Slide 1

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 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

Slide 2

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

Slide 3

Vapor Pressure is determined primarily from $\Delta_{vap}H$
$\Delta_{vap}H$ depends on the intermolecular forces

Vapor Pressure is independent of volume
Neither the volume of the gas or liquid matter

Vapor Pressure is a strong function of temperature

The Vapor Pressure is the
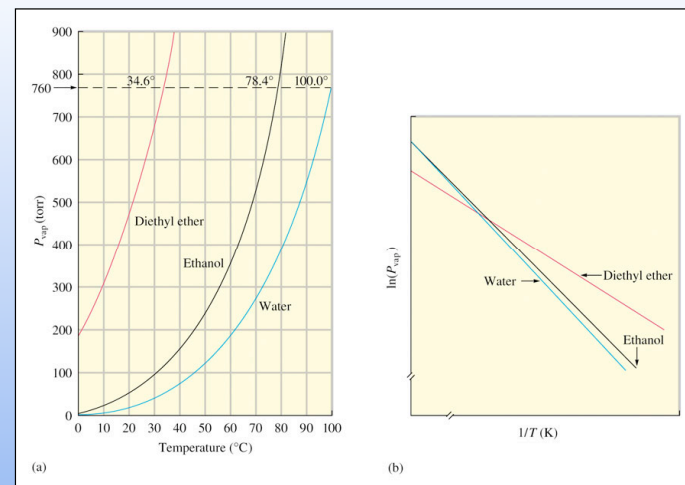PARTIAL PRESSURE OF THAT SUBSTANCE!

Slide 4

(a) P_{vap} (torr) vs Temperature (°C), showing Diethyl ether, Ethanol, Water, with reference lines at 34.6°, 78.4°, 100.0° and 760 torr.

(b) $\ln(P_{vap})$ vs $1/T$ (K), showing Water, Diethyl ether, Ethanol.

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How Does Vapor Pressure Change with T?

$$\ln\left(\frac{P_2}{P_1}\right) = -\frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

The Claussius-Clapeyron Equation

Relates the vapor pressure P_1 at temperature T_1 to the vapor pressure P_2 at temperature T_2

What is the normal boiling point of water?

Given the vapor pressure of water at 25°C is 24 Torr and the ΔH_{vap} = 40.8 kJ mol^{-1}

What is the boiling point?

Definition: The boiling point is temperature at which the vapor pressure is equal to prevailing pressure

What is the normal boiling point?

Definition: The normal boiling point is temperature at which the vapor pressure is equal to 1 atm

---

What is the normal boiling point of water?

Given the vapor pressure of water at 25°C is 24 Torr and the ΔH_{vap} = 40.8 kJ mol^{-1}

This question is asking at what temperature is the vapor pressure of water equal to 1 atm.

Use the Claussius-Clapyeron Equation

What is the normal boiling point of water?

Given the vapor pressure of water at 25°C is 24 Torr and the ΔH_{vap} = 40.8 kJ mol^{-1}
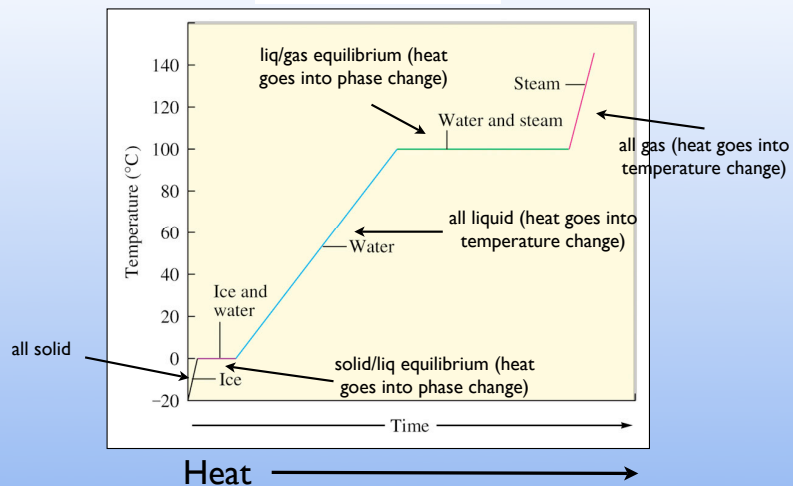
Slide 1: Phase Transitions

Phase Transitions

liq/gas equilibrium (heat goes into phase change)

Steam

Water and steam

all gas (heat goes into temperature change)

Water

all liquid (heat goes into temperature change)

Ice and water

all solid

Ice

solid/liq equilibrium (heat goes into phase change)

Temperature (°C): 140, 120, 100, 80, 60, 40, 20, 0, −20

Time

Heat

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Slide 2: Previous Thermo

Previous Thermo

Single Phase
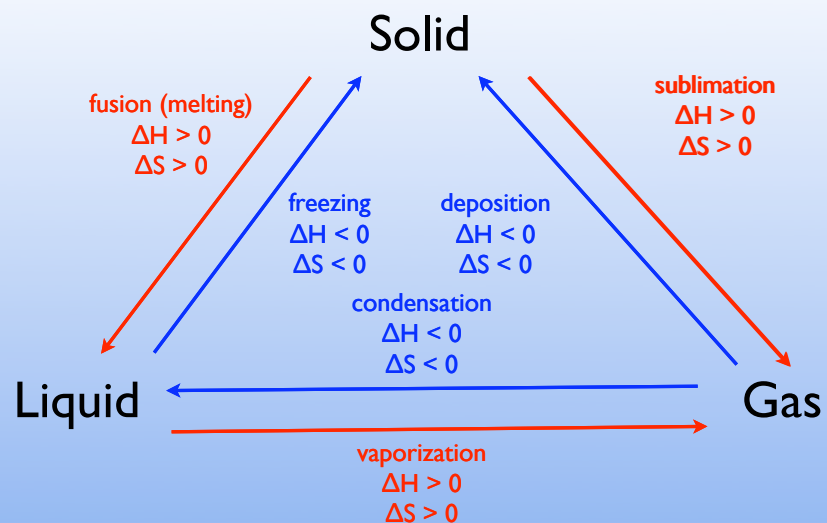energy into goes into temperature change
at constant P

$q = \Delta H = C_p \Delta T$
you need heat capacity of specific phase (sol, liq, gas)

Phase Change
energy into goes into phase change
(the two phases have the same free energy
but one is higher in enthalpy)

$q = \Delta H_{transition}$ for example $q = \Delta H_{fus}$ for melting

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Slide 3: The different phase transitions

The different phase transitions

Solid

fusion (melting)
$\Delta H > 0$
$\Delta S > 0$

sublimation
$\Delta H > 0$
$\Delta S > 0$

freezing
$\Delta H < 0$
$\Delta S < 0$

deposition
$\Delta H < 0$
$\Delta S < 0$

condensation
$\Delta H < 0$
$\Delta S < 0$

Liquid

Gas

vaporization
$\Delta H > 0$
$\Delta S > 0$

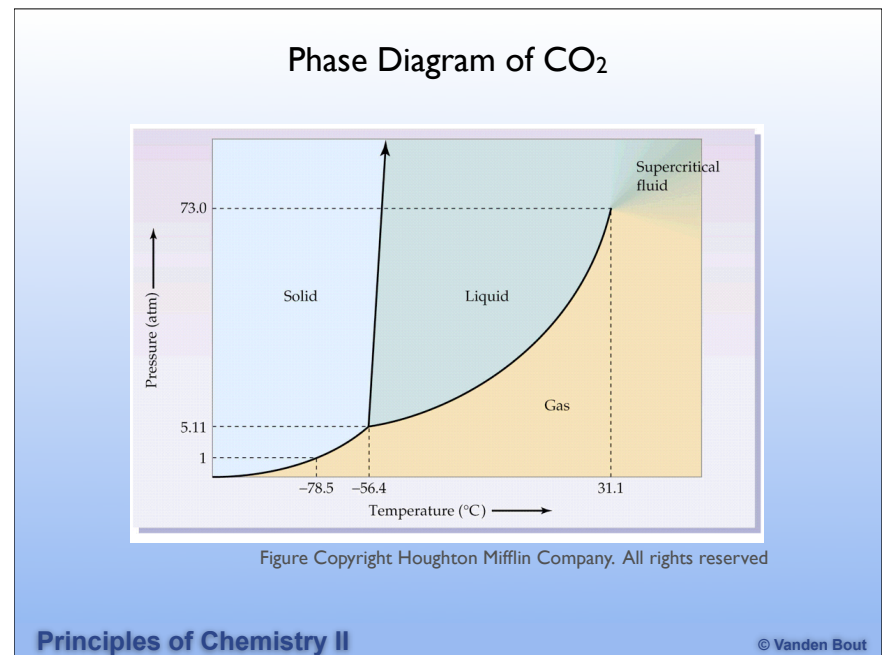Principles of Chemistry II   © Vanden Bout
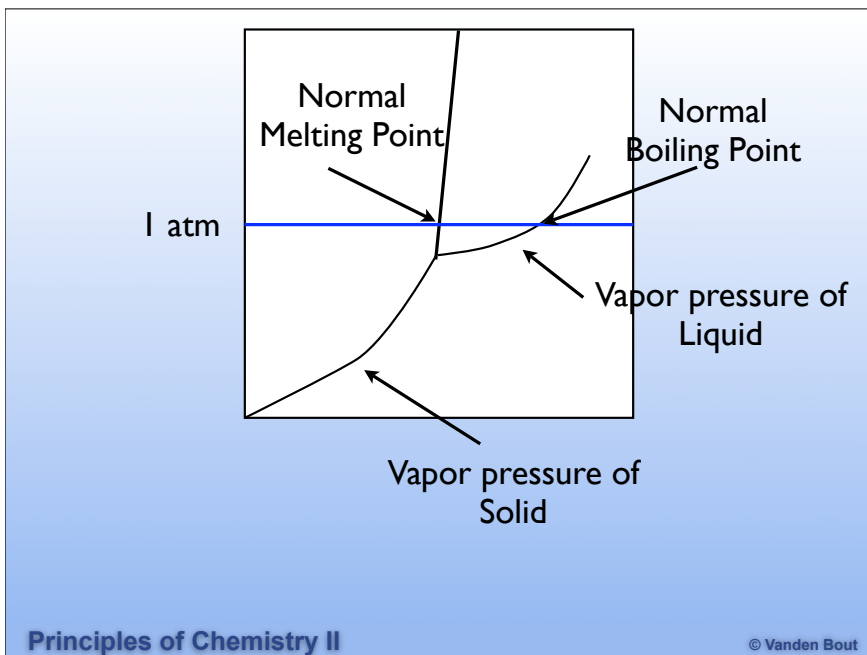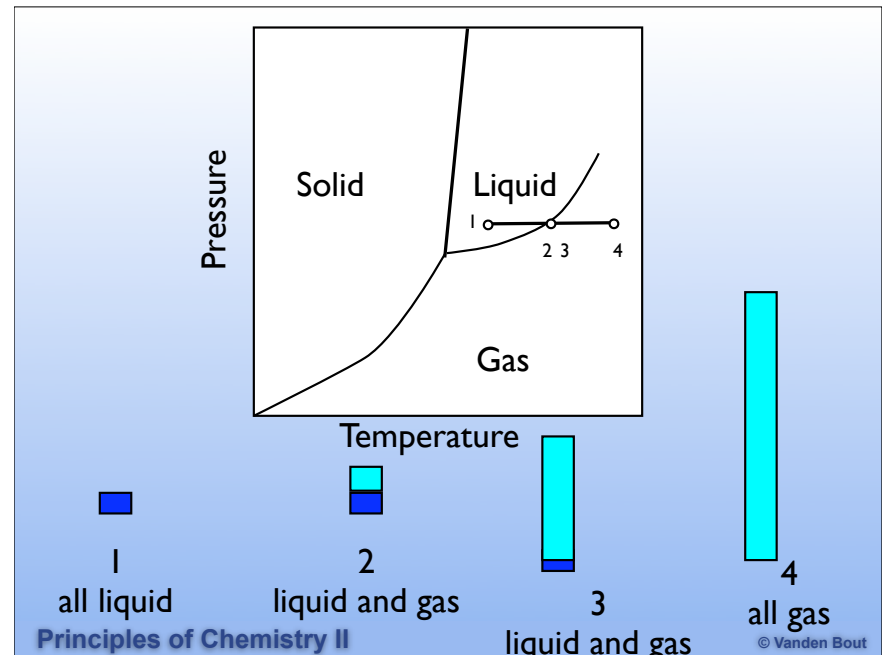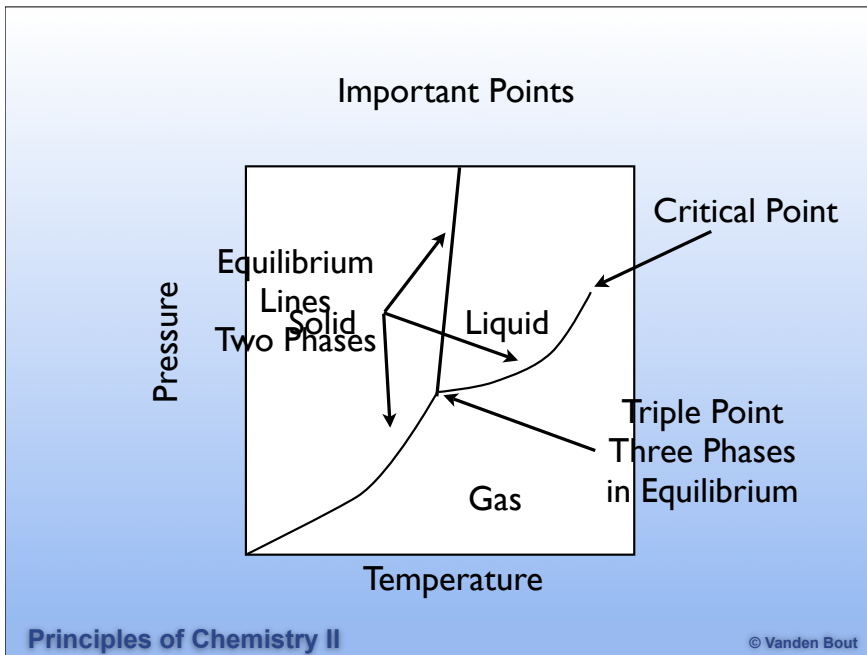
Slide 4: Phase Diagrams

Phase Diagrams

The diagram on the right shows different phases for a compound as a function of temperature and pressure

What is the phase labeled "A"?

A.   solid
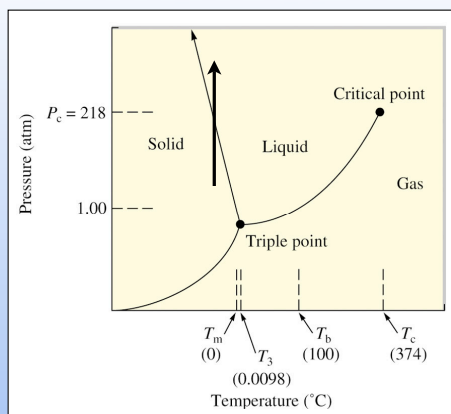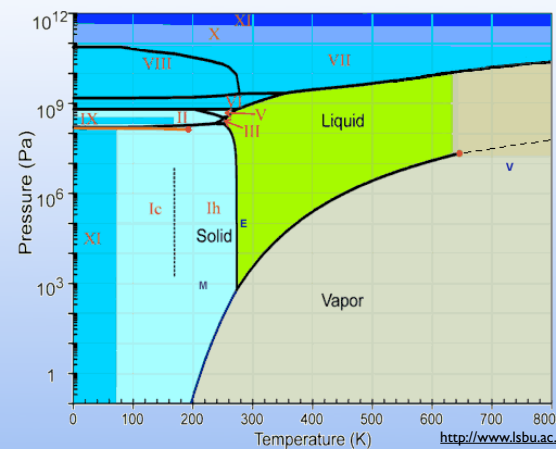
B.   liquid

C.   gas

D.   no way to know

Pressure

Temperature

A, B, C

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Important Points

Critical Point

Equilibrium Lines
Two Phases

Solid

Liquid

Pressure

Triple Point
Three Phases
in Equilibrium

Gas

Temperature

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Pressure

Solid   Liquid

1   2 3   4

Gas

Temperature

1
all liquid

2
liquid and gas

3
liquid and gas

4
all gas

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Normal
Melting Point

Normal
Boiling Point

1 atm

Vapor pressure of
Liquid

Vapor pressure of
Solid

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Phase Diagram of CO$_2$

73.0

Supercritical
fluid

Solid   Liquid

Pressure (atm)

5.11

1

Gas

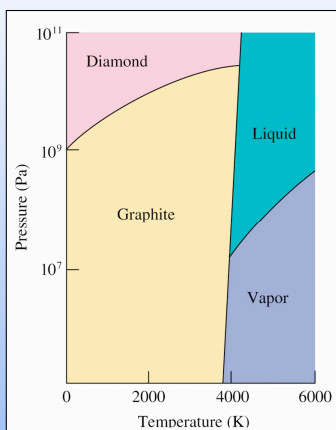−78.5 −56.4   31.1

Temperature (°C)

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Phase Diagram of Water

At a constant temperature, increasing the pressure will cause ice to melt
(it moves to the higher density phase which for water is a liquid)

Phase Diagram of Water

Many different solid phases. At very high
pressure the liquid will solidify

Other Substances