Bonding

Three Types:

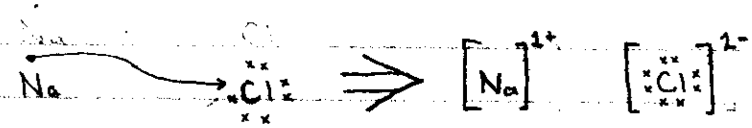
- Ionic Bonding - (metal loser / non-metal gainer)
- Covalent Bonding - (non-metal sharer)
- Metallic Bonding - (metals only - weird)

CH_4 - Covalent Bond
$LiCl$ - Ionic Bond
Na_2O - Ionic Bond
Au - Metallic Bond
N_2 - Covalent Bond
CO_2 - Covalent Bond

Ionic Bonding

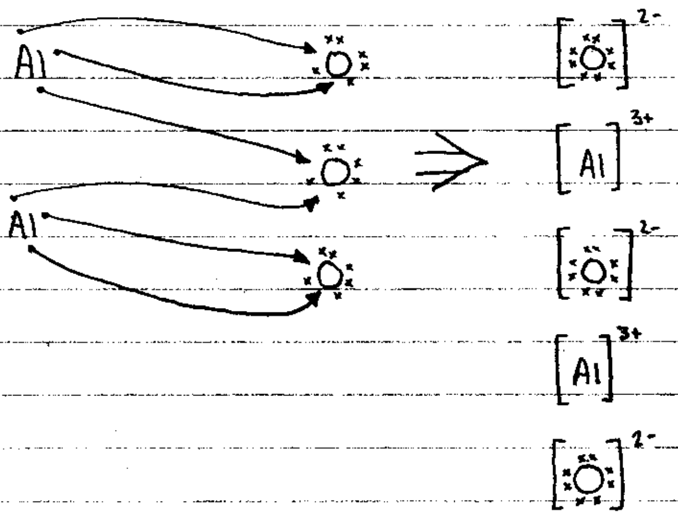
- Metallic element will lower I.E. (ionization energy) loss e^- (Metals are losers)
- Non-metallic element will higher EN (electronegativity) gain e^-
- Therefore a transfer of electrons occurs (metals → non-metals)
  - Transfer must satisfy the octet rule
  - creates cations (positive) and anions (negative)
  - ionic bond is a result of a positive/negative attraction

eg. Sodium with chlorine



- Strong electrostatic forces of attraction create the ionic bond
- Multiple ions spontaneously arrange themselves into a crystal lattice structure! (lowest energy arrangement)

Aluminum with Oxygen



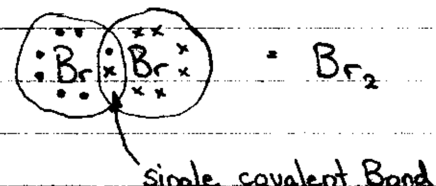
Al_2O_3

Covalent Bonding

- non-metallic elements only
- octet rule will be satisfied through sharing
    - sharing can be even → non-polar covalent bond
    - sharing can be skewed → polar covalent bond
- sharing is always in pairs
    - $2e^-$ / one pair → single covalent bond
    - $4e^-$ / two pair → double covalent bond
    - $6e^-$ / three pair → triple covalent bond

eg 1

Br with Br ⇒

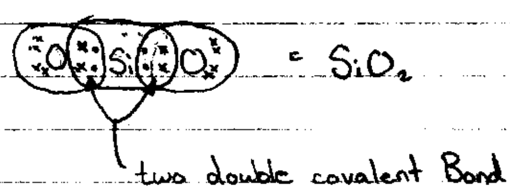


= Br_2

needs 1 needs 1

e2

Si with O ⇒



= SiO_2

needs 4 needs 2

× 2

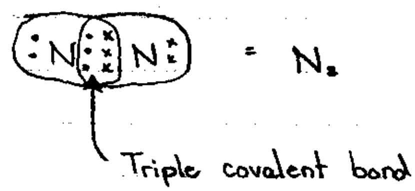
Covalent Bond Continue

Valence Shell Electron Pair Repulsion Theory — Valence e^- pairs repel each other and will locate as far as possible from each other

eg 3

N with N

needs 3 — needs 3

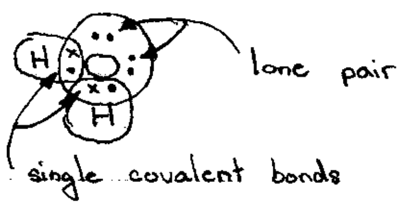
⇒ 

$= N_2$

eg 4

O with H

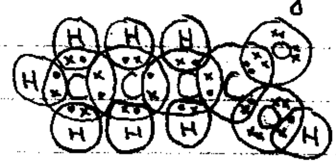
needs 2 — needs 1 × 2

⇒ 

$= OH_2$

- mutual electrostatic force of attention between atomic nuclei and bonding e^- creates the covanlent bond
- very strong bonds, they are "true bonds"
- only type of bonding that can create small molecule (discrete covalent molecule)
- molecules can be very complex

eg 5



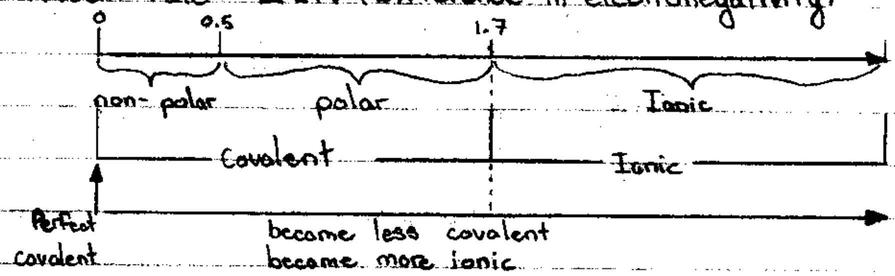
Ionic v.s. Covalent Bonding and Molecular Polarization

Alex Li

Easy Rule : metal + non-metal → Ionic

non-metal + non-metal → Covalent

More Difficult rule : ΔEN (Difference in electronegativity)



eg.1 Li (0.98) F (3.98) ΔEN = 3.98 - 0.98

= 3.00 ∴ ionic

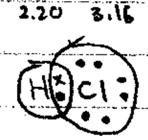
eg 2 H (2.20) O (3.44) ΔEN = 3.44 - 2.20

= 1.24 ∴ polar covalent

eg 3 H (2.20) C (2.65) ΔEN = 2.55 - 2.20

= 0.35 ∴ non-polar covalent

eg 4 HCl



ΔEN = 3.16 - 2.20

= 0.96

show bond stretched → H : Cl: (greater EN) → H :Cl: ← covalent diagram

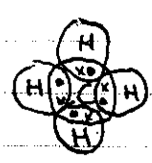
middle suggest even sharing

e⁻ pair shifts towards the more EN Cl

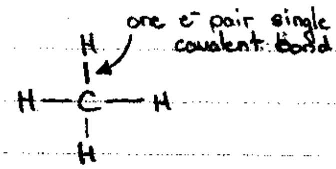
$[\,\text{:Cl:}\,]^{1-}$ if it were ionic

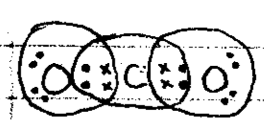
Not Covalent

Stick Diagram



→





→ :O=C=O: (two e⁻ pair double covalen bond; show lone pairs)

Sample Bonds

$C - C$ (2.55, 2.55) non-polar

$O \leftarrow\!\!+ H$ (3.44, 2.20)

$C +\!\!\rightarrow O$ (2.55, 3.44) polar (toward oxygen)

↑ shows polarization (e^- shift) towards O

$H - C$ (2.20, 2.55) non-polar ($\Delta EN = 0.35 < 0.5$)

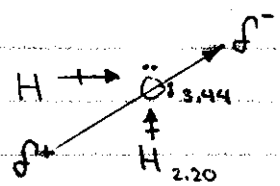
$C \nRightarrow O$

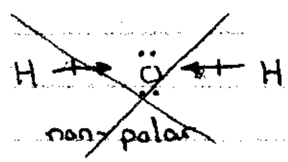
$\delta^+ H +\!\!\rightarrow Cl: \delta^-$

δ^+ partial positive charge
δ^- partial negative charge

} The partial charges are a result of the shift in e^- due to ΔEN

non-polar molecular
no net molecular polarization
bond polarization are balanced





net molecular polarization