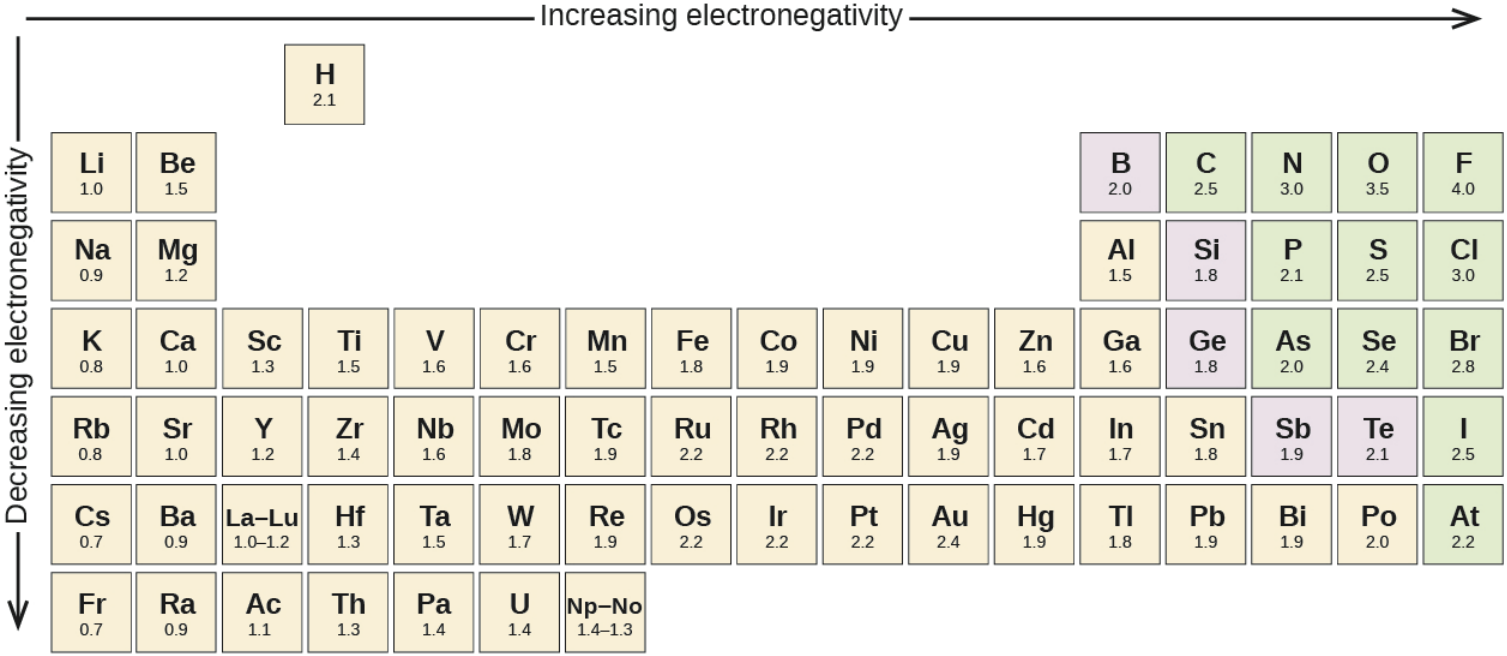
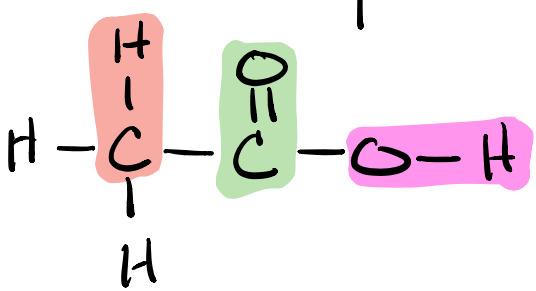
Today

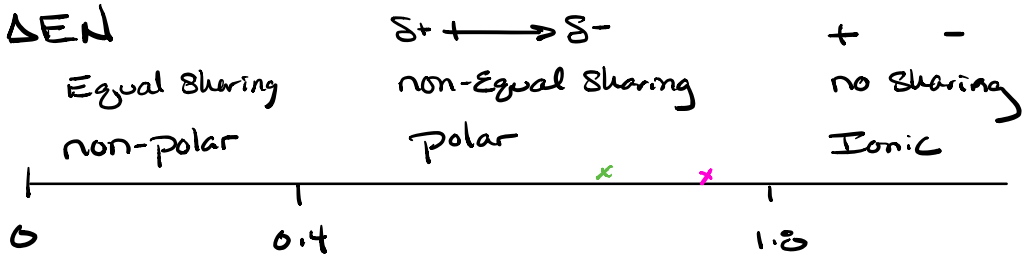
- few examples of EN of Bonds end of 4.2
- Skip 4.3 ⇒ Because we did this at end of Chapter 3 Nomenclature
- Look Lewis Structures 4.4



$$\Delta EN = |EN_1 - EN_2|$$



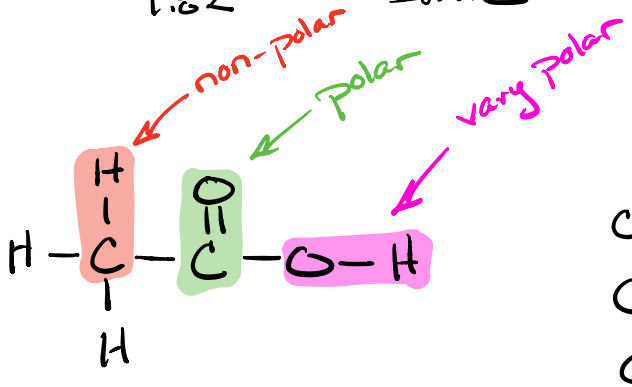
	ΔEN
C – H	$2.5 - 2.1 = 0.4$
C – O	$3.5 - 2.5 = 1.0$
O – H	$3.5 - 2.1 = 1.4$



0 - 0.4 non-polar

0.4< - 1.8 polar

1.8< Ionic



ΔEN	
C - H	2.5 - 2.1 = 0.4
C - O	3.5 - 2.5 = 1.0
O - H	3.5 - 2.1 = 1.4

metal + nonmetal = expectation ⟶ Ionic

Al - Br
1.5 2.8

$\Delta EN = |2.8 - 1.5| = 1.3$ polar

nonmetal + nonmetal

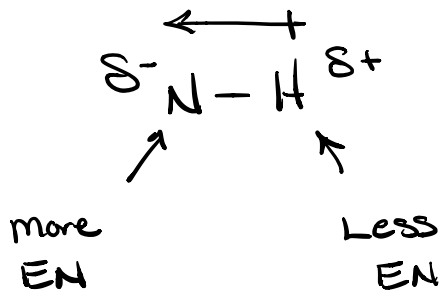
B - F
2.0 4.0

$\Delta EN = |4.0 - 2.0| = 2.0$ Ionic

N - H
3.0 2.1

$\Delta EN = |2.1 - 3.0| = |-0.9| = 0.9$ polar

$= 3.0 - 2.1 = 0.9$



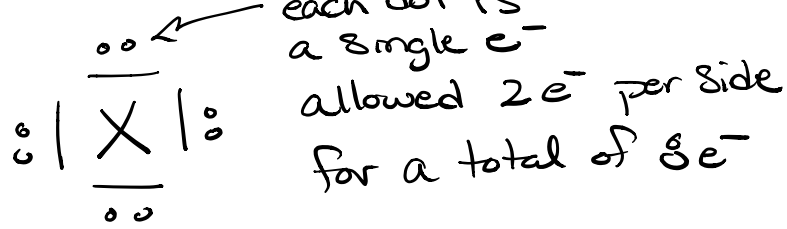
ΔEN is a magnetude (a positive value)

$\Delta EN = |EN_1 - EN_2|$

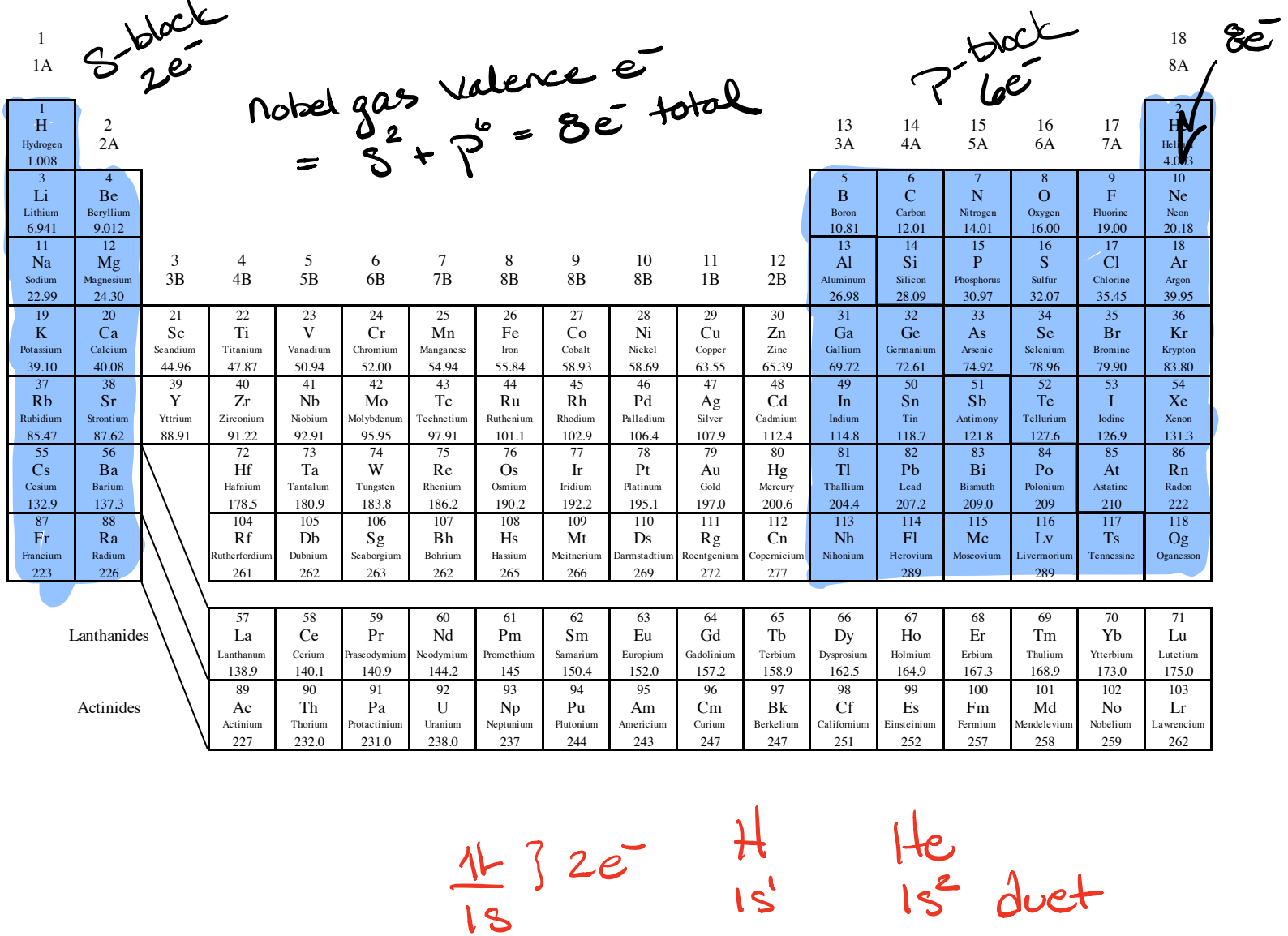
Lewis Structures

- provide atom connectivity
- Model or Theory that help to find or predict the atom connectivity of Simple inorganic & Simple organic molecules
- System used to write the atom connectivity of simple & complicated

Start with Lewis dot Structures



8e⁻ ⇒ an octet ⇒ isoelectronic w/ nobel gas


1
1A
2
2A
3
3B
4
4B
5
5B
6
6B
7
7B
8
8B
9
8B
10
8B
11
1B
12
2B
13
3A
14
4A
15
5A
16
6A
17
7A
18
8A
1 H Hydrogen 1.008
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
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
s-block
2e⁻
Nobel gas valence e⁻
= s² + p⁶ = 8e⁻ total
p-block
6e⁻
8e⁻
1s } 2e⁻
H
1s¹
He
1s² duet

Group "A" values are the # of valence e^-

1A	2A	3A	4A	5A	6A	7A
• Li	•Be•	•B•	•C•	•N•	•O•	•F•
• Na			•Si•		•S•	

Goal is to share e^- to obtain an octet

⇒ there will be some exceptions

Two Systems

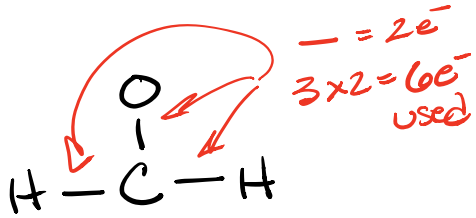
1st – Traditional System

- locate central atom
- ✓ – Bond all elements to the central with a single bond
- ✓ – place lone pairs of e^- on outter most (most EN) Elements to give them an "octet" ($8e^-$).
- ✓ – Do octet Count
- we use double & triple bonds to give central atom an octet if needed
- check e^- used
- check octets
- check formal charge

later

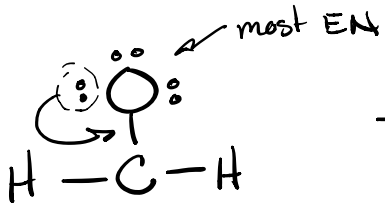
* Central Element underlined

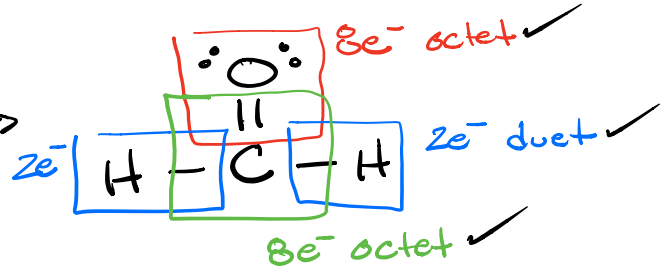
$\underline{CH_2O}$

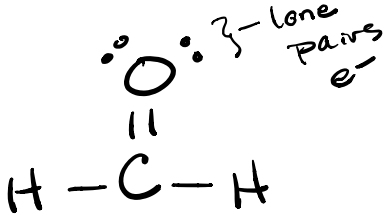


e⁻ Count

		VE		
C	1 x	4e⁻	=	4
H	2 x	1e⁻	=	2
O	1 x	6e⁻	=	6
				12e⁻ ✓

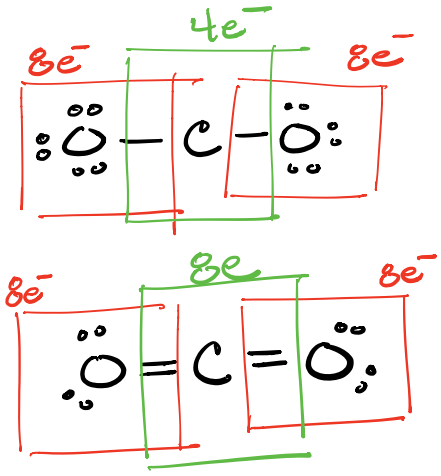






Formaldehyde

CO_2



Count e^-

4A C 1 × $4e^-$ = 4

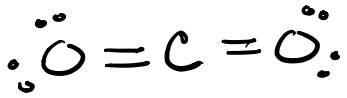
6A O 2 × $6e^-$ = 12

$16e^-$ ✓

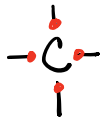
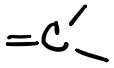
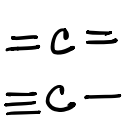
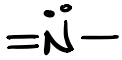
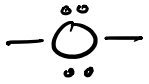
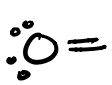
octets ✓

$16e^-$ ✓

Formal Charge Later



Common Bonding Patterns

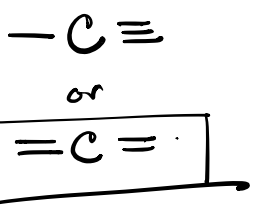
# of atoms it's bonding to	4A	5A	6A	7A
				
4				
3				
2				
1				

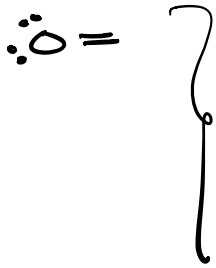
CO_2

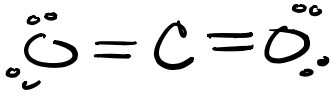
2 oxygens
⇒ carbon is bonding to two things
⇒ oxygen is bonding to one

C $1 \times 4 = 4$
O $2 \times 6 = 12$
16e⁻ ✓

octet ✓

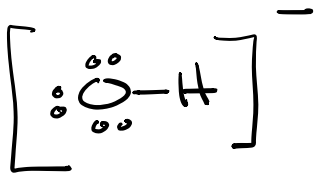






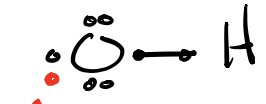
OH^- ← an extra e^- — hydroxide

6A O $1 \times 6e^- = 6$
1A H $1 \times 1e^- = 1$
$7e^-$
charge $+ 1e^-$
$8e^-$



Verify octet ✓
Verify $8e^-$ ✓

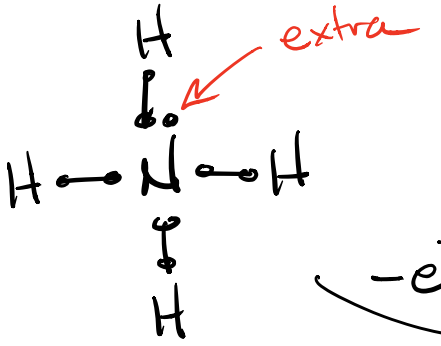
$6e^- \quad 1e^- = 7e^-$
$+1e^-$
$8e^-$



extra e^-

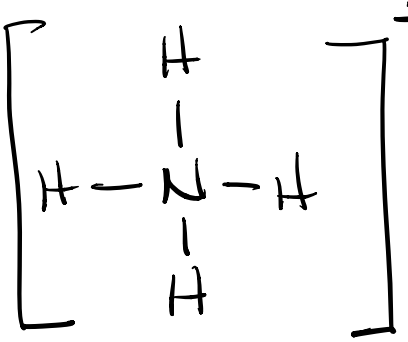
NH_4^+ ← 1 less e^-

5A N $1 \times 5 = 5$
1A H $4 \times 1 = 4$
$9e^-$
$-1e^-$
$8e^-$

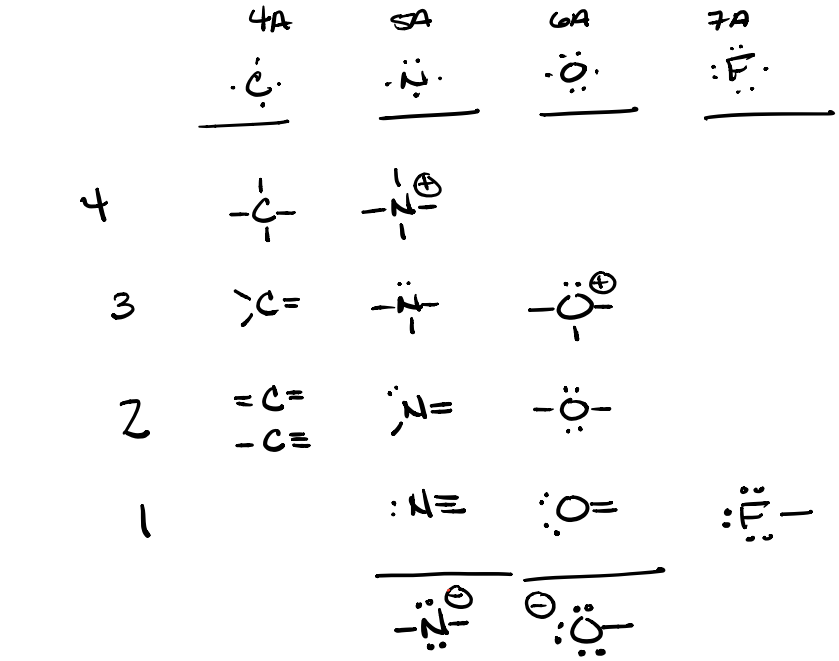


extra

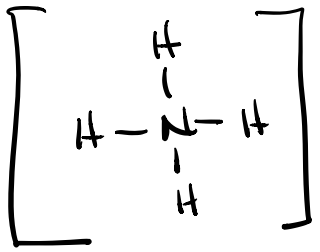
$-e^-$



octet ✓
e^- ✓

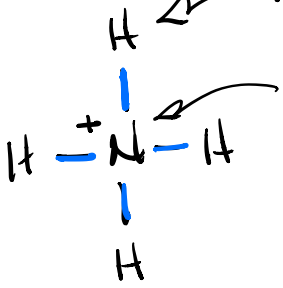


Formal Charge = Valence e^- − ½(bonding e^-) − nonbonding e^-



+ ← delocalized meaning over the whole molecule

But formally which element carries the positive charge?



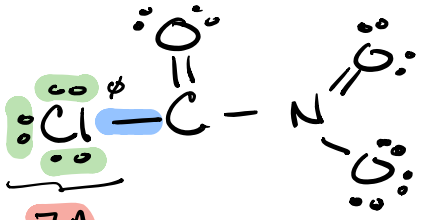
Valence e^-

FC = 1 − ½(2) − 0 = 1 − 1 = 0

Valence e^-

FC = 5 − ½(8) − 0 =

5 − 4 = 1+



7A

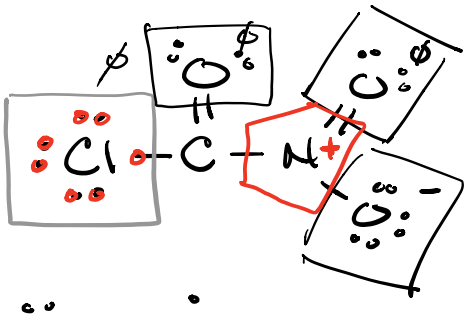
valence

non bonding

$$\text{Cl} = 7 - \tfrac{1}{2}(2) - 6$$

$\tfrac{1}{2}$ bonding

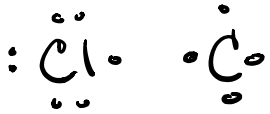
$$7 - 1 - 6 = \emptyset$$

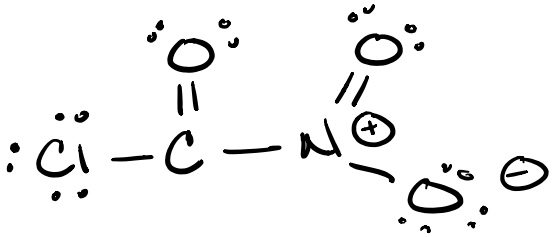


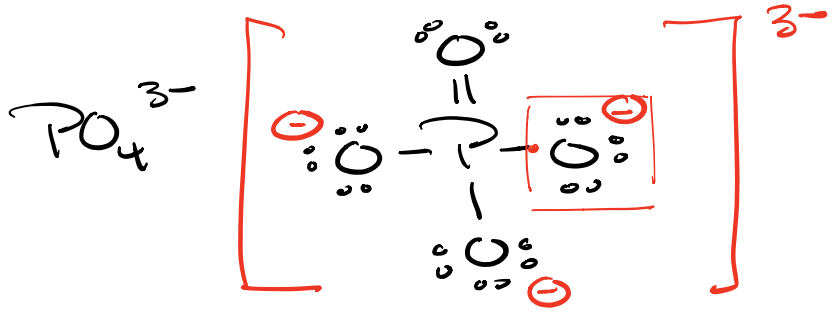
$$7 - \tfrac{1}{2}\text{bonding} - \text{nonbond}$$

How many did it come with

How many demonstrated






PO_4^{3-}
3-