

Honors Chemistry Unit 13 Compounds
Intermolecular Forces Worksheet

Name: _____

<i>Types of Solids*</i>	<i>Intermolecular Force(s) Between Particles</i>
1. Metallic solids (Metals) <u>Examples:</u> Na, Cu, Fe, Mn , etc...	** <i>Metallic bonding:</i> Valence electrons form mobile sea of electrons which comprise the metallic bond.
2. Ionic Crystals (Ionic Solids) <u>Examples:</u> NaCl, MgCl ₂ , MgO, etc...	** <i>Ionic Bonding:</i> Attraction of charged ions for one another. Lattice energy is a measure of ionic bond strength.
3. Covalent Crystals (Network Solids) <u>Examples (very rare):</u> C(diamond), SiC(s), SiO ₂ (quartz/glass/sand)	** <i>Network covalent bonding:</i> Network solids are extremely hard compounds with very high melting and boiling points due to their endless 3-dimensional network of covalent bonds.
4. Molecular solids <u>Examples:</u> (a) Need H bonded to O, N or F: H ₂ O, HF, NH ₃ . (b) CHF ₃ , CH ₃ COCH ₃ (acetone) and H ₂ O, HF, NH ₃ . (c) C ₆ H ₆ (benzene), polymers (polyethylene, etc.), molecular elements (H ₂ , N ₂ , O ₂ , etc...), and all the compounds from (a and b) above. Types (b) and (c) together are called Van der Waals forces.	One or more of the following: (a) <i>Hydrogen bonding:</i> Hydrogen bonds are weaker than covalent bonds, but stronger than (b) or (c) below. (b) <i>Dipole-dipole forces:</i> these forces act between <i>polar</i> molecules. They are much weaker than hydrogen bonding. (c) <i>Dispersion forces</i> (induced dipole – induced dipole or London dispersion forces): universal force of attraction between instantaneous dipoles. These forces are weak for small, low molecular weight molecules, but large for heavy, long, and/or highly <i>polarizable</i> molecules. They can dominate over (b) above for these large molecules.
5. Atomic solids <u>Examples:</u> He, Ne, Ar, Kr, Xe	<i>Dispersion forces:</i> See Section 4(c) above.

*Note: Many of the compounds given as examples are *not* solids at room temperature. But if you cool them down to a low enough temperature, eventually they will become solids.

** No distinction between intramolecular bonding and intermolecular forces.

Physical properties depend on these forces. The *stronger* the forces between the particles,

- the *higher* the *melting point*.
- the *higher* the *boiling point*.
- the *lower* the *vapor pressure* (partial pressure of vapor in equilibrium with liquid or solid in a closed container at a fixed temperature).
- the *higher* the *viscosity*
- the *higher* the *surface tension*

1. List **all** types of IMFs that would occur in each of the following

- | | |
|------------------------------------|--------------------|
| a. CH ₃ CF ₃ | c. SO ₂ |
| b. CCl ₄ | d. BrF |

2. List the **dominant (strongest)** type of IMF for the pure substances, then rank the strength of each compound based on IMFs within the samples.

(1 = strongest, 2 = in between, 3 = weakest)

Substance	IMF	Relative Strength
HBr		
O ₂		
CH ₃ OH		

3. Circle all of the species below that can form a hydrogen bond in its pure form. Explain why the other species couldn't hydrogen bond.



4. Rank the following compounds from weakest intermolecular forces to strongest. Justify your answers.



5. Which of the following will have the highest melting point

- a. naphthalene C₈H₁₀ c. quartz SiO₂
b. methane CH₄ d. ethanol C₂H₅OH

6. Circle **all** the compounds which would be expected to form intermolecular hydrogen bonds in the liquid state:

- (a) CH₃OCH₃ (b) CH₄ (c) HF (d) CH₃CO₂H (e) Br₂ (f) CH₃OH

7. What type of solid will each of the following substances form in its solid state? Choices to consider are *metallic, ionic, covalent, or molecular solids*.

- a. C₂H₆ d. CO₂ g. Al
b. Na₂O e. N₂O₅ h. C(diamond)
c. SiO₂ f. NaNO₃ i. SO₂

8. For the table below, specify the *dominant intermolecular force* involved for each substance in the space immediately following the substance. *Then in the last column, indicate which member of the pair you would expect to have the higher boiling point.*

	Substance #1	Dominant Intermolecular Force	Substance #2	Dominant Intermolecular Force	Substance with Higher Boiling Point
a.	HCl(g)		I ₂		
b.	CH ₃ F		CH ₃ OH		
c.	H ₂ O		H ₂ S		
d.	SiO ₂		SO ₂		
e.	Fe		Kr		
f.	CH ₃ OH		CuO		
g.	NH ₃		CH ₄		
h.	HCl(g)		NaCl		
i.	SiC		Cu		