

Earth's Subsystems

Science Grade-Level Expectations

The exercises in this instructional task address content related to the following science grade-level expectations:

- (ESS-M-A7) Identify the components of the hydrosphere (GLE 34)
- (ESS-M-A11) Demonstrate the results of constructive and destructive forces using models or illustrations (GLE 32)
- (ESS-M-B3) Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (GLE 38)

	Objectives
Task	<ul style="list-style-type: none"> - Interpret scientific data - Develop a conclusion supported by evidence - Describe interactions among Earth's subsystems - Determine long term and short term effects of destructive and constructive events
<u>Sample Student Exemplar Response</u>	

Implementation Tips:

- This task is intended to be integrated into a larger unit that contains hands-on science opportunities, student-led investigations, non-fiction reading, and a variety of other instructional strategies.
- Teachers may choose to use or modify the task as part of an instructional lesson or as a formative or summative assessment.
- Strategic instructional decisions will need to be determined prior to implementation such as:
 - Should the provided text be read aloud to students or read independently by students?
 - Will students work collaboratively or individually to complete the task?
 - What content knowledge and skills will students need to have prior to attempting the task?
 - Does the task need to be modified based on the needs of the students at the time of implementation?

- Analyze the data below to compare relative amounts of water from various sources of the hydrosphere.

One estimate of global water distribution
(Percents are rounded, so will not add to 100)

Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	--	96.5
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Ground water	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources* (Oxford University Press, New York).

Task Part 1: Using the data above, determine where most of the fresh water on Earth is found? Cite evidence from the data to support your conclusion.

- Read the article [Mount St. Helens: World of Change](#).
- View the video clip, [Will Mount St. Helens Erupt Again?](#)

Task Part 2: Analyze how the eruption of Mount St. Helens was both a constructive and destructive force that affected the geosphere, hydrosphere, atmosphere, and biosphere of the Earth. In your description, identify both short-term and long-term effects. Include a model or illustration to support your analysis.

Sample Student Exemplar Response:

Part 1

Most of the freshwater on Earth is not surface water on land (lakes, rivers, streams). Data shows that 68.7% of the world's freshwater is located in glaciers, ice caps, and permanent snow. This leaves less than 32% located in ground water, ice, permafrost, lakes, swamps, and rivers.

Part 2

Volcanoes are a part of the geosphere. When volcanoes erupt, they are initially destructive. They spew hot lava, expel rocks and ash, and emit hot gases into the atmosphere. The lava and ash that falls out of the air smothers vegetation, animals, and humans. These living organisms are part of the biosphere. The geosphere and biosphere are also impacted in the short term through hot lava burning everything that the lava touches.

The atmosphere and hydrosphere are also impacted by the expelled heat and particles. Volcanic ash and steam form destructive clouds in the atmosphere. Birds may suffocate, fly off course, or fall from the sky because their feathers are affected by the ash and moisture. Many airports may cancel flights and ground planes due to the visibility of pilots decreasing. The steam then cools and creates rain. The rain formed (hydrosphere) combines with the ash and rocks and may cause destructive mudslides (geosphere) that can kill all life forms (biosphere) in their path. If the rain (hydrosphere) water combines with sulfuric fumes from the volcano, it can produce destructive acid rain over large areas. Acidic rain water can kill vegetation, amphibians, and fish (biosphere) and leach into the soil (geosphere).

In the long term, volcanic eruptions can be constructive. The lava, rocks, and ash form new surface structures (geosphere) and soil that can stimulate new growth in plants (biosphere). After a few years, the site of inactive volcano can become a rich ecosystem.

Examples of models include a sketch of an erupting volcano with the resulting changes labeled correctly on each part of the sketch. Another type of model that students may use is a table with events recorded in either long and short terms columns, constructive and destructive columns, or in columns labeled geosphere, hydrosphere, atmosphere, and biosphere.