Finish off Chapter 3

- Finish our look at Ionic Compounds w/ Polyatomic Ions
- Periodic Trends
  - Size of atoms & Ions
  - Electronegativity of elements
  - Electron affinity of elements

Polyatomic Ions in Ionic Compounds

Main Group metals w/ Polyatomics

1A Na^+ with SO_3^{2-} Sulfite

Na^+	SO_3^{2-}
Na^+	
2+	2−

Na_2SO_3

Soduim Sulfite

3A Al^{3+} SO_3^{2-}

2 × Al^{3+}	3 × SO_3^{2-}
6+	6−

$Al_2(SO_3)_3$

part of Sulfate

Balancing the ionic Compound

Parenthesis are used anytime we have multiple polyatomics

$Al_2(SO_3)_3$

2 Al^{3+}

3 S } not charged SO_3^{2-}

9 O }

Al^{3+} | OH^- OH^- OH^-

3+ 3−

$Al(OH)_3$

1 Al

3 H

3 O

Incorrect

~~$AlOH_3$~~ ≠

1 Al

1 O ✗

3 H

Correct

$Al(OH)_3$

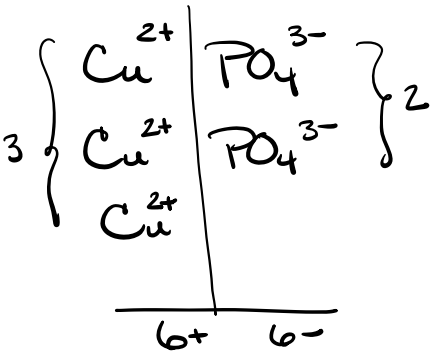
1 Al

3 O ✓

3 H

Transition Metals w/ Polyatomics

Copper (II) Cu^{2+} PO_4^{3-} Phosphate



$Cu_3(PO_4)_2$

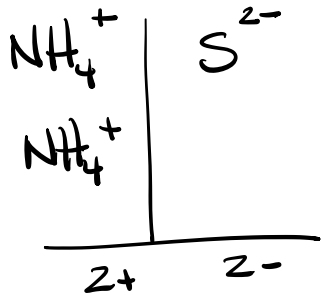
Copper (II) Phosphate

or

Cupric Phosphate

* Cationic Polyatomic

NH_4^+ ammonium ion



$(NH_4)_2S$

ammonium Sulfide

NH_4^+ | $C_2H_3O_2^-$

+1 −1

$NH_4C_2H_3O_2$

ammonium acetate

3 { NH_4^+ NH_4^+ NH_4^+ | PO_4^{3-}

$(NH_4)_3PO_4$

ammonium phosphate

main Group metals & nonmetals fixed charge

Transition metals multiple charges

Polyatomic ions families

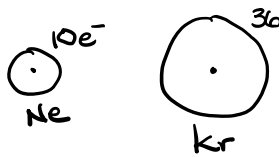
Cation $^{x+}$ | Anion $^{y-}$

+ # −

needs to match

Periodic Trends

① Size



Electrons are volume of atom

Decrease →

↓ Increasing Size

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (289)	117 Ts Tennessine	118 Og Oganesson
Lanthanides			57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides			89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

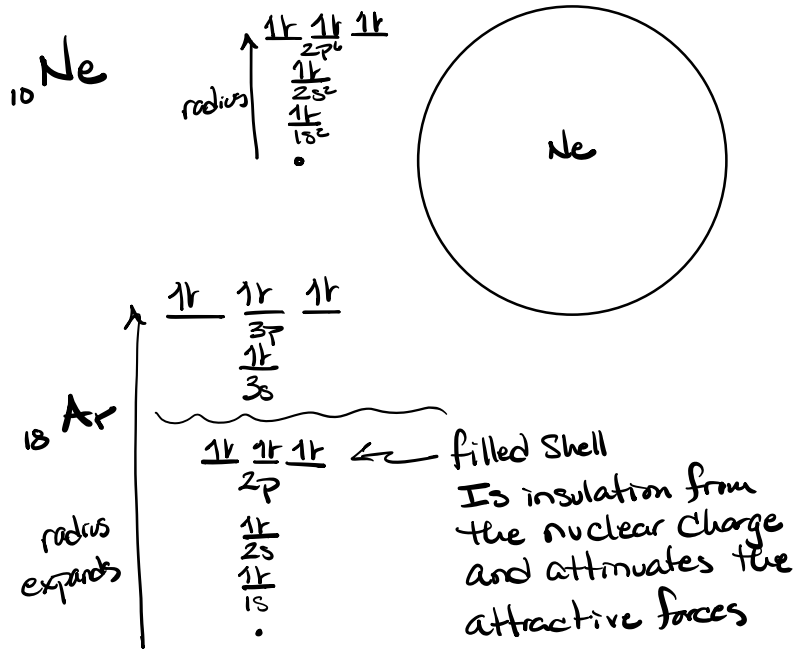
Pure Appl.Chem., Vol.85, pp.1047–1078, 2013.
Values rounded to four significant figures.

Smoke detectors

$1s^2 2s^2 2p^1$	$1s^2 2s^2 2p^2$	$1s^2 2s^2 2p^3$	$1s^2 2s^2 2p^4$	$1s^2 2s^2 2p^5$	$1s^2 2s^2 2p^6$ ← filled level
${}_5B$	${}_6C$	${}_7N$	${}_8O$	${}_9F$	${}_{10}Ne$
$\#e^-$ 5	6	7	8	9	10
$\#p^+$ 5	6	7	8	9	10

p^+ attracted to e^-

Add $1e^-$ at same time add $1p^+$



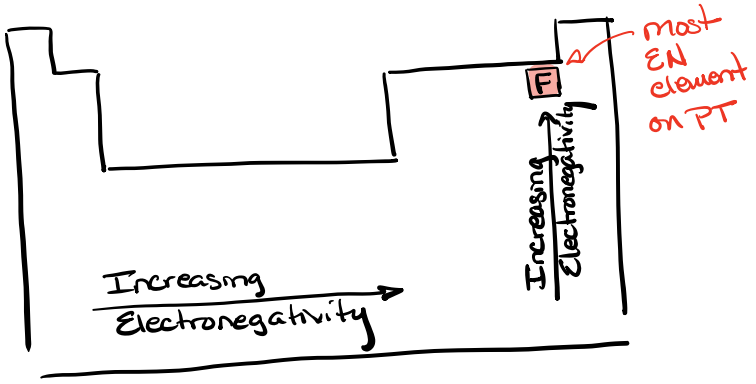
Atom Size trends

- Across a period we see decreasing size until the end of a subshell or shell, and
  - s-block
  - d-block
  - p-block

  the next element at the beginning of the new block increases in size.

- Down a group the elements all increase in size

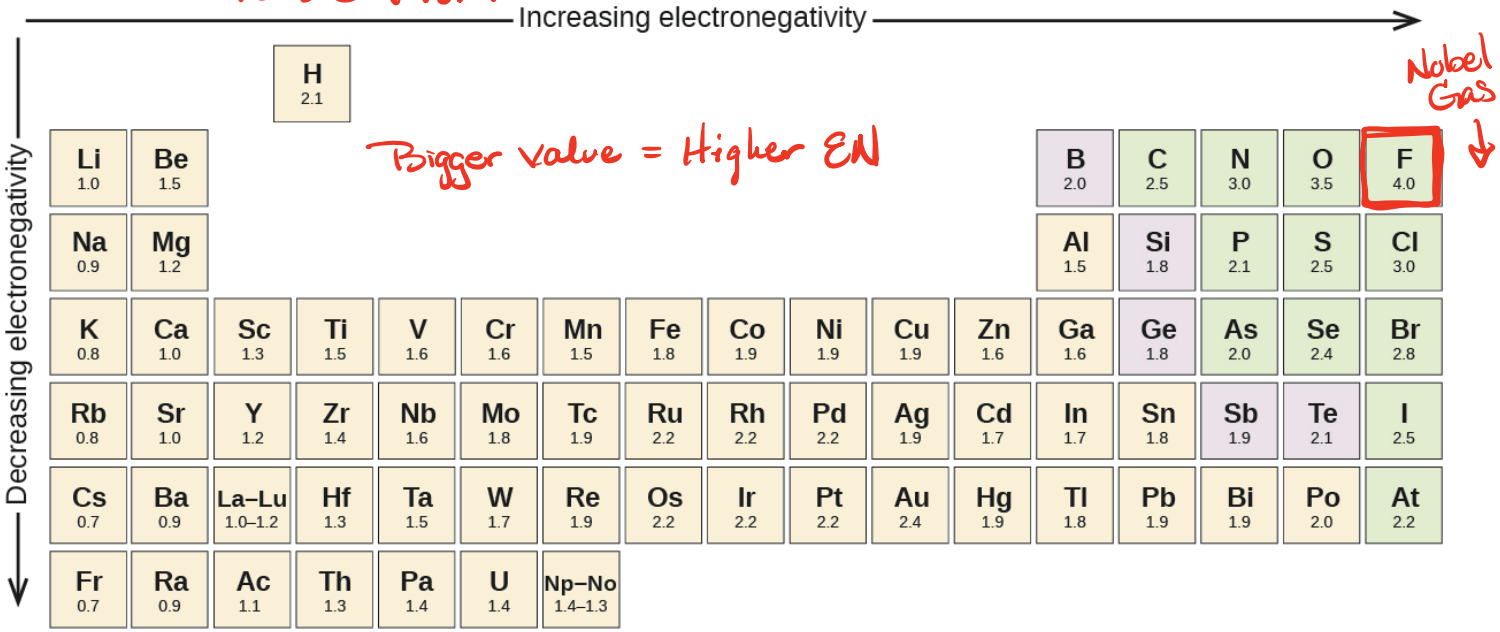
Electronegativity - The strength with which an atom "attracts" or "pulls" electrons



Nobel Gas
- He
- Ne
- Ar
- Kr

All have filled shells
⇒ Don't want or need more e^-

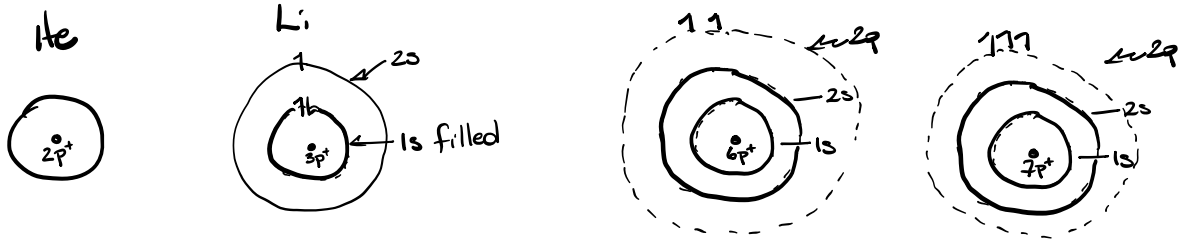
Table From Textbook



Covalent bond types depend on Electronegativity of the elements

$\Rightarrow$ we will use this a lot.

Question – How does a closed shell or closed subshell provide shielding (protection) for the next electrons?



$\frac{\uparrow\downarrow}{1s}$ $_2He$

$\frac{1}{2s}$ $\frac{\uparrow\downarrow}{1s}$ $_3Li$

$\frac{1}{2p}$ $\frac{1}{2s}$ $\frac{\uparrow\downarrow}{1s}$ $_6C$

$\frac{1}{2p}$ $\frac{\uparrow\downarrow}{2s}$ $\frac{\uparrow\downarrow}{1s}$ $_7N$

p^+ field + in sign

e^- field − in sign

attract

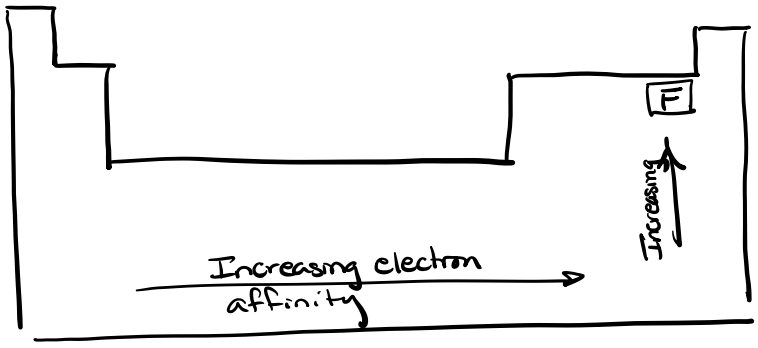
Electron affinity – A measure of how much energy is released when an atom captures an e^-. Also a measurement of how strongly an atom holds an e^-.

units - kJ/mole

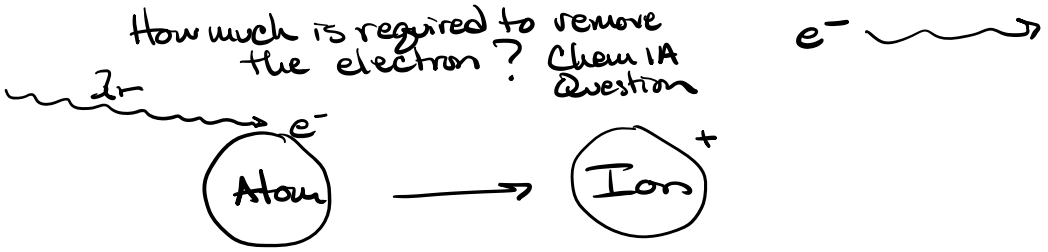
$$F + e^- \longrightarrow F^{\ominus} + \text{energy}$$

$1s^2 2s^2 2p^5$ $\quad$ $[1s^2 2s^2 2p^6]^-$ $\quad$ energy: kJ

Electron affinity



Used in Chem 1A for some topics


How much is required to remove the electron? Chem 1A Question
e⁻
hν
e⁻
Atom
Ion
+

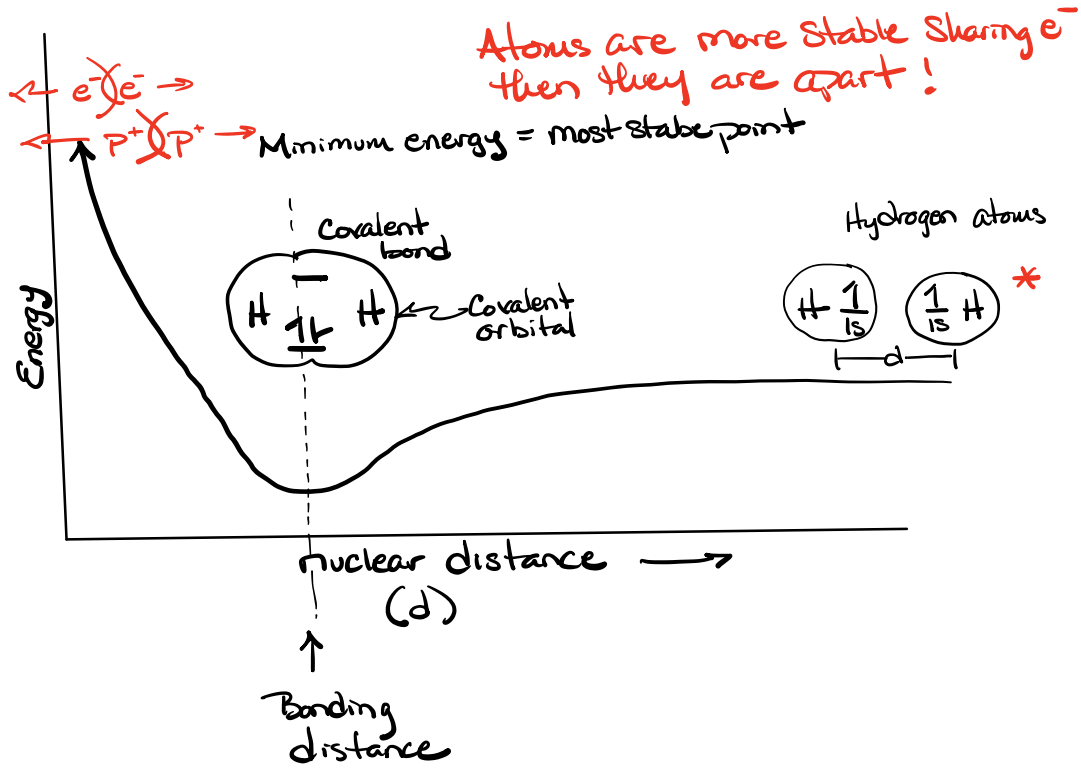
Chapter 4

4.1 Ionic bonding & nomenclature } Covered as part of Chapter 3

4.2 Covalent bonding

- Lewis Structures
- Formal Charge
- 3-D Shape

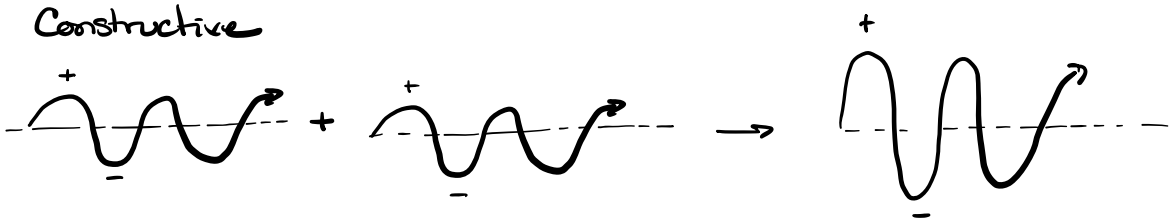
Energy Diagram



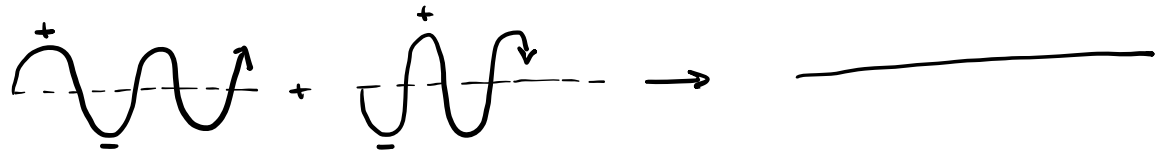
Covalent

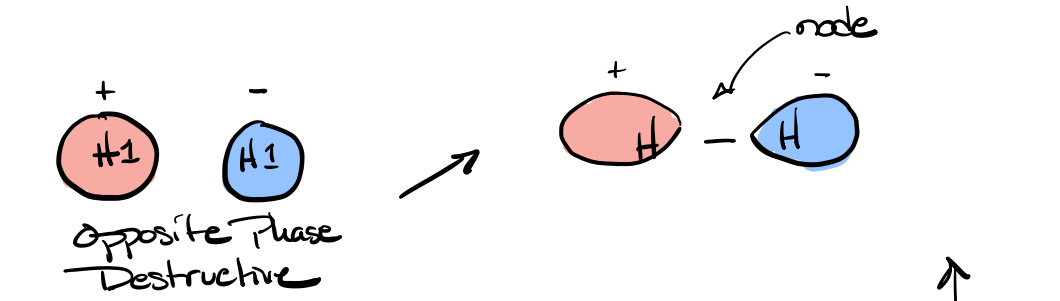
"Shared" "outer most electrons"

Constructive



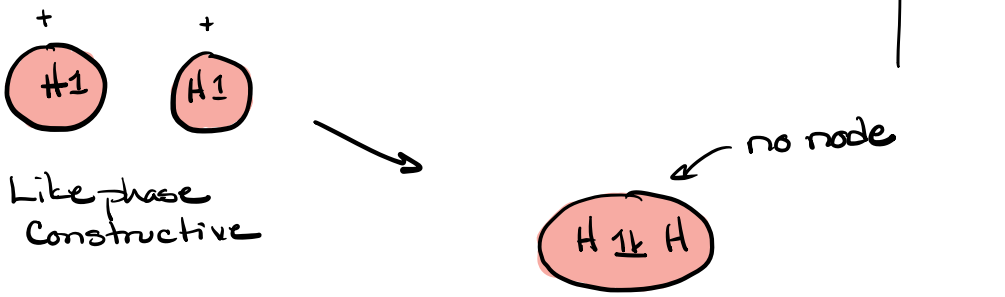
Destructive





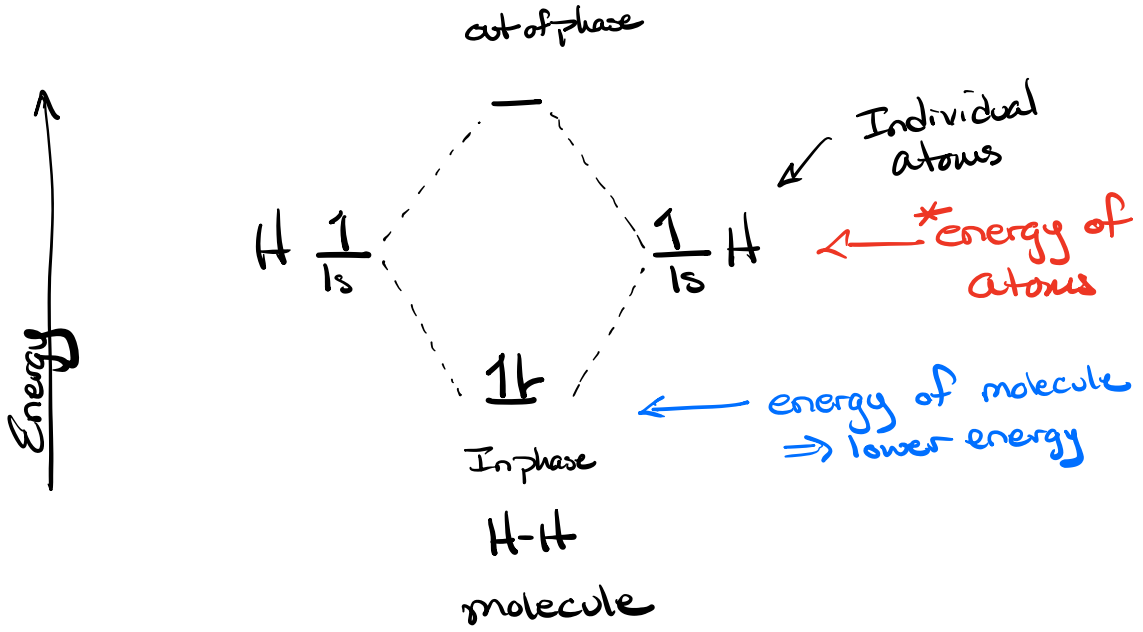
Both happen at same time

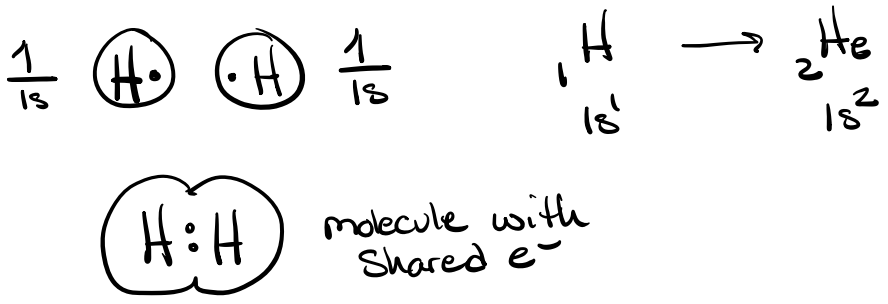
Energy

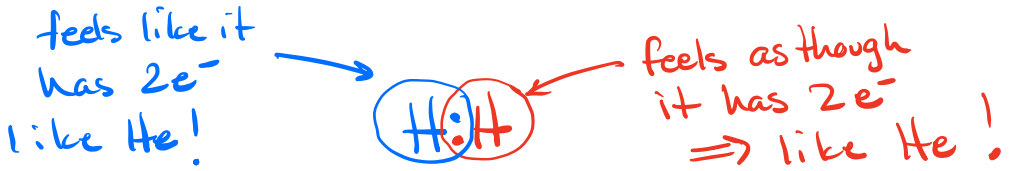


Atomic Orbitals

Molecular Orbitals







Both have a noble gas configuration from sharing!

H_2 A molecule of hydrogen H–H ← Sharing of 2e⁻