Chemistry 122 – Recitation I

- TA: Yu Kay Law
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  - Website: http://www.chemistry.ohio-state.edu/~ylaw/122/
    - Recitation slides/additional handouts.
  - Office hours: M. F. 9:30 – 10:30, or by appointment.
  - You are encouraged to use Dr. Loza and other TAs' office hours.
- Format:
  - ~20 minutes recitation activity (occasionally part of this will be "closed book".
    - Occasionally will add/subtract problems from standard activity.
  - ~5 minutes going over key concepts/activity.
  - 20 minutes at the end of recitation – quiz
  - **Must be here at the beginning of recitation to take quiz**.
- Homework
  - Not just the problems on Mastering Chemistry!!

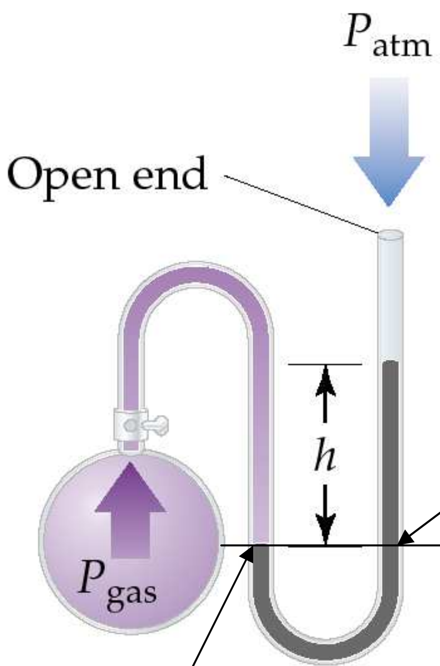
Academic Misconduct

- Read statement on syllabus
- Quoting Dr. Loza's powerpoint
  - ALL PAPERS, BOOKS are to be put away during a quiz.
  - NO cell phones, NO ipods, MP3 players, NO hats, NO food.
  - **Approved calculators only** – NO TI-83s or TI-34/36s
- Complete COAM quiz on Carmen

Recitation Activity 1 – Ch. 10.1-4 and review of Lewis structures/molecular shapes

- First section of Dr. Loza's activity:
  - Q. 2, 3, 4
- Deduce the shape and polarity of each of the following molecules:
  - CCl_4
  - PF_3
  - PF_5
  - CH_2Cl_2

Q. 2 – manometer problem



Pressure here = P_{atm} + h

Key concept: at this point both arms of the U-tube have the same pressure

Pressure here = P_{gas}

Therefore:
$$\begin{aligned} P_{gas} &= P_{atm} + h \\ &= (748) + (650) \\ &= 1398 \end{aligned}$$

Therefore, pressure = 1398/760 = 1.839 atm

Q. 3: Ideal Gas Law

Recall: STP = 1 atm, 0 ℃

P1 = 1 atm
V1 = 0.500 L
T1 = 273 K

P2 = ?
V2 = 3.75 L
T2 = 35℃ = 308 K

Note that temperature must be in Kelvins

All three quantities are changing → need to use full ideal gas law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow P_2 = P_1 \cdot \frac{V_1}{V_2}\frac{T_2}{T_1}$$

$$P_2 = (1)\frac{(0.500)}{(3.75)}\frac{(308)}{(273)} = 0.150\,\text{atm}$$

Q. 4: Stoichiometry

From the balanced chemical equation

$$?\,\text{mol NH}_3 = 5.00\,\text{mol O}_2 \times \frac{4\,\text{mol NH}_3}{5\,\text{mol O}_2} = 4.00\,\text{mol NH}_3$$

Using the ideal gas law

$$PV = nRT$$ (must learn)

P = 8.00 atm
V = ?
n = 4.00 mol (from above)
R = 0.08206 L atm/mol K
T = 750℃ + 273 = 1023 K

$$V = \frac{nRT}{P} = \frac{(4.00)(0.08206)(1023)}{(8.00)}$$

V = 42.0 L

Working Out Lewis Structures

- This assumes it obeys the Octet rule
  - Bad idea to pretend it *doesn't* if you can make it obey it …
- For a given molecule:
  - Write down a skeleton structure for the molecule, using the following guidelines
    - Take advantage of name – quite often it is in the same order
    - Usually Os don't bond directly to each other
      - exception: hydrogen peroxide
    - Oxoacids: H bonds to O, which bonds to the central atom
    - Less electronegative atom at centre
    - Nature loves symmetry – try and be as *symmetric* as possible.
    - Remember that H can only form one bond – it is never the central atom.

Lewis Structures, continued

Example: Determine the Lewis structure of PF_3

Since P is much less electronegative than F, and since there is only one of it, let's assume for now that P is at centre.

F

F P F

Next, determine the number of valence electrons needed (N) to satisfy the Octet Rule

In this example, N = 8 x 4 = 32

Determine how many atoms there are available (A) in this molecule/ion

In this example, P has 5 valence electrons → 5 x 1 = 5
F has 7 valence electrons → 7 x 3 = 21

A = 5 + 21 = 26

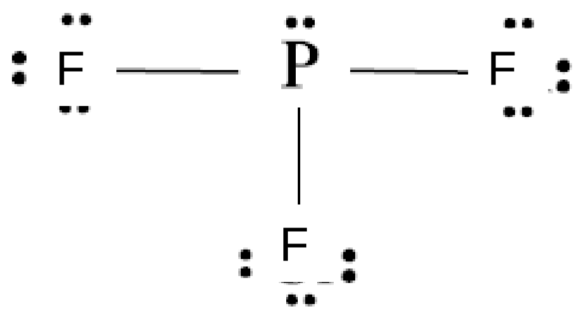
Calculate the number of shared electrons (S) by subtracting the number of electrons available (A) from the number of electrons needed (N) → S = N - A

In the example, S = 32 – 26 = 6

The number of bonds is therefore given by S/2 (2 electrons per bond)

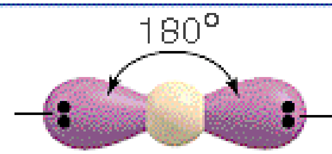
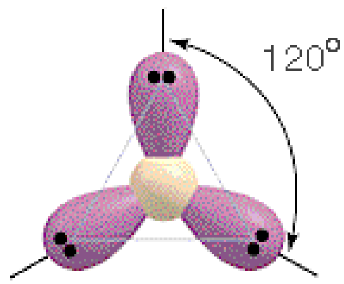
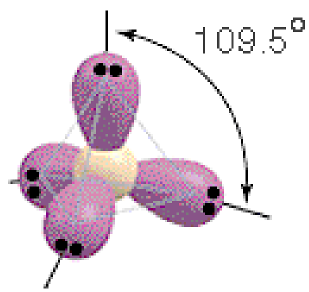
In this example, number of bonds = 6 / 2 = 3

Put in bonds and lone pairs (add as necessary to fulfil octet rule), noting that where necessary you may need to put in multiple bonds

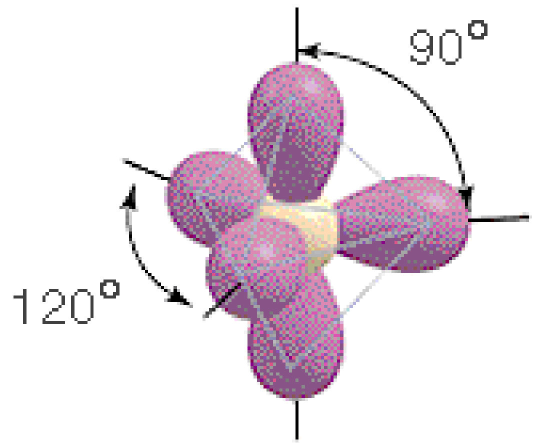
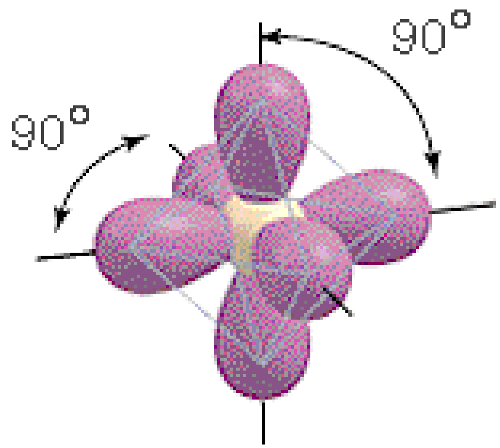


LEARN these geometries!

ELECTRON-PAIR GEOMETRIES AS A FUNCTION OF THE NUMBER OF ELECTRON PAIRS

Number of Electron Pairs	Arrangement of Electron Pairs	Electron-Pair Geometry	Predicted Bond Angles
2		Linear	180°
3		Trigonal planar	120°
4		Tetrahedral	109.5°

ELECTRON-PAIR GEOMETRIES AS A FUNCTION OF THE NUMBER OF ELECTRON PAIRS

Number of Electron Pairs	Arrangement of Electron Pairs	Electron-Pair Geometry	Predicted Bond Angles
5		Trigonal bipyramidal	120° 90°
6		Octahedral	90° 180°

Note that these <u>will</u> involve mixing with *d* orbitals

How to Find the Structure

- Find the Lewis Structure of the molecule

Example: find the structure of PF_3

- Now, we consider how many electron domains we have …

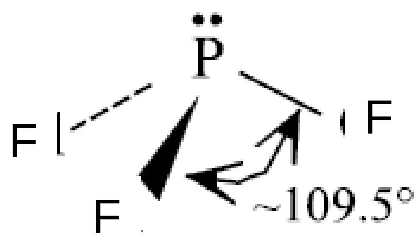
For this molecule, you have 3 single bonds + 1 lone pair = 4 electron domains.
Therefore, the electron pair geometry is **tetrahedral**

- Finally, assign a structure, noting that the amount of repulsion goes as:

lone pair > triple bond > double bond > single bond

  – Note that this hierarchy would impinge on bond angles.

- Learn the names of the various structures based on how many lone pairs they have.



Answers to the rest of those problems

- CCl_4 – tetrahedral, non-polar
  - Note that C-Cl bonds are polar but they cancel out.
- PF_5 – tetrahedral bipyramidal, non-polar
  - note exception to octet rule
  - Again note cancellation of dipoles
- CH_2Cl_2 – tetrahedral, **polar**
  - Dipole moments do not cancel

- Final note: generally assume C, H to have similar electronegativities.