Last of the Phases Notes

Besides knowing all of the phases BASICS, heating and cooling curves, phase diagrams, this is included into what you MUST remember…

Boiling point is when the vapor pressure is the same as the air pressure upon a liquid. At that point a liquid can jump into the gas phase. This is possible at nearly any temperature, and is shown on Table H. For instance…

If the air pressure is lower than normal, say at 30 kPa, water can boil at 70°C.

Or…

What is the boiling point of ethanoic acid at normal pressure? About 118°C

When vapor pressure = air pressure, then the liquids boil

In a sealed system (a corked flask) with a liquid inside, some liquid will evaporate. The pressure of the evaporated gas above the liquid is called the vapor pressure.

Vapor pressure will be lower when the temperature is low (low KE). If you heat the liquid, the increase in KE will give more particles the energy to vaporize, leading to increased vapor pressure.

At some point too much energy will force too many particles into the gas phase, pressure builds up until the flask bursts.

If temperature is held constant, a dynamic equilibrium is reached. That means that the rate of evaporation equals the rate of condensation. Vapor pressure is a physical constant.

Cooling to a new constant temperature leads to a new dynamic equilibrium with a lower vapor pressure than before.

Take out Table H, which shows 4 liquids and all their vapor pressures at all different temperatures. Since water has a higher vapor pressure/boiling point at normal pressure than propanone and ethanol, there must be a reason for this. Here it comes…

Compounds with a strong attraction molecule to molecule (inter-molecular) have lower vapor pressures, and higher boiling points than those with less inter-molecular attractions.

Propanone has the lowest intermolecular attraction of these 4 liquids, so it has the lowest boiling point - at any given pressure.
It also has the highest vapor pressure

Ethanoic acid has the strongest inter-molecular attractive forces of the 4 liquids on table H, and at any pressure, it has the highest boiling point & lowest vapor pressure

That means it takes the most kinetic energy to make this liquid boil when it is compared to the others.
When comparing solids, liquids, and gases, remember these facts…

Solids and liquids can't be compressed nearly at all, because their particles are so close together already. Gases compress easily.

Solids hold their shape, liquids take the shape of the bottom of the container they are put into, gases will fill any sized container you put them into (to ever lower pressures as the volume size increases)

Solids have the lowest kinetic energy, but it is never zero except at zero Kelvin. Liquids have mid-ranged kinetic energy. Gases have the most kinetic energy.

At normal pressure (1 atm/760 mmHg, 101.3 Pa)

Water changes from solid to liquid at 273 Kelvin. It goes liquid to gas at 373 K

Water evaporates when ever it is a liquid, but only to a small degree over a short time frame. Water evaporates at ALL TEMPERATURES.

The kinetic molecular theory explains phase behaviors this way…

1. All particles have kinetic energy. Solids have less kinetic energy than do liquids, liquids less than gases.

2. Solids have low enough kinetic energy that the intermolecular forces of attraction exceed the kinetic energy of the particles, so they will quiver a little, but they stay locked together.

3. Solids gaining kinetic energy will shake loose, and form liquids. This is not a chemical change. It takes relatively less kinetic energy to shake solids into liquids, as not all the intermolecular bonds are being broken, the molecules are still quite "stuck together", but not into a 3-D grid pattern.

4. Liquids can gain kinetic energy and warm up because temperature is really just a measurement of kinetic energy.

5. At some point the kinetic energy reaches a level to shake the liquid molecules so fast that they cannot remain liquid anymore. This is when their kinetic energy creates a vapor pressure equal to air pressure, and the <u>whole liquid</u> starts to boil.

6. Liquids phase change to gas at the BP.

7. The amount of energy to bust apart all of the intermolecular bonding between molecules is greater than to shake loose the same number of molecules from solid to liquid. For example…

   It takes 3340 joules to convert 10.0 grams ice into 10.0 grams water

But

   It takes 22,600 joules to convert 10.0 grams water into 10.0 grams of steam

The kinetic theory explains the differences between phases. It all comes down to a different amount of kinetic energy, and when phase changing, to changing amounts of potential energy.