1 Morning class week 6 day 3: Hybridization

1. **Main group hybridization**

   3. **Linear sp and planer sp^2 hybridization**

      (a) *sp hybridization, the linear hybridization scheme:* In molecules such as N_2 and HCCH, the main group atom has either just one bond to it or two bonds which are in a straight line. For such atoms we use sp hybridization.

      i. To generate the four orbitals used in sp hybridization, start off in the left-most column with three $2p$ and one $2s$ atomic orbitals.

      ii. Now mix a $2s$ and a $2p$ orbital to generate the four orbitals involved in sp hybridization.

      (b) *sp^2 hybridization, the planar hybridization scheme:* In molecules such as water, H_2O, and acetone, CH_2O, the central main group atom has either just two bonds, which are not in a straight line, or three bonds, which are in a plane. For such atoms we use sp^2 hybridization.

      i. To generate the four orbitals used in sp^2 hybridization, start off in the left-most column with three $2p$ and one $2s$ atomic orbitals.

      ii. Now mix a $2s$ and a $2p$ orbital to generate one of the sp^2 hybrids pointing in the direction of *one* of the three planar directions.

      iii. Now mix another pair of orbitals to generate the four orbitals in the sp^2 hybridization scheme.

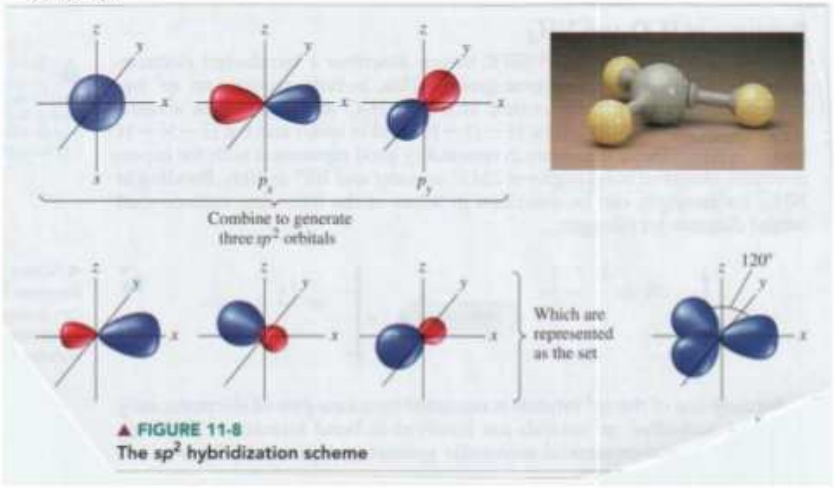
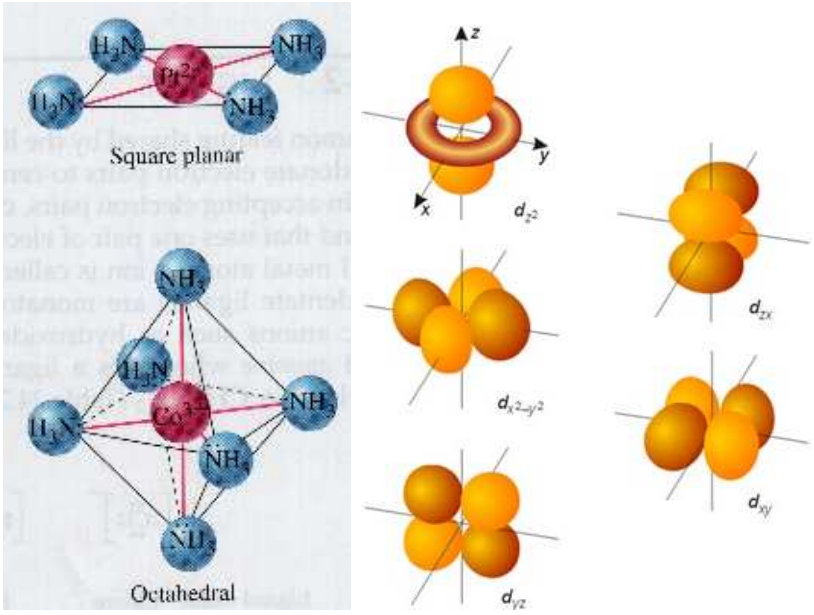


Figure 2: sp^2 hybridization

      (c) Please review what you have learned. The diagram shown above may be an aid in this review process.

2. **Transition metal hybridization** includes d-orbitals. d-orbital hybridization allows, among other geometries, the octahedral and the square planar geometries, see below $Pt^{2+}(NH_3)_4$ and $Co^{3+}(NH_3)_6$. Of the two, the octahedral geometry is the more common. The square planar geometry dominates for transition metals with exactly eight valence d-electrons.

3. Shown below are the five d-orbitals. Please draw these five d-orbitals on your own. In drawing these



orbitals, to obtain a 3-D perspective, it is best to partially eclipse the lobes, see picture.

(a) *dsp^2 hybridization, the square planar hybdridization scheme* uses the $x^2 - y^2$ orbital.

i. To generate square planar hybridization, please start by drawing, on the left side of an empty page, the valence $d_{x^2-y^2}$, p_x, p_y, and s orbitals.
ii. Please first mix the s and $d_{x^2-y^2}$ orbitals.
iii. Next mix the p_x orbital with one of the s and $d_{x^2-y^2}$ mixes.
iv. Finally mix the p_y orbital with the other of the s and $d_{x^2-y^2}$ mixes.
v. The square planar hybridization scheme has been achieved. Please review.

(b) *d^2sp^3 hybridization, the octahedral hybridization scheme* uses the d_{z^2} and $d_{x^2-y^2}$ orbitals.

i. To generate octahedral hybridization, please start by drawing, on the left side of an empty page, the valence $d_{x^2-y^2}$, d_{z^2}, p_x, p_y, p_y, and s orbitals.
ii. Please first mix the s and d_{z^2} orbitals.
iii. Next mix the p_z orbital with one of the s and d_{z^2} mixes.
iv. Now, please mix $d_{x^2-y^2}$ with the other of the s and d_{z^2} mixes.
v. Please mix p_x with one of these last set of mixes and mix p_y with the other of the last two mixes.
vi. The octahedral hybridization scheme has been achieved. Please review.