Which has a lower Enthalpy?

A. liquid iron

B. solid iron 

C. they are exactly the same

D. it depends on the temperature

Which has a higher Entropy?

A. liquid iron 

B. solid iron

C. they are exactly the same

D. it depends on the temperature

Which has a lower Gibb's Free Energy?

A. liquid iron

B. solid iron

C. they are exactly the same

D. it depends on the temperature

Equilibria

Balance between stability of
lower Enthalpy (energy)
& higher Entropy

Physical Equilibria

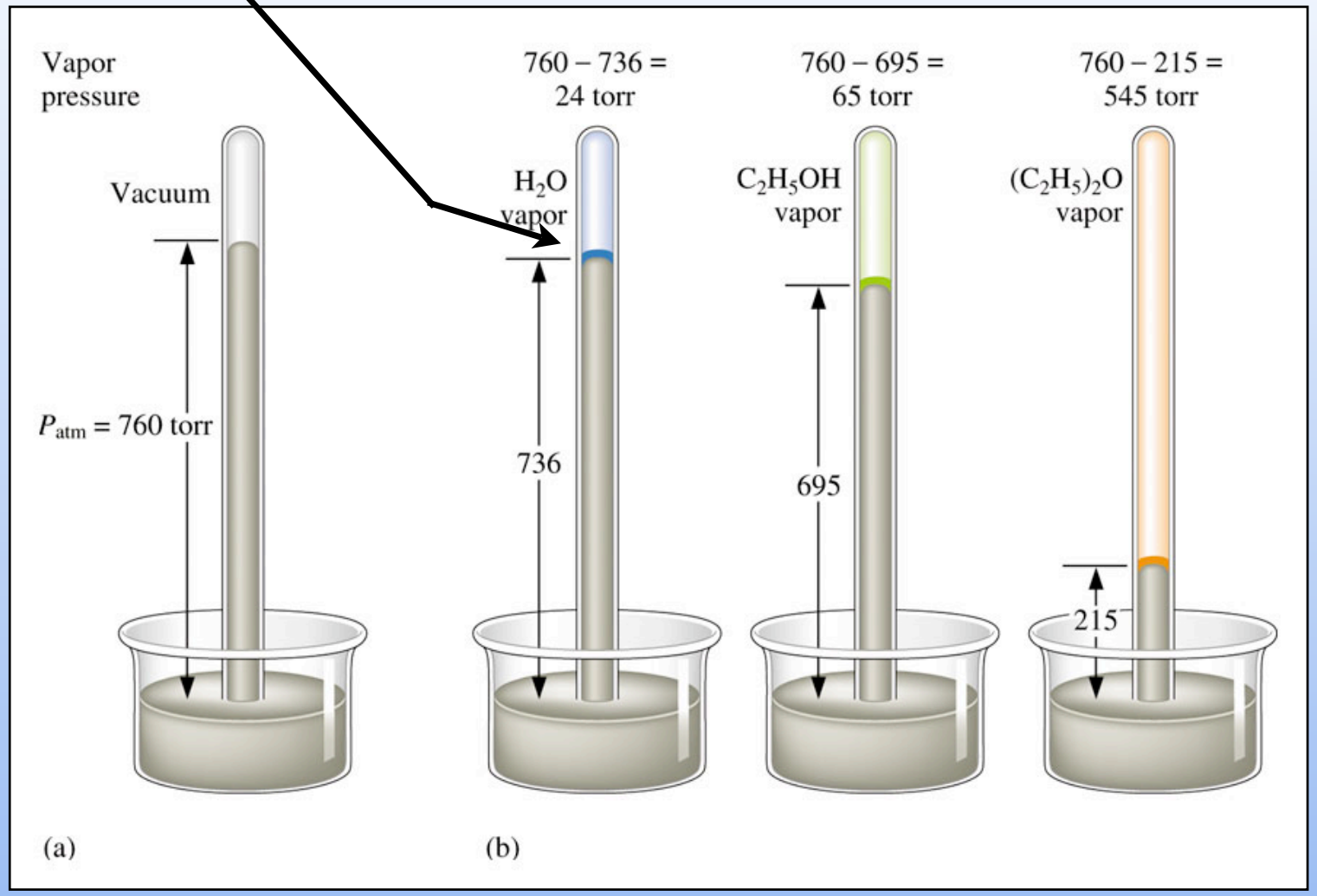
Phase transitions (no "chemistry")

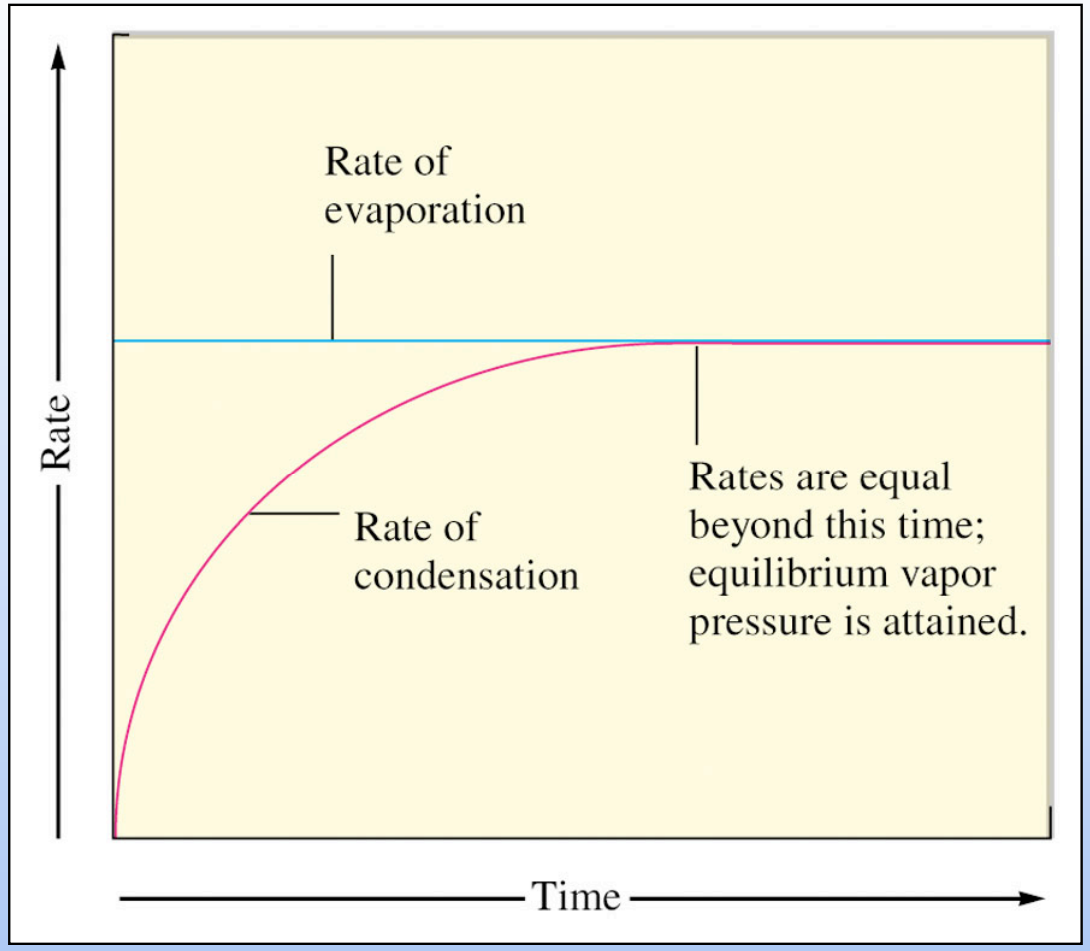
State with the lowest free energy is most stable

$$G = H - TS$$

therefore at high temperature
the state with highest S will be the most stable

Vapor pressure





Look at movie

Comparing different liquids

what matters is the free energy of the vapor compared to the liquid

For almost all substances the difference in ENTROPY between the vapor and the liquid is the same!

$$\Delta S_{vap} = 85 \text{ J K mol}^{-1}$$

Therefore the diversity in liquids properties is dominated by the ENTHALPY of vaporization

Enthalpies of Vaporization

Water	40.65 kJ mol^{-1}
Ammonia	23.35 kJ mol^{-1}
Diethyl Ether	27.4 kJ mol^{-1}
Methane	8.19 kJ mol^{-1}
Methanol	37.8 kJ mol^{-1}
Ethanol	38.5 kJ mol^{-1}
Propanol	47.5 kJ mol^{-1}
Butanol	51.6 kJ mol^{-1}

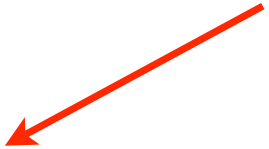
Why does butanol (C_4H_9OH) have a lower vapor pressure than methanol (CH_3OH)?

A. it has a higher entropy

B. it has stronger inter molecular forces

C. it has a lower molecular weight

D. it has a higher density

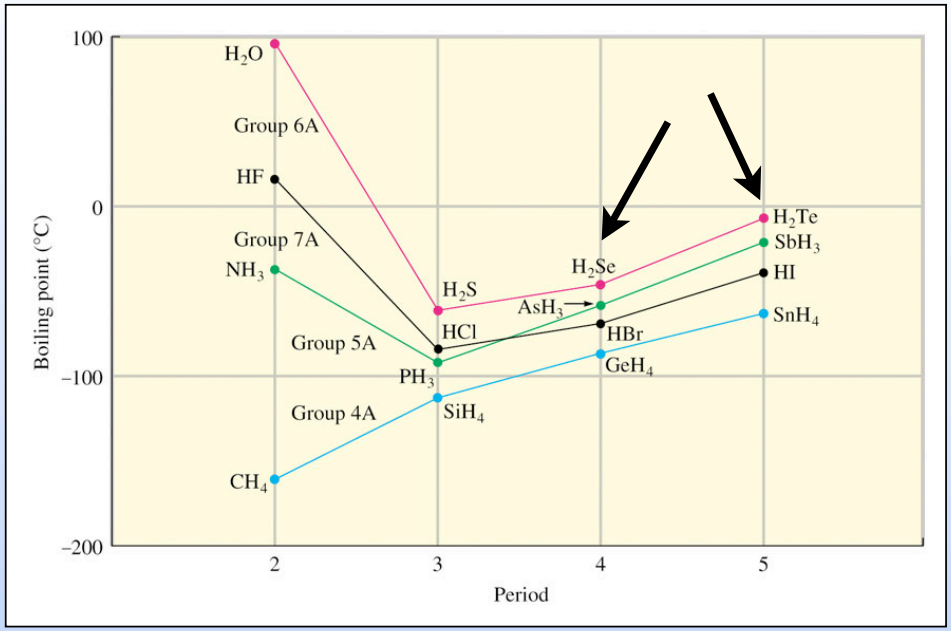


Intermolecular forces lead to the enthalpy difference between the liquid and the vapor

The larger the IMF the larger the ΔH_{vap}

The larger the ΔH_{vap} the smaller the vapor pressure

The the smaller the vapor pressure the higher the boiling point



Why is the boiling point of H_2Te higher than H_2Se?

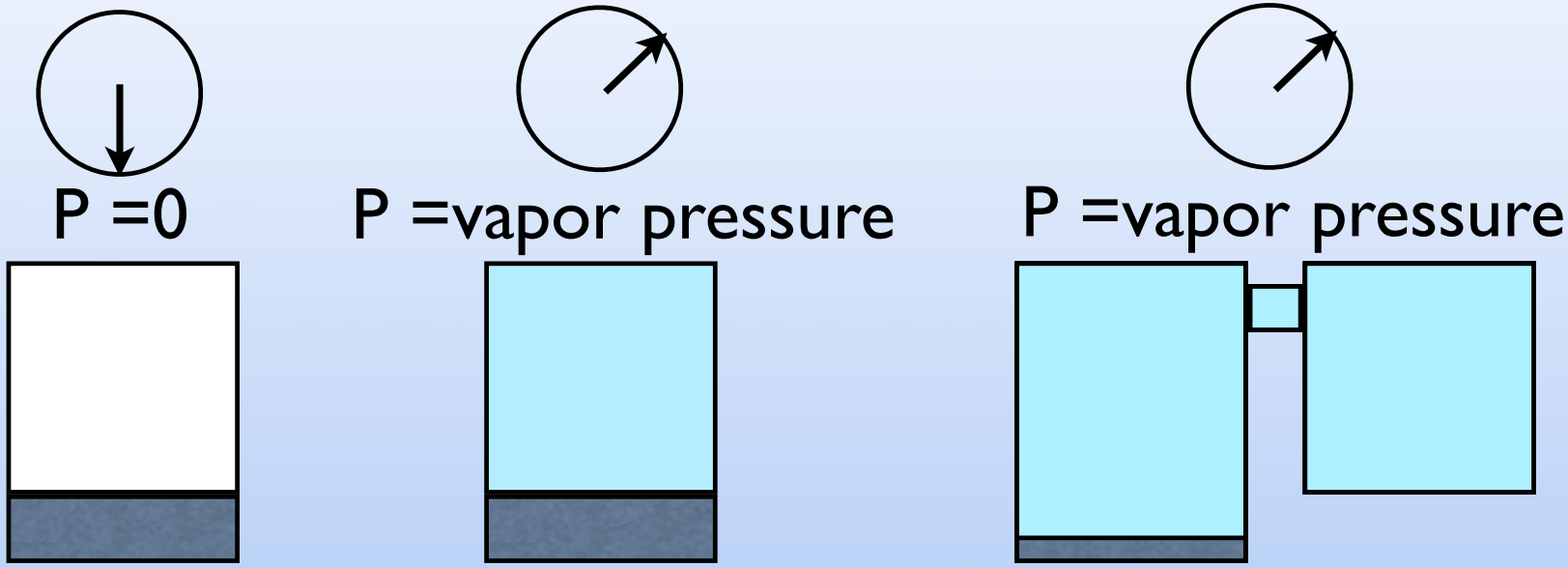
A. H_2Te has a larger dipole

B. H_2Se has more dispersion forces

C. H_2Te has more dispersion forces ←

D. Both A & C

Before we get to boiling let's look at how different properties affect vapor pressure



first all liquid

then comes to equilibrium with liquid + vapor with a pressure that is the vapor pressure

then add more volume

At equilibrium there is less liquid, but the same Pressure!

Quick Quiz

You have two containers.
one has a total volume of 2 L and
one has a total volume of 1 L
Into each you place 500 mL of liquid ether
They have the same temperature

Which container has a higher pressure at equilibrium?

A. the 2 L container

B. the 1 L container

C. they are exactly the same ←

D. it depends on the temperature

What do you remember from last time?

You have two containers
one has a total volume of 2 L and
one has a total volume of 1 L
Into each you place 500 mL of liquid ether

Which container has a greater number of ether molecules in the gas phase at equilibrium?

A. the 2 L container ←

B. the 1 L container

C. they are exactly the same

D. it depends on the temperature