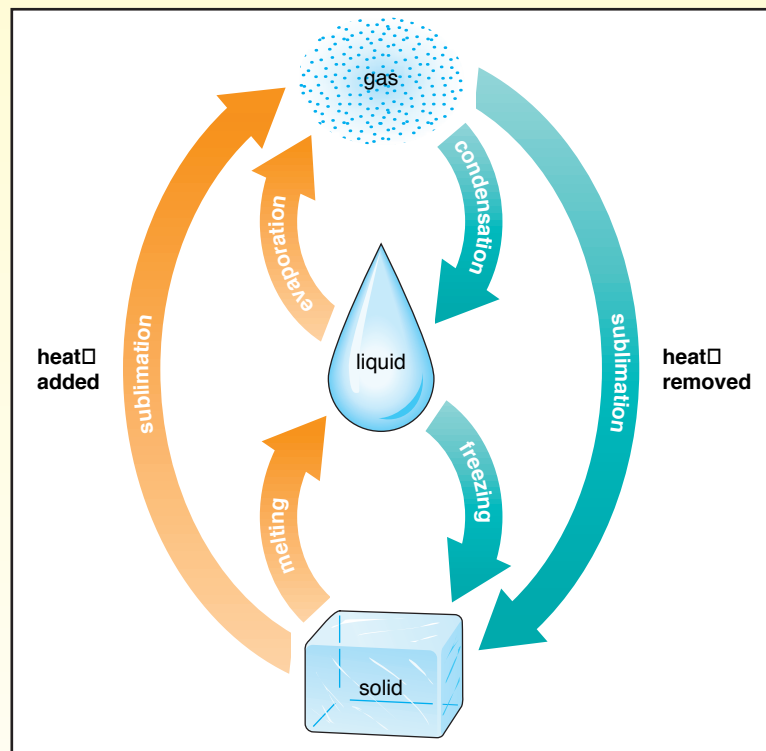
**As You Read...****Think about:**

1. How does water change from one form to another on Earth?
2. Where is water stored near the surface of the Earth?
3. What does an example of a "loop" in the water cycle involve?
4. What properties of Earth materials affect the flow of groundwater?
5. Why does groundwater flow so much more slowly than water in a river?
6. What conditions make groundwater a nonrenewable resource?

Digging Deeper**THE WATER CYCLE**

Water exists at the Earth's surface as liquid, solid, and vapor. It is forever changing from one of those three states to another. You can easily observe how water changes from liquid to solid by freezing and from solid to liquid by melting. Water also changes from liquid to vapor by evaporation and from vapor to liquid by condensation. Condensation is how clouds and raindrops form. Water can even change from vapor directly into solid; by the process of sublimation. That is how snowflakes are formed, high in the atmosphere.



Change of state of water.

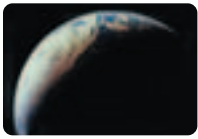
The total amount of water near the surface of the Earth stays almost the same through time, but water is always moving from place to place. You can think of places



where water resides, like the ocean or lakes or glaciers, as “reservoirs.” Water moves from reservoir to reservoir in various ways. It can move in the form of liquid, solid, or vapor. This complicated movement of the Earth’s water is called the water cycle.

One of the most important “loops” in the water cycle involves evaporation of water from the ocean surface, transport in the form of water vapor to the continents by winds, and precipitation as rain or snow on the continents. The rainfall then runs off by way of streams, rivers, and groundwater back to the ocean. You modeled a similar loop with your distillation setup. Another important “loop” in the water cycle involves condensation of water vapor in the atmosphere to form rain, soaking of the rain into the ground, uptake of the water by plant roots, and return of that water, in the form of water vapor, back into the atmosphere by transpiration through the leaves of the plants. You modeled transpiration using a potted plant in this investigation. There are many other “loops” as well. The Earth’s water cycle is very complicated in its details.





Groundwater Flow

Most of the materials beneath the Earth's surface are porous. That means that they contain tiny open spaces as well as solids, just like a sponge. The porosity of a material is the percentage of open pore space it contains. Loosely packed sand and gravel can have porosities as high as 25%. Solid rock is much less porous. Many rocks have a porosity of only a small fraction of a percent.

Another important property of Earth materials is their permeability. The permeability describes how easy it is to force a fluid to flow through the pore spaces of the material. Loose sand and gravel have high permeability. Solid rock usually has low permeability. The best sources of groundwater, called aquifers, have high porosity and also high permeability. Sand, gravel, and fractured rock make the best aquifers.

Groundwater flow is much slower than flow in streams and rivers. That is because the passageways through the pore spaces are very small, so there is a lot of friction with the solid walls of the pores. Speeds of flow in streams and rivers are often greater than a meter per second. Groundwater flow is often as slow as several meters per day.

For a large town or city to obtain its water from groundwater, there needs to be a large aquifer. Several widely spaced wells are used to pump water from the aquifer, all at the same time. If the groundwater is replaced as fast as it is pumped, then it is a renewable resource. If the groundwater is pumped faster than it is replaced, however, then the level of the groundwater falls. It becomes more and more difficult to obtain the required water. Then the groundwater is not really a renewable resource, because the replacement might take far longer than a human lifetime!