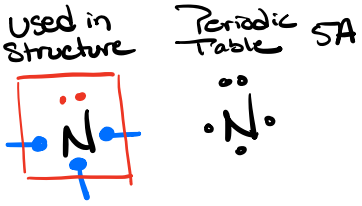
Plan for today

- Formal Charge
- Lewis Structures that have multiple centers
- Lewis Structures that have Charges
- Traditional vs. Common Bonding vs. Valence e^-
- VSEPR Theory
  3D - Shape

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

Valence e^-: # it is supposed to have

½ bonding − nonbonding: $-e^-$ it is demonstrating

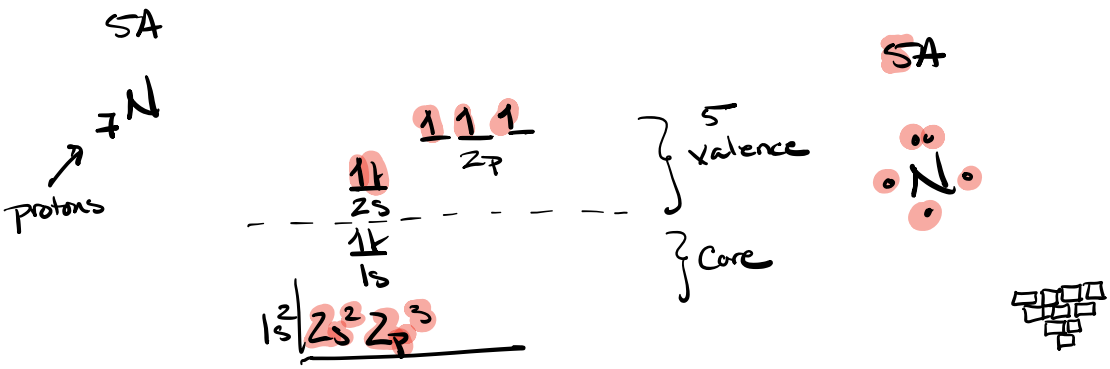


5A

Formal Charge = $5 - \frac{1}{2}(6) - 2$

$= 5 - 3 - 2$

$= 0$



4e⁻ demonstrated

Supposed to have 5e⁻

1 less e⁻ or Lost 1e⁻

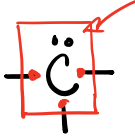
5 − 4 = +1

6e⁻ demonstrated

Suppose to have 5e⁻

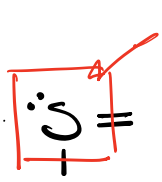
gained 1e⁻

5 − 6 = −1



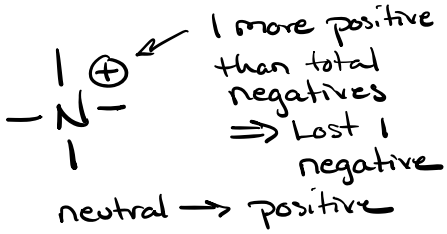
demonstrating 5e⁻

4 − 5 = −1



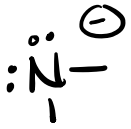
demonstrating 5e⁻

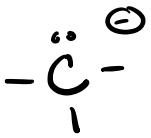
6 − 5 = +1

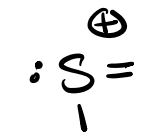


1 more positive than total negatives ⇒ Lost 1 negative

neutral → positive

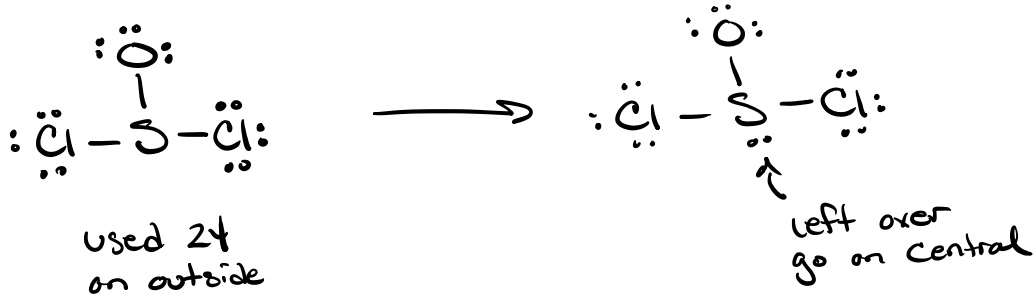






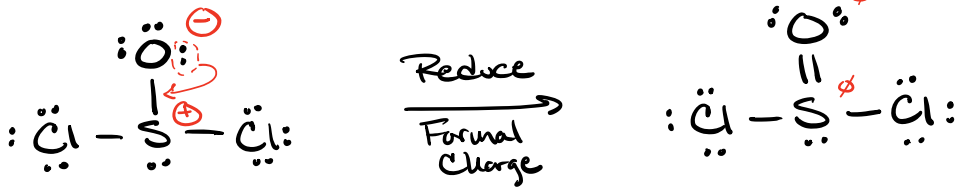
$SOCl_2$

S $1 \times 6e^- = 6e^-$
O $1 \times 6e^- = 6e^-$
Cl $2 \times 7e^- = 14e^-$
$26e^-$



used 24 on outside elements

left over go on central



Reduce → Formal Charge

3 Checks
- octet ✓
- $26e^-$ ✓
- Formal Charge ✗ ?

3 Checks
- $26e^-$ ✓
- octets ✗
- S has 10
- Formal Charge

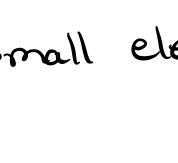
Formal Charge or Octet Rule

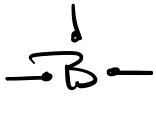
↑ more important

Some octet exceptions

3A

Small elements





Can get to six by bonding, but 8 is difficult.

Bond to 3 things & have less than octet.

Large Elements ⇒ Can exceed an octet

Period 3 & below

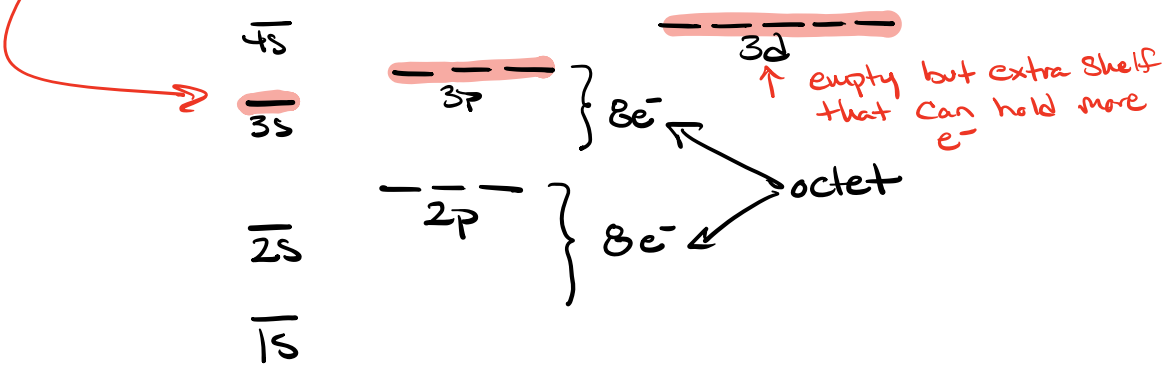
C N O F — Must obey octet

Period 3: Si P S Cl

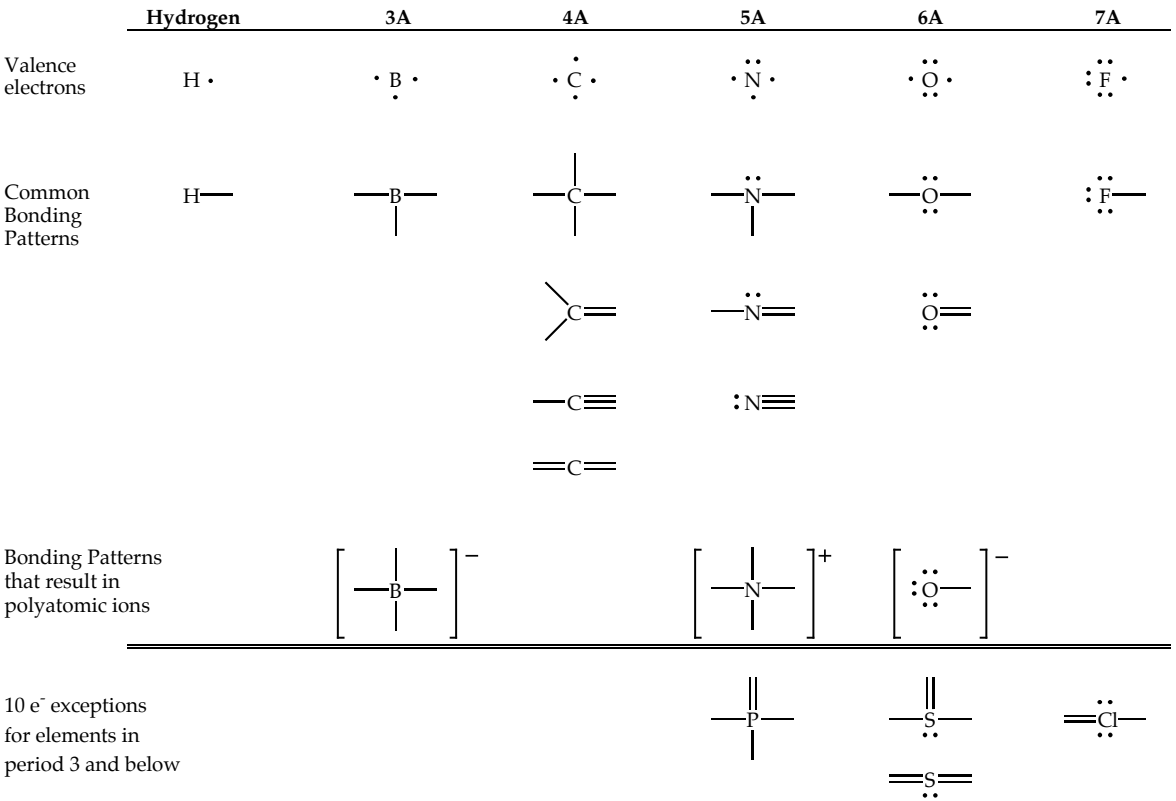
Period 4: Ge As Se Br

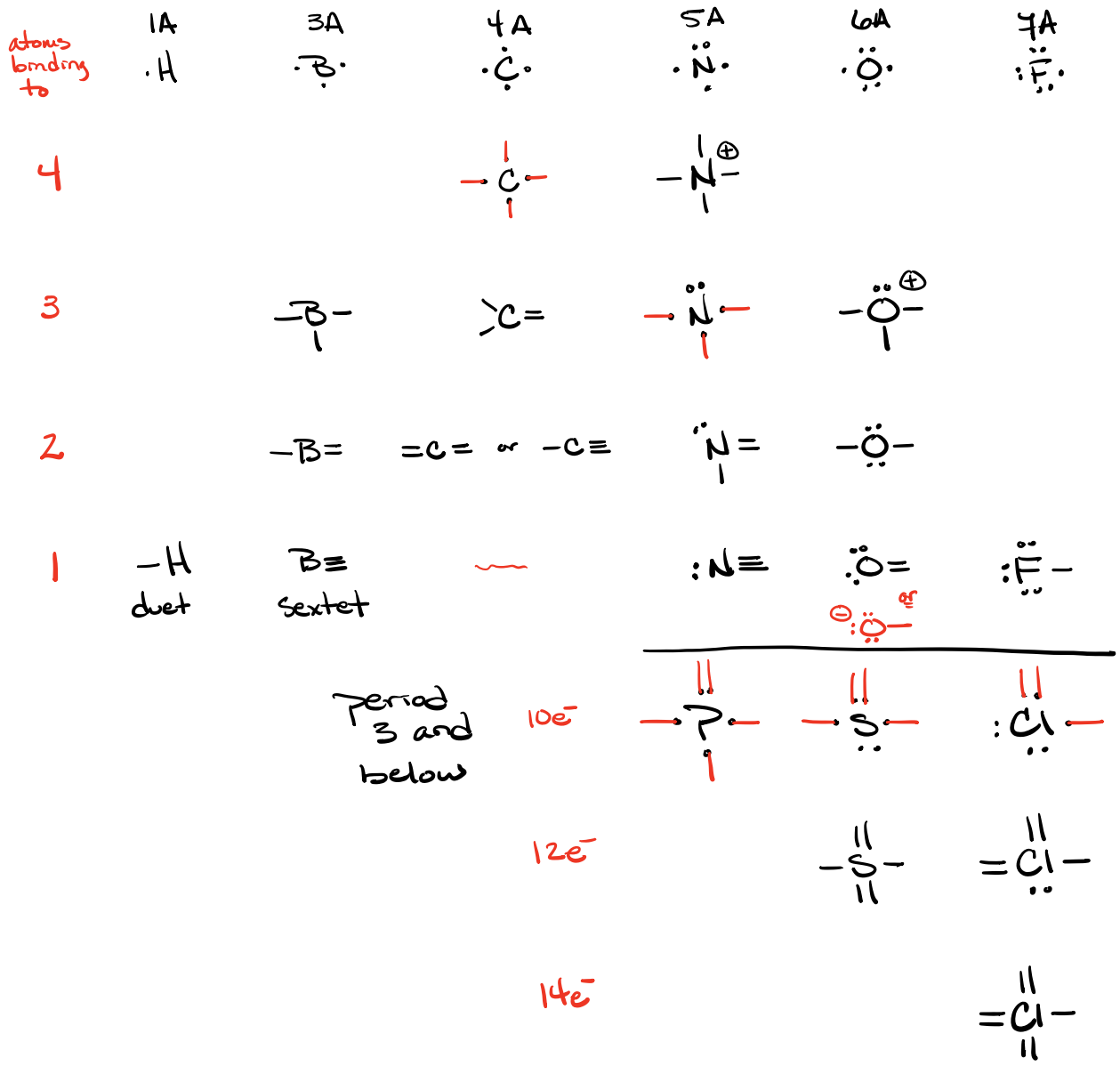
Can exceed an octet

10, 12, 14 e^- exceptions



Lewis Structures - Common Bonding Patterns For Representative Elements




atoms bonding to
1A
3A
4A
5A
6A
7A
4
3
2
1
H
duet
B
sextet
Period 3 and below
10e⁻
12e⁻
14e⁻
or

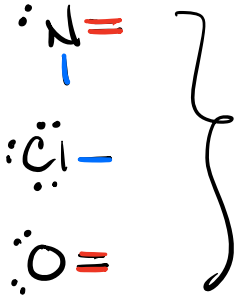
NOCl

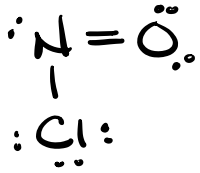
2 atoms

N 1 × 5e⁻ = 5e⁻
O 1 × 6e⁻ = 6e⁻
Cl 1 × 7e⁻ = 7e⁻
18e⁻

Cl – N – O

Cl bound to 1 · oxygen bound to 1





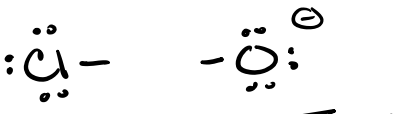
18e⁻ ✓
octets ✓
Formal charge ✓

OCl⁻ ← anion

hypochlorite ion

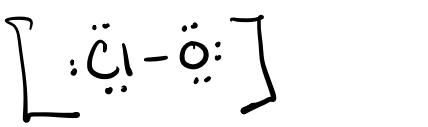
extra e⁻

O 1 × 6e⁻ = 6e⁻
Cl 1 × 7e⁻ 7e⁻
13e⁻ ← odd #
+1e⁻
14e⁻ even # ✓



Formal

=



net

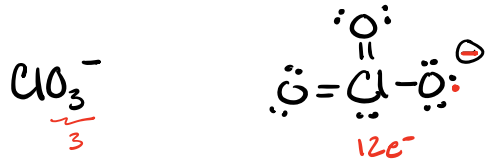
Formal Resides or is carried by an atom. A structure may have many formal charges

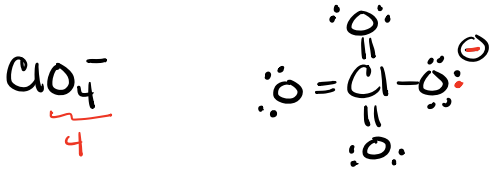
net = Sum of formal charges

$Cl^{\ominus}$

OCl^- — 1 —  — 8e⁻ — hypochlorite

ClO_2^- — 2 —  — 10e⁻ — chlorite

ClO_3^- — 3 —  — 12e⁻ — chlorate

ClO_4^- — 4 —  — 14e⁻ — perchlorate

Positive Charge

H_3O^+ ← 1 less e⁻

3

H: 3 × 1e⁻ = 3e⁻

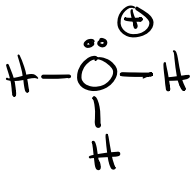
O: 1 × 6e⁻ = 6e⁻

9e⁻ ← odd # !

−1e⁻

8e⁻ even # !

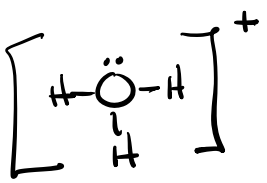
H– × 3 –Ö–



8e⁻ ✓

octet ✓

formal charge ✓



Hydrodium ion

multicentered Structures

must be given some structural information

$C_2H_4O_2$ ⇐ no structural info

CH_3CO_2H (C-C) hydrogen on end is bound to oxygen

CH_3-CO_2H

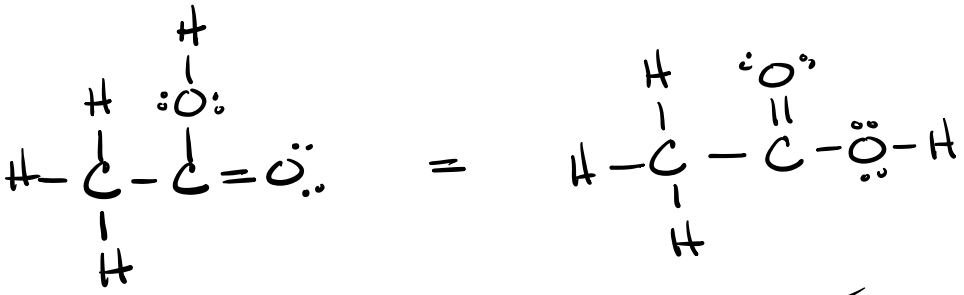
↑ bound to 4 ↑ bound to 3

C 2 × 4e⁻ = 8e⁻

H 4 × 1e⁻ = 4e⁻

O 2 × 6e⁻ = 12e⁻

24e⁻



24e⁻ ✓

octet ✓

formal Charge ✓

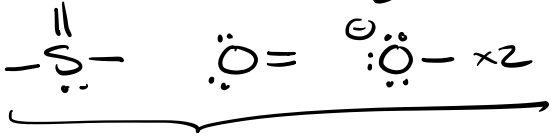
↳ really for period 3 & below or if an ion

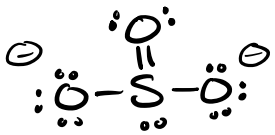
no Charge

SO_3 Sulfur trioxide ⇒ not SO_3^{2-} Sulfite

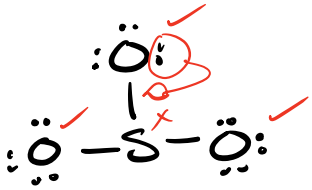
S 1 × 6e⁻ = 6 e⁻
O 3 × 6e⁻ = 18e⁻
24e⁻

Common Bonding Pattern ✗





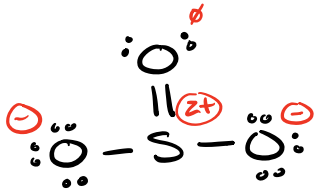
26e⁻ ✗



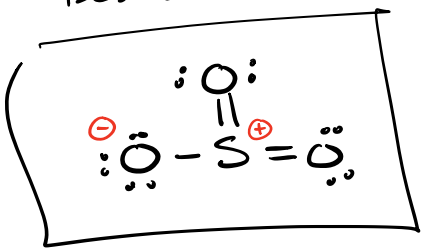
24e⁻ ✓
octet ✗

⇒ Not really Fair at this level

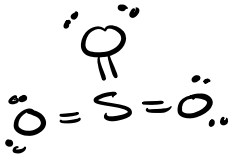
Best answer



24e⁻ ✓
octet ✓
Formal Charge ?



24 ✓
octet ✗ 10e⁻ on Sulfur
Formal Charge lower



24e⁻ ✓
12e⁻ on S
no Formal Charges