CHEM 1120- 12.1-3

[TRAP CARD]

Intermolecular Force: The Force that holds molecules and atoms together in a liquid or solid state. Strength determines type of state

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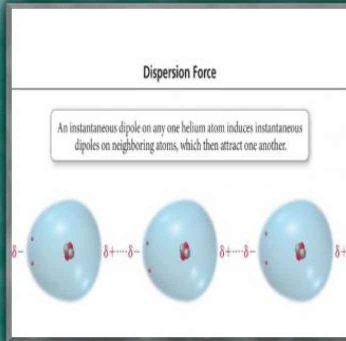
CHEM 1120- 12.1-3 #1

[SPELL CARD]



Temporary weak dipole interactions that can occur in nonpolar and polar molecules

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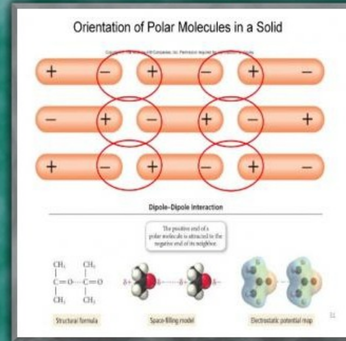
CHEM 1120- 12.1-3 #2

[SPELL CARD]



Dipole-Dipole Interaction B/W Polar Molecules that is permanent. It is determined by geometry

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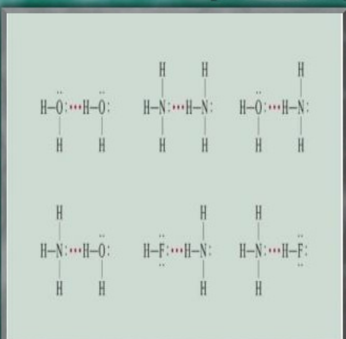
CHEM 1120- 12.1-3 #3

[SPELL CARD]



H Bonds

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CHEM 1120- 12.1-3

[TRAP CARD]

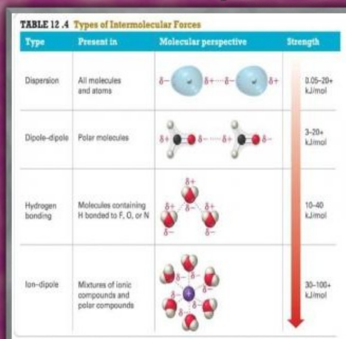

TABLE 12 .4 Types of Intermolecular Forces

Type	Present in	Molecular perspective	Strength
Dispersion	All molecules and atoms		0.05–20+ kJ/mol
Dipole–dipole	Polar molecules		3–20+ kJ/mol
Hydrogen bonding	Molecules containing H bonded to F, O, or N		10–40 kJ/mol
Ion–dipole	Mixtures of ionic compounds and polar compounds		30–100+ kJ/mol

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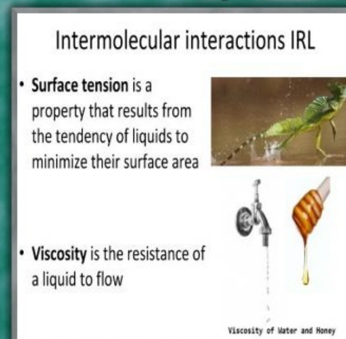
CHEM 1120- 12.4 #1

[SPELL CARD]



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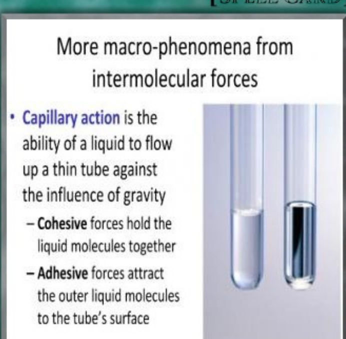
CHEM 1120- 12.4 #2

[SPELL CARD]



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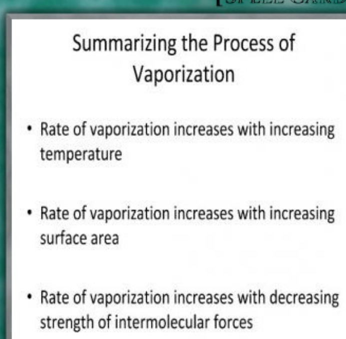
CHEM 1120- 12.5 #1

[SPELL CARD]



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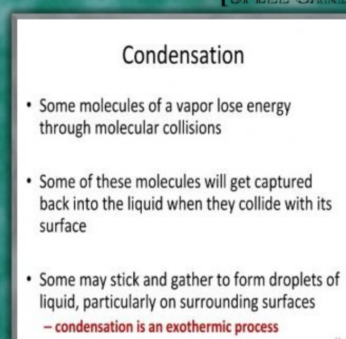
CHEM 1120- 12.5 #2

[SPELL CARD]



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CHEM 1120- 12.5 Prob.1

[Spell Card]

Calculate the mass of water (in g) that can be vaporized at its boiling point with 155 kJ of heat.

The heat of vaporization for water ΔH_{vap} is +40.7 kJ/mol at 100 °C.

155 kJ * 1mol H2O/40.7 kJ = 3.81 mol H2O
3.81 mol H2O * 18.0 g/ 1 mol H2O = 68.7 g H2O

91102591

CHEM 1120- 12.5 #3

[Spell Card]

Heat of Vaporization

- Liquids that evaporate easily are said to be **volatile**
  - For example, gasoline and fingernail polish remover
- Liquids that do not evaporate easily are **nonvolatile**
  - For example, motor oil
- The amount of energy required to vaporize one mole of liquid is called the **heat of vaporization, ΔH_{vap}**
  - Or enthalpy of vaporization
- It is always endothermic; therefore, ΔH_{vap} is positive
- It is somewhat temperature dependent

$$\Delta H_{condensation} = -\Delta H_{vaporization}$$

96562504

CHEM 1120- 12.5 #4

[Spell Card]

- Once the rates of vaporization and condensation are equal, the total amount of vapor and liquid will not change (at constant T)
- Evaporation and condensation are still occurring, but there is no net gain or loss of either vapor or liquid

34359298

CHEM 1120- 12.5 #5

[Spell Card]

Vapor pressure

- Pressure exerted by the vapor when it is in dynamic equilibrium with its liquid is called the **vapor pressure**
- The weaker the attractive forces between the molecules, the more molecules will be in the vapor
  - Therefore, the weaker the attractive forces, the higher the vapor pressure
  - The higher the vapor pressure, the more volatile the liquid

81226880

CHEM 1120- 12.5 #6

[Spell Card]

- The *normal boiling point* of a liquid is the point at which the vapor pressure of the liquid equals the atmospheric pressure

TABLE 12.8 Boiling Points of Water at Several Locations of Varied Altitudes

Location	Elevation (ft)	Approximate Pressure (atm)*	Approximate Boiling Point of Water (°C)
Mount Everest, Tibet (highest mountain peak on Earth)	29,035	0.32	78
Mount McKinley (Denali), Alaska (highest mountain peak in North America)	20,320	0.46	83
Mount Whitney, California (highest mountain peak in 48 contiguous United States)	14,495	0.60	87
Denver, Colorado (mile high city)	5,280	0.83	94
Boston, Massachusetts (sea level)	20	1.0	100

*The atmospheric pressure in each of these locations is subject to weather conditions and can vary significantly from these values.

As liquid is heated to boiling point, it stops heating. The heat is added to the boiling. Temperature increases again once all liquid is turned to gas

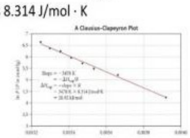
80097025

CHEM 1120- 12.5 #7

[Spell Card]

Clausius-Clapeyron Equation

- The natural logarithm of the vapor pressure ($\ln P_{vap}$) versus inverse temperature ($1/T$) is a linear function
  - A graph of $\ln P_{vap}$ versus $1/T$ is a straight line
  - The slope of the line: $-\Delta H_{vap} / R$
  - Where R is 8.314 J/mol · K



40254658

CHEM 1120- 12.5 Prob.2

[Spell Card]

Diethyl ether is a volatile, highly flammable organic liquid that is used mainly as a solvent.

The vapor pressure of diethyl ether is 401 mmHg at 18°C. The heat of vaporization (ΔH_{vap}) is 26.0 kJ/mol. Calculate its vapor pressure at 32°C.

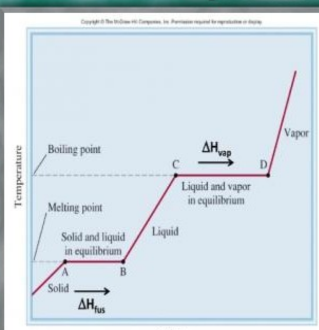
$C_2H_5OC_2H_5$

ln(P2/P1)= -Triangle Hvap/R (1/T2 - 1/T1)
Triangle Hvap= 26.0 kJ/mol * 1000 J/ 1 kJ =2.6E4 J/mol
T1= 291 K, T2= 305 K
ln(P2/401 mmHg) = -2.6E4 J/mol /8.314 J/k*mol (1/305 K - 1/291 K)
eln(P2/401 mmHg) = e(.494)
P2= e(.494)/401 mmHg

94064774

CHEM 1120- 12.6

[Spell Card]



Sublimation is Solid to Gas, reverse is deposition
Fusion is melting; it is endothermic
Does not need all solids to be melted for T to rise

74350981

CHEM 1120- 12.8

[Trap Card]

Water: an extraordinary substance

- A liquid at room temperature
  - Most molecules with similar molar masses are gases at room temperature
  - This is due to H-bonding (4 at a time)
- An excellent solvent
  - Dissolves many ionic and polar molecules
  - Has a large dipole moment
  - Even many small nonpolar molecules have some solubility in water, for example: O_2, CO_2
- Has a very high specific heat
  - Moderating effect on coastal climates (review 10.4)
- Expands when it freezes at a pressure of 1 atm
  - Ice is less dense than liquid water

46084885