PHASES OF MATTER
4: PHASE DIAGRAMS

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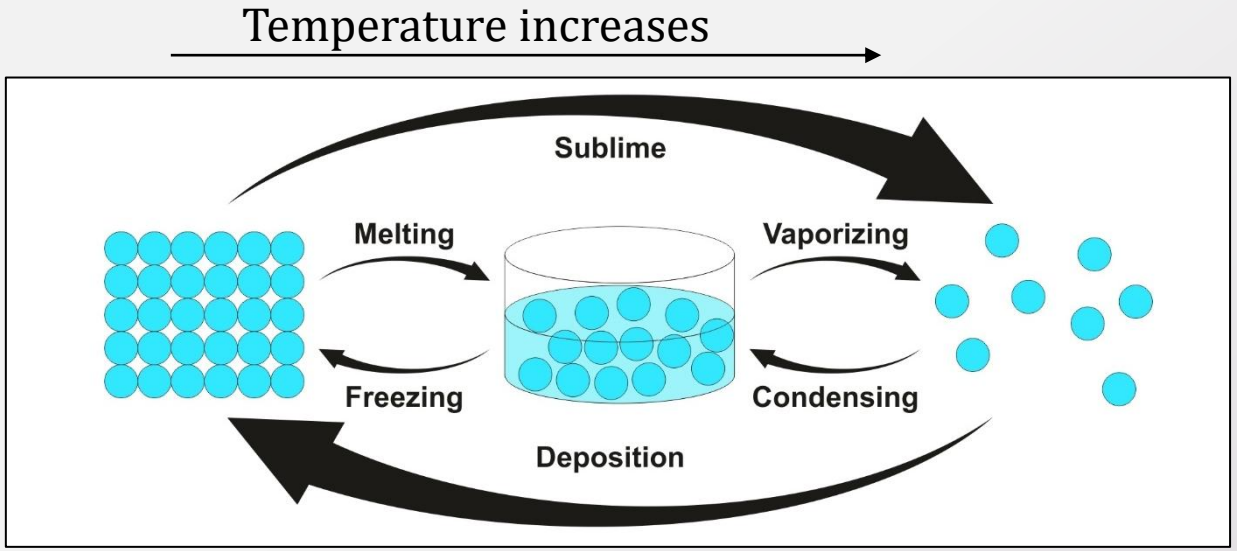
PHASE CHANGES

- Phase changes occur with change in temperature.



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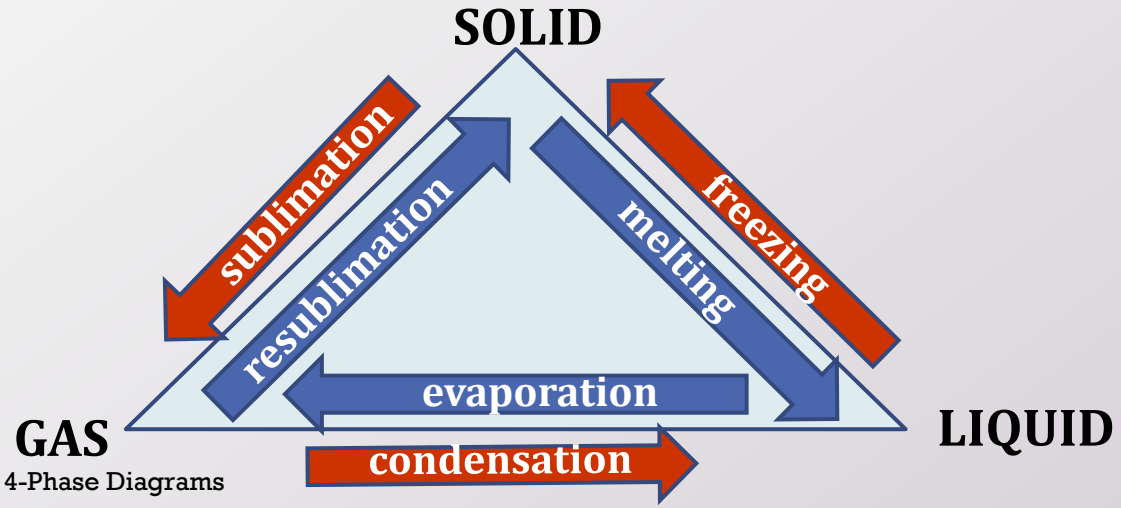
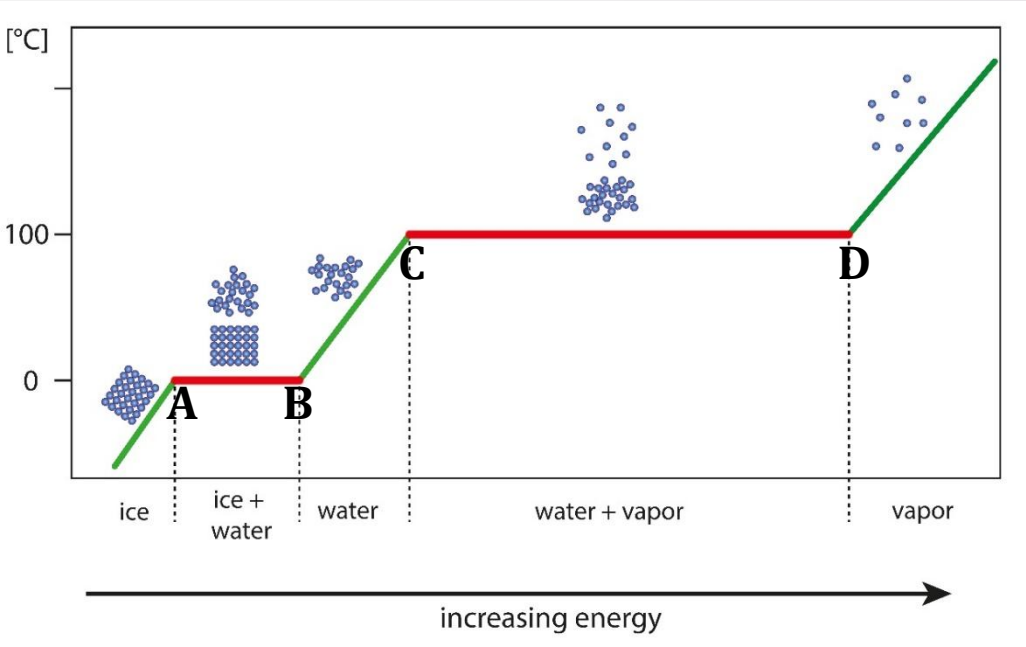


HEATING CURVE

- A heating graph shows how the temperature changes the phases of a substance.
- Until point A the phase and temperature are both changes. Between B and C also the phase changes as the temperature increases.
- Points A-B and C-D indicate even as heat is applied to the system the phase does not change – the energy is used to break the IM forces (dynamic equilibrium).



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PHASE DIAGRAMS

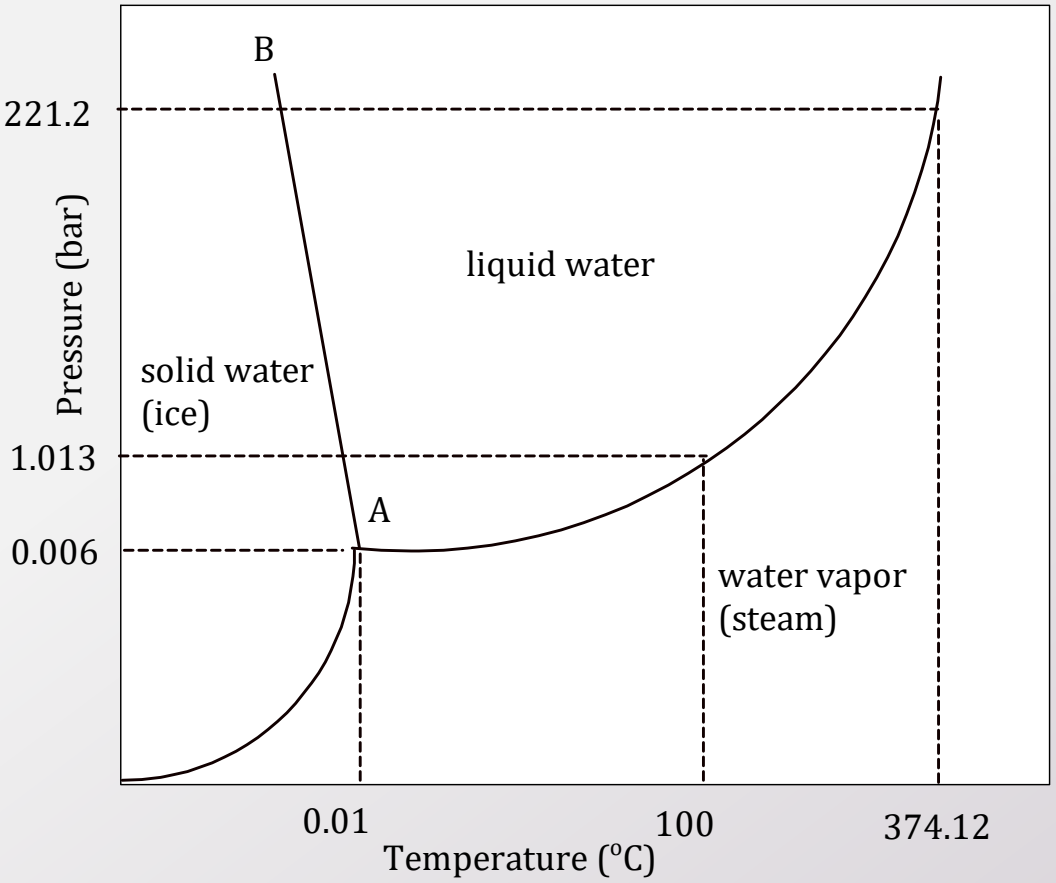
In a phase diagram, phases are separated by lines that represent equilibrium between those phases.

In addition to the phase equilibrium, there are a few other properties that can be determined from the phase diagram.

- Critical temperature (T_c) – the temperature above which a gas cannot be liquefied by application of pressure
- Critical pressure (P_c) – the pressure that must be applied to liquefy a gas at Tc.
- Supercritical fluid – the fluid that exists above T_c and P_c.
- Triple point – the temperature and pressure point at which three phases co-exist.

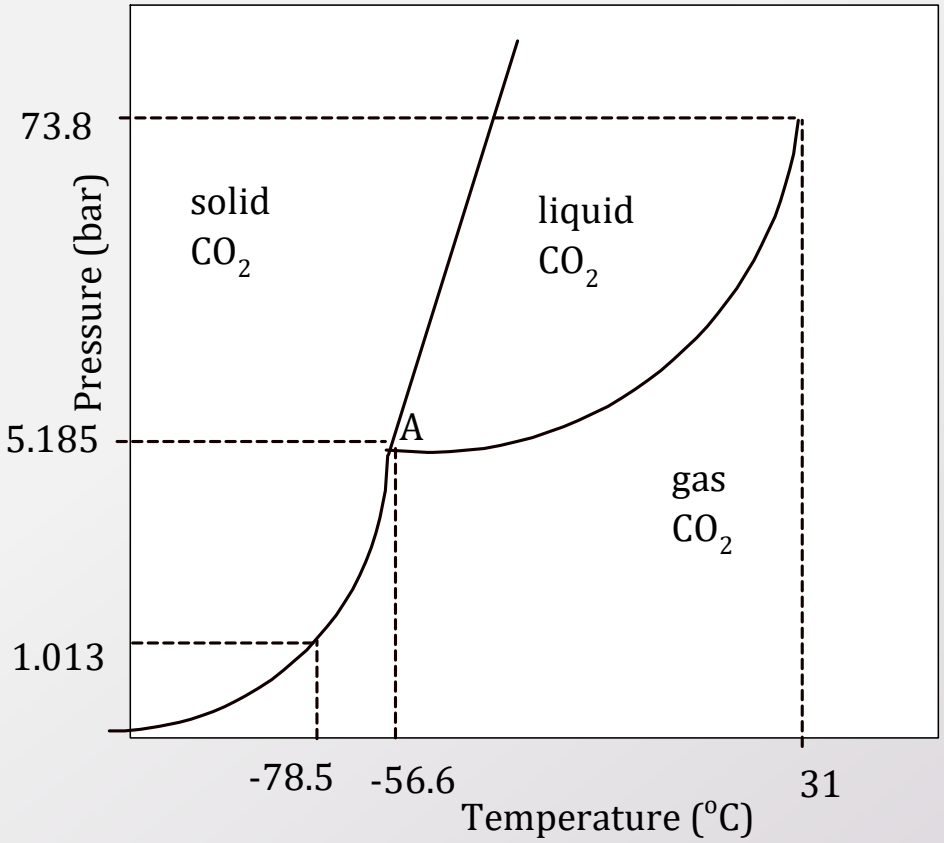
PHASE DIAGRAM: WATER

- The triple point, A, is the point where all three phases, solid, liquid and gas are in equilibrium.
- Slope AB shows equilibrium between solid and liquid.



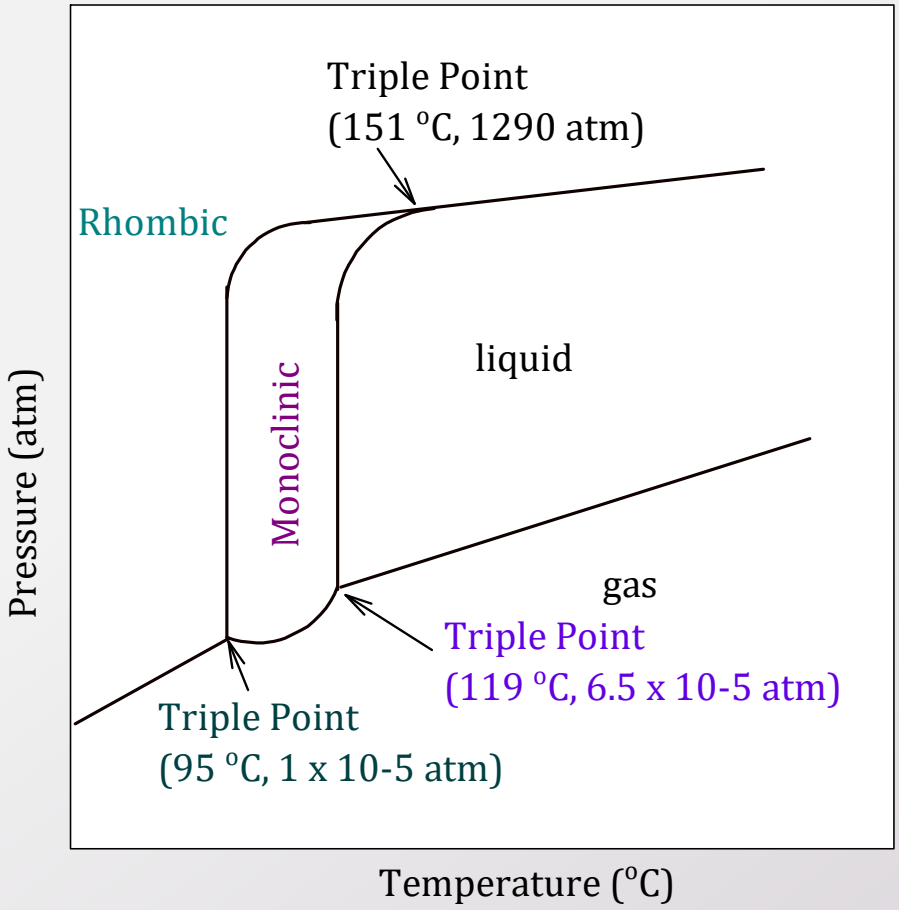
PHASE DIAGRAM: CARBON DIOXIDE

- At STP, carbon dioxide is never a liquid. That is why carbon dioxide sublimes directly from solid to gas.
- At critical point the gas starts to behave like a liquid.



PHASE DIAGRAM: SULFUR

The phase diagram for sulfur shows the existence of two different solid structures for sulfur, rhombic and monoclinic, gives rise to more than one triple point.



EXAMPLE: PHASE DIAGRAM

Using the phase diagram

a) determine the normal boiling point and melting point of the substance (at 1atm);

b) determine the physical state of the substance at 2 atm and 110 ^{o}C, and

c) determine the pressure and temp. that correspond to the triple point of the substance.

Answer:

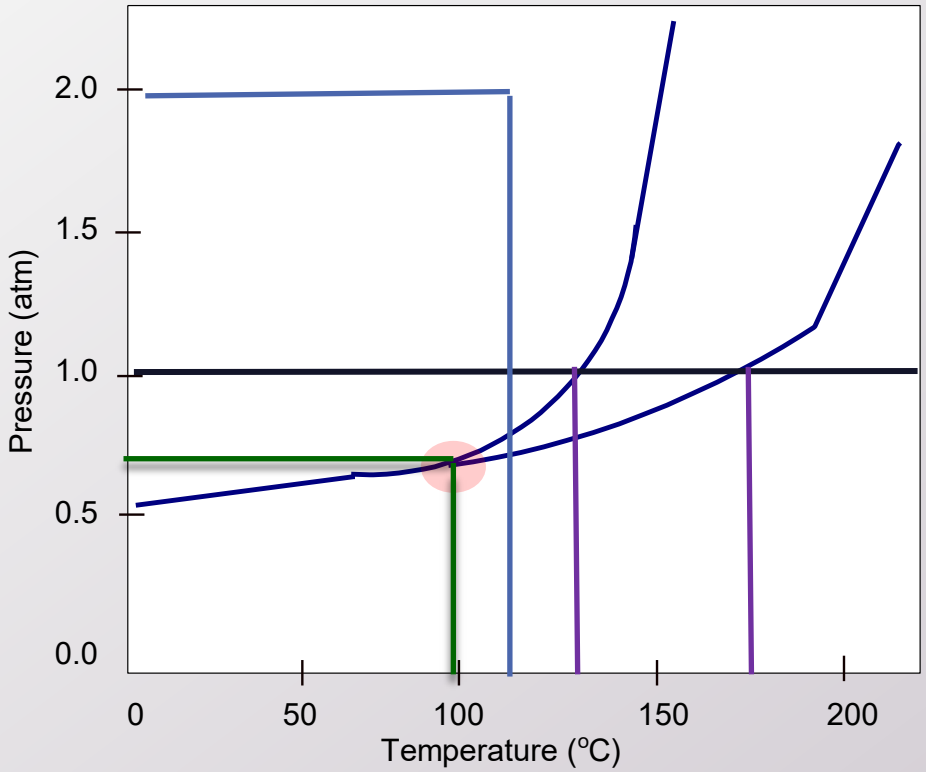
Draw lines!

Black is for 1atm pressure (normal P)

a) Purple lines at the phase changes:
   mpt. ~140 ^{o}C and bpt ~ 175 ^{o}C

b) Blue lines: should be solid.

c) Green line: ~ 0.7 atm and 100 ^{o}C.



KEY TERMS

- All different phases of substances
- Critical temperature and pressure
- Triple point
- Phase diagrams