

On table H, the curved line for water shows EVERY BOILING POINT for water — at every pressure. All substances have many boiling points, if the pressure can be adjusted.

At the point on table H of 60 kPa + 55°C Water and Ethanol are still liquids but propanone has boiled into a gas. At 60 kPa propanone has the lowest boiling point because it has the weakest intermolecular attractions of these 3 substances.

At the 4 points where all of the curves on table H cross the dotted line called Standard Pressure are called: The NORMAL BOILING POINT for propanone, the NORMAL BOILING POINT for ethanol, the NORMAL BOILING POINT for water, + the NORMAL BOILING POINT for ethanoic acid. The acid has the highest boiling point because it has the strongest intermolecular attractions.

On any heating curve, the segment DE is longer than BC. The reason is that it takes more energy to boil a liquid into a gas than to melt a solid into a liquid.

On any heating curve, the phase changes at BC and DE require energy to be added. Since there is NO TEMPERATURE CHANGE, and NO Kinetic Energy change, it's the POTENTIAL ENERGY increases.

On any phase diagram, the normal boiling point and the normal freezing point happen ONLY at standard pressure, which is 101.3 kPa or 1 atmosphere.

On table H, the point of 20 kPa + 120°C is IN FRONT of all four of the lines. At this point, all 4 substances are GASES.

While pointing at the curve of water on Table H: The hottest water can be is it's boiling point. If you can control the pressure on the surface of a liquid like water, you can change the temperature that it boils. You become God-Like.

On a cooling curve, the phase changes at BC and DE require energy to be removed. Since there is NO TEMPERATURE CHANGE, and no Kinetic Energy change, it's the POTENTIAL ENERGY that decreases.

During a melting phase change on a heating curve, energy is added but the temperature (& Kinetic Energy) do not increase.

During melting, the POTENTIAL ENERGY increases.

During a freezing phase change on a cooling curve, energy is removed but the temperature (and Kinetic Energy) do not decrease. During freezing, it's the POTENTIAL ENERGY decreases.

On a phase diagram, the TRIPLE POINT is the unusual circumstance of low temperature and pressure that all 3 phases can co-exist at the same time. There's melting, freezing, boiling, condensing, deposition and sublimation, all at once!

Solids have the lowest KE and usually are the densest phase. They hold their shape + volume. They don't compress much at all. Liquids have middle level KE, and fit the bottom of any container. They are not compressible. Gases have the most KE, they have no shape + fill any container. They compress easily since they're mostly empty space.

Imagine you have 75 mL propanone + 75 mL water in identical containers in a room. Since propanone has WEAKER INTER-MOLECULAR attractions, the vapor pressure in the bottle of propanone is greater. As you heat them both up together, the propanone bottle explodes 1<sup>st</sup> due to the higher Vapor Pressure.

The Critical Point on a phase diagram is the crazy place where very high temperature + very high pressure make the words liquid and gas meaningless. The substance exists as both and normal properties change. It is at ~218 atm + 374 K kPa for water

The kinetic molecular theory says that collisions between gas particles are elastic. That means when they collide no energy is lost. All energy is transferred to other particles. This is a lie.

Of course there is a loss of energy, but that loss is small and made up by the Sun each day.

When you add heat to any liquid, the KINETIC Energy increases, the temperature increases, but POTENTIAL energy does not change. Only ONE ENERGY changes at a time. Potential energy only changes during phase changes.

The phase changes we need to know, and can be pointed out on a phase diagram, are: freezing + melting, vaporizing + condensing, and, sublimation + deposition.

The KMT, kinetic molecular theory says that gases are made up of small particles called atoms or molecules. This is true. It also says they only move in straight lines, very fast, this is also true. The collisions of particles cause the gas pressure (true again). Finally, it says gas particles are separated by vast distances relative to their own size.

All true!

A barometer measures pressure of gases (or the air). The old barometers measured how high the column of mercury was pushed by this air pressure. Higher pressure pushed mercury higher. Normal Pressure was determined to be 760 mm of Hg.

The kinetic molecular theory says that gases act like small hard spheres. They do act that way, but they are not round balls! They all have shapes (straight lines, bent angles, pyramids, etc.) They can get tangled up some, but they don't really. If they get tangled up enough they become liquids.

The Kinetic molecular theory says that gas particles have no attraction or repulsion for each other. That's a lie. That would result in gases losing energy over time, becoming liquids. They don't seem to lose any energy because they get some "FREE ENERGY" from the Sun, every morning.

Aqueous is not really a phase, even though there is a phase symbol: AQ. Solids (or liquids or gases) can dissolve into water. They MIX. It is a phase change from S, L or G to become AQ, but AQUEOUS refers to a mixture, not the phase of a substance.