UNIT5-DAY2-VDB

Thursday, January 17, 2013
8:01 AM

Thinking Like a Chemist About Phase Changes

UNIT 5 DAY 2

What are we going to learn today?

Do your homework (HW and LM)
Become familiar with the course website

Quick pre-assessment – do your best.

Thinking Like a Chemist in the context of Phase Changes
- Vapor Pressure
- Boiling/Condensation
- Phase Diagram

ANNOUNCEMENTS

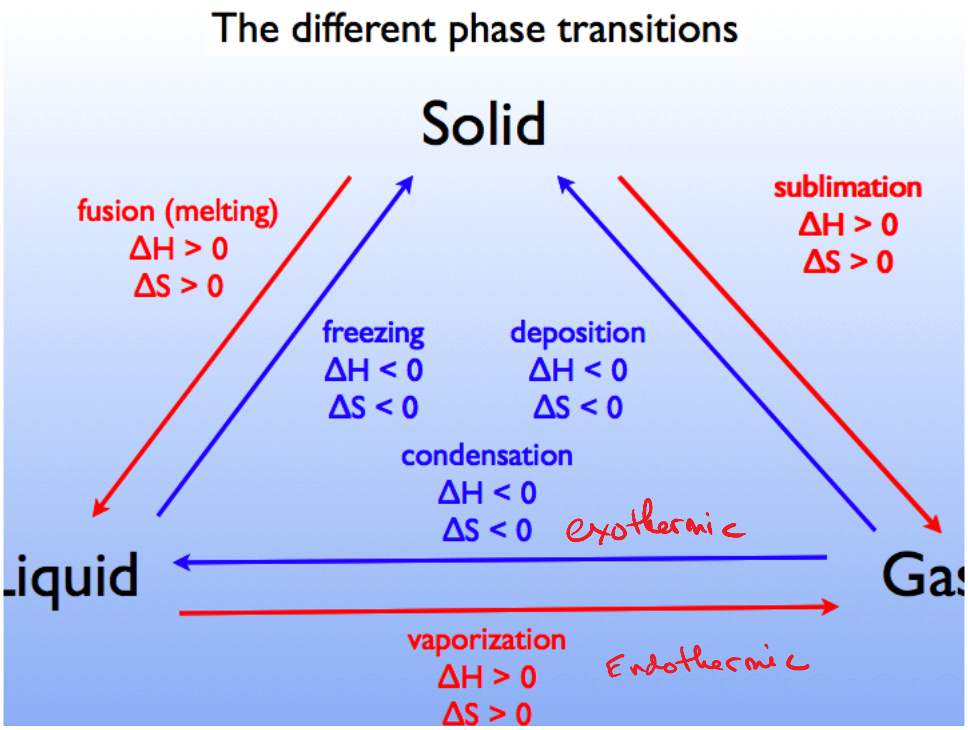
HW1	DUE Tue 9AM
LM04 – Phase Diagrams	DUE Tue 9AM
LM05 – Vapor Pressure	DUE Tue 9AM

If Quest is slow – step away from computer for 15 minutes then try again

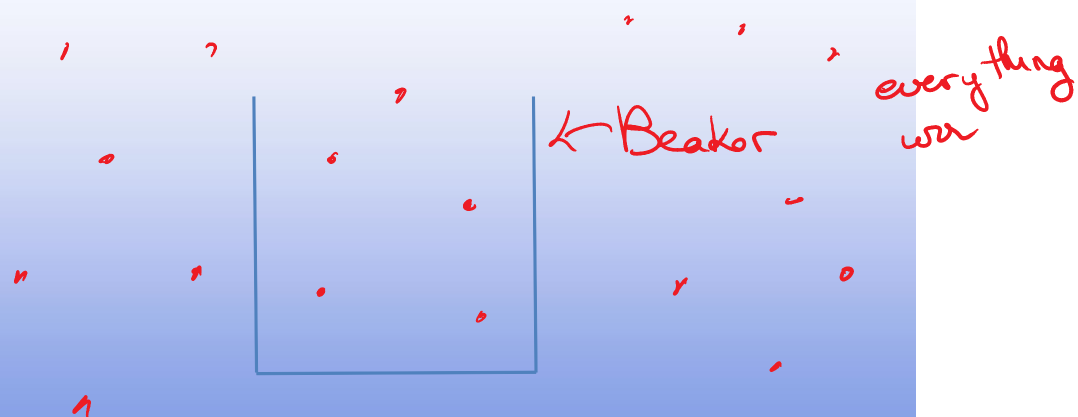
Quiz Question 1

The sign for ΔH_{vap} is:

a) always "-"
b) always "+"
c) could be "+" or "-" depending on T
d) could be "+" or "-" depending on IMFs



What if there were no IMF?



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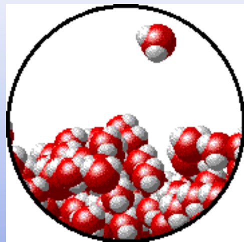
What if there were no IMF?



If no attraction molecules would wander away and spread out all over the universe.

This is entropy.

IMF hold them back

But… what about evaporation?

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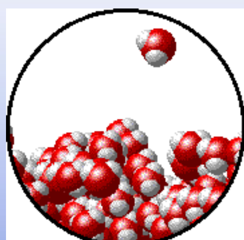
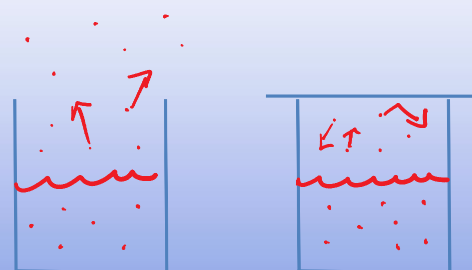
But there are IMFs !



But… what about evaporation?



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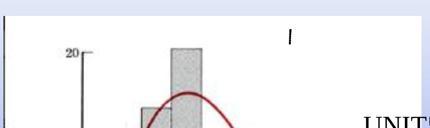
Boltzmann distribution explains EVAPORATION!

What happens to distribution when you increase T?

$KE = \frac{1}{2}mv^2$



Boltzmann distribution explains EVAPORATION!

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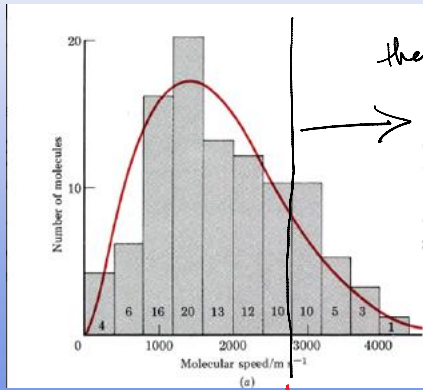


these have enough KE → can evaporate! on surface

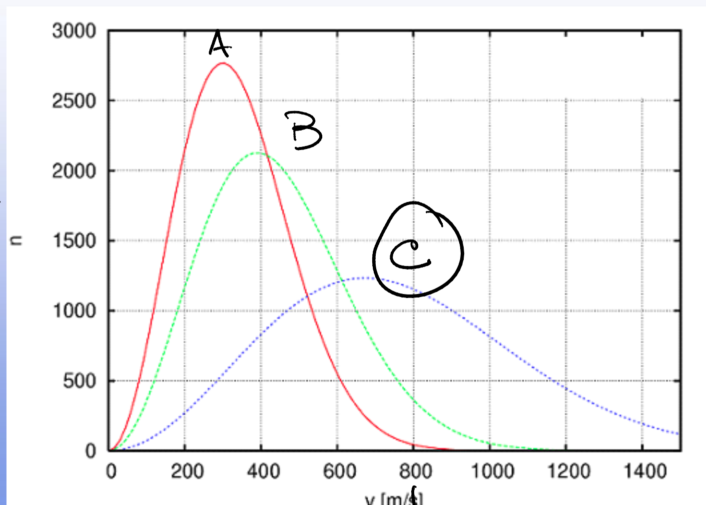
#

speed

Poll: CLICKER QUESTION 3

Which distribution is a distribution at higher T?

$KE \propto T$



#

speed

We can measure how many molecules escape – Vapor Pressure

number of gas moles directly proportional to partial pressure

Dr. McCord's video on vapor pressure

http://www.youtube.com/watch?feature=player_embedded&v=gIXCxNbVO3k

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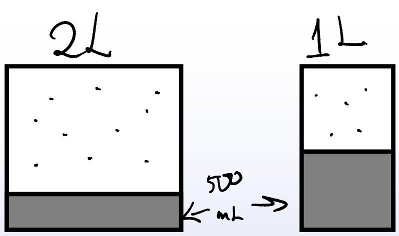
VP is property of liquids

Polling Question 2/3

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

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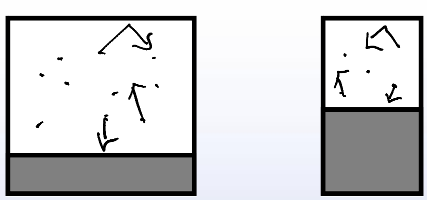
VP property of liquids

Same liquid, same temp, pressure is the same

Polling Question 4/5

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 the greater number of molecules of the ether in the gas phase?

VP of ether same whether other gases ... the

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 the greater number of molecules of the ether in the gas phase?

A. The 2 L container
B. The 1 L container
C. they are exactly the same
D. it depends on the temperature

other gas in the atmosphere or not

Partial Pressure is the VP

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Look at this Data at 25° C

760 Torr = 1 atm

Compound	VP (Torr)	ΔH_{vap} (kJ mol^{-1})
Water	24	40.65
Diethyl Ether	545	27.4
Propane	7500	18.8
Methanol	127	37.8
Ethanol	65	38.5
Propanol	44	47.5
Butanol	7	51.6

VP ↑ ΔH_{vap} ↓

amt energy from liquid → gas (IMFs)

Not linear!

What is the relationship between VP and ΔH_{vap} ?

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Polling Question 6

Why does octane (C_8H_{18}) have a lower vapor pressure Than hexane (C_6H_{14}) at 25° C?

A. octane has higher entropy

B. octane has stronger inter molecular forces

C. octane has a lower molecular weight

D. octane has a higher density

E. is an alcohol

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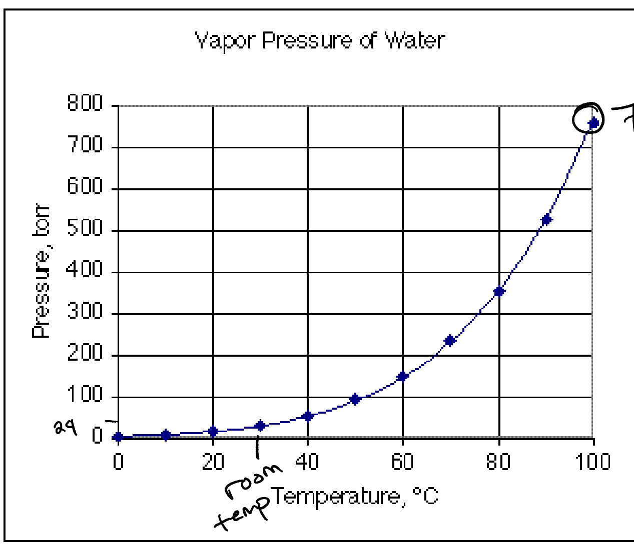
How does VP change with T?



760 torr

temperature at which VP = external pressure

Temp = Boiling temp

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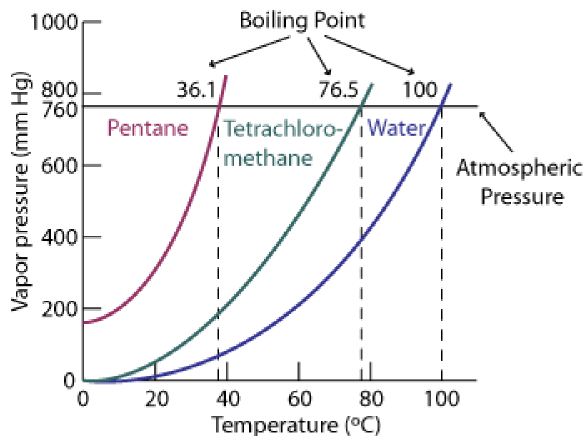
Polling Question 7

IS THE NORMAL BOILING POINT THE SAME FOR ALL LIQUIDS?

a) YES
b) NO

↳ temp @ 1 atm



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Mathematical Relationship between VP and T

Vapor pressure of a liquid increases with increasing T

Clausius-Clapeyron equation

Vapor Pressure

$$ln\left(\frac{P_2}{P_1}\right) = \Delta H^{\circ}_{vap}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

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What did we learn just now?

Vapor Pressure is related to the "energy" of a substance.

VP is dependent on T.

VP is independent of amount of liquid present.

The stronger the IMFs, the bigger the difference between the liquid and the gas (which has essentially no potential energy since the "molecules" are so far apart), the larger the $\Delta H_{vap,}$ the lower the VP.

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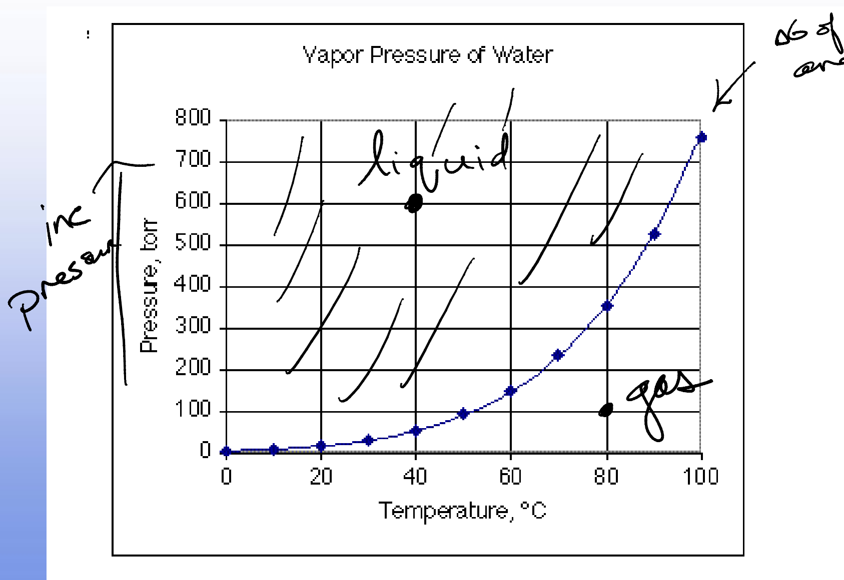
Where would you find gas? Liquid?



ΔG of liquid and gas are same on the line

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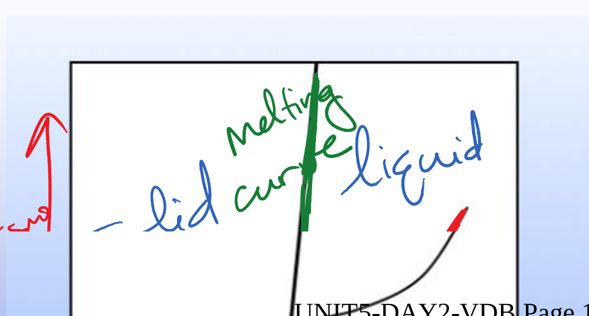
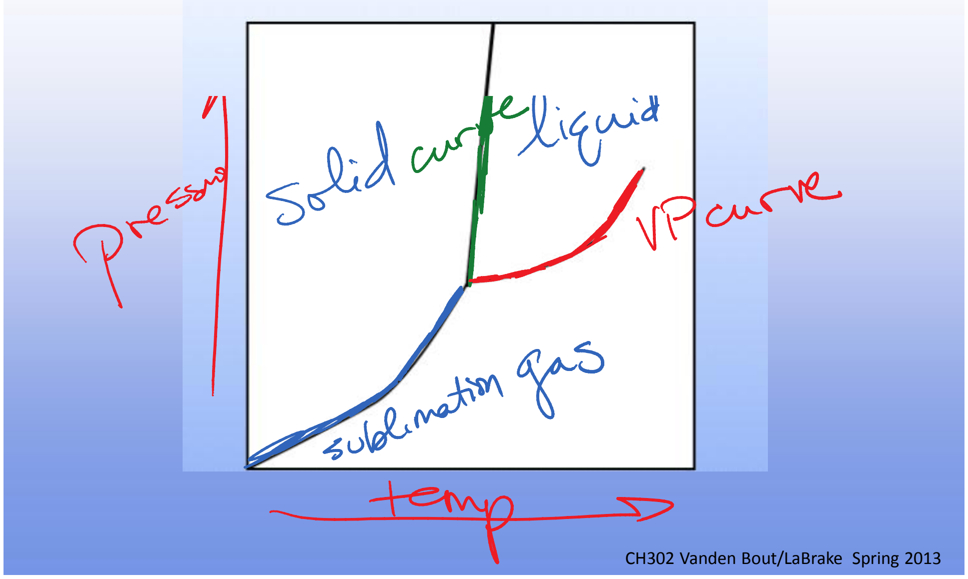
PHASE DIAGRAM




Solid
curve
liquid
VP curve
sublimation
gas
temp
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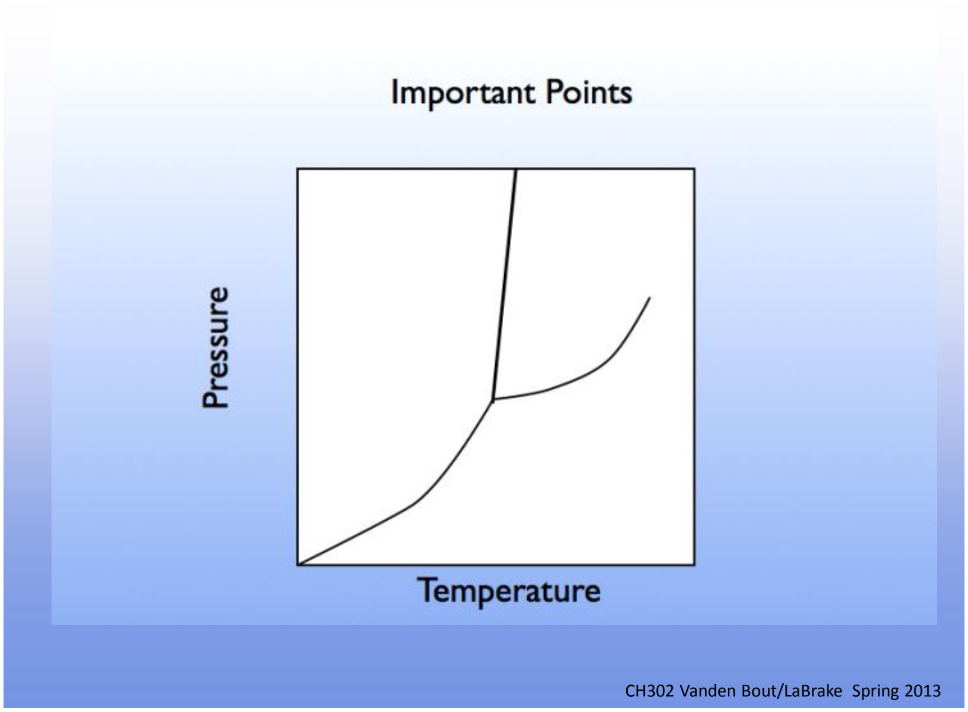
Important Points
Pressure
Temperature
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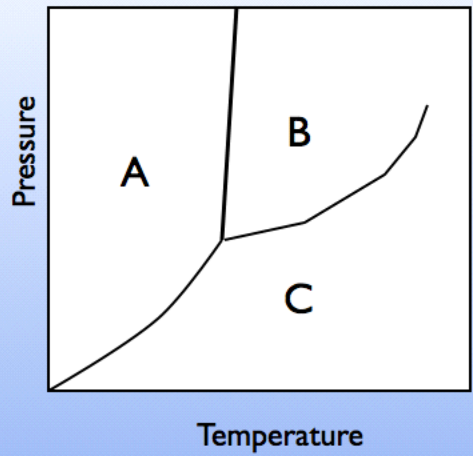
Phase Diagrams

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

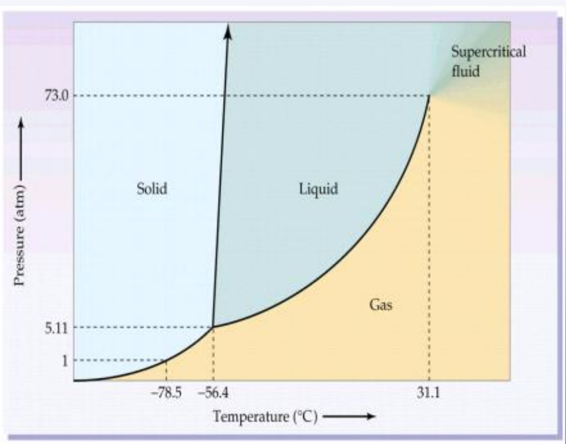
B. liquid

C. gas

D. no way to know

Polling Question 9

What is the temperature at the triple point?



A. 73.0 ° C

B. -78.5 ° C

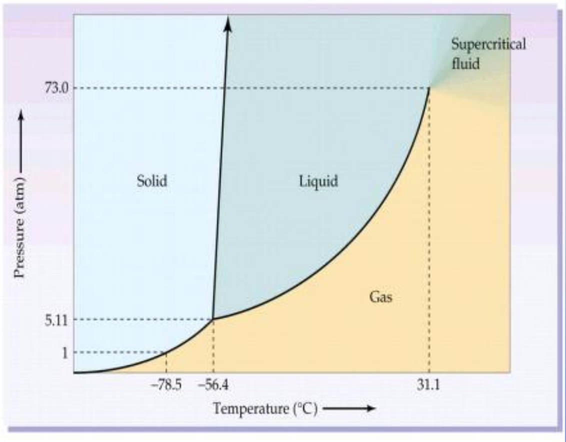
C. -56.4 ° C

D. 31.1 ° C

E. 5.11 ° C

Polling Question 10

At the triple point solid, liquid, and gas all have the same….



A. number of moles
B. free energy
C. volume
D. density
E. entropy

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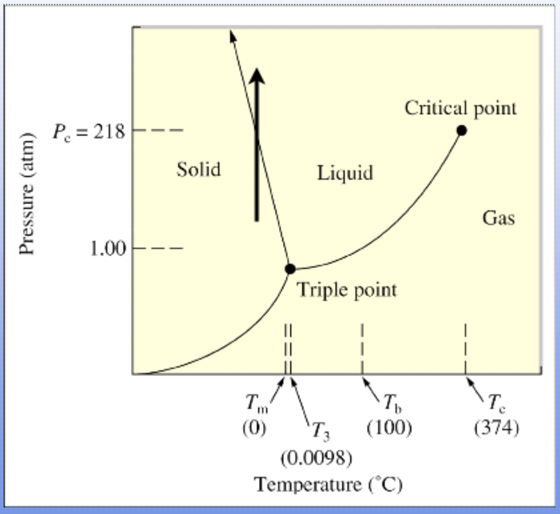
Polling Question 11

As the pressure is raised the melting point of water



A. decreases
B. increases
C. stays the same

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What did we learn just now?

Boiling is when the vapor pressure equals the external pressure.

Normal "phase changes" occur at 1 atm, but phase change temperatures vary with pressure.

Phase changes are an equilibrium condition.

You can refer to a Phase Diagram to determine at what phase a particular substance will be in based on the external Pressure and Temperature.

What did we learn today?

Vapor Pressure is Temperature dependent.

When Vapor Pressure = External Pressure, liquid will boil.

The macroscopic property of boiling and melting can be explained by thinking of microscopic concept of the IMFs. The energy that goes into the system to cause the change is transferred to the potential energy of the system during the change.

Phase Diagrams are a chemist's and a chemical engineers friend.

LEARNING OUTCOMES

Understand how intermolecular forces and temperature affect vapor pressure.

Interpret phase diagrams and identify normal boiling and melting points, critical point and triple point.

Describe both boiling and evaporation (macroscopically and microscopically).

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