Time	Item	
10	introduction	
30	Density explanation	2:50
10 min	Greenhouse to collect hydrological cycle simulator	
15 min	Break	3:10
30	Adventures in Density Lab pg 9 project WET Add oil, two soda cans / Soap Bubbles	3:40
15	reflection on the experiments and hydrological cycle	3:55
10	Discussion on group measurements	
25	group projects discussion	4:30
15	Reflection …tie Valentines days to ecosystem … extra points for tomorrow … verse or song or music	4:45
	Next Day	
20	Discussion of Density tied to ocean currents	2:20

Time	Item	
1:30	Project plus break	3:50
40	presentation	4:30
15	**reflection**	

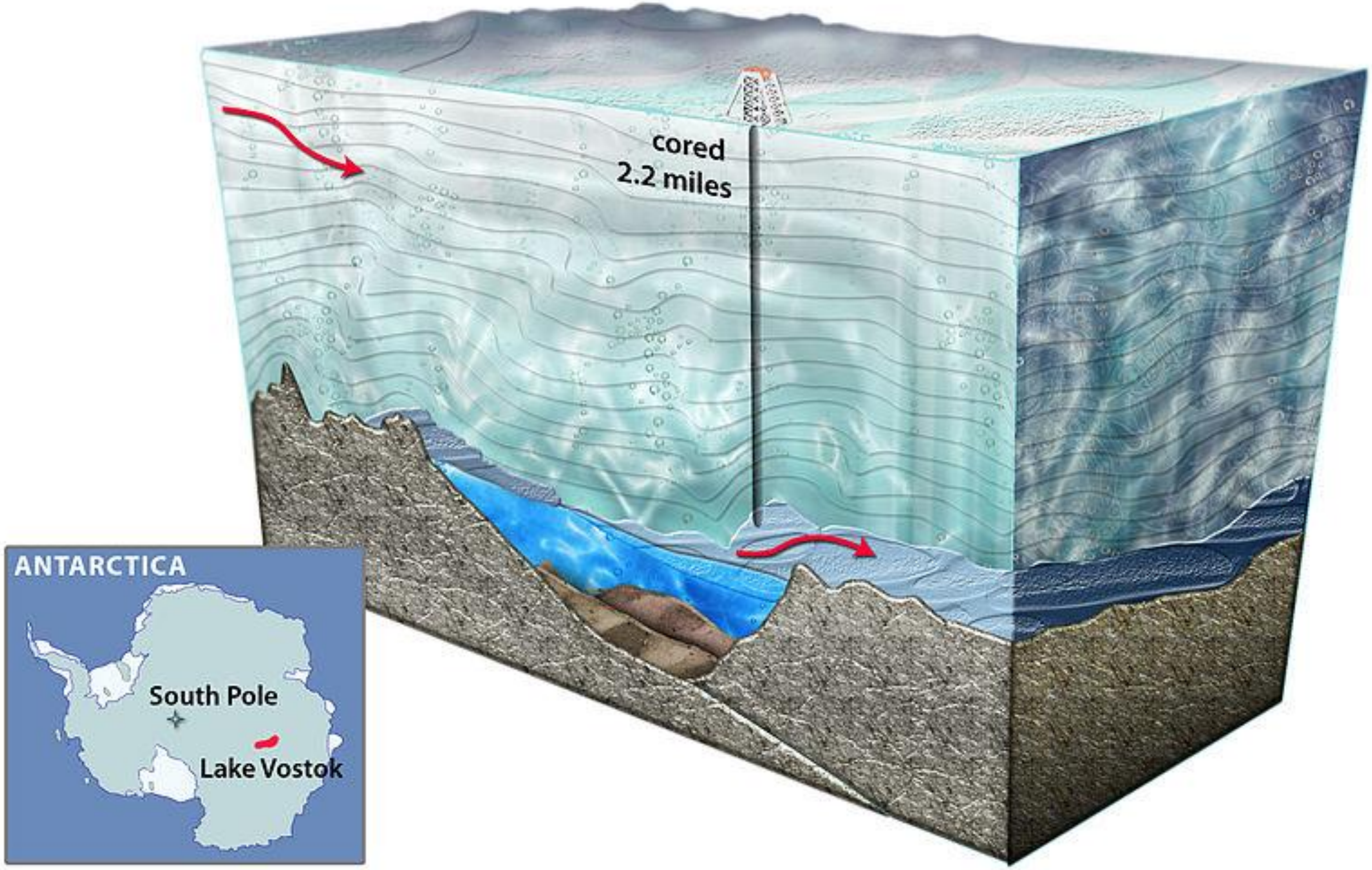
Week Three

- Properties of Water
  - Density
  - Buoyancy
- Density Lab
- Reflection on the Hydrological simulator
- Feedback on grading
- Semester Project
- Design project

News … week of 10 FEB.2012

Lake Trapped Under Ice Is Reached in Antarctica

- **Lake Vostok** (Russian: озеро Восток, lit. "Lake East") is the largest of more than 140 subglacial lakes found under the surface of Antarctica. The overlying ice provides a continuous paleoclimatic record of 400,000 years, although the lake water itself may have been isolated for 15[3][4] to 25 million years.[5]


cored
2.2 miles
ANTARCTICA
South Pole
Lake Vostok

As ‘Yuck Factor’ Subsides, Treated Wastewater Flows From Taps

SAN DIEGO — Almost hidden in the northern hills, the pilot water treatment plant here does not seem a harbinger of revolution. It cost $13 million, uses long-established technologies and produces a million gallons a day.

Four Properties that are critical to life on earth

- Bonds to itself and other substances
- Dissolves a variety of substances
- Cools when it evaporates
- Expands when it freezes

Units of measurement

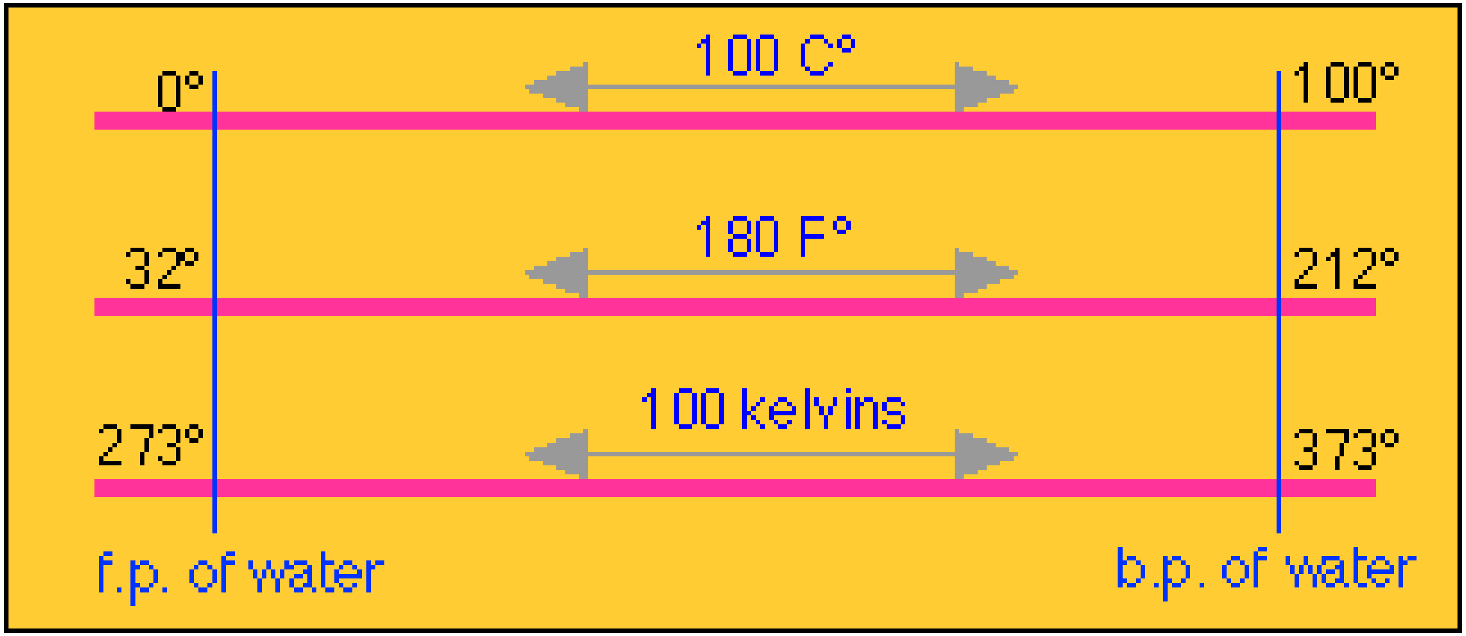
- The natural sciences begin with ***observation*,** and this usually involves ***numerical measurements*** of quantities such as length, volume, density, and temperature.

- Most of these quantities have ***units*** of some kind associated with them, and these units must be retained when you use them in calculations.

Units of 10

prefix	abbreviation	multiplier	--	prefix	abbreviation	multiplier
peta	P	10^{18}		deci	s	10^{-1}
tera	T	10^{12}		centi	c	10^{-2}
giga	G	10^{9}		milli	m	10^{-3}
mega	M	10^{6}		micro	µ	10^{-6}
kilo	k	10^{3}		nano	n	10^{-9}
hecto	h	10^{2}		pico	p	10^{-12}
deca	da	10		femto	f	10^{-15}

Temperature



CONVERTING BETWEEN FAHRENHEIT AND CELSIUS

$$T_{Fahrenheit} = \frac{9}{5} T_{Celsius} + 32$$

$$T_{Celsius} = \frac{5}{9} (T_{Fahrenheit} - 32)$$

$S = \pi r^3$

Length, Volume,

Length:

- 1 inch = 2.54 centimeter (1/12() = 1/100()
- 1 meter = 3.280 839 895 feet
- 1 square centimeter = 0.155 000 31 square inch

Volume Calculations:

- 1 cubic centimeter = 0.061 023 744 095 cubic inch
- 1 cubic inch = 16.387 064 cubic centimeter

Cube= Width x Height x Length

Sphere = $V = \prod r^3$, r= radius

Mass (Weight)

- 1 gram = 0.035 273 961 95 ounce
- 1 ounce = 28.349 523 125 gram
- 1 lb, lbs = 0.453 592 37 kilogram

Density

- Definition = unit wt/ unit volume
- **density** - the mass of matter per

unit volume;

density is typically

- expressed in units of grams per
- milliliter (g/mL), grams per cubic
- centimeter (g/cm3), or kilograms
- per cubic meter (kg/m3).

You can find the volume of an irregular shape using a technique called displacement. To displace means to "take the place of" or to "push aside." You can find the volume of an irregularly shaped object by putting it in water and measuring the amount of water displaced.

DENSITY

$$D = \frac{m}{V}$$

Density (kg/m^3 **or** g/cm^3) → D

m ← *Mass* (kg **or** g)

V ← *Volume* (m^3 **or** cm^3)

Use the displacement method to find the volume of irregular objects. Use a scale to find the mass.

Material	Kg/m3	g/cm3
Platinum	21,500	21.5
Lead	11,300	11.3
Steel	7,800	7.8
Titanium	4,500	4.5
Aluminum	2,700	2.7
Glass	2,700	2.7
Granite	2,600	2.6
Concrete	2.300	2.3
Plastic	2,000	2.0
Rubber	1,200	1.2
Liquid water	1,000	1.0
Ice	920	0.92
Oak (wood)	600	0.60
Pine (wood)	440	0.44
Cork	120	0.12
Air (avg.)	0.9	0.0009

Volume

Volume is the amount of space an object takes up.

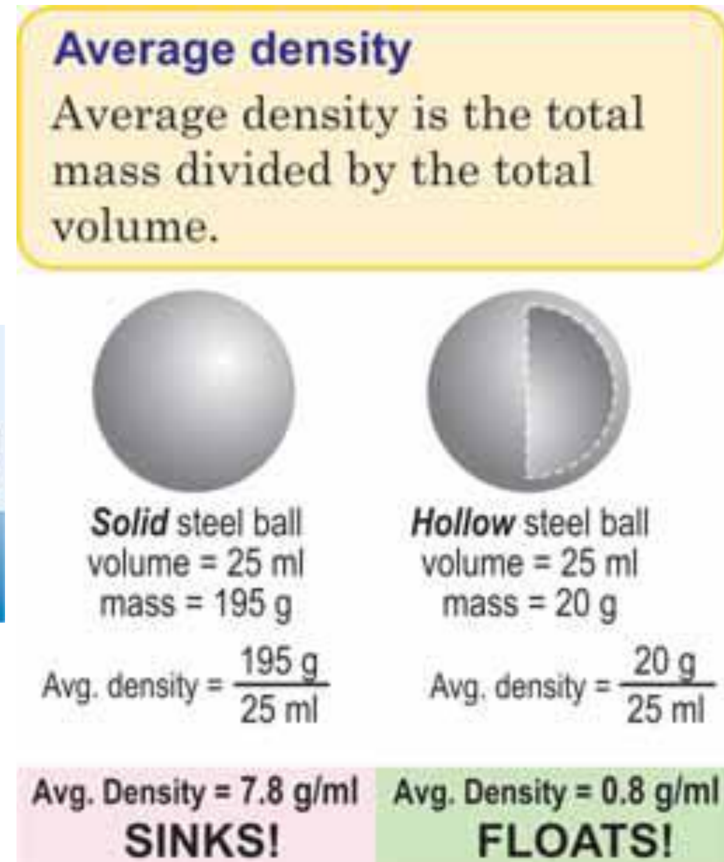
Calculate the volume based on its measurements

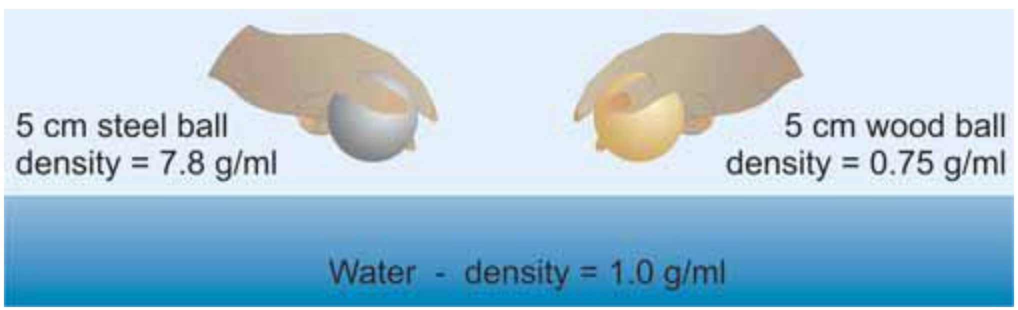
The displacement method

You can find the volume of an irregularly shaped object by putting it in water and measuring the amount of water displaced.

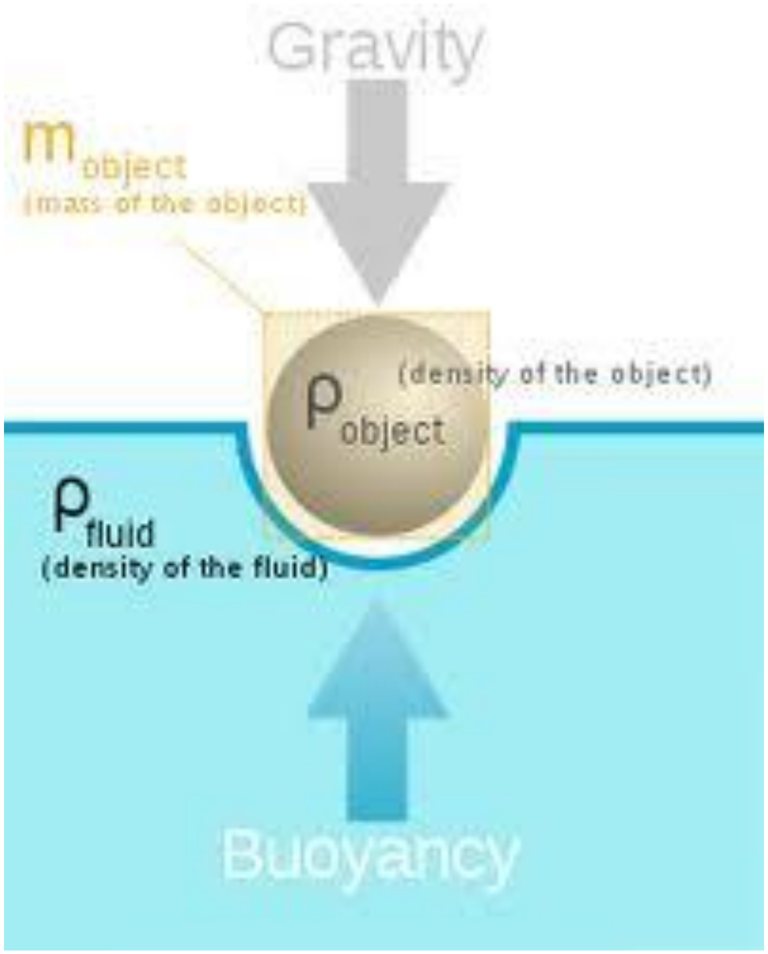
Buoyancy

- **Archimedes' principle –** states that the buoyant force is equal to the weight of the fluid displaced by an object.

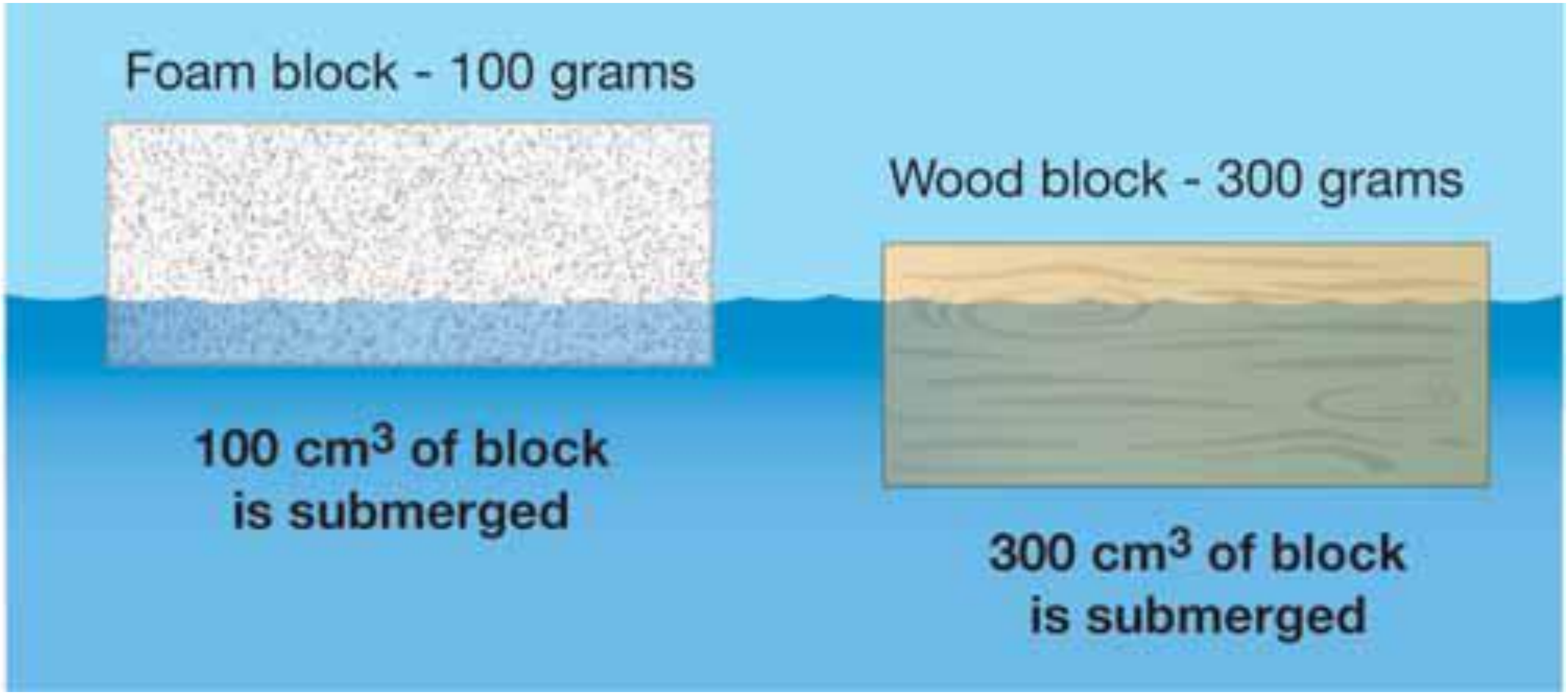




Buoyancy Forces



Sinking or Floating



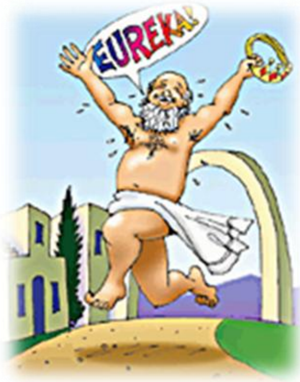
You can see the answer to this question in the pictures above. If a foam block and a wood block of the same size are both floating, the wood block sinks farther into the water. Wood has a greater density, so the wood block weighs more. A greater buoyant force is needed to balance the wood block's weight, *so the wood block displaces more water. The foam block has to sink only slightly to displace water with* a weight equal to the block's weight. A floating object displaces just enough water to make the buoyant force equal to the object's weight.

How would you determine the density of an odd shape item?

Legend has it that Archimedes added to his fame by using the concepts of volume and density to figure out whether a goldsmith had cheated Hiero II, the king of Syracuse. The goldsmith had been given a piece of gold of a known weight to make the crown. Hiero suspected the goldsmith had kept some of the gold for himself and replaced it with an equal weight of another metal.

Explain the steps you could follow to determine whether or not the crown was pure gold.

Archimedes' principle



- The most famous application of buoyancy is due to

Archimedes of Syracuse around 250 BC. He was asked to determine whether the new crown that King Hiero II had commissioned contained all the gold that he had provided to the goldsmith for that purpose; apparently he suspected that the smith might have set aside some of the gold for himself and substituted less-valuable silver instead. According to legend, Archimedes devised the principle of the "hydrostatic balance" after he noticed his own apparent loss in weight while sitting in his bath. The story goes that he was so enthused with his discovery that he jumped out of his bath and ran through the town, shouting "eureka" to the bemused people.

- **Problem Example 8**If the weight of the crown when measured in air was 4.876 kg and its weight in water was 4.575 kg, what was the density of the crown?

- ***Solution:*** The volume of the crown can be found from the mass of water it displaced, and thus from its buoyancy: (4876 – 4575) g / (1.00 g cm^{-3}) = 301 cm^3. The density is then (4876 g) / (301 cm^3) = **16.2 g cm^{-3}**

The densities of the pure metals: silver = 10.5, gold = 19.3 g cm^{-3},

http://www.chem1.com/acad/webtext/pre/density.html

Semester Projects

Project discussion: …What projects would we want to work on around the college campus?

Pond Health
Connecting into Mansfield system
Ground water run-off
Student Foot-print
Drinking water quality
Project of your choosing

Expectations: use of process and well designed method.
Present results and paper at end of course

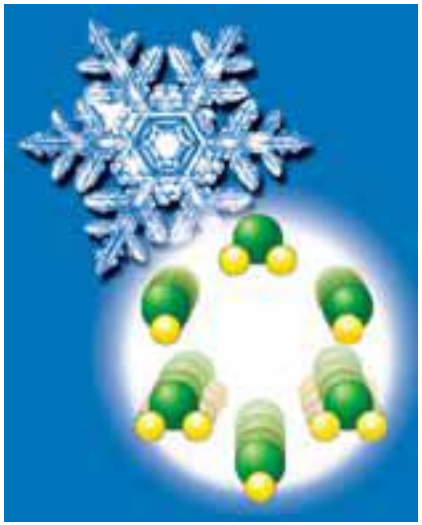
Connect to the bridge articles

Create a presentation of your efforts that include the following:

•Defining the problem being solved
•Creating many options
•Convergent on the few solutions
•Sketch and decide on a final solutions
•Do a mind test process and present results
•Prepare/present a final presentation of your conclusions and results.

Show all work, plans and team assignments

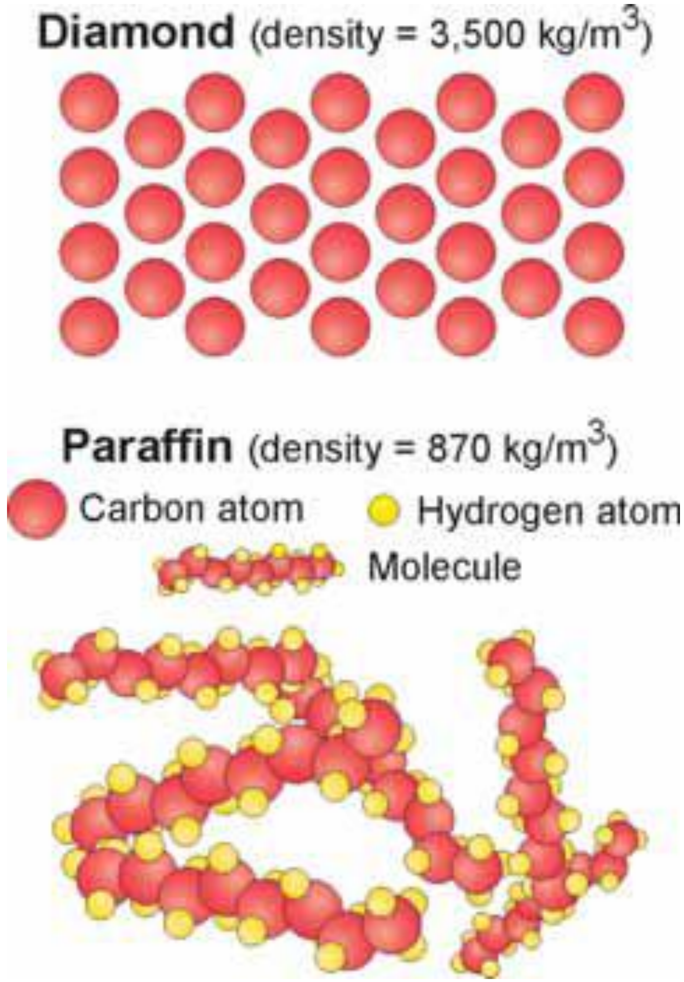
Water is *less dense in* solid form



As water freezes, molecules of water separate slightly from each other because of the honeycomb structure. This causes the volume to increase slightly, while the mass stays the same. As a result the density decreases. This explains why water expands when it is frozen and also floats. The density of ice is about 0.92 g/cm3 whereas the density of water is about 1.0 g/cm3.

The six-sided crystal form explains the six way symmetry you see when you examine snowflakes with a magnifying lens.

The carbon atoms in diamonds are packed tightly while the carbon atoms in paraffin are not.

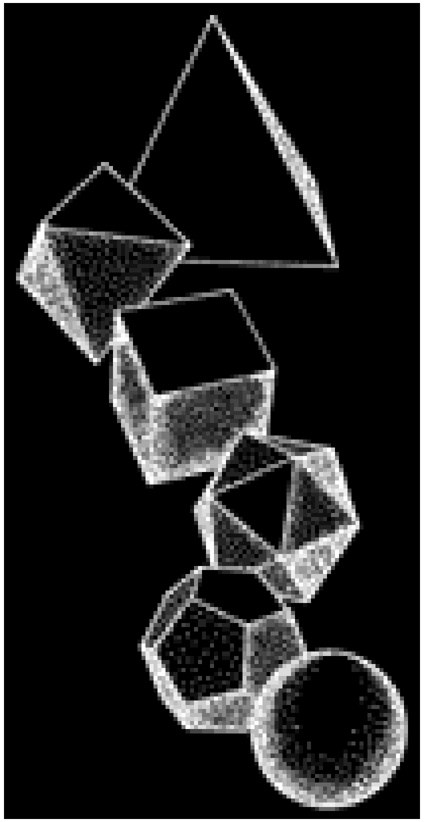


Oil and Water

A few examples of density with oil, colored water and Ice.

See hand outs for the class to do experiments.

Bubbles



Shape	# of sides	Volume	Surface Area
Tetrahedron	4	1 cubic inch	7.21 square inches
Cube	6	1 cubic inch	6 square inches
Octahedron	8	1 cubic inch	5.72 square inches
Dodecahedron	12	1 cubic inch	5.32 square inches
Icosahedron	20	1 cubic inch	5.15 square inches
Sphere	infinite	1 cubic inch	4.84 square inches

http://link.brightcove.com/services/player/bcpid34762914001?bckey=AQ~~,AAAAB_wnNRk~,WN9MweAQd_tBaI99JKgDAcW3bUx7peWv&bctid=1134687413001

Although water has the simple formula H_2O, it is a complex chemical solution. "Pure" water essentially is nonexistent in the natural environment. Natural water, whether in the atmosphere, on the ground surface, or under the ground, always contains dissolved minerals and gases as a result of its interaction with the atmosphere, minerals in rocks, **organic** matter, and living organisms.

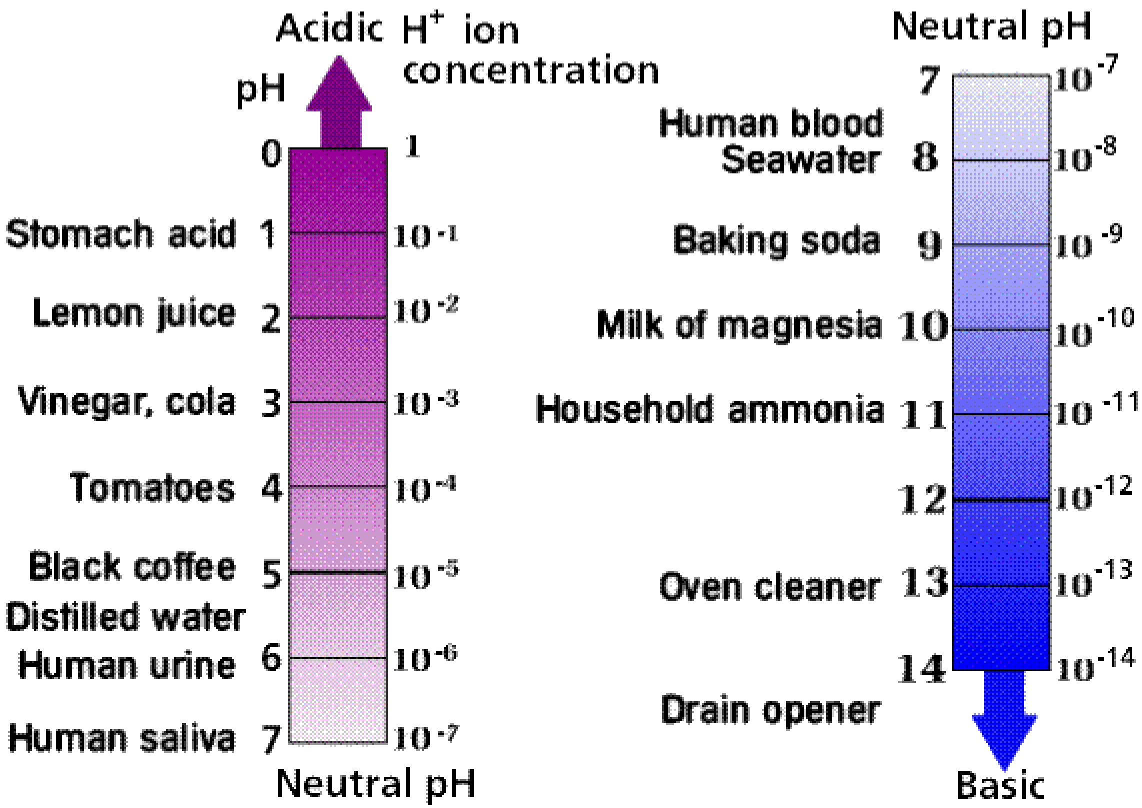
Natural Acidity

- Natural rainwater is slightly acidic because it interacts with carbon dioxide (CO_2) in the atmosphere, forming carbonic acid (H_2CO_3). Some of the carbonic acid in the rainwater then breaks down (dissociates), producing more hydrogen ion and bicarbonate ion, both of which are dissolved in the rainwater.
- The two reactions in rainwater are as follows:

$$H_2O + CO_2 = H_2CO_3$$

$$H_2CO_3 = HCO_3^- + H^+$$

PH



Acidic
H+ ion concentration
pH
0
1
Stomach acid 1
10 -1
Lemon juice 2
10 -2
Vinegar, cola 3
10 -3
Tomatoes 4
10 -4
Black coffee 5
10 -5
Distilled water
Human urine 6
10 -6
Human saliva 7
10 -7
Neutral pH
Neutral pH
7
10 -7
Human blood
Seawater 8
10 -8
Baking soda 9
10 -9
Milk of magnesia 10
10 -10
Household ammonia 11
10 -11
12
10 -12
Oven cleaner 13
10 -13
14
10 -14
Drain opener
Basic

Dissolution

Slightly acidic rainwater reacts with land-derived dust particles in the atmosphere. These reactions result in the rainwater gaining dissolved calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), and other elements

Dissolution

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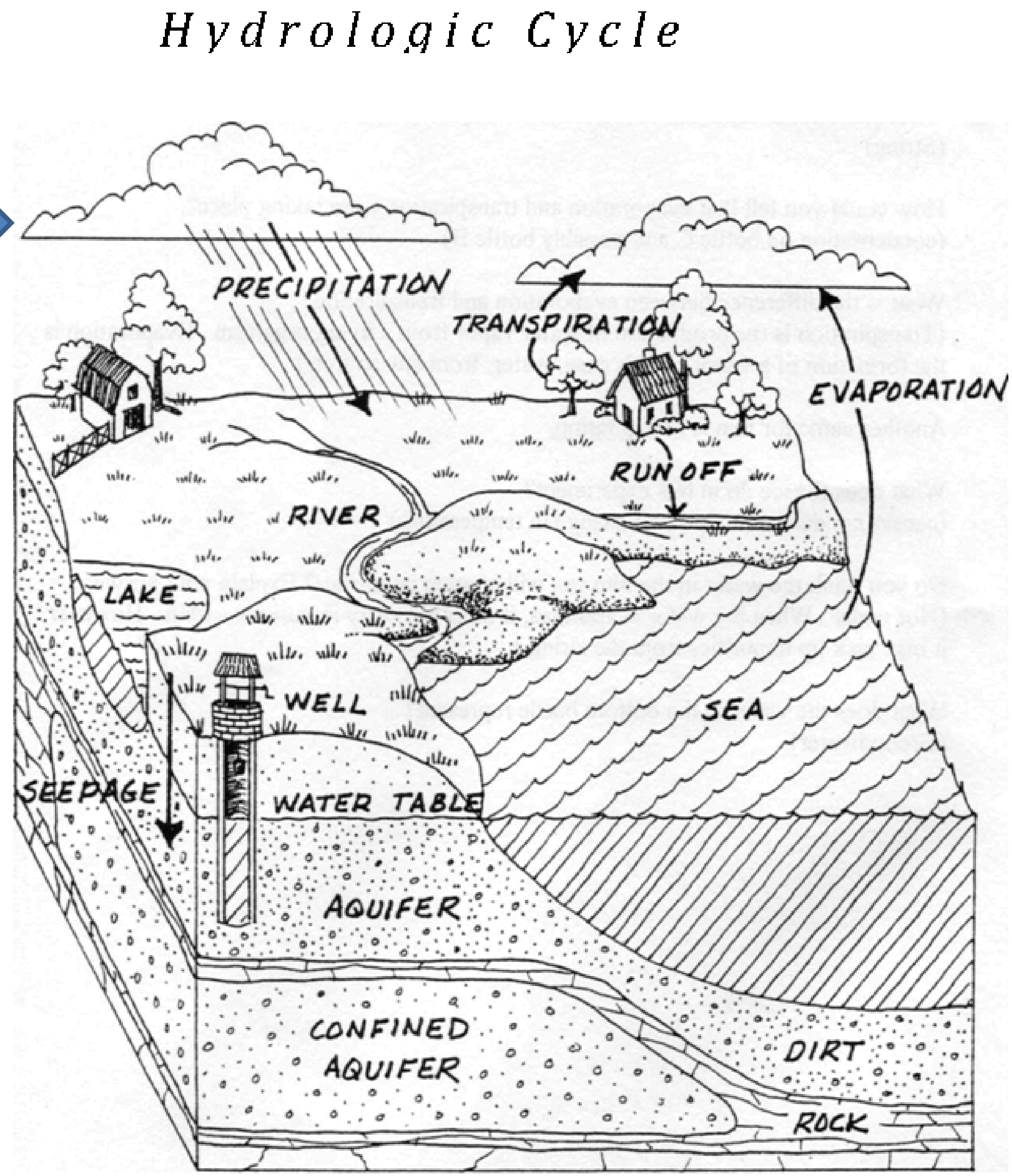
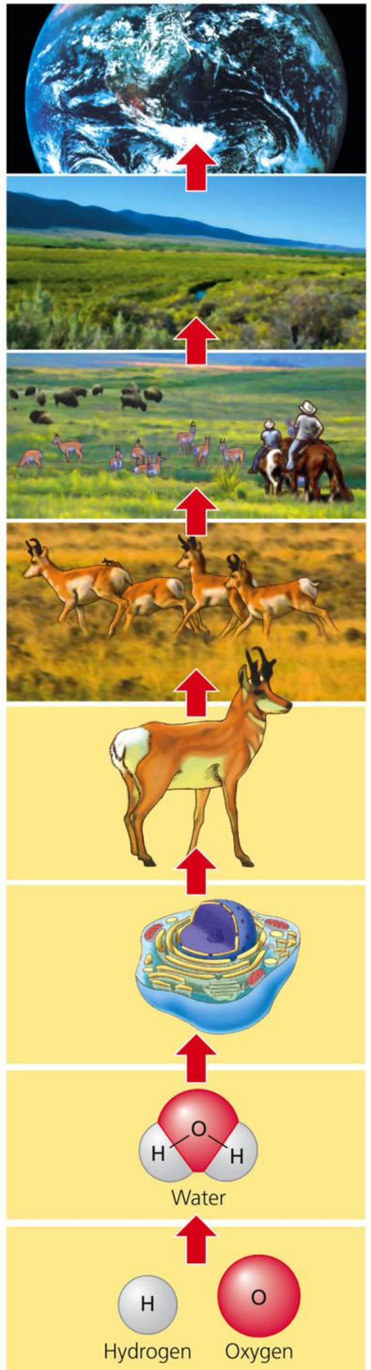


Ecologists Study Interactions in Nature

- **Ecology**: how organisms interact with each other and their nonliving environment
- **Organisms**
- **Populations**
- **Communities**
- **Ecosystems**
- **Biosphere**



Biosphere	**Parts of the earth's air, water, and soil where life is found**
Ecosystem	**A community of different species interacting with one another and with their nonliving environment of matter and energy**
Community	**Populations of different species living in a particular place, and potentially interacting with each other**
Population	**A group of individuals of the same species living in a particular place**
Organism	**An individual living being**
Cell	**The fundamental structural and functional unit of life**
Molecule	**Chemical combination of two or more atoms of the same or different elements**
Atom	**Smallest unit of a chemical element that exhibits its chemical properties**

Fig. 3-5, p. 58

Ecosystems Have Living and Nonliving Components

- Abiotic
  - Water
  - Air
  - Nutrients
  - Rocks
  - Heat
  - Solar energy

- Biotic
  - Living and once living

Streams and Lakes

The composition of stream and lake water varies from one place to another, and within a single watershed varies both seasonally and along the stream's path. The major source of dissolved minerals in streams and lakes is the rocks the water moves over and through along its path from where it falls as precipitation to where it exits the watershed or enters the lake. As the slightly acidic water encounters rocks, the minerals begin to dissolve and contribute their elements to the water. The type of rocks in the watershed influence stream-water composition. A stream flowing over sedimentary rocks will have a different composition than a stream flowing over **igneous** rocks

Streams and Lakes part 2

- Also contributing to stream-water and lake-water composition are reactions between the water and the **biomass** , particularly in forests. Leaves and branches help neutralize the pH of the precipitation and contribute dissolved elements. Biologic activity in the stream or lake (e.g., photosynthesis) can change pH and dissolved oxygen content. Temperature influences the amount of dissolved gases (e.g., oxygen).
- Stream-water composition changes from **headwaters** to outlet because the water is in contact with the rocks and sediments of the streambed for cumulatively longer times
- Lake-water composition is influenced by evaporation, among many other factors. As water evaporates, the dissolved minerals are left behind. The more evaporation, the higher the concentration of dissolved minerals (salts) in the water. If evaporation continues far enough, minerals such as calcite ($CaCO_3$) or gypsum ($CaSO_4 \cdot 2H_2O$) may **precipitate** from the solution

Groundwater

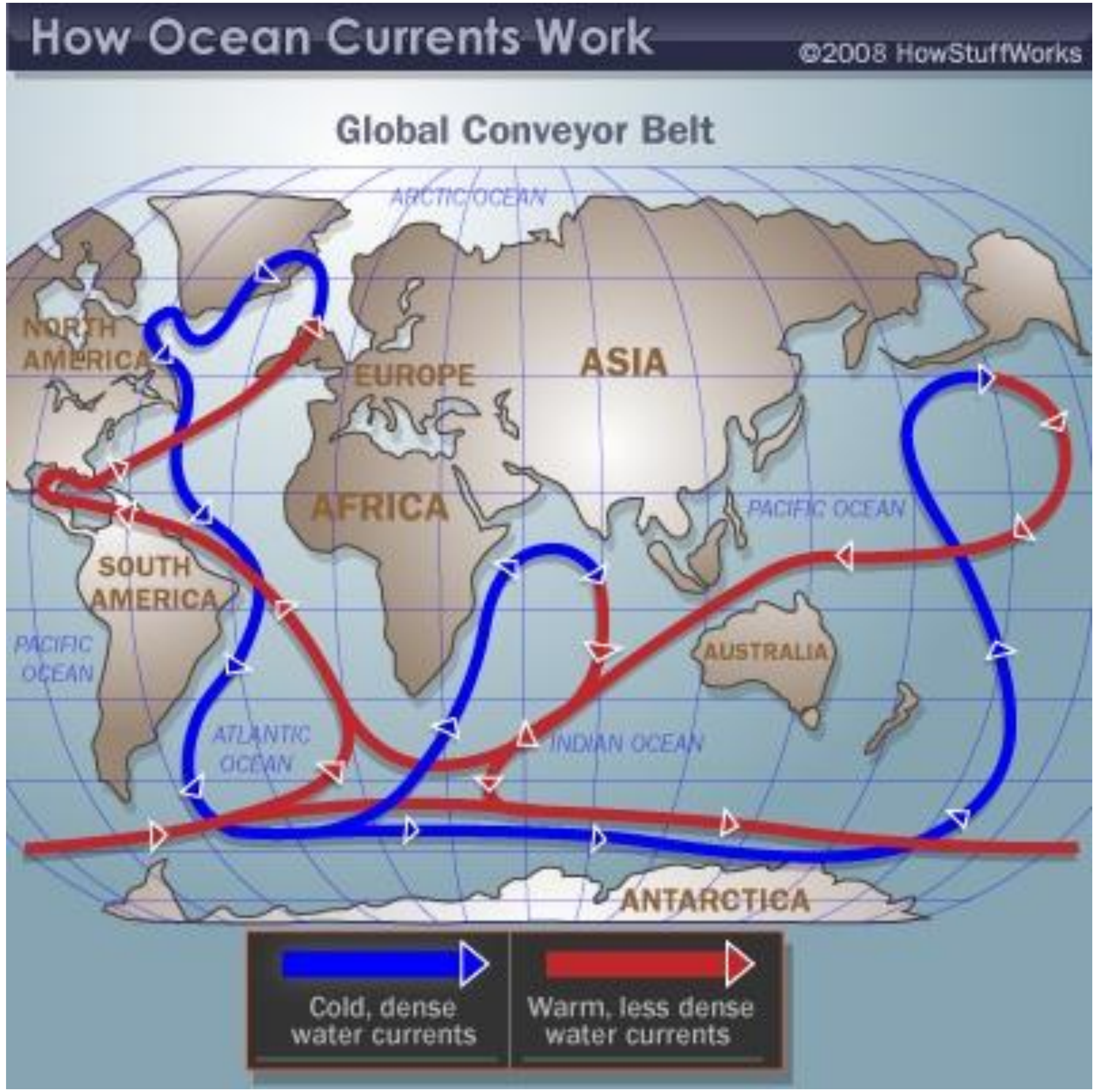
What controls the composition of groundwater is:

(1) the geologic materials groundwater is moving through,

(2) the type of reactions taking place, and

(3) the contact time, or length of time groundwater has been in contact with the rocks. The contact time may vary from a few days to more than 10,000 years. Groundwater that follows deep paths below the ground may be in contact and able to react with rocks for thousands or tens of thousands of years

Highly Soluble Minerals. Groundwater encountering easily dissolved minerals such as gypsum ($CaSO_4 \cdot 2H_2O$) or halite ($NaCl$), will become saltier.


How Ocean Currents Work
©2008 HowStuffWorks
Global Conveyor Belt
ARCTIC OCEAN
NORTH AMERICA
EUROPE
ASIA
AFRICA
PACIFIC OCEAN
SOUTH AMERICA
PACIFIC OCEAN
AUSTRALIA
ATLANTIC OCEAN
INDIAN OCEAN
ANTARCTICA
Cold, dense water currents
Warm, less dense water currents

Movement

The global conveyor belt begins with the cold water near the North Pole and heads south between South America and Africa toward Antarctica, partly directed by the landmasses it encounters. In Antarctica, it gets recharged with more cold water and then splits in two directions -- one section heads to the Indian Ocean and the other to the Pacific Ocean. As the two sections near the equator, they warm up and rise to the surface in what you may remember as **upwelling**. When they can't go any farther, the two sections loop back to the South Atlantic Ocean and finally back to the North Atlantic Ocean, where the cycle starts again.

Speed

- The global conveyor belt moves much more slowly than surface currents -- a few centimeters per second, compared to tens or hundreds of centimeters per second. Scientists estimate that it takes one section of the belt 1,000 years to complete one full circuit of the globe. However slow it is, though, it moves a vast amount of water -- more than 100 times the flow of the Amazon River. [source: NOAA: "Currents"].

Benefits

- The global conveyor belt is crucial to the base of the world's food chain. As it transports water around the globe, it enriches carbon dioxide-poor, nutrient-depleted surface waters by carrying them through the ocean's deeper layers where those elements are abundant. The nutrients and carbon dioxide from the bottom layers that are distributed through the upper layers enable the growth of algae and seaweed that ultimately support all forms of life.
- The belt also helps to regulate temperatures.

Remember

- The earth is rotating around its axis
- It’s rotating around the sun
- The moon is rotating around the earth.

- The Sun is providing energy

We will discuss in more depth in the weather unit