Introduction to Physical Science

Lewis Symbols

Presented by Robert Wagner

Lewis Symbols

- Used to describe the valence electron configuration
  - Elemental Symbol
  - Dot for each electron
- Calcium ·Ca·
  - Does not show the inner electrons

Atoms	Electronic Configuration	Lewis Symbol
sodium	$[Ne]3s^1$	Na·
magnesium	$[Ne]3s^2$	·Mg·
aluminum	$[Ne]3s^23p^1$	·Al·
silicon	$[Ne]3s^23p^2$	·Si·
phosphorus	$[Ne]3s^23p^3$	·P·
sulfur	$[Ne]3s^23p^4$	:S·
chlorine	$[Ne]3s^23p^5$	:Cl·
argon	$[Ne]3s^23p^6$	:Ar:

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Formation of Ionic Compounds

- Can use Lewis Symbols to show electron transfer for ionic bonds
- Can use Lewis Symbols to show covalent bonds as well
  - Single bond - single pair of shared electrons

Metal		Nonmetal		Ionic Compound
Na·	+	:Cl·	→	$Na^+[:Cl:]^-$
sodium atom		chlorine atom		sodium chloride (sodium ion and chloride ion)
·Mg·	+	:O·	→	$Mg^{2+}[:O:]^{2-}$
magnesium atom		oxygen atom		magnesium oxide (magnesium ion and oxide ion)
·Ca·	+	2 :F·	→	$Ca^{2+}[:F:]^-_2$
calcium atom		fluorine atoms		calcium fluoride (calcium ion and two fluoride ions)

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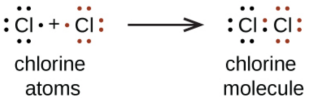

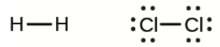

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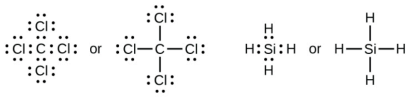
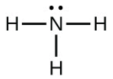
The Octet Rule

- It is the tendency of main group atoms to form enough bonds to get eight electrons in the valence shell
- Exceptions
  - Hydrogen - needs only two electrons to fill its valence shell
  - Transition & Inner Transition elements do not follow octet rule

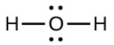


carbon tetrachloride

silane



ammonia

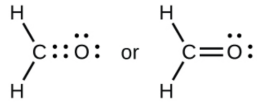


Water

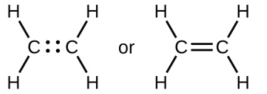
hydrogen fluoride

Double and Triple Bonds

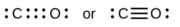
- Sometimes an atom needs to share more than one pair of electrons
- Double bond
  - Two pairs of electrons are shared
- Triple bond
  - Three pairs of electrons are shared



formaldehyde



ethylene

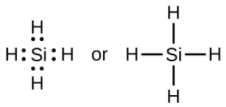


carbon monoxide

cyanide ion

Writing Lewis Structures

- For simple molecules and ions
  - Pair up the unpaired electrons
- Example:
  - Si has 4 valence electrons
  - Each hydrogen has one valence electron (4 total)

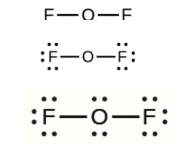


silane

Writing Lewis Structures

- For more complicated molecules
  - Determine the total number of valence electrons
  - Draw the structure, arranging electrons around a central atom (connect with a single bond)
  - Distribute remaining electrons on terminal atoms (not H) to complete octets
  - Place remaining electrons on central atom
  - Rearrange to make multiple bonds when possible

OF_2 has 20 valence electrons (O = 6, F = 7x2 = 14)

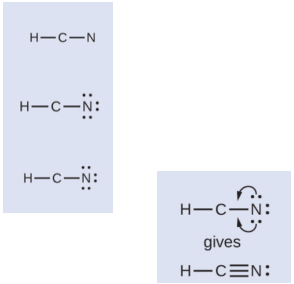


All 20 electrons have been used so no multiple bonds needed

Example

- What is the Lewis structure for HCN?
  - Calculate number of valence electrons
  - Draw skeleton - connect w/single bonds
  - Distribute electrons to terminal atoms
  - Place remaining electrons on central atom
  - Rearrange electrons to form multiple bonds

Valence electrons: (1x1) + (4x1) + (5x1) = 10



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Summary

- Lewis Symbols are used to describe the valence electron structure of an atom or ion
- Atoms generally follow the octet rule and want to have eight electrons in their valence shell
- Hydrogen is an exception as it has only one valence electron and the transition and inner transition elements do not follow the octet rule