UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TECHNICAL CHEMISTRY - BMMV 1013

Chemical Bonding

Chapter 5

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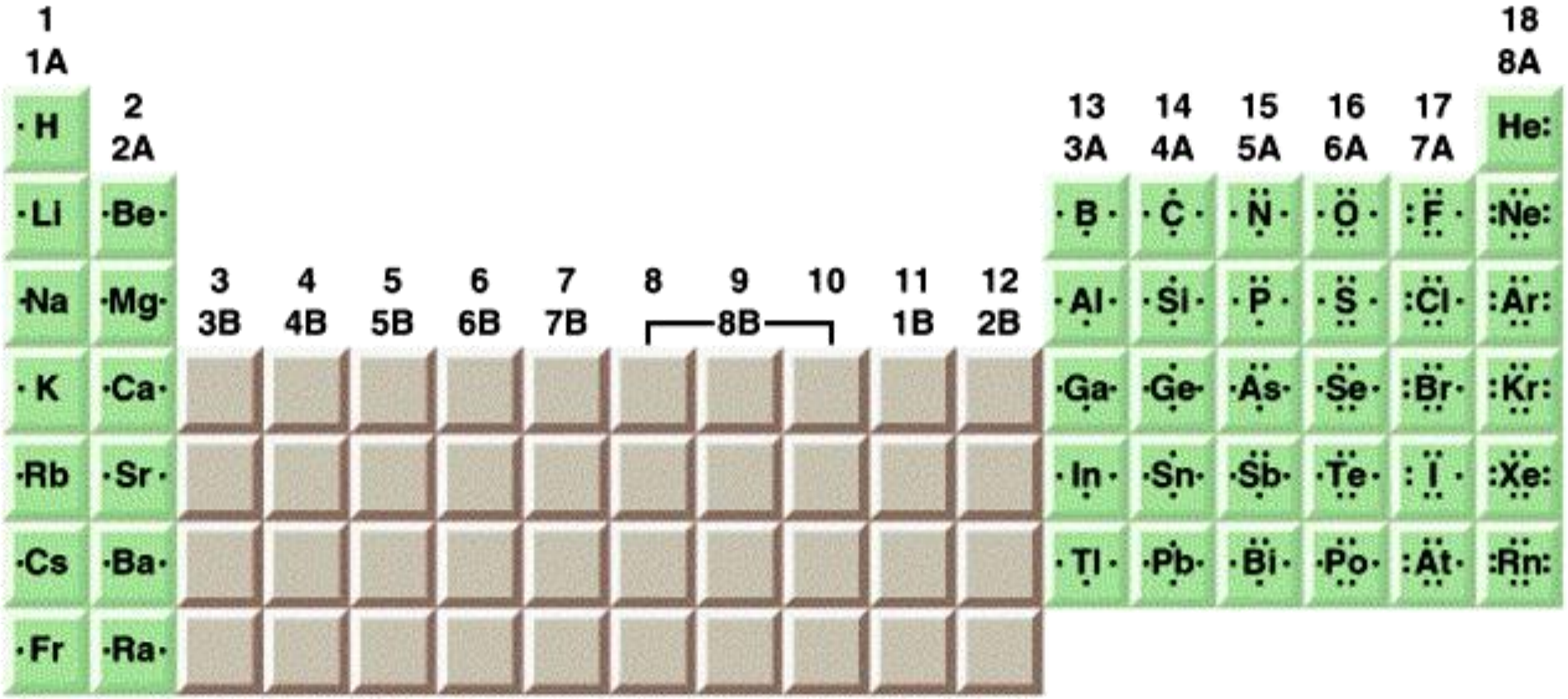
Valence electrons are the outer shell electrons of an atom. The valence electrons are the electrons that participate in chemical bonding.

Group	e^- configuration	# of valence e^-
1A	ns^1	1
2A	ns^2	2
3A	ns^2np^1	3
4A	ns^2np^2	4
5A	ns^2np^3	5
6A	ns^2np^4	6
7A	ns^2np^5	7

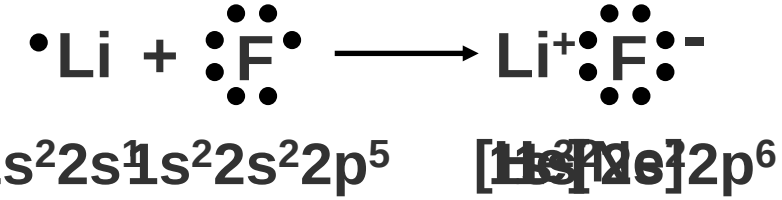
Lewis Dot Symbols

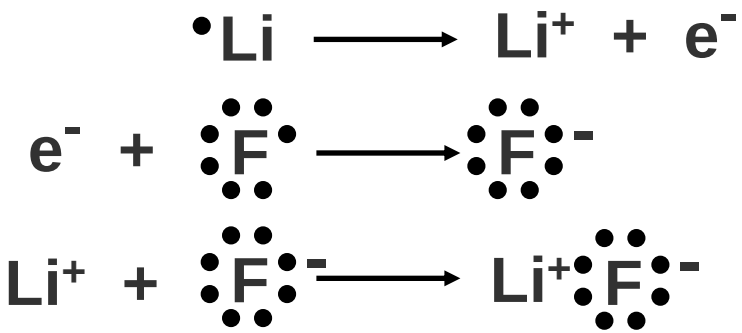


The Ionic Bond (Electrovalence)

An *Ionic bond* is the electrostatic force that holds ions together in an ionic compound

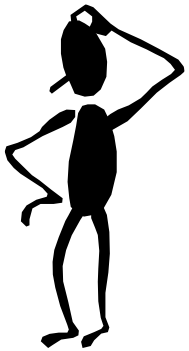
Ionic compound combine a Group IA & Group IIA metal with a halogen or oxygen



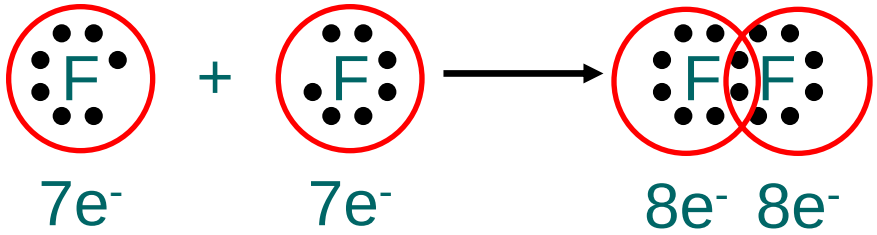


The Covalent Bond

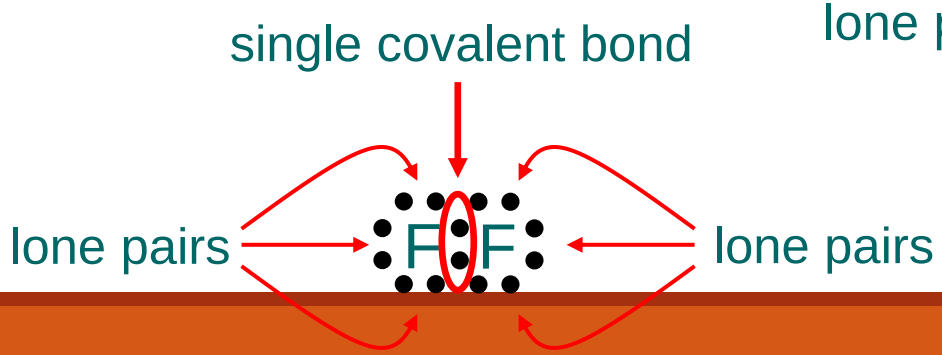
A ***covalent bond*** is a chemical bond in which two or more electrons are shared by two atoms. (Non metal & non metal)

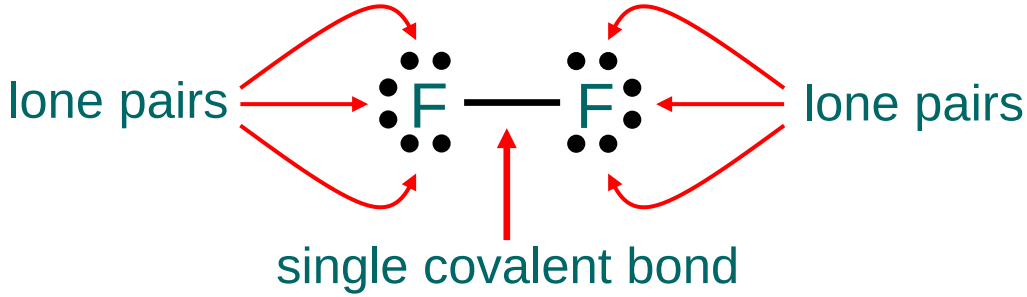


Why should two atoms share electrons?

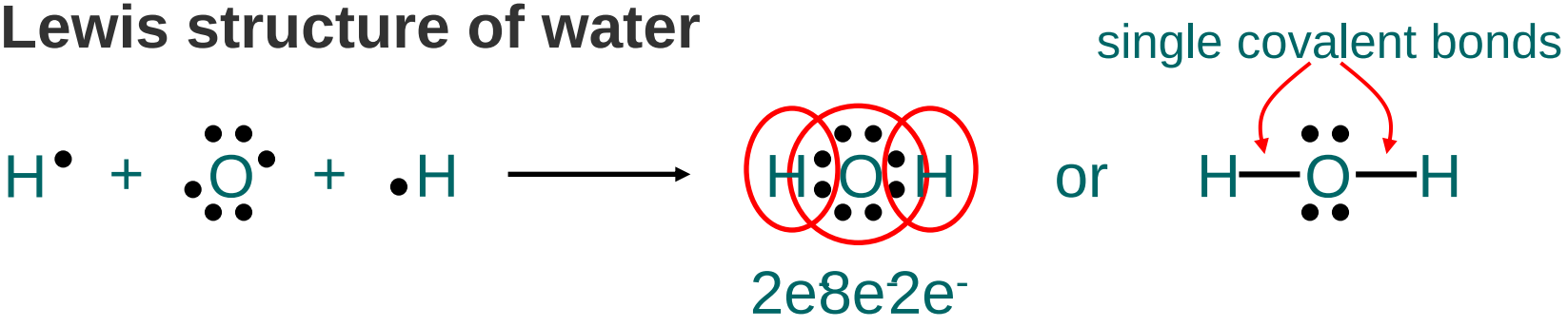


Lewis structure of F_2

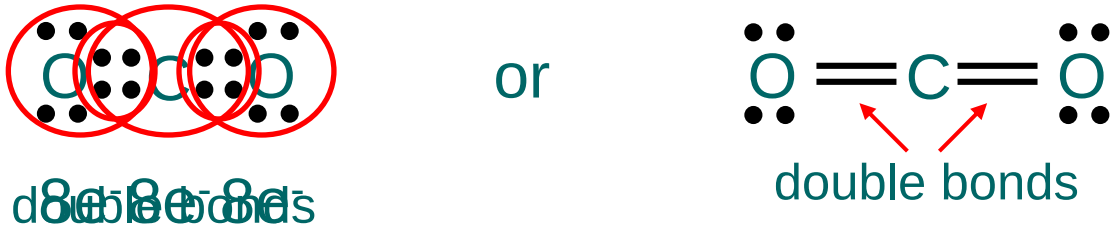




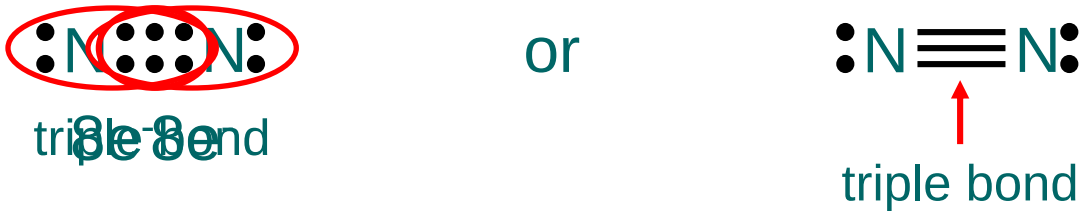
Lewis structure of water



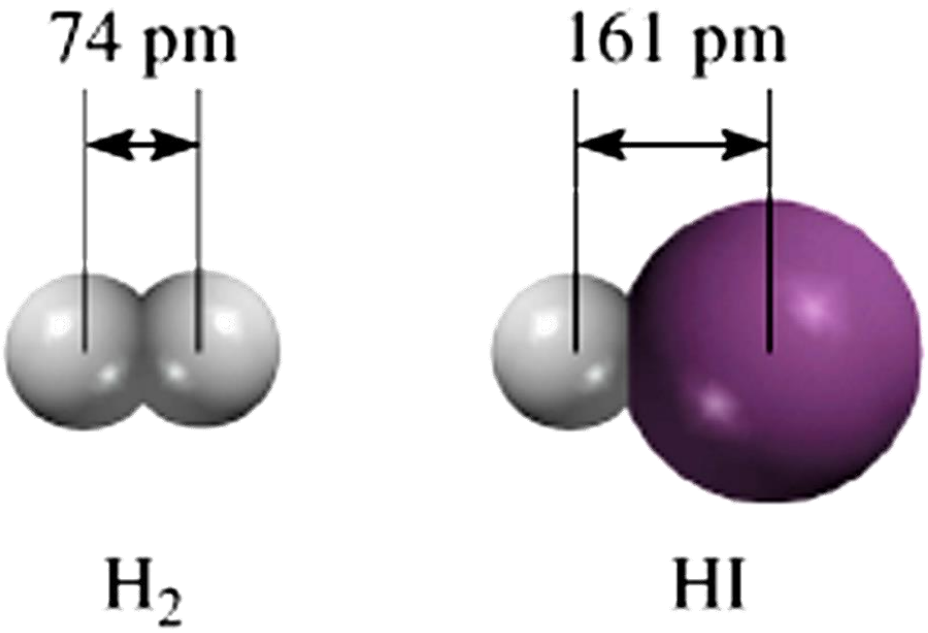
Double bond – two atoms share two pairs of electrons



Triple bond – two atoms share three pairs of electrons



Lengths of Covalent Bonds



Bond Type	Bond Length (pm)
C-C	154
C=C	133
C≡C	120
C-N	143
C=N	138
C≡N	116

Bond Lengths

Triple bond < Double Bond < Single Bond

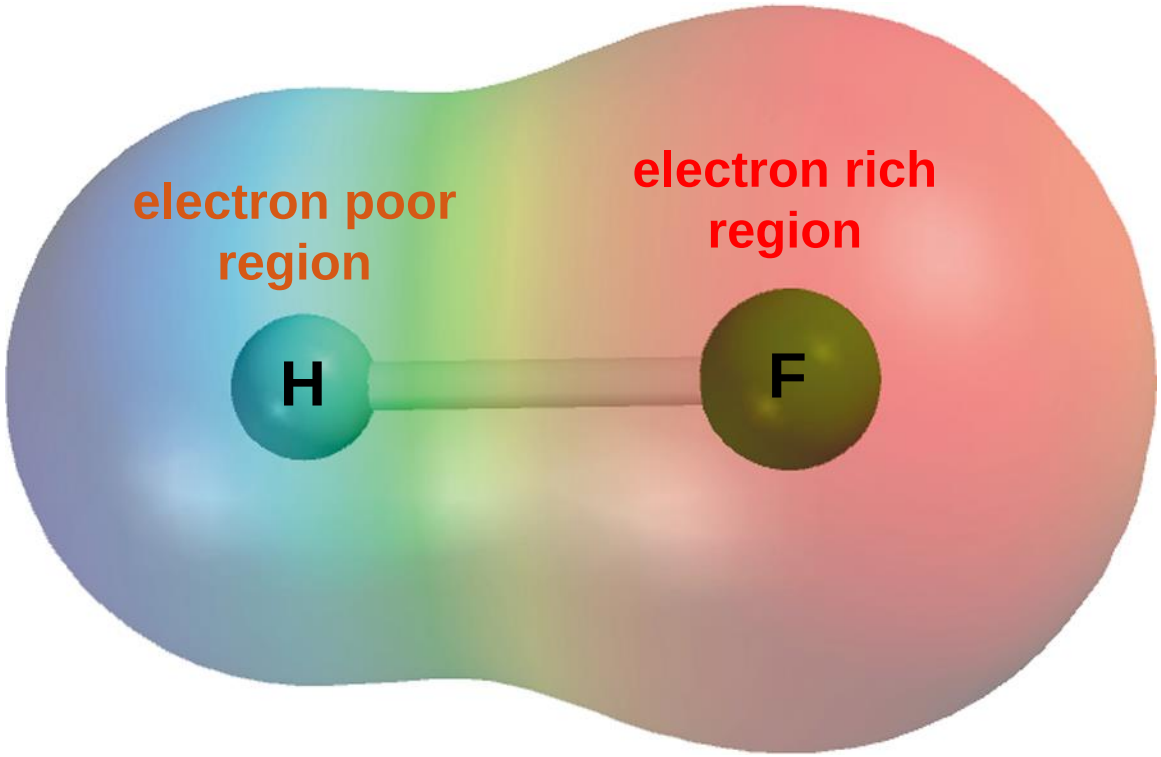
Comparison of Ionic and Covalent Compounds

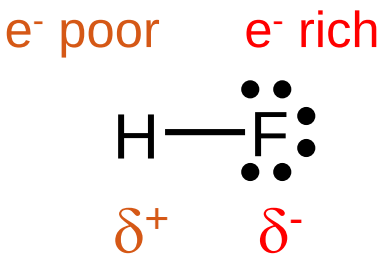
Table 9.3 Comparison of Some General Properties of an Ionic Compound and a Covalent Compound

Property	NaCl	CCl_4
Appearance	White solid	Colorless liquid
Melting point (°C)	801	−23
Molar heat of fusion* (kJ/mol)	30.2	2.5
Boiling point (°C)	1413	76.5
Molar heat of vaporization* (kJ/mol)	600	30
Density (g/cm^3)	2.17	1.59
Solubility in water	High	Very low
Electrical conductivity		
Solid	Poor	Poor
Liquid	Good	Poor

** Molar heat of fusion and molar heat of vaporization are the amounts of heat needed to melt 1 mole of the solid and to vaporize 1 mole of the liquid, respectively.*

Polar covalent bond or ***polar bond*** is a covalent bond with greater electron density around one of the two atoms

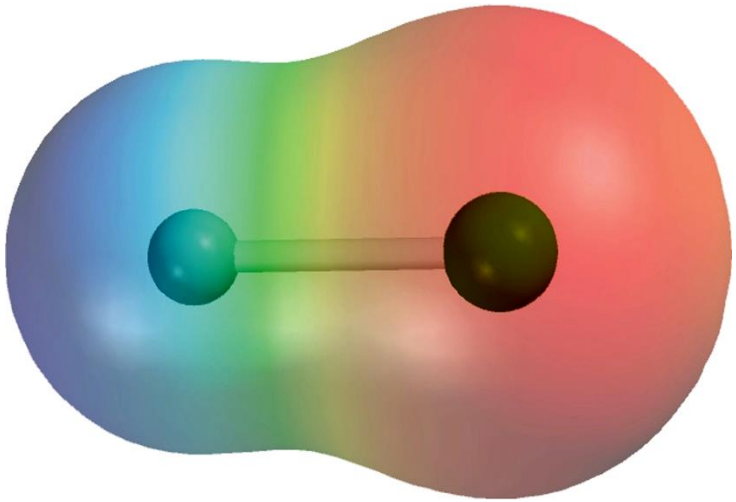




Electronegativity is the ability of an atom to attract toward itself the electrons in a chemical bond.

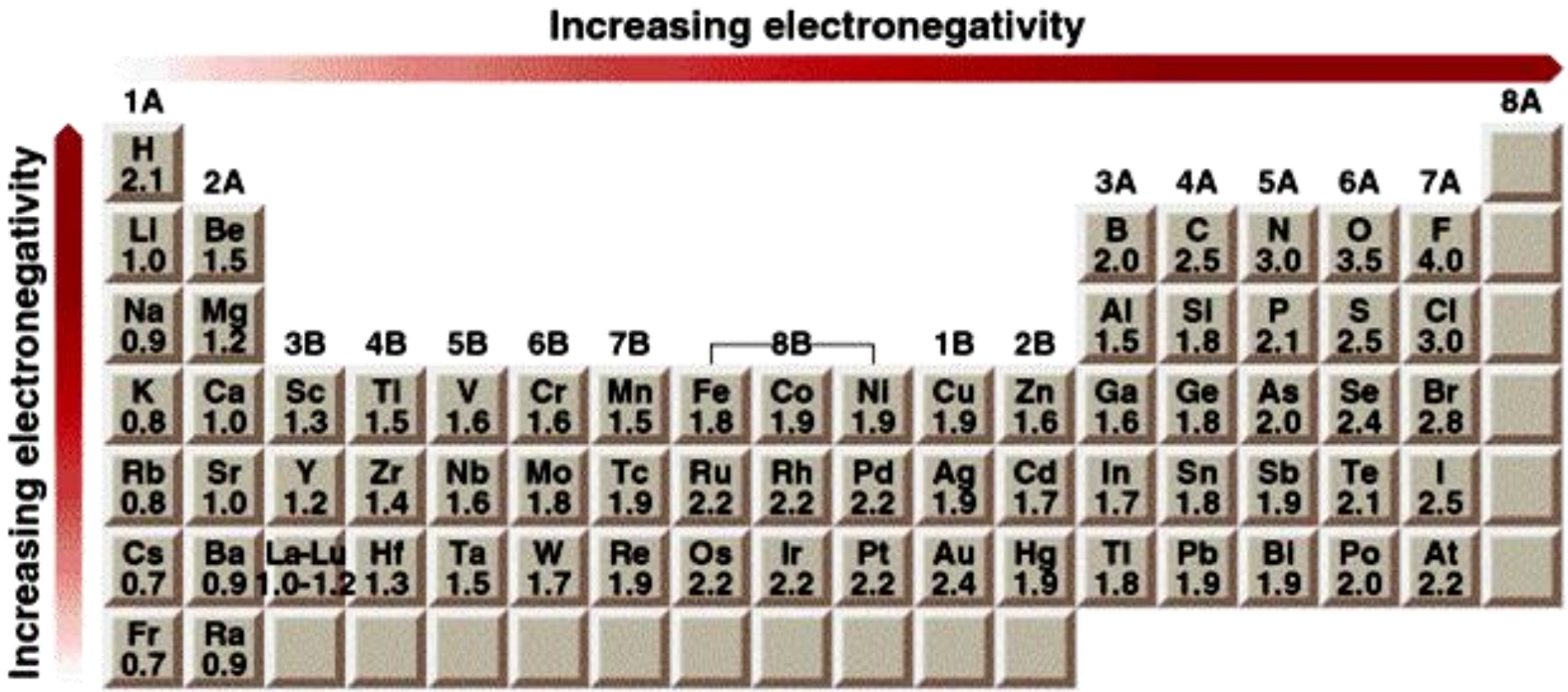
Electron Affinity - measurable, Cl is highest

Electronegativity - relative, F is highest



Both are related but different concepts. EA refers to an isolated atom and E refers to an atom in chemical bond. Usually, EA > then E >.

Electronegativities of Common Elements



Classification of bonds by difference in electronegativity

Difference	Bond Type
0	Covalent
≥ 2	Ionic
0 < and <2	Polar Covalent

Increasing difference in electronegativity →

Covalent → **Polar Covalent** → **Ionic**

share e^- | partial transfer of e^- | transfer e^-

Classify the following bonds as ionic, polar covalent, or covalent: The bond in CsCl; the bond in H_2S; and the NN bond in H_2NNH_2.

Intermolecular Forces

Intermolecular forces are attractive forces **between** molecules.

Intramolecular forces hold atoms together in a molecule.

Intermolecular vs Intramolecular

- 41 kJ to vaporize 1 mole of water (**inter**)
- 930 kJ to break all O-H bonds in 1 mole of water (**intra**)

Generally, **inter**molecular forces are much weaker than **intra**molecular forces.

"Measure" of intermolecular force

boiling point

melting point

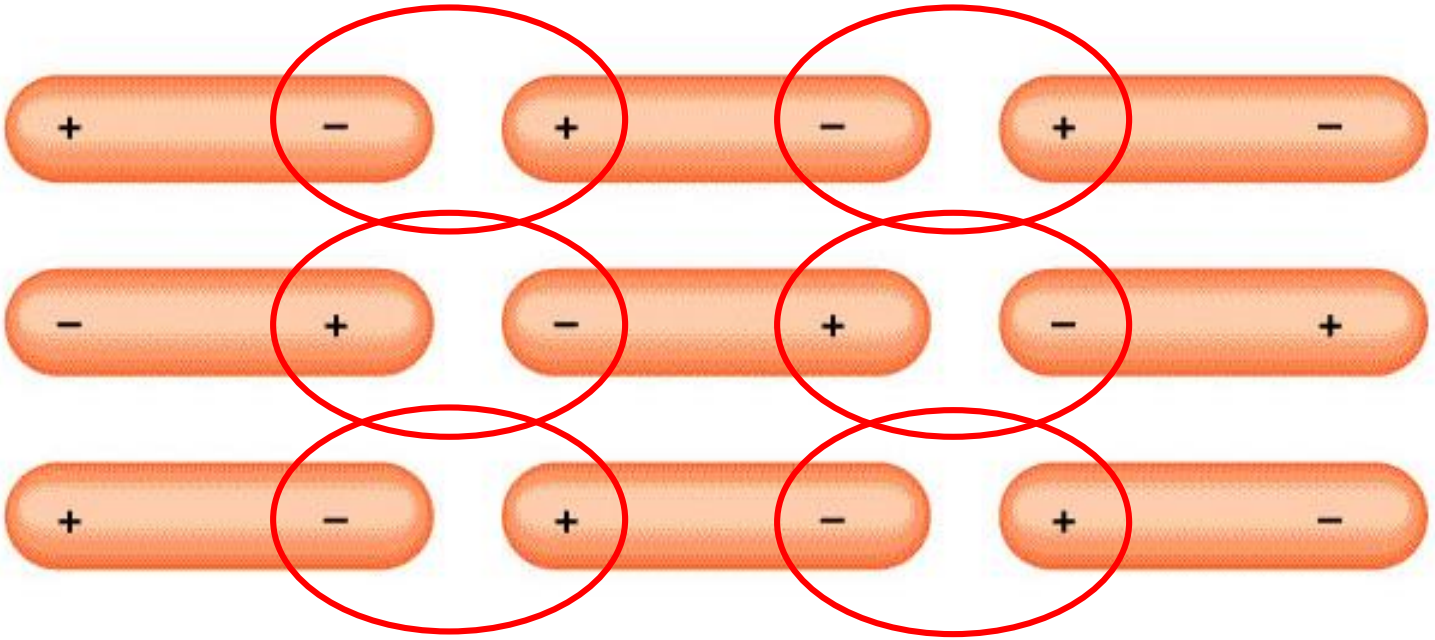
ΔH_{vap}

Intermolecular Forces

Dipole-Dipole Forces

Attractive forces between **polar molecules**

Orientation of Polar Molecules in a Solid

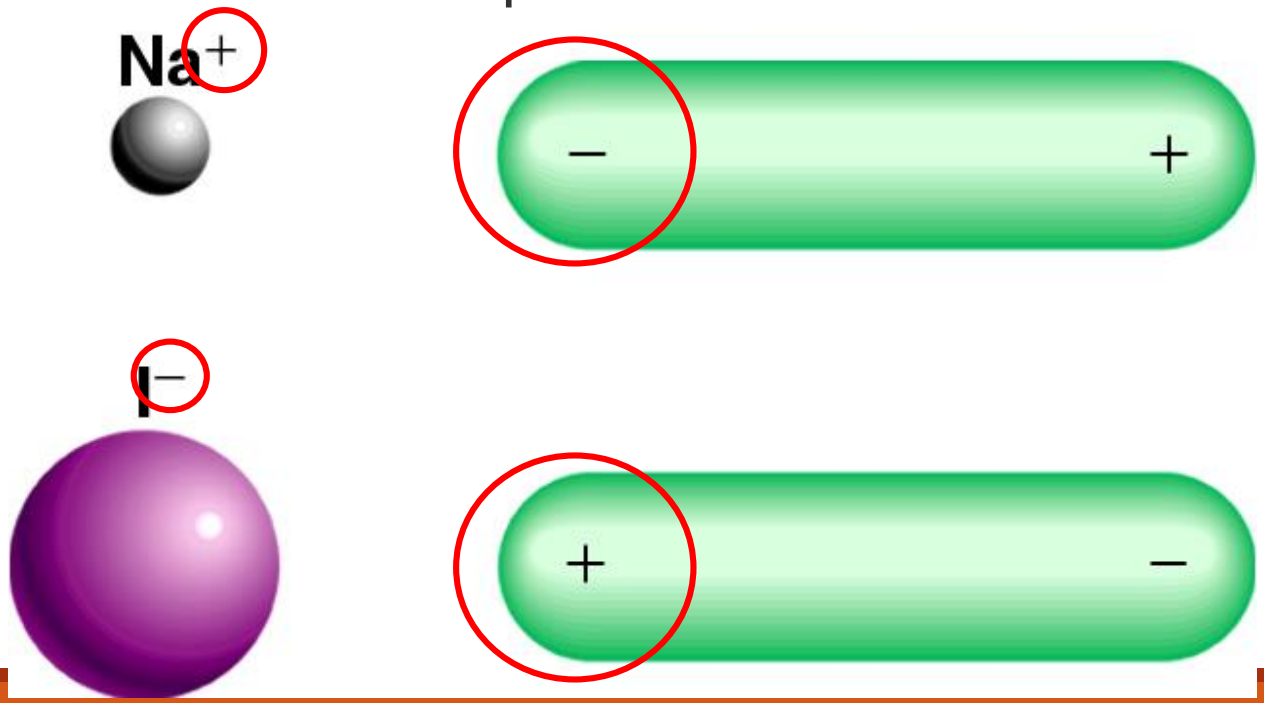


Intermolecular Forces

Ion-Dipole Forces

Attractive forces between an **ion** and a **polar molecule**

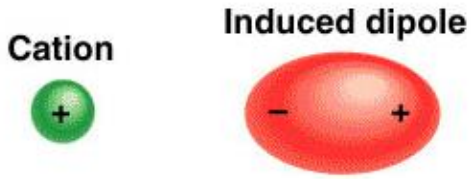
Ion-Dipole Interaction



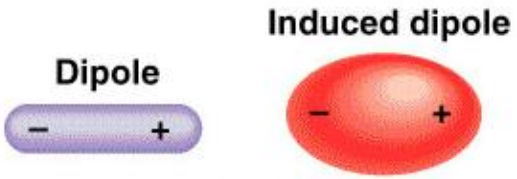
Intermolecular Forces

Dispersion Forces (London)

Attractive forces that arise as a result of **temporary dipoles induced** in atoms or molecules



ion-induced dipole interaction



dipole-induced dipole interaction

Dispersion Forces Continued

Polarizability is the ease with which the electron distribution in the atom or molecule can be distorted.

Polarizability increases with:

- greater number of electrons
- more diffuse electron cloud

Dispersion forces usually increase with molar mass.

Table 11.2 Melting Points of Similar Nonpolar Compounds

Compound	Melting Point (°C)
CH_4	−182.5
CF_4	−150.0
CCl_4	− 23.0
CBr_4	90.0
CI_4	171.0

What type(s) of intermolecular forces exist between each of the following molecules?

HBr

CH_4

SO_2

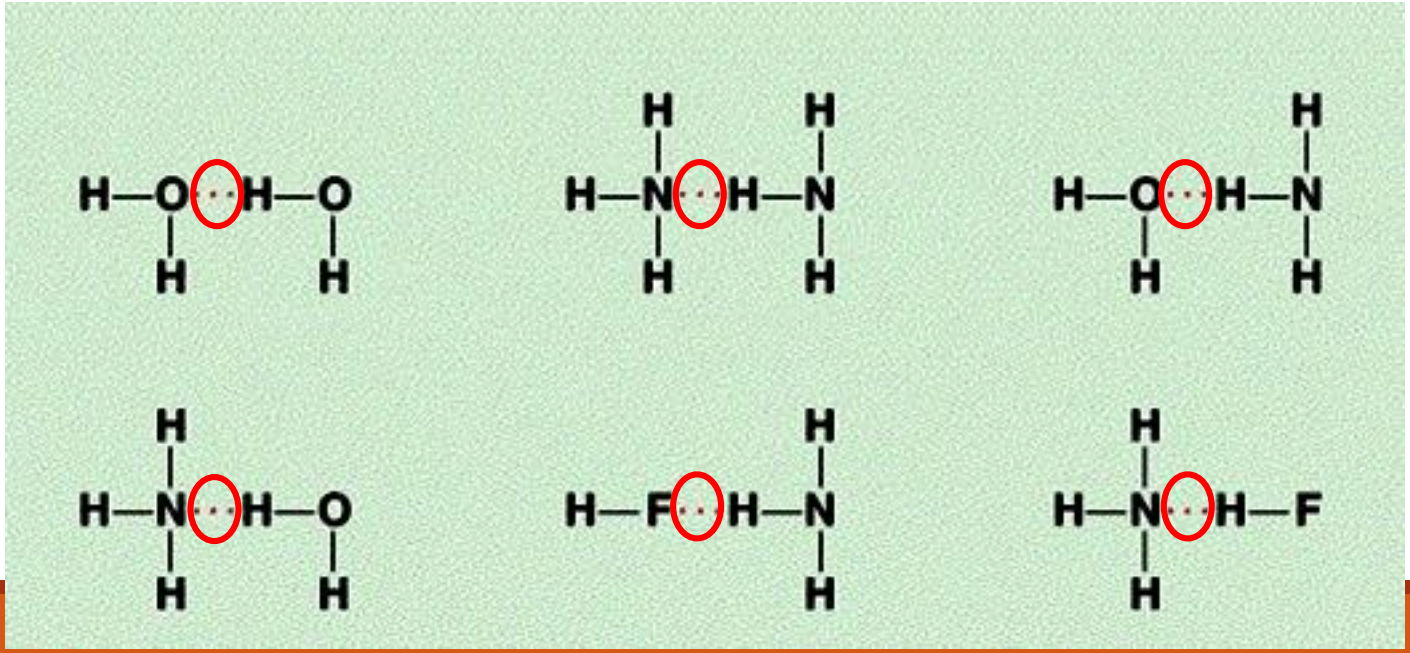
Intermolecular Forces

Hydrogen Bond

The ***hydrogen bond*** is a special dipole-dipole interaction between they hydrogen atom in a polar N-H, O-H, or F-H bond and an electronegative O, N, or F atom.

A — H--B or A — H--A

A & B are N, O, or F



Why is the hydrogen bond considered a “special” dipole-dipole interaction?