

B E A M D R I P

References & Study Guide

The Water Cycle — Earth

Every fact and question in the game's Water Cycle world and the sources behind them — for curious minds!

22

TOPICS

66

QUESTIONS

40+

SOURCES

A note on how this was built

This game is not only intended to be fun, but also to build real knowledge. The facts and trivia are meant to pique real scientific curiosity, and to reward learners as they play. Each of the 88 claims across these 22 topics was verified against a live source. Peer-reviewed papers were preferred where they exist, then agency sources — NASA, NOAA, USGS, EPA — then university and specialist outreach. No blogs, no content farms.

Start here

Foundational reference links.

USGS Water Science School

The single best starting point for the water cycle — plain-language explanations backed by the agency that measures it.

[Where is Earth's Water?](#) [How Much Water is There?](#) [Glossary](#)

NOAA JetStream

NOAA's online weather school — the atmosphere side of the cycle, written for learners rather than meteorologists.

[What a Cycle!](#) [How much water is in that cloud?](#)

NASA Science

For everything above the weather — sunlight, auroras, and the worlds beyond this one.

[Auroras](#) [The habitable zone](#)

NOAA National Severe Storms Laboratory

Where the storm science lives — hail, updrafts, and severe weather explained by the people who chase it.

[Severe Weather 101: Hail](#)

Atmospheric Optics

A specialist labour of love covering rainbows, halos and moonbows in beautiful depth.

[Moonbows](#) [The Antisolar Point](#)

Looking for the quiz? The companion *Printable Quiz & Answer Key* has all 66 questions laid out to print, with the answers and explanations at the back.

The 22 Topics and Source Links

TOPIC 1

The cycle is a loop

DID YOU KNOW?

The water cycle is the endless journey water takes — rising into the sky, forming clouds, falling, and flowing back, over and over.

QUESTIONS IN THIS TOPIC

- 1.1 Where does the water cycle begin?
- 1.2 Water can naturally be...
- 1.3 🍷 The water you drank today may have once fallen as rain on...

WHERE THIS COMES FROM

The endless-loop framing and all three states of water occurring naturally on Earth are the foundation of every agency description of the water cycle.

WORTH NOTING

The “water the dinosaurs drank” idea is literally true — Earth's water is billions of years old and continuously recycled. Topic 13 is the one twist: a small amount of genuinely *new* water is still being made, inside your own cells.

SOURCE LINKS

- [USGS · Where is Earth's Water?](#)
- [NOAA JetStream · What a Cycle!](#)

TOPIC 2

The Goldilocks zone

DID YOU KNOW?

Earth orbits in the Sun's “Goldilocks zone” — the habitable just-right band where it's neither too hot nor too cold for liquid water. That's why Earth can hold water as solid, liquid, AND gas all at once.

QUESTIONS IN THIS TOPIC

- 2.1 Another name for water?
- 2.2 Some of Earth's water may have first arrived on...
- 2.3 🍷 Across the universe, water takes on all kinds of forms. Deep inside Uranus and Neptune, water becomes “superionic ice”, ice that is...

WHERE THIS COMES FROM

NASA defines the habitable zone as the band around a star where it is neither too hot nor too cold for liquid water on a planet's surface.

WORTH NOTING

Superionic ice is as strange as it sounds: around **5,000 K** and over **3.3 million times** Earth's atmospheric pressure, it is solid and scorching at once, and it conducts electricity. Researchers think it may be the *most common form of water in the universe* — buried inside ice giants like Uranus and Neptune, far outweighing all the familiar water on planetary surfaces.

SOURCE LINKS

- [NASA · What is the habitable zone?](#)
- [Quanta · Nature's most common form of water](#)
- [Lawrence Livermore National Laboratory](#)

TOPIC 3

The cycle moves energy

DID YOU KNOW?

The water cycle doesn't just move water — it redistributes the Sun's energy and moisture all around the planet, evening out hot and cold regions.

QUESTIONS IN THIS TOPIC

- 3.1 The whole water cycle is powered mainly by...
- 3.2 The Sun's energy travels 93 million miles through empty space to reach Earth as...
- 3.3 🍷 Warm, higher energy, wet air always drifts toward cooler, drier places until things balance out. Zoomed way out, the whole water cycle works like...

WHERE THIS COMES FROM

Solar-driven evaporation and the poleward transport of heat and moisture are core to how the atmosphere balances the planet.

WORTH NOTING

The numbers cross-check: Earth sits about 93 million miles from the Sun (1 AU $\approx$ 92.96 million), and because space is a vacuum, that energy can only arrive as electromagnetic waves — light.

SOURCE LINKS

- NOAA JetStream · What a Cycle!
- USGS · Glossary of Water Cycle Terms

TOPIC 4

Evaporation

DID YOU KNOW?

Evaporation is when the Sun's heat turns liquid water into invisible water vapor that floats up into the air.

QUESTIONS IN THIS TOPIC

- 4.1 Evaporation turns liquid water into...
- 4.2 Most water vapor in the air comes from...
- 4.3 🍷 Ribbons of water vapor in the sky called “atmospheric rivers” can carry more water than...

WHERE THIS COMES FROM

Oceans supply most of the moisture in the air, and NASA has measured how much water atmospheric rivers move.

WORTH NOTING

This one is even bigger than it first sounds. NASA's figure — more than twice the Amazon's flow — describes an **average** atmospheric river. The strongest carry far more still, and a single one can transport water vapour at 7–15× the daily discharge of the Mississippi.

SOURCE LINKS

- NASA JPL · Ranking Atmospheric Rivers
- NOAA · What are atmospheric rivers?
- USGS · Rivers in the Sky

TOPIC 5

Condensation

DID YOU KNOW?

Condensation is when rising vapor cools and gathers into tiny droplets — that's how clouds are made.

QUESTIONS IN THIS TOPIC

- 5.1 When vapor condenses into a cloud, the heat it absorbed during evaporation is...
- 5.2 A cold drink “sweats” on the outside because...
- 5.3 🍹 Most cloud droplets can't form on their own — each one usually needs a tiny...

WHERE THIS COMES FROM

Latent heat release and condensation nuclei are the two mechanisms behind every cloud that has ever formed.

WORTH NOTING

Genuinely clean air barely rains. Water vapour needs a microscopic speck — dust, sea salt, smoke — to condense onto. Without those nuclei, air can become wildly supersaturated and still refuse to form droplets.

SOURCE LINKS

- NOAA JetStream · How much water is in that cloud?
- NOAA JetStream · What a Cycle!

TOPIC 6

What clouds are made of

DID YOU KNOW?

A fluffy cloud looks light as cotton, but it's actually made of countless tiny water droplets and ice crystals — and can add up to over a million pounds.

QUESTIONS IN THIS TOPIC

- 6.1 What are clouds actually made of?
- 6.2 Why doesn't the liquid water and ice in a cloud just fall straight down?
- 6.3 🍹 All the droplets together in a big storm cloud can weigh as much as...

WHERE THIS COMES FROM

The USGS actually does the arithmetic on cloud weight, using a measured cloud density of about half a gram per cubic metre.

WORTH NOTING

A single cubic kilometre of cumulus weighs roughly **1.1 million pounds** — and floats, because the dry air beneath it is denser still. The bigger misconception the quiz corrects: a cloud is not water vapour. Vapour is invisible. A cloud only appears once that vapour has condensed into liquid droplets and ice.

SOURCE LINKS

- USGS · How Much Does a Cloud Weigh?
- NWS · How much does a typical cumulus cloud weigh? (PDF)

TOPIC 7

Precipitation

DID YOU KNOW?

Precipitation is water falling back to Earth from clouds as rain, snow, sleet, or hail.

QUESTIONS IN THIS TOPIC

7.1 Precipitation falls from...

7.2 Which falls faster — rain or snow?

7.3 🧊 A drifting snowflake can take how long to reach the ground?

WHERE THIS COMES FROM

Terminal-velocity measurements for rain and snow come from meteorological field research.

WORTH NOTING

Large raindrops top out near **22 mph**; snowflakes drift at about **2.2 mph**. Wet or rimed snowflakes fall roughly twice as fast as dry ones, which is why the range runs 1–4 mph — and why a flake from a high cloud really can take an hour to land.

SOURCE LINKS

→ NOAA · Frozen hydrometeor terminal fall velocity (PDF)

→ NWS · Cloud and Precipitation Processes (PDF)

TOPIC 8

Rainbows

DID YOU KNOW?

A rainbow isn't an arc but a full circle of light! The ground blocks the bottom half, so we only see the top — but from an airplane, you can sometimes see the whole ring!

QUESTIONS IN THIS TOPIC

8.1 A rainbow forms when sunlight passes through a raindrop and...

8.2 Two people standing side by side looking at the same rainbow are actually...

8.3 🌕 Under a bright enough full moon, you can sometimes see a real rainbow at night, called a...

WHERE THIS COMES FROM

Rainbow geometry is thoroughly documented by the National Weather Service and atmospheric-optics researchers.

WORTH NOTING

The 42° angle is measured from the **antisolar point**, which is precisely where your own shadow's head points. So “your own personal rainbow” is not a simplification: shift a few feet and different raindrops are doing the work. Moonbows need a nearly-full moon less than 42° above the horizon, with rain opposite it.

SOURCE LINKS

→ NWS · How Do Rainbows Form?

→ NOAA NESDIS · What Causes a Rainbow?

→ Atmospheric Optics · Moonbows

→ NASA APOD · A Full Circle Rainbow

TOPIC 9

Auroras

DID YOU KNOW?

Auroras aren't just shifting curtains of light — seen from space, they form a complete glowing ring called the auroral oval, circling Earth's magnetic pole. From the ground, you only ever see your own small slice of that ring.

QUESTIONS IN THIS TOPIC

- 9.1 Auroras happen when...
- 9.2 An aurora's most common color, green, comes from charged particles striking...
- 9.3 🌍 Earth isn't the only planet with auroras — they've also been spotted on...

WHERE THIS COMES FROM

NASA documents both the auroral oval and the altitude-dependent chemistry that sets an aurora's colour.

WORTH NOTING

Colour is altitude. Oxygen glows **green below about 150 miles** and **red above** it, while nitrogen lower down adds blue and violet fringes. From the ground you only ever see a slice of what is, from space, a complete glowing ring around the magnetic pole.

SOURCE LINKS

- [NASA · Auroras](#)
- [NASA Space Place · What Is an Aurora?](#)
- [NASA JPL · Jupiter's Auroras](#)

TOPIC 10

Collection

DID YOU KNOW?

Collection is when fallen water gathers in oceans, lakes, rivers, and underground — ready to rise again.

QUESTIONS IN THIS TOPIC

- 10.1 About how much of Earth's surface is covered by water?
- 10.2 Water stored underground is called...
- 10.3 🌍 Most of Earth's FRESH (non-salty) water is stored as...

WHERE THIS COMES FROM

The USGS maintains the definitive inventory of where Earth's water actually sits.

WORTH NOTING

About **71%** of Earth's surface is water-covered, and **over 68%** of all fresh water is locked in ice and glaciers. Another 30% is underground — meaning the lakes and rivers we actually see hold a tiny sliver of the fresh water there is.

SOURCE LINKS

- [USGS · How Much Water is There on Earth?](#)
- [USGS · Where is Earth's Water?](#)
- [USGS · Water stored in glaciers](#)

TOPIC 11

Why the ocean is salty

DID YOU KNOW?

The ocean is salty because rivers constantly wash dissolved minerals and salts into it — and when seawater evaporates into clouds, the salt gets left behind, so the sea only grows saltier over time.

QUESTIONS IN THIS TOPIC

- 11.1** About how much of Earth's water is salty seawater?
- 11.2** On average, how long does a water molecule stay in the ocean before evaporating back into the sky?
- 11.3** 🧂 Salt is sodium + chlorine. Our oceans are full of salty water — but pure sodium metal, on its own, reacts with water by...

WHERE THIS COMES FROM

Residence time — how long a water molecule stays in one reservoir — is a standard hydrological measure.

WORTH NOTING

The contrast is startling: a water molecule spends about **9 days** in the atmosphere but roughly **3,000 years** in the ocean. The ocean really is the water cycle's slow lane. And the sodium point is a nice piece of chemistry — pure sodium metal explodes on contact with water, yet the sea is harmless because every sodium atom there is already locked to chlorine.

SOURCE LINKS

- [USGS · How Much Water is There on Earth?](#)
- [Britannica · Residence time](#)

TOPIC 12

You are part of the cycle

DID YOU KNOW?

A sleeping human can release up to about a cup of water into the room's air over a single night — through breathing and invisible perspiration through the skin. You're quietly feeding the water cycle even in your sleep.

QUESTIONS IN THIS TOPIC

- 12.1** Humans use the water cycle to cool down. What's the name of the process when sweat dries off your skin?
- 12.2** Every breath you exhale is at nearly 100% humidity. Compared with the air in a steamy tropical jungle, your breath is...
- 12.3** 🧴 The water vapor in the breath you just exhaled was, moments earlier, part of your...

WHERE THIS COMES FROM

Respiratory physiology research measures exactly how saturated exhaled air is, and where that moisture comes from.

WORTH NOTING

Air becomes **fully saturated at 37 °C** deep in your lungs — about 44 mg of water per litre. Because saturation depends only on temperature, your breath genuinely carries more moisture than rainforest air saturated at a cooler temperature. And that water was body fluid moments earlier: it comes from the mucus lining your airways, a net loss your body must replace from its own reserves.

Bonus: about **25% of it never escapes**. As breath cools from 37 °C to roughly 34 °C on the way out, a quarter of the vapour re-condenses on your airway — your body quietly reclaiming it before it reaches the room.

SOURCE LINKS

- [Nature, Scientific Reports · Water and heat exchanges in mammalian lungs](#)
- [Advances in Physiology Education · Insensible water loss during sleep](#)
- [Fluid Physiology · Insensible Water Loss](#)

TOPIC 13

Your body makes water

DID YOU KNOW?

Most of Earth's water is billions of years old — but brand-new water is being made all the time, and your own body produces a little of it every day!

QUESTIONS IN THIS TOPIC

- 13.1** What part of a cell acts as a “water factory,” chemically fusing the food you eat to the air you breathe to make brand-new water molecules?
- 13.2** Your body is about 60% water, and every cell needs a steady supply. About how much of your daily water needs do your own cells provide?
- 13.3** 🧐 The water inside your body is most similar to...

WHERE THIS COMES FROM

Metabolic water is produced at the end of the electron transport chain, where oxygen accepts protons to form H_2O .

WORTH NOTING

Your mitochondria make roughly **250–350 mL a day** — about 10% of your water turnover — chemically identical to what you drink, but assembled inside your cells from the food you ate and the air you breathed. Fat yields the most: about 1.1 g of water per gram burned.

SOURCE LINKS

- Springer · A budget for brain metabolic water production
- ScienceDirect · Metabolic Water

TOPIC 14

Water inside the Earth

DID YOU KNOW?

Earth may hide an entire ocean's worth of water deep inside it — not sloshing in a cave, but chemically locked inside crystals in the mantle.

QUESTIONS IN THIS TOPIC

- 14.1** Deep inside Earth's mantle, a mineral called ringwoodite may hold as much water as...
- 14.2** It's believed some of this deep water is recycled surface water, carried down into the mantle by which part of the deep water cycle?
- 14.3** 🧐 Volcanoes release recycled deep water — but also brand-new water, formed by heat and pressure that reaches the air for the very first time. What is volcanic water called?

WHERE THIS COMES FROM

This traces to a single landmark paper in *Nature* — the strongest source behind any topic in the game.

WORTH NOTING

In 2014 researchers found a fleck of **ringwoodite** inside a diamond from Juína, Brazil, spat up by a volcano from hundreds of kilometres down. It was about **1.5% water by weight**, held as hydroxide rather than liquid. Scaled across the mantle transition zone (410–660 km deep), that implies as much water down there as in all the surface oceans combined.

SOURCE LINKS

- Pearson et al. (2014) · Nature 507, 221–224
- Scientific American · An Ocean's Worth of Water

TOPIC 15

Nature's distiller

DID YOU KNOW?

The water cycle is the largest water purifier on Earth — a giant, solar-powered distiller. Every time the Sun evaporates seawater, the salt and impurities are left behind, so only pure water rises to form clouds and fall as fresh rain.

QUESTIONS IN THIS TOPIC

15.1 Evaporating water and letting it re-condense to leave salt and impurities behind is a purification method called...

15.2 Because evaporation leaves the salt and minerals behind, the rain that falls from clouds is essentially...

15.3 🧐 Rainwater starts out pure — but by the time it lands, it's turned slightly acidic. Why?

WHERE THIS COMES FROM

The EPA and USGS both document the natural acidity of clean rain and how it differs from pollution-driven acid rain.

WORTH NOTING

Clean rain is not neutral — it sits at about **pH 5.6**, because falling drops dissolve atmospheric CO₂ into weak carbonic acid. That is entirely natural, and it is what slowly dissolves limestone into caves. Pollution-driven acid rain is a different thing at pH 4.2–4.4, caused by sulfur and nitrogen oxides.

SOURCE LINKS

→ [US EPA · What is Acid Rain?](#)

→ [USGS · Acid Rain and Water](#)

TOPIC 16

Snowflakes

DID YOU KNOW?

Snow is nature's greatest atmospheric scrubber! As snowflakes drift down, their intricate branching shapes act like tiny nets — scrubbing the air and catching dust, pollution, and even microplastics on the way to the ground.

QUESTIONS IN THIS TOPIC

16.1 Why do no two snowflakes look exactly alike?

16.2 About how many water molecules make up a single snowflake?

16.3 🧐 Here's the flip side: on a single snowflake, why do all six arms look nearly identical to one another?

WHERE THIS COMES FROM

Wet deposition — precipitation scavenging dust and pollutants from the air — is well established in atmospheric science.

WORTH NOTING

No two flakes alike, because each takes a unique path through shifting temperature and humidity. *Yet all six arms match*, because a single flake is small enough that all six arms travel through identical conditions at identical moments. Same principle, opposite outcomes.

SOURCE LINKS

→ [NWS · Cloud and Precipitation Processes \(PDF\)](#)

TOPIC 17

Hail

DID YOU KNOW?

Hail is built inside towering thunderstorms, where powerful updrafts hurl ice up again and again until it grows heavy enough to fall.

QUESTIONS IN THIS TOPIC

- 17.1** Hail forms inside tall thunderstorm clouds, lifted up and down by strong...
- 17.2** A hailstone grows as it collides with “supercooled” water droplets — water that is...
- 17.3** 🍷 Cut a big hailstone in half and you'll see...

WHERE THIS COMES FROM

NOAA's National Severe Storms Laboratory documents how hail grows inside thunderstorm updrafts.

WORTH NOTING

Hailstones grow by colliding with **supercooled** droplets — liquid water still below freezing, which freezes onto the stone on contact. The onion rings are the classic reading of a hailstone's history, though researchers note layering can also reflect changing wet and dry growth conditions rather than one lap each.

SOURCE LINKS

→ [NOAA NSSL · Severe Weather 101: Hail](#)

TOPIC 18

Wind

DID YOU KNOW?

Wind is just air moving from high-pressure areas to low-pressure areas — and the greater the pressure difference, the faster the wind blows!

QUESTIONS IN THIS TOPIC

- 18.1** Which famous air current picks up moisture near Hawaii and drops it on the U.S. West Coast?
- 18.2** Warmer air carries more energy, letting it hold far more water vapor than cold air. This warm, moisture-heavy air then flows toward areas of...?
- 18.3** 🍷 Scientists studying some of the most remote, untouched places on Earth were stunned to find microplastics in...?

WHERE THIS COMES FROM

The Pineapple Express is a specific, named atmospheric river, and microplastics in remote snow come from a peer-reviewed study.

WORTH NOTING

Researchers sampling some of the most remote snow on Earth — Arctic ice floes and the Swiss Alps — found microplastics in **20 of 21 samples**. Wind carried them there, and snow scrubbed them out of the air on the way down. It is Topic 16's mechanism, with an uncomfortable payload.

SOURCE LINKS

→ [NOAA · What are atmospheric rivers?](#)
→ [Bergmann et al. \(2019\) · Science Advances](#)

TOPIC 19

Plants and green water

DID YOU KNOW?

About 10% of all the moisture in the air comes directly from plants — rain they soak up from the soil and breathe back out through their leaves. Scientists call this soil-and-plant water “green water.”

QUESTIONS IN THIS TOPIC

- 19.1** Plants release water through their leaves in a process called...
- 19.2** A single large oak tree can release how much water in a day?
- 19.3** 🍷 Big forests like the Amazon release so much water vapor that they can...

WHERE THIS COMES FROM

The USGS quantifies both how much atmospheric moisture comes from plants and how much a single tree moves.

WORTH NOTING

Transpiration supplies about **10%** of atmospheric moisture, and one large oak moves roughly **40,000 gallons a year** — about 109 a day. Scale that to the Amazon and the forest generates much of its own rainfall, exporting “flying rivers” of vapour across a continent.

SOURCE LINKS

- USGS · Evapotranspiration and the Water Cycle
- NOAA JetStream · Leaf it to Me

TOPIC 20

Frost, deposition and sublimation

DID YOU KNOW?

Frost forms when it's so cold that water vapor turns directly into ice — skipping the liquid stage completely in a process called deposition.

QUESTIONS IN THIS TOPIC

- 20.1** The reverse of deposition — when ice turns straight into vapor without melting first is called...
- 20.2** Which of these can sublimate?
- 20.3** 🍷 Dry ice (frozen CO₂) sublimates into a spooky, rolling fog. How does that fog actually form?

WHERE THIS COMES FROM

Deposition and sublimation are the two phase changes that skip the liquid stage entirely.

WORTH NOTING

The dry-ice question corrects a myth worth correcting: the rolling fog is *not* the carbon dioxide, which is colourless. It is ordinary water vapour from the room, condensed by the intense cold. And CO₂ skips liquid entirely at everyday pressure — it needs about 5 atmospheres before a liquid phase is even possible.

SOURCE LINKS

- USGS · Glossary of Water Cycle Terms
- NOAA JetStream · What a Cycle!

DID YOU KNOW?

When you take a hot shower, you can create your own micro-clouds! Hot water evaporates into warm, moisture-packed air; when that humid air hits the cooler air and surfaces of the room, its vapor condenses into countless tiny droplets — the very same way a real cloud forms, just in your bathroom.

QUESTIONS IN THIS TOPIC

- 21.1** Clouds that form at ground level are called...
- 21.2** Why does fog form low, near the ground, instead of high in the sky?
- 21.3** 🍷 Some dry desert areas string up giant nets to collect...

WHERE THIS COMES FROM

Fog forms by the same physics as any cloud, and fog harvesting in Chile is a documented, working water supply.

WORTH NOTING

In Chile's Atacama — the driest non-polar desert on Earth — mesh nets intercept the coastal fog known as the *camanchaca*. A single square metre of well-placed mesh can wring out several litres a day. Communities drink it and grow potatoes, lemons and figs with it. And the **Atrapaniebla brewery**, run by the Carcuro brothers, brews award-winning beer from it — the low mineral content is said to give it an unusually clean taste.

SOURCE LINKS

- [Mongabay · Fog harvesting in the Atacama](#)
- [New Atlas · Chile's fogcatchers](#)
- [Atlas Obscura · Fog Beer at Atrapaniebla](#)

DID YOU KNOW?

The science of weather and the atmosphere is called meteorology — and by reaching the end, you've explored most of its biggest ideas!

QUESTIONS IN THIS TOPIC

22.1 Which list contains **ONLY** real water-cycle processes?

22.2 Gravity and pressure both shape the water cycle and weather. Which of these affects **BOTH**?

22.3 🍷 Aside from Earth, what is the only other world in our solar system with stable, long-term liquid lakes and a three-phase weather cycle on its surface?

WHERE THIS COMES FROM

The closing question points to the only other world with a surface liquid cycle like Earth's.

WORTH NOTING

The Moon shapes both halves of this world's physics: its gravity raises the ocean tides, and it tugs on the atmosphere itself as well. The wrong answers are worth knowing too — Venus is the hottest planet in the solar system at roughly **467 °C**, hot enough to melt lead, and Jupiter has *no solid surface at all*: its Great Red Spot is a storm wider than Earth that has been turning for centuries, not rainfall. Titan is the real answer — methane clouds, methane rain, methane seas.

SOURCE LINKS

→ [NASA · Titan: Facts](#)

→ [NASA · Tides and the Moon](#)

→ [NOAA · What Causes Tides](#)

→ [NASA · Venus: Facts](#)

→ [NASA · Jupiter: Facts](#)

→ [NASA · The Great Red Spot](#)