

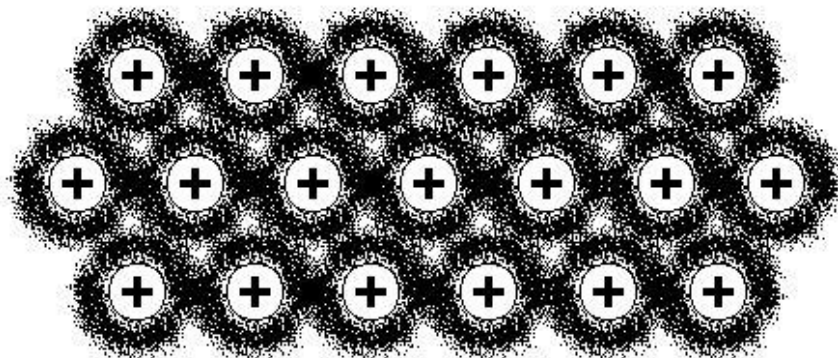
Unit Five: Chapter 6 ~ Chemical Bonding

Metallic Bonds

- Metallic bonds are different from other types of bonds because _____
_____.
- Occur between _____ atoms (all the _____ or _____ metals).
- The _____ energy levels of most metal atoms are occupied by
_____.
- Vacant orbitals (_____) _____ which allows the _____
electrons of the atom to _____ throughout the entire metal.
- Valence electrons in metallic bonds are _____ meaning they do not
_____ but move _____ about the
metal's network of _____ atomic orbitals.

- _____ can be defined as the chemical bonding that results from _____.
- Metallic bonds _____ result in chemical compounds.
- Properties of Metallic Bonds:
 - _____
 - _____ a wide range of light frequencies and are therefore _____
 - _____ the ability of a substance to be hammered into _____
 - _____: the ability of a substance to be drawn out to _____

Metallic Sea of Electrons



<http://www.sciencenews.org/~chem101/sciencenews/electrons.jf>

Electrons are not bonded to any particular atom and are free to move about in the solid.

Ions

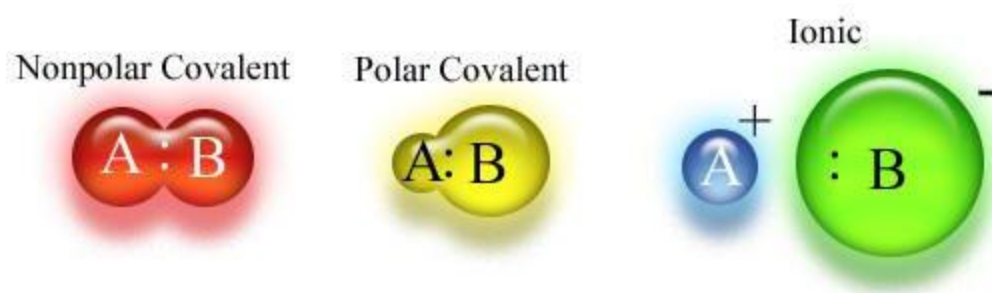
- Particles with a _____ (_____)
- _____ – one atom with a charge
 - Examples: _____
- _____ – two or more atoms with a charge
 - Examples: _____

Chemical Bond

- A _____ is a mutual electrical _____ between the _____ of different atoms that _____ the atoms together.
- Energy force between atoms in their valence area as a result of _____.
- Nature favors arrangements with _____ potential energy.
 - Atoms are _____ by themselves and have _____ then when they are _____.
- Results in a _____

Types of Chemical Bonds

- _____ Bonds
- _____ Bonds
 - _____ bonds
 - _____ bonds



<http://schools.birdville.k12.tx.us/cms/lib2/TX01000797/Centricity/Domain/912/ChemLessons/Lessons/Bonding/image015.jpg>

- To determine bond type use:
 - 1. _____
 - _____
 - 2. _____
 - _____ electronegativity values of the _____
in the bond
 - 3. _____
 - _____

Electronegativity Values of the Elements

1	1																	18	
	1																	2	
1	H																	He	1
	2.1																	-	
2	3	4																10	2
	Li	Be																Ne	
	1.0	1.5																-	
3	11	12																18	3
	Na	Mg																Ar	
	0.9	1.2																-	
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	4
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
	0.8	1.0	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	3.0	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	5
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
	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	1.800	1.9	2.10	2.5	2.6	
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	6
	Cs	Ba	La ★	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
	0.7	0.9	1.1	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	2.4	
7	87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	7
	Fr	Ra	Ac ▲	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og	
	0.7	0.9	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

6	★	58	59	60	61	62	63	64	65	66	67	68	69	70	71	6
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
		1.1	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.2	1.2	1.2	1.3	1.1	1.3	
7	▲	90	91	92	93	94	95	96	97	98	99	100	101	102	103	7
		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	
		1.3	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	-	

Ionic Bond

- An _____ is a chemical bond that results from the _____ between large numbers of _____.
- Forms by the _____ of valence electrons from a _____ to a _____.
 - Metals _____ electrons → _____
 - Nonmetals _____ electrons → _____
- Ionic bonds have an _____ of _____.

- _____ bond type
 - “The bigger the difference the stronger the bond.”

- Produces _____

- Most exist as _____ solids

- _____ network of positive and negative _____ mutually _____ to one another.



Covalent Bond

- A _____ results from the _____ of electron _____ between _____ atoms.
- Covalent bonds can be _____ or _____.

Polar Covalent Bond

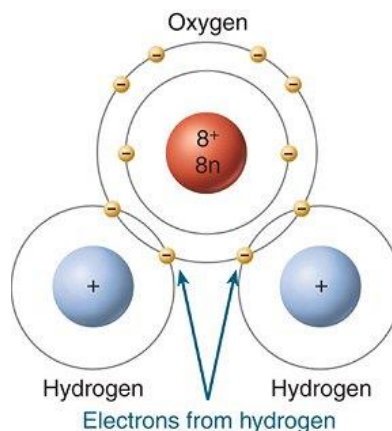
- A _____ is a covalent bond in which the bonded atoms have an _____ for the _____ valence electrons in _____ orbitals between _____.
- Causes _____ on polar molecules.

- Polar covalent bonds have an

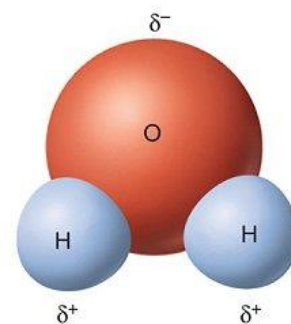
of _____.

- _____ bond type

- Produces _____



(a) Electron shells in a water molecule



(b) Distribution of partial charges in a water molecule

<http://eweb.furman.edu/~wworthen/bio111/2water.jpg>

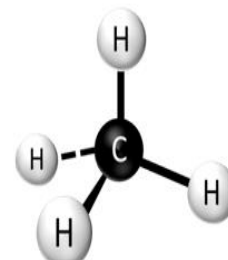
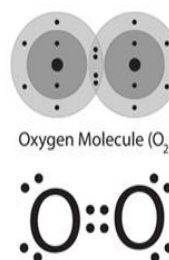
Nonpolar Covalent Bond

- A _____ is a covalent bond in which the bonded atoms have an _____ attraction for the _____ valence electrons in _____ orbitals between _____.

- This results in _____

_____ distribution of

charge.



- _____ charges anywhere on the molecule.

- Nonpolar covalent bonds have an _____

of _____.

- _____ bond type
- Produces _____

Compound Vocabulary

- _____
 - A _____ group of _____ that are held together by _____.
 - _____ particle of a _____ compound.
- _____
 - The _____ collection of atoms from which an _____ compound's formula can be established.
 - _____ particle of an _____ compound.
- _____
 - _____ for chemical _____ using chemical _____ for _____ and _____ for number of _____.

- _____
- _____ atoms of the _____ with
a _____ covalent bond.

Diatomic Molecules

- | | |
|---------|---------|
| • _____ | • _____ |
| • _____ | • _____ |
| • _____ | • _____ |
| • _____ | |

Why Do Chemical Bonds Form?

- Octet rule...
 - An atom has _____ of electrons (____ e⁻) in its _____ shell
 - Occurs by elements _____ electrons
 - Results in an atom having a _____ configuration
 - Results in _____ and _____
for an atom with a _____ valence shell

Octet Exceptions

- _____ - _____ e⁻ maximum
- _____ - _____ e⁻ maximum
- _____ octet - incorporates _____ orbitals in addition to just _____
 - Certain atoms when bonded to _____ can hold more than _____ e⁻ in their valence shell

Lewis Electron Dot Diagrams

- Show _____ between atoms using _____
for _____ (nucleus and inner-electrons) and _____ for _____
_____.
- Begin with the _____ and their corresponding _____...
 - ... end with a _____ showing what happened to the valence electrons in the _____.

Lewis Electron Dot Diagrams

- **IONIC BONDS:**

- 1. Draw _____ for each element in compound (both _____ and _____).
- 2. Draw an _____.
- 3. Draw _____ by placing _____ in _____ showing transfer of valence electrons and corresponding _____ on the ion.

- Ex. 1:

- Ex. 2:

- Ex. 3:

- Ex. 4:

- Ex. 5:

- Ex. 6:

- Ex. 7:

- Ex. 8:

- Ex. 9:

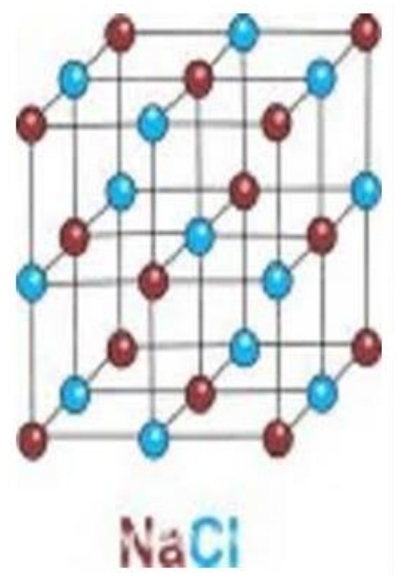
- Ex. 10:

- Ex. 11:

- Ex. 12:

Lattice Structure (Crystal Lattice)

- _____ crystal
- _____ arrangement of ions in an _____, repeating _____ pattern that _____ energy
 - Varies with the _____ and _____ of the ions and the numbers of ions of different charges.
- _____
 - Amount of energy _____ ionic bonds and crystal structure
 - Must be _____ in order to _____ bonds
 - Measured in _____



Lewis Electron Dot Diagrams:

- **COVALENT BONDS:**
 - 1. Draw _____ for each element in the compound and _____ the electrons (dots).

- 2. Draw an _____.
- 3. Draw _____ by placing elements together putting _____
_____ them.

- Helpful hints ☺

- Put _____ atoms in the _____
- _____ goes in the _____
- Each atom _____ have 8 electrons around it
 - Except _____
 - But do _____ just add electrons!!!
- Always start with _____ bonds, then _____, then _____
 - _____ and the _____ usually can only have
_____ bonds

- **Bonds in Lewis Structures**

- Single bonds → X X
- Double bonds → X X
- Triple bonds → X X

- Ex. 1:

- Ex. 2:

- Ex. 3:

- Ex. 4:

- Ex. 5:

- Ex. 6:

- Ex. 7:

- Ex. 8:

- Ex. 9:

- Ex. 10:

- Ex. 11:

- Ex. 12:

Lewis Electron Dot Diagrams:

- **POLYATOMIC IONS:**

- Same as covalent bonds, except:

- Positive charge = _____

- Negative charge = _____

- Ex. 1:

- Ex. 2:

- Ex. 3:

- Ex. 4:

- Ex. 5:

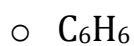
- Ex. 6:

Resonance Structures

- _____ possible structure can be drawn to represent the
_____ compound.
 - Actual structure is a _____ of the two, so that it
_____ bond length

- Reduced bond length results in a _____ bond

- Examples:



More about bonds...

- _____

- The _____ distance between atoms in a _____ bond.

- _____ bonds are _____

- _____
 - The _____ number of degrees between two _____ from the _____.
- _____
 - The energy required to _____ a chemical bond and form _____ isolated atoms
 - Usually measured in _____

Ways to represent a chemical compound...

- 1. _____
- 2. _____
- 3. _____
 - Shows _____ for _____
 (polar & nonpolar) compounds using _____ and _____ for _____ electrons
 - _____ bond (____ pair of shared electrons): X X

- _____ bond (____ pairs of shared electrons): X X
- _____ bond (____ pairs of shared electrons): X X

Why study bonding?

- The _____ reason for studying bonding is to determine a molecule's _____...
 - ...which in turn determines whether a _____ will be
_____...
 - ...which in turn determines a molecules _____
_____...
 - ...which in turn describes its _____!

Molecular Geometry

- Predicting molecular geometry is based on the simplest assumption _____
_____.
- The _____ of bonding _____ stay as
_____ from each other as possible.

- The element with the _____ value will hold the bonding electrons _____ to its _____.
- _____ arrangement of atoms in a _____ (_____) bond
- Determines _____:
 - _____: when there is _____ in the molecule that _____ any high electronegativity difference
 - _____: when there are _____ (on the _____ atom) that create a _____ end with a _____ electronegativity difference; _____

VSEPR Theory

- “_____”
 - Refers to the _____ between _____ of _____ valence electrons in the _____.

- VSEPR theory states that the _____ between the valence level electron _____ surrounding an atom causes these pairs to be _____.
- Includes _____ pairs **AND** _____ electron pairs around the _____ atom in a _____.
- Results in _____.

VSEPR Structure	General Format	# atoms (around central atom)	# lone e- pairs (around central atom)

- _____ = central atom; _____ = bonded atoms; _____ = lone pairs of electrons

- Ex. **AB₂** Model – (_____)

- Ex. **AB** Model – (_____)

- Ex. **AB₃** Model – (_____)

- Ex. **AB₄** Model – (_____)

- Ex. **AB₅** Model – (_____)

- Ex. **AB₆** Model – (_____)

- Ex. **AB₂E** Model – (_____)

- Ex. **AB₂E₂** Model – (_____)

- Ex. **AB₃E** Model – (_____)

Hybridization

- Mixing of _____ orbitals of _____ energy from _____ sublevels to form _____ with _____ energy.
- Hybrid orbitals include:
 - _____ -- made from _____ s and _____ p orbitals
 - _____ -- made from _____ s and _____ p orbitals
 - _____ -- made from _____ s and _____ p orbital

Intermolecular Forces

- _____ (energy force) between molecules (covalent compounds)
- _____ determines the type of intermolecular force
- _____ physical properties such as melting and boiling
- Types:
 - _____ (also called _____ force)
 - _____
 - _____

London Dispersion Force (van der Waal's force)

- Intermolecular force due to _____ creating instantaneous _____ charged poles
- Only intermolecular force for _____ covalent compounds
- _____ type of intermolecular force
 - Results in very _____ melting and boiling point
- Compounds are usually _____ at room temperature

Dipole-dipole

- Intermolecular force between polar compounds due to _____
_____ of molecules lining up
 - _____ – created by _____ and _____
charge separated by a short distance
- Causes _____ melting and boiling points which are both physical properties

Hydrogen Bonding

- Type of _____
- Intermolecular force between _____ with H and _____
_____ element (O/N/F)
- _____ type of intermolecular force
- Results in _____ melting and boiling points (reason water is liquid at room temperature)

Ionic Compound Properties

- Hard _____ crystal structures
- _____ melting and boiling points
- _____ in water
- _____ electricity if liquid or when dissolved in water
 - (both release _____ to pass charge)
- Tend _____ to dissolve in alcohols

Polar Covalent Compound Properties

- Can be _____
- _____ melting and boiling points
- _____ in water
- _____ will conduct electricity when dissolved in water (but not all)
- Tend to _____ in alcohols

Nonpolar Covalent Compound Properties

- Usually _____ or _____
- _____ melting and boiling points
- Do _____ dissolve in water
- _____ conduct electricity
- _____ in alcohols

Exam Date: _____

- **Chemical Bonding (Chapter 6)**
 - ✓ Metallic bonding
 - ✓ Ions (monatomic / polyatomic)
 - ✓ Chemical bonds: ionic bonds / polar covalent bonds / nonpolar covalent bonds (what elements are in them / how they form / electronegativity difference)
 - ✓ Molecule / formula unit / chemical formula / diatomic molecules
 - ✓ Octet Rule / Lattice structure
 - ✓ Electron Dot Diagrams: ionic bonds / covalent bonds / polyatomic ions
 - ✓ Resonance / Hybridization
 - ✓ Bond Length / Bond Angle / Bond Energy
 - ✓ VSEPR (structures / effect on polarity)
 - ✓ Intermolecular forces (London dispersion / dipole-dipole / hydrogen bonding)
 - ✓ Compound properties: ionic / polar covalent / nonpolar covalent