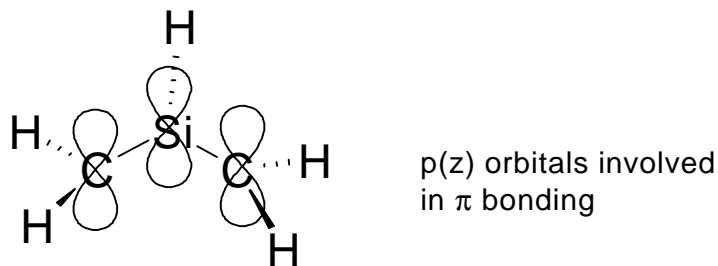
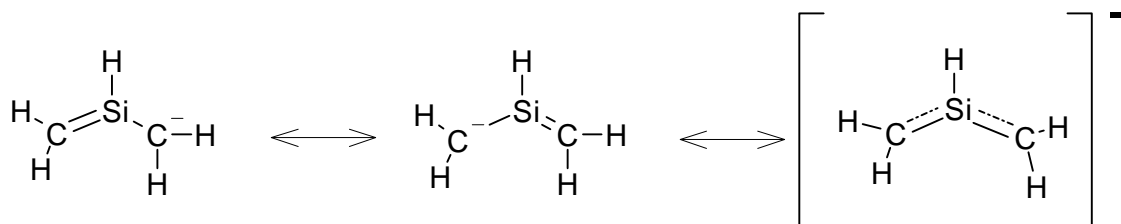


## INORGANIC CHEMISTRY -SECOND HOURLY EXAM

November 11, 1996

1. The planar 2-silaallyl anion,  $[\text{CH}_2\text{SiHCH}_2]^-$ , (shown below) is of current theoretical interest. The molecule is planar and of  $C_{2v}$  symmetry. For this problem, we are considering the  $\pi$  bonding interactions *only*! Therefore all interactions will involve only the  $p_z$  orbitals of the silicon and two carbon atoms.



- A.) Using the character table for  $C_{2v}$  symmetry, to which irreducible representation does the silicon  $p_z$  orbital belong? [5 pts]
- B) Consider the two carbon SALC's (symmetry adapted linear combinations). To which irreducible representation does the additive combination ( $p_z(1) + p_z(2)$ ) belong? The subtractive combination ( $p_z(1) - p_z(2)$ )? [5 pts]
- C) Draw a qualitative molecular orbital interaction diagram for  $\pi$  bonding in the 2-silaallyl anion. Be sure to fill the appropriate MO's with electrons. [5 pts]
- D) Qualitatively sketch the  $\pi$  molecular orbitals in this molecule. [5 pts]
- E) What is the overall  $\pi$  bond order in 2-silaallyl anion? What is the average  $\pi$  bond order per Si-C bond? [5 pts]

2. For the following classes of element- hydrogen compounds, explain the nature of element hydrogen bonding, give two specific examples, and of one application. [20 pts]

- A) saline hydrides
- b) interstitial hydrides
- c) boron hydrides (use diborane to explain the bonding)
- d) protonic main group hydrides

3. A) What is a superacid? [5 pts]

B) Why is  $\text{FSO}_3\text{H}$  a stronger acid in conjunction with  $\text{SbF}_5$  than by itself? Use equations as necessary. [10 pts]

4. A) Classify the following substances as hard acids (HA), soft acids (SA), hard bases (HB), or soft bases (SB). [8 pts]

Benzene	_____
$\text{Ag}^+$	_____
$\text{Li}^+$	_____
$\text{BF}_3$	_____
$\text{SbH}_3$	_____
F <sup>-</sup>	_____
$\text{H}_2\text{O}$	_____
Fe	_____

B) Using the Drago-Wayland equation below, and the table of parameters attached. Calculate  $\Delta H$  for the reaction of  $\text{BF}_3$  with  $\text{NH}_3$ . [6 pts]

$$-\Delta H = C_A C_B + E_A E_B$$

C) Would you expect the reaction of  $\text{BF}_3$  with  $\text{AsH}_3$  to be more or less exothermic than with  $\text{NH}_3$ ? Why? [6pts]

5. For the following questions, insert the symbol (or name) of the Group 1, Group 2, or Group 13 element which best fits the description. [20 pts]

- a) This element has an oxide called “lime” \_\_\_\_\_
- b) The simple hydride of this element is a covalent polymer \_\_\_\_\_
- c) This element has been used as a rodent poison \_\_\_\_\_
- d) One allotrope contains icosahedra of this element \_\_\_\_\_
- e) Lightweight alloys of this element are used in battleships \_\_\_\_\_
- f) This alkali metal forms mostly the peroxide on reaction with oxygen \_\_\_\_\_
- g) In combination with arsenic, this element forms a valuable semiconductor \_\_\_\_\_

- h) This radioactive element is a byproduct of uranium refining \_\_\_\_\_
- i) The nitrate of this element is known as saltpeter \_\_\_\_\_
- j) A radioactive isotope of this element is concentrated in dairy milk \_\_\_\_\_