

Grade 8 Science – Water - WATER -The Universal Solvent

Name: _____ Class: _____ Date: _____

Water, the Universal Solvent

Water is called the "universal solvent" because it is capable of dissolving more substances than any other liquid. This is important to every living thing on earth. It means that wherever water goes, either through the air, the ground, or through our bodies, it takes along valuable chemicals, minerals, and nutrients that are dissolved within it.

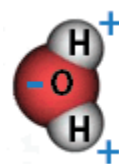
It is water's chemical composition and physical attributes that make it such an excellent solvent. Water molecules have a polar arrangement of oxygen and hydrogen atoms—one side (hydrogen) has a positive electrical charge and the other side (oxygen) has a negative charge. This allows the water molecule to become attracted to many other different types of molecules. Water can become so heavily attracted to a different compound, like salt (NaCl), that it can disrupt the attractive forces that hold the sodium and chloride in the salt compound together and, thus, dissolves it.

Our Kidneys and Water Make a Great Pair

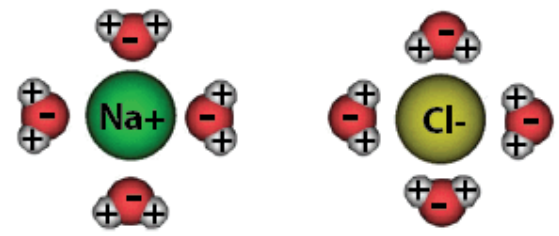
Our own kidneys and water's solvent properties make a great pair in keeping us alive and healthy. The kidneys are responsible for filtering out substances that enter our bodies from the foods and drinks we consume. But, the kidneys have got to get rid of these substances after they accumulate them. That is where water helps out; being such a great solvent, water washing through the kidneys dissolves these substances and sends them on the way out of our bodies. This happens through cells' outer layer or cell membrane which is selectively permeable.

Why Salt Dissolves in Water

At the molecular level, salt dissolves in water due to electrical charges and because both water and salt compounds are polar, with positive and negative charges on opposite sides in the molecule. The bonds in salt compounds are called ionic because they both have an electrical charge—the chloride ion is negatively charged and the sodium ion is positively charged. Likewise, a water molecule is ionic in nature, but the bond is called covalent, with two hydrogen atoms both situating themselves with their positive charge on one side of the oxygen atom, which has a negative charge. When salt is mixed with water, the salt dissolves because the covalent bonds of water are stronger than the ionic bonds in the salt molecules.



The positively-charged side of the water molecules are attracted to the negatively-charged chloride ions and the negatively-charged side of the water molecules are attracted to the positively-charged sodium ions. Essentially, a tug-of-war ensues with the water molecules winning the match. Water molecules pull the sodium and chloride ions apart, breaking the ionic bond that held them together. After the salt compounds are pulled apart, the sodium and chloride atoms are surrounded by water molecules, as this diagram shows. Once this happens, the salt is dissolved, resulting in a homogeneous solution.



Salt dissolved in water

Water Falling as Rain

When water vapour collects together, or condensation happens in the atmosphere, water droplets form and are pulled to Earth by gravity. We call this rain. As rain falls, it collects other particles and dissolves them into solution – Sulphur and nitrogen compounds and other pollutants are picked up by rain and sometimes this leads to the water becoming acidic and this is called acid rain. This acidic nature sometimes makes water even more capable of dissolving things once it lands on the ground.

Water in the Ground

Water can even dissolve solid rock. When water falls on the ground, it soaks into the ground. As it soaks in, it starts to dissolve material that it is contact with. This helps transport nutrients from the ground surface to the roots of plants. As water sinks deeper into the ground, it starts to interact with the rock that it is flowing around. Certain rock like limestone is easily dissolved by water and as it is dissolved, it creates tunnels and caves as it washes away the dissolved rock over thousands and sometimes millions of years of dissolving. These dissolved minerals are found in all ground water and sometimes are deposited in caves as rock icicles called stalactites or stalagmites. The water that comes from limestone areas has a lot of dissolved minerals in it from the rock.



Hard Water vs Soft Water

Water that passes through soft rock like limestone, dissolves a lot of minerals and carries them in solution. These are in the water and are easily deposited in other areas – even in drinking water in our homes. Hamilton has hard water since our water sources come from the surrounding areas that all have limestone. Minerals from our hard water can be found on our taps and in our showers. Sometimes the dissolved minerals actually make our water taste better or have more 'flavour'.

Questions:

1. Why is water such a good solvent?

Water molecules have a polar arrangement of oxygen and hydrogen atoms—one side (hydrogen) has a positive electrical charge and the other side (oxygen) has a negative charge. This allows the water molecule to become attracted to many other different types of molecules.

2. How does water help our kidneys?

Water helps out by being such a great solvent. Water washing through the kidneys and dissolves substances and sends them on the way out of our bodies.

3. How does water dissolve things like salt?

The very strong covalent bonds are stronger than the ionic bonds holding the salt molecules together and the parts are pulled apart and surrounded by the water molecules.

4. How is acid rain created?

Acid rain is created when water dissolves or absorbs particles in the atmosphere that create a higher pH (sulphur compounds and nitrogen compounds). These substances come from industrial processes and pollution.

5. What are two things that rain does when it hits the ground?

As soon as rain hits the ground, it starts dissolving things in soils and brings them down to the roots of plants. As it flows over and around rocks, it starts dissolving rocks and washing this hard water away – thus creating open spaces that eventually become caves.

6. Explain why these statues are changing.

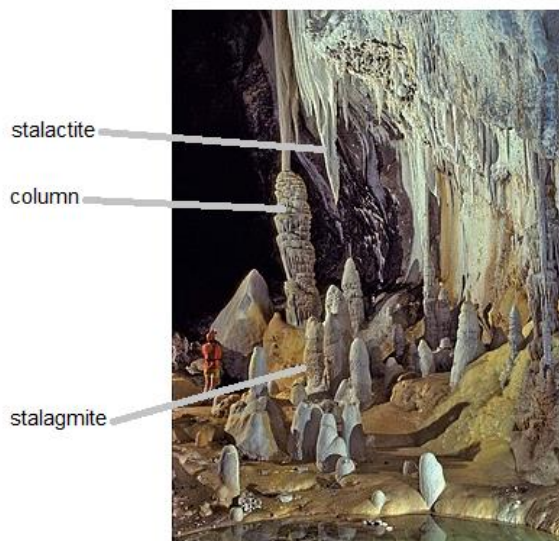


Limestone Statue



The right pictures are the result of the statues being exposed to acid rain which dissolves the rock that the figures are made of. The details and the polish is dissolved that the statues are ruined over time.

7. Explain how this cave and the stalactites and stalagmites were formed using what you know about water and about dissolving and crystallization of supersaturated solutions.



The stalactites are formed when supersaturated water drips into the cave, the evaporation of the water leaves behind a tiny amount of crystal growth and this makes the stalactite grow. As some of the water hits the ground, the same thing happens and there is a bit of crystal that grows out of the super-saturated water. A column is created by the growth of a stalactite into a stalagmite and the two join.