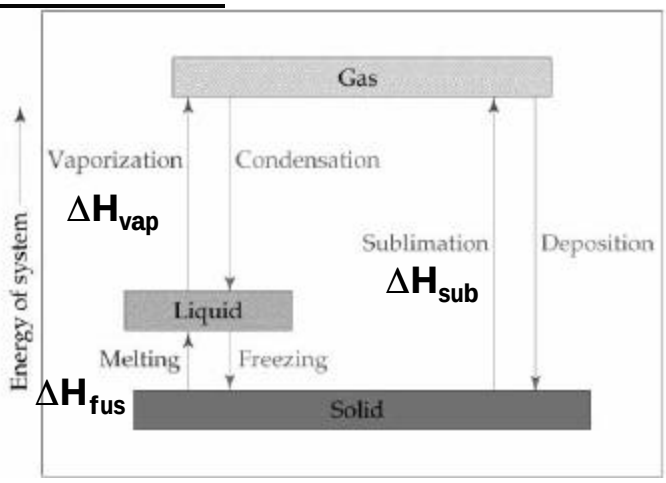
Phase Equilibrium and Phase Diagrams

Chemistry 35

Fall 2000

Energetics of Phase Changes



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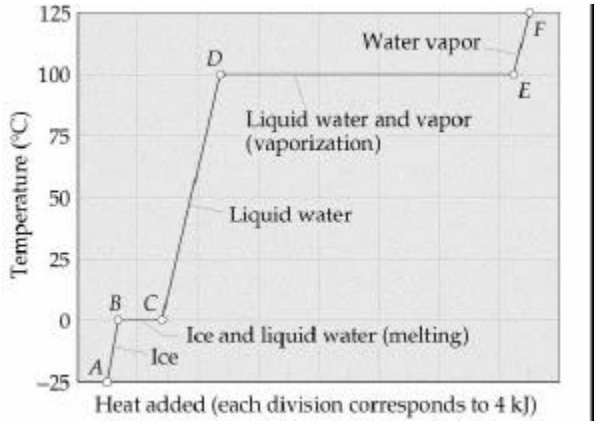
Heating Curves

- How does the *temperature* of a system vary as a function of **added energy**?



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Vapor Pressure

- If we put a liquid in a container (and $V_{container} > V_{liquid}$ and $T < T_b$): ***some of the liquid will vaporize***

Why?

- If molecules on the *surface* have sufficient Kinetic Energy, they can overcome intermolecular attraction and escape to the gas phase
- The **reverse** process can happen too!
- Process reaches a *steady state condition* (equilibrium):

$$X(l) \quad X(g)$$

amt in gas phase = ***vapor pressure***

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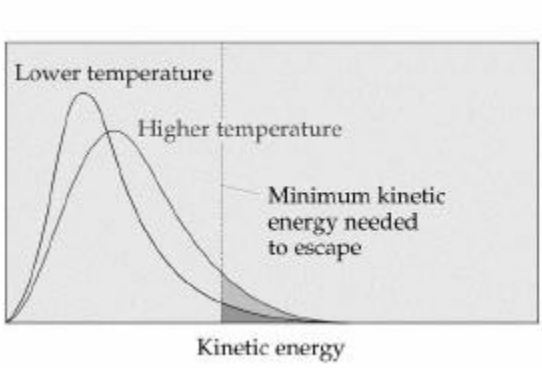
Vapor Pressure is Temperature Dependent

- Fraction of molecules with sufficient K.E. to escape surface *increases with temperature:*



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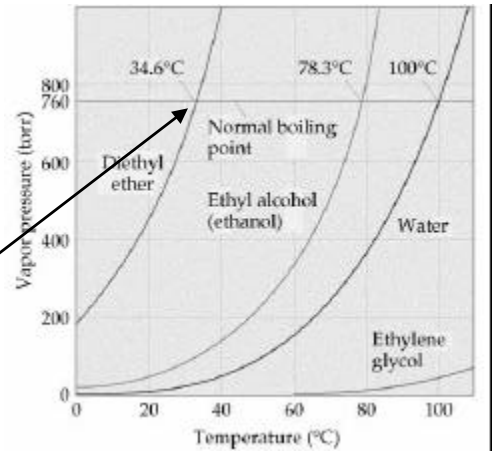
Temp Dependence of VP

- We define the ***boiling point*** as the *temperature at which:*

$$VP = P_{ext}$$

- At P_{ext} = 1 atm, this is called the ***Normal BP***



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Clausius-Clapeyron Equation

- The relationship between VP and temperature can be quantified by the equation:

$$\text{Ln } P = (-\Delta H_{vap}/RT) + C$$

- Thus, a plot of *Ln P versus 1/T* will be a straight line with a <u>slope = $-\Delta H_{vap}/R$</u>

-convenient way to: determine value of ΔH_{vap}
determine VP at any temp T

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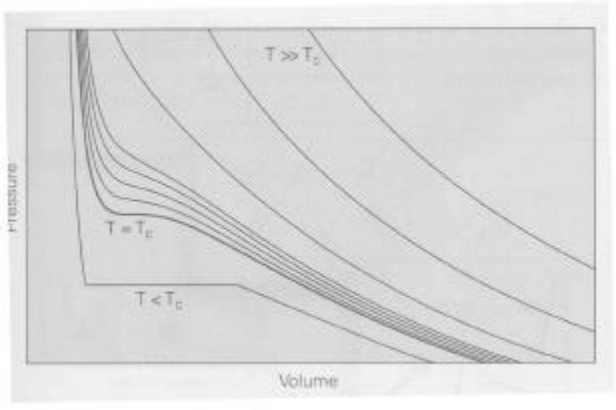
P-V Isotherms: Critical Temperature

-only get ideal gas behavior at high temperatures

-below a *critial temperature* (T_c), volume abruptly decreases at some pressure

(phase change to liquid)



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Phase Diagrams

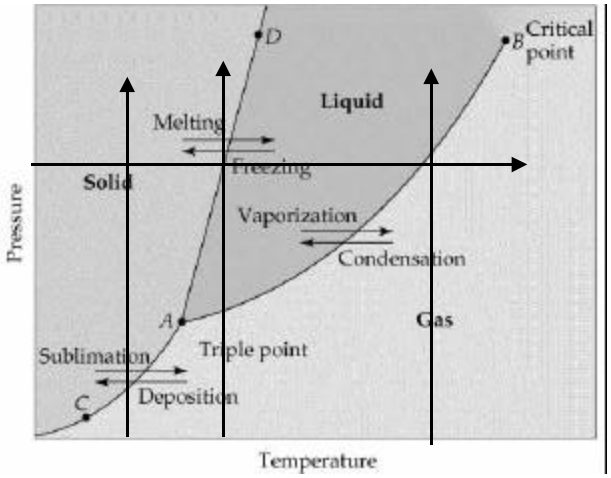
AB: *VP curve*

Pt. B: *Critical Point*

(Liquid, Gas: No diff)

Pt. A: *Triple Point*

(all 3 phases in equilibrium)



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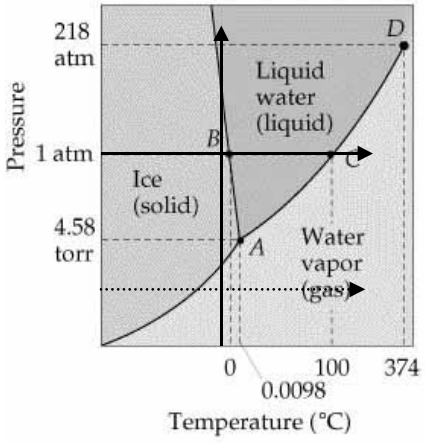
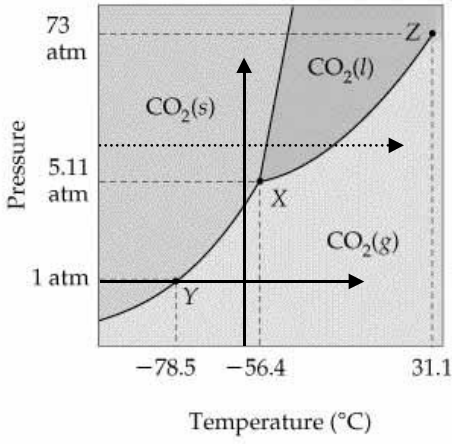
Phase Diagrams: Water and CO_2





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