

## Last Time

phase - a quantity of matter that is homogeneous throughout.

property - any characteristic that can be measured or observed.

- intensive or extensive

state - the condition of the system as described by its properties.

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## A pure substance -

a substance that is chemically homogeneous with a fixed chemical composition

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gases - compressible  
fluid (flow under stress)  
molecules rarely exert forces on each other

solids - incompressible  
rigid  
strong intermolecular forces  
dense

liquids - relatively incompressible  
fluid  
dense  
properties are determined by intermolecular forces

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boiling point -  
at a given pressure,  
the temperature above which liquid is  
no longer present. (all vapor)

freezing point -  
at a given pressure,  
the temperature below which no liquid  
is present. (all solid)

FP & BP are pressure dependent.

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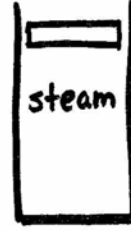
Consider a piston/cylinder filled with water,



$$T < T_{BP}$$



$$T = T_{BP}$$



$$T > T_{BP}$$

New definition for BP

SATURATION TEMPERATURE ( $T_{sat}$ ) -

temperature at which vaporization occurs at a given pressure.

SATURATION PRESSURE ( $P_{sat}$ ) -

pressure at which vaporization occurs for a given temperature.

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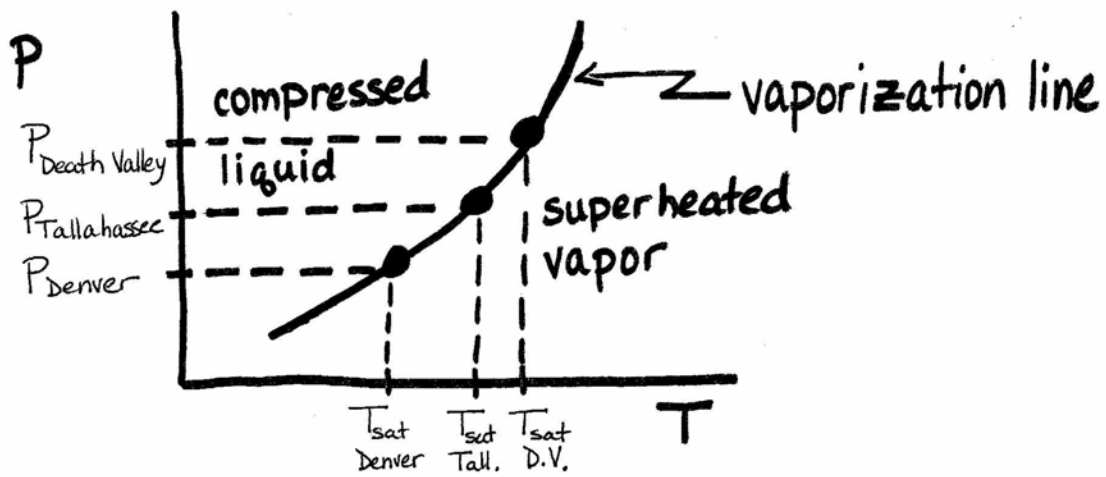
Saturated liquid -

- liquid that is @  $T_{sat}$  for a given  $P$
- liquid that is @  $P_{sat}$  for a given  $T$
- gets the subscript "f"

Saturated vapor -

- Vapor that is @  $T_{sat}$  for a given  $P$
- Vapor that is @  $P_{sat}$  for a given  $T$
- gets the subscript "g"

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liquid @  $T < T_{sat}$  for a given pressure is called  
 subcooled liquid or  
 compressed liquid ( $P > P_{sat}$  for given  $T$ )

vapor @  $T > T_{sat}$  for a given pressure is called  
 superheated vapor

Along vaporization line  $T$  &  $P$  are dependent properties.

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At saturation  $P$  &  $T$  are dependent, yet states can vary  
 new property for sat liq & sat vap in equilibrium,

**Quality  $\chi$**

is defined only  
 at saturation

$$\chi \equiv \frac{\text{mass sat vap}}{\text{total mass}}$$

$$\chi = \frac{m_g}{m_f + m_g}$$

vaporization

$g \rightarrow$  sat. vap.

$f \rightarrow$  sat. liq.

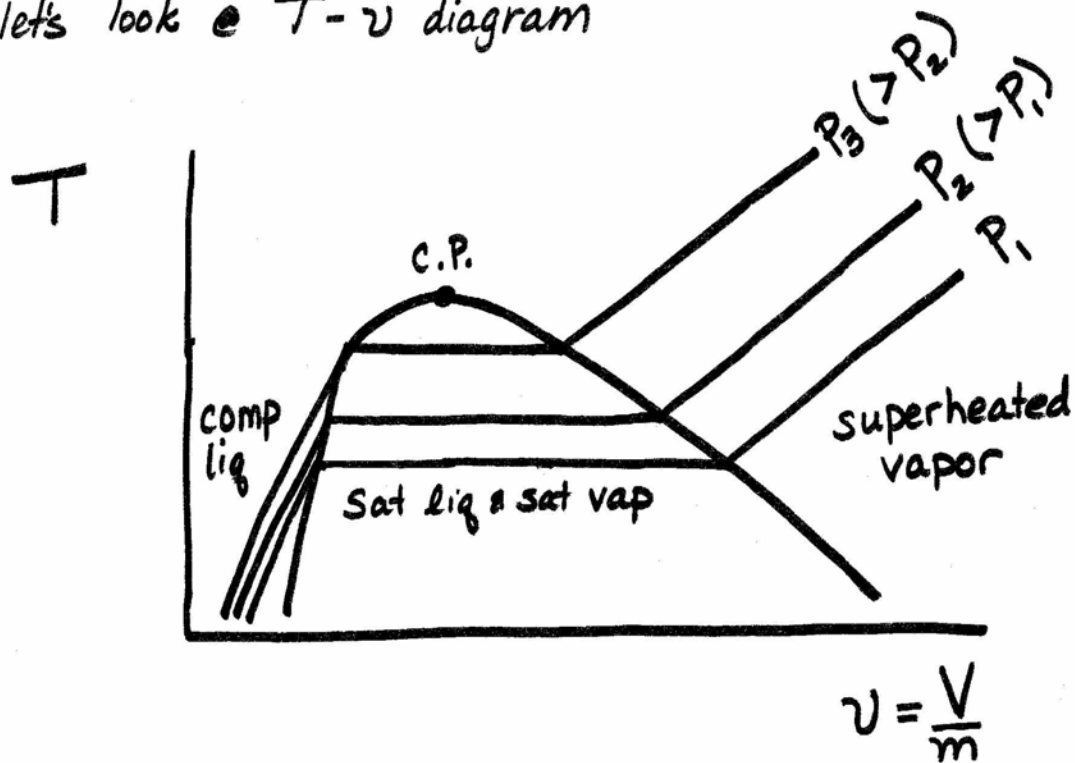
$$\chi = \frac{m_g}{m_i + m_g}$$

sublimation

$i \rightarrow$  sat. solid.

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let's look @  $T-v$  diagram



Point where sat liq & sat vapor states are identical is called the **CRITICAL POINT (C.P.)**

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Point where sat. liq. & sat. vap. states are identical is called the **CRITICAL POINT**

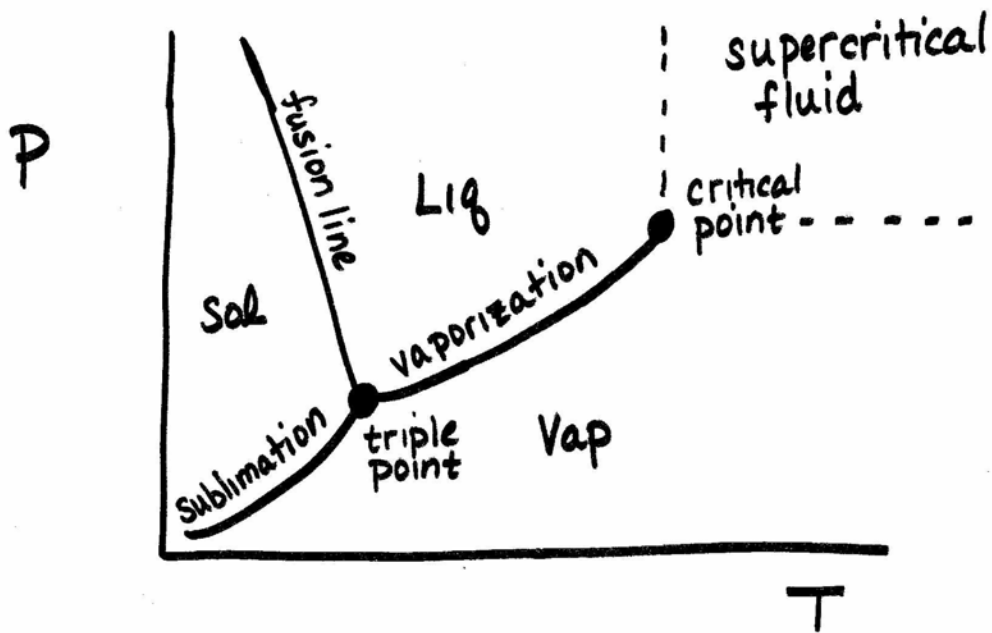
- 2 distinct phases are not present; only 1 phase,
- above the critical point is fluid

For a given substance, there is a characteristic C.P.

- critical temperature,  $T_c$
- critical pressure,  $P_c$
- critical specific volume,  $v_c$

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For Water,



Triple Point

- intersection of fusion, vaporization & sublimation lines.
- all 3 phases can coexist in equilibrium.

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The state of a simple compressible substance is defined by 2 independent intensive properties, (of  $P, T, v, x$ )

Note: @ saturation,  $P$  &  $T$  are dependent  
 $v$  &  $x$  are dependent

let's look @ the diagrams...

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