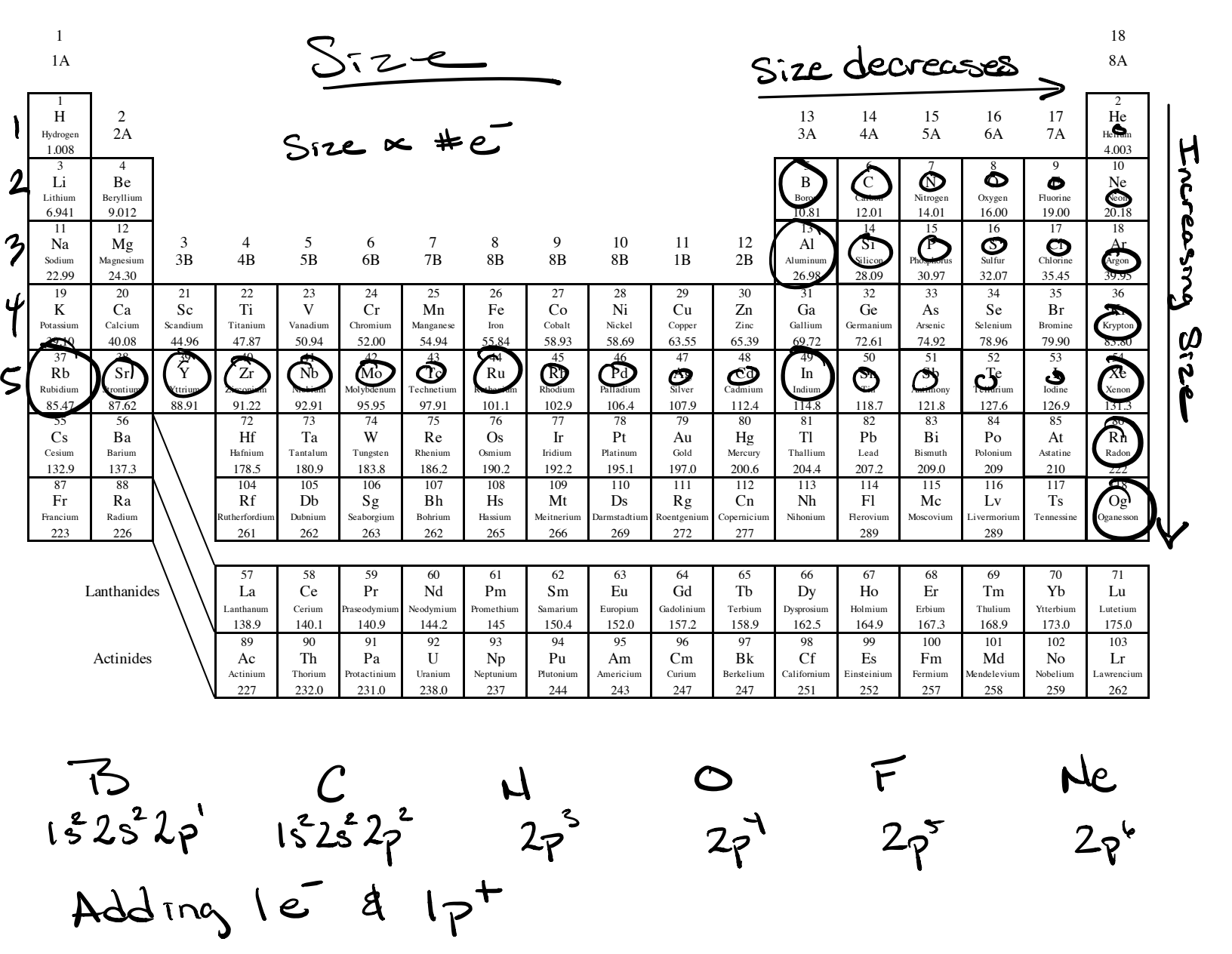
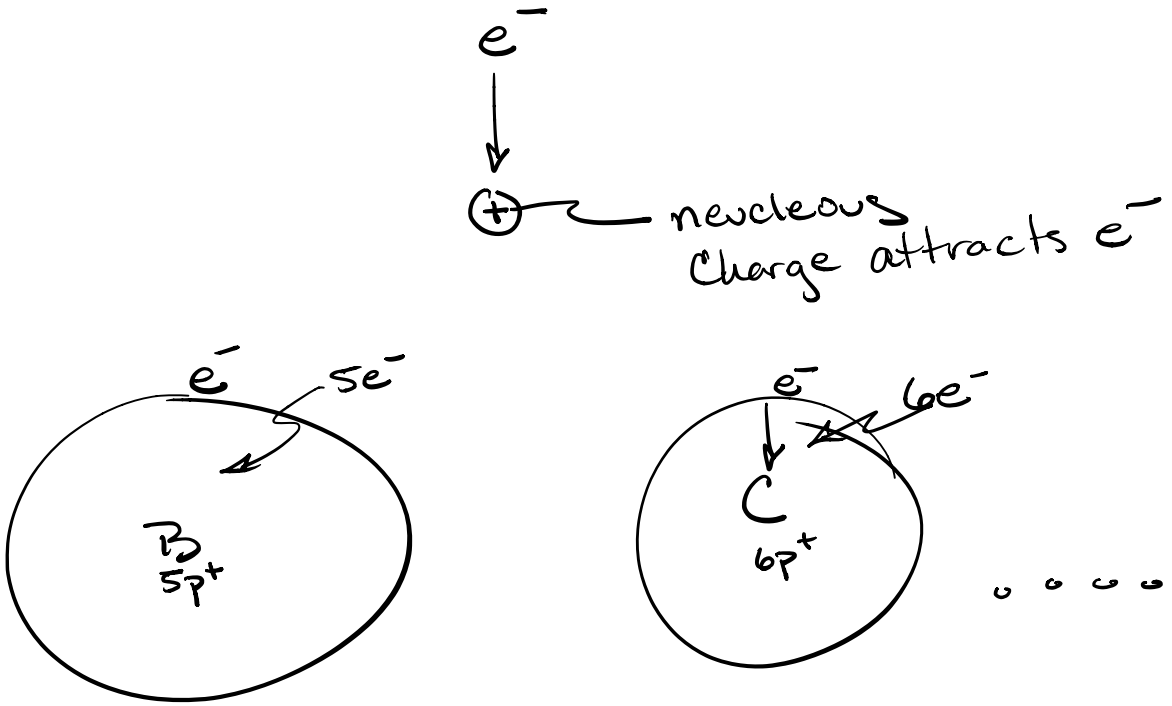
- New suggested homework for Chapter 3 on Canvas
- Exam 1 still open → Try finishing by tonight
- Cancelling afternoon lab

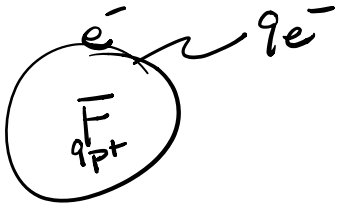
Yet to Cover in Chapter 3

- Periodic Trends
  - Size of atoms & Ions (measurable)
  - Electronegativity (Calculated)
  - Electron affinity (measurable, done by experiment)

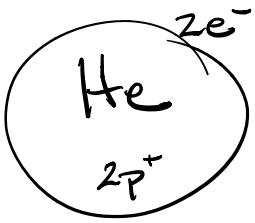
$$e^- + atom_{(gas)} \longrightarrow atom^-_{gas} + energy \quad kJ/mole$$


Size
Size ∝ #e⁻
Size decreases
Increasing Size
1 1A
18 8A
2 He Helium 4.003
13 3A
14 4A
15 5A
16 6A
17 7A
1 H Hydrogen 1.008
2 2A
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 65.39
31 Ga Gallium 69.72
32 Ge Germanium 72.61
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 95.95
43 Tc Technetium 97.91
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 263
107 Bh Bohrium 262
108 Hs Hassium 265
109 Mt Meitnerium 266
110 Ds Darmstadtium 269
111 Rg Roentgenium 272
112 Cn Copernicium 277
113 Nh Nihonium
114 Fl Flerovium 289
115 Mc Moscovium
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
B
1s² 2s² 2p¹
C
1s² 2s² 2p²
N
2p³
O
2p⁴
F
2p⁵
Ne
2p⁶
Adding 1e⁻ & 1p⁺

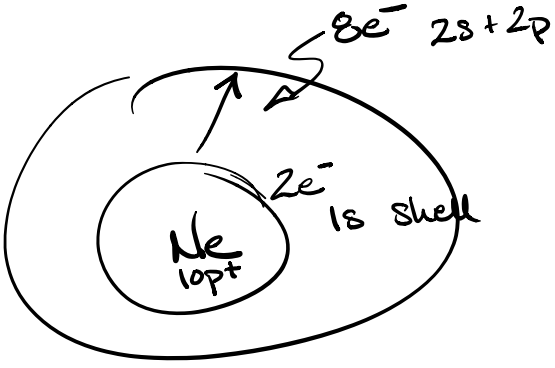




down a group



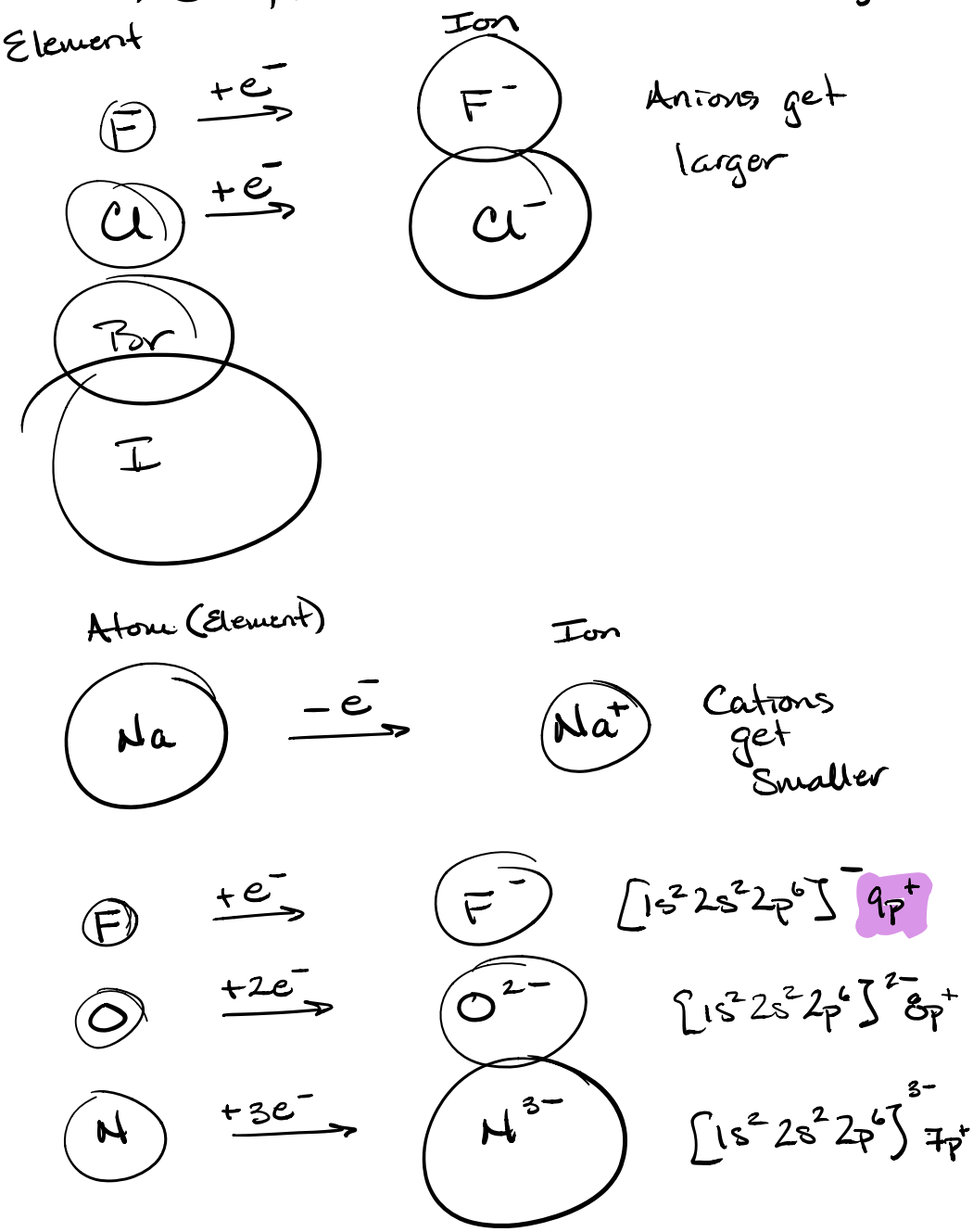
$1s^2$



$\underbrace{1s^2}\ \underbrace{2s^2 2p^6}$

↑ filled shell

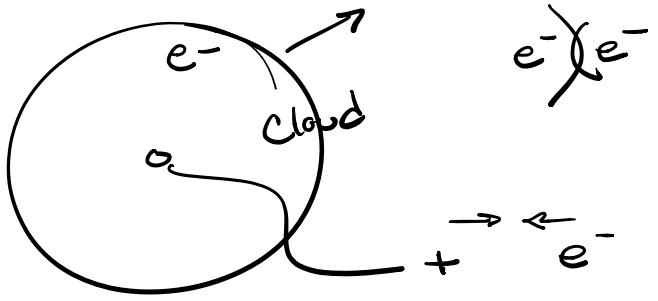
– A filled shell (level) shield the outer (valence) e^- from the nuclear charge



F $+e^-$ → F^- $[1s^2 2s^2 2p^6]^-$ $9p^+$

O $+2e^-$ → O^{2-} $[1s^2 2s^2 2p^6]^{2-}$ $8p^+$

N $+3e^-$ → N^{3-} $[1s^2 2s^2 2p^6]^{3-}$ $7p^+$



Electronegativity – A property that describes How strongly an atom pulls e^- in a chemical bond. unitless value

Electron Affinity – How much energy is released when an atom captures an e^-. It is also a measure of how strongle an element holds e^- kJ/mole

kJ = kilo Joules
= Joules $\times 10^3$

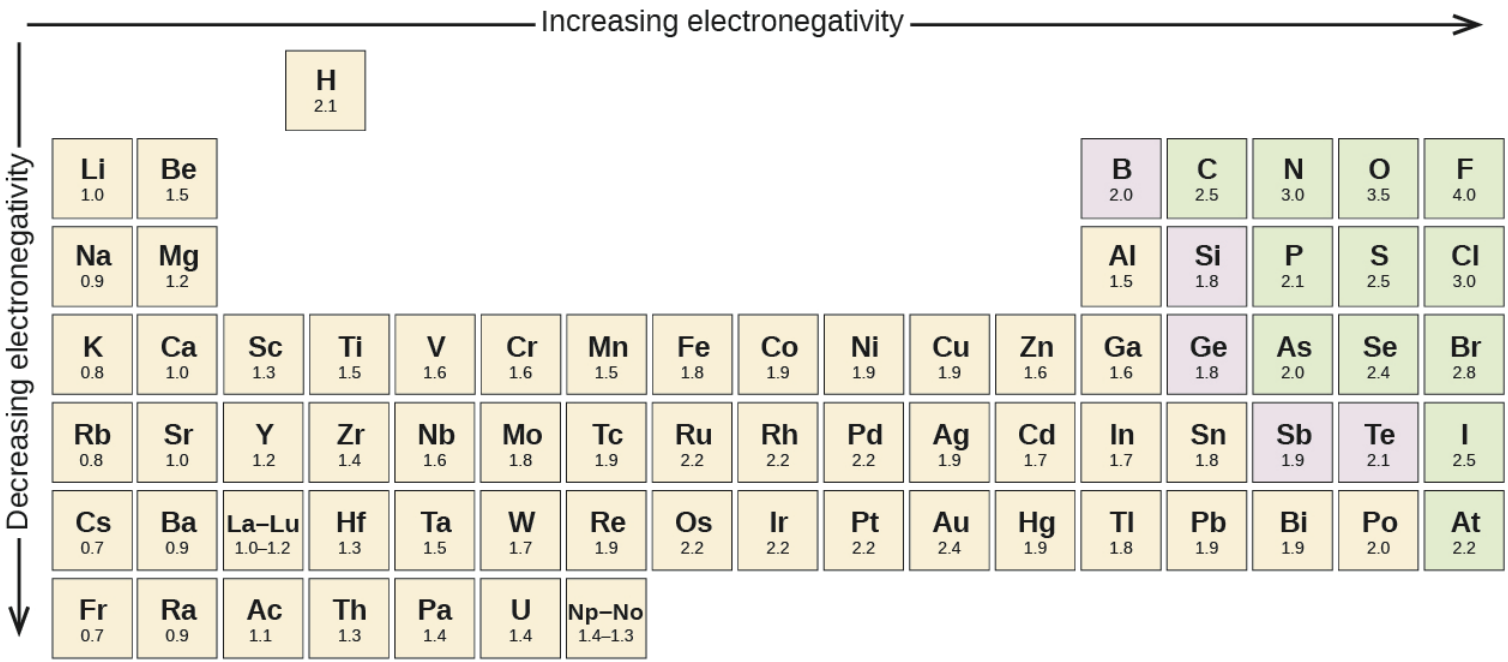
Electronegativity (EN)

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
2.1												2.0	2.5	3.0	3.5	4.0	
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 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	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 95.95	43 Tc Technetium 97.91	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 263	107 Bh Bohrium 262	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 269	111 Rg Roentgenium 272	112 Cn Copernicium 277	113 Nh Nihonium	114 Fl Flerovium 289	115 Mc Moscovium	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

Increase →

most EN

Increase ↑


Increasing electronegativity
Decreasing electronegativity
H 2.1
Li 1.0
Be 1.5
B 2.0
C 2.5
N 3.0
O 3.5
F 4.0
Na 0.9
Mg 1.2
Al 1.5
Si 1.8
P 2.1
S 2.5
Cl 3.0
K 0.8
Ca 1.0
Sc 1.3
Ti 1.5
V 1.6
Cr 1.6
Mn 1.5
Fe 1.8
Co 1.9
Ni 1.9
Cu 1.9
Zn 1.6
Ga 1.6
Ge 1.8
As 2.0
Se 2.4
Br 2.8
Rb 0.8
Sr 1.0
Y 1.2
Zr 1.4
Nb 1.6
Mo 1.8
Tc 1.9
Ru 2.2
Rh 2.2
Pd 2.2
Ag 1.9
Cd 1.7
In 1.7
Sn 1.8
Sb 1.9
Te 2.1
I 2.5
Cs 0.7
Ba 0.9
La–Lu 1.0–1.2
Hf 1.3
Ta 1.5
W 1.7
Re 1.9
Os 2.2
Ir 2.2
Pt 2.2
Au 2.4
Hg 1.9
Tl 1.8
Pb 1.9
Bi 1.9
Po 2.0
At 2.2
Fr 0.7
Ra 0.9
Ac 1.1
Th 1.3
Pa 1.4
U 1.4
Np–No 1.4–1.3

Chapter 4

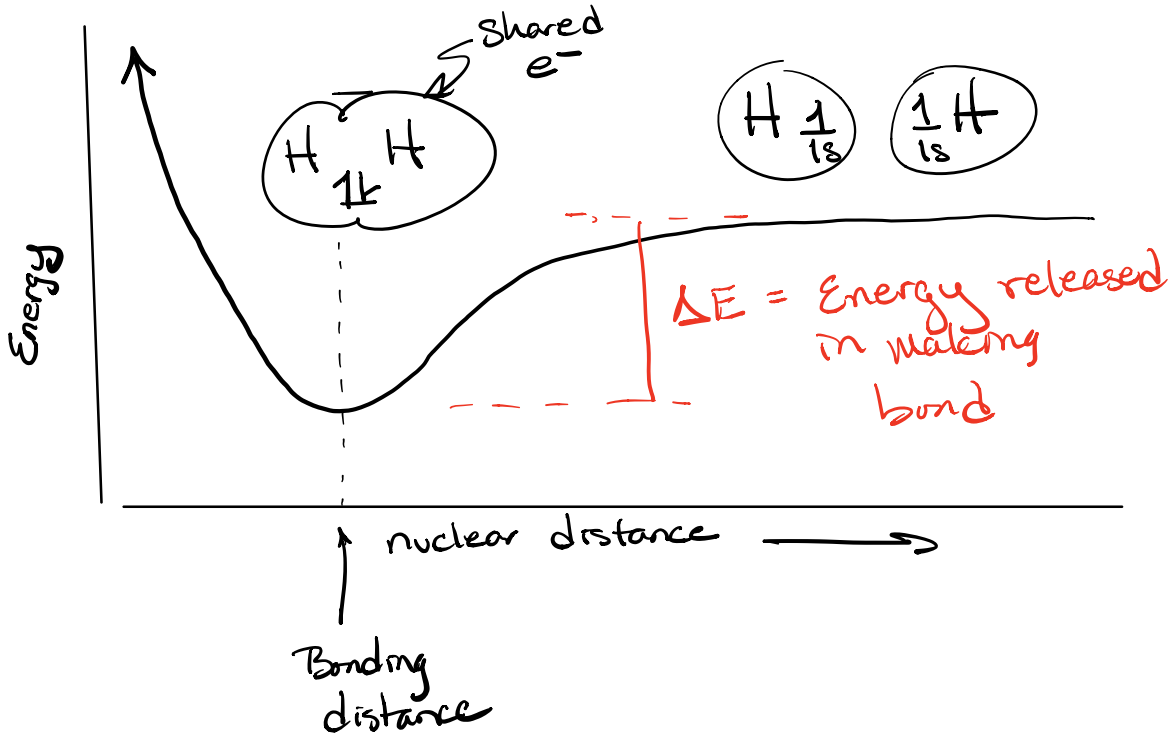
Ionic Bonding
Nomenclature } we've covered this

Covalent Bonding
- Lewis Structures
- Formal Charge
- 3-Dimentional Shape

4.1 Ionic Bonding

+ −
electrostatic attraction

4.2 Covalent Bonding



H 1

$1s^1$

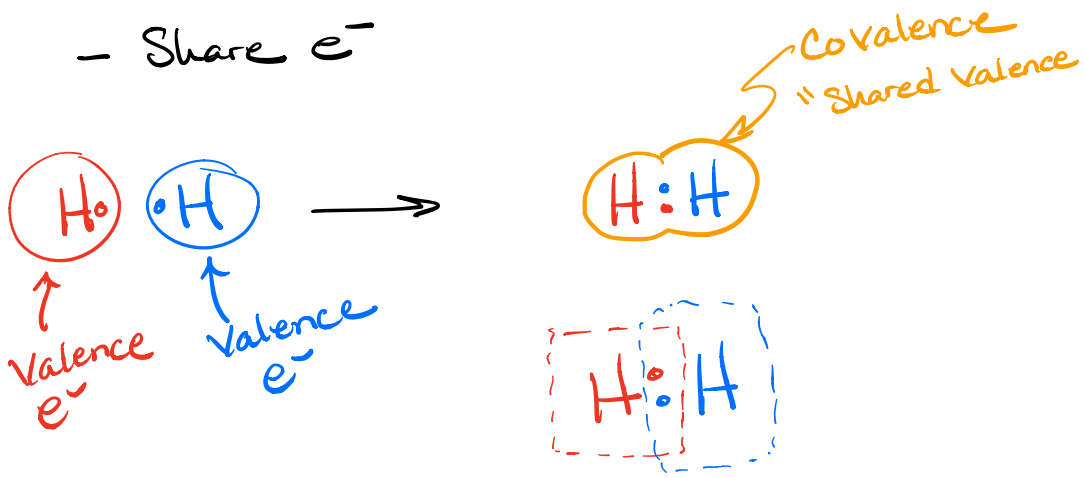
Noble Gas

He 1+

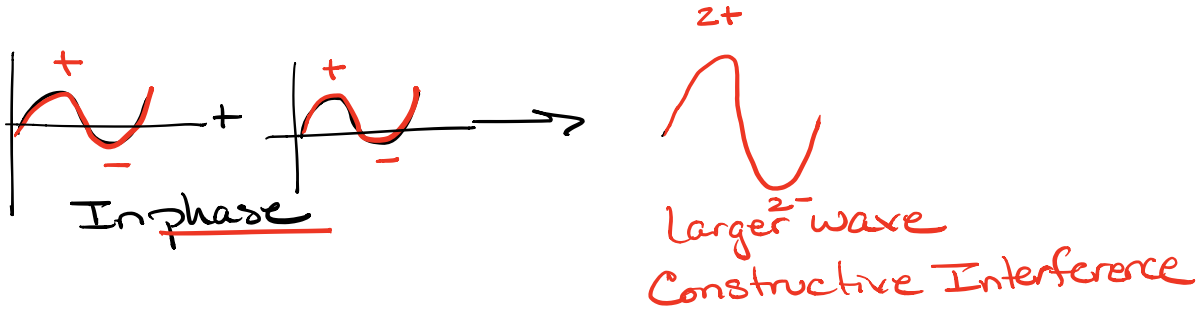
$1s^2$ ← filled out shell or level

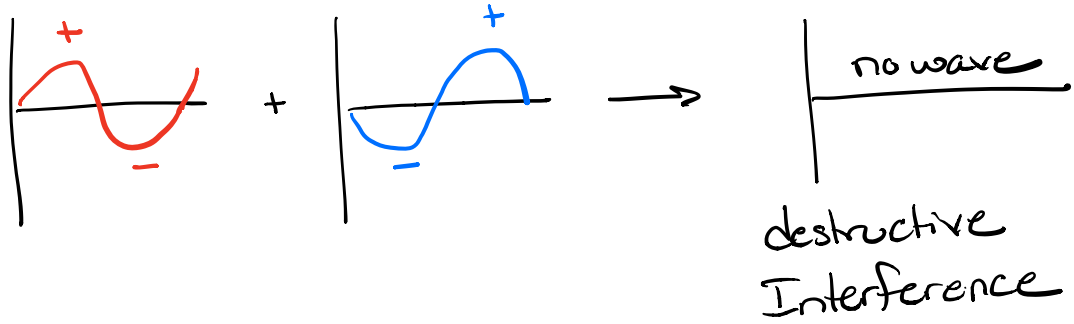
Two ways to accomplish a filled level

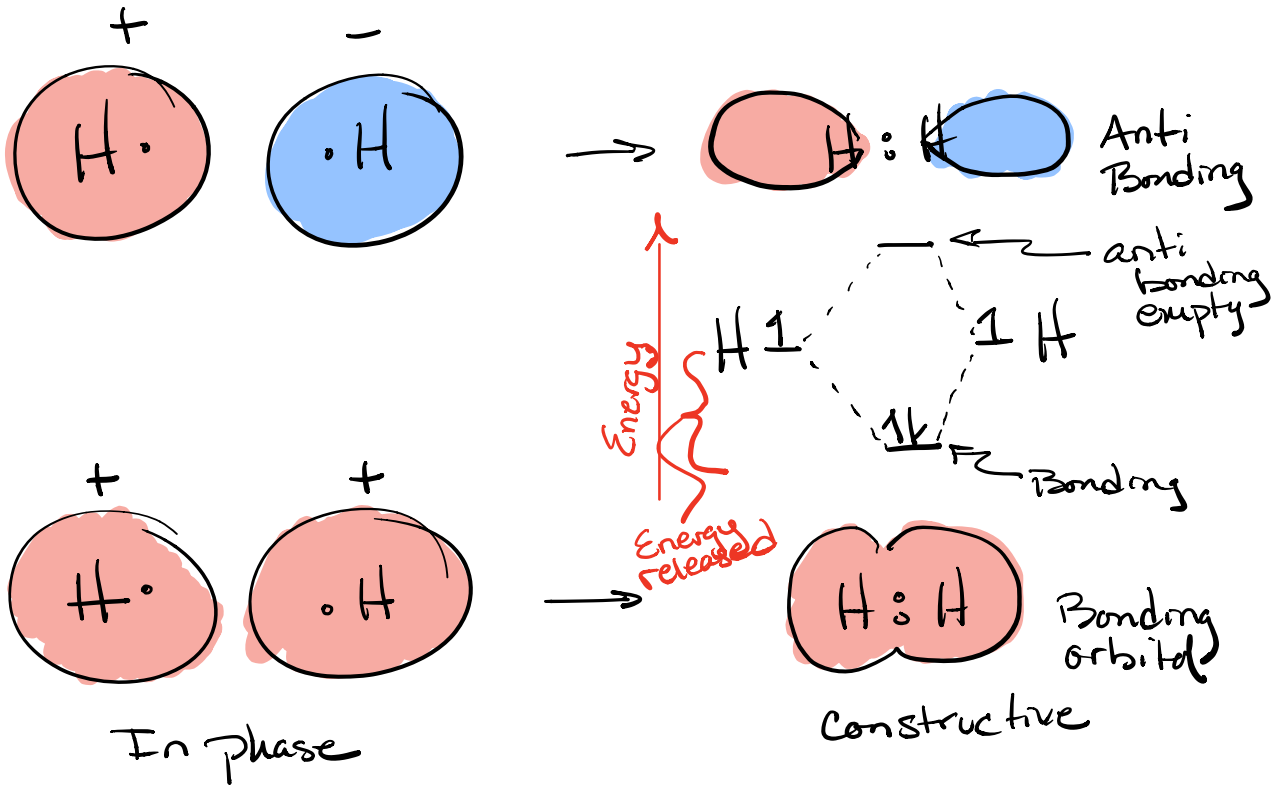
- Form an ion add or give up e^-
- Share e^-

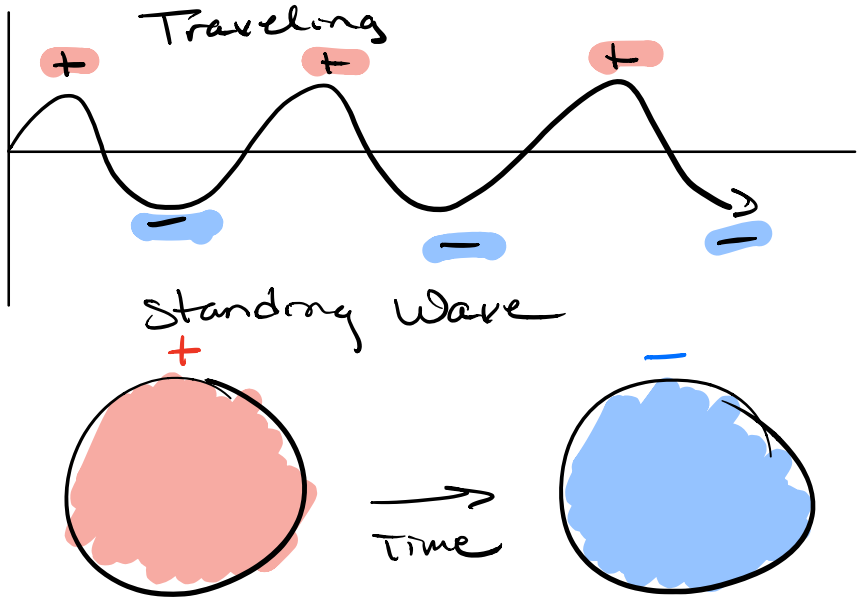


Each atom feels as though it is isoelectronic with helium.


+
+
+
+
In phase
2+
2-
Larger wave
Constructive Interference


+
+
+
no wave
destructive
Interference

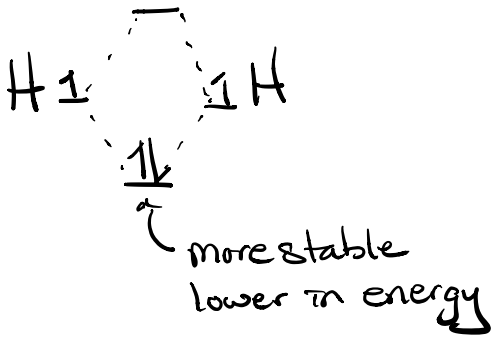

+
−
H·
·H
H : H
Anti
Bonding
anti
bonding
empty
Energy
H 1
1 H
1k
Bonding
Energy
released
+
+
H·
·H
H : H
Bonding
orbital
In phase
Constructive

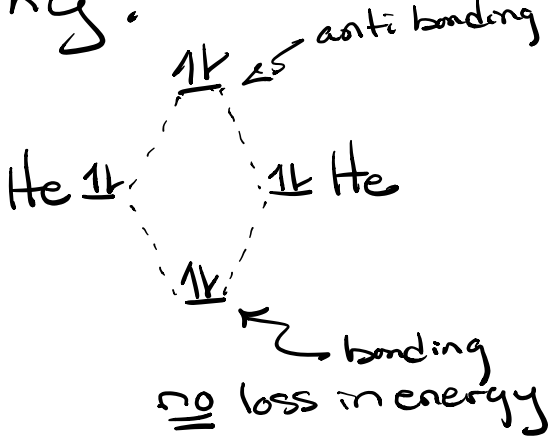


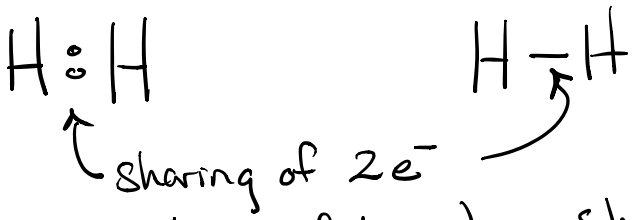
H_2 hydrogen likes to be diatomic
— to atoms in a molecule
sharing e^-

He helium likes to be monoatomic

why?

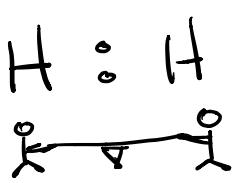




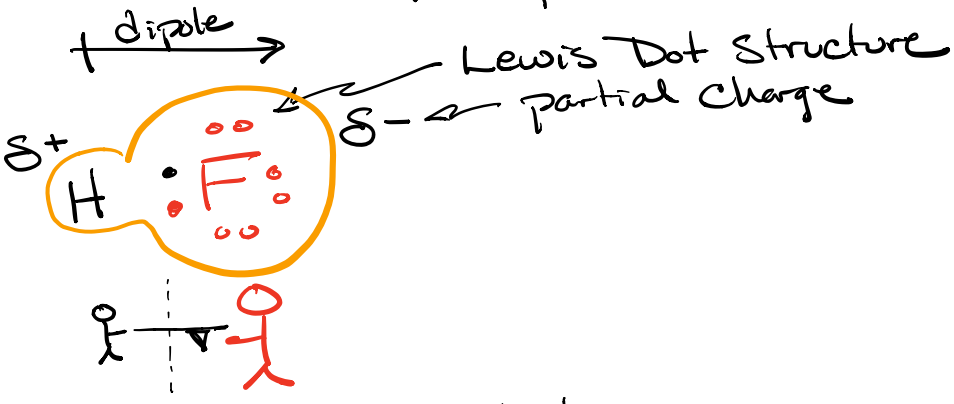


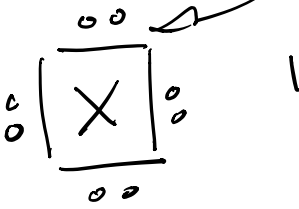
Chemical bond = Sharing of 2 or more e^-

$EN_{2.1} - EN_{2.1} = \Delta EN = 0$



Equal Bond
Equal Sharing
non-polar bond





Lewis Dot Structures

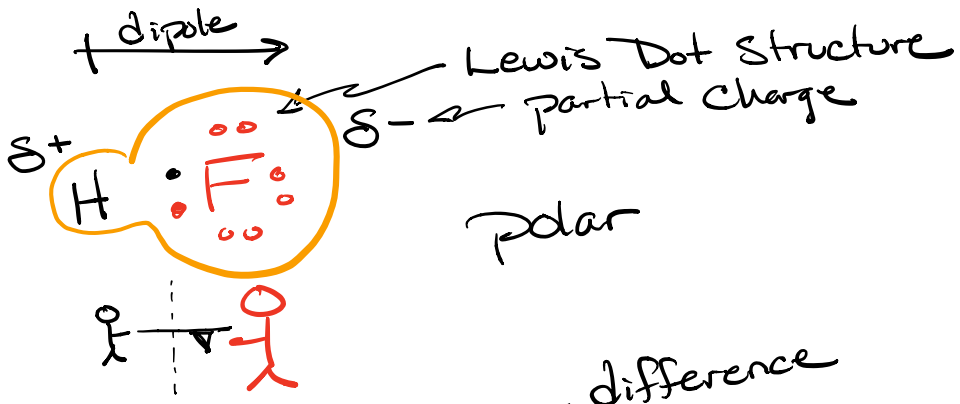
IIIA — 7 valence e^-

F

$1s^2|2s^2 2p^5$

7 valence e^-

δ = delta or "partial"



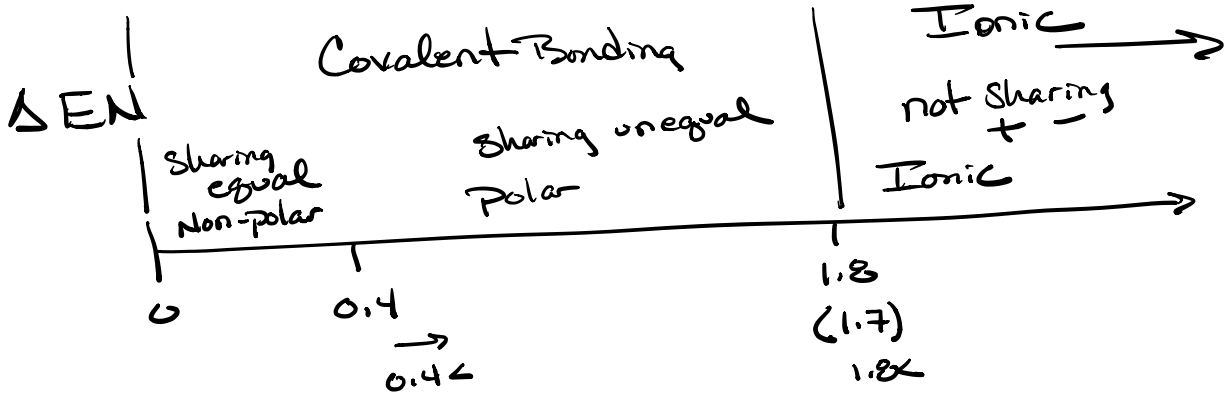
difference

$\Delta EN = |EN_1 - EN_2|$

	H	F
EN	2.1	4.0

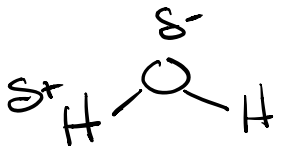
$\Delta EN = |4.0 - 2.1|$

$\Delta EN = 1.9$



Δ = Capital Delta = "Difference"

δ = lower case Delta = "partial"



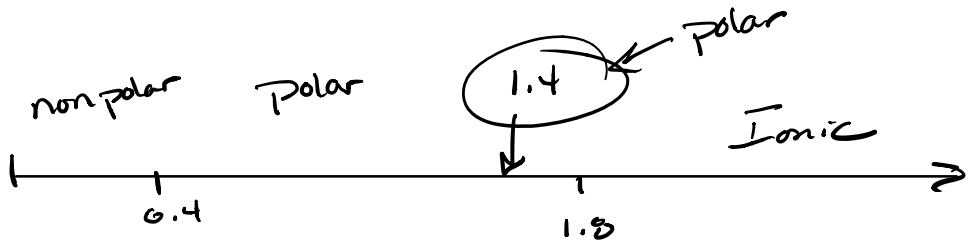
Polar

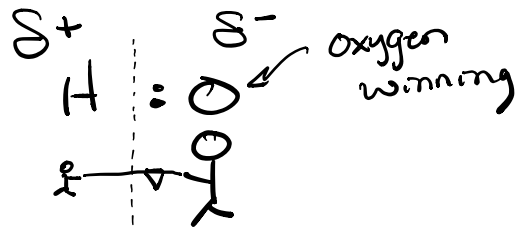
ΔEN of Oxygen & hydrogen

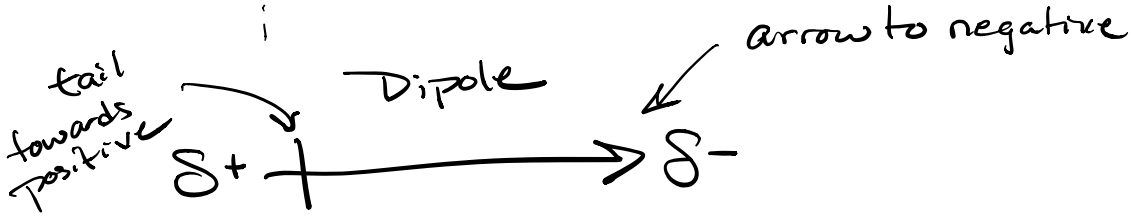
$$\Delta EN = |EN_H - EN_O|$$

$$= 3.5 - 2.1$$

$$= 1.4$$



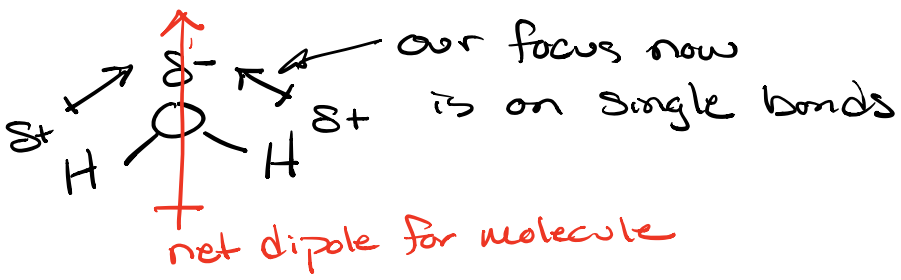




→ Small arrow = Small ΔEN

→ large Arrow = large ΔEN

Vectors
magnetude
&
Direction



4.3 Nomenclature

Ionic ← we already did this

Covalent ← tomorrow

O=C=O ← 4e⁻

H−C≡N ← 6e⁻

≡

C≡N

C≡N