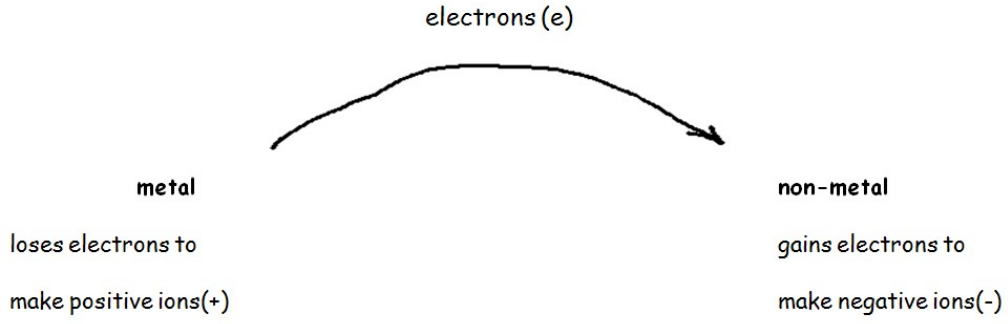
Chemical Bonding

- elements combine with other elements during chemical reactions to form compounds
- the elements are "bonded" together in compounds
- two types of compounds (bonds):
  1. ionic
  2. covalent

Ionic Bonding

- involves ions
- form when a metal and a non-metal make an ionic compound
- involves the transfer of e's from the metal to the non-metal



e.g. Show the three steps involved when the following elements react to form a compound:

1. Na and Cl

step 1) Draw Lewis diagrams

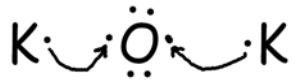
step 2)

step 3) Net Ionic Equation

$Na^+ + Cl^- \rightarrow NaCl$

Metals want to lose e's and non-metals want all their e's paired.

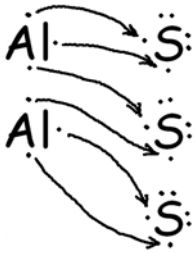
2. K and O



Net ionic equation:

$2K^+ + O^{2-} \rightarrow K_2O$

3. Al and S



Net ionic equation:

$2Al^{3+} + 3S^{2-} \rightarrow Al_2S_3$

4. Mg and O

Net ionic equation:

Mg2+ + O2- → MgO

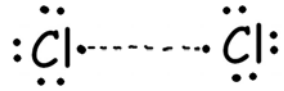
Covalent Bonding

- two non-metals bond to make a molecular compound
- involves sharing of e's
- pair all single e's in the Lewis diagrams

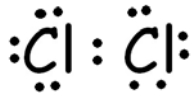
e.g. Show how the following molecules are formed

1. Cl_2

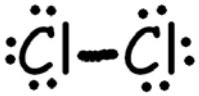
step 1: Lewis diagram



step 2: Lewis structure



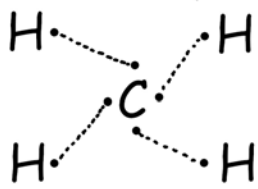
step 3: structural diagram



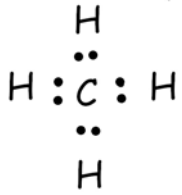
In a structural diagram, each shared pair of e's is translated into a line.

2. CH_4

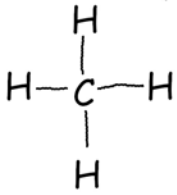
Lewis diagram



Lewis structure

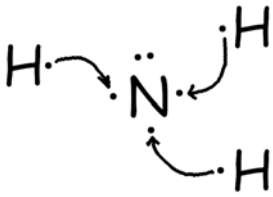


structural diagram

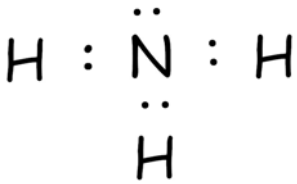


3. NH_3

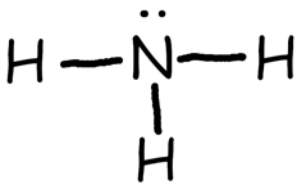
Lewis diagram



Lewis structure



structural diagram

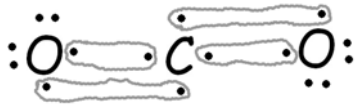


Multiple Covalent Bonding

e.g. CO_2

Lewis diagram

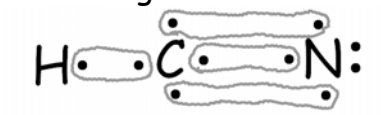
Lewis structure



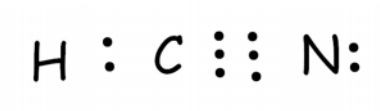
structural diagram

e.g. HCN

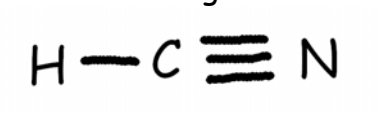
Lewis diagram



Lewis structure



structural diagram



Summary

- 1 shared pair of e's = 1 line = single covalent bond
- 2 shared pair of e's = 2 lines = double covalent bond
- 3 shared pair of e's = 3 lines = triple covalent bond

Bonding Capacity

Group #	# of covalent bonds	example:
14	4	C
15	3	N,P
16	2	O,S
17 and H	1	H,Cl

Electronegativity (EN)

- the ability of an atom to attract the shared e's in a covalent bond
- in general, atoms with a high EA also have a high EN
- fluorine has the highest EN, 3.98

Polar Covalent Bonding

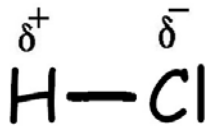
- a special type of covalent bond in which the e's are unequally shared
- occurs when the difference in EN (ΔEN) is greater than 0.7 for the atoms making the covalent bond
- the e's in the covalent bond will be pulled closer to the atom with the larger EN

e.g. Show that H-Cl is a polar covalent bond

EN H = 2.20
EN Cl = 3.16
} $\Delta EN = 3.16 - 2.20 = 0.96$

$0.96 > 0.7 \quad \therefore$ polar covalent

δ means partial or a little bit



Cl pulls the e's in the bond towards it

Bonding Continuum

covalent	polar covalent	ionic
$0 < \Delta EN < 0.7$	$0.7 < \Delta EN < 1.7$	$\Delta EN > 1.7$

Properties of Ionic and Covalent Compounds

ionic compounds - solid at room temperature
- high boiling and melting point
- many are highly soluble in water
- poor conductors in the solid state; however, conduct in the dissolved or liquid state

* An electric current can flow only if the charged particles are available to move and carry the charge

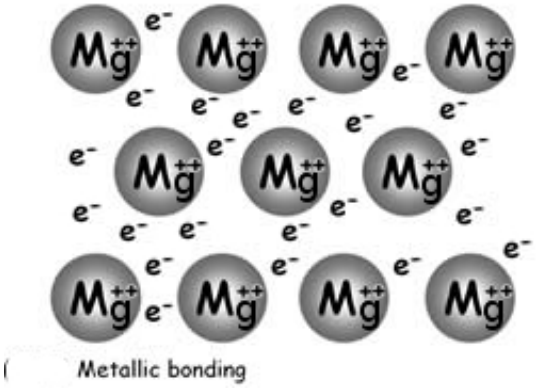
covalent compounds - variety of properties
ie. some dissolve in water, some do not
some conduct in dissolved or liquid state, some do not

* If only consider covalent compounds that contain atoms with a ΔEN less than 0.5, all are gases at room temperature, and do not conduct electricity in the solid, liquid, or gas state.

* Covalent compounds do not form ions in the liquid or dissolved state therefore they cannot carry a current.

Metallic Bonding

- metals bond to themselves or other metals
- not ionic or covalent, metals release their e's to a shared pool of e's
- e's are free to move therefore metals they are not held in a rigid lattice formation. Metals can be easily hammered into sheets or drawn into wires
- force holding metal atoms together is called a metallic bond



Metallic bonding

- alloy ~ homogeneous mixture of two or more metals
  - eg. bronze - copper, tin, lead
  - steel - iron, carbon