Anne Berland
EDCI 403
Science Extension Project

Water Cycle Game

OVERVIEW

Students explore the importance of water as it moves between living and nonliving parts of the earth and ecosystem.

WATER PRINCIPLES

1. Water is fundamental for life on earth.
2. Water influences weather and climate by transferring energy between the ocean, land and atmosphere.
3. Water and humans are inextricably linked
4. Water connects the Earth's land, ocean and atmosphere into an integrated system.
5. The impacts of climate change will occur primarily through changes in the water cycle.

KEY CONCEPTS

1. Water moves through many different phases
2. Phases have different residence times - fast or slow
3. A cycle is not a circle, the path taken by a water molecule is complex, it is not moving towards an end point
4. Conservation of matter

DURATION

40 minutes to 1 hour

PHYSICAL ACTIVITY

Options for low, moderate and high

MATERIALS

- Dice (2 per phase = 20 dice)
- Phase Information Sheets (10)
- Pencils
- Student Worksheets (one per student)
- Class Data Sheet
- Whiteboard, flipchart or computer and projector for tabulating data and creating graphs
- Blank graph paper or provided graph sheet (one per student)

BACKGROUND

The water cycle is the continuous movement of water between the earth and the atmosphere. Without the water cycle, water would not be able to reach the plants and animals, including humans!, that rely on it to live. Water is not only important for sustaining life, but it also moves sediment, nutrients and pathogens throughout aquatic ecosystems. Understanding where water exists in our environment helps students the importance of the ocean and atmospheric phases of the water cycle.

In this game, students take on the roll of a water molecule and record their movements through the water cycle. In recording their movements, comparing them with classmates, and compiling data as a class, they will learn about the never-ending circulation of water from the clouds, to the land, to the ocean, and back to the clouds. Playing this game outside provides an opportunity to integrate science with physical activity. By arranging the phase locations strategically, students can run, hop and twirl their way through the water cycle.

SET-UP PRIOR TO ACTIVITY

1. Print out Phase Information Sheets. Consider laminating them if the game will be played outside, or to use again later.

Outside:

1. Identify 10 areas within the play environment to represent the water cycle stages. Use the natural or constructed features of the environment to help you define the areas, for example, a pathway or other linear feature could be a river. If there are no obvious features, use cones, rope or other markers.
2. Place two dice and the appropriate Phase Information Sheet at each location. Affix each information sheet so that it won't go missing during the game.

3. If playing with dice, ensure there is a hard surface available to roll the dice onto.

Inside:

1. Move tables or desks around within the classroom to create 10 areas to represent the water cycle stages.
2. Place two dice and the appropriate Phase Information Sheet on each desk or table, or affix it to a wall.

ACTIVITY

1. Review why water is important (for biology and climate).
2. Tell students they are going to be a water molecule moving through the water cycle.
3. Revisit the phases of the water cycle with students. This could be a brief refresher as the water cycle is part of the Grade 2 curriculum in B.C.
    a. Phases to cover include clouds, ocean, snow field, glacier, river, lake, soil surface, groundwater, plants and animals.
    b. Processes they should be aware of are melting, freezing, precipitation, evaporation, sublimation.
4. Provide each student with a Student Worksheet. They should put their name on the top of the sheet immediately.
5. Show the students where each of the water cycle phase locations are within the play area or classroom.
6. If playing outside, define the boundaries of the play area and identify any safety hazards or concerns.
7. Review the rules of the game:
    a. The game begins when the leader calls out "*PRECIPITATION*!",
    b. They will write their starting point at the top of their sheet
    c. They will find a die and an Information Sheet at each phase location. They will roll the die and use the information sheet to find out where to go next.
    d. They should write the next phase of the water cycle on their Student Worksheet before moving.
    e. Sometimes, the dice roll will indicate that the students remain where they are. They must record this by writing the phase name on the Student Worksheet again, and then roll the dice again.
    f. As the students are water molecules, they do not WANT to go to any phase, they will follow where the dice tells them to go after rolling the dice ONCE.
    g. The game ends when the leader calls out "*EVAPORATION*!", and all the students will leave their stations to gather together.

8. Allow students to disperse throughout the area and select a starting point. Alternatively you can assign students to start at particular locations, but this can be decided by the teacher.
9. Call “PRECIPITATION”
10. Monitor students as they move through the game, and remind them of the rules as needed.
11. Allow students to move through the phases of the water cycle for 10-15 minutes, or longer if they are enjoying the game.
12. When the game has run its course, call “EVAPORATION” and gather students for debriefing.

DEBRIEF/DISCUSSION

1. Gather the students together.
2. Ask the students to add up the total number of movements through each phase of the water cycle.
3. Ask students to compare their movements with a partner.
4. Have the students look at a diagram of the water cycle. Did their movements go in a circle?
5. Discuss the game. The following questions could be used as a starting points for discussion:
    a. *Which phases did you visit the most?*
    b. *Was anyone stuck at any phase for a long period of time?*
    c. *Which phases of the water cycle did you move away from quickly?*
    d. *What are the processes that moved water from one place to another?*
    e. *What was your favourite water cycle phase to go to?*
    f. *What surprised you about your movement through the water cycle?*
    g. *What frustrated you about the game?*
6. Extend the discussion to weather, climate and climate change:
    a. *What do you think would happen if the temperature on earth gets warmer?*
    b. *What happens if there is more evaporation? More precipitation?*

DATA ANALYSIS OPTIONS

Use the following analysis procedure to link the water cycle game to data analysis principles. Discuss the various results and graphs as a class.

1. The teacher can use the Class Data Sheet to compile the data.
2. To aggregate the data, teachers could ask students to call out their totals, they could write them themselves on the Class Data Sheet, or the teacher could collect the record sheets and compile the numbers.
3. On the Class Data Sheet, find the total number of times the students moved through each stage of the water cycleIdentify which phases of the water cycle were visited the most and least amount of times.
4. Identify which students spent the most and least amount of time at each phase of the water cycle.
5. Calculate the total number of movements and record this in the appropriate place on the Class Data Sheet.
6. Calculate the percentage totals for movements at each phase of the water cycle and record this on the Class Data Sheet. As a class, discuss ways this data could be represented visually.
7. Create a bar chart to represent the visits to each phase of the water cycle. The phases of the water cycle will be listed along the *x*-axis and the count totals will be on the *y*-axis. This can be carried out as a class, using a flip chart, whiteboard or computer and projector screen, or students can create their own bar chart using blank paper or the provided blank graph.
8. Create a pie chart that shows the relative number of movements through each phase of the water cycle.
9. Ask students to count and record the number of consecutive turns they stayed at each phase location (residence time). Students will likely have multiple values for various cycle phases.
10. Collect the residence time data on another copy of the student record sheet. Use multiple rows per student if necessary.
11. Calculate the average residence time at each of the phase locations.

TEACHING CONSIDERATIONS

- To increase the physical activity in the game, consider what types of movements you could assign to the different phases of the water cycle. Post cards describing the movements to remind students what to do and to be active! Some examples are:
    - Gallop like a horse or jump like a rabbit as animals
    - Grow tall on tip toes with arms outstretched as plants
    - Run quickly in the river
    - Twirl as snowflakes
    - Sway in waves of the ocean
    - Stomp in puddles on the soil surface
    - Jump up to the clouds
    - Squats to show water becoming groundwater
    - Move low and slow as a glacier
    - Hop on lily pads across a lake
- Ensure that students of all mobilities are able to access each water cycle phase location.
- Another fun way to record movements is by having a jar of different coloured beads for each station. Students add a bead to a string or lanyard to track which phases they pass through, and then can decode the colours afterwards.

CURRICULAR CONNECTIONS

This game can be used to implement the B.C. Science Curriculum through the following connections:

- Grade 2 Science Curricular Content: Water sources, cycles, and conservation and First People's knowledge of water are covered in the Grade 2 Science Content. This game is most likely too complicated for Grade 2 students, but as older students should be familiar with the water cycle, they may not need much of a refresher.
- Grades 3 and 4 Science Curricular Competencies: Use tables, simple bar graphs, or other formats to represent data and show simple patterns and trends; Make simple inferences based on their results and prior knowledge; Compare results with predictions, suggesting possible reasons for findings.
- Grades 3 - 6 Science Curricular Competencies: Identify First Peoples perspectives and knowledge as sources of information; Experience and interpret the local environment
- Grades 5 and 6 Science Curricular Competencies: Identify patterns and connections in data; Transfer and apply learning to new situations; Compare data with predictions and

develop explanations for results; Demonstrate an openness to new ideas and consideration of alternatives.

Additionally, the game integrates with the following Big Ideas from other disciplines in the B.C. Curriculum:

- Math
    - Grade 4: Analyzing and interpreting experiments in data probability develops an understanding of chance.
    - Grade 5: Data represented in graphs can be used to show many-to-one correspondence.
    - Grade 6: Data from the results of an experiment can be used to predict the theoretical probability of an event and to compare and interpret.
    - Grade 7: Data from circle graphs can be used to illustrate proportion and to compare and interpret. .
- Physical and Health Education
    - Grades 2 - 4: Daily participation in physical activity at moderate to vigorous intensity levels benefits all aspects of our wellbeing.
    - Grades 5 - 6: Daily physical activity enables us to practice skillful movement and helps us develop personal fitness.

INCORPORATE FIRST PEOPLE'S KNOWLEDGE OF WATER

Incorporate First People's Science Knowledge into THE discussion.

- We can see that the ocean is a major part of the water cycle. *If water is so important to humans, and most of the water is in the ocean, how is the ocean important to us? What connections do we have to the ocean? Which oceans are we connected to via bodies of water? How do we affect the ocean via these connections? How are we connected to the ocean by the products we use, jobs in our communities, breaths we take, food we eat, climates we live in?*
- See Unit 8 - Ocean Connections (pg. 178) here: http://www.fnesc.ca/wp/wp-content/uploads/2015/08/PUBLICATION-61496-Science-First-Peoples-2016-Full-F-WEB.pdf
- We can also discuss students' connections with water. *What is your relationship with water? Is water important to your identity? Do you take water for granted? Where does our drinking water come from? Do we pay for water? Do you know how expensive it is? Where does wastewater go?*

- See Unit 3 - Relationships to Freshwater here: http://www.fnesc.ca/wp/wp-content/uploads/2019/08/3.3-Relationships-to-Fresh-Water.pdf

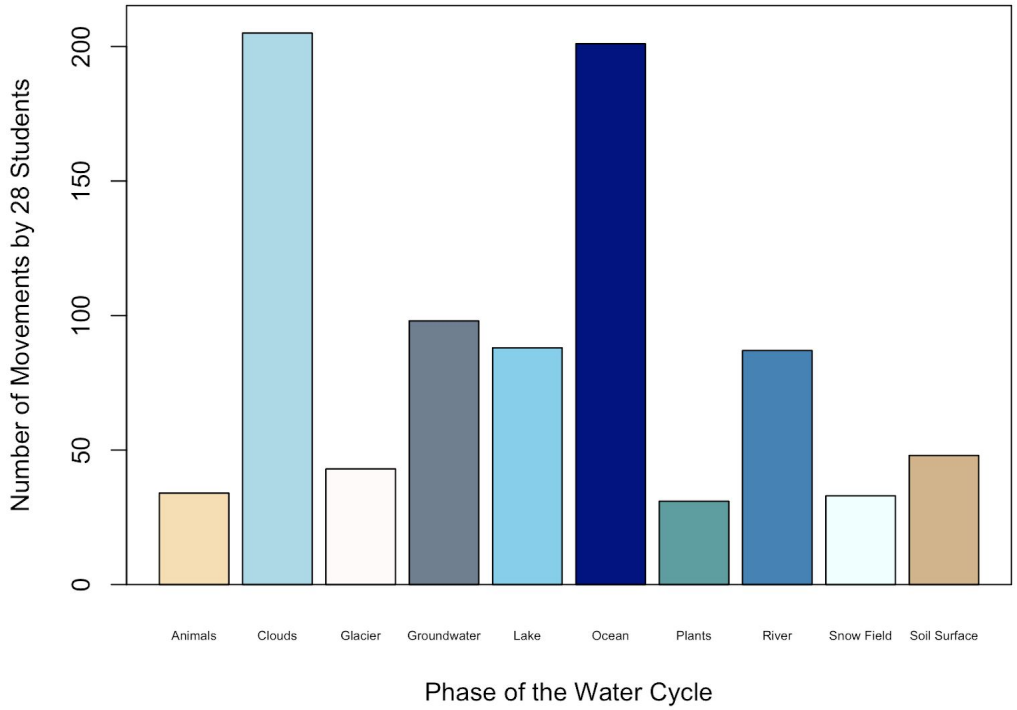
ASSESSMENT

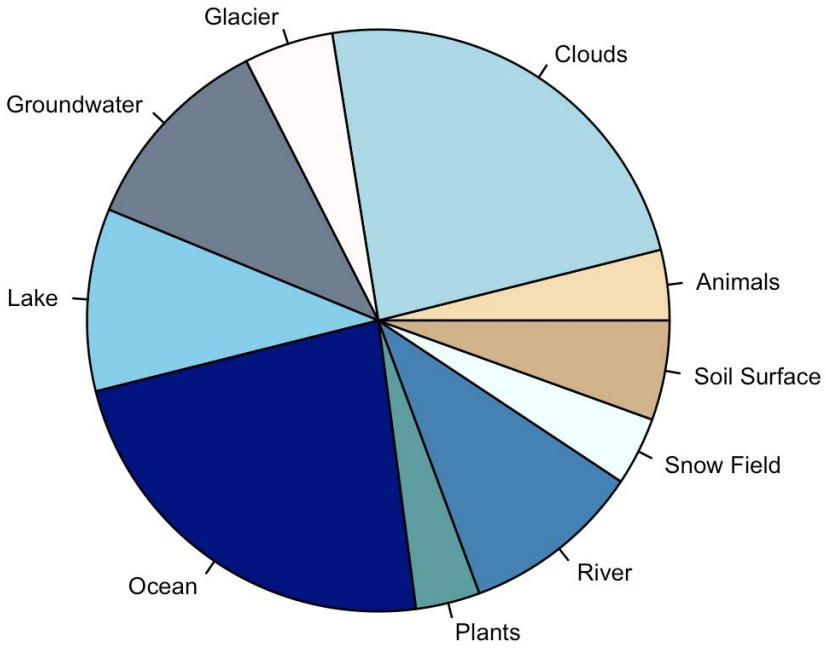
The teacher should be observing and listening to students during the game and in the debrief discussion afterwards. Attention should be given to who is understanding the concept of the water cycle, and who needs further assistance. Ensure students understand the expectation that they will actively participate in the game in a respectful way, with positive attitudes. The teacher can take in the completed bar and pie charts to provide feedback where necessary. Ask students to respond on the back of their sheet to one of the following reflection prompts. Responses could be in writing, or as drawings.

- “During the water cycle game, I was most surprised by …”
- “In the water cycle game, I spent the most time in _____. What this tells me about the water cycle is …“
- “The earth getting warmer affects the water cycle by …”
- “Where does water come from and where does it go?

SAMPLE GRAPHS

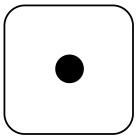
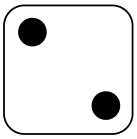
These graphs were created by simulating data for 28 students that each made 30 movements in the water cycle game, starting from a randomly determined phase location. The data collected in class may approximate this distribution.



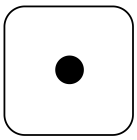
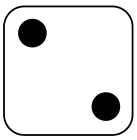


WATER CYCLE PHASE INFORMATION SHEETS

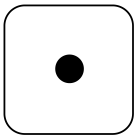
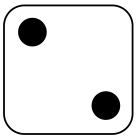
RIVER

	RIVER - Water flows into a bigger river
	LAKE - Water flows from the river into a lake
	OCEAN - Water flows from the river to the ocean
	OCEAN - Water flows from the river to the ocean
	GROUNDWATER - Water filters through the soil to become groundwater
	CLOUDS - Heat causes water to evaporate and form clouds

GLACIER

	GLACIER - Water remains as ice in the glacier
	GLACIER - Water remains as ice in the glacier
	GLACIER - Water remains as ice in the glacier
	RIVER - Ice melts into liquid water and flows into a river
	OCEAN - Ice melts into liquid water directly into the ocean
	CLOUDS - Ice sublimates to become gas and form clouds

OCEAN

	CLOUDS - Heat causes water to evaporate and form clouds
	CLOUDS - Heat causes water to evaporate and form clouds
	OCEAN - Just float with the tides! Water remains in the ocean
	OCEAN - Just float with the tides! Water remains in the ocean
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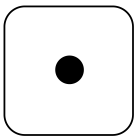
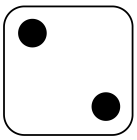
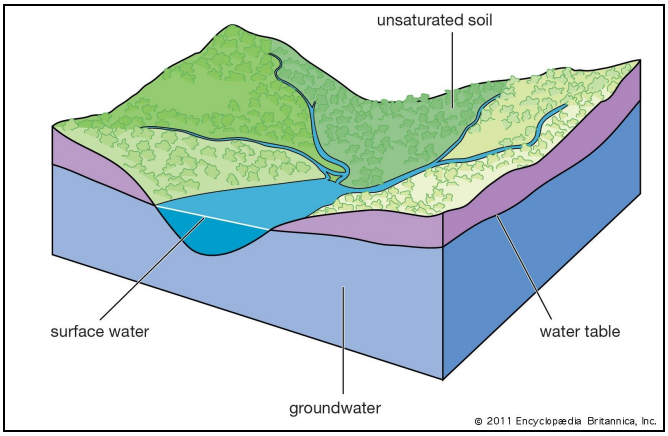
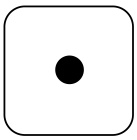
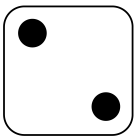
	OCEAN - Just float with the tides! Water remains in the ocean

SOIL SURFACE

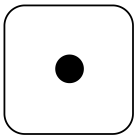
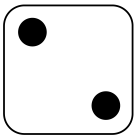
	RIVER - Water runs off the soil surface into a river
	LAKE - Water runs off the soil surface into a lake
	CLOUDS - Heat causes water to evaporate and form clouds
	GROUNDWATER - Water filters through the soil to become groundwater
	PLANTS - Roots of a plant absorb the water
	ANIMALS - Slurp! An animal drinks the water from the soil surface



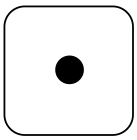
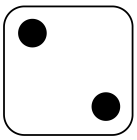
GROUNDWATER

	GROUNDWATER - Water remains as groundwater
	GROUNDWATER - Water remains as groundwater
	GROUNDWATER - Water remains as groundwater
	RIVER - Water filters up through the soil into a river
	LAKE - Water filters up through the soil into a lake
	PLANTS - Roots of a plant absorb the water

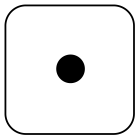
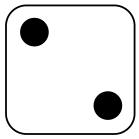
SNOW FIELD

	GLACIER - Snow freezes into ice and becomes part of a glacier
	GLACIER - Snow freezes into ice and becomes part of a glacier
	GLACIER - Snow freezes into ice and becomes part of a glacier
	RIVER - Snow melts into water and flows into a river
	GROUNDWATER - Snow melts into water, and filters through the soil to become groundwater
	CLOUDS - Snow sublimates to become gas and form clouds

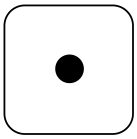
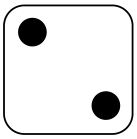
PLANTS

	CLOUDS - You've been transpired! The water leaves the plant and rises to form clouds
	CLOUDS - You've been transpired! The water leaves the plant and rises to form clouds
	CLOUDS - You've been transpired! The water leaves the plant and rises to form clouds
	PLANTS - The water is used by the plant
	PLANTS - The water is used by the plant
	ANIMALS - Munch! An animal eats the plant

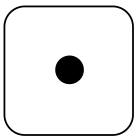
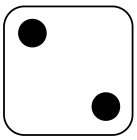
CLOUDS

	OCEAN - Water condenses from gas to liquid, precipitates as rain into the ocean
	SOIL SURFACE - Water condenses from gas to liquid, precipitates as rain onto the soil
	SNOW FIELD - It's cold! Water condenses then precipitates as snow onto a mountain
	LAKE - Water condenses from gas to liquid, precipitates as rain into a lake
	RIVER - Water condenses from gas to liquid, precipitates as rain into a river
	CLOUDS - Just chill out here, water remains a droplet within a cloud

LAKE

	LAKE - Water remains in the lake
	RIVER - Water flows out of the lake into a river
	PLANTS - Roots of a plant absorb the water
	ANIMALS - Slurp! An animal drinks the water from the lake
	GROUNDWATER - Water filters through the soil to become groundwater
	CLOUDS - Heat causes water to evaporate and form clouds

ANIMALS

	CLOUDS - Through respiration and evaporation, the water leaves the animal's body and rises to form clouds
	CLOUDS - Through respiration and evaporation, the water leaves the animal's body and rises to form clouds
	CLOUDS - Through respiration and evaporation, the water leaves the animal's body and rises to form clouds
	ANIMALS - Water is used by the animal's body
	SOIL SURFACE - The animal's urine and feces are excreted onto the soil
	SOIL SURFACE - The animal's urine and feces are excreted onto the soil

TEACHER AND STUDENT WORKSHEETS

Water Cycle Student Record Sheet

Name: _____

Starting Phase: _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____

Totals:

Animals: _____ Lake: _____ Snow Field: _____

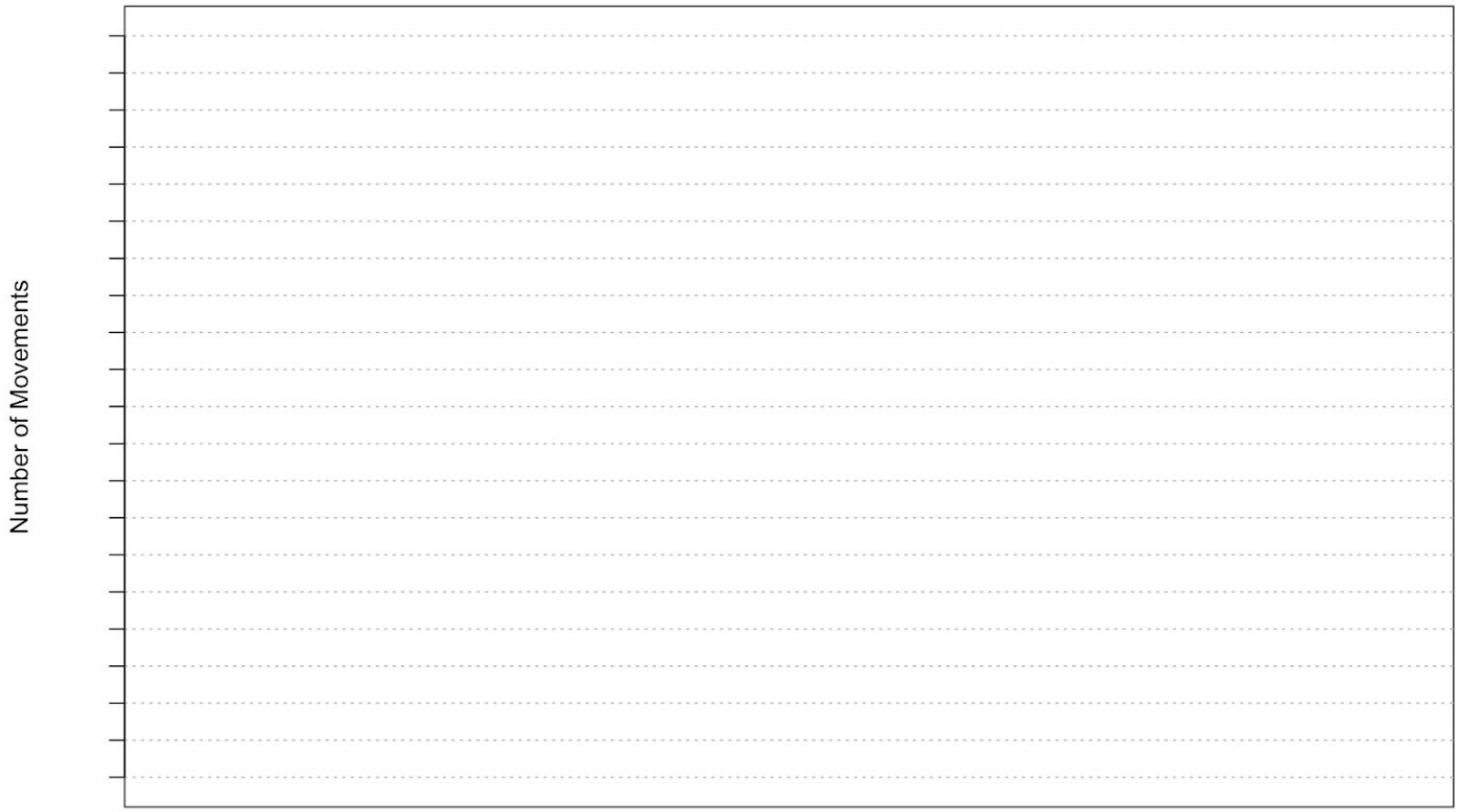
Clouds: _____ Ocean: _____ Soil Surface: _____

Glacier: _____ Plants: _____

Groundwater: _____ River: _____

Water Cycle Game Movement Totals

Name: _____ Date: _____



Water Cycle Teacher Guide

Phase	Process and Destination
Clouds	Water condenses from gas to liquid, precipitates as rain into the ocean
	Water condenses from gas to liquid, precipitates as rain into a river
	Water condenses from gas to liquid, precipitates as rain onto the soil
	Water condenses from gas to liquid, precipitates as rain into a lake
	Water condenses from gas to liquid to solid, precipitates as snow onto a mountain
	Water remains a water droplet within a cloud
Ocean	Water remains in the ocean
	Heat causes water to evaporate and form clouds
River	Water flows from the river to the ocean
	Water flows into a bigger river
	Water flows from the river into a lake
	Water filters through the soil to become groundwater
	Heat causes water to evaporate and form clouds
Glacier	Ice remains in the glacier
	Ice melts into liquid water and flows into a river
	Ice melts into liquid water directly into the ocean
	Ice sublimates to become gas and form clouds
Soil Surface	An animal drinks the water from the soil surface
	Water filters through the soil to become groundwater
	Roots of a plant absorb the water
	Water runs off the soil surface into a river
	Water runs off the soil surface into a lake
	Heat causes water to evaporate and form clouds

Groundwater	Water remains as groundwater
	Water filters up through the soil into a river
	Water filters up through the soil into a lake
	Roots of a plant absorb the water
Animals	Water is used by the animal's body
	The animal's urine and feces are excreted onto the soil
	Through respiration and evaporation, the water leaves the animal's body and rises to form clouds
Plants	Through transpiration, the water leaves the plant and rises to form clouds
	An animal eats the plant
	The water is used by the plant
Lake	Water flows out of the lake into a river
	Water filters through the soil to become groundwater
	Roots of a plant absorb the water
	An animal drinks the water from the lake
	Heat causes water to evaporate and form clouds
	Water remains in the lake
Snowfield	Snow sublimates to become gas and form clouds
	Snow melts into water and filters through the soil to become groundwater
	Snow melts into water and flows into a river
	Snow freezes into ice and becomes part of a glacier

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