Exam 2
Friday, March 18
100 pts

1. (24 pt) Explain each of the following true statements, supporting your answers with diagrams and other supporting information as necessary! Note that it is better to say why your explanation does not fit the data than to come up with an invalid (or totally made up!) reason that it would fit! (8 pt each)

    a. The N-O bond lengths in HNO_3 are not all equivalent to one another. Central atoms in this molecule have angles of 120° and 108°.

    b. The size of a Ba atom is larger than an I atom, but Ba^{2+} is smaller than I^-.

    c. The energy of an electron in a 2p orbital on a particular atom is higher than that of a 2s orbital on the same atom.

2. (24 pts) Draw the **best** inequivalent Lewis dot structures (with equivalent resonance structures if appropriate) for the following molecules and ions. Predict the geometry, draw it in 3-D, label the bond angles and predict the hybridization at all central atoms and predict whether the molecules or ions are polar or not. (7 pts each)

Formula	Lewis dot structure(s)	Draw geometry and indicate bond angles	Geometry at **each** central atom(s)	Polar or Non Polar?
SeF_4^{2-}				
$H_2PO_4^-$				
NO_2^+				

3. (6 pt) What is the definition of an ionization energy for an element (as part of your answer write a relevant chemical equation)?

What happens to ionization energy as you go down the periodic table?

Why is the ionization energy for S less than that of P?

4. (5 pt) For each of the statements below, indicate whether they are true or false based on the resonance structures of the CO_3^{2-} ion below.
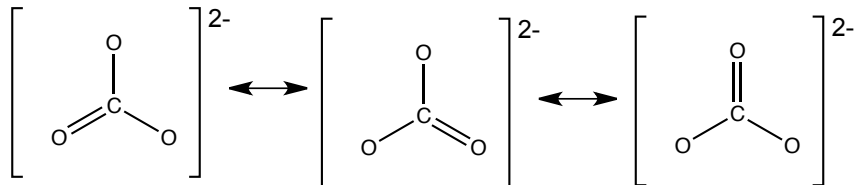
_____ The structure of carbonate switches back and forth between the three forms
_____ The carbonate ion is an average of the three structures.

_____ Each C-O bond has a bond order of 1.33.

_____ Each oxygen atom has a double bond 1/3 of the time.

_____In a single resonance structure, two of the oxygen atoms have -1 formal charges.

5. (6 pt) An element X forms a compound with the formula $[O–X–Cl]^-$. The compound has a bent structure and a bond angle of approximately 107°. The element is also has its valence electrons in the 4th principle quantum level. Identify X!

6. (18 pt, 3 pt each) Answer each of the following questions:

_____ What is the element with the smallest size in period 4?

_____ What is the **electron domain geometry** for the Si in SiH_3^-?

_____ How many radial nodes does a $5p_y$ orbital have?

_____ What is the formal charge for an O with a triple bond and a lone pair?

_____ Which element in Group 5A has the highest electronegativity?

_____ What is the electron configuration for Pd^{2+}?

7. (12 pt total) Consider the $4d_{x^2-y^2}$ orbital.

    a. Calculate the number of radial and angular nodes and draw a picture of this orbital, labeling your axes carefully. (4 pt)

    b. Draw the radial probability diagram for this orbital above, labeling the axes and any radial nodes. (4 pt)

    c. Add on the same radial probability diagram the 3px orbital. How does its radial probability diagram differ from that of $4d_{x^2-y^2}$? (4 pt)

8. (8 pt) Tetrazene is a rather unstable hydride of nitrogen that decomposes above 0°C.   It also a base that can pick up an H^+, to form the tetrazinium ion which has the formula $[H_2NNNNH_3]^+$ (4 nitrogen atoms connected in a line, with H's on the end N's).

    Draw a valid Lewis dot structure for the tetrazinium ion. Clearly indicate the following in your answer:
    *   any formal charges
    *   relative bond lengths in the molecule —which would you expect to be longer or shorter and why
    *   bond angles and geometries at **ALL** N atoms
    *   Would there be any other important resonance structures? Why or why not?