BERKELEY MATH CIRCLE

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

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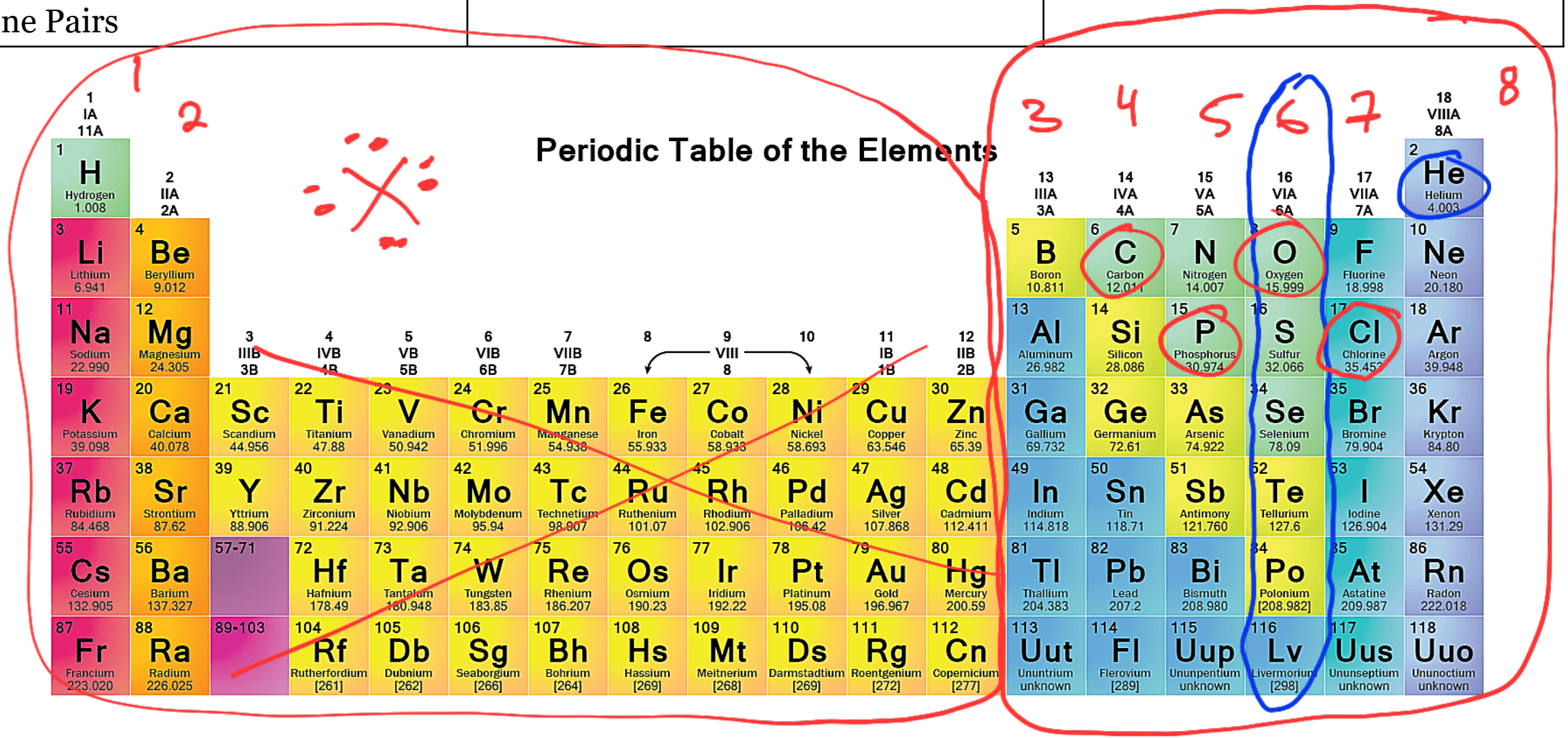
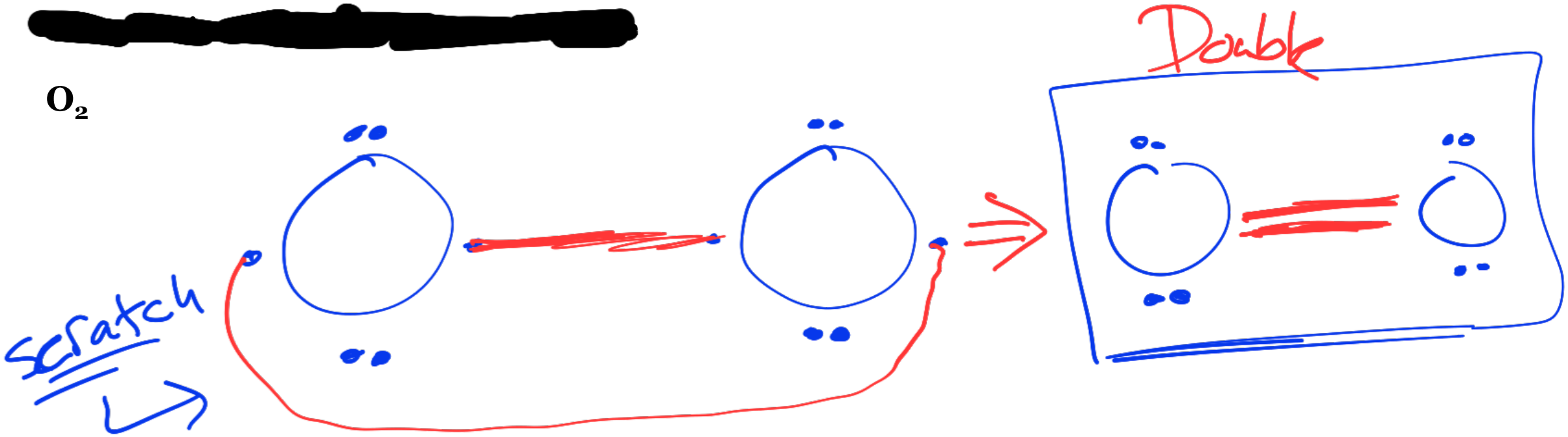
Ground Rules	Number of Electrons Drawn	Dot Diagrams
• Octet Rule (except Hydrogen) • Single Bonds • Double Bonds • Triple Bonds • Lone Pairs	• Obtained from the Periodic Table • Column's 1-8 = # of e's	• Four sides to our atom symbol • One dot per side first • After, electrons can be paired

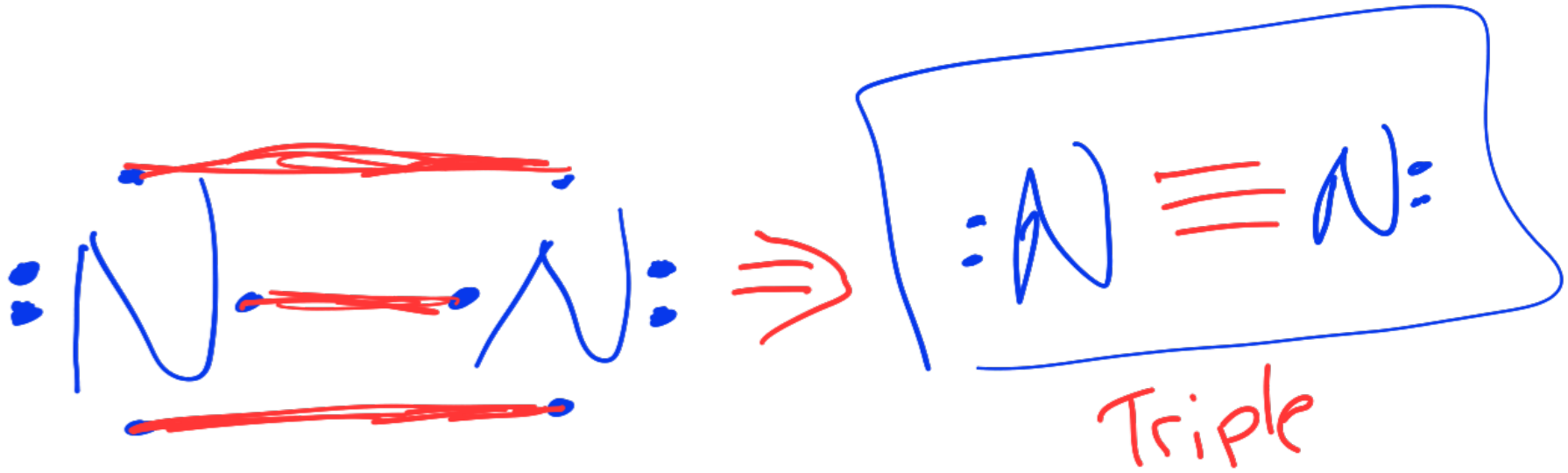


[redacted]

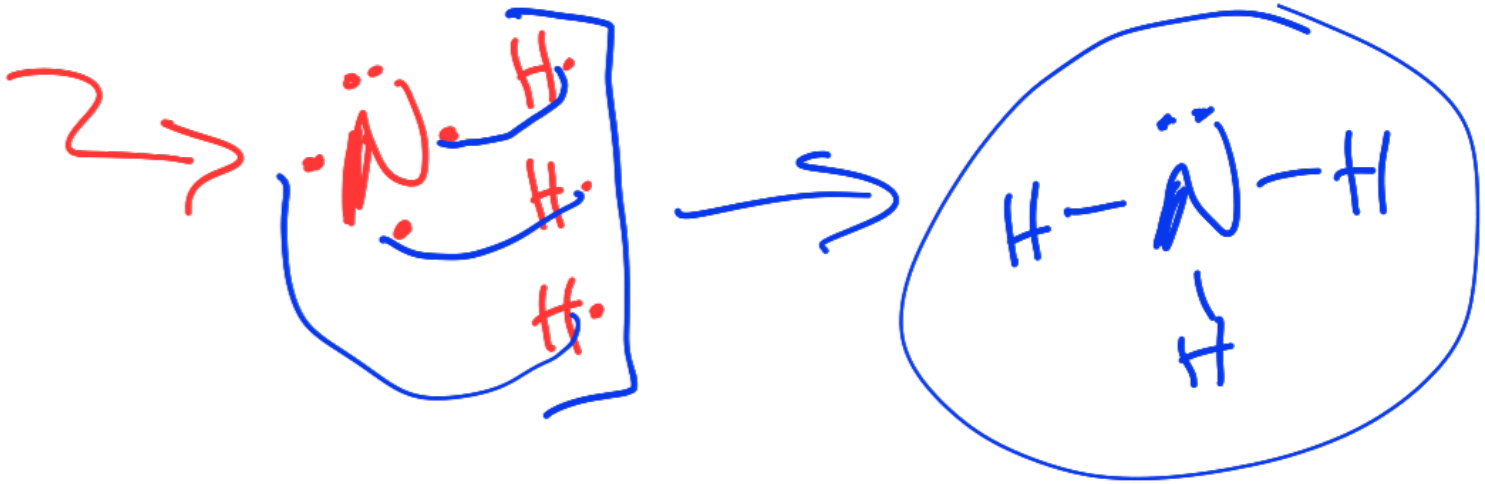
O_2



N_2



NH_3 (hw)

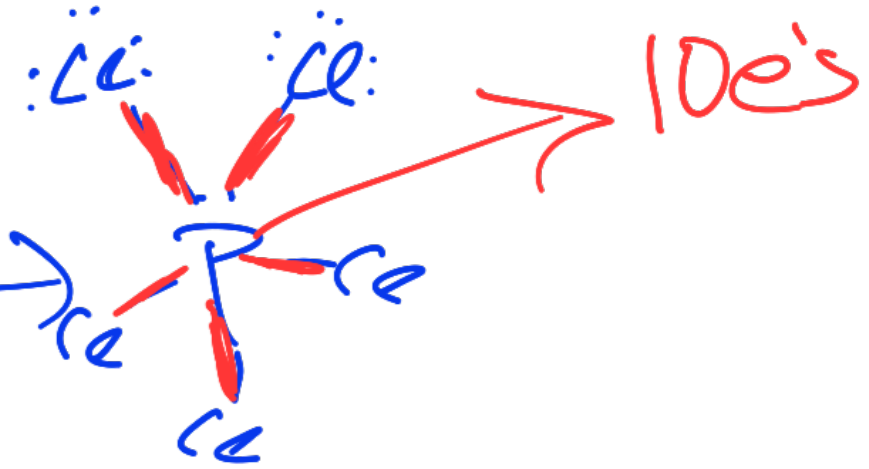


H_2S (hw)

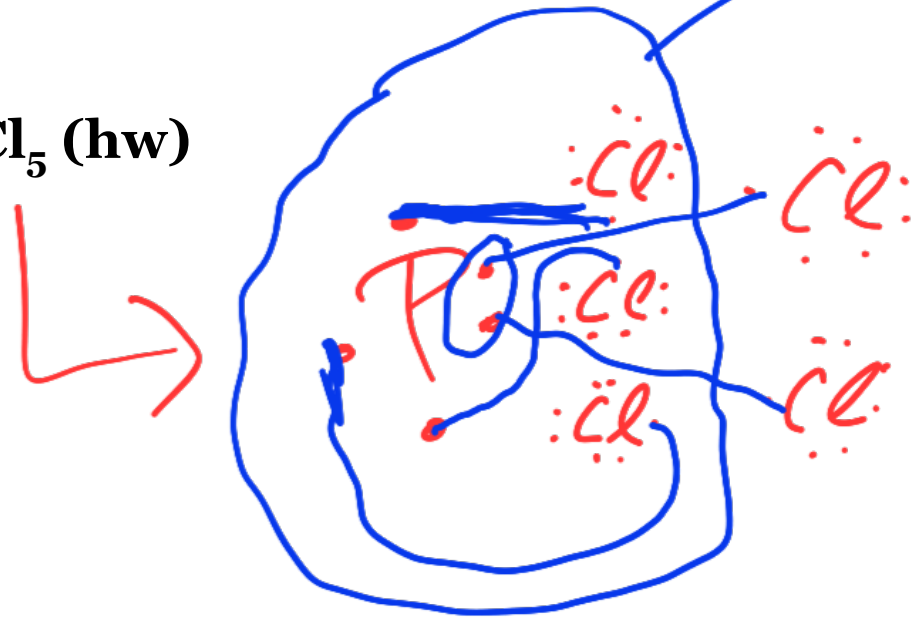
HCN

Let's have fun drawing some EXCEPTIONS (electrons may need to be moved and/ or the Octet rule may be broken!)

CO



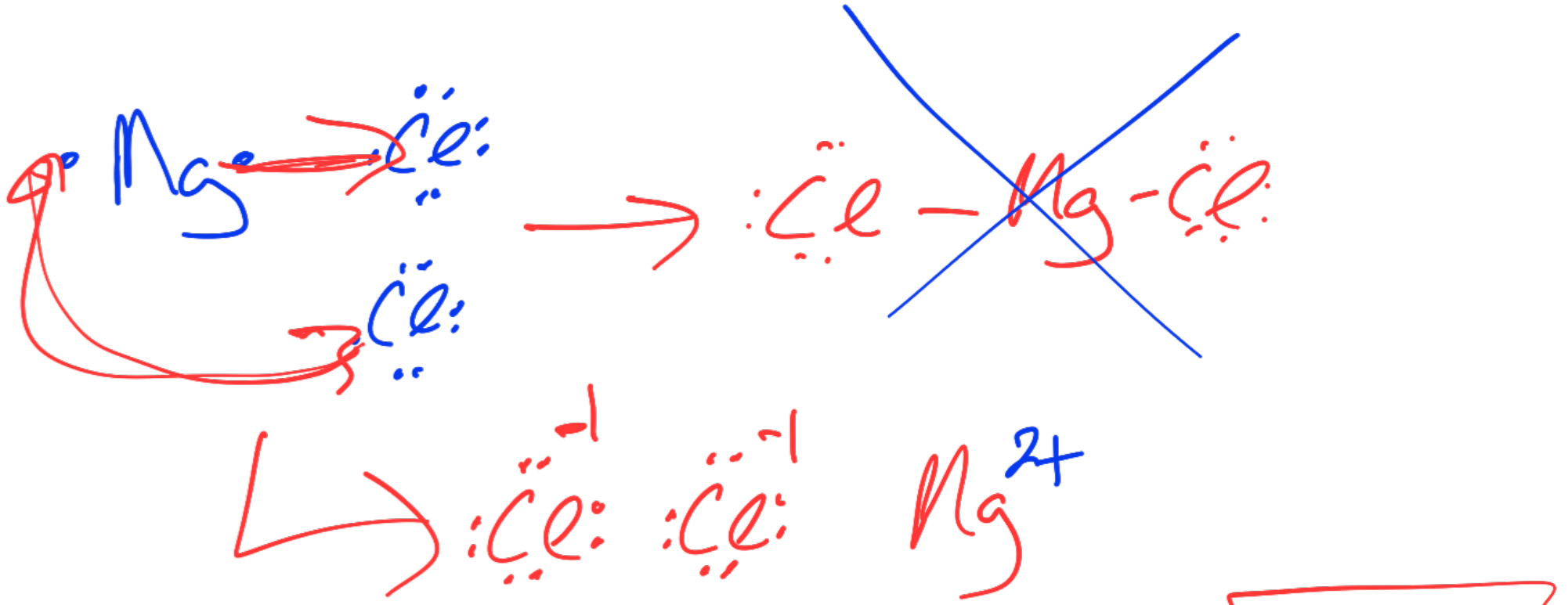
PCl_5 (hw)



Two Bond types in Chemistry

1) Covalent Bonds: formed from non-metal element with non-metal (sometimes a metalloid with a non-metal). Electrons in these bonds are shared (i.e., what we have been doing – single, double and triple bonds!)
2) Ionic Bonds: formed from metal with non-metal. In these bond types, electrons are taken or given away. For example:

$MgCl_2$



We have been (and will only) focus on Covalent Bonds (the first type above), as that gets us into VSEPR Theory!

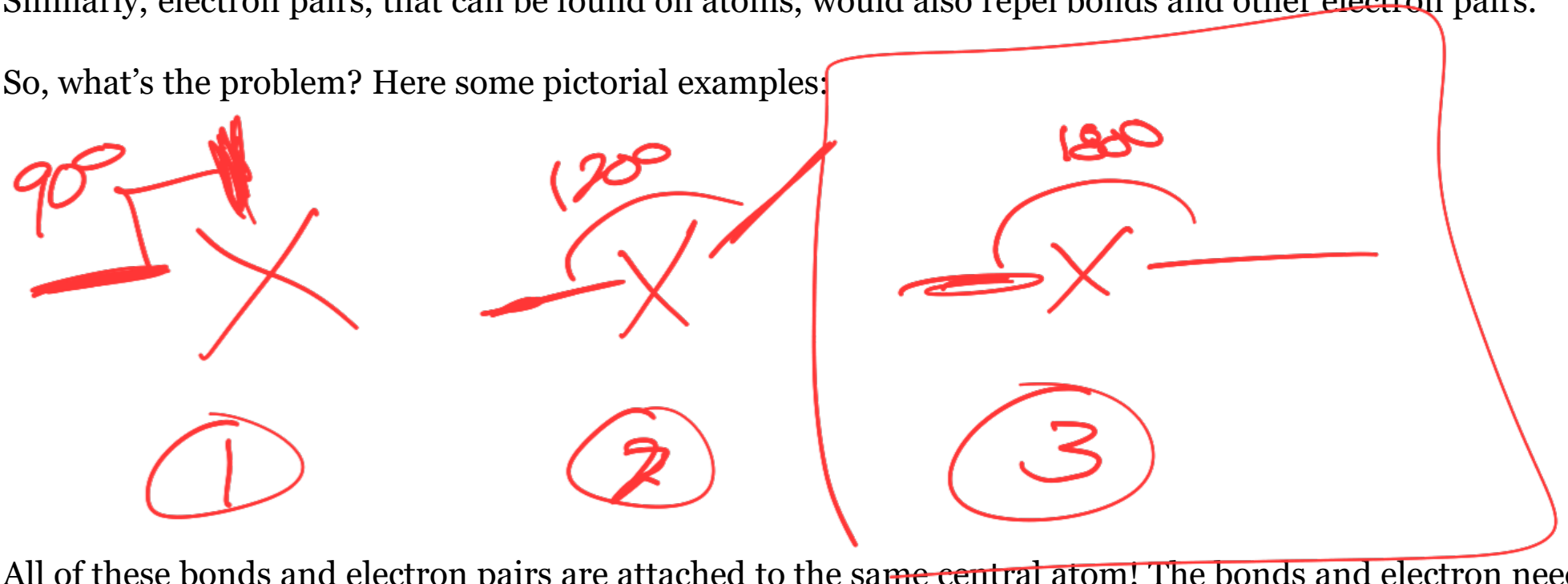
VSEPR Theory

What is VSEPR Theory?

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

Since electrons REPEL each other, it makes sense that bonds would repel each other since they contain electrons. Similarly, electron pairs, that can be found on atoms, would also repel bonds and other electron pairs.

So, what's the problem? Here some pictorial examples:



All of these bonds and electron pairs are attached to the same central atom! The bonds and electron need to stay attached while simultaneously repelling each other!

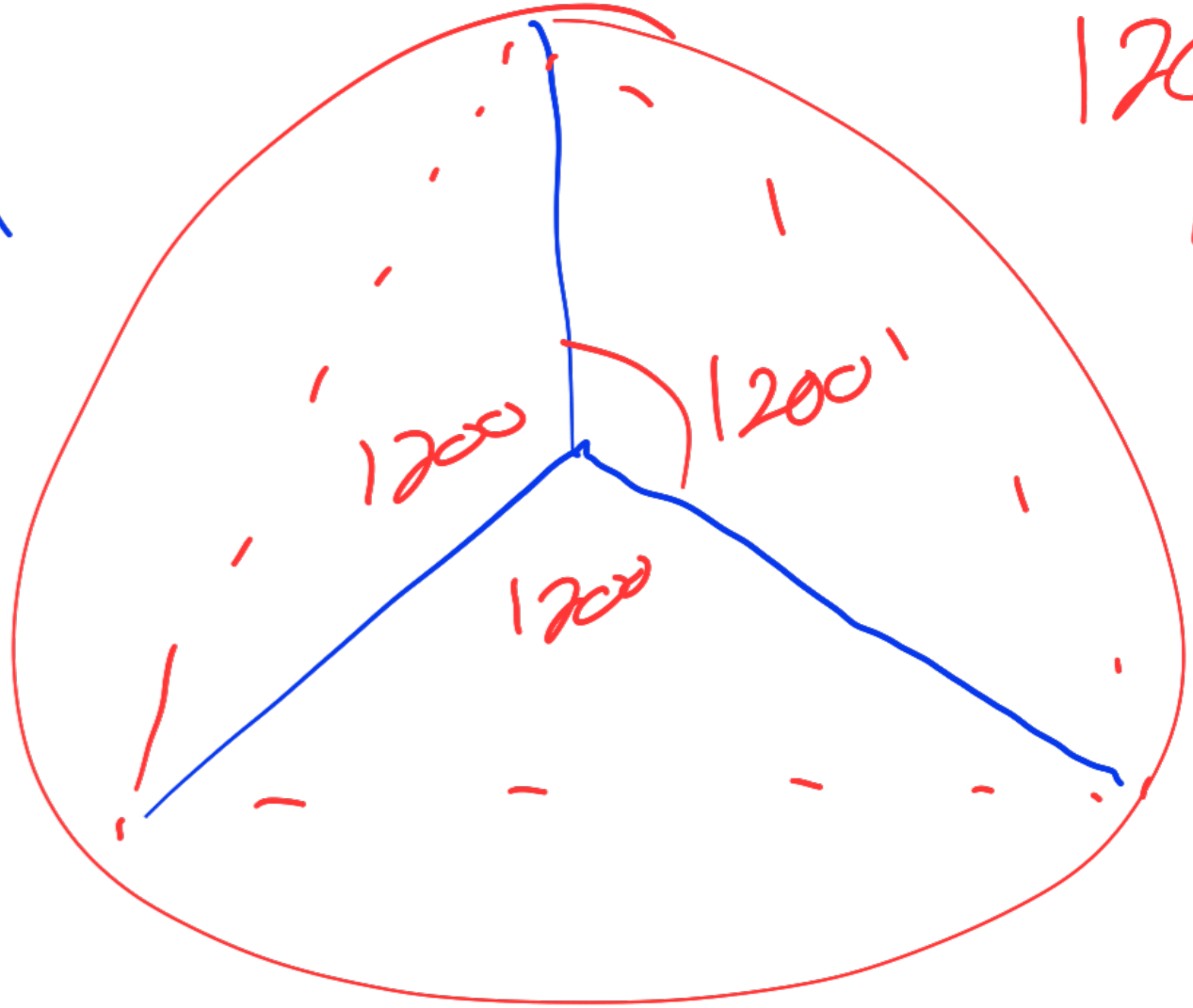
This causes them to take on specific shapes. We will use the rest of this lecture to explore those shapes!

As before, here are some ground rules to use!

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.

Let's look at some of our previous work to start to think about these shapes, and we can even try some new Lewis Structures!

Trigonal Planar



$120° \rightarrow \frac{360}{3}$

Reviewed 1, 2, + 3 attachments.

W/ Beg. II, we added 4 attachments