Educator Guide

Science Activity 5: Distant Reservoirs: Water in the Solar System

Educator Preview

Activity Snapshot

Learners explore the different reservoirs of water on planetary bodies in the solar system.

Timing | 45 minutes

Get Ready & Team Up	10 min.
Investigating Water in the Solar System	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 20–45 min. each

Prep Snapshot*

Prep Time 10 min.

- Space Need: Large open area
- Prepare the *Our Ideas* poster.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Collaboration
- Critical Thinking

Science Practices

- Analyzing and Interpreting Data

Guiding Question

Where is the most water in the solar system?

Learners Will Do

Get information about different planetary bodies to discover where water can be found in our solar system.

Learners Will Know

Scientists gather data to understand the natural world, including the solar system.

Connecting Across Activities

Activity 4: Exploring the Solar System	Activity 5: Water in the Solar System	Activity 6: Choose a Potential Water Reservoir to Explore
Last time, learners explored the physical properties of planetary bodies in the solar system.	**Today**, learners explore the different reservoirs of water on planetary bodies in the solar system.	**Next time**, learners will combine what they have learned to choose an extraterrestrial water reservoir to explore for life.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction, pgs. iii–xxv. Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/2b464918

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples & Templates
- 1 deck of Planetary Cards (weblink) or Planetary Cards: Large Print/ Translatable version (PDF)
- tape (painter's if possible)

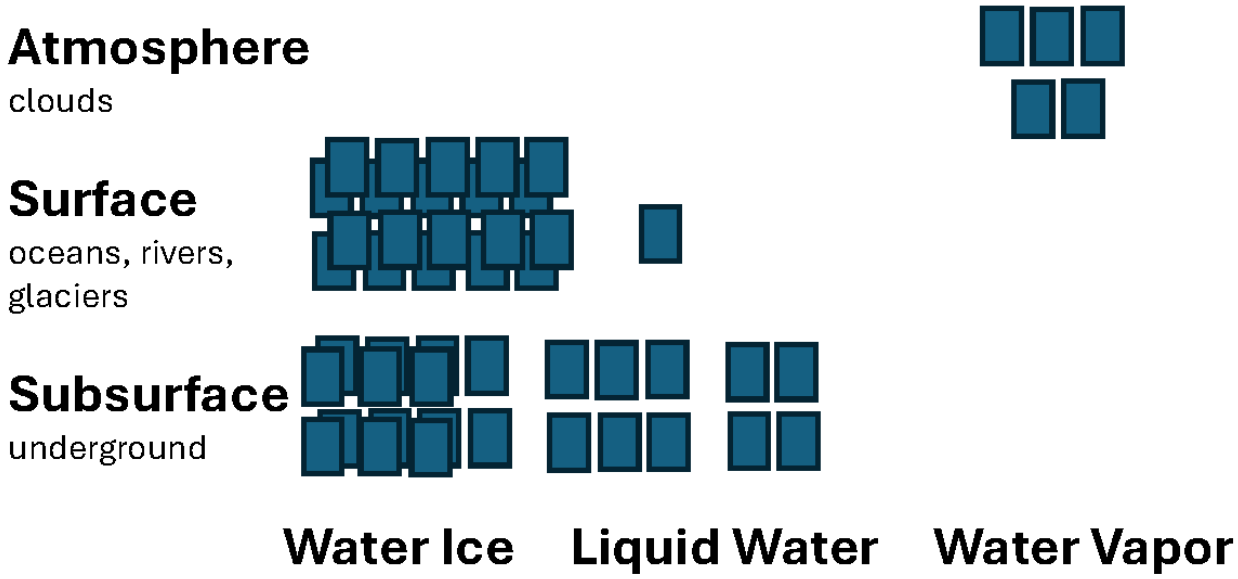
For each learner

- pencil

Activity 5 Materials Preparation (10 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. Ensure that there is an area of the *Our Ideas* poster open to make a chart. Along one side of the chart will be the reservoir type (atmosphere, surface, subsurface), and along the other side will be the state of water (ice, liquid, vapor). You may need to rewrite these terms in an open part of the poster.



3. Print one copy of Science Activity 5 Finding Water Worlds Handout, pg. 77, for each pair of learners.
4. Print one copy of Science Activity 5 Types of Reservoirs Handout, pg. 78, for each group of four learners.

In Your Space

5. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.

Teaching Tip

Lead this activity in a room with a large open area.

Activity Guide

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We explored the planets, dwarf planets, moons, and asteroids in the solar system. This helped us start thinking about where to search for life.)*

2. Ask: **What is the big question we are trying to answer?** *(Where in the solar system should NASA search for life?)* If necessary, display NASA's Eyes on the Solar System app to remind learners about the solar system. As needed, use NISE's Exploring the Solar System: Pocket Solar System or Solar System in Sound instead.

3. Say: **Today, we will continue our search for life in the solar system. We've learned many factors about habitability, including temperature, salinity, where to find water, and how much water is present on different planetary bodies, but in this activity, we're going to focus only on where water is and how much of it there is on each body in the solar system.** Refer to the word *habitability* on the *Our Ideas* poster. Share the Guiding Question or a similar question from the *Our Ideas* poster with learners aloud and in writing (using multiple languages as needed): **Where is the most water in the solar system?**

4. Organize learners into pairs.

Investigating Water in the Solar System (25 min.)

Planetary Systems Challenge

5. Give each pair a copy of *Science Activity 5 Finding Water Worlds Handout*, pg. 77. Say: **This page gives instructions to help you think about where there is water throughout the solar system. You'll be collecting groups of cards that are all located near the same planet or belt. For example, the Earth category includes the Earth Subsurface, Earth Surface, Earth Atmosphere, and Moon Surface cards.** Show these cards to learners to support their understanding. **As a pair, you have about 10 minutes to follow the instructions.**

6. Deal one deck of *Planetary Cards* so each pair has approximately the same number of cards.

7. Give learners a few minutes to review the instructions and ask questions. As needed, offer clarifications and explain that learners are trading cards so each pair has all the cards for one planet and all its moons, or for all the dwarf planets, moons, and asteroids in one belt.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Teaching Tip

The following Planetary Systems Challenge works best with exactly 10 learner pairs. If you have more than 20 learners, make some groups of four as needed to have exactly 10 groups. If you have fewer than 20 learners, have some pairs collect multiple card sets with few cards (e.g., Mercury and Venus; all inner planets).

Support Thinking

To help learners understand what they will be doing during this activity, play the translatable video Water How to Science (2:55–3:22).

8. Give learners 10 minutes to follow the instructions.
9. After about 10 minutes, pairs should be arranged in a line by distance from the Sun, with the Mercury group on one side of the room, the Kuiper Belt group on the other side, and all the other groups between them. If needed, provide support to ensure they are organized correctly.
10. Say: **You have organized yourself by planetary locations. Now, we are going to represent the amount of water at each planetary location.** Have learners represent the water in two different ways:
    - **Hand Raising:** Have pairs with a total water value below 50 hold their cards down low; with a value between 50 and 100 at normal hand level; with a value above 100 up high.
    - **Speech Volume:** One pair at a time, in distance order from the Sun, have all pairs say their total water value. Have pairs with lower values speak quietly and pairs with higher values speak loudly.
11. Have learners think about their data representation. Ask: **What do you notice about where water is in the solar system?** Have learners discuss in pairs and record their ideas on the *Our Ideas* poster. *(There is generally less water in the inner solar system, closer to the Sun, and more water in the outer solar system, farther from the Sun.)*

Teaching Tip

For reference to remember the order of the planets from the sun, you can share the Solar System Mnemonic, pg. 6 in the STEM Event Water Cards Activity (PDF) with your learners.

Level Up!

As a third way of displaying the information, tape the sets of cards on a wall at different heights depending on how much water is in each planetary system. (5 min.)

Level Up!

To help learners remember the graph they created

- have them draw a version of it in their Notebooks.
- take a picture or audio/video recording. If you take a picture, print it and attach it to the *Our Ideas* poster.
- have them enter the data into a spreadsheet and use it to create a graph and compare it to the human graph they created.

See the Water in the Solar System Key, pgs. 79-80, for a brief overview of the droplet values for all cards. (45 min.)

Support Thinking

- Show the video Water in the Solar System and the Science Activity 5 Water Worlds in the Solar System Poster (JPG) to support learner understanding about the locations of water in the solar system.
- After learners have created their representation, project the Water in the Solar System Key, pgs. 79-80 to make the patterns easier to analyze.

Reservoirs Challenge

12. Organize learners into groups of four.

13. Collect all the *Planetary Cards*.

14. Give each group a copy of *Science Activity 5 Types of Reservoirs Handout*, pg. 78. Say: **Now that we have explored where water is generally located in planetary systems, we will explore the reservoirs where water is found and what form it is in within those systems. This page helps you understand different forms of water and where they are found. You'll be sorting water into groups based on its form and its location. For example, the "Water vapor in the atmosphere" category includes the atmosphere cards for Venus, Earth, Mars, Jupiter, and Saturn.** Show these cards to learners to support their understanding. **As a group, you have about 10 minutes to follow the instructions.**

15. Shuffle the single deck of *Planetary Cards* and re-deal them so each group has about the same number of cards.

16. Give learners a few minutes to review the instructions. As needed, offer clarifications and explain that learners are trading cards so each group has all the cards for a particular reservoir (atmosphere, surface, subsurface) and form of water (ice, liquid, vapor). Note that some reservoirs contain water in multiple forms (for example, subsurface water can be ice and liquid). Explain that such cards can be placed in either of the categories to which they belong.

17. Give learners 10 minutes to follow the instructions.

18. After about 10 minutes, say: **You know that water can be found in different reservoirs – on the surface, in the subsurface, and in the atmosphere.** Refer to these words on the *Our Ideas* poster. **You also know that it can take different forms.** Refer to the word *liquid* on the *Our Ideas* poster. Ask: **Besides liquid, what other forms can water take?** *(Water can be a solid, as water ice, or a gas, as water vapor.)* Add the terms *water ice* and *water vapor* to the *Our Ideas* poster.

Teaching Tip

The following Reservoirs Challenge works best with exactly 6 groups. If you have more than 24 learners, make larger groups as needed to have exactly 6 groups. If you have fewer than 24 learners, have some groups collect multiple card sets.

Support Thinking

- To help learners understand what they will be doing during this activity, play the translatable video Water How to Science (3:22–4:05).
- Learners may not be familiar with the term *water vapor*. Provide ways for them to experience water vapor, such as by observing water evaporating (for example, from a cup of hot water) and condensing (for example, on a cold surface). Ask: **Where have you experienced water in the air before?**

19. Say: **In order to remember where water is located, add your cards to the poster in the category where they belong.** Have each group tape their cards on the poster with backside circles of painters tape (so they can be reused) in the category to which they belong (for example, surface+ice or subsurface+liquid).

Level Up!

Have learners identify which reservoirs contain water in multiple states (for example, ice and liquid) and tape those cards in between categories on the *Our Ideas* poster. (5 min.)

Reflect (10 min.)

20. Have learners revisit the Guiding Question in their small groups: **Where is the most water in the solar system?** *(Most of the water in the solar system is in the outer solar system in the subsurface of planetary bodies.)* Ask: **How does this information help us decide where to search for life?** *(We can prioritize the bodies that have liquid water because we know life on Earth needs liquid water. Except for Earth, all this liquid water is underground, so we will need a way to learn about the subsurface of planetary bodies.)* **What are some planetary bodies with liquid water?** *(Callisto, Europa, Ganymede; Dione, Enceladus, Titan; Titania; Triton; Pluto)* As needed, remind learners of the terms *water ice*, *liquid water*, *water vapor*, *subsurface*, *surface*, and *atmosphere* on the *Our Ideas* poster.

21. Say: **Next time, you will use the information you've gathered to make a recommendation about the best planetary bodies to search for life.**

Level Up!

Have learners think about ways their knowledge of water on other planetary bodies is limited. Ask: **What else would you like to learn about water in these reservoirs?** (5 min.)

Level Up!

- Ask this story prompt question: **What kind of stories do you know about traveling to explore other planets?** *(Possible responses include stories from fiction and stories of humans sending robots to other planets.)* Have learners share with a partner (note that the sharing can take forms other than speaking aloud). Consider returning to learners' ideas at the start of the next activity. (20 min.)
- Tell learners, if anyone asks them what they did today, they can tell them "We learned about where there is water in the solar system." (5 min.)
- Read more about where NASA missions have found water on Mars! NASA Is Locating Ice on Mars With This New Map - NASA. (5 min.)

After the Activity

1. Clean up:
   - Save the *Our Ideas* poster for Activity 6.
   - Collect the ***Planetary Cards***.
2. Plan for Science Activity 6. See Science Activity 6 Preparation on pg. 82.
3. Take time to reflect on the following educator prompt. **How were learners thinking about habitability during this activity? How do you know?**

Water in Extreme Environments Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/7cb5c428

Finding Water Worlds

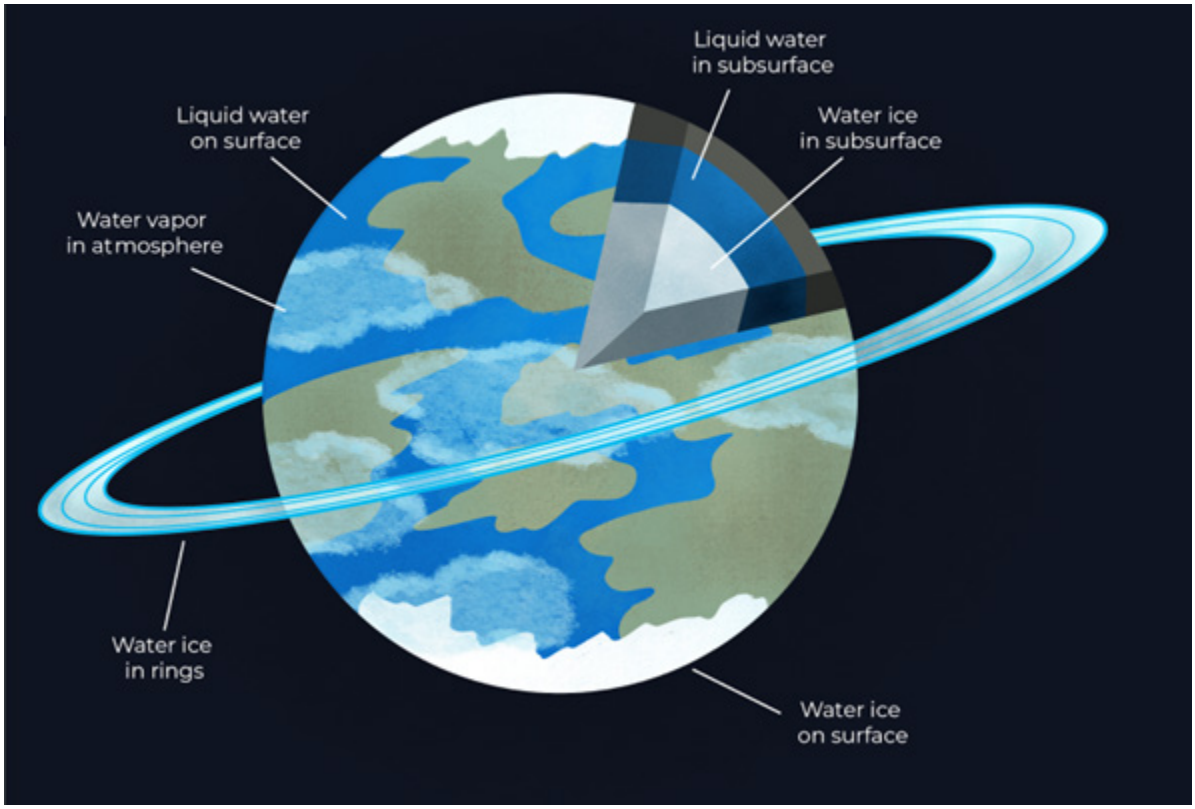
1. As a pair, review the cards you have.
2. Trade cards with other pairs until you have all the cards for one of these locations:
   - Mercury (1 card)
   - Venus (1 card)
   - Earth and the Moon (4 cards)
   - Mars and its moons (3 cards)
   - Main Asteroid Belt (2 cards)
   - Jupiter and its moons (8 cards)
   - Saturn and its moons (17 cards)
   - Uranus and its moons (11 cards)
   - Neptune and its moons (3 cards)
   - Kuiper Belt (4 cards)

Note: You will need to read some cards closely to figure out which location they are in.

3. Once you have all the cards for one location, give away the rest of your cards to pairs that need them.
4. Add the water values on your cards. Remember the total.
5. Form a line in order of distance from the Sun. The Mercury group should be on one side of the room and the Kuiper Belt group should be on the other side.

Types of Reservoirs

1. As a group, review the cards you have.

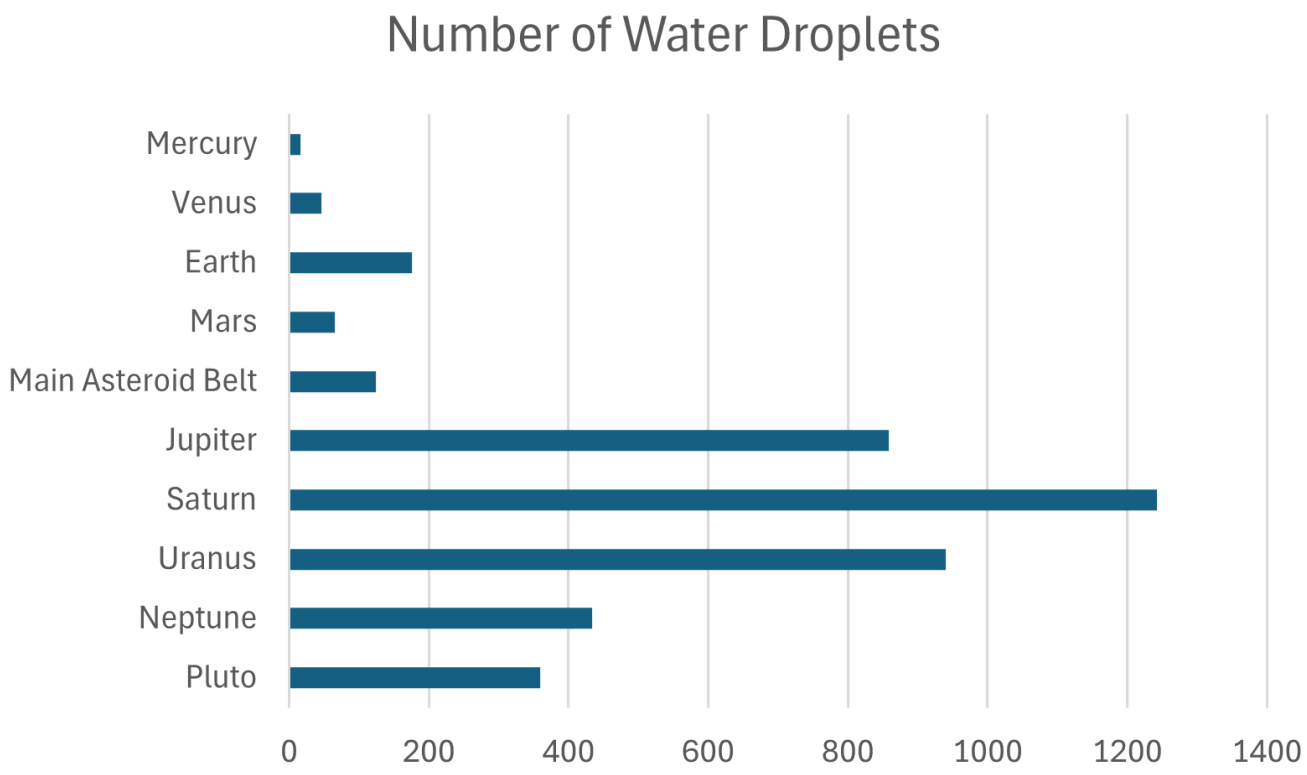


2. Trade cards with other groups until all your cards fit in one of these categories:
   - Water vapor in the atmosphere (6 cards)
   - Water ice on the surface/in rings (~20 cards)
   - Water ice in the subsurface (~14 cards)
   - Liquid water on the surface (1 card)
   - Liquid water in the subsurface (~10 cards)
   - No water (3 cards)

Note: Some cards can be used in multiple categories.

3. Once you have all the cards in one category, give away the rest of your cards to groups that need them.

Water in the Solar System Key



Location in the Solar System	Planetary Body (Planet or Moon)	Subsurface (Groundwater, Ground Ice, Subsurface Oceans)	Surface (Oceans, lakes rivers, polar caps)	Atmosphere (Clouds, rain, snow, humidity)	Rings	Total number of water droplets
Inner	Mercury	0	16	0	0	16
Inner	Venus	0	0	46	0	46
Inner	Earth	14	155	3	0	172
Inner	Moon	0	4	0	0	4
Inner	Mars	22	42	4	0	66
Asteroid Belt	Vesta	0	0	0	0	0
Asteroid Belt	Ceres	124	0	0	0	124
Outer	Jupiter	0	0	77	0	77
Outer	Io	0	0	0	0	0
Outer	Europa	175	19	0	0	194
Outer	Ganymede	285	32	0	0	317
Outer	Callisto	244	27	0	0	271
Outer	Saturn	0	0	72	0	72
Outer	Rings	0	0	0	91	91
Outer	Mimas	79	9	0	0	88
Outer	Enceladus	81	9	0	0	90
Outer	Tethys	134	15	0	0	149
Outer	Dione	129	14	0	0	143
Outer	Rhea	141	16	0	0	157
Outer	Titan	255	28	0	0	283
Outer	Iapetus	153	17	0	0	170
Outer	Uranus	200	0	0	0	200
Outer	Miranda	86	10	0	0	95
Outer	Ariel	133	15	0	0	148
Outer	Umbriel	138	15	0	0	153
Outer	Titania	156	17	0	0	173
Outer	Oberon	154	17	0	0	171
Outer	Neptune	197	0	0	0	197
Outer	Triton	213	24	0	0	237
Kuiper Belt	Pluto	187	21	0	0	208
Kuiper Belt	Charon	137	15	0	0	152