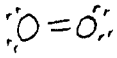
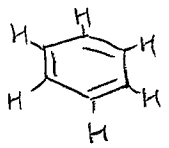
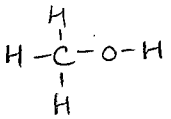
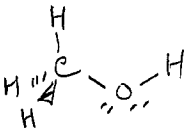
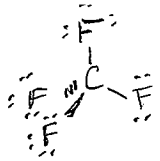
Review and Practice Exercises on IMFs and Solutions

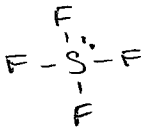
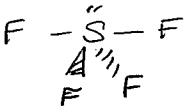
Practice Exercise: Consider the intermolecular forces present in the molecules below and place them in the relational (Venn) diagram, where the largest circle represents those molecules that participate in London dispersion forces (aka. induced dipole-induced dipole), the middle circle represents those that have dipole-dipole forces and the smallest circle represents those that participate in 'hydrogen bonding'.

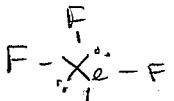
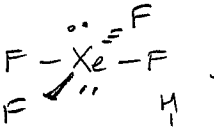
O_2  non-polar ∴ LDF's

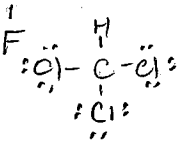
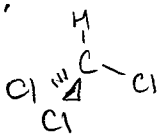
C_6H_6 (benzene)  non-polar ∴ LDF's

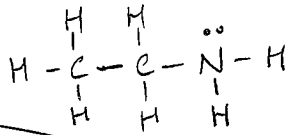
CH_3OH   polar ∴ dipole-dipole & H-bonding

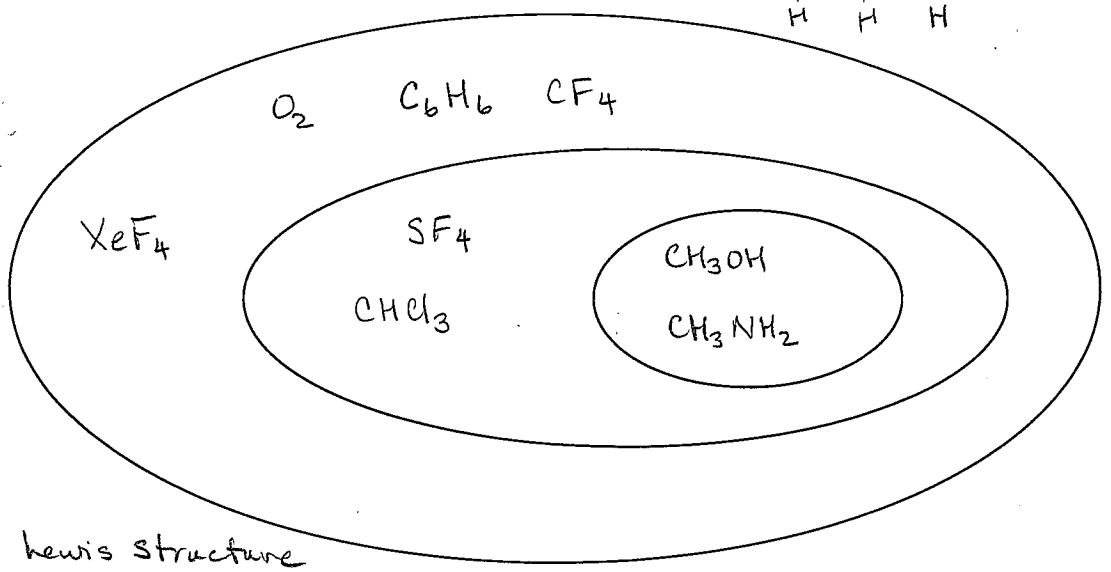
CF_4  non-polar ∴ LDF's

SF_4   polar ∴ dipole-dipole

XeF_4   non-polar ∴ LDF

$CHCl_3$   polar ∴ dipole-dipole

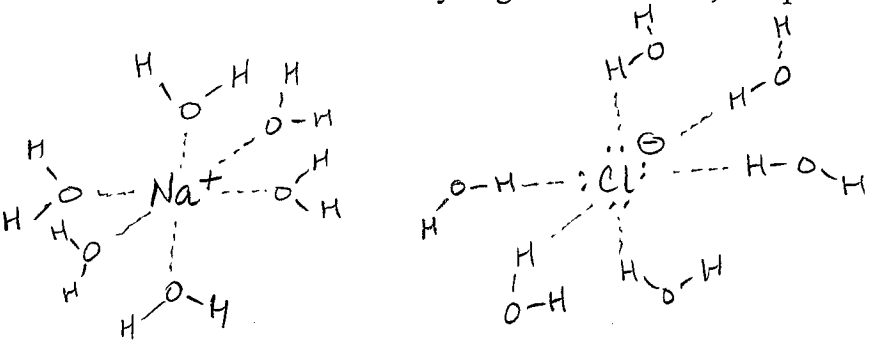
CH_3NH_2 



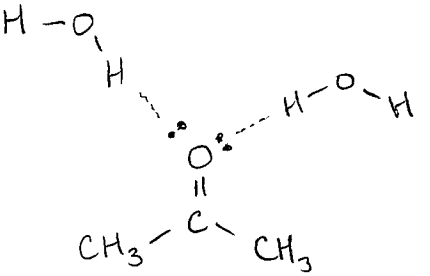
1. draw lewis structure
2. predict molecular geometry
3. determine molecule polarity (i.e., net dipole moment)
4. identify dominant inter-molecular force

Practice Exercise: Consider the intermolecular forces between solute and solvent and draw a molecular level picture indicating the dominant intermolecular force present. In cases where 'hydrogen-bonding' exists, indicate if the solute can act as a 'hydrogen-bond' donor, acceptor or both.

Sodium chloride in Water

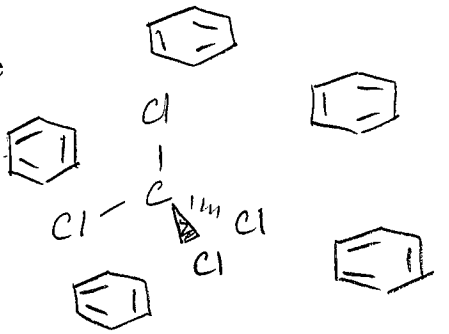


2-Propanone in Water



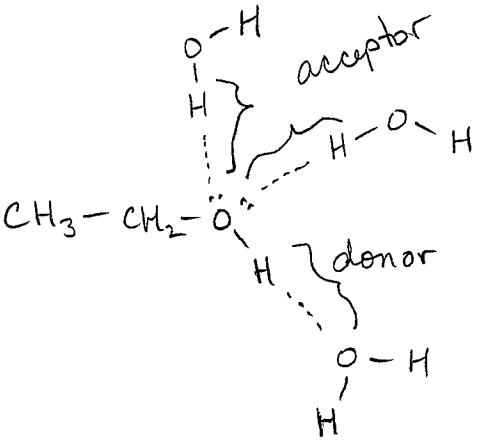
2-propanone acts as H-bond acceptor

Carbon tetrachloride in Benzene



non-specific LDF forces

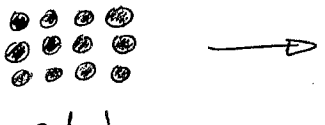
Ethanol in Water



ethanol can act as H-bond donor & acceptor

Practice Exercises on IMFs and Solutions

Practice Exercise: Describe the molecular level processes that need to take place in order for a pure solute to dissolve in a pure solvent in order to make a solution. Consider the energy requirements for each process and predict which will be endothermic or exothermic.

1. 

solute particle separation
endothermic
$\Delta H_1 > 0$

2. 

solvent particle separation
endothermic
$\Delta H_2 > 0$

3. 

solute - solvent interactions
exothermic
$\Delta H_3 < 0$

overall:
$\Delta H_{soln} = \Delta H_1 + \Delta H_2 + \Delta H_3$
may be exo or endo thermic

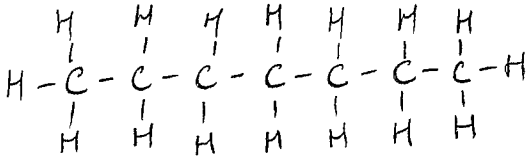
Practice Exercise: Use a molecular level description to explain the difference between *melting* and *dissolving*? Illustrate your answer using chemical reactions.

melting - phase change S → L
change in the arrangement of particles in a pure substance that results in more particle movement; always endothermic

dissolving - process of separating solute & solvent particles to form a solution; may be endo or exo thermic

Both are physical processes that do not result in chemical change & therefore reversible.

Practice Exercise: Predict whether each of the following substances is more likely to dissolve in the nonpolar solvent carbon tetrachloride (CCl_4) or in water: C_7H_{16}, Na_2SO_4, **HCl**, and I_2.

C_7H_{16}  non-polar molecule

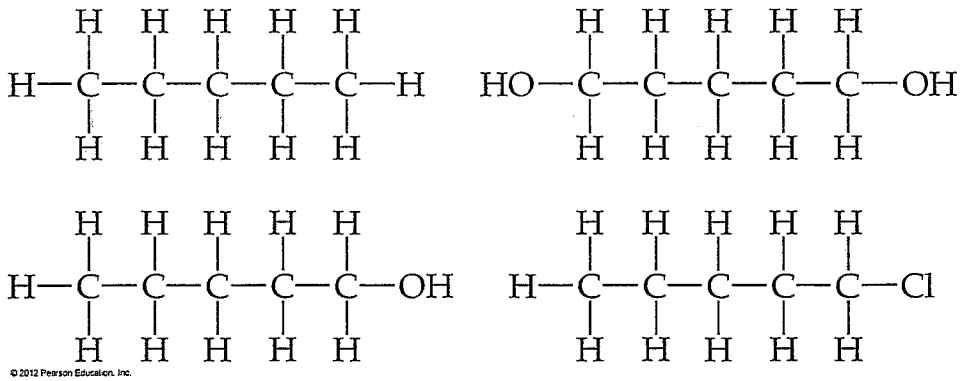
Na_2SO_4 $2\,Na^+ + SO_4^{2-}$ ionic

HCl $H^{\delta+}-Cl^{\delta-}$ ⟶ polar molecule ; ionizes in water to $H^+_{(aq)}$ & $Cl^-_{(aq)}$

I_2 I-I non-polar

∴ C_7H_{16} & I_2 more soluble in CCl_4
HCl & Na_2SO_4 more soluble in H_2O

Practice Exercise: Arrange the following substances in order of increasing solubility in water.



$C_5H_{12} \simeq C_5H_{11}Cl < C_5H_{12}O < C_5H_{12}O_2$