CHEM 362 – Fall 2019
Prof K .R. Dunbar
TA: Ellen Song

PLTL Worksheet #11:

1. Why are bonds between second row elements shorter than third row elements?
   - 3rd row atoms are larger
   - 3p orbitals are more diffuse

2. Why is white phosphorous explosive, while the other allotropes are not?
   - Bond angles are ~60°, which is highly strained

3. *Metals*
   a. What are the 4 physical properties of metals?
      1) High reflectivity
      2) High electrical conductance
      3) High thermal conductance
      4) Mechanical properties such as strength & ductility
   b. Describe how bonding in metals is different from "normal molecules"
      - no more contribution
      - Two e⁻ covalent bonds between nearest neighbors are impossible

      Delocalization of e⁻ across all atoms results in energy bands

4. *Lanthanide contraction*
   a. What is it?
      - decrease in ionic radii going across the lanthanide series, and smaller than expected radii for 2nd & 3rd row metals
        → due to poor shielding of 4f & 5f orbitals
   b. Of the pairs of lanthanides given, indicate which would have a larger atomic radii
      i. Ce vs Dy
      ii. Ho vs Er
      iii. Sm vs Yb

CHEM 362 – Fall 2019
Prof K .R. Dunbar
TA: Ellen Song

5. *Survey of Elements*
   a. Write one fact about each of the 1st and 2nd row elements

pg 354-359 of Dr Dunbars notes (10_2)

   b. Why do simple cations of elements such as B, C, N, O etc. not exist?

very high ionization energy.

   c. Why is N_2 relatively unreactive?

- $N \equiv N$ bond strength
- ~~relative~~ electron structure → crucial when there lone pairs or from an MO theory point of view

   d. Third row (non-transition metal) elements can have their d-orbitals involved in bonding. What consequence does this cause for the resultant geometries?

can have more than 4 bonds (unlike carbon)

   e. Why are C=C bonds fine, but Si=Si bonds unfavourable?

$\pi - \pi$ overlap is not as good for Si compared to C.

→ 2s & 2p or all filled, = more e^- e^- repulsion

CHEM 362 – Fall 2019
Prof K .R. Dunbar
TA: Ellen Song

6. *Hard Soft Acid Base Theory*

a. Write the formula for the quantitative definition of hardness

$$N = \frac{ID - EA}{2}$$

b. Classify the following as hard or soft acids or bases

i. Ca^{2+} HA

ii. F^- HB

iii. Pd^{2+} SA

iv. H_2O HB

v. Co^{3+} HA

vi. $CH_3SO_2^+$ HA

vii. SCN^- SB

viii. ClO_4^- HB

ix. Cu^+ SA (Cu^{2+} could be considered intermediate) or borderline

x. Gd^{3+} HA

c. Would you expect the following reactions to proceed as written? Why or why not?

i. $AsF_3 + PI_3 \rightarrow ASI_3 + PF_3$ Yes. HA / HB and SA/SB in product

ii. $MgS + BaO \rightarrow MgO + BaS$ Yes HA/HB and SA/SB in product

iii. ~~$2PF_2I + 2Hg_2F_2 \rightarrow P2F_2I_2$~~ Ignore this one.

iv. $CoF_2 + HgBr_2 \rightarrow CoBr_2\ HgF_2$ No HB / SA in products