

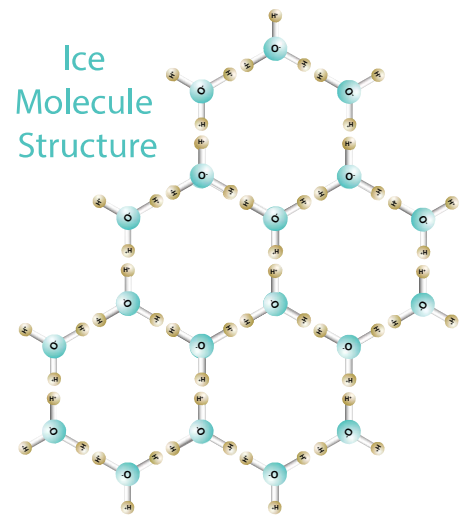
# Physical Properties of Water

Vocabulary	
specific heat	coolant
kinetic energy	

Water is the only natural substance that is found in all three states: solid (ice), liquid, and gas (steam). It **boils** at 212°F or 100°C and **freezes** at 32°F or 0°C. Water has a high **specific heat** index. Specific heat is the amount of energy required to change the temperature of a substance. Water can absorb a lot of heat before it begins to get hot, which is why the sand at the beach **always** feels hotter than the ocean water. Land absorbs heat faster than water.

Water's high specific heat index makes it **valuable**, especially to manufacturing companies. It is used as a **coolant** because it can absorb a lot of heat before it begins to get hot. Water can move over heated elements in a factory, absorbing the heat from machines. In a car, water is a coolant in the radiator that absorbs heat put out by the engine.

When water molecules make a change in phase or state, their molecules rearrange themselves into different patterns. In the liquid phase, water molecules are closer together with no regular arrangement. The particles of a liquid vibrate, move about, and slide past each other. A solid has tightly packed particles that are usually in a regular pattern. There is very little vibration or movement of the particles of a solid. In the gaseous phase, water molecules are widely spaced apart and very active with no regular arrangement. Generally, as the temperature rises, matter moves to a more active state. This movement of molecules is called **kinetic energy**.



Most substances are the densest in their solid form. However, water is different. Solid water, or ice, floats on top of liquid water. Why is this? In order to float on water, a substance must be less dense than water. When ice is formed, the water molecules are tightly packed together, preventing them from changing shape. Ice has a regular pattern with the molecules held rigidly apart by their bonds. This causes ice to form a crystalline lattice structure. These crystals have many open spaces throughout their structure, making ice less dense than liquid water.



	Gas	Liquid	Solid
particle arrangement	well separated — no regular arrangement	close together — no regular arrangement	tightly packed — a regular pattern
shape	assumes the shape of its container - no shape	assumes the shape of its container - no shape	retains a fixed volume and shape
kinetic energy — movement	very active	slide past each other	rigid
fluid	fluid — flows easily	fluid — flows easily	not a fluid — does not flow easily
volume	volume of container	fixed volume	fixed volume

## Questions

1. Why does water's high specific heat make it a good coolant for car radiators?

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2. Which state of matter has the most kinetic energy? the least kinetic energy?

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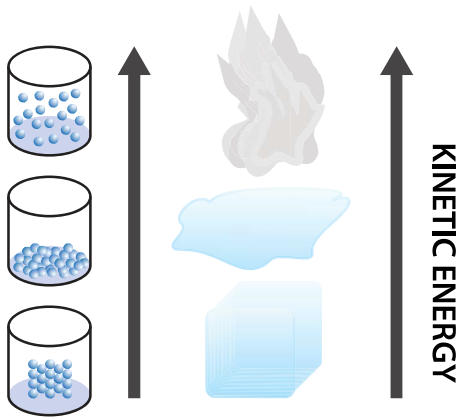
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3. How does heat affect water and its state of matter?

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4. What is the picture below showing? Please explain.



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5. Fill in the definitions of the vocabulary words.

Vocabulary	
specific heat	
kinetic energy	
coolant	

# The Chemistry of Water

Vocabulary	
solvent	atom
molecule	bond

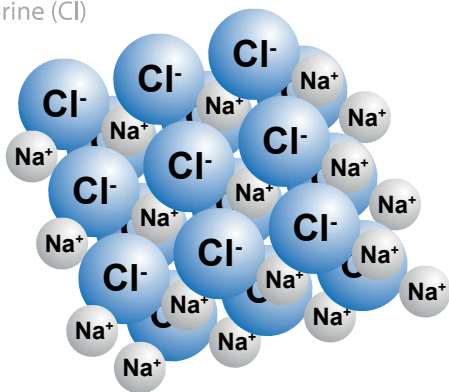
Water is called the universal **solvent**. It is called this because more substances dissolve in water than in any other chemical. A **molecule** of water is made up of two hydrogen **atoms** and one oxygen atom. An atom is the basic unit of a chemical element. The hydrogen and oxygen atoms of a water molecule are held together by **bonds**. In the configuration of a water molecule, the two hydrogen atoms occur on the same side of the oxygen atom. The hydrogen atoms create a positive electrical charge while the oxygen atom creates a negative charge.

When water molecules orient towards each other, they arrange themselves so that positive and negative charges meet. Since opposite electrical charges attract, water molecules tend to attract each other. This makes the water molecules clump or “stick” together and form drops or beads on smooth surfaces.

The electrical charges of the water molecule cause it to be a good solvent—a substance that allows other substances to become part of it. Look at the picture below. It shows how the NaCl (table salt) molecule breaks apart when mixed with water. The positive Na (sodium) atom is attracted to the negative O (oxygen) atom, and the negative Cl (chlorine) atom is attracted to the positive H (hydrogen) atoms.

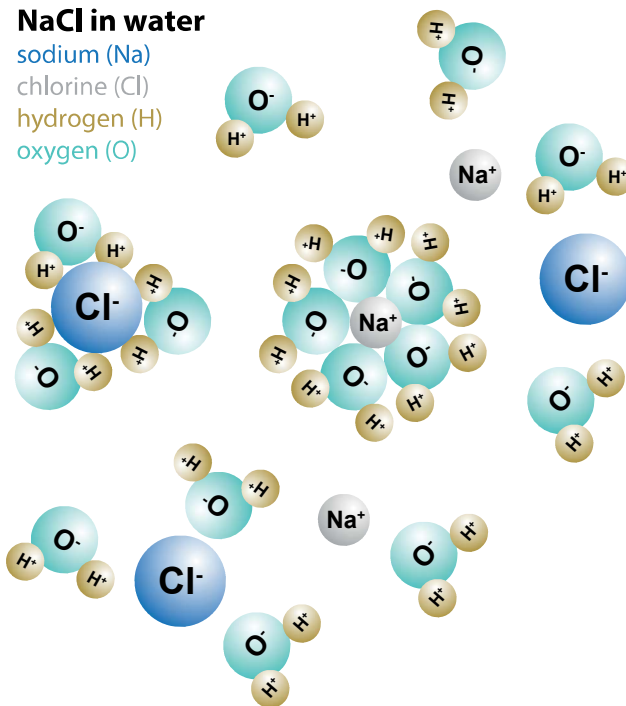
## NaCl crystal structure

sodium (Na)  
chlorine (Cl)



## NaCl in water

sodium (Na)  
chlorine (Cl)  
hydrogen (H)  
oxygen (O)



## Review Questions

1. How many atoms are in a water molecule?

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2. Draw a picture of a water molecule.

3. Describe the structure of a water molecule.

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4. How do water molecules form droplets of water?

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5. Why is water called the universal solvent?

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6. Explain how NaCl or table salt dissolves in water.

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7. Write the definitions of the following words.

Vocabulary	
<b>solvent</b>	
<b>molecule</b>	
<b>atom</b>	
<b>bond</b>	