Chemistry 448/548 Test 2 Fall 2025

Very Short Answer Questions: (3 points each)

1. Ionic compounds are frequently soluble in _____ dielectric constant solvents.
2. Ions generally increase in size with _____coordination number.
3. _____ is the alkaline earth ion that polarizes best. (Be sure to write the ion.)
4. _____are orbitals with no net overlap.
5. Define electronegativity:

6. The valence bond wave equation for HCl is: $\psi = \mathbf{a}\psi_{H(1)Cl(2)} + \mathbf{b}\psi_{H(2)Cl(1)} + \mathbf{c}\psi_{H(1)H(2)} + \mathbf{d}\psi_{Cl(1)Cl(2)}$. Order **a** - **d** according to size (use <, >, +): _____
7. Bent bonds most typically occur in _____.
8. What is the shape of SF_4? _____
9. Infrared spectroscopy operates on the _____s^{-1} time scale.
10. Two of the elements in Groups IVA - VIIA have only one isotope. What are they? _____and _____.

Discussion Questions: (You must show work to receive credit!)

1. Explain why the Born-Landé equation ($U = ANZ^+Z^-e^2/4\pi\varepsilon_0 r + NB/r^n$) is reasonable. (10 points)

2. To ionize Mg to Mg^{2+} costs two times as much energy as to form Mg^+. The formation of O^{2-} is endothermic rather than exothermic as for O^-. Nevertheless, magnesium oxide is always formulated as $Mg^{2+}O^{2-}$ rather than as Mg^+O^-. (5 points)
   a) What theoretical reason can be given for the $Mg^{2+}O^{2-}$ formulation.
   b) What simple experiment could be performed to prove the magnesium oxide was not Mg^+O^-.

3. The bond angles in NO_2^+, NO_2, and NO_2^- are 180º, 134º, and 115º, respectively. Why? (10 points)

4. Compare and contrast X-ray, neutron, and electron diffraction methods. (10 points)

5. What are the three types of phosphorus? Describe them. (10 points)

6. Consider the square planar molecule MH_4. Using a group increment scheme, what are the 4 bonding and 4 anti-bonding MOs for this molecule. Ignore weighting factors. (15 points)
   Hint(s):
   Make the *z*-axis pass through M and be perpendicular to the plane of the paper.
   There are 9 possible orbitals on M that must be considered for bonding 4*s*, $4p_x$, $4p_y$, $4p_z$, $3d_{z2}$, $3d_{x2-y2}$, $3d_{xy}$, $3d_{xz}$, and $3d_{yz}$. Not all of these orbitals will be used in bonding.
   Draw the molecule and number the hydrogens 1-4 in cyclic fashion.

7. Three possible resonance structures of SCN^- are (i) $[S\text{-}C{\equiv}N]^-$, (ii) $[S{=}C{=}N]^-$, and (iii) $[S{\equiv}C\text{-}N]^-$. Rank them in order of relative importance and justify your answer. (10 points)