

**Why does a molecule form?**

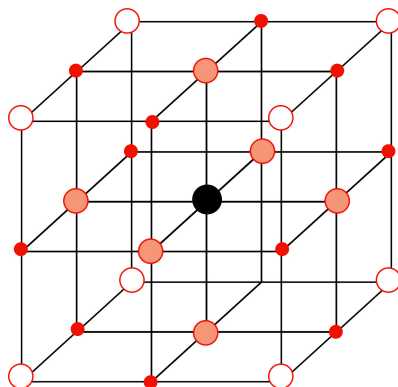
## Electronegativity

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| 2.1 |     |     |     |     |     |     |     |     |     |     |     | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |    |
| H   |     |     |     |     |     |     |     |     |     |     |     | B   | C   | N   | O   | F   |    |
| 1.0 | 1.5 |     |     |     |     |     |     |     |     |     |     | 1.5 | 1.8 | 2.1 | 2.5 | 3.0 |    |
| Li  | Be  |     |     |     |     |     |     |     |     |     |     | Al  | Si  | P   | S   | Cl  |    |
| 0.9 | 1.2 |     |     |     |     |     |     |     |     |     |     | 1.6 | 1.8 | 2.0 | 2.4 | 2.8 |    |
| Na  | Mg  | 1.3 | 1.5 | 1.6 | 1.6 | 1.5 | 1.8 | 1.8 | 1.8 | 1.9 | 1.6 | 1.6 | 1.8 | 2.0 | 2.4 | 2.8 |    |
| 0.8 | 1.0 | Ca  | Sc  | Ti  | V   | Cr  | Mn  | Fe  | Co  | Ni  | Cu  | Zn  | Ga  | Ge  | As  | Se  | Br |
| 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 | 2.2 | 2.2 | 2.2 | 1.9 | 1.7 | 1.7 | 1.8 | 1.9 | 2.1 | 2.5 |    |
| Rb  | Sr  | Y   | Zr  | Nb  | Mo  | Tc  | Ru  | Rh  | Pd  | Ag  | Cd  | In  | Sn  | Sb  | Te  | I   |    |
| 0.7 | 0.9 |     | 1.3 | 1.5 | 1.7 | 1.9 | 2.2 | 2.2 | 2.2 | 2.4 | 1.9 | 1.8 | 1.8 | 1.9 | 2.0 | 2.2 |    |
| Cs  | Ba  |     | Hf  | Ta  | W   | Re  | Os  | Ir  | Pt  | Au  | Hg  | Tl  | Pb  | Bi  | Po  | At  |    |
| 0.7 | 0.9 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |
| Fr  | Ra  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |

## Ionic Bonds

What are the properties of an Ionic Bond and Ionic Compounds?

Are Ionic compounds molecules?



What does covalent really mean?

Can two atoms really “share” electrons equally?

Polar Covalent Bonds

Coordinate Covalent Bonds

How do we determine what type of bond forms between two atoms?

$F_2$

$H_2O$

KCl

Wannabe Crystal Structures

**Valence Electrons****Electron Dot Diagrams**

Li      Be      B      C      N      O      F      Ne

**Lewis Dot Diagrams***Just the basics*H<sub>2</sub>                      Cl<sub>2</sub>                      H<sub>2</sub>S                      CH<sub>4</sub>NCl<sub>3</sub>                      PCl<sub>3</sub>                      NH<sub>3</sub>                      C<sub>2</sub>H<sub>6</sub>**More Complex Lewis Dot Structures***Double Bonds/ Triple Bonds*

How can you tell when a double or triple bond forms?

O<sub>2</sub>                      N<sub>2</sub>                      C<sub>2</sub>H<sub>4</sub>                      C<sub>2</sub>H<sub>2</sub>

## The Halogens!

*More than 8 Electrons*

Which elements can see more than 8 electrons? Why?

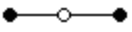
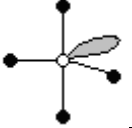
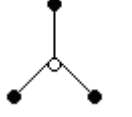
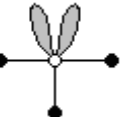
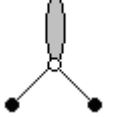
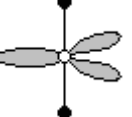
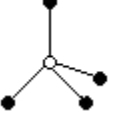

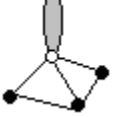

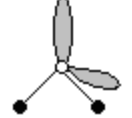
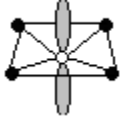
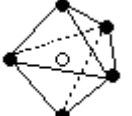

*Less than 8 Electrons**Ions*

Which elements can see less than 8 electrons?



**Molecular Geometry**

How do we arrange atoms around a central atom?

| Type                               | Picture   | Shape                  | Example                          | Type                           | Picture   | Shape                           | Example          |
|------------------------------------|---|------------------------|----------------------------------|--------------------------------|---|---------------------------------|------------------|
| A <sub>2</sub> and AB <sub>2</sub> |    | Linear                 | H <sub>2</sub> / CO <sub>2</sub> | AB <sub>4</sub> E              |    | Irregular tetrahedral (sea saw) | SF <sub>4</sub>  |
| AB <sub>3</sub>                    |    | Triangular             | BCl <sub>3</sub>                 | AB <sub>3</sub> E <sub>2</sub> |    | T-shaped                        | ClF <sub>3</sub> |
| AB <sub>2</sub> E                  |    | Angular or Bent        | PbI <sub>2</sub>                 | AB <sub>2</sub> E <sub>3</sub> |    | Linear                          | XeF <sub>2</sub> |
| AB <sub>4</sub>                    |    | Tetrahedral            | CH <sub>4</sub>                  | AB <sub>6</sub>                |    | Octahedral                      | SF <sub>6</sub>  |
| AB <sub>3</sub> E                  |   | Triangular pyramidal   | NH <sub>3</sub>                  | AB <sub>5</sub> E              |   | Square pyramidal                | ClF <sub>5</sub> |
| AB <sub>2</sub> E <sub>2</sub>     |  | Angular or Bent        | H <sub>2</sub> O                 | AB <sub>4</sub> E <sub>2</sub> |  | Square planar                   | XeF <sub>4</sub> |
| AB <sub>5</sub>                    |  | Triangular bipyramidal | PCl <sub>5</sub>                 | AB <sub>7</sub>                |  | Pentagonal bipyramidal          | IF <sub>7</sub>  |

## **Dipole Moments**

Dipole

Polar Covalent Bond

Molecule with a dipole moment

Consider the following four molecules:

$\text{H}_2$

$\text{HCl}$

$\text{BCl}_3$

$\text{NH}_3$

**Intermolecular Forces**

The Inverted Milk Bottle

Intramolecular Forces

Intermolecular Forces

London Dispersion Forces

Dipole–Dipole

Hydrogen Bonding



What determines a substance boiling or melting points?

Would James Bond drink a Martini if the ice cubes were not floating?

Why does DNA hold together?

van der Waals Forces

How does a tree drink?

Explain why ammonia is a gas at room temperature and water is a liquid.

Which has a higher boiling point Helium or Xenon?

Why do we sometimes say “Inter-particle Forces”

What really determines a substance boiling or melting point?

What intermolecular forces are present in the following species:

| <b>Species</b>        | <b>London Forces present?</b> | <b>Dipole Forces present?</b> | <b>Hydrogen Bonding present?</b> |
|-----------------------|-------------------------------|-------------------------------|----------------------------------|
| <b>He</b>             |                               |                               |                                  |
| <b>NaCl</b>           |                               |                               |                                  |
| <b>KCl</b>            |                               |                               |                                  |
| <b>NH<sub>3</sub></b> |                               |                               |                                  |
| <b>H<sub>2</sub>O</b> |                               |                               |                                  |
| <b>CH<sub>4</sub></b> |                               |                               |                                  |
| <b>H<sub>2</sub></b>  |                               |                               |                                  |
| <b>HF</b>             |                               |                               |                                  |