

Unusual Properties of Water

Modern chemistry and physics have disclosed that water is vastly different from almost any other small molecule. Its unusual properties are a direct result of the polar nature of the water molecule.

Color title A and the related illustration.

Water is not only a *good solvent*, it is the best. It dissolves more different substances than any other solvent known. This is because so many other molecules are ionic or polar, and their electrical charges make them attracted to the water molecules, causing them to stay in solution. Thus we find that water dissolves many kinds of salts and sugars, many proteins, such as gelatin, and a variety of hormones that dissolve in our blood (since blood is mostly water) and regulate various life processes. Even nonpolar molecules dissolve to some extent if they are small. Thus enough oxygen dissolves to allow fish and other aquatic animals to survive, and enough carbon dioxide dissolves to enable algae and many plants to live underwater.

Color title B and the related illustration.

A capillary is any tube of extremely small diameter, including the tiniest of our blood vessels. If a capillary tube is made of glass or any other substance that is polar, water will spontaneously climb up inside it without having to be pumped in any way. The smaller the tube, the higher the water climbs. The attraction is so great between the water molecules and the molecules of the tube that water will climb in defiance of the force of gravity. This is termed *capillary action*.

Color title C and the related illustration.

Water is also unusual in being able to absorb a lot of heat energy without having its temperature increase by very much. (A chemist or physicist would say it has a *high specific heat*.) An amount of heat that will raise the temperature of a container of water by 10 degrees will raise the temperature of an equal weight of alcohol by 20 degrees and an equal weight of iron by 94 degrees. Water molecules are held together so strongly by their hydrogen bonds that an amount of heat that will get other molecules moving much

faster will not speed up water molecules much at all. This property of water helps to reduce temperature fluctuations in the animal or plant body, and it also makes for mild climates in the vicinity of large bodies of water.

Color titles D and E and the related illustrations.

Heat of vaporization is the amount of heat energy required to evaporate a given weight of a liquid. Water has a very *high heat of vaporization*, which means that it takes a lot of heat to evaporate just a little water. This keeps water in many more lakes and ponds during the summer than would be the case if water had a lower heat of vaporization. Heat of fusion is the heat energy that must be removed from a given weight of water in order to freeze it. Water's relatively *high heat of fusion* means that it takes much longer for lakes and streams to freeze in the winter, allowing living things more time to adjust to the change.

Color title F and the related illustration.

Hydrogen bonds hold water molecules together so tightly that the water's surface acts like a membrane. The insect known as the water strider is actually able to walk on that surface without breaking through.

Color title G and the related illustration.

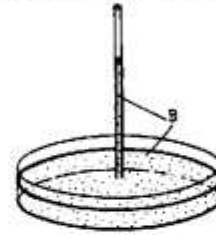
Almost everything contracts when it is cooled, and water is no exception, up to a point. That point is 3.8°C. When cooled below that temperature, water molecules slow down and start to arrange themselves into a crystal structure in which each water molecule is hydrogen-bonded to four other water molecules. This structure is completed when the water freezes. What is most unusual is that this crystal structure takes up more space than the same molecules did in the liquid state, so ice is less dense than water, and it floats. The water below is still at 3.8°C. Since ice is a good insulator, lakes and ponds can freeze over in the winter without freezing all the living things in the water below. If ice didn't float, lakes would freeze from the bottom up, and many of them would eventually freeze solid, killing all life in them.

UNUSUAL PROPERTIES OF WATER.

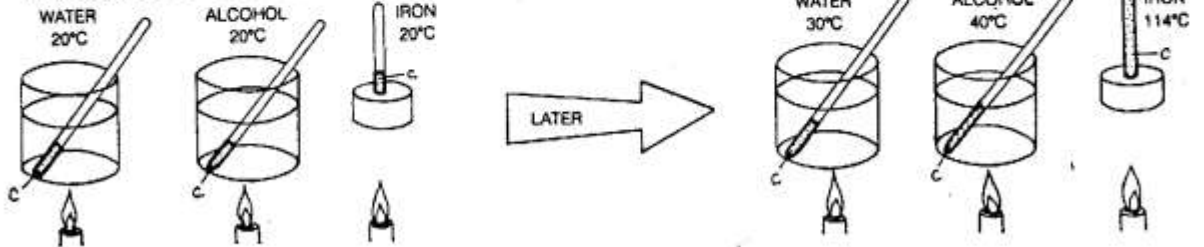
GOOD SOLVENT.



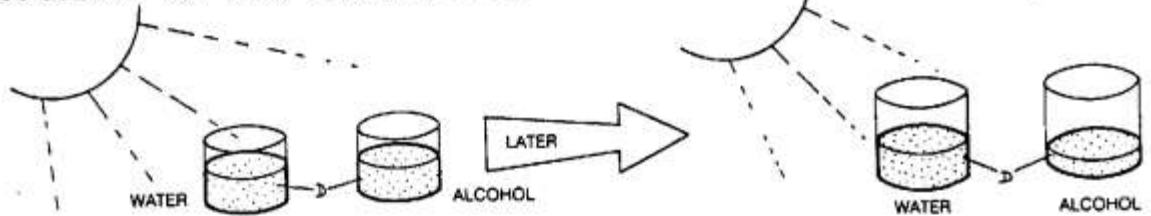
CAPILLARY ACTION.



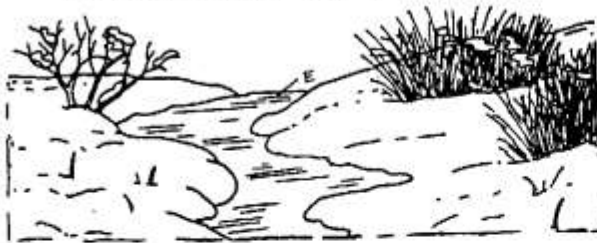
HIGH SPECIFIC HEAT.



HIGH HEAT OF VAPORIZATION.



HIGH HEAT OF FUSION.



HIGH SURFACE TENSION.



EXPANSION ON FREEZING.

