LESSON 2 - WHERE ARE WE IN THE WATER CYCLE?

Overview:
Students discover the amount of available fresh water in a group activity and demonstration, learn the water cycle through notes, discussion and a role play, and use online resources to determine their water usage and consider water conservation.

Suggested Timeline: 3 hours

Materials:
- Water, Water… Everywhere? (Teacher Support Material)
- World's Available Water (Teacher Support Material)
- Water, Water…Everywhere? (Student Handout – Individual)
- for the world's available water activities:
  (per group of 2-3)
  - large white sheet of paper
  - two different colored sheets of construction paper (blue and red)
  - marker
  - an open area to work
  - glue

  (for teacher demonstration or individual student activity)
  - 1000 mL beaker of water
  - map of the Earth or globe
  - 100 mL graduated cylinder
  - 10 mL graduated cylinder
  - salt
  - freezer or ice bucket
  - eyedropper or glass stirring rod
  - small metal bucket
  - overhead transparency of 'World's Available Water' (Teacher Support Material)
  - teacher-made poster of available freshwater vs. all other water on Earth
- The Water Cycle (Teacher Support Material)
- The Water Cycle (Student Handout – Individual)
- The Water Cycle (Student Handout – Group)
- for the water cycle demonstration:
  - clear plastic jar with lid
  - hot water
  - food coloring
  - ice
- student access to computers with the Internet
- for the water cycle role play
  - adhesive labels
  - roll of yarn

Method:

INDIVIDUAL FORMAT:

1. Provide students with the necessary materials for 'Water, Water…Everywhere?' (Student Handout – Individual) and allow them to complete the activity. Have students submit their answers to questions or discuss answers together.
2. When all students have completed the activity, post a teacher-made poster of the available freshwater vs. other water on a bulletin board with student estimate posters.
3. Hand out 'The Water Cycle' (Student Handout – Individual). Using Internet resources, have students complete the water cycle notes, review game, water usage assignment and conservation questions.

GROUP FORMAT:

1. Use 'Water, Water…Everywhere?' (Teacher Support Material) and 'World's Available Water' (Teacher Support Material) to lead the group activity on water availability and complete the demonstration and discussion.
2. Introduce the water cycle by performing the demonstration described on 'Water Cycle' (Teacher Support Material).
3. Hand out 'The Water Cycle' (Student Handout - Group). Use the teacher support material to guide students through a discussion of water on Earth and the water cycle. You may choose to use an overhead projector or computer projector to display images. Students should fill in information on their handout along the way.
4. Using the 'Water Cycle Role Play' (Teacher Support Material), guide students in a student-directed role play.
5. Hand out 'Where Are We in the Water Cycle?' (Student Handout – Group). Allow students access to computers with the Internet to complete the questions.
6. Discuss students' water usage, as determined by their online activity. Have them share what reasonable changes they could make at home to conserve more water.

Assessment:

- Assessment of students' understanding of the connections in the water cycle
- Affective assessment of students' attitudes toward conservation

Extensions:

- Discuss the shortage of water in Florida and the government's efforts to begin desalination as a way of dealing with the demand

Water, Water… Everywhere?

For a Group Setting

Materials:

(per group of 2-3)
- large white sheet of paper
- two different colored sheets of construction paper (blue and red)
- marker
- an open area to work

(for teacher demonstration)
- 1000 mL beaker of water
- map of the Earth or globe
- 100 mL graduated cylinder
- 10 mL graduated cylinder
- salt
- freezer or ice bucket
- eyedropper or glass stirring rod
- small metal bucket
- overhead transparency of 'World's Available Water' (Teacher Support Material)

Procedure:

1. Tell students that today's activity is going to start by having them estimate the amount of freshwater on Earth that is potable (fit for human consumption).
2. Divide students into groups, supplying each group with the materials listed above. Provide each group an open area in which to work.
3. Instruct students as follows:
   a) Using your marker, draw a large water droplet on your paper.
   b) Your blue construction paper represents all of the available fresh water on the Earth. Your red paper represents all of the other water on the Earth. The total amount of freshwater suitable for drinking will be represented by 100 pieces.
   c) Rip up your two colours of paper into 100 pieces – think….how many should be blue (potable fresh water) and how many should be red (all other water)? A group member should record how many pieces of each colour you ripped up as an estimate of each kind of water.
4. Tell students that the following demonstration will reveal how much freshwater is actually available on Earth.
   a) Put up the overhead of 'World's Available Water' (Teacher Support Material), covering all but the first row of information.
   b) Show the class a 1000 mL beaker of water and tell them that it represents all of the water available on Earth.
   c) **Key Q:** Looking at the map of the Earth, what kind of water makes up most of the water on Earth? (saltwater)

Pour 30 mL of the water from the 1000 mL beaker into the 100 mL graduated cylinder. Tell students that this represents the Earth's fresh water (amount 3% of the total amount). Pour salt into the remaining water in the 1000 mL beaker and stir it up. Tell students that this 970 mL represents all of the saltwater on the Earth. Show students row two of the chart on the overhead.

4. **Key Q:** What do we find at the north and south poles? (ice)
   Almost 80% of the Earth's water is frozen in glaciers and ice caps. Pour 6 mL of the water from the graduated cylinder (fresh water) into a 10 mL graduated cylinder. Pour the rest (24 mL) into an ice bucket or put in a nearby freezer. Hold up the 6 mL of water in the small graduated cylinder. Tell students that this represents the non-frozen fresh water (about 0.6% of the total). About 1.5 mL of this water is found at the surface; the rest is found underground. Show students row three of the chart on the overhead.
5. Use the eyedropper to remove a single drop of water from the small graduated cylinder and release it into a small metal bucket (drop it from a significant height so that the students can hear the sound of it hit the bucket). Tell them that this single drop represents the clean, fresh water on Earth that is not frozen, salty or polluted. This represents 0.003% of the total! Show students row three of the chart on the overhead.
6. Remind students of their estimates of how much available fresh water there is on Earth. The correct answer, in terms of pieces of paper would be:
   - 99.5 pieces of paper should be red (other water)
   - half of a piece of paper should be blue – this represents the 0.5% of water on Earth that is potentially available. Only one small corner of this half (0.003%) is potable water.
7. Go back to the last row on the chart.
   Key Q: If there is 7 million liters of water per person available on Earth, why does approximately 1/3 of the world's population not have access to clean water? (proximity to clean water, drought, flooding, contamination, other organisms on Earth need water too)

Adapted from A Drop in the Bucket, pp. 238-241 *Project Wet – Water Education for Teachers*

World's Available Water

TOTAL WATER (100%) on Earth, divided among all people (based on a world population of 6 billion people)	=233.3 billion liters/person
Minus the 97% each share (226.3 billion liters) that contains salt (oceans, seas, some lakes and rivers) 233.3 – 226.3 billion liters	= 7 billion liters/person
Minus the 80% of the 7 billion frozen at the north and south poles (5.6 billion) 7 – 5.6 billion liters	= 1.4 billion liters/person
Minus the 99.5% of the 1.4 billion liters that is unavailable (polluted, too far underground, trapped in soil, etc.) (1.393 billion liters) 1.4 – 1.393 billion liters	= 7 million liters/person

The Water Cycle
For A Group Setting

Motivational Set - demonstration

Materials – clear plastic jar with lid, hot water, ice, food colouring

Procedure

1. Tell students to watch what you are doing carefully so that they can answer questions along the way. Tell them that you are simulating the water cycle and that they must figure out what each part of your demonstration represents.
2. Pour hot water into the plastic jar, filling it 1/3.
3. Add several drops of food coloring.
   Key Q: What does the food coloring represent? (material dissolved in water)
   Key Q: What kinds of materials might be dissolved in the water? (e.g., carbon monoxide from fossil fuel combustion)
4. Place the inverted lid on the top of the container and fill with ice.
   Key Q: What does the ice represent? (the cooler upper atmosphere)
5. Have students watch what happens next and make observations.
   Key Q: What is it called when the water changes from a liquid to a gas (the steam that can be observed)? (evaporation)
   Key Q: Why do water droplets form on the sides of the jar? (the water vapor is condensing as it hits the jar)
   Key Q: What happens to the materials dissolved in the water? (depends on their size – some form clouds and contribute to acid rain later, others do not evaporate and are left to contaminate the earth and possibly the groundwater supply)

Why is Water so Important?

Approximately 71% of the Earth's surface is covered by water

Water is life! If we are deprived of water, we die! The human body is at least 65% water – our blood is 90% water and our brains are 75% water

Food we eat contains water –

chicken → 75% pineapple → 80%
tomato → 95% corn → 80%

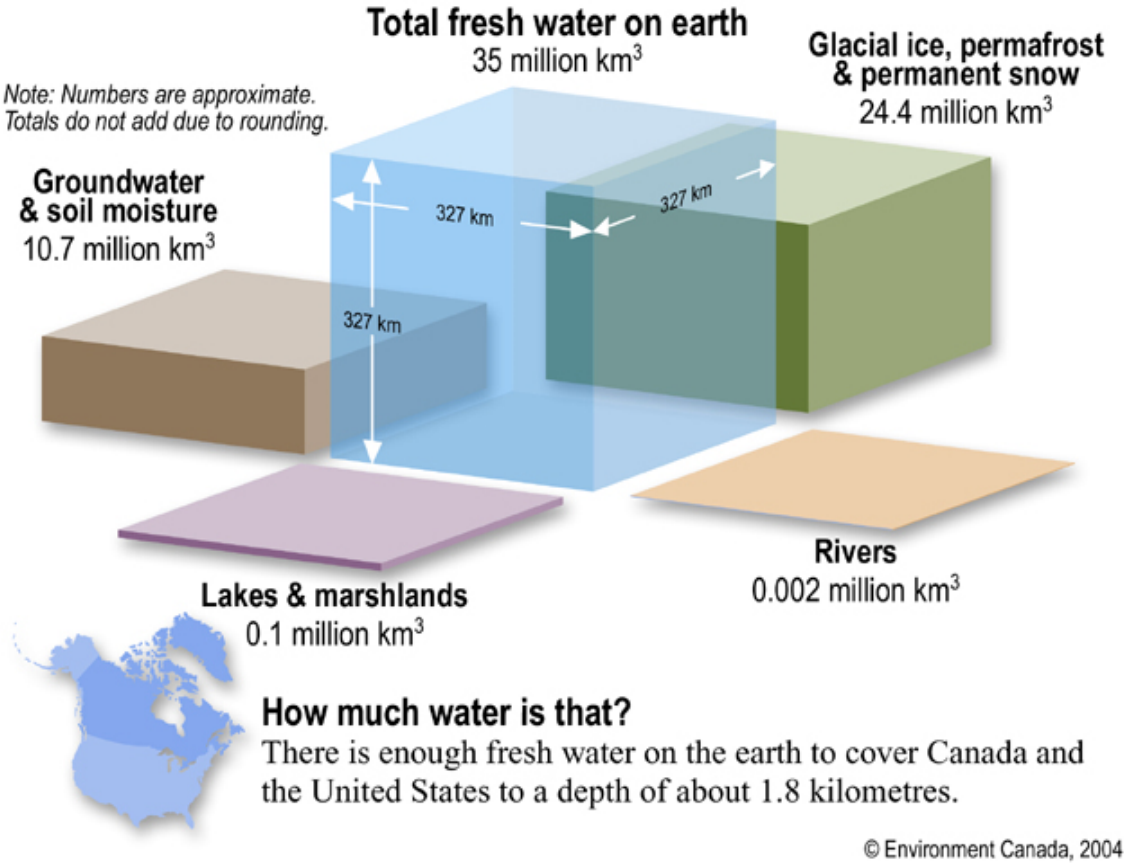
Only 1% of the world's water supply is in the form of fresh liquid water. Most of the water on Earth is salt water. We have not found a cheap and easy way to remove the salt from our water to create more freshwater.

World's freshwater supply just a drop in the bucket

Of all fresh water not locked up in ice caps or glaciers, some 20% is in areas too remote for humans to access and of the remaining 80%, about three-quarters comes at the wrong time and place – in monsoons and floods – and is not always captured for use by people. The remainder is less than 0.08 of 1% of the total water on the planet.

Where on earth is all that fresh water?

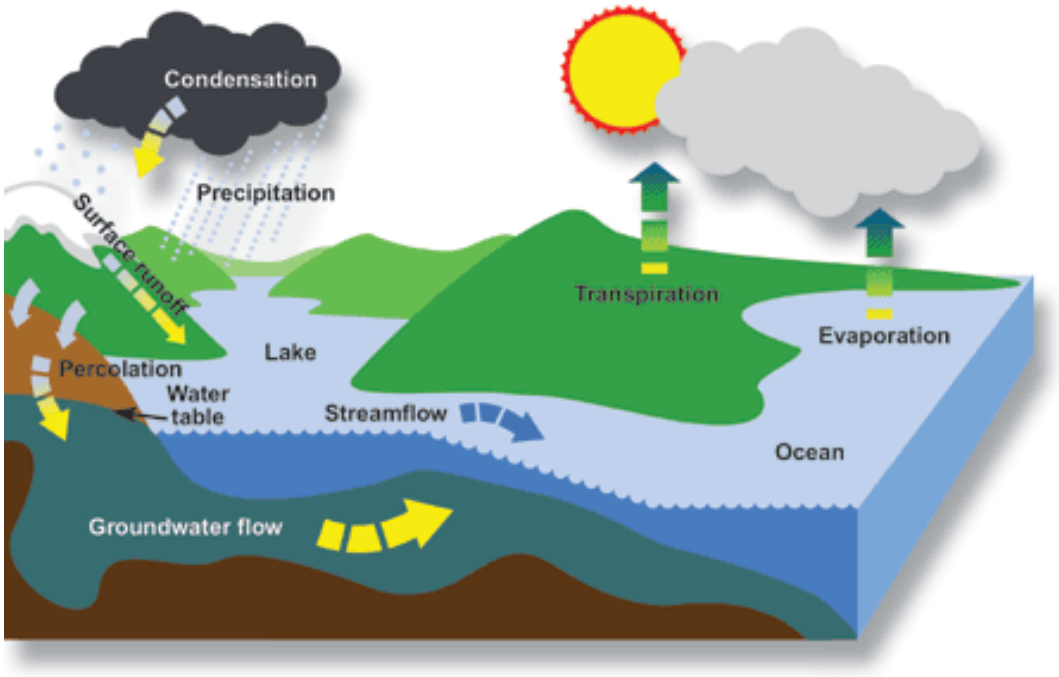
There are about 35 million km^3 of fresh water on the earth. Here's where that water is found.



How much water is that?

There is enough fresh water on the earth to cover Canada and the United States to a depth of about 1.8 kilometres.

Our planet is like a spaceship, which means that there will be no new water molecules added to our planet. Nature recycles our water, ensuring that we have a constant supply of freshwater.



The water cycle includes the processes of:

1. evaporation – water changes from liquid to a gas (vapor) with the sun's energy

2. transpiration – water vapor is given off by plants. Each day an actively growing plant transpires 5-10 times what it can hold at once!

3. condensation – cooled water vapor becomes liquid again and tiny drops collect around dust particles, forming clouds or fog

4. precipitation – water returns to the Earth as rain, hail, sleet or snow

5. runoff – when there is a lot of rain or snow melting, excess water will flow to creeks and ditches and end up in rivers and lakes

6. percolation – precipitation moves downwards or *percolates* through joints, pores and cracks in the soil and in rocks until it reaches the water table and becomes groundwater.

7. groundwater – water held in cracks and spaces in the Earth. Depending on the area, groundwater can flow to streams or be tapped by wells. Some groundwater may have been there for thousands of years!

8. water table – the level where water sits in a shallow well

Water Cycle Role Play

Materials

- ball of yarn
- identification tags (director, research assistant, communications consultant, cloud, ground, sun, plant, body of water, groundwater, evaporation, transpiration, condensation, precipitation, runoff, percolation, groundwater, water table)
- wide open space

Procedure

1. Tell students that you are going to be testing their knowledge of the water cycle in a different way! As a class, the students will be *making* the water cycle. Using identification tags (roles written on labels), designate students for each role.
2. Identify the responsibilities for each role as follows:
   - director – organize all of the components of the cycle (with the help of the research assistant and communications consultant)
   - research assistant – use notes and any other resources needed to help the director to organize the components of the cycle; once the cycle has been set up, check that it is correct
   - communications consultant – form the 'communication lines' (yarn) between components of the cycle under the guidance of the director and research assistant; be responsible for line maintenance
   - cloud, ground, sun, etc. (all other components) – move to the appropriate spot in the cycle and think about what connections can be made with other components of the cycle
3. Bring the students into an open space. Explain that the cycle would not occur without the energy of the sun driving it all! Have the student playing the role of the sun shine down on the other components to set the role play in motion. The director should move students to their appropriate spots, the research assistant should use the copy of a water cycle as a guide, and the communications consultant should connect the parts using the ball of yarn. There are two options here for the ball of yarn:
   a) Under the guidance of the communications consultant, the students can throw the ball of yarn to one another to make a web that is connected
   b) The ball of yarn can be cut into individual strands and connections can be made using the strands. Students will then see that they may have to hold five strands to make all of the connections!
4. Once the director is confident that the cycle construction is completed, go through the cycle with students, encouraging them to think of additional connections to be made.
5. **Key Q:** We have not included humans in this water cycle. Where do we fit in? (Humans divert water from watersheds for our uses, often adding pollutants, then returning it to the cycle.)
   Key Q: What happens if we cut a strand? (Do so with scissors) What parts are all affected?

Student Handout INDIVIDUAL

Name: _____ Date: _____ Period: ____

Water, Water… Everywhere?

Purpose: To estimate the amount of available fresh water on Earth and compare that value to what is actually present.

Materials:

For Part I:
- large white sheet of paper
- glue
- two different colored sheets of construction paper (blue and red)
- marker
- an open area to work

For Part II:
- 1000 mL beaker of water
- 100 mL graduated cylinder
- 10 mL graduated cylinder
- salt
- teaspoon
- ice bucket
- eyedropper
- small metal bucket

Procedure:

Part I: An Estimation of Available Freshwater

1. Find an open area in which to work. Using your marker, draw a large water drop on your paper.
2. With your marker, write 'Estimate of the World's Available Fresh Water' at the top of the paper. Write your name somewhere on the paper.
3. Your blue construction paper represents all of the available fresh water on the Earth. Your red paper represents all of the other water on the Earth. The total amount of fresh water suitable for drinking will be represented by 100 pieces.
4. With your marker, write 'Key' under your water droplet. Write that blue paper represents available fresh water and red paper represents all other water.
5. You will be ripping up your pieces of construction paper so that there are 100 pieces, each representing a percentage of the world's available fresh water. Think for a moment about what percent of the water on Earth would be available fresh water. Rip up the appropriate number of pieces of blue paper to represent this amount (each piece should be fairly small). For example, if you think that 50% of the world's water is available fresh water, you would rip up 50 blue pieces of paper. How many blue pieces of paper (available fresh water) did you rip up? _____

Student Handout INDIVIDUAL

6. Rip up the remainder of the 100 pieces from the red paper to represent all other water on Earth. For example, if you estimated that 50% of the world's water is available fresh water, this would leave you with 50% being other water. You would then rip up 50 pieces of red paper. How many red pieces of paper (other water) did you rip up? _____
7. Using your glue, paste the pieces of paper on the water droplet that you have drawn. Mix up the blue and red pieces.
8. Hand in your materials and your water droplet sheet to your teacher.

Part II – Finding out the Amount of Freshwater on Earth

1. Fill up the 1000 mL beaker of water. This represents all of the water available on Earth.

   The total water on Earth (100%), divided among all of the people on Earth (approximately 6 billion) **= 233.3 billion liters/person**

2. Consider what a map of the world or a globe looks like. What *kind* of water covers most of the Earth (freshwater, ice or salt water)? _____

3. Pour 30 mL of the water from the 1000 mL beaker into the 100 mL graduated cylinder. This represents the Earth's fresh water (about 3% of the total amount).

   Pour salt into the water remaining in the 1000 mL beaker and stir it with the teaspoon. This represents all of the saltwater on the Earth.

   97% of the total water on Earth contains salt (in oceans, seas, some lakes and rivers) 233.3 – 226.3 billion litres/person **= 7 billion litres/person**

4. Think again of what a map of the world or a globe looks like. What *kind* of water is found at the north and south poles (freshwater, ice or salt water)? _____

5. Almost 80% of the Earth's water is frozen in glaciers and ice caps. Pour 6 mL of the water from the 100 mL graduated cylinder (fresh water) into a 10 mL graduated cylinder. Pour the rest (24 mL) into an ice bucket. The 6 mL of water in the small graduated cylinder represents the non-frozen fresh water (about 0.6% of the total). About 1.5 mL of this water is found at the surface; the rest is found underground.

   80% of the 7 billion litres of water per person is frozen at the poles 7 billion – 5.6 billion **= 1.4 billion litres/person**

6. Use the eyedropper to remove a single drop of water from the small graduated cylinder and release it into the metal bucket, listening to it hit the bottom. This single drop represents the clean, fresh water on Earth that is not frozen, salty or polluted. This represents 0.003% of the total!

   99.5% of the 1.4 billion litres/person is unavailable (polluted, trapped in soil, too far underground) (1.393 billion) 1.4 – 1.393 billion litres water/person **= 7 million litres/person**
7. Recall your estimates of how much available fresh water there is on Earth. The correct answer, in terms of pieces of paper is:

99.5 pieces of paper should be red (other water). Half of a piece of paper should be blue – this represents the 0.5% of water on Earth that is potentially available. Only one small corner of this half (0.003%) is potable water. So, o*nly a small corner of one piece of paper should be blue.*

8. There is 7 million litres of water per person available on Earth. Why do you think, then, that approximately 1/3 of the world's population not have access to clean water? List at least two reasons.

_____

_____

_____

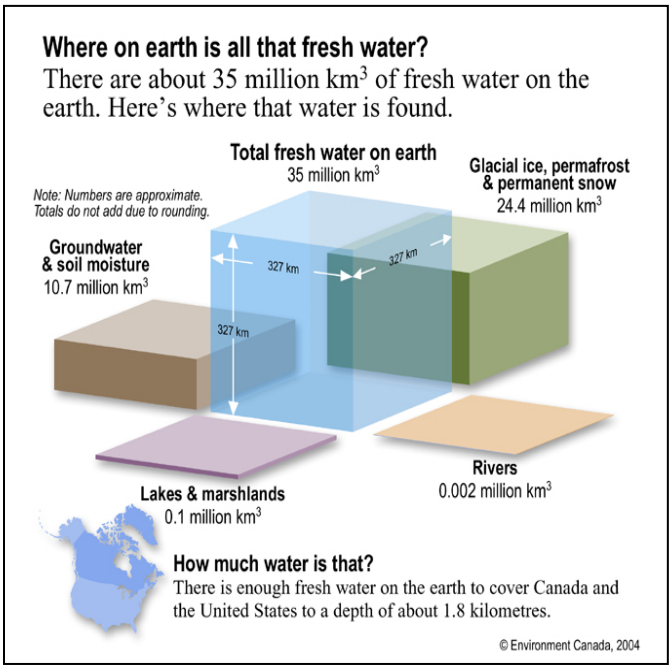
Adapted from A Drop in the Bucket, pp. 238-241 *Project Wet – Water Education for Teachers*

Student Handout INDIVIDUAL

The Water Cycle

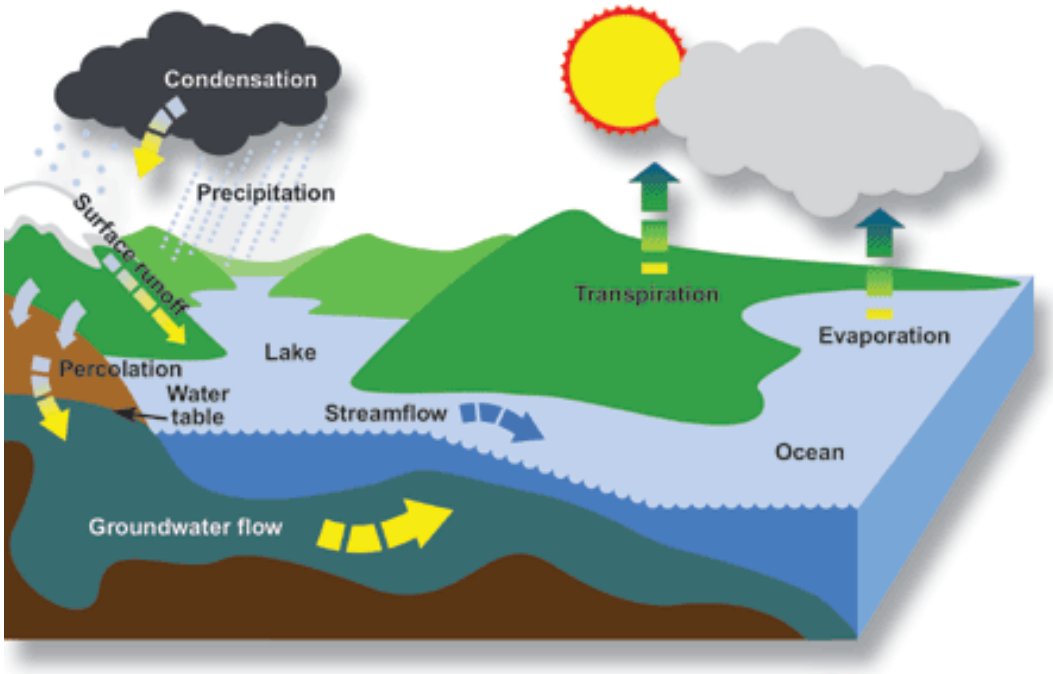
Why is water so important?

- Approximately 71% of the Earth's surface is covered by water
- Water is life! If we are deprived of water, we die! The human body is at least 65% water – our blood is 90% water and our brains are 75% water
- Food we eat contains water (e.g., chicken - 75%; pineapple - 80%; tomato - 95%; corn - 80%)
- Only 1% of the world's water supply is in the form of fresh liquid water. Most of the water on Earth is salt water. We have not found a cheap and easy way to remove the salt from our water to create more freshwater.



Our planet is like a spaceship, which means that there will be no new water molecules added to our planet. Nature recycles our water, ensuring that we have a constant supply of freshwater.

Student Handout INDIVIDUAL



To define the following terms about the water cycle, go to the following website:

http://www.ec.gc.ca/Water/en/nature/grdwtr/e_cycle.htm

Summarize the information that you find on the website.

condensation:

precipitation:

percolation:

runoff:

Student Handout INDIVIDUAL

evaporation:

transpiration:

ground water:

water table:

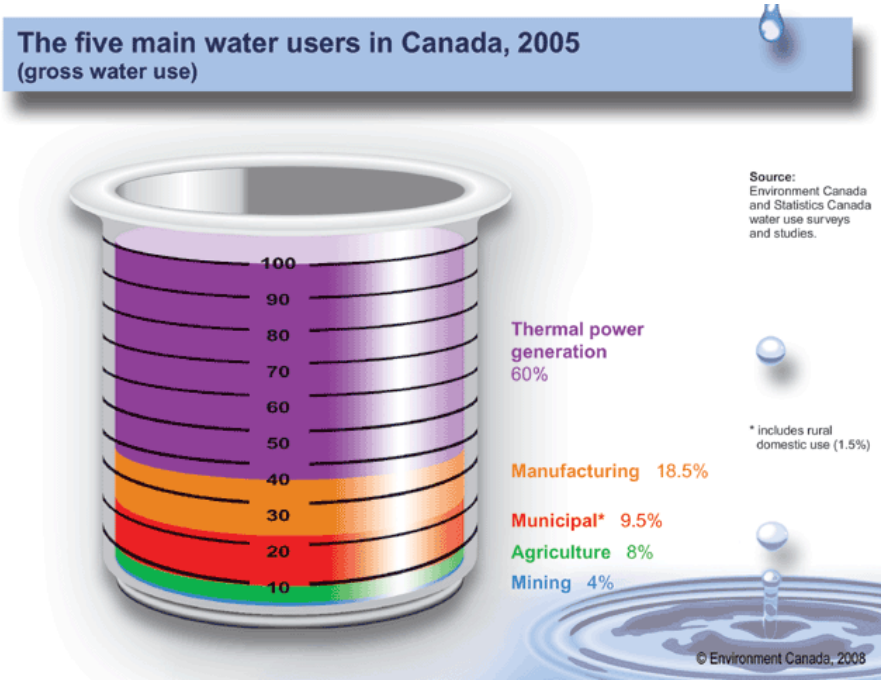
To test your knowledge of water and the water cycle, go to the following website: http://www.epa.gov/OGWDW/kids/flash/flash_qagame.html and play the game.

Record your score: _____

Student Handout INDIVIDUAL

Where Are We in the Water Cycle?

From the water cycle, we divert water for our own uses. Canadians are among the biggest water users in the world. Here is how our water is used:



Each time we draw water from the water cycle, we likely have a dramatic effect on our wildlife. Once water has been used by humans, even if it is filtered through a water treatment plant, it is often contaminated or polluted. Such contamination can have far-reaching effects. Two examples are listed below.

- Lawn and agricultural fertilizers seep into groundwater and end up in lakes, rivers and oceans causing algal blooms. The toxins from the algae can cause the water to be unsuitable for other animals and people.
- Some prescription drugs that end up in sewage are not filtered out in wastewater treatment plants. These can affect the health of animals such as fish and frogs living in waterways.

On a day to day basis, we must use water responsibly. When we conserve water, we reduce the destruction of natural habitats by lessening the need for dams. We also slow down the depletion of groundwater supplies and lessen the demands on water treatment facilities.

We must also pay attention to what we are putting into our water. Pollutants like detergents, fertilizers, motor oil, cleaning fluids, and fuels can have devastating long-term effects on wildlife.

Student Handout INDIVIDUAL

To develop a greater awareness of how you use water and what you can do to act more responsibly, complete the following activity:

1. Go to the Government of Canada's water use calculator at: http://www.on.ec.gc.ca/reseau/waterCalculator/login_e.html and complete the survey.

   a. How much water does your household use? _____

   b. How did this compare to the provincial average? _____

   _____

   c. How did this compare to the national average? _____

   _____

2. Click on 'Water Conservation Tips' or go to 
   http://www.on.ec.gc.ca/reseau/watertips/watertips_e.html
   Play the 'Interactive Flash Version' to answer the following questions:

   a) What % of water is used in the bathrooms of a house? _____

   b) List three changes that can be made in a bathroom to help to conserve water.

   _____

   _____

   _____

   c) How much water per week (in cm) is necessary in a yard? _____

   d) List three water-conserving tips for the kitchen.

   _____

   _____

   _____

   e) Compared to older models, how much water can newer washing machines save?

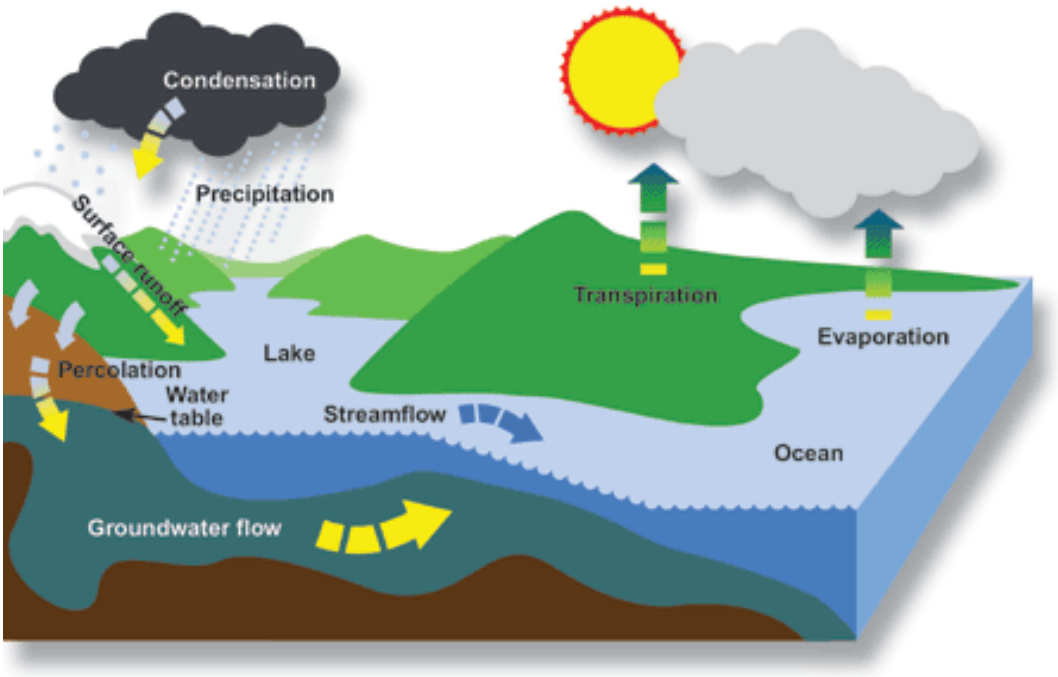
   _____

Student Handout GROUP

The Water Cycle

Why is water so important?

The Water Cycle



The water cycle includes the processes of:

1. _____ – water changes from liquid to a gas (vapor) with the sun's energy

2. _____ – water vapor is given off by plants. Each day an actively growing plant transpires 5-10 times what it can hold at once!

3. _____ – cooled water vapor becomes liquid again and tiny drops collect around dust particles, forming clouds or fog

4. _____ – water returns to the Earth as rain, hail, sleet or snow

Student Handout GROUP

5. _____ – when there is a lot of rain or snow melting, excess water will flow to creeks and ditches and end up in rivers and lakes

6. _____ – precipitation moves downwards or *percolates* through joints, pores and cracks in the soil and in rocks until it reaches the water table and becomes groundwater.

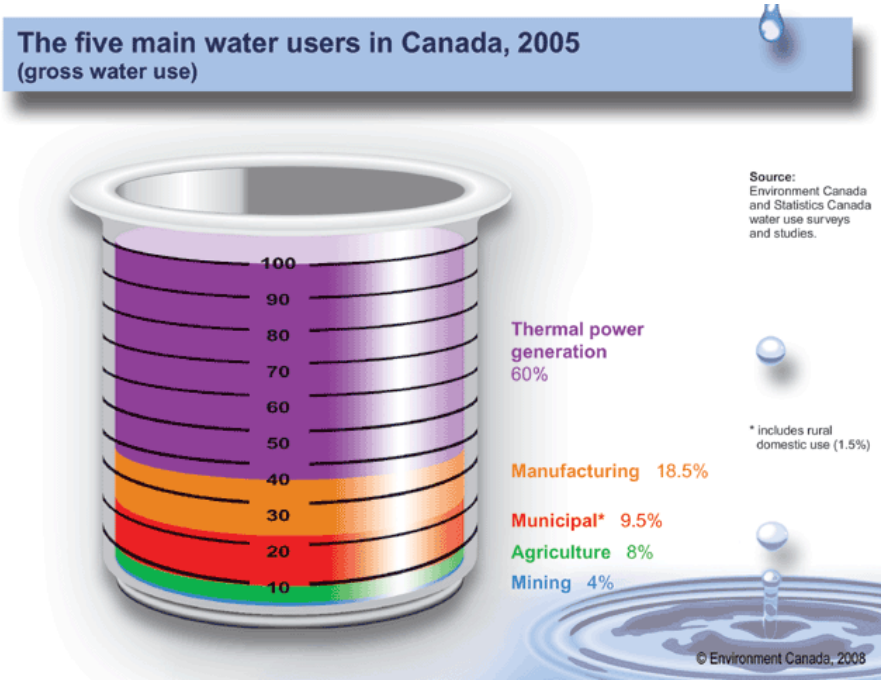
7. _____ – water held in cracks and spaces in the Earth. Depending on the area, groundwater can flow to streams or be tapped by wells. Some groundwater may have been there for thousands of years!

8. _____ – the level where water sits in a shallow well.

Student Handout GROUP

Where Are We in the Water Cycle?

From the water cycle, we divert water for our own uses. Canadians are among the biggest water users in the world. Here is how our water is used:



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On a day to day basis, we must use water responsibly. When we conserve water, we reduce the destruction of natural habitats by lessening the need for dams. We also slow down the depletion of groundwater supplies and lessen the demands on water treatment facilities.

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Student Handout GROUP

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   a) How much water does your household use? _____

   b) How did this compare to the provincial average? _____

   c) _____

   d) How did this compare to the national average? _____

   e) _____

2. Click on 'Water Conservation Tips' or go to http://www.on.ec.gc.ca/reseau/watertips/watertips_e.html. Play the 'Interactive Flash Version' to answer the following questions:

   a. What percent of water is used in the bathrooms of a house? _____

   b. List <u>three</u> changes that can be made in a bathroom to help to conserve water.

   _____

   _____

   _____

   _____

   c. How much water per week (in cm) is necessary in a yard? _____

   d. List <u>three</u> water-conserving tips for the kitchen.

   _____

   _____

   _____

   _____

   e) Compared to older models, how much water can newer washing machines save?

   _____