Chapter 11: Liquids and solids and IMFs
or, How molecular shapes and polarity help determine physical and chemical properties

Properties of solids, liquids and gases (11.2)
Examine table 11.1 and 11.2 to discern how solids, liquids and gases have differences in

1. ____________________________________
2. ____________________________________
3. ____________________________________
4. ____________________________________
5. ____________________________________
6. ____________________________________

Matching game: match the characteristic properties with the correct state of matter
1. assumes volume and shape of container: __________  
2. least compressible: __________  
3. has translational movement among particles: __________  
4. does not flow: __________  
5. diffusion in substance occurs slowly __________

<table>
<thead>
<tr>
<th>TABLE 11.1  Some Characteristic Properties of the States of Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas</strong></td>
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<tr>
<td><strong>Liquid</strong></td>
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<tr>
<td><strong>Solid</strong></td>
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</tbody>
</table>


Intermolecular forces (11.3)
Intermolecular forces are the forces that exist _______________________________ molecules

IMFs are not ______________ ionic or covalent bonds and are usually _______________________________

IMFs hold particles of liquids and solids ________________________________
The _____________________________ the attractions between the atoms or molecules, the _____________________________ it will take to separate them.

Boiling a liquid requires that energy is _____________________________ to separate particles, in order to ____________________________________________________________________.

Strong attractive forces lead to: 
________________________________________________________________________ and ______________________________________________________________________

Covalent bonds __________________________ during physical changes

Types of intermolecular forces:

Type ___________________________ between:

all atoms/molecules __________________________
any polar molecules __________________________
ions with polar molecules __________________________
N–H, O–H, and F–H __________________________
with N, O, F __________________________

Instantaneous Dipoles:

An ___________________________________ dipole on one helium _________________ induces an instantaneous dipole on neighboring atoms, causing new attractive forces.

Called London forces, or dispersion forces because electrons are _________________ by other electrons

Do bigger atoms/molecules have more dispersion forces than smaller atoms/molecules?

Rank in terms of higher boiling points: He, Ne, Ar, Xe
Bigger atoms have _______________ electron clouds, and _______________ Dispersion forces.

Bigger particles have _______________ dispersion forces and _______________ boiling points.

Does shape play a role in boiling points? Which has the higher boiling point?

Dipole-Dipole forces

Dipole-Dipole forces are ___________________________ dispersion forces.

The positive end of a ___________________________ is attracted to the ___________________________ of its neighbor.

Rank in terms of boiling points:
- Dimethyl ether  CH₃OCH₃
- Acetonitrile  CH₃CN
- Propane  CH₃CH₂CH₃

Think Lewis Structures and polarity.

Hydrogen bonding

- Hydrogen must be bonded to ___________________________
- Hydrogen must form attraction to a ___________________________

The partially ___________________________ is strongly attracted to the ___________________________.

H must be bound to an ___________________________

Why? ___________________________

H of X–H only bonds to :O–H, :N–H, or :F–H

Why? ___________________________
Rank the two molecules for boiling points:

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Molar Mass (amu)</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>C₂H₅O</td>
<td>46.07</td>
<td>CH₃CH₂OH</td>
</tr>
<tr>
<td>Dimethyl Ether</td>
<td>C₂H₆O</td>
<td>46.07</td>
<td>CH₃OCH₃</td>
</tr>
</tbody>
</table>

Rank in terms of boiling points:
1. CH₃CH₂CH₂CH₃ (butane)  
2. CH₃CHCH₂OH (2-methyl propanol)  
3. CH₃CH₂CH₂CH₂OH (butanol)  

Solubility

- Like ______________________ like
- Polar solvents dissolve other____________________
- To dissolve, a solvent must overcome the ______________________ of the solute.
- This is simplified (ignores ______________________), but a good place to start
- Non-polar solvents dissolve other ______________________ substances
- Treat –CH₂–, –CH₃ groups as ______________________
- Multiple –CH₂– groups in a chain are ______________________

Heat energy values:

- C₅ steam = 1.84 J/g-K
- C₅ water = 4.18 J/g-K
- C₅ ice = 2.09 J/g-K

ΔHₜₜₜ = 6.01 kJ/mol
ΔHₐₜₐₜ = 40.67 kJ/mol.