Areas nearer the Equator are *warmer/colder* _____ than areas nearer the North or South Pole.
 - d) At the North and South Pole the Sun's rays travel through *less/more* _____ air.
 - e) The *upper/lower* _____ part of the atmosphere is heated from below.
 - f) The *lower/higher* _____ you go temperatures in the troposphere decrease.

KEY WORDS

displace: to move

revolve: turn around

demolish: destroy

condensation: when a gas becomes a liquid

precipitation: rain, snow etc that falls to the ground

charge with: to absorb and store something

ash: the soft grey powder that remains after burning something

droplet: a very small drop of liquid

gravity: the force that makes objects fall to the ground

3 Atmospheric phenomena

Atmospheric phenomena occur in the troposphere. They are responsible for changes in the weather. The wind and water vapour in the air cause these phenomena.

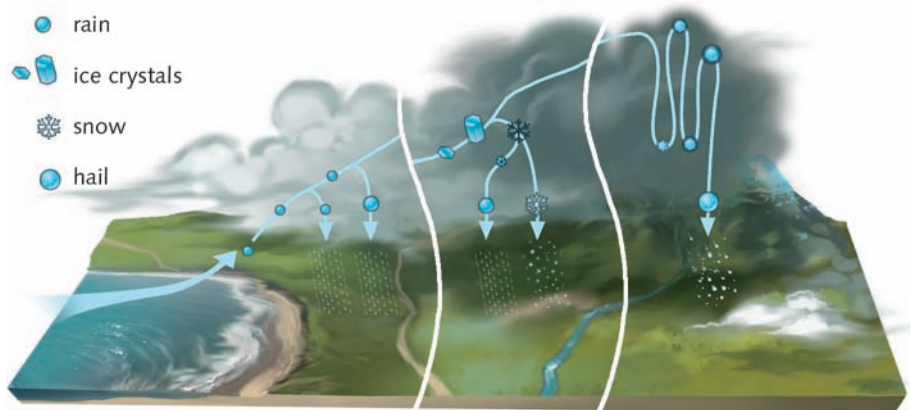
Atmospheric phenomena caused by the wind

The unequal warming of the Earth's surface causes horizontal differences in pressure; this then causes large air masses to move or **displace**. This displacement produces **winds**, which can be very strong and violent.

- **Hurricanes:** violent tropical storms that form over the ocean. They consist of a central area (the eye), around which clouds and winds **revolve** at great speeds (200 km/h).
- **Whirlwinds or dust storms:** the Earth heats up; it then heats the air. The air rises in a spiral and collects sand and dust particles.
- **Tornadoes:** start inside large storm clouds and have an inverted cone shape when they leave the clouds and reach the ground or the sea. These winds can reach speeds of 480 km/h and **demolish** everything in their path.

Atmospheric phenomena caused by water vapour

Water vapour in the atmosphere causes different atmospheric phenomena that are due to **condensation** or **precipitation**.



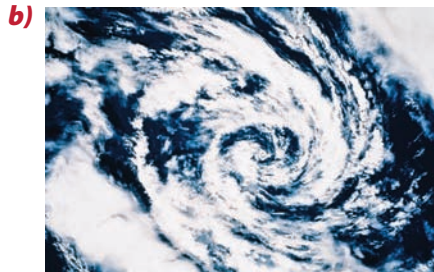
Formation of rain, snow, and hail

Due to condensation		Due to precipitation	
Clouds	These form when air that is charged with water vapour rises, cools, and condenses around tiny dust particles, salt, or ash .	Rain	This occurs when the water droplets in a cloud join together. When they are big enough, gravity makes them fall.
Fog	This consists of low clouds that form close to the ground. It occurs when the air on the ground cools down but does not go below 0°C.	Snow	This occurs when the temperature inside a cloud reaches 0°C. The water droplets freeze and join together. They fall from the cloud when they are heavy enough.
Frost and dew	Frost forms when the temperature of the Earth's surface is below 0°C and water vapour freezes. Dew is condensed water vapour. This occurs during the night when temperatures drop.	Hail	This occurs when there are strong rising air currents inside the cloud which deep freeze the water droplets (-50°C).

Activities

23 What is wind? How is it formed? Write notes to describe the process in your exercise book.

24 Read the descriptions of atmospheric phenomena caused by the wind. In your exercise book, note down which label corresponds to which photograph: *whirlwind or dust storm, tornado, hurricane*.



25 Copy the words below into your exercise book. Then listen, repeat, and underline the stressed syllables.

hurricane

whirlwind

dust storm

tornado

26 In your exercise book, match the verbs (left) to their meaning (right).

displace

destroy

revolve

move

demolish

turn around

27 Complete the sentences with the correct verb from Activity 26.

- a) Tornadoes reach speeds of 480 km/h and _____ everything in their way.
 b) In the eye of a hurricane, clouds and winds _____ at speeds of up to 200 km/h.
 c) Horizontal differences in pressure cause large air masses to _____.

28 Match the photographs to the atmospheric phenomena.



29 Listen to the descriptions. Which atmospheric phenomenon caused by water vapour is the speaker describing?

30 Listen again. Are these phenomena due to condensation or precipitation?

31 Now choose and describe four phenomena caused by water vapour and test your partner.

Example:

A: *This is condensed water vapour. It occurs at night when the temperature drops.*

B: *Dew. It's due to condensation.*

32 Answer these questions in your exercise book.

- a) What is condensation? What atmospheric phenomena does it cause?
 b) What is the difference between dew and frost?
 c) What is precipitation? What atmospheric phenomena does it cause?
 d) Find out how a snowflake forms.
 e) How does hail form?
 f) How do clouds form?

KEY WORDS

far: a great distance: the opposite of near

world: our planet: the Earth

differentiate: to tell the difference between things

4 Climate and temperature





Climate refers to the main atmospheric phenomena in a specific region, which occur every year.

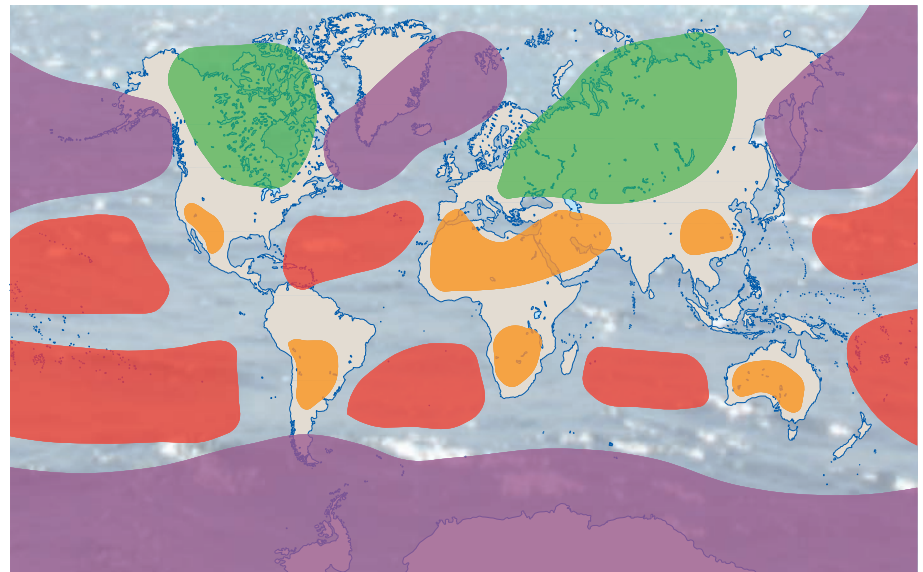
The climate of a region depends on the latitude and how near or **far** it is from the sea. It is expressed in terms of temperature and rainfall.

Temperature, humidity, and pressure differences around the **world** mean the troposphere contains large **air masses** that have the features of the area where they were formed. In this way, we can **differentiate** between cold, warm, dry, or humid masses.

These air masses move around. The place where cold air meets warm air is called a **front**.

- A **warm front** occurs when a mass of warm air moves towards a mass of cold air.
- A **cold front** occurs when a mass of cold air moves towards a mass of warm air.

	polar continental (cold and dry)
	polar maritime (cold and humid)
	tropical continental (warm and dry)
	tropical maritime (warm and very humid)



Air masses. The two large masses of tropical and polar air in each hemisphere are subdivided into continental and maritime.

Climate is not the same as **atmospheric weather**. Atmospheric weather refers to a series of atmospheric phenomena that occur at a specific time in a specific place.

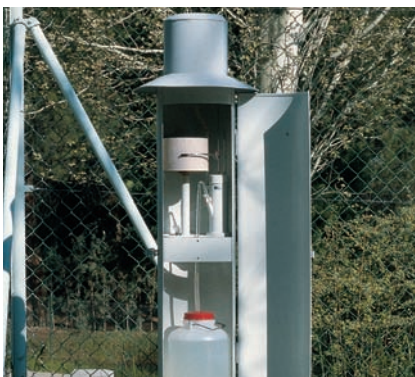
We describe atmospheric weather in terms of: Sun, rain, maximum and minimum temperatures, clouds, winds, and fronts.

These scientific instruments measure data to predict the weather:

- **Thermometer:** measures atmospheric temperature
- **Barometer:** measures atmospheric pressure
- **Rain gauge (pluviometer):** measures the amount of rain or snow that falls in a particular place and at a particular time
- **Hygrometer:** measures atmospheric humidity
- **Weather vane:** shows the direction of the wind
- **Wind gauge (anemometer):** measures the strength of the wind




Barometer




Rain gauge (pluviometer)


Activities

33 What is atmospheric weather? Give some examples. Explain how it is different from climate.

34  Copy and complete this in your exercise book. Listen and check.

Differences in _____, humidity, and _____ in the _____ mean we can differentiate between cold, warm, _____, or humid _____ masses. These air masses move around and the place where _____ air meets _____ air is called a _____.

35  Listen and say what the speaker is describing.

36  Listen, repeat, and underline the stress in your exercise book: *thermometer, barometer, pluviometer, hygrometer, weather vane, anemometer.*

37 Match the columns.

thermometer	amount of water or snow
barometer	strength of the wind
rain gauge	atmospheric humidity
hygrometer	atmospheric temperature
weather vane	atmospheric pressure
wind gauge	direction of the wind

38 If there is an 80 km/h north wind, what instruments do we use to find out the direction and speed of the wind?

39 Test your partner on the scientific instruments used in weather prediction.

Example:

A: *This instrument measures the direction of the wind.*

B: *It's a weather vane.*

40 Look at the table and answer the questions in your exercise book.

Month	Average temperature (°C)		Total average precipitation (mm)
	Daily minimum	Daily maximum	
Jan	2,6	9,7	37
Feb	3,7	12	35
Mar	5,6	15,7	26
Apr	7,2	17,5	47
May	10,7	21,4	52
Jun	15,1	26,9	25
Jul	18,4	31,2	15
Aug	18,2	30,7	10
Sep	15	26	28
Oct	10,2	19	49
Nov	6	13,4	56
Dec	3,8	10,1	56

a) What do the following terms refer to: minimum temperature, average temperature, average precipitation.

b) What are the three wettest months? Do these data refer to climate or weather? Why?

c) Draw a graph to represent average minimum and maximum temperatures. Which month has the largest difference between the maximum and minimum temperature? And the lowest?

d) Calculate the annual average minimum temperature and the annual average precipitation.

KEY WORDS

raw material: natural substances

humidity: the amount of water in the air

ultraviolet radiation: a form of energy from the Sun which is harmful in large amounts

filter: something you pass air, water etc through to clean it

plankton: microscopic organisms that float in water and feed many animals

deforestation: when the vegetation in an area disappears

5 The atmosphere and living things: the greenhouse effect

Nearly all living things depend on air to survive, because some atmospheric gases are necessary to perform the vital functions. Plants need carbon dioxide for **photosynthesis** and nearly all organisms use oxygen to respire.

Our planet has the right environment for life to exist and develop, because the air contains some of the **raw material** necessary for life. Atmospheric components, such as carbon dioxide and water vapour, maintain the planet's optimal temperature and **humidity** conditions, thanks to the greenhouse effect. Water vapour condenses and forms clouds, which provide water for living things through rainfall. The ozone layer in the atmosphere protects living things from harmful **ultraviolet radiation** from the Sun.

Changes in the composition of the atmosphere

The destruction of the ozone layer

The use of CFC gases (**chlorofluorocarbons**) is gradually destroying the ozone layer.

CFCs are often used in fridges, air conditioning units, and aerosols.

The decrease in this **filter**, which protects against solar radiation, causes:

- a decrease in the number of algae, **plankton**, and larvae
- an increase in skin cancer, eye irritations, cataracts, and blindness
- a reduction in our defences against allergies and infectious diseases

The destruction of the ozone layer mainly affects **Antarctica**. Every spring a large amount of the ozone disappears, creating the **ozone hole**.

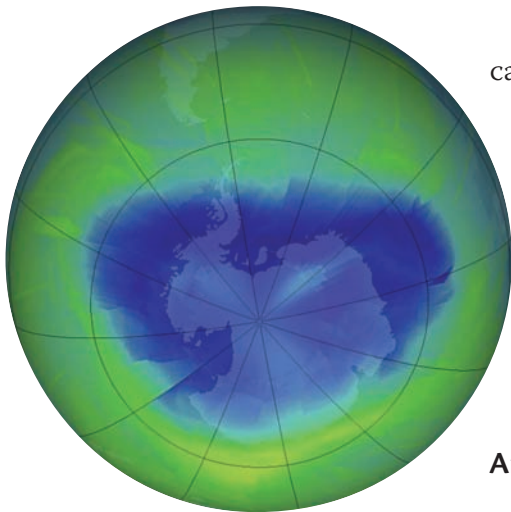
An increase in the greenhouse effect

The increase in the greenhouse effect has two main causes:

- the release of large quantities of carbon dioxide into the atmosphere from the combustion of oil-based fuels
- **deforestation:** the destruction of large areas of forest, which could have consumed this excess of carbon dioxide through photosynthesis


A direct consequence of an increase of greenhouse gases in the atmosphere is **global warming:** an increase in the global temperature of the planet. This can cause: a rise in sea levels, which would flood many coastal areas and destroy cities and agricultural land; **climate change**, and the disappearance of many species of animals and plants.

Human activities alter the composition of the air and introduce possibly harmful gases and particles. **Air pollution** is greater in cities than in rural areas, so asthma, bronchitis, and lung cancer are more frequent in urban areas.



The ozone hole over Antarctica in 2010

Activities

41  Complete the paragraph with the words in the box. Listen and check.

oxygen

vital functions

humidity

ultraviolet

photosynthesis

ozone

air


carbon dioxide

Most living things need (a)_____ to survive, because it contains atmospheric gases used for the (b)_____. (c)_____ uses carbon dioxide and most organisms use (d)_____ to breathe. (e)_____ and water vapour maintain optimal temperature and (f)_____ conditions on the Earth, thanks to the greenhouse effect. The (g)_____ layer protects living things from harmful (h)_____ radiation.

42 What gases are responsible for the destruction of the ozone layer?

43 What factors have caused the greenhouse effect to increase?

44 What benefits does the greenhouse effect have for our planet? What damage occurs if it increases?

45  Listen and complete the sentences with the missing words in your exercise book.

The (a)_____ layer acts as a (b)_____ against solar radiation. The use of (c)_____ gases is destroying this layer, mainly in the (d)_____, where there is now an ozone hole. This has serious consequences: the numbers of algae, (e)_____, and larvae (f)_____, while skin cancer and eye problems (g)_____. Also, our defences against infectious (h)_____ become weaker.

46 Find out how astronauts can live outside the atmosphere.

47 Look at the photo and read the text. Then answer the questions in your exercise book.

The Kyoto Protocol is an agreement between most of the United Nations countries to reduce greenhouse gas emissions by 5.2% (with respect to the 1990 level) between 2008 and 2012. By 2006, 111 countries had signed the agreement, but the USA and China, two of the countries that produce the most pollution, did not sign it. The European Union agreed to reduce emissions of the six greenhouse gases (for example CO₂) by 8% across all EU countries. This meant that emissions in some countries must be reduced, but in others, such as Spain, they could increase. By 2011, Europe had succeeded in reducing its emissions by more than 8%, but Spain had already exceeded the 15% increase that was agreed for 2008–2012. Globally, the concentration of atmospheric CO₂ is still increasing.

In 2009, the Copenhagen Climate Change Summit took place. The intention of the 192 countries present was to increase commitment to the environment and include recommendations to stop the planet's average temperature increasing by more than 2 °C. However, they did not commit to following any recommendations.



a) What can you see in the photo? What is produced there?

b) What is the objective of the Kyoto Protocol?

c) How many countries had signed it by the end of 2006?

d) Which two countries pollute the most?

e) What percentage did the EU agree to reduce greenhouse gas emissions by?

f) Has Spain controlled its emissions sufficiently?

g) Why did the 192 countries meet in Copenhagen in 2009?

h) Did the countries present in Copenhagen definitely agree to apply the Summit's recommendations?

48 Cover your book and test your partner on the questions in Activity 47.

Revision activities

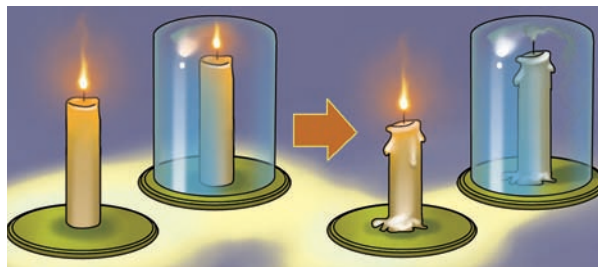
1 Find eight words from this unit in the word search. Write them down, with definitions, in your exercise book.



2 Match the columns in your exercise book.

Troposphere	Contains the ozone layer
Ionosphere	75% of all gases are here
Stratosphere	Reflects radio and TV waves
	The weather takes place here

3 Look at the diagram below and answer the questions in your exercise book.



- Which gas is consumed when a candle burns?
- Why does the candle inside the jar go out but the one on the outside stay alight?

4 In your exercise book, match the instruments to what they measure.

Thermometer	Humidity
Barometer	Wind strength
Anemometer	Atmospheric temperature
Hygrometer	Atmospheric pressure

5 Why do the following help reduce the amount of CO₂ in the atmosphere? What effect will they have on the greenhouse effect?

- Using wind or solar energy.
- Using hybrid or electric cars.
- A reduction in the amount of heating we use and thermal insulation in houses.
- Using public transport instead of private vehicles.
- Turning the television, lights, radio, etc. off when you leave a room.

6 The words in *italic* in these sentences are incorrect. In your exercise book, write out the correct sentences.

- Plants use carbon dioxide for *respiration*.
- Living things obtain water through *radiation*.
- All living things use oxygen for *photosynthesis*.
- We are protected from ultraviolet *precipitation* by the ozone layer.

Talking points

7 Describe a gas to your partner. Your partner has to guess what gas you are describing.

Example:

A: *It has no colour, no taste, and no smell. It forms 78% of the atmosphere.*

B: *It's nitrogen.*

8 Work in a group. We must all help to reduce atmospheric pollution. Discuss how we can do this.

Example:

A: *We can use less fuel to heat water by having a shower and not a bath.*

B: *Good idea! We can also use public transport and not private cars. That would reduce air pollution.*

9 Work in a group. Discuss the following questions. Then compare your answers with another group.

- How do forests help to reduce carbon dioxide?
- Why does the air in the atmosphere not escape into outer space?
- Why do atmospheric pressure, the amount of oxygen, and temperature decrease the higher up you go?