3d molecular designs
Transforming Science Learning

Get to Know H_2O with Hands-on Models

Kim Parfitt

Taught for 18 years at Cheyenne Central High School

And after 11 years of using 3D models and attending CBM summer courses, I am now working full-time for this amazing company.

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Leadership Academy

Now, about you…

Workshop Learning Goals

You will be able to:

- Wonder how a simple water molecule can help students build science literacy.
- Explore how the polar nature of water allows interactions with other molecules to make life possible (and interesting).
- Explain how modeling with the Water Kit can reveal and support student thinking in biology.

Investigate the materials at your table.

What do you notice?

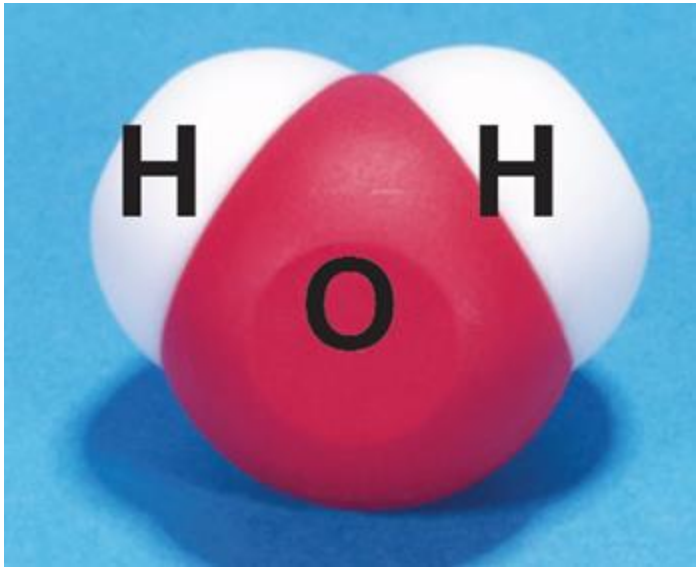
What do you wonder?

Atom

Molecule

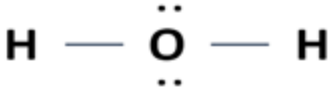
Compound

Bond

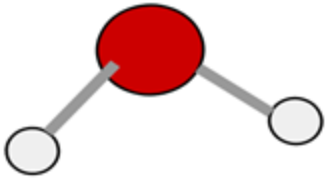


H_2O

Molecular formula



Lewis structure



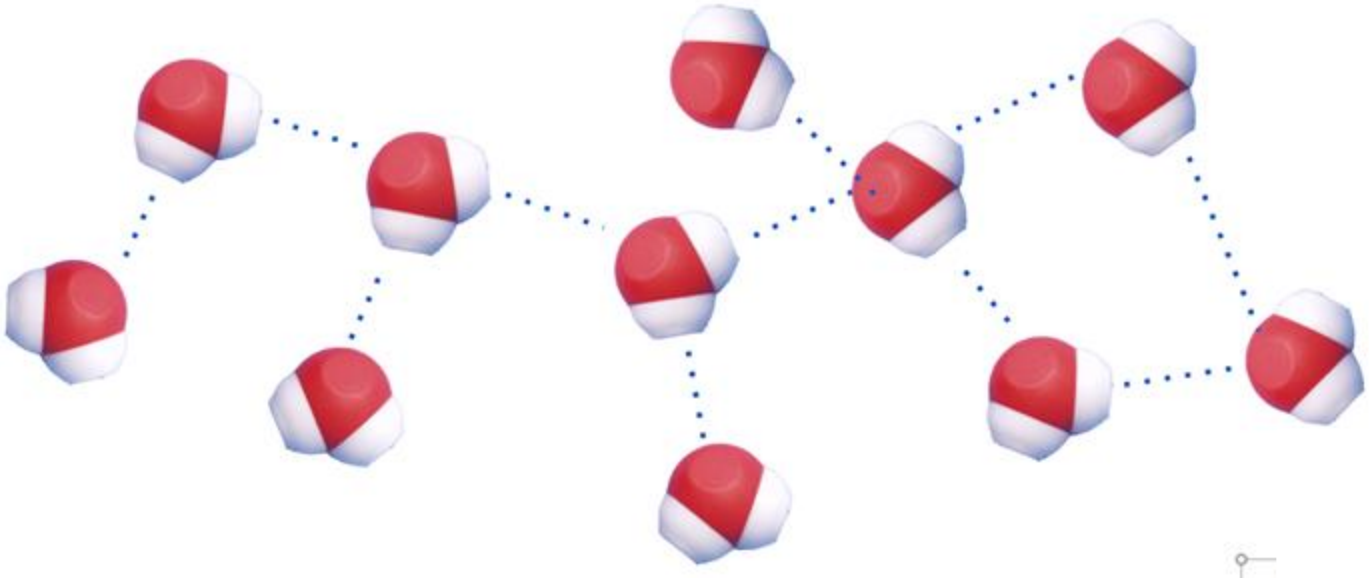
Ball-and-stick model

Space-fill model

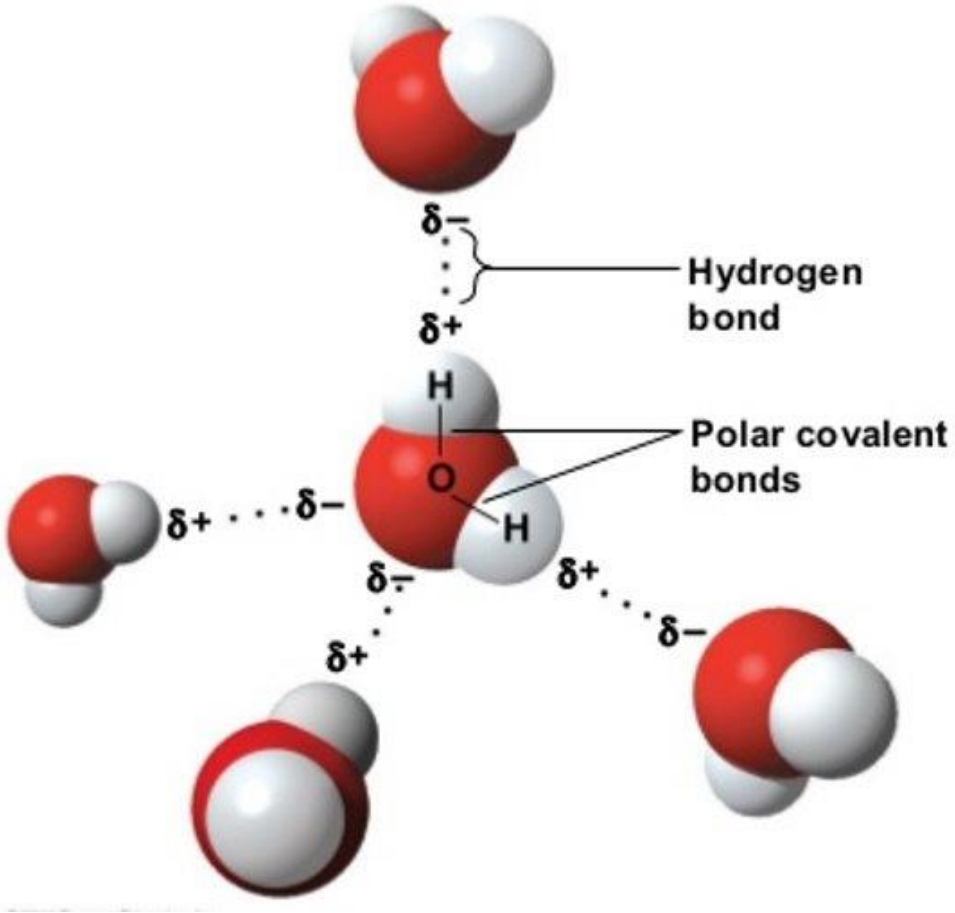
Polar Molecule

The shared electrons in a water molecule spend more time near the oxygen atom and less near the two hydrogen atoms, resulting in **slightly positive** and **slightly negative** regions.

Intermolecular attractions (hydrogen bonds) consequence of polarity

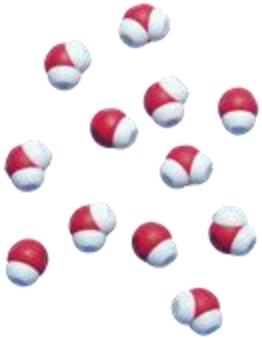


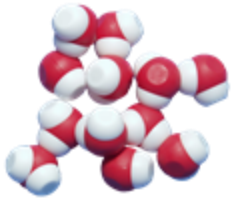
See how many water molecules one can a water molecule bond with.

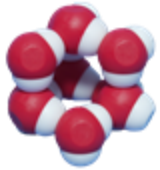

δ–
δ+
Hydrogen bond
H
O
H
Polar covalent bonds
δ+
δ–
δ–
δ+
δ+
δ–

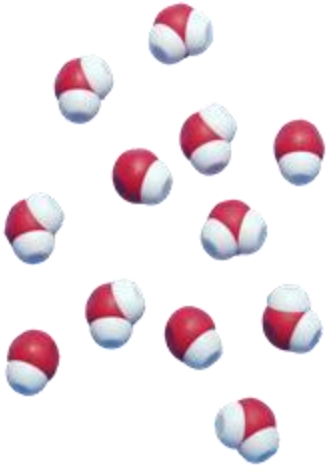
Concepts I count on:

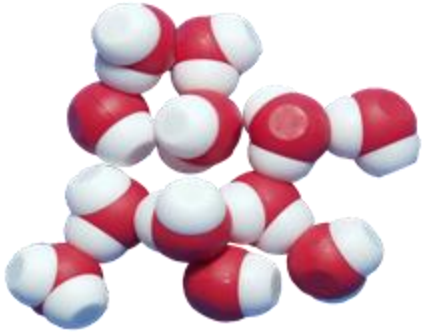
- Polar molecule
- Covalent bonds are atoms sharing an electron
- Hydrogen bonds are weaker attractions between molecules
- Adhesion and cohesion made possible
- Color scheme in modeling
- First transfer of 3D model into science notebook
- How to manage materials in our classroom

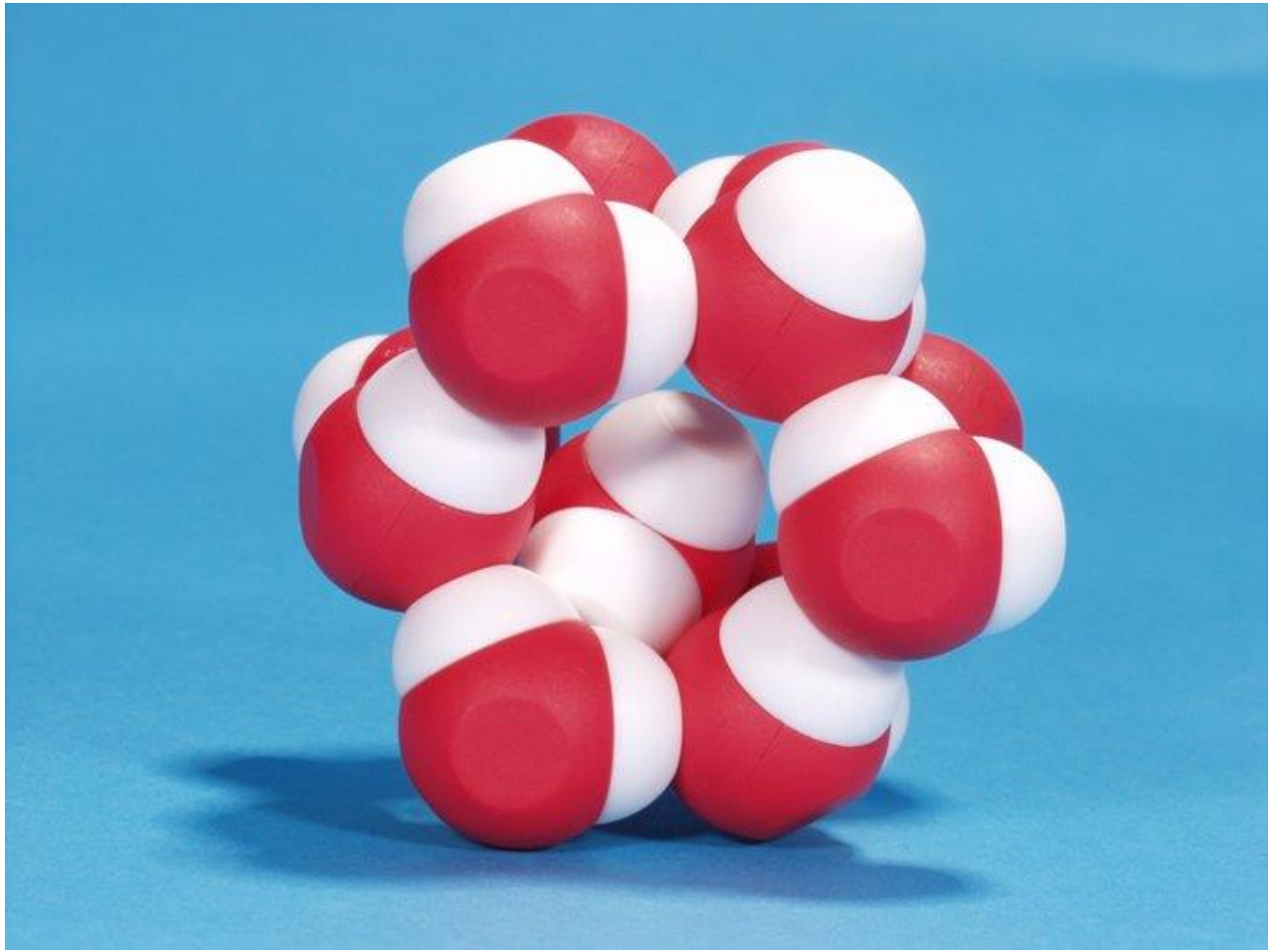


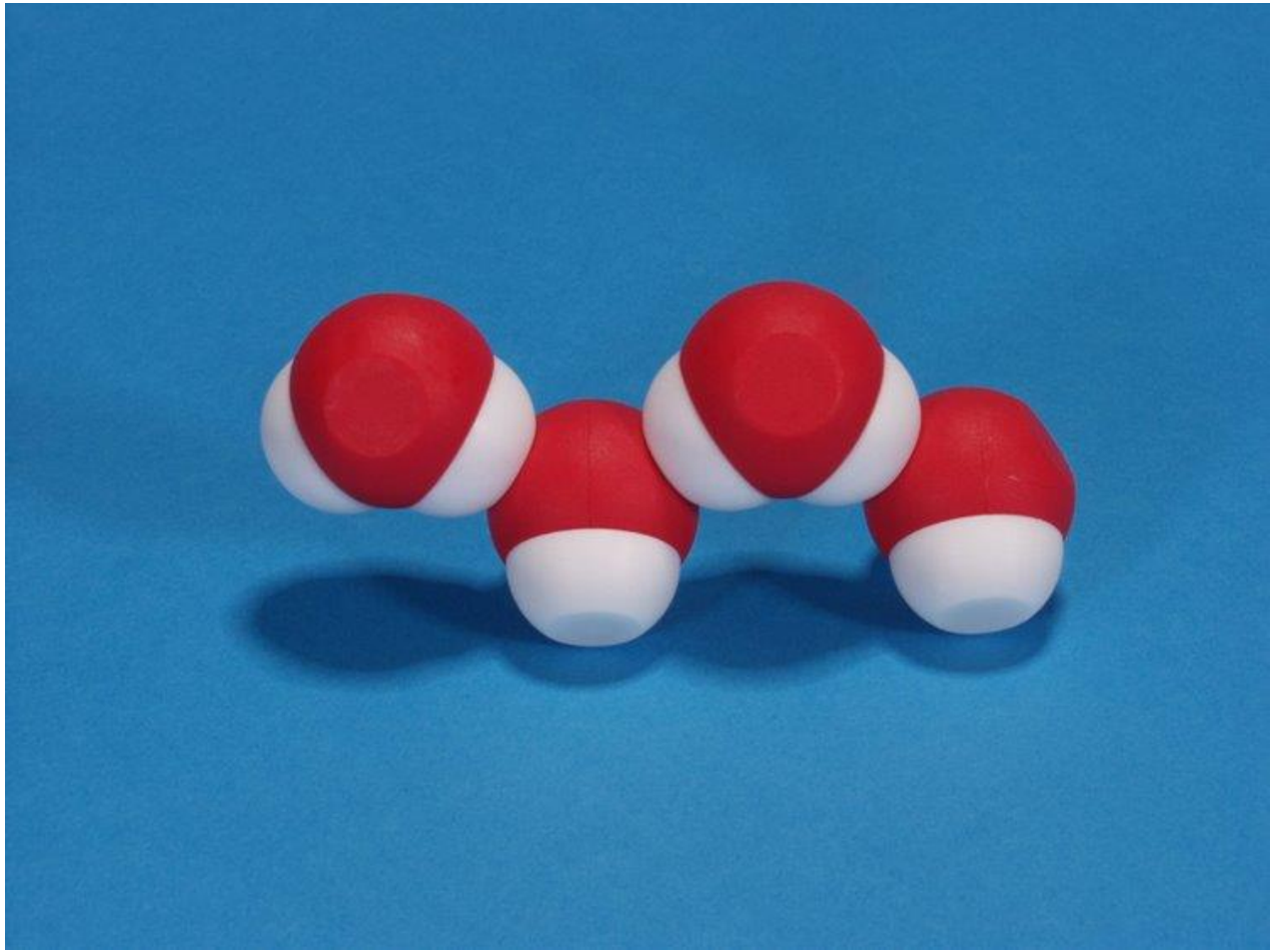


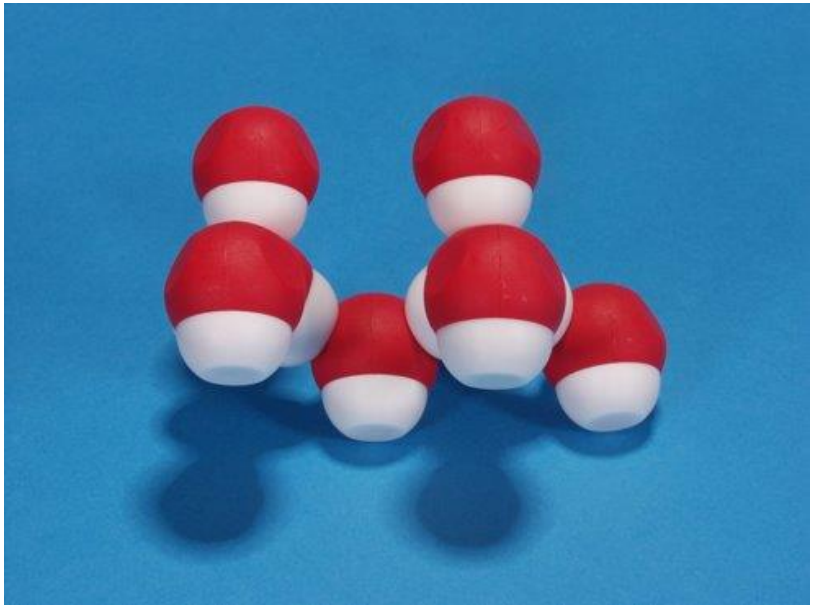


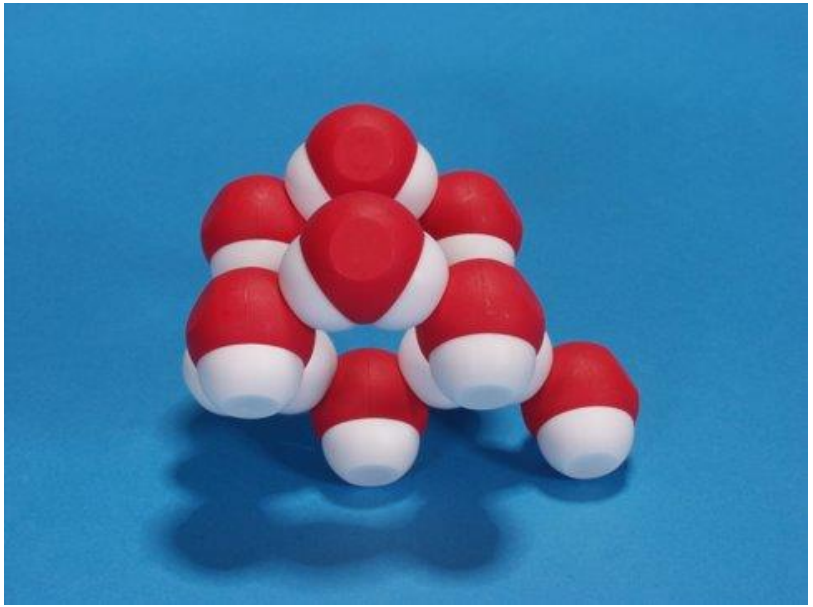


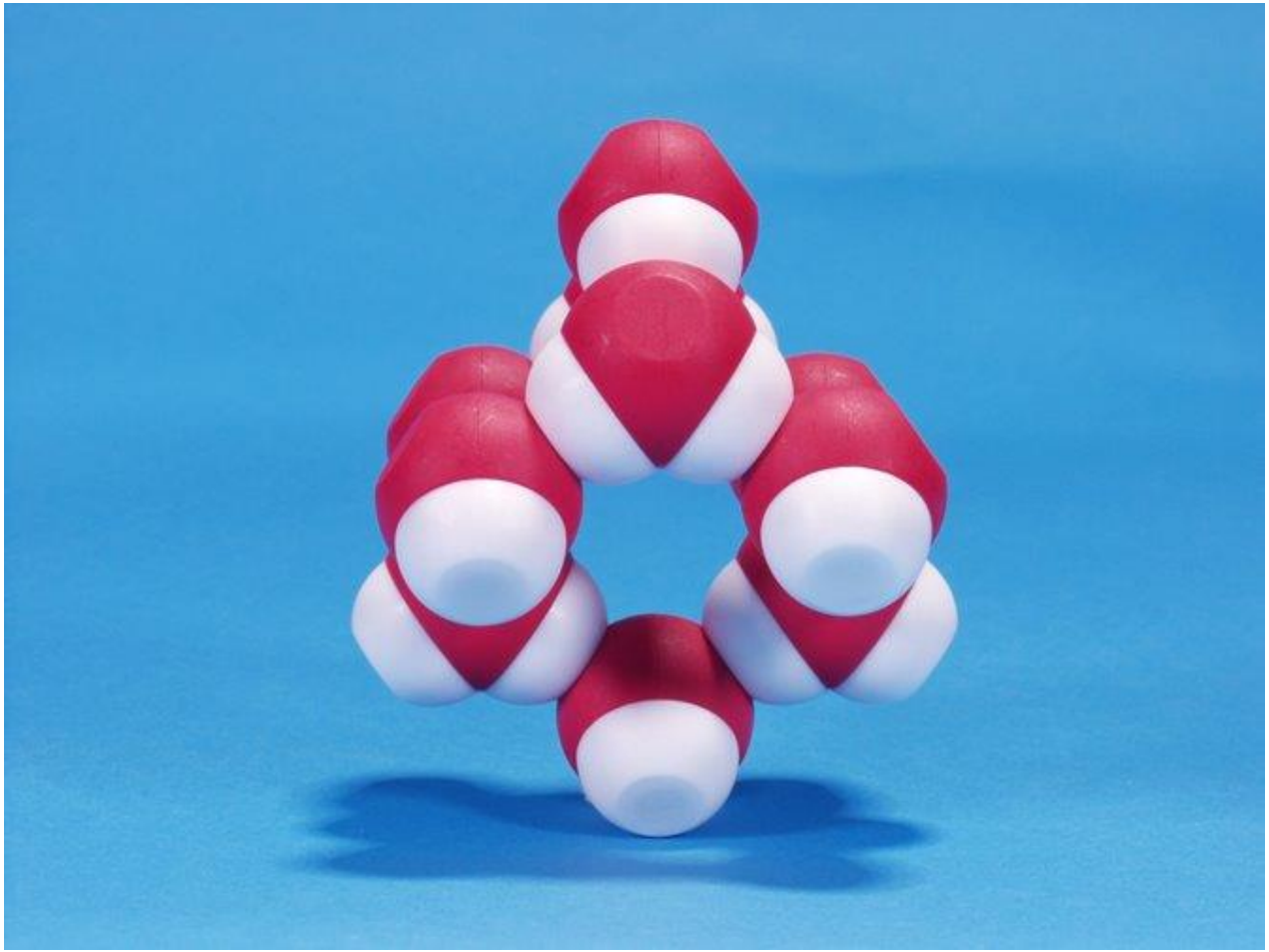


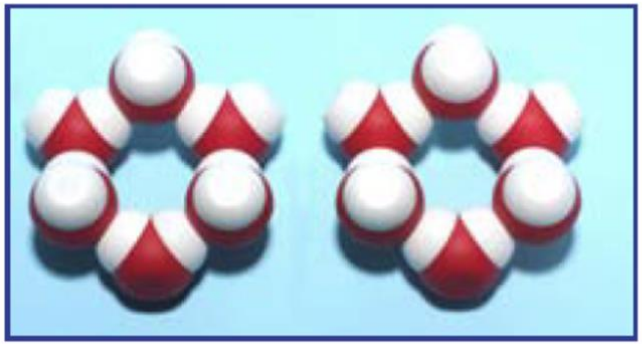


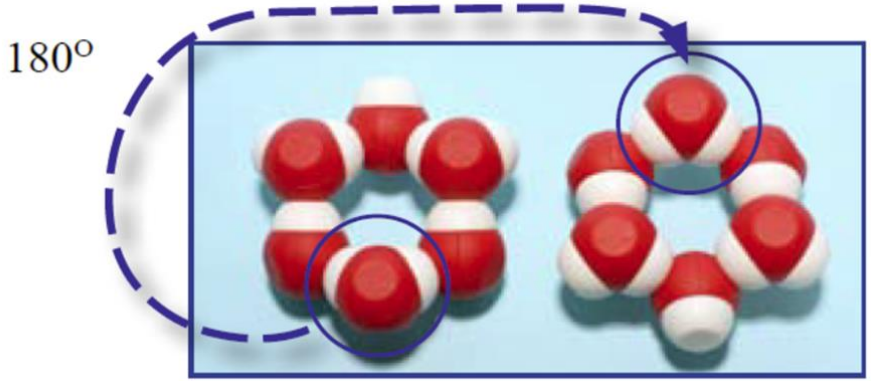


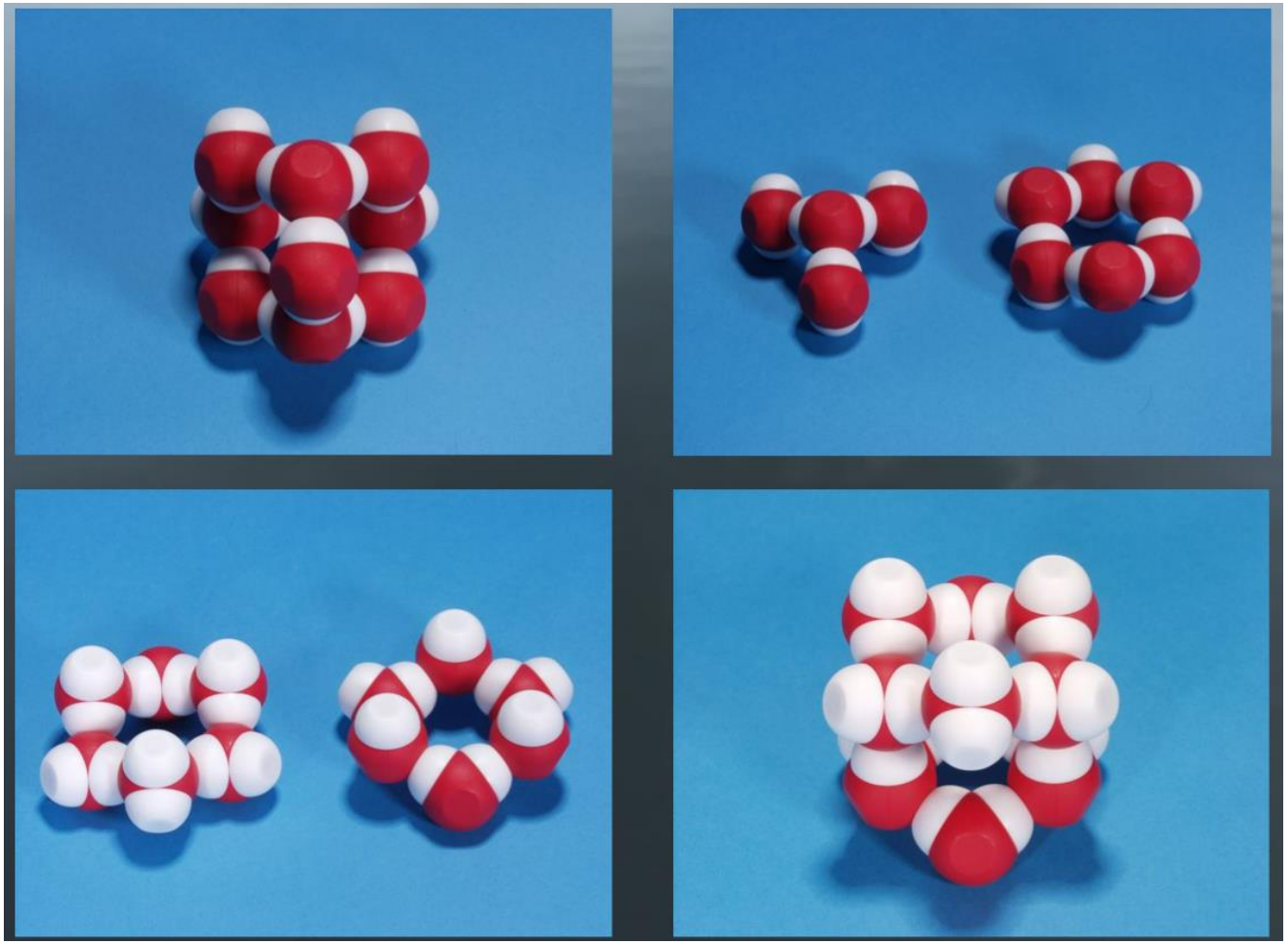









180°



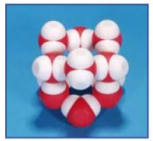
3d molecular designs

3D Molecular Designs
. . .where molecules become real™

Just For Fun Activities (continued)

Hexagonal Ice

Scientists have described twelve structures of ice, many of which can be constructed with the Water Kit®. Check the 3D Molecular Designs website for more information on ice and how to construct some of the twelve different structures of ice. To construct Ice 1h, hexagonal ice, follow the directions for the *Step Method* or the *Pattern Method* (on the next page).



Step Method

1. Hold one molecule horizontally in front of you with the hydrogen atoms to the sides.

2. Add two vertical (hydrogen atoms pointing up and down) molecules to the two hydrogen atoms from the first step. *See the first picture on the right.*

3. Add a horizontal molecule to the lower hydrogen on each molecule added in step 2. *See the 2nd picture to the right.*

4. Add one vertical molecule to connect the hydrogen atoms from the molecules added in step 3. *See the 3rd picture to the right.*

5. Create a second hexagonal ring following steps 1-4.

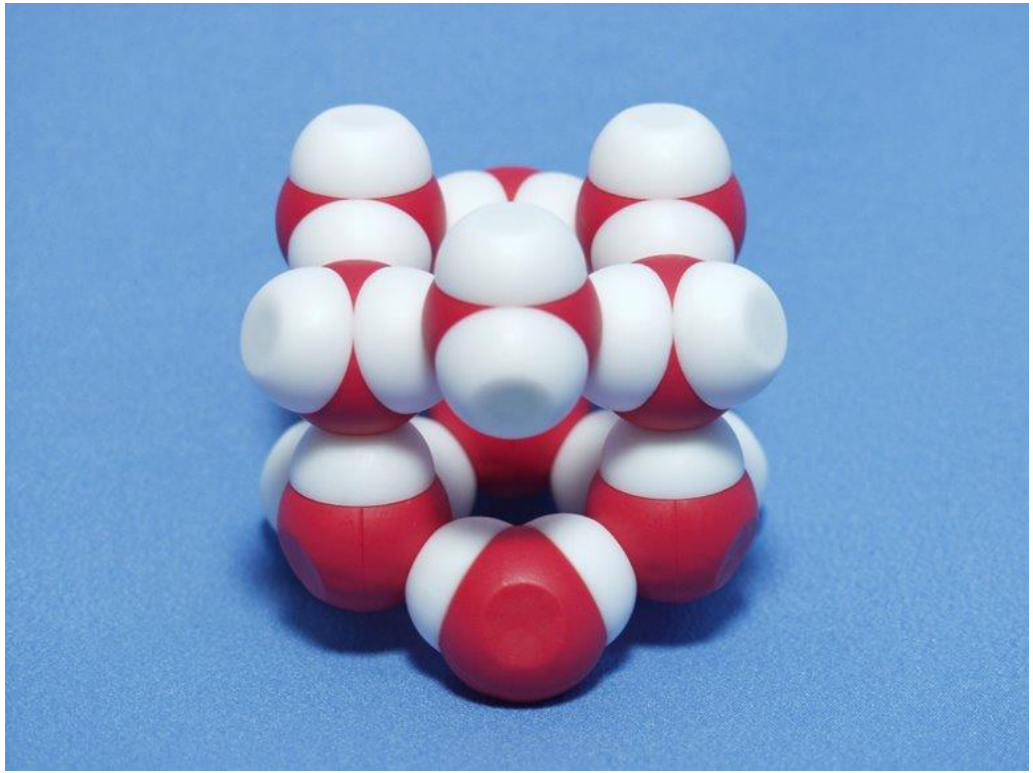
6. Orient the two hexagonal rings the same way – then rotate one ring 180 degrees.

7. Place one hexagonal ring on top of the other. Do not flip one ring over – the hydrogen atoms on both rings should point the same way.

You have now formed a model of an ice cube. Note that it is possible to place a 13th water molecule into the hole formed by this lattice. Now you can see why ice floats. Ice has empty spaces in it. The same volume occupied by 12 water molecules in a solid ice lattice, can contain more water molecules in its liquid form.

3d molecular designs

Density



Volume

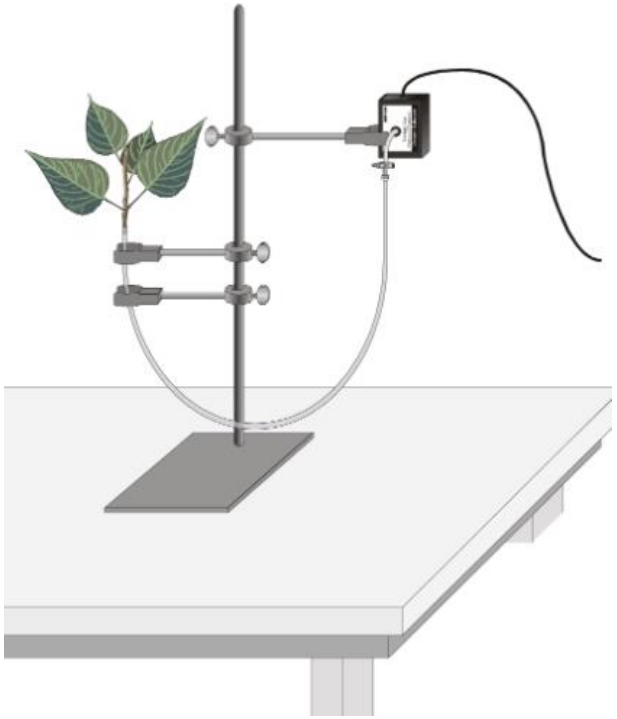
The crystalline structure of ice has a lot of space.

As water freezes it expands.

Source: NASA/JPL-Caltech/MSSS

Mars has all the ingredients for life – water, chemicals and energy – but no signs of living things yet

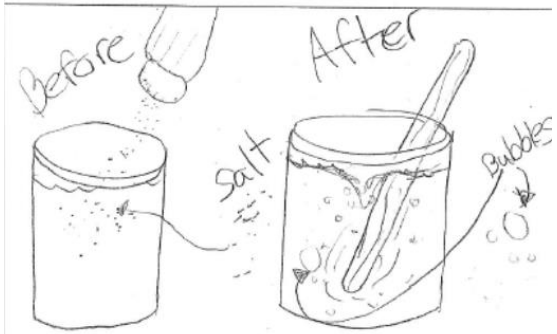
TRANSPIRATION



Dissolving Pre Model

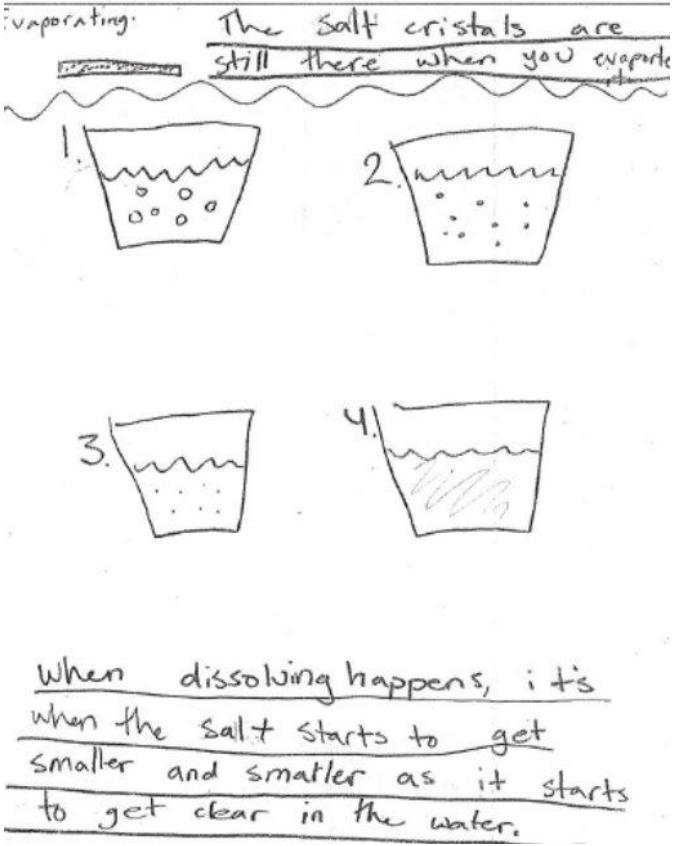
So dissolving just means it disappers in the water and adds more to the water and makes it a solution

Dissolving Pre Model



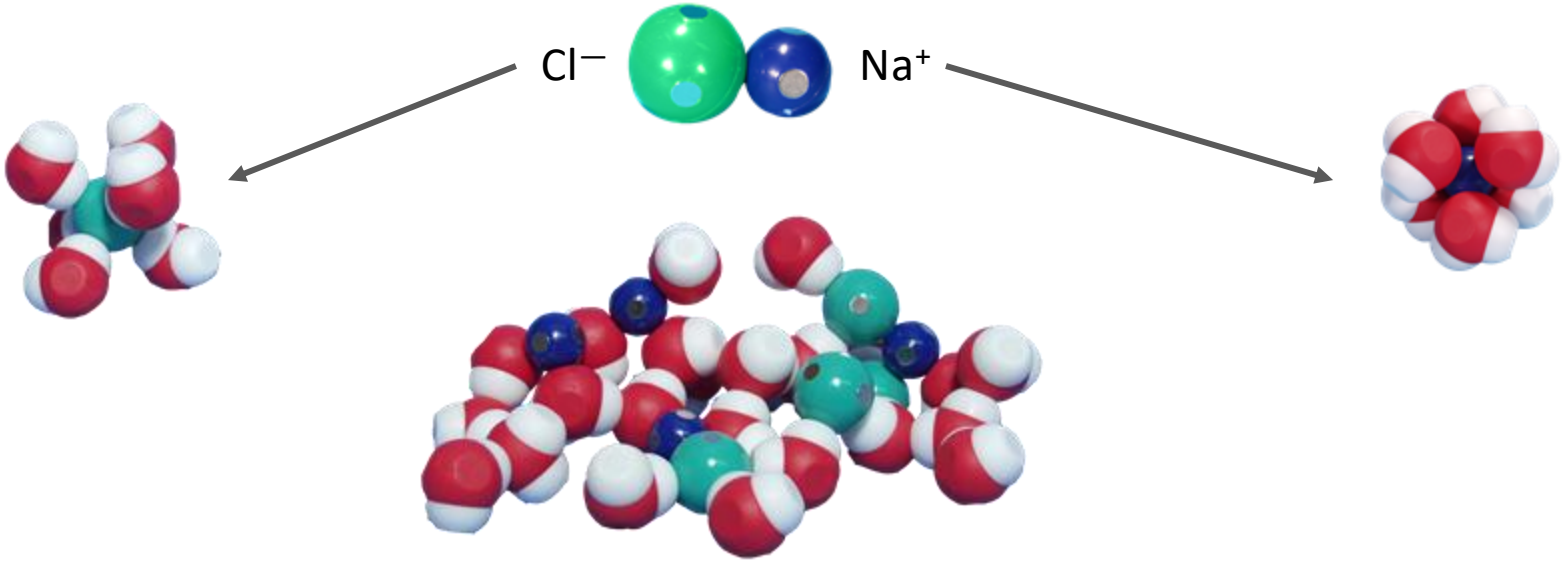
Here is a picture of what salt looks like before and after the salt has been added to the water.

Dissolving Pre Model



When dissolving happens, it's when the salt starts to get smaller and smaller as it starts to get clear in the water.

Why is water so good at dissolving things?

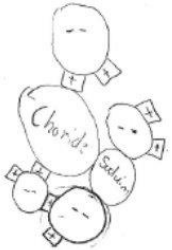


Dissolving Post Model

Sodium - (blue) - attracted to red (oxygen)

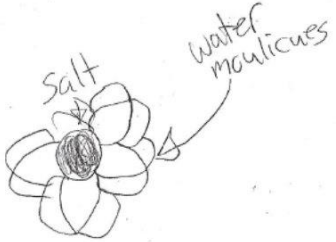
Chorick - (green) - attracted to white (hyrogen)

Salt - NaCl



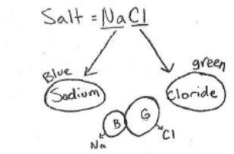
Dissolving Post Model

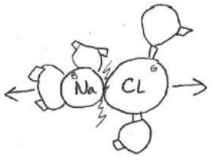
magnified



This is a picture of salt dissolving by water molicue surounding the salt.

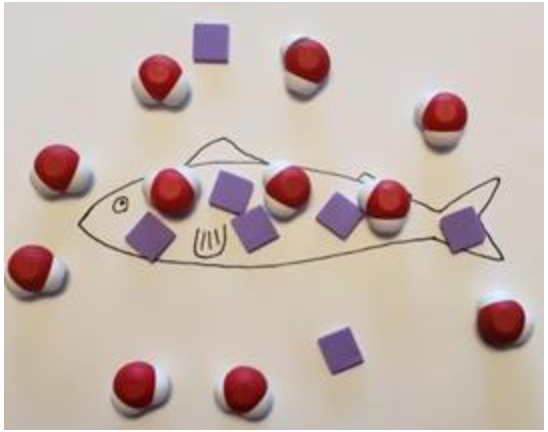
Dissolving Post Model

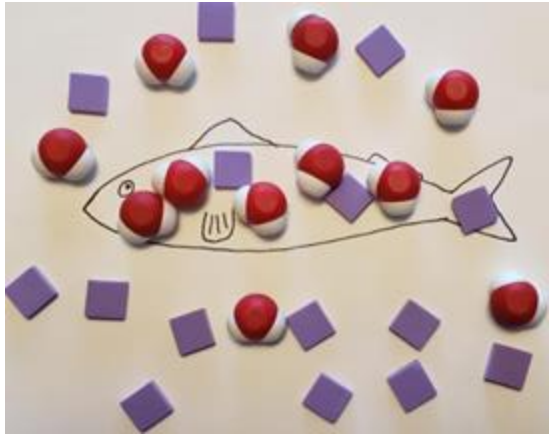


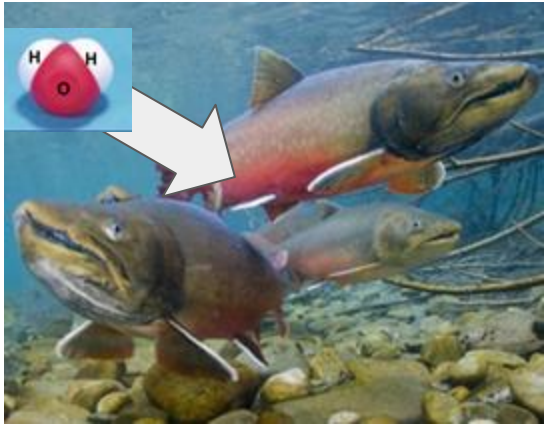


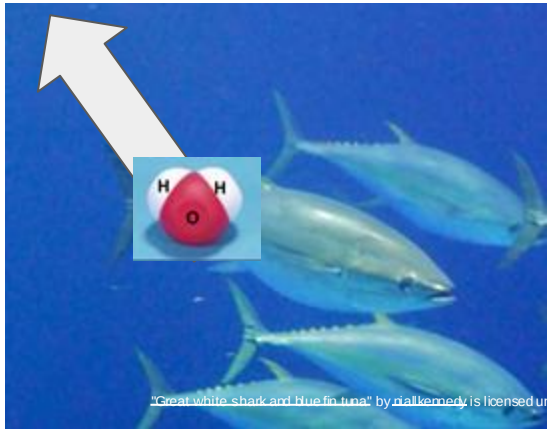
When the sodium and cloride/salt separates in the water, the water Molecules separate them by comeing right onto the salt.

Do fish drink water?

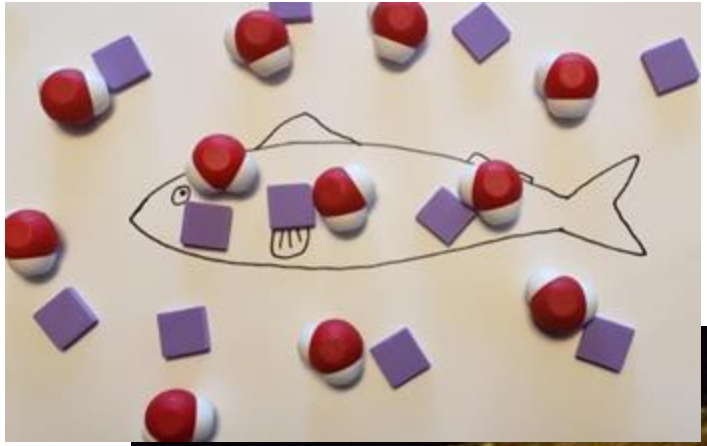


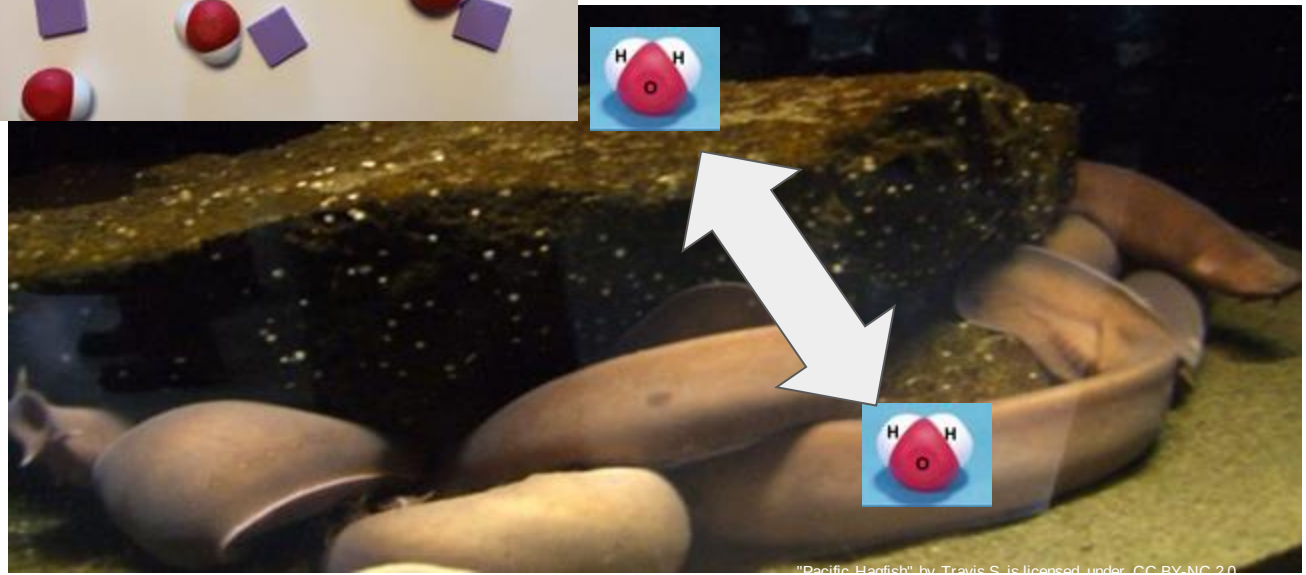






"Bull Trout Underwater" USFWS Mountain Prairie CC BY 2.0

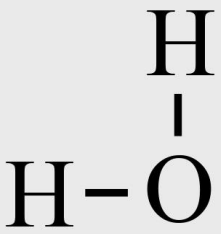




Building a Water Molecule

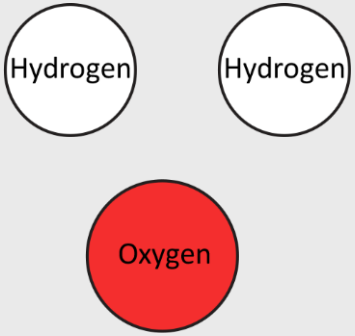
A single **water molecule** contains **one oxygen atom** and **two hydrogen atoms** that are **covalently bonded** together, meaning that they share electrons.

1. Study the chemical structure shown below.
2. Drag and connect the pieces on the right to build your own single water molecules in three common molecule representations.
3. Answer the question below and move to the next slide.

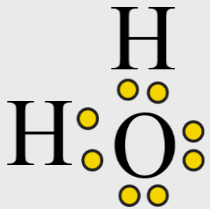


Chemical Structure Representation

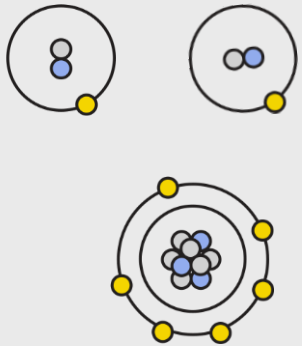
Atom Spacefill Representation



Lewis Structure Representation



Bohr Model Representation



What is the bond called that joins a hydrogen to an oxygen in a water molecule?

3-D Molecular Designs
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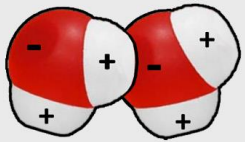
The Polar Nature of Water

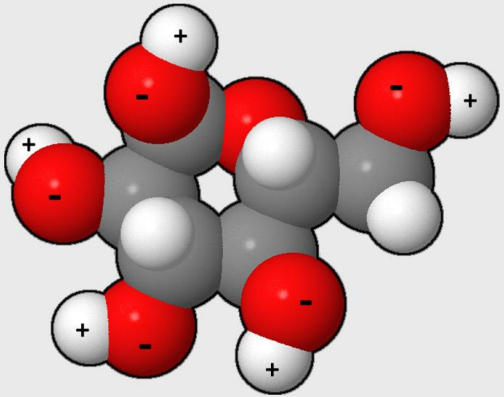
The shared electrons in a water molecule spend more time near the oxygen atom and less near the two hydrogen atoms, resulting in **slightly positive** and **slightly negative** regions.

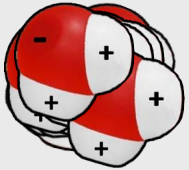
This impacts how they interact with other molecules, forming **hydrogen bonds** when they get close to an opposite charge.

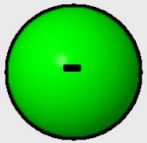
1. Study how two water molecules interact using the image shown below.
2. Drag the water molecule shown to the right to demonstrate how water molecules might interact with the other common molecules.



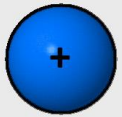
Glucose



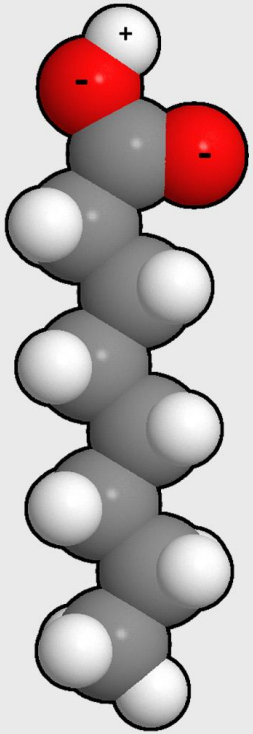




Chloride Ion



Sodium Ion



Fatty Acid

3-D Molecular Designs
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The Three States of Matter

Matter can exist in three states, **solid**, **liquid** and **gas**.

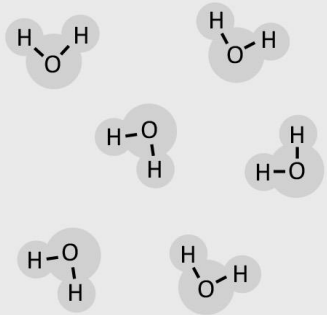
As a gas (above 100°C), water molecules barely form hydrogen bonds with each other, and are very spread out.

As a liquid (between 0°C and 100°C), water molecules are very close to each other and form and break hydrogen bonds quickly.

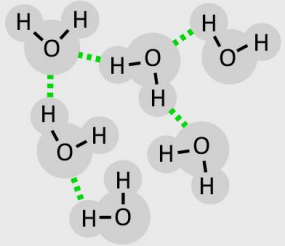
As a solid (below 0°C), water molecules form permanent hydrogen bonds that crystalize into a hexagonal lattice structure.

1. Study the various chemical drawings shown above and to the right.
2. Drag and rotate the water molecule shown to the right to create three illustrations of the three states of matter.
3. Answer the question to the right and move to the next slide.

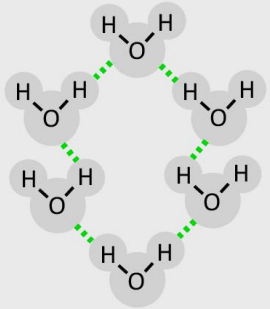
Water as a Gas
(above 100°C)



Water as a Liquid
(between 0°C and 100°C)



Water as a Solid
(below 0°C)



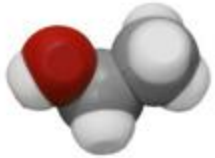
Why is solid water (ice) less dense than liquid water?

Methane
(CH_4)

Methanol
CH_3OH

Ethane
(C_2H_6)

Ethanol
(C_2H_5OH)



- Ethanol is an alcohol made from grains.
- Ethanol is polar.

- Ethane is an odorless, colorless gas that can be used as a fuel, a freezing agent, and in making other chemicals.
- Ethane is non-polar. It does not have partial positive or negative charges.

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THANK YOU FOR ATTENDING!

Kits and models used in this session:

Water Kit©

Purchase kits at **3dmoleculardesigns.com**.

Use discount code **FC22** to receive 20% off most items in our catalog.

Student Modeling Packs are not eligible for discount.

- Understand polarity
- Create non-polar ethanol
- Compare the various strengths of hydrogen, covalent, and ionic bonds
- Investigate capillary action and transpiration
- Demonstrate the differences between adhesion and cohesion
- Explain surface tension, evaporation, and condensation
- Show the states of water (gas, liquid, and solid)
- Dissolve salt to explore solubility
- Model ice structures and snowflakes
- Define and create models of the states of osmosis
- Understand the basics of water autoionization, dissociation and pH

www.3dmoleculardesigns.com/Teacher-Resource/Water-Kit.htm