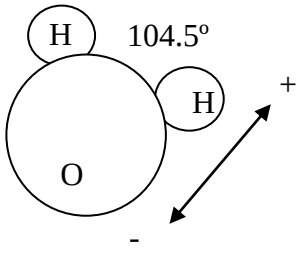
PHYSICAL: Properties of water (light, color, heat)
(read: pp 29-33; 38-39; 46-47 in Dodson)

THE WATER MOLECULE

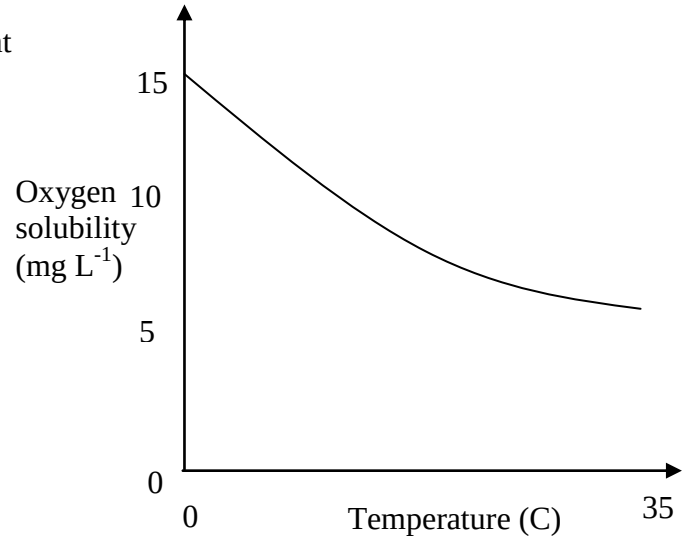


- H_20. A water molecule consists of two hydrogen atoms and a oxygen atom, in a "Mickey Mouse" type of arrangement.

- Highly polar (positive pole and negative pole)

- Hydrogen bonds—weak bonds between water molecules due to charges of water molecule.

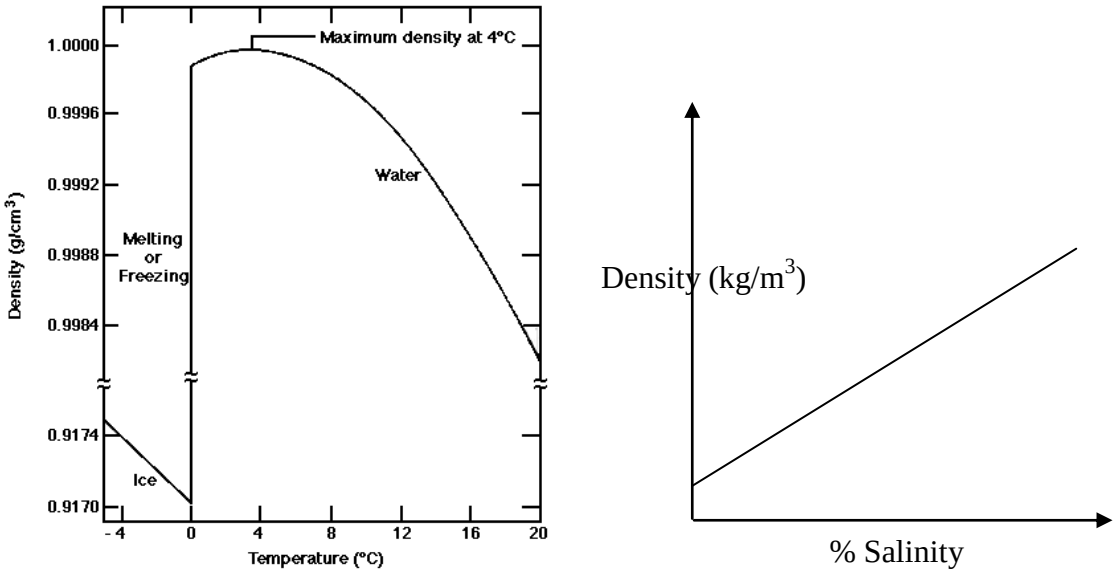
- Hydrogen bonds of water have many consequences, including:
  - Viscous (stickiness between molecules)
    - Water is ~100 times more viscous than air
  - Boundary layers—stickiness of water means that materials are surrounded by a microscopic layer of water that isn't moving.
  - Surface tension—boundary between water and air
    - *Neuston*—habitat at the air-water boundary
  - Solvent—water is a great solvent of other charged (polar) molecules
    - Solubility of gases
    - Temperature dependent



DENSITY

Density—mass per volume

- Water is extremely dense
- Water changes density as a function of temperature in an unusual way
  - >4 degrees C—When warmed, molecules get excited and take up more space (less dense)
  - 0-4 degrees C—When closer to 0 degrees C, water starts taking up slightly more space as the molecules start to stick (freeze) (less dense)
  - <0 degrees C—Freshwater freezes forms a crystalline structure and takes up more space (less dense)
  - Salinity increases water density
  - Water freezes at 0 degrees C (32 degrees F)
  - Water boils at 100 degree C (212 degrees F)



Source: Modified from GCSU

- This relationship between temperature and density controls many aspects of freshwater ecology, especially in high latitude areas.
- For example:
  - Vertical stratification
  - Ice on top of lake

HEAT in WATER

- Heat—a form of energy
- Temperature-sensation of cold or hot
- Specific heat—the number of calories it takes to raise temperature by 1 degree C.
  - Water has extremely high specific heat
    - Implications:
      - Lower fluctuations in temperature

- Buffers nearby climate

- Evaporation—when water changes from a liquid to gas
  - Process removes heat from water

LIGHT in WATER

- Light is needed for photosynthesis, controlling primary production and vertical distribution of organisms.
  - Euphotic zone—area of lake where there is enough light for photosynthesis to exceed respiration
  - Compensation depth—where photosynthesis = respiration
  - Aphotic zone—deep (dark) area of lake where not enough light for photosynthesis.
  - PAR –photosynthetically active radiation

- Too much light, especially UV wavelengths, can negatively impact biota.

- Measurement
  - Secchi disk—black and white disk lowered off of shaded side of boat until it disappears.
    - Ranges from <1 m to 40+ m
    - Generally depth where ~10% of surface light remaining
  - Photometer—measures for a specified wavelength of light

- Light attenuation
  - Total reduction in light energy as a function of depth
  - Attenuation is the sum of absorbance and scattering
  - Extinction coefficient
    - Slope of relationship between depth and log light

- Absorbance
  - Water naturally absorbs light
  - Different wavelengths are absorbed at different rates (see figure below)
  - Pigments such as dissolved organic compounds (DOC) strongly influence absorption rates.
  - By absorbing light, light energy is converted to heat energy, warming water.

- Scattering and reflection
  - Change in direction of light during interactions with material
  - Snow, ice scatter and reflect light
  - Fine particles scatter light

What factors influences how much light is at a depth?

- How much light hits the surface of the lake
  - Location
  - Aspect
  - Surrounding vegetation
  - Snow, ice
- How rapidly light is attenuated
  - See above