EARTH AND SPACE

The water and carbon cycles

Teacher review edition. Ask your teacher if anything is unclear.

How do water and carbon move through the environment?

What you will learn

- Name and explain the main processes in the water cycle.
- Trace carbon through photosynthesis, feeding, respiration and burning.
- Explain the difference between a store and a transfer.

Water moves around Earth

The water cycle describes water moving between the air, land and oceans.

- The same water can be used again and again.
- Water may stay briefly in one place or remain in ice or underground for many years.

From water to clouds and rain

Evaporation
Liquid water changing into water vapour at its surface.

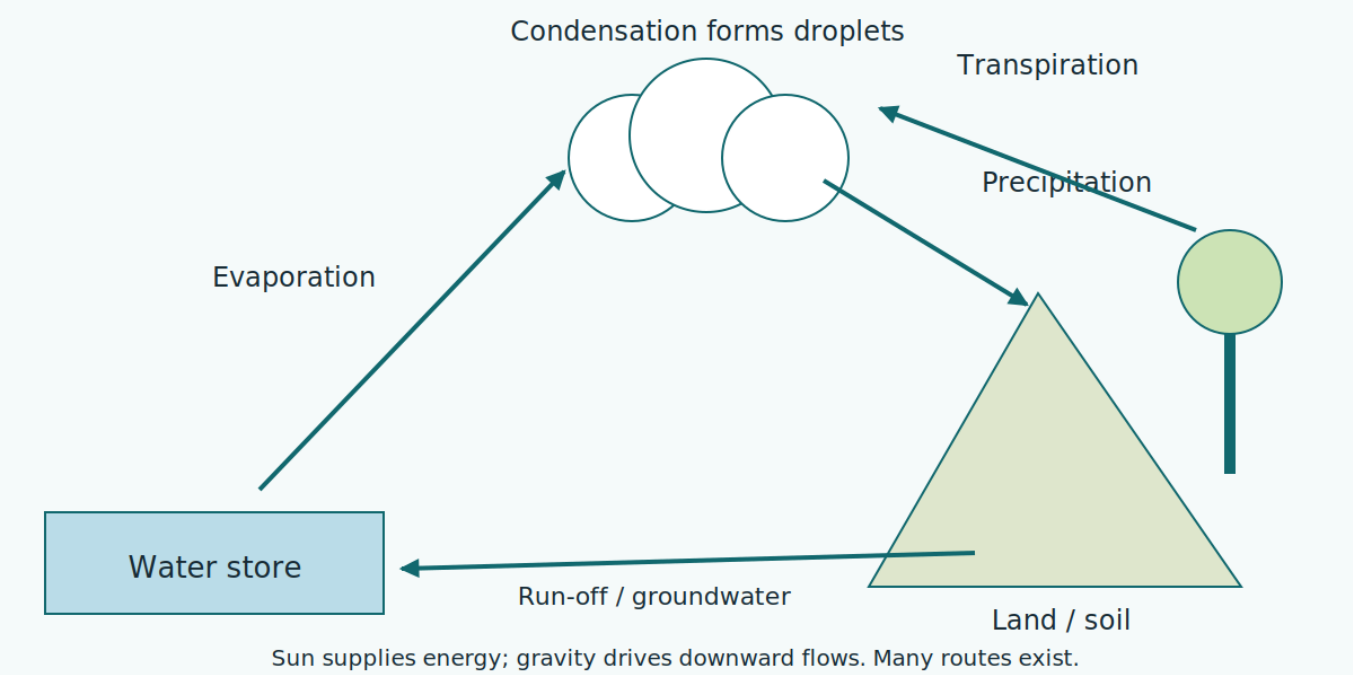
Condensation
Water vapour changing into liquid water.

Precipitation
Water falling from clouds as rain, snow or hail.

Transpiration
The loss of water vapour from a plant, mainly through tiny pores in its leaves.

Energy from the Sun drives evaporation; gravity brings precipitation to the ground.

- Evaporation: liquid water changes into water vapour, an invisible gas.
- Condensation: as moist air cools, water vapour changes into tiny liquid droplets.
- Clouds contain water droplets, ice crystals or both.
- Precipitation: water falls from clouds as rain, snow or hail.



Energy from the Sun drives evaporation; water vapour condenses into droplets, and precipitation returns water to the ground. Arrows show possible routes, not a compulsory sequence.

Water on and under the ground

Water can follow several routes after reaching the ground.

- Surface runoff: water flows over the ground into streams and rivers.
- Infiltration: water soaks into the soil.
- Groundwater: water held in spaces and cracks underground.
- Plants take up water through their roots.
- Transpiration: water vapour leaves mainly through tiny leaf pores called stomata.

Where carbon is found

> **Carbon store**
> A place where carbon is held, such as the atmosphere, an ocean, a forest or rocks.

Carbon is an element found in all living things.

- Carbon stores include the atmosphere, oceans, living things, fossil fuels and rocks.
- The carbon cycle describes carbon moving between these stores.
- Some transfers are quick, such as an animal eating a leaf.
- Other changes, such as fossil-fuel formation, take millions of years.

Carbon moves through living things

> **Carbon transfer**
> Carbon moving from one store to another, for example through feeding, respiration or burning.

Process	What happens to carbon
Photosynthesis	Plants take in carbon dioxide and use its carbon to make glucose.
Feeding	Carbon in food moves from one organism to another.
Respiration	Living cells release energy from food and return carbon dioxide to the surroundings.
Decomposition	Decomposers break down dead organisms and waste. Carbon passes into decomposers and soil, and some returns to the air as carbon dioxide.

Burning fuels and changing the cycle

Combustion means burning.

- Complete burning of a carbon-containing fuel in oxygen produces carbon dioxide.
- Burning fossil fuels moves carbon from underground stores into the atmosphere.
- Cutting down forests leaves fewer trees to take in carbon dioxide by photosynthesis.
- Carbon in removed trees may return to the air when the wood burns or decays.

Matter is transferred, not created

Arrows in a cycle show possible routes, not one compulsory journey.

- A water molecule or carbon atom does not have to follow every arrow.
- A store grows when more material enters than leaves.
- Example: 100 units + 12 entering − 7 leaving = 105 units.
- The extra carbon came from another store; it was not created.

Worked examples

When methane burns completely in oxygen, carbon dioxide and water form: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. Check that the number of each type of atom is the same on both sides.

Work through it

1. Carbon: CH_4 contains 1 carbon atom; CO_2 contains 1 carbon atom.
2. Hydrogen: CH_4 contains 4 hydrogen atoms; $2H_2O$ contains 4 hydrogen atoms.
3. Oxygen: $2O_2$ contains 4 oxygen atoms; CO_2 and $2H_2O$ contain 4 oxygen atoms in total.
4. The atoms have been rearranged to form new substances. No atoms have been lost or created.

Common mistakes

Common mistake: A cloud is made only of water vapour.

Remember: Water vapour is invisible. Clouds contain tiny liquid-water droplets, ice crystals or both.

Common mistake: Plants get the carbon in their food from soil minerals.

Remember: Plants take in carbon dioxide, mainly through their leaves. Photosynthesis uses that carbon to make glucose.

Answering questions

- When tracing a cycle, name each process on the arrow and show its direction. For example: lake → evaporation → water vapour → condensation → cloud droplets.
- For a carbon-transfer question, say where the carbon starts, the process moving it and where it ends. Avoid saying only “carbon goes round the cycle”.

Try an investigation

Draw a water-cycle diagram with arrows labelled evaporation, condensation, precipitation, runoff and transpiration. In a teacher-supervised test, place a clear bag around some leaves and compare it with an empty bag kept in the same conditions. Explain where any droplets could have come from.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.