Lecture notes for 1/7/04

<u>Temperature scales continued</u>

Celcius:

- originated in 1742, uses degrees C
- pure water freezes at 0 degrees C and boils at 100 degrees C

Kelvin:

- originated around 1850, denoted K
- based on 0 = absolute 0, the point at which there is no kinetic energy
- water freezes at 273.15 K
- We'll be using this scale when we discuss light

Converting between scales:

- temperature increments: 1 K = 1 degree C = 1.8 degrees F
- degrees C = K – 273.15
- degrees F = degrees C * 1.8 +32

example:

	Degrees F	***Degrees C***	***K***
Hot day/ body temp.	98.6	37	310
Cold day	-22	-30	243

<u>Thought experiment</u>

On a clear summer day, the temperature is 50 degrees F in both Seattle and Spokane. From experience, we expect that by the middle of the day, it will be hotter in Spokane than in Seattle. Why? Both cities receive approximately the same amount of energy from the sun. The difference is that Seattle is kept cooler by wind from the ocean. To understand why the ocean has a cooling effect, read on to find out about specific heat.

2.4) <u>More on heat</u>

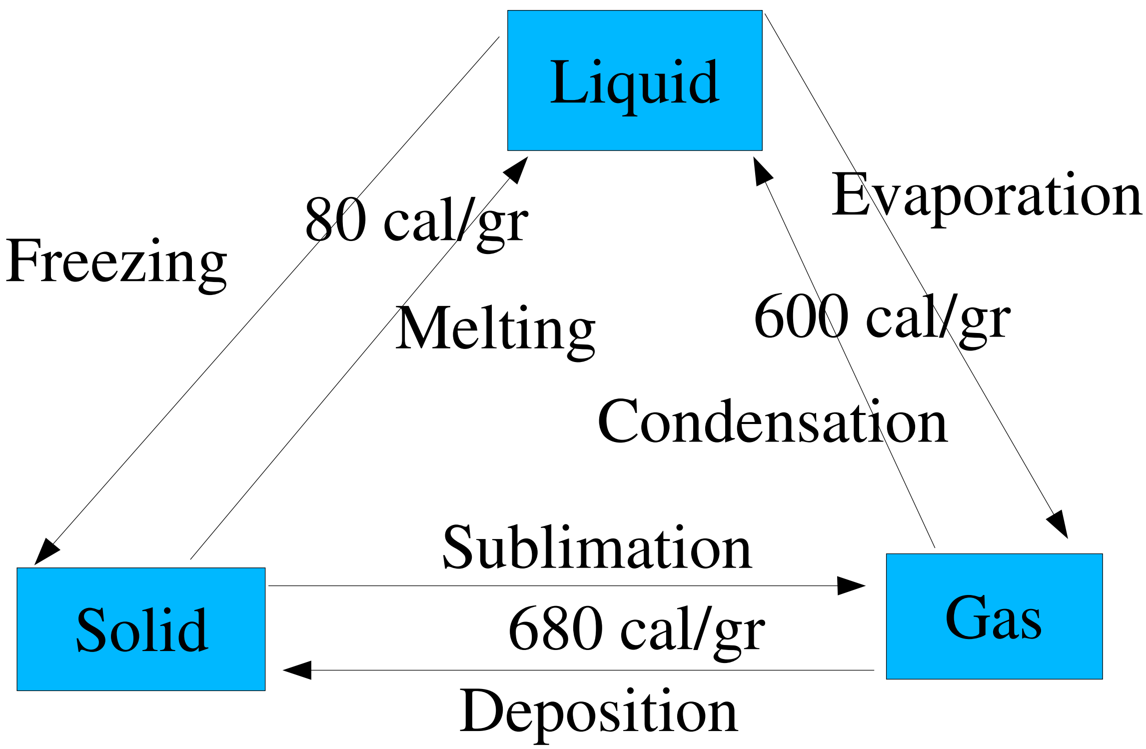
i.) specific heat (C_p) – the amount of energy needed to raise a unit of mass one unit of temperature

- example: it takes one calory of energy Q to raise 1 gram of liquid water by 1 degree C, so the specific heat of water = 1 cal/(gram * degrees C)
- specific heat = the ratio of heat needed to the temperature change
- $Q = C_p m \Delta T$, where m is the mass and ΔT is the temperature change
- the specific heat of ice is 0.5 cal/(gr * deg C), so it takes less energy to raise the temperature of a unit mass of ice than to raise the same mass of liquid water by the same amount
- water has a higher specific heat than dirt (specific heat of dirt = 0.2 cal/(gr deg C))

- thus, the same amount of energy will change the temperature of the dirt much more than it will change the temperature of water. This helps explain why the temperature rises more in Spokane than in Seattle.
- In reality, the ocean also absorbs more energy than the dirt, because the dirt is more reflective. We can see this from observing how much darker the ocean is than the land in satellite images.

ii.) latent heat – heat/energy that is exchanged when the state of a substance changes, i.e. liquid water <--> water vaper <--> ice

- example: a water droplet evaporating
- During evaporation, the fastest molecules in the liquid escape, so the net and average kinetic energy of the liquid decreases. Thus evaporation is a heat loss to the liquid.
- But, energy is conserved, so heat must be stored in gas form.
- Condensation is the reverse process – it is a warming for the material surrounding the newly formed liquid.
- Condensation occurs when 2 slow-moving molecules collide and stick together. Since this removes slow-moving molecules from the gas, the average energy of the remaining gas is higher.
- Water evaporates in the tropics, moves towards the poles, and condenses in the colder region, releasing latent heat. This is an important process for transporting heat around the globe.
- Evaporating 1 gram of liquid water requires 600 calories, while heating 1 gram liquid water from 0 to 100 degrees C requires only 100 calories. Thus evaporation requires much more energy.
- To melt ice and form liquid water requires 80 cal/gr.
- Water can also go directly from solid to vapor, called sublimation, or from vapor to solid, called deposition.
- If evaporation occurs in a different place from condensation, then both water and energy are moved.



2.5) <u>Heat/energy transfer mechanisms</u>

i.) conduction – molecule by molecule movement of energy (such as heat moving up a spoon)

- Good conductors (copper) move energy easily
- Bad conductors (air) don't
- example: a down jacket has air pockets so not much heat is transported through the jacket.
- Conduction is not important in the atmosphere.

ii.) convection – mass movement of air molecules (or liquid)

- efficient way to move energy
- example: thermals (hot air at the surface rises and is replaced by cooler air from above)
- example: bubbles in a heated pan transport heat upwards from the bottom.

iii.) radiation – energy that is transmitted by electromagnetic waves, it is released by all objects