BERKELEY MATH CIRCLE

The Math of Chemistry: Building Molecules & Their Geometric Shapes Part III

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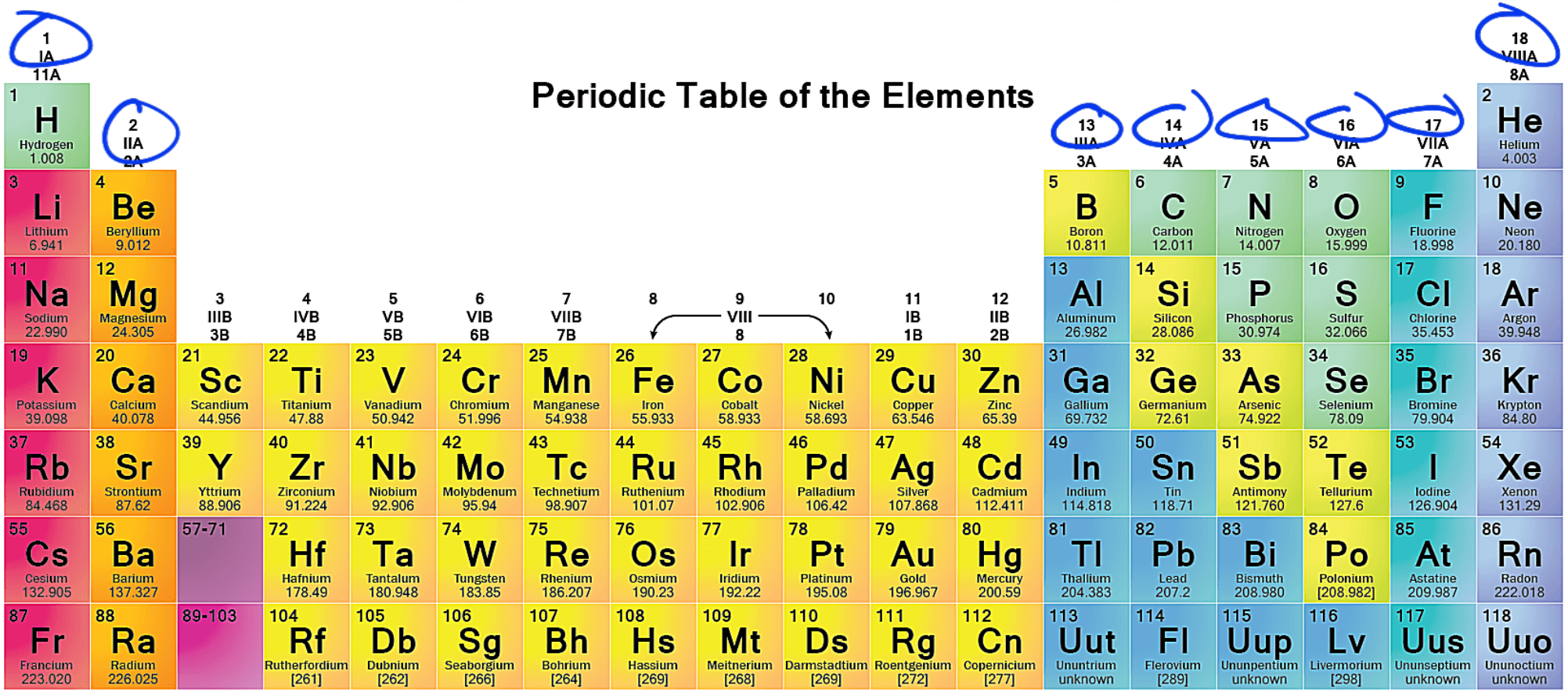
Rules from 1st Lecture

Ground Rules	Number of Electrons Drawn	Dot Diagrams
• Octet Rule (except Hydrogen) • Single Bonds • Double Bonds • Triple Bonds • Lone Pairs	• Obtained from the Periodic Table • Column's 1-8 = # of e's	• Four sides to our atom symbol • One dot per side first • After, electrons can be paired



VSEPR Theory Review

VSEPR Theory = **V**alence **S**hell **E**lectron **P**air **R**epulsion Theory

Electrons REPEL each other since they are negatively charged. Therefore, bonds repel each other since they contain electrons. Similarly, electron pairs, that can be found on atoms, also repel bonds and other electron pairs. All bonds (single, double, triple) and electron pairs that are attached to the same central atom need to simultaneously repel each other and stay attached!

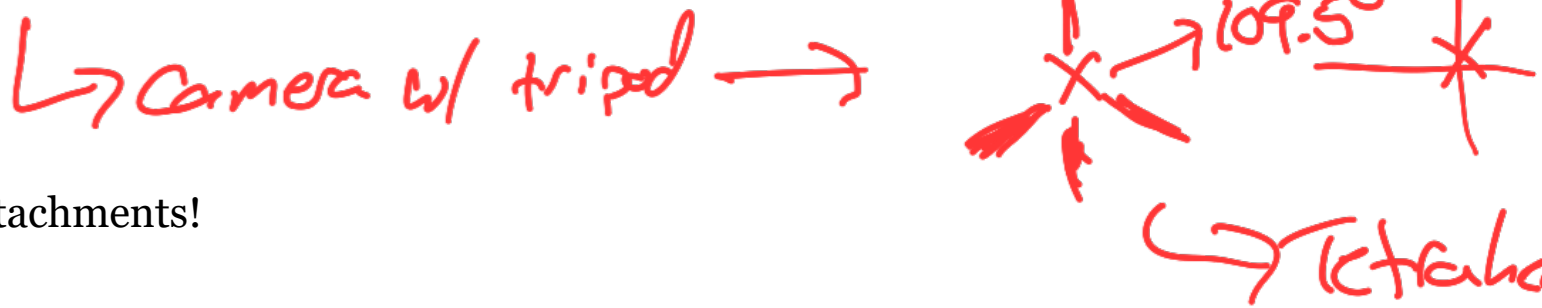
Rules from 2nd Lecture

1. Identify your central atom (more than one can exist!).
2. COUNT how many separate attachments are on THAT atom.
3. One attachment = single bond, double bond, triple bond, or an electron pair.
4. EACH one of these counts as ONE attachment!
5. Place all attachments around your central atom in a way that MINIMIZES their interaction while SIMULTANEOUSLY staying attached. 2D and 3D options may exist.

VSEPR Shapes!

Let's review how to hold 1, 2, & 3 attachments!

Let's review how to hold 4 attachments!



Let's review how to hold 5 attachments!

Let's review how to hold 6 attachments!

NOW, let's explore if some of those attachments are electron pairs instead of bonds!

H_2

180°

Linear

1 attachment

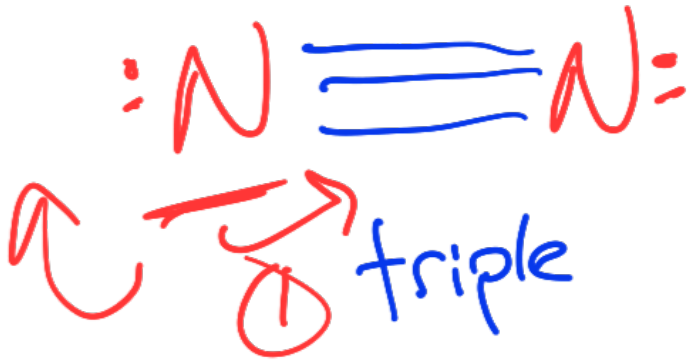
CO_2

Linear

2 Attachments

(2 bonds)

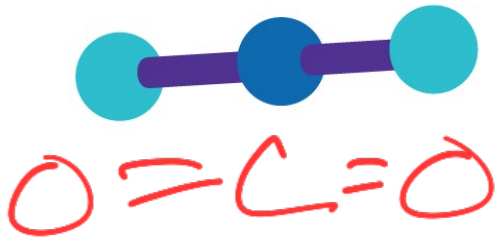
N_2



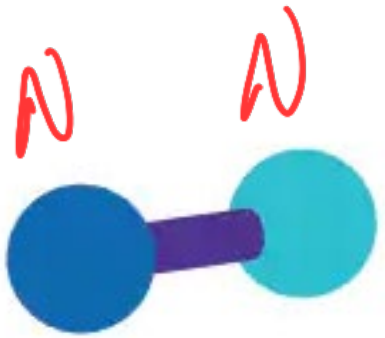
Linear

2 Attachments (1 bond + 1 e⁻ pair)

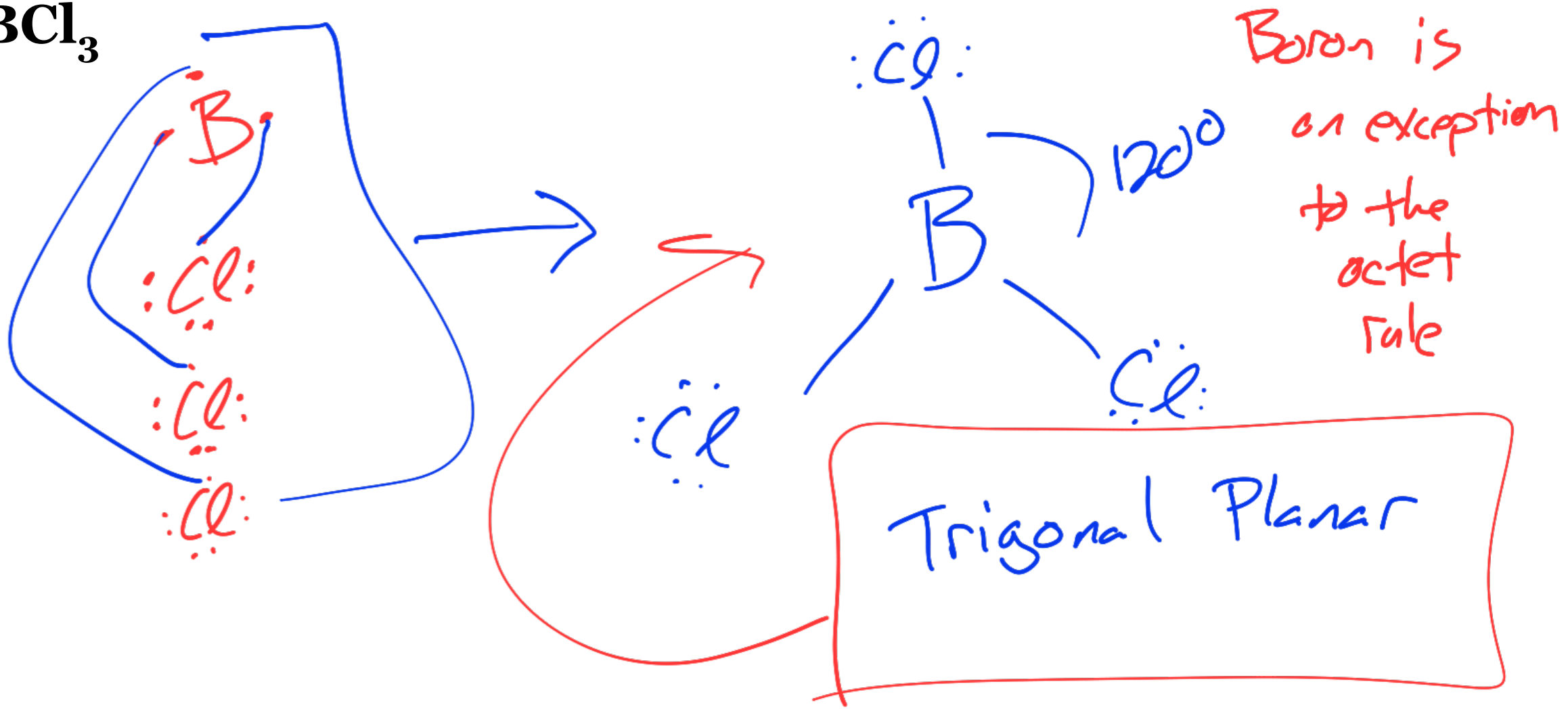
CO_2



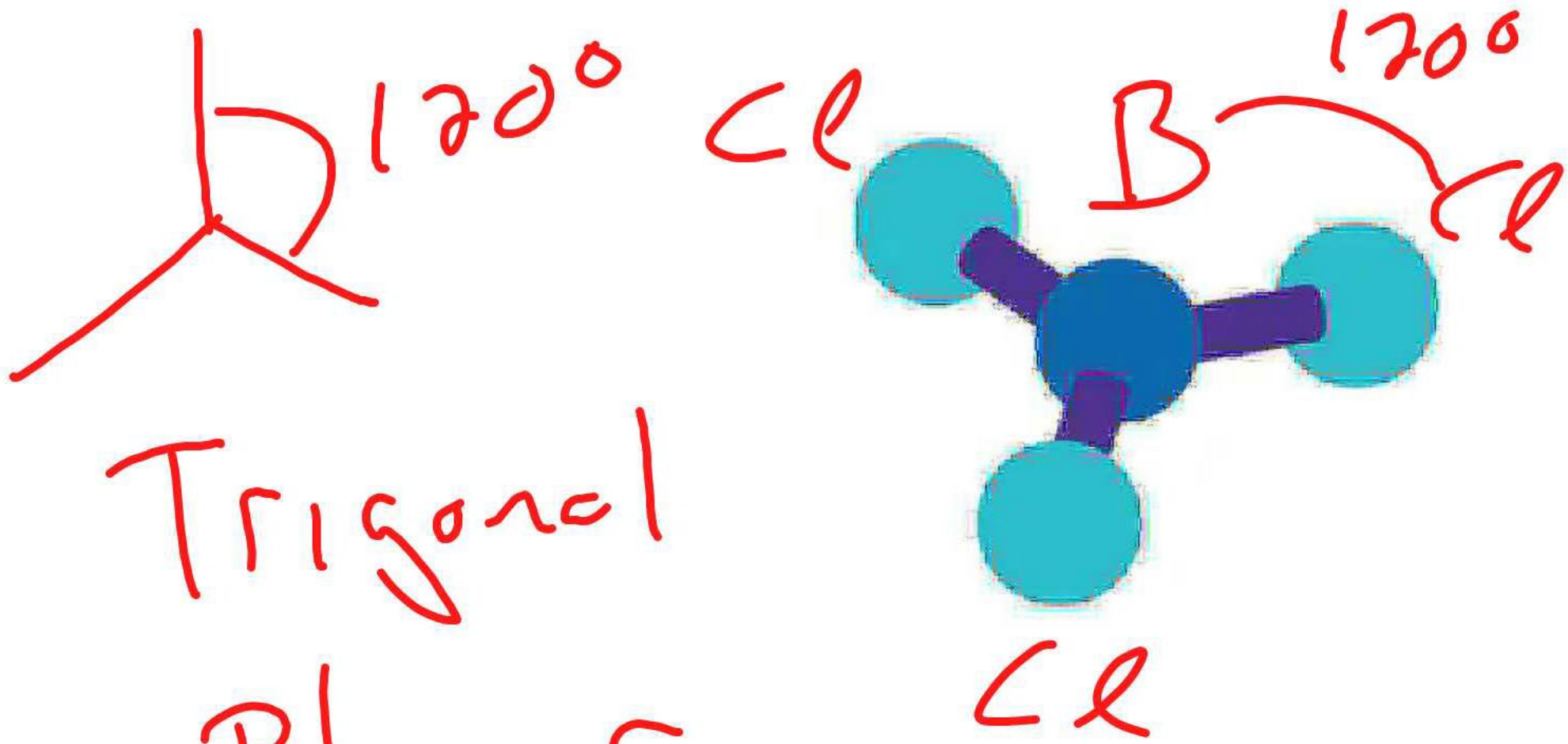
N_2



BCl_3

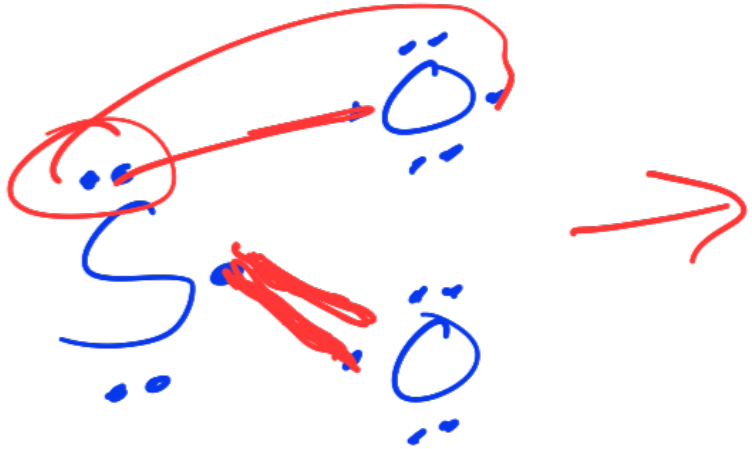

B
Cl
Cl
Cl
Cl
Cl
Cl
B
Cl
120°
Boron is an exception to the octet rule
Trigonal Planar

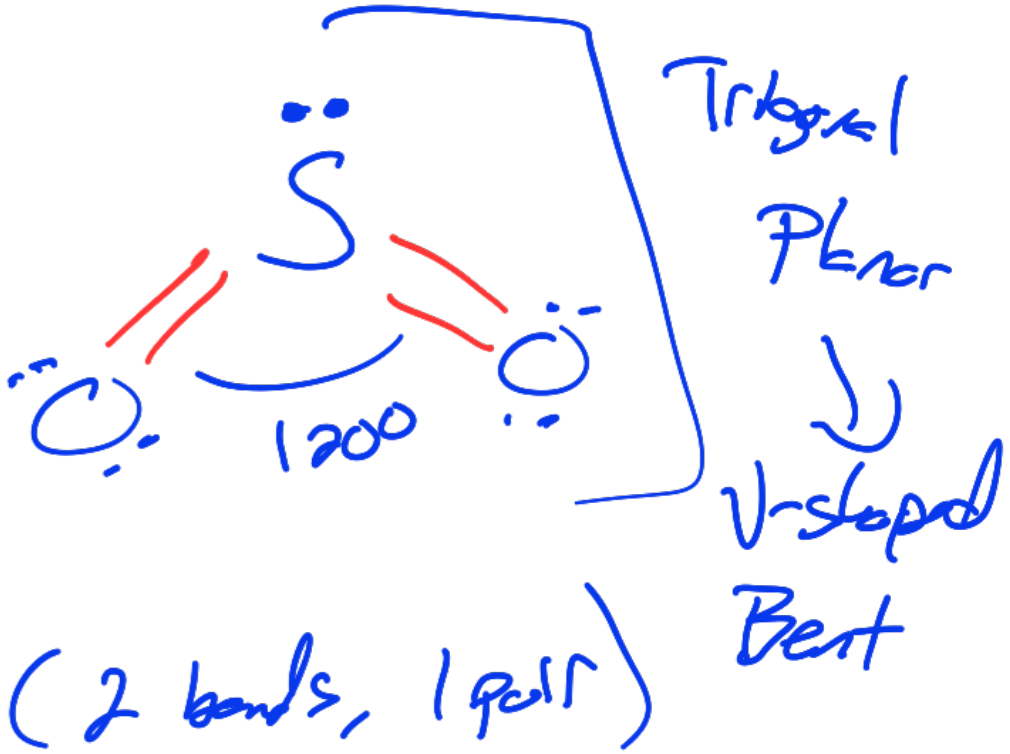
BCl_3



Trigonal Planar

SO_2





Trigonal Planar

↓

V-shaped Bent

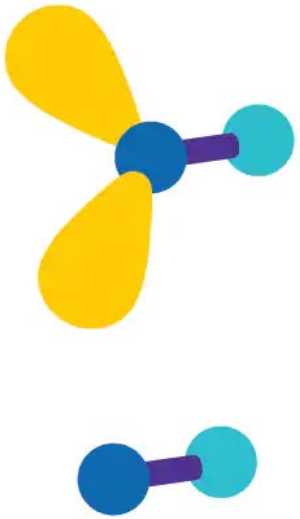
(2 bonds, 1 pair)

O_2

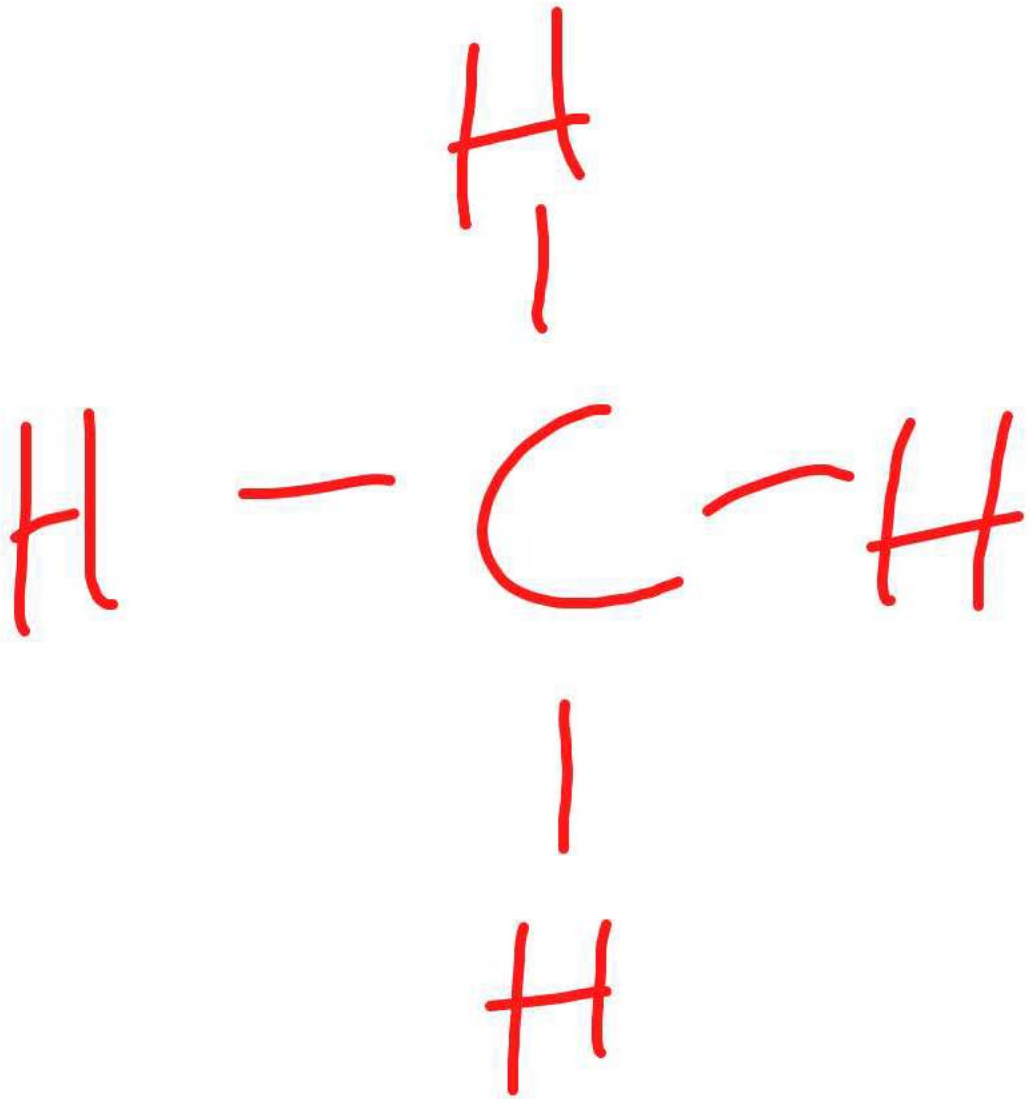
Trigonal Planar
(1 bond, 2 pairs) → linear

SO_2

O_2



CH_4



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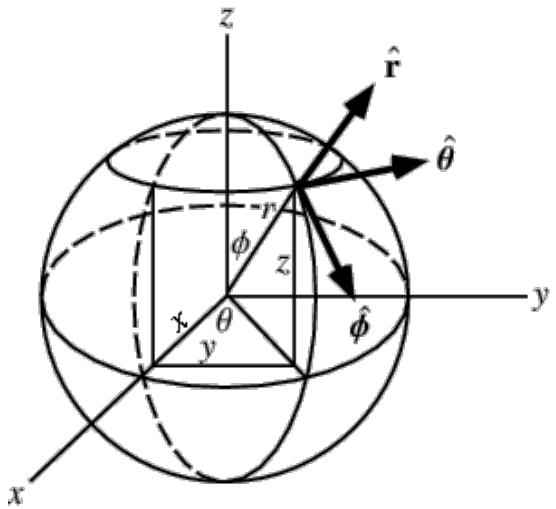
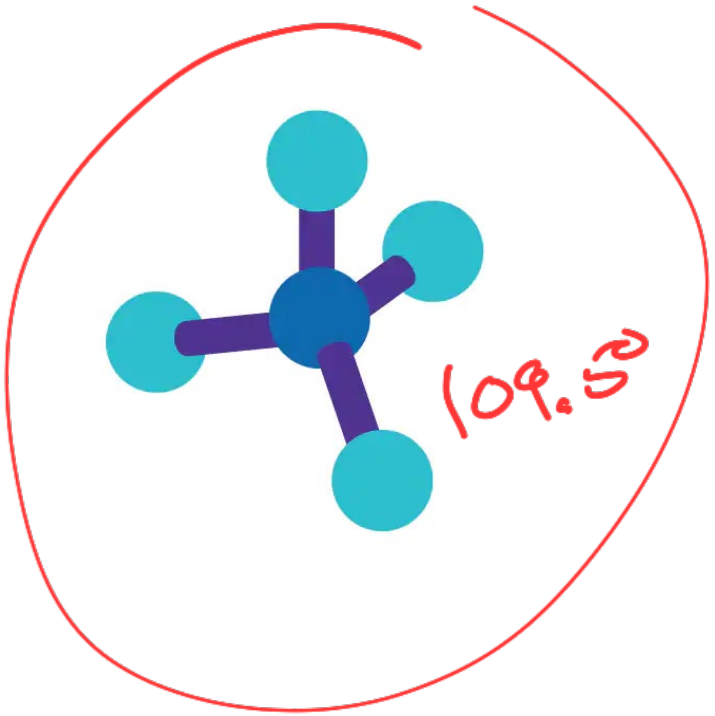
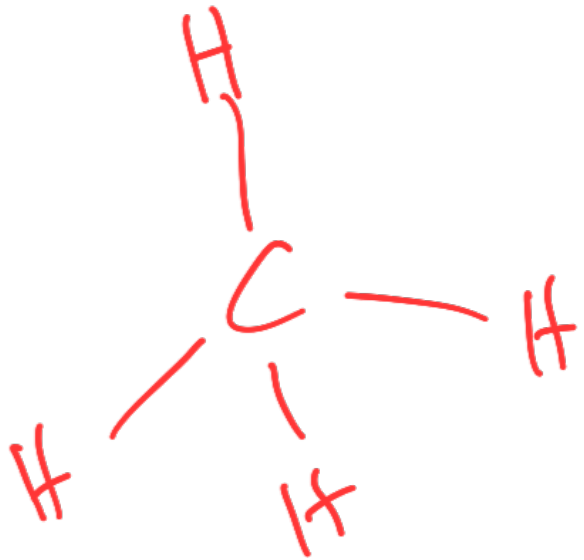
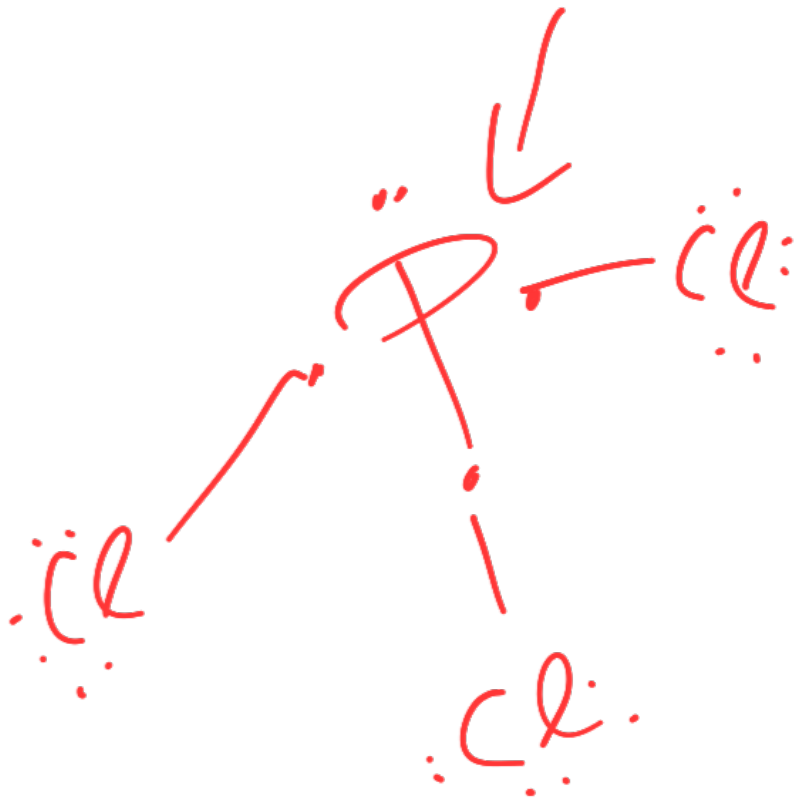






PCl_3



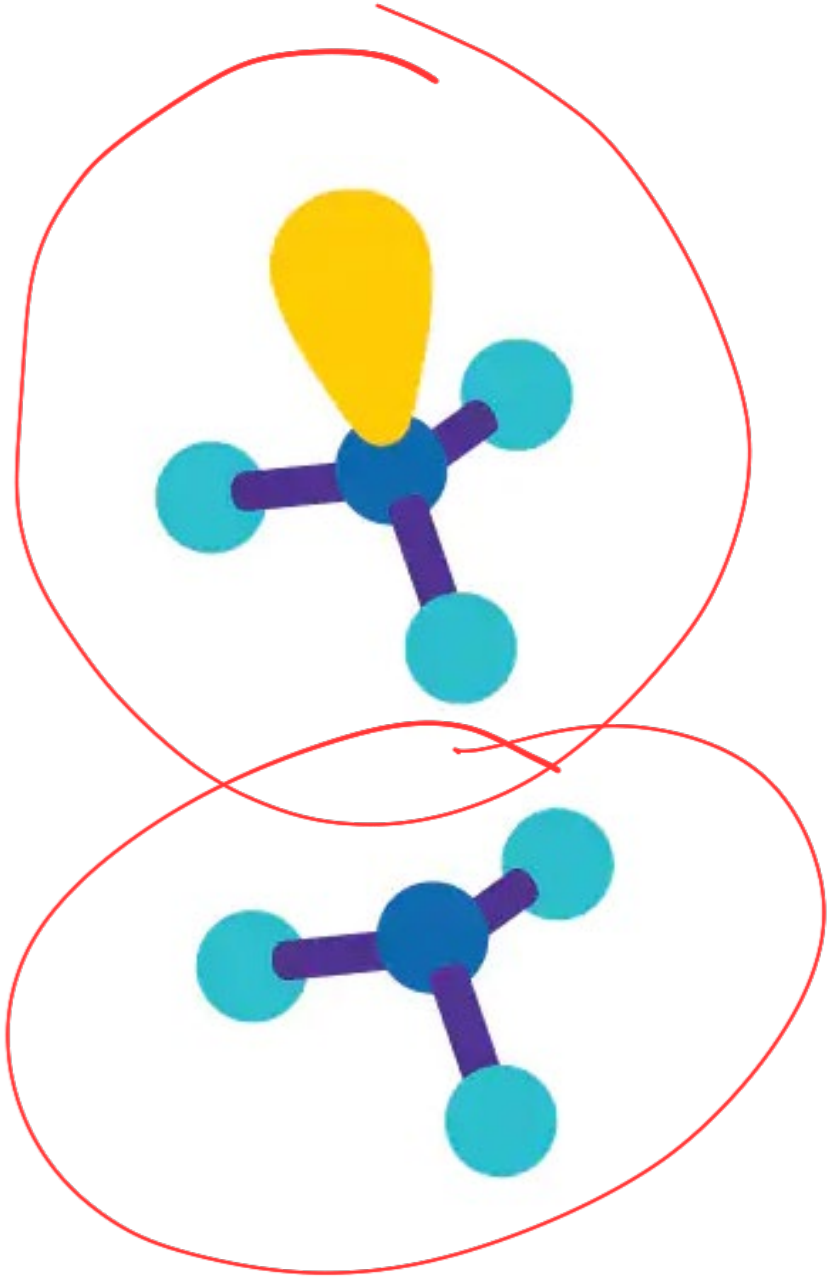
4 attachments

↳ 3 + 1

Trigonal

Pyramidal

PCl_3



H_2O

4 attachments

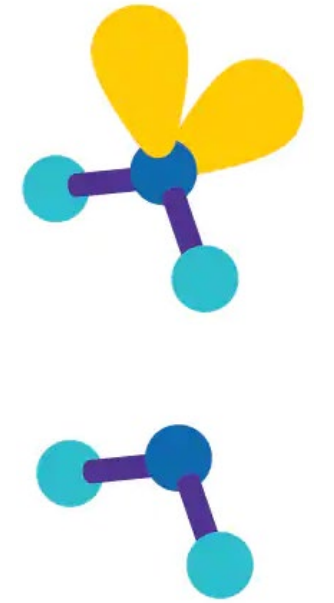
(2 + 2) V-shaped

HF

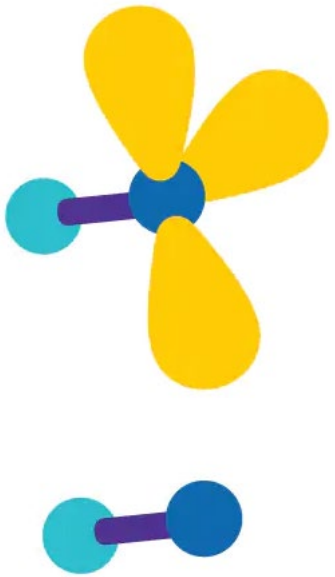
4 attachments

(1 + 3) Linear

H_2O

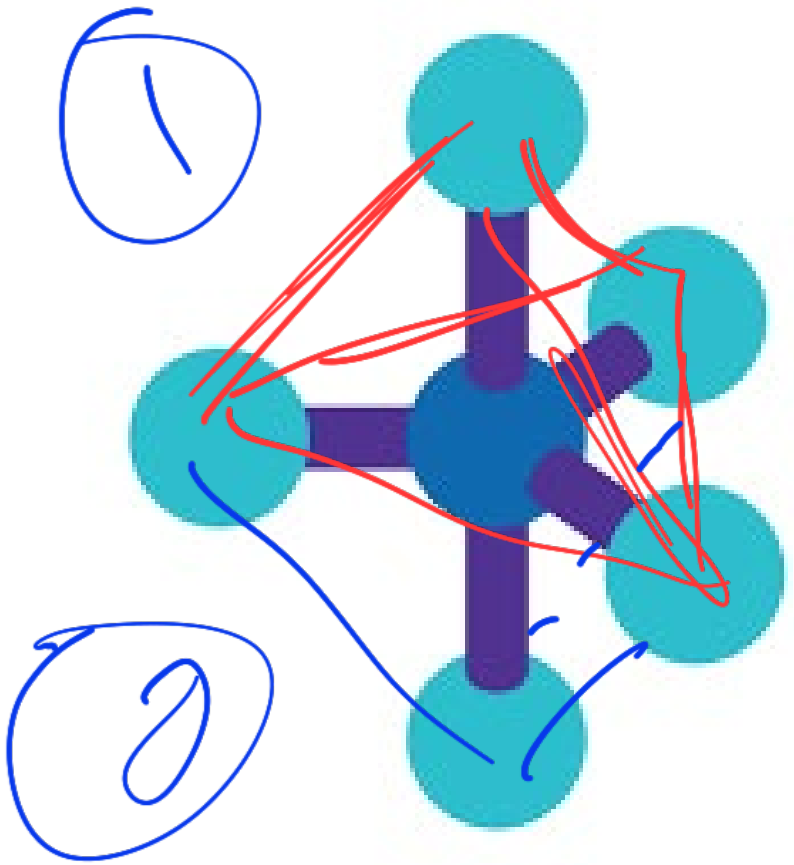


HF

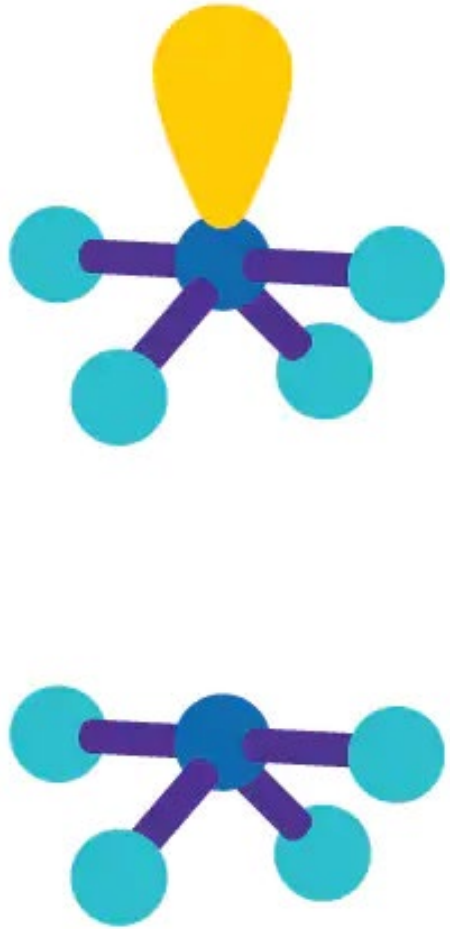


PCl_5

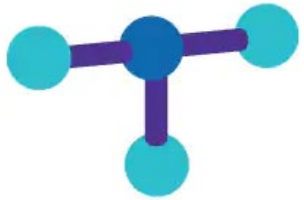
Trigonal Bypyramidal



SF_4



ClF_3



I_3^-