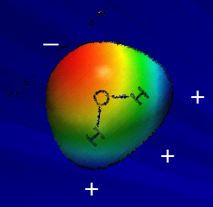
Note taker needed for SWS 2007

See me after class if interested

Unusual Properties of Water

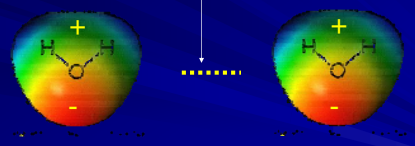
Polarity



Electric Dipole

Orientation

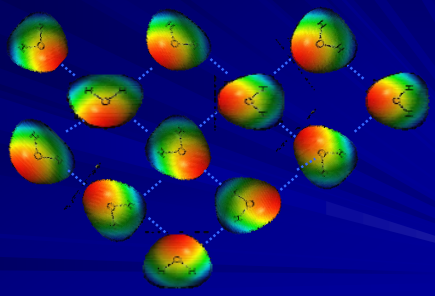
Bond (hydrogen bond)



Opposite charges attract each other

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

Hydrogen Bonding in Water



Hydrogen Bonding Gives Water Unusual Properties

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
Wide Liquid Range (100°C)
Other Unusual Thermal Properties
Unusual Density

Density

$\frac{M}{V}$ grams / cm^3

Low mass and high volume = low density
High mass and low volume = high density

Density

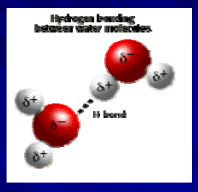
Most substances are denser in their solid state than in their liquid state

(the solid will sink in the liquid)

Liquid to Solid?

Water

Density $\frac{M}{V}$ **(mass) (volume)**



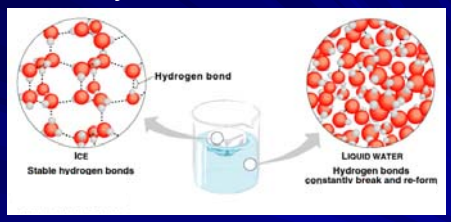
In **liquid water** each water molecule is bonded On average to 3 other water molecules.

In **solid water**, each water molecule is bonded to 4 other water molecules and the bonds are farther apart.

For the same amount (mass) of water molecules, the volume occupied is greater for solid water compared to liquid water. Therefore, the density of solid water is less than the density of liquid water.

Low density

High density



Fewer molecules
In a given volume

More molecules
In a given volume

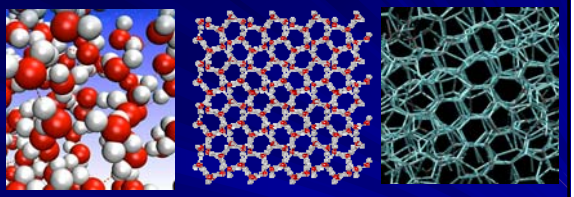
The density of pure water at 25°C is 0.997 g/mL.

The density of ice at 0°C is 0.917 g/mL.

Density

Liquid

Crystalline Ice



Hydrogen bonds
Break and re-form

Stable hydrogen bonds yield
Fixed distances between molecules
(same number of molecules occupy a larger volume)

http://www.youtube.com/watch?v=SVR7tfsjPO0&NR=1

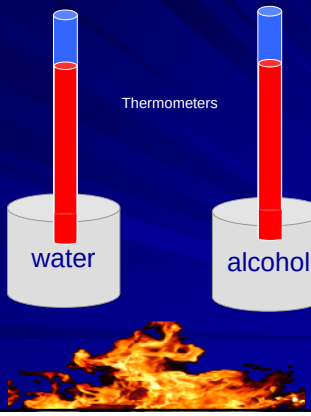
Why is this important?

Importance

lakes

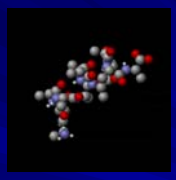
Thermal Properties

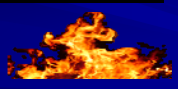
Heat and Temperature Change



Heat Capacity

The amount of heat input required to raise the temperature of a 1 g of a substance by 1°C.





When heat is added to water, the molecules speed up or vibrate more freely. This disturbs hydrogen bonds, but causes only a small change in temperature, because much of the heat energy is used to break or disrupt the hydrogen bonds

Heat capacity of Water

$$1 \ \frac{\text{Cal}}{\text{g} \cdot {}^{o}\text{C}}$$

It requires 1 calorie of heat input to raise the temperature of 1 g of water by 1 degree Celsius

1 g of water is equal to 1 mL

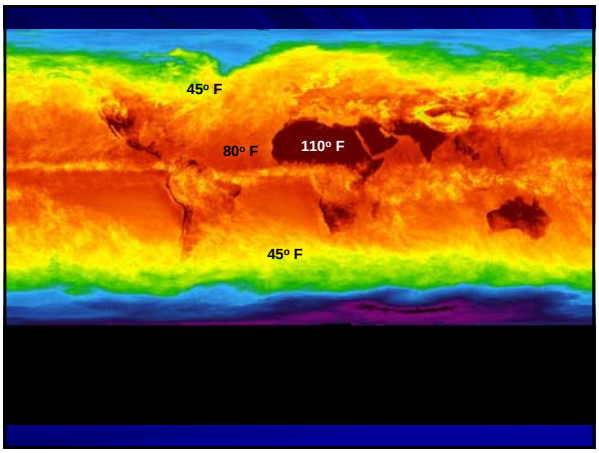
Heat Capacity of Liquids

Water	**1.00**	**cal/g·°C**
Alcohol	0.52	
Oil	0.38	
Mercury	0.03	

The amount of heat (calories) required raise the temperature of a given amount of a substance by 1° Celsius.

Temperatures of large standing bodies of water remain relatively constant.

This thermal buffering protects life on Earth from otherwise possibly lethal temperature fluctuations.



Heat Capacity and Florida Climate

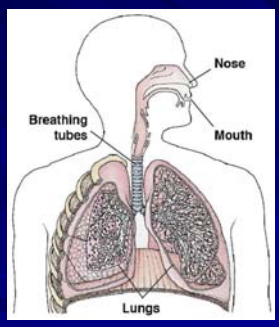
Why does Florida typically receive rain in the afternoon during the summer?

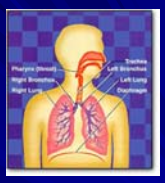
Rainfall

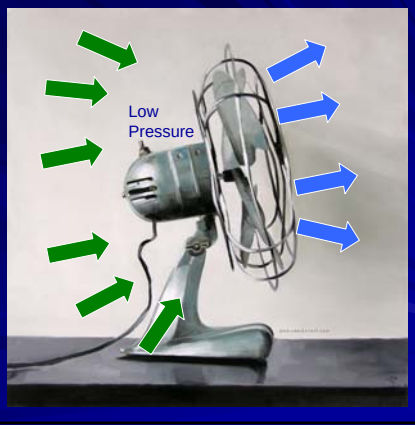
Air moves in response to differences in pressure.

Air will move from areas of high pressure to areas of low pressure.

Try breathing.





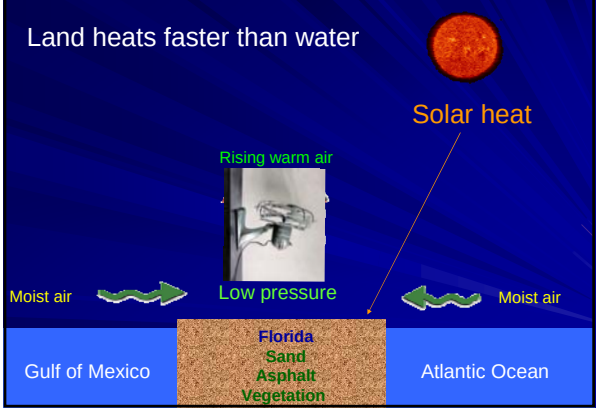


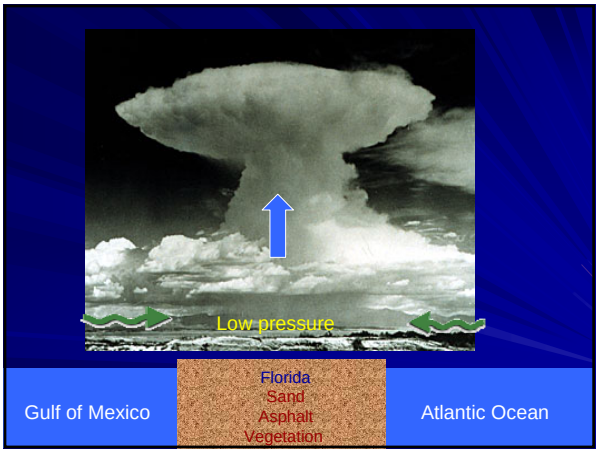
Heat Capacity, Pressure, and Florida Weather

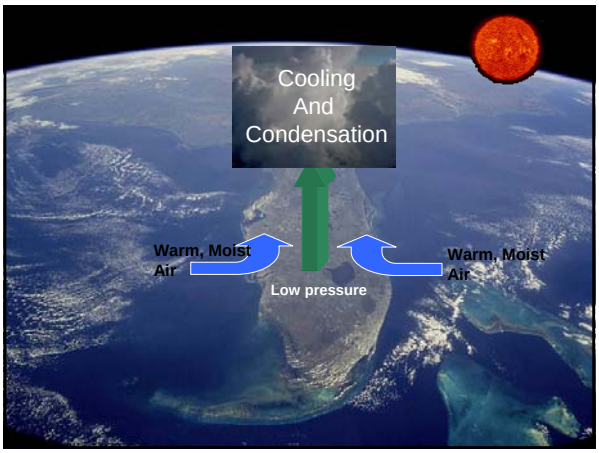
Heat Capacities:

Water	**1.00**	**cal/g·°C**
Asphalt	0.22	
Sand	0.19	→ Land
Vegetation	0.85	

Land heats faster than water

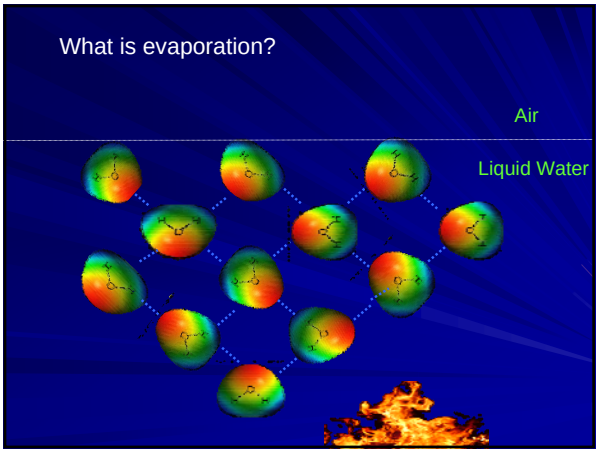




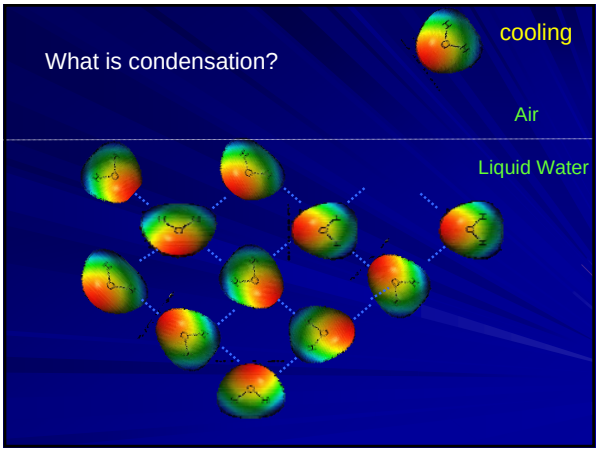


Heat, Evaporation and Condensation

What is evaporation?




vapor

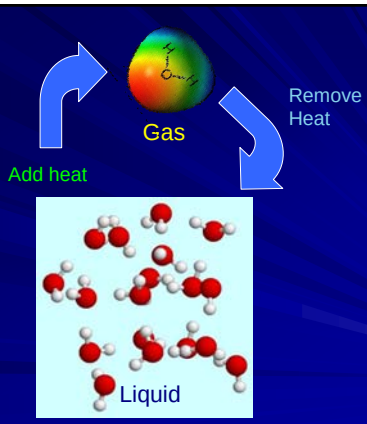

What is condensation?
cooling
Air
Liquid Water


Condensation
CHAMPAGNE

Evaporation: heat input to liquid water excites molecules, breaks hydrogen bonds and molecules escape to vapor phase.

Condensation: heat removal from gaseous water lowers their energy allowing them to rejoin the liquid phase and re-establish hydrogen bonds.

Both processes are ultimately controlled by hydrogen bonding



How Much Heat?