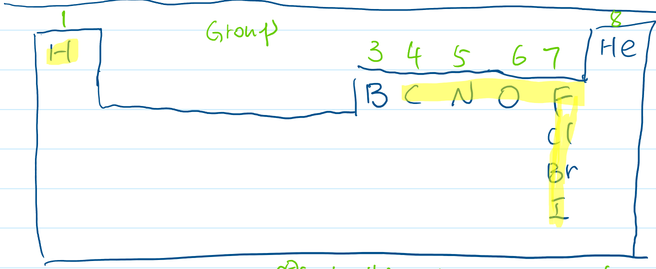
MTW1 8-29

Monday, August 29, 2022 4:26 PM

Topics : Lewis Dot Structures
Octet Rule
Formal charge
Drawing Lewis structures from condensed structural formula



These are the atoms that we care about in Ochem

$e^{\ominus}s$ in the outer most shell of atom

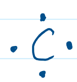
Group # = # of valence $e^{\ominus}s$ that atom has in its neutral non-bonded state (exception : He)

Lewis Dot Structures → illustrate valence $e^{\ominus}s$ and bonding in molecules

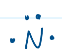
↳ symbol of element (letter(s)) surrounded by # valence $e^{\ominus}s$ (dots)

e.x.

Carbon



Group 4 = 4 valence $e^{\ominus}$



Group 5 = 5 valence $e^{\ominus}$

Octet Rule: atom like to have filled valence shell

↳ for Group 1-7 elements react to achieve 8 valence $e^{\ominus}s$ (exception : H, He, Li)

Covalent Bond: · atoms share $e^{\ominus}s$ to fill their valence shells
· These are the bonds C, N, O make

Make Lewis Dot Structures:

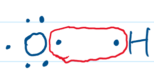
① Determine # of valence $e^{\ominus}s$ for each atom

↳ # valence $e^{\ominus}s$ for each atom in the neutral non-bonded state (Recall group #)

↳ add / subtract $e^{\ominus}s$ for formal charges

e.x.

OH (neutral)



make bond

⇒

2 valence $e^{\ominus}s$

Counting valence $e^{\ominus}s$:

· all LPs

$\cdot\ddot{\underset{\cdot\cdot}{O}}\cdot \quad \cdot H \Rightarrow$ make a bond $\quad \cdot\ddot{\underset{\cdot\cdot}{O}} - H$

↑ 7 valence $e^{\ominus}s$

Counting valence $e^{\ominus}s$:
- all LPs
- $2e^{\ominus}s$ / bond

$:\ddot{\underset{\cdot\cdot}{O}}^{\ominus} - H$

8 valence $e^{\ominus}s$!

- $1e^{\ominus}$ from H
- $6e^{\ominus}$ from O
- $1e^{\ominus}$ from $\ominus$

② Determine <u>connectivity</u> of atoms

↳ arrangement / bonding of atoms

e.x H_2O →

H – ~~H~~ – O

as drawn, this H has <u>4</u> valence $e^{\ominus}s$ ⇒ NOT HAPPENING

$H\cdot \; \cdot\ddot{\underset{\cdot\cdot}{O}}\cdot \; \cdot H$

|||

$H - \ddot{\underset{\cdot\cdot}{O}} - H$

$2e^{\ominus}$ $\quad$ $8e^{\ominus}$

③ Connect atoms w/ single bonds then put remaining $e^{\ominus}s$ on atoms to <u>fullfill valence</u>

↳ $8e^{\ominus}$ C, N, O, X

↳ $2e^{\ominus}$ H

"X" = halogens (X = F, Cl, Br, I)

Let's make CH_4 (methane)

↳ C = group 4 = 4 valence $e^{\ominus}s$

H = group 1 = 1 valence $e^{\ominus}$

$\cdot\dot{\underset{\cdot}{C}}\cdot \quad \cdot H \quad \cdot H \quad \cdot H \quad \cdot H$

```
    H
    :
H : C : H
    :
    H
```

$2e^{\ominus}$ – 1 C–H

$8e^{\ominus}$ – 4 C–H

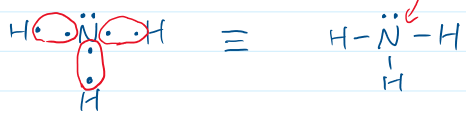
|||

```
    H
    |
H - C - H
    |
    H
```

<u>Ammonia</u> (NH_3)

$H\cdot \; \cdot\ddot{N}\cdot \; \cdot H \equiv H - \ddot{N} - H$

$8e^{\ominus}s$
- 6 from 3 N–H
- 2 from LP



8 e⁻s ← 2 from LP

Formal charge : a book keeping tool for counting
keeping track of the # of valence e⁻s

To Calculate :
① Draw the correct Lewis Dot Structure

② Assign each atom:
- 1 e⁻ from each covalent bond (line)
- all unshared / non-bonding e⁻s (dots)

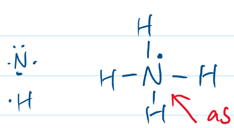
③ Compare this # with the # of valence e⁻s in neutral non-bonded state (group #)

Formal Charge = # Valence e⁻s in neutral non-bonded state − (# of unshared e⁻s + 1/2 of all shared e⁻s)

Valence e⁻s in neutral non-bonded state ⇓ group
of unshared e⁻s ⇓ # e⁻s in LPs
1/2 of all shared e⁻s ⇓ # bonds

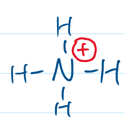
Overall molecular charge: the sum of all formal charges in the molecule.

e.x. what is the formal charge in Ammonium (NH_4)?



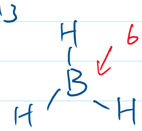
as drawn, 9 e⁻s !

have to give 1e⁻ ⟶



5 − (0 + 4) = 1
↑ group # ↑ # of LPs ↑ # of bonds

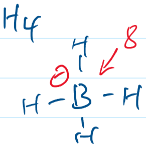
BH_3



6 valence e⁻s

F.C on B: ∅   3 − (0 + 3) = ∅

BH_4



8 valence e⁻s

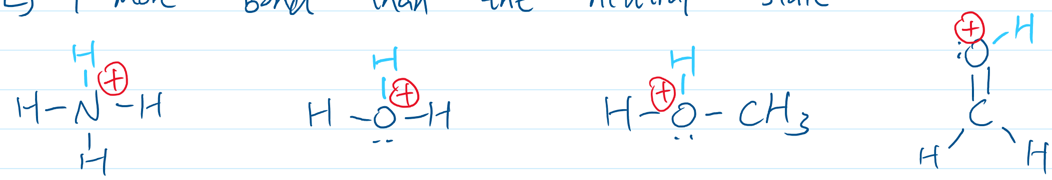
F.C on B: −1   3 − (0 + 4) = −1

(X = F, Cl, Br, I)

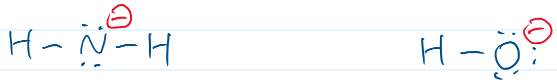
Thoes are the Neutral Bonding Patterns for C, N, O, X (X = F, Cl, Br, I)
- all neutral
- all have filled valence

For atoms w/ filled octet:

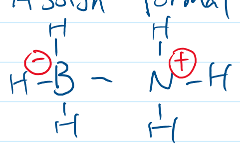
↳ 1 more bond than the neutral state → ⊕ (-Onium)



↳ 1 fewer bond than the neutral state → ⊖



e.x. Assign formal charges below: group# #LP # of bonds



B: $3 - (0 + 4) = -1$

N: $5 - (0 + 4) = +1$

Lewis structures from the condensed structural Formula

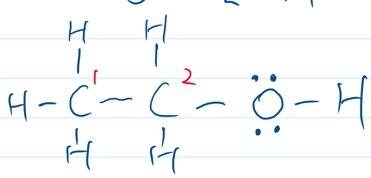
↳ $CH_3CHOHCH_3$

① Determine the bonding between atoms

↳ read left-to-right

↳ keep in mind # of bonds / LPs for each atom to have a filled valence.

e.x. $\overset{1}{C}H_3\overset{2}{C}H_2OH$



ethanol

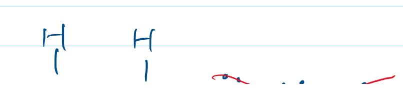
② Determine how many valence e⁻s have been used for bonding

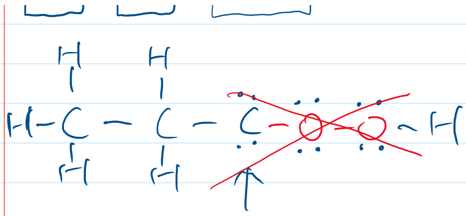
③ Add multiple bonds to eliminate unbonded e⁻s

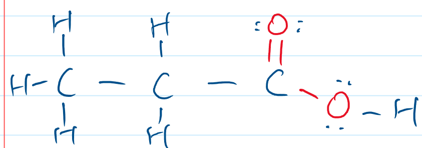
Draw non-bonded e⁻s as L.Ps

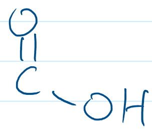
↳ avoid charges when possible

e.x. $\overset{1}{C}H_3\ \overset{2}{C}H_2\ \overset{3}{C}OOH$ ($CH_3CH_2CO_2H$)



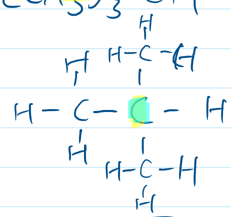




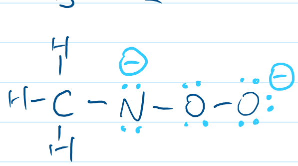
 } COOH , } CO_2H

" Carboxylic acid"

$(CH_3)_3CH$



CH_3NO_2



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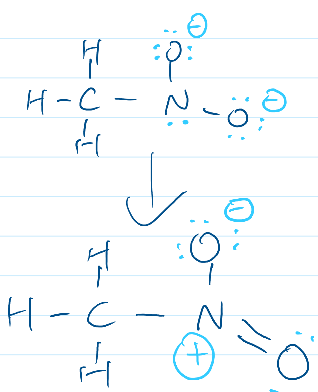

CH_2CH_2