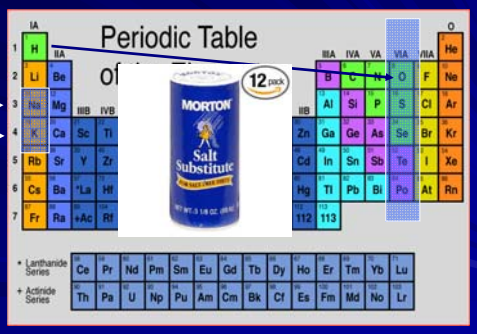
Water, Life, Civilization: Why Water?

Water: H_2O

Water: H_2O



Water and Similar Compounds

Water

H_2O

Hydrogen Sulfide

H_2S

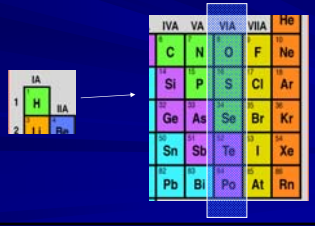
Water: H_2O

Hydrogen Sulfide: H_2S

Water is the only substance that exists as a gas, solid, and liquid at ambient earth temperatures

Boiling Point and Freezing Point

	Solid	Gas	
	F.P	B.P	liquid range
Water (H_2O)	0°C	100°C	100°C
Hydrogen Sulfide (H_2S)	-84°C	-60°C	24°C
Hydrogen Selenide (H_2Se)	-64°C	-42°C	22°C
Hydrogen Telluride (H_2Te)	-49°C	2°C	47°C



H_2O

Two hydrogen atoms
One Oxygen atom

What makes water so unusual?

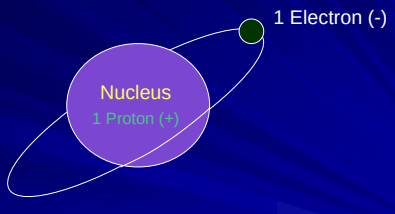
Hydrogen: 1 electron (-), 1 proton (+)

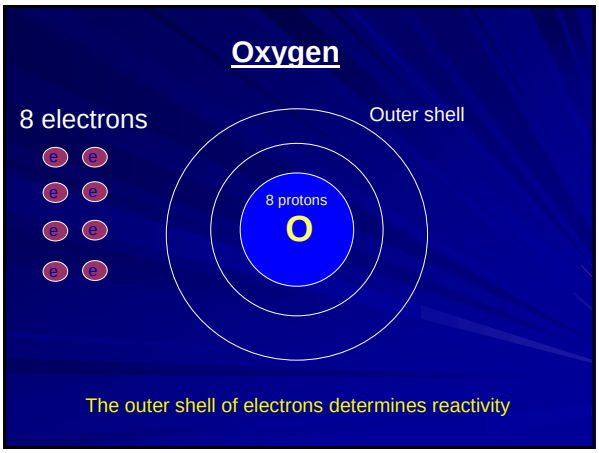
Oxygen: 8 electrons (-), 8 protons (+)

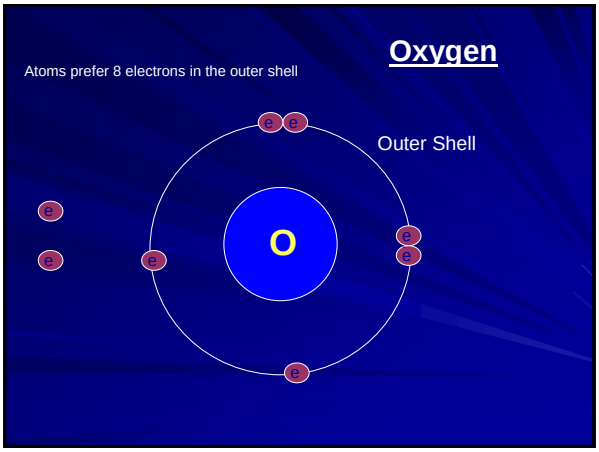
In water, the hydrogens shares their one electron with oxygen, which shares one of its electrons with each hydrogen.

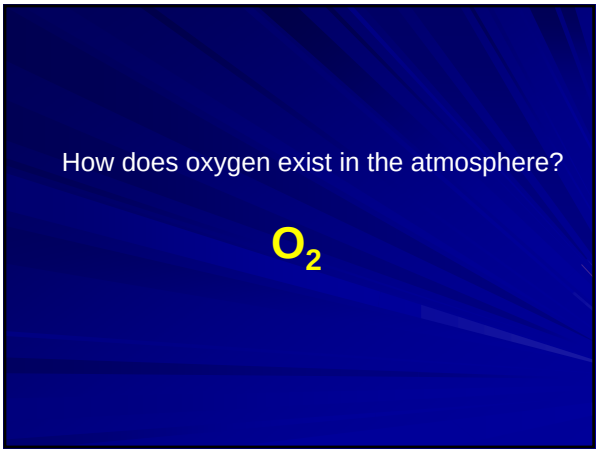
This sharing of electrons forms the bond between hydrogen and oxygen atoms to make the water molecule.

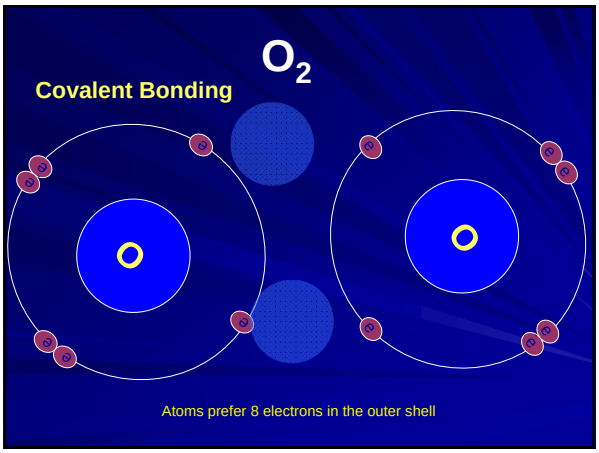
Hydrogen H

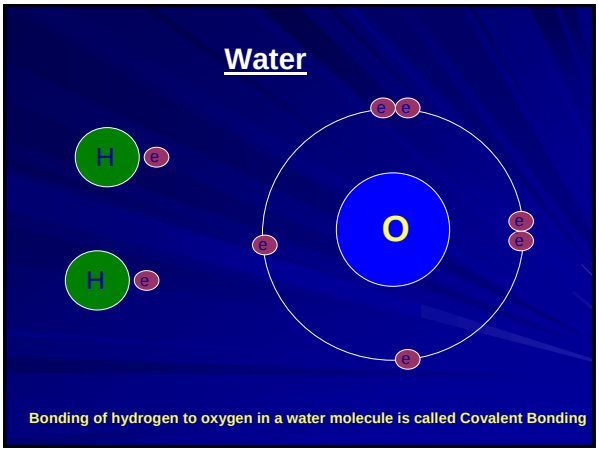


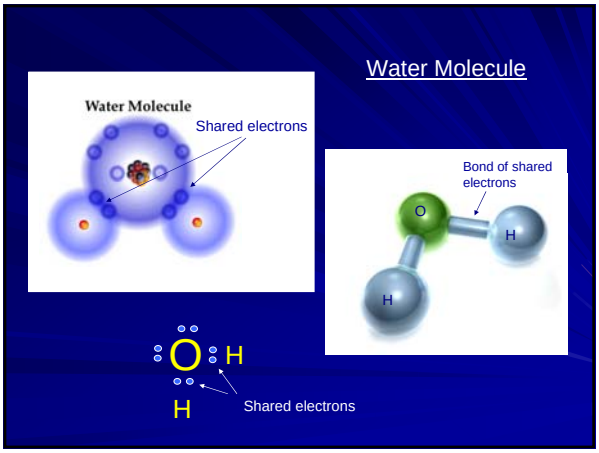

Oxygen
8 electrons
Outer shell
8 protons
O
The outer shell of electrons determines reactivity


Oxygen
Atoms prefer 8 electrons in the outer shell
Outer Shell
O


How does oxygen exist in the atmosphere?
O_2


Covalent Bonding
O_2
Atoms prefer 8 electrons in the outer shell


Water
H
H
Bonding of hydrogen to oxygen in a water molecule is called Covalent Bonding

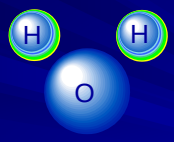

Water Molecule
Water Molecule
Shared electrons
Bond of shared electrons
O
H
H
H
Shared electrons

Extra Credit Questions:

Write your responses on the back of the lecture question sheet

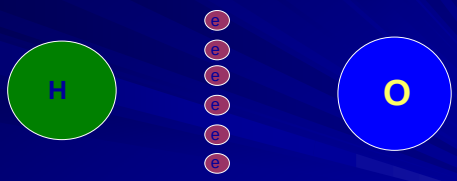
1. The diameter of the earth is _____
2. One potential source of water on earth is _____
3. The human development that ended the paleolithic and began the neolithic revolution was _____
4. Warming of the earth following the last glaciation was fast or slow? (choose one)
5. The bonding between oxygen and hydrogen in a water molecule is called _____ bonding.

Water is Unbalanced by Oxygen



Oxygen is "Electron Greedy"

Oxygen attracts electrons very strongly

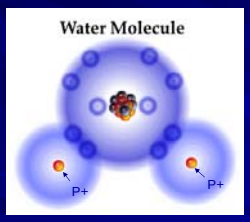


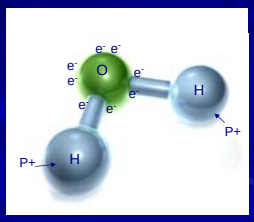
Oxygen's pull on electrons is about 50% stronger than hydrogen

Electrons are negatively charged, protons positive

Oxygen is “electron greedy”

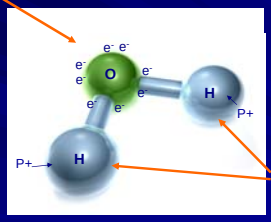
Oxygen pulls electrons toward itself and away from hydrogen





This pulling of electrons toward itself is called “electronegativity”

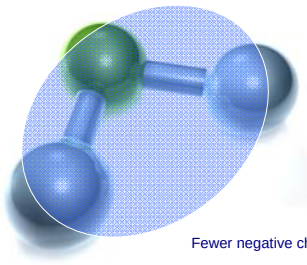
Abundant electrons (negative charge)



Two protons (+ charge)

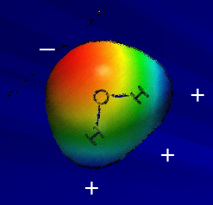
More negative charges

(-)



Fewer negative charges

Polarity

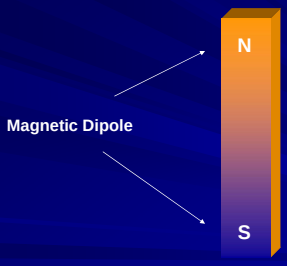


Red = lots of e^-
Blue = few e^-

Electric Dipole

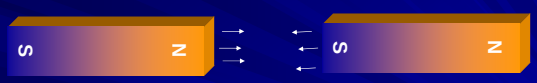
Consequences of Polarity

Magnets and Polarity



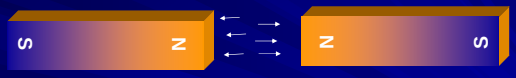
Magnetic Dipole

Polarity



Opposite Poles Attract

Polarity

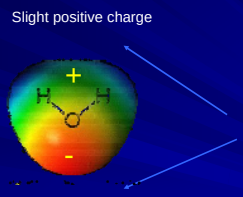


Same Poles Repel

Polarity

http://games.mochiads.com/c/g/polarityfreak/polarityfreak-11-Mochi-Sec.swf

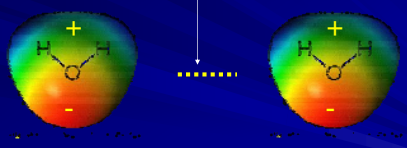
Polarity



Electric Dipole

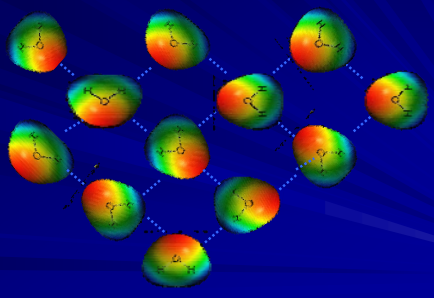
Orientation

Bond (hydrogen bond)



Opposite charges attract each other

Hydrogen Bonding in Water



Hydrogen Bonding Gives Water Unusual Stability

Examples

Extensive Hydrogen Bonding Allows Water
to Exist as a Liquid at Normal Temperatures
And across a wide range in temperatures

High Boiling and Freezing Points
Other Unusual Thermal Properties
Unusual Density

Summary

Hydrogen and oxygen share electrons to form water
The water molecule is electrically unbalanced
Oxygen is electron greedy; it is highly electronegative
Oxygen draws electrons toward itself and away from hydrogen
This creates a slight negative charge near oxygen
There is also a slight positive charge near hydrogen
The result is a molecule that is polar (+ and – poles)
This polarity accounts for electrostatic bonding between water molecules
Bonding between water molecules gives water unusual stability.

No Class Friday

Properties