Chemistry 103, Dr. Hamers
WORKSHEET #8 – INTERMOLECULAR FORCES
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CHAPTER 12
INTERMOLECULAR FORCES (IMF)

Criteria for each type of IMF:
- **H-bonding**: H bonded to a N, O, or F
- **Dipole**: polar molecule (molecules with O, S, N, and P - polar; hydrocarbons, C_xH_y - nonpolar)
- **Induced dipole/London Dispersion Forces/Instantaneous dipole**: All molecules; $\#e^- \uparrow \rightarrow$ LDFs↑; as the atom or molecule becomes more polarizable (e.g., a bigger atom), the LDF↑

TYPES OF IMFs
- Ion–Dipole: example, NaCl(s) dissolved in H_2O(l); *Criteria*: ionic compound + polar molecule
  ion-dipole forces > lattice energy → salt dissolves; if ion-dipole forces < lattice energy → salt insoluble
- H-bonding: e.g., CH_3OH(l) + H_2O(l); H_2O(l) + H_2O(l); *Criteria*: H bonded to N, O, or F
  In water, angle of **O····H–O** is 180°. The **O····H** represents the H-bonding IMF
- Dipole–Dipole: example, F–Cl with F–Br; *Criteria*: polar molecule(s)
- Dipole–Induced Dipole: example, HF with SF_6; *Criteria*: polar molecule + nonpolar molecule
- Induced Dipole–Induced Dipole: example, Ne and He; *Criteria*: both molecules are nonpolar; hydrocarbons (compounds containing only C and H) are considered nonpolar compounds

LIQUID PROPERTIES
Vapor Pressure: Pressure of a gas over a liquid at a specific T
Boiling Point (bp): when vapor pressure = atmospheric pressure
Normal bp: bp when atmospheric pressure = 1.0 atm
Adhesive forces (attractive = polar/polar, nonpolar/nonpolar; repulsion = polar/nonpolar)
Cohesive forces (IMFs favor a spherical surface)
Capillary Action: balance of Cohesive and Adhesive forces
Viscosity; Volatility; Surface Tension

IMFs↑ ⇒ Boiling Point↑; Melting Point↑; Surface Tension↑; Vapor Pressure↓; Viscosity↑; ΔH_{vap} ↑
Molar mass ↑ ⇒ Boiling Point ↑; Melting Point ↑; Vapor Pressure ↓; Viscosity ↑; ΔH_{vap} ↑

Clausius-Clapeyron: $\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$ where P_1 and P_2 are the vapor pressures in torr or atm at two temperatures (T_1 and T_2), T in K, ΔH_{vap} in J/mol, and R = 8.314 J/Kmol

ΔH_{fus} = Heat of Fusion: Energy for Solid → Liquid; **$Heat_{solid\ to\ liquid} = \Delta H_{fus}$ x mol**
ΔH_{vap} = Heat of Vaporization: Energy for Liquid → Gas; **$Heat_{liquid\ to\ gas} = \Delta H_{vap}$ x mol**
