Earth's four spheres: what each is, how they interact, and where the water is

Sphere	What it is	Contains
Geosphere (lithosphere)	the solid Earth	crust, mantle, core; rocks, soil, sediment, mountains, sea floor, volcanoes
Hydrosphere	all the water	oceans, lakes, rivers, groundwater, soil moisture, vapour and clouds, ice and snow, water in living things
Atmosphere	the layer of gases	N2 78%, O2 21%, Ar 0.9%, CO2 0.04%, water vapour; troposphere (weather), stratosphere (ozone), mesosphere, thermosphere
Biosphere	all living things and where they live	every organism, from the lower atmosphere to the deep ocean and into rock
Cryosphere (often separated)	the frozen water	ice sheets, glaciers, sea ice, snow, permafrost

Interactions: name the two spheres and what moves

Event	Spheres	What crosses
Volcano erupts	geo → atmo, hydro, bio	ash and gas into the air; lava into the sea; habitats buried
Rain on a hillside	hydro → geo, bio	water erodes soil, dissolves minerals, feeds plants
Photosynthesis	bio ↔ atmo, hydro	takes CO2 and water, gives O2
Roots split rock	bio → geo	biological weathering
River builds a delta	hydro → geo	erosion then deposition
Hurricane	hydro, atmo → geo, bio	warm ocean feeds the storm; flooding and habitat loss
Ocean absorbs CO2	atmo → hydro → bio	carbonic acid; shell-building affected
Glacier carves a valley	cryo → geo	U-shaped valley, moraines
Ice melts	cryo → hydro	sea level rises
Forest fire	bio → atmo, geo	smoke and CO2; ash onto soil
Undersea earthquake	geo → hydro	tsunami
Burning fossil fuels	geo → atmo → hydro, bio	CO2, warming, acidification

Where the water is (USGS Water Science School)

Store	Of all water	Of fresh water
Oceans and seas (saline)	96.5%	
All fresh water	2.5%	100%
Glaciers, ice caps, permanent snow	1.74%	68.7%
Groundwater (fresh)	0.76%	30.1%
Ground ice, permafrost	0.022%	0.86%
Lakes (fresh)	0.007%	0.26%
Soil moisture; atmosphere; swamps	0.001%; 0.001%; 0.0008%	0.05%; 0.04%; 0.03%
Rivers; living things	0.0002%; 0.0001%	0.006%; 0.003%

97.5% of water is salt; 98.8% of the fresh water is ice or underground; rivers and lakes, where people get most of theirs, hold about a quarter of one percent of the fresh water.

From sciencewithshobha.com/blog/earths-four-spheres-geosphere-hydrosphere-atmosphere-biosphere-what-each-one-is-how-they-interact-with-20-examples-the-hydrosphere-in-detail-where-earths-water-is-and-a-printable-chart/ · 1-on-1 online science and AP tutoring, KS2 to A level, Grades 5 to 12, free 30-minute first class.

The water cycle as the spheres exchanging water, and a practice set

[ ] Evaporation (oceans, lakes, soil) and transpiration (plants, biosphere) put vapour into the atmosphere
[ ] Condensation makes clouds; precipitation (rain, snow, hail) returns water to the surface
[ ] On land: surface run-off into rivers and lakes (geosphere channels); infiltration to soil moisture and groundwater; storage as snow and ice (cryosphere); uptake by living things (biosphere)
[ ] Rivers and groundwater return it to the ocean; ice melts; the cycle continues, driven by the Sun's energy and gravity
[ ] Residence times: about 9 days in the atmosphere; weeks to months in a river; decades to centuries in a lake or glacier; thousands of years in the deep ocean and deep groundwater

Curriculum	Where
US NGSS	Grade 5 5-ESS2-1 (model the interactions of the four spheres), 5-ESS2-2 (salt and fresh water amounts); MS-ESS2-4 water cycle
England	Year 4 water cycle; KS3 Earth and atmosphere; GCSE Geography water cycle stores and flows
Australia	Year 7 water cycle; Year 9 AC9S9U02 global systems and the four spheres
CBSE	Class 7 Geography Our Environment: lithosphere, hydrosphere, atmosphere, biosphere
Ontario	Grade 8 water systems

Practice

1. Name the four spheres and one thing found in each.
2. A flood washes topsoil from a field into a river and out to sea. Which spheres interact, and what moves?
3. What percentage of Earth's water is fresh? Where is most of it?
4. Why are rivers so important to people when they hold so little water?
5. Describe two ways the biosphere changes the atmosphere.
6. Is a cloud part of the hydrosphere or the atmosphere? Explain.
7. Which sphere does soil belong to? Why is the answer 'all four'?
8. Give one interaction in which the cryosphere affects the hydrosphere.

Answers

1. Geosphere: rock; hydrosphere: ocean; atmosphere: oxygen; biosphere: a tree (any). 2. Hydrosphere (flood water) erodes the geosphere (soil) and carries it through the hydrosphere; the biosphere loses farmland and the sea gains sediment. 3. 2.5%; in glaciers and ice caps (68.7%) and groundwater (30.1%). 4. They are renewed constantly by the water cycle and are accessible at the surface, so a tiny store supplies a large flow. 5. Photosynthesis removes CO2 and adds O2; respiration and decay add CO2; forest fires add smoke and CO2. 6. Both: it is water (hydrosphere) suspended in the air (atmosphere); the spheres overlap. 7. Geosphere (mineral grains), hydrosphere (moisture), atmosphere (air in pores), biosphere (roots, worms, bacteria). 8. Melting ice sheets raise sea level and add fresh water to the ocean.