

Precipitation – the story for teachers

Precipitation is a generic term used to describe any form of moisture that falls from the air to the ground. This includes snow, hail, sleet, drizzle and rain. Find out the total amount of precipitation in your local area and share this with the children. Then look for areas of Britain that are wetter and drier. It is a good idea to represent this visually and discuss the reasons for the differences. A good school atlas should contain a map showing the distribution of precipitation. The conclusion should be that generally western areas of the country receive more precipitation than eastern areas. A good idea is to turn to a page showing the physical geography of the British Isles. Some children will see a correlation between high land and high rates of precipitation. This is your starting point for your lesson on the water cycle.

At any time, 97% of all the earth's water is in the oceans: of the remainder, much is locked up in ice or in lakes or underground stores. Only 0.034% of the earth's water is in the atmosphere at any one time. This is important since some descriptions of the water cycle leave children with the impression that vast amounts of water are moving round the system at great speed.

The water cycle operates because air absorbs and releases water vapour. Water vapour enters the air by evaporation when warm air crosses an ocean or when puddles on the playground 'magically' disappear. A cloud is a visible sign that evaporation has taken place, usually at some distant location, and the water vapour has then condensed again back into the water droplets (or ice crystals) which form clouds. Clouds contain tiny droplets or ice crystals suspended in the atmosphere. Some clouds (but not all) are accompanied by precipitation at your location. If you draw clouds with suspended raindrops, you should be prepared for the question 'Why don't all clouds produce precipitation?'

To answer this question, you first have to have some knowledge about molecular motion in the three phases or states of water. The average energy of molecules determines the phase of any substance. Temperature is simply a measure of the average energy of molecules. Water as a gas (water vapour), water in liquid form and water as a solid (ice) are often found together in the same cloud. Ice crystals will be found in the higher, colder part of the cloud where the molecules are locked into hexagonal crystals. Liquid water molecules are moving fast enough to break free from these crystal structures but they are still attached to one another. As water vapour the molecules are free to move about.

Molecules are moving on average fastest when water is a gas, slower when it becomes a liquid and slowest in the solid, ice.

If we cool a quantity of water, the molecules will start to move more slowly and, eventually, as the temperature falls below freezing point, more and more molecules will lock together and become ice crystals. Heat the same quantity of water and the molecules speed up. Some begin to travel fast enough to leave the surface and fly into the air. The molecules have evaporated to become water vapour. The opposite is also true; if the average speed of the molecules in water vapour slows down, it may condense to a liquid state.

A basic mechanism for the creation of raindrops is for ice crystals formed around tiny specks of dust or smoke and falling from high parts of a cloud to collide and break into smaller units. Liquid water molecules of different sizes can gather around these broken fragments. If enough liquid particles gather together, the result is a raindrop. Then, when the raindrop is large and heavy enough, gravity will pull it towards the ground. You should at this point see the possibilities for enhancement of understanding through drama.

There is no one answer to the question 'Why don't all clouds produce precipitation?', but, at this level (middle primary), you might say 'The conditions in the cloud are not favourable for the growth of droplets'. You might elaborate and say that the molecules in the water vapour are travelling too fast and would need to slow down so that droplets can form, or that not enough particles have collided or attached themselves to ice crystals yet. In the case of cirrus, the clouds are too high and are composed almost entirely of ice crystals.

Condensation has nothing to do with cooler air being able to 'hold' less water vapour than warmer air, and this should not be part of your explanation of the water cycle. Air does not hold water in the way a sponge holds water.

Precipitation occurs as part of the water cycle but the 'orographic' or 'relief' mechanism (where hills and mountains cause rain to fall) does not account for all precipitation. Why does it rain on perfectly flat areas like the Prairies? We will have to leave this and more involved explanations for later stages.

Rain is only one form of precipitation. If ice crystals grow and become heavy, and if the temperature of the air is low enough, then the crystals will fall as snowflakes. If snowflakes pass through a layer of warmer air near the ground the snowflakes will partially melt but freeze once more and fall as sleet. If the snowflakes melt completely but temperatures near the ground are below freezing, the rain will freeze again on contact with the ground. This is called freezing rain and is extremely dangerous, as it leaves a layer of ice on the streets and can cause traffic accidents.

Hail is formed in thunderclouds where upward currents carry ice droplets back up to the top of the cloud; they gather more moisture as they fall, only to be lifted up once again. In this way, successive layers are added to the ice droplet until it reaches such a size that gravity takes over and pulls it to the ground. Particularly violent thunderclouds can lead to very large hailstones. Giant hailstones have been measured at 0.75 kg.

The rain gauge activity can be extended by involving the class in RainCatch, an activity organized by the Royal Meteorological Society.

New words

condensation – water changing state from a gas (water vapour) to a liquid

evaporation – water changing state from a liquid to a gas (water vapour)

hail – precipitation in the form of spherical or irregular pellets of ice

sleet – a mixture of rain and snow, usually formed when snow partially melts as it passes through a warm layer of air

transpiration – the evaporation of water into the atmosphere from the leaves and stems of plants

Precipitation – middle primary

By using a range of materials and activities, we aim to focus on these outcomes and targets:

Pupil Learning Outcomes

- The water cycle explains the path of the continuous movement of water on earth.
- Precipitation occurs during the water cycle.
- Precipitation occurs when water vapour condenses and falls from clouds.
- Precipitation can occur in the form of rain, hail, snow or sleet.

Scotland: 5–14 Environmental Studies

People and place: The physical environment

- Level A: describe the main types of local weather, including seasonal change, and how it affects their own lives.
- Level B: describe main weather elements and some effects on people's everyday lives.

Earth and space: Materials from Earth

- Level A: give the main uses of water.
- Level B: explain why water conservation is important.

Earth and space: Changing materials

- Level B: describe how everyday materials can be changed by heating or cooling.
- Level B: give examples of everyday materials that dissolve in water.
- Level C: describe in simple terms the changes that occur when water is heated or cooled.

Skills in social subjects – enquiry

- Level A: process/classify simple information.
- Level A: suggest ways of finding answers to given questions.
- Level B: process/classify simple information in a variety of ways.
- Level B: present some simple conclusions based on their findings.

Skills in science – investigating

- Level A: make suggestions and contribute to the planning of simple practical explorations.
- Level A: carry out simple observations and measurements.
- Level A: record observations in a simple form.
- Level A: answer simple questions about what happened.
- Level B: answer questions on the meaning of the findings.
- Level B: use simple equipment and techniques to make observations and measurements.
- Level B: make suggestions about what might happen.

England and Wales National Curriculum

Geography

Key Stage 1

- 1b: observe and record
- 2a: use geographical vocabulary
- 2b: use fieldwork skills
- 4b: recognise changes in physical and human features

- 7a: study at a local scale
- 7b: carry out fieldwork investigations outside the classroom

Key Stage 2

- 1b: collect and record evidence
- 1c: analyse evidence and draw conclusions
- 2a: use appropriate geographical vocabulary
- 2b: use appropriate fieldwork techniques
- 3a: identify and describe what places are like
- 3d: explain why places are like they are
- 7c: carry out fieldwork investigations outside the classroom

Science – scientific enquiry

Key Stage 1

- 1: know that it is important to collect evidence by making observations and measurements when trying to answer a question.
- 2a: ask questions.
- 2b: use first-hand experience and simple information sources to answer questions.

Science – life processes and living things

Key Stage 1

- 2b: know that humans and other animals need food and water to stay alive.
- 3a: recognise that plants need light and water to grow.

Science – materials and their properties

Key Stage 2

- 2a: describe changes that occur when materials are mixed.
- 2b: describe changes that occur when materials are heated or cooled.
- 2c: know that temperature is a measure of how hot or cold things are.
- 2d: know about reversible changes including dissolving, melting, boiling, condensing, freezing and evaporating.
- 2e: know about the part played by evaporation and condensation in the water cycle.
- 3b: know that some solids dissolve in water to give solutions but some do not.
- 3d: know how to recover dissolved solids by evaporating the liquid from the solution.

WALT

We are learning to ...

Describe the water cycle.

Understand what precipitation is and where it comes from.

Phase 1 Overview

Establish the children's prior knowledge:

- What is the water cycle?
- What is precipitation?
- Where does it come from?

Phase 2 Input

The water cycle

Water can be found on land, in the sea, in rivers and lakes, in the ground and in plants and animals. The earth has the same amount of water at any one time. It moves around and around in a cycle, although only a very small amount of water at any one time is actually found within the atmosphere. The cycle is made up of a few main parts:

- Some of the water at the earth's surface turns into water vapour and rises into the air. This is called evaporation.
- Plants also give evaporation a bit of a hand by losing water out of their leaves. This is called transpiration. This water vapour also rises into the air.
- When water vapour cools, it turns into tiny droplets of water and collects together to form clouds. This is called condensation.
- When the clouds cool further, the drops of water become bigger and heavier and the air cannot hold them up. Precipitation then occurs. It has many forms: rain, snow, sleet or hail.
- When the water falls back on to the land or the sea, the cycle begins again.

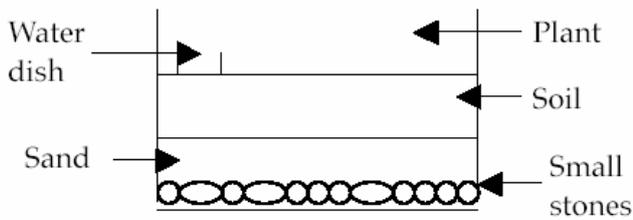
The water cycle facts (resources download) are in large print and can be printed out onto coloured paper or card to display within the classroom. Here they are for reference:

- Water in the sea is salty, but when it evaporates it leaves the salt minerals behind.
- Only 0.034% of water is ever in the clouds at any one time.
- The water we drink and use today is the same water used by the dinosaurs!
- Two-thirds of a human being is made up of water.
- Three-quarters of a tree is made up of water.
- In 100 years, an average molecule of water will spend 98 years in the sea, 20 months as ice, two weeks in lakes or rivers and less than one week in the atmosphere! (This can be demonstrated visually using lentils as molecules.)
- Raindrops are shaped like doughnuts not drips!

Make a mini water cycle

What you need:

- a large glass bowl or an empty fish tank
- small stones
- sand
- soil
- a plant
- a small dish of water
- cling-film



Fill the bowl or tank as shown in the diagram. Cover tightly with cling-film and leave in a sunny position in the classroom. The water in the soil and dish should evaporate, while the plant should transpire. The water vapour should then condense on the cling-film. Precipitation may occur when the drips become too heavy.

Phase 3 Process

What different types of precipitation are there? (Rain, hail, sleet and snow) You can show the children the photographs on the resources pdf. (resources download), which show various types and effects of precipitation as well as a rain gauge.

The children can take part in the following activities:

Evaporation

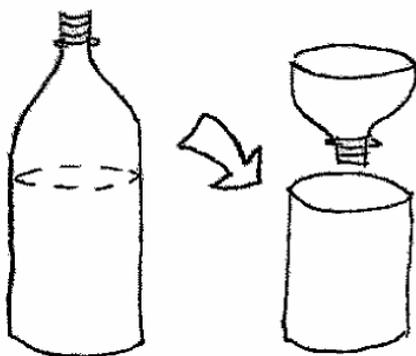
This activity shows how evaporation affects salty water and fresh water.

- Dissolve a teaspoon of salt in some water. Pour the mixture into a saucer and set aside in a sunny place in the classroom.
- Fill another saucer with fresh water and place it next to the salty one.
- Over the next few days the water should evaporate, leaving the salt crystals behind.

Make a rain gauge

What you need:

- a clear plastic bottle
- strong tape
- water
- a ruler (marked in mm)
- copies of rain gauge worksheet (resources download)



Cut the bottle in two as shown in the diagram. Upright the neck and place it inside the bottle. Add some water as a base level (this prevents inaccurate readings). Explain to the children that we measure precipitation by depth. Use the tape to fasten a ruler to the side of the gauge with the bottom of the scale next to the base level of water. Place the gauge outside and ask the children to record the daily precipitation levels for a week, using the table on the worksheet. After each reading, return the water to the base level ready for the next day's rain.

Making raindrops

What you need:

- mirror
- paper towel
- kettle
- precipitation activities worksheet (resources download)

Water vapour turns to water droplets or ice with a reduction in temperature. Try this experiment to make raindrops by cooling your breath.

Breathe on a mirror. What happens? Now count how many times you need to breathe on it to make the water droplets run. Wipe the mirror dry after use with a paper towel.

A kettle can be used to make lots of condensation on a cold windowpane.

After activities have been completed, children can be asked to complete the precipitation activities worksheet which describes all the activities, including the mini water cycle.

Phase 4 Review

Complete the precipitation poetry worksheet (resources download) . After thinking of two words for each type of precipitation, children can make a 'poem' using these words, e.g. 'Wet splashy rain, horrible cold sleet, ...'.

The following questions can be used in discussion:

- What is precipitation?
- What types of precipitation do we get?
- Where does the precipitation come from? (Try to work through the water cycle here, prompting the children for newly learned words such as evaporation and condensation.)