

Mid-Term 1

Do all questions. If you think that you may wish to have an answer re-graded, it must be done in permanent ink. No liquid paper/white-out or other such correction tools should be used in the answer area - if an answer is wrong, just put a line through it. You may use a calculator and a ruler, but no additional material may be used. Answer all questions on the test - if more space is required, use the back of the page and indicate that your answer is not complete.

Question #1 [20 points]

(a) What is Hund's rule: [2]

(b) What does effective nuclear charge Z^* indicate (use your own words and the equation relating it to σ)? [4]

(c) Provide an equation that defines the 2nd ionization energy for any element (E) **AND** indicate the group for which the second ionization energies are the greatest. [4]

(d) How are "orthogonal" and "normal" defined in the context of wave functions Ψ_n and Ψ_m ? [2]

(e) Provide a definition of electronegativity (use your own words not an equation): [4]

(f) List four of the types of symmetry operations (include a general symbol for the corresponding symmetry element): [4]

Question #2 [20 points]

(a) Fill in the blanks: [4]

Orbital	# of radial nodes	# of angular nodes*	description of angular nodal surface
5p _y			
	1	2	the xz plane and the yz plane
4s			
	3	1	the yz plane

*give the appropriate quantum number

(b) Write an acceptable set of LCAO equations for sp² hybrid orbitals. Include drawings to indicate the orientation of each hybrid orbital: [9]

(c) Draw reasonable representations of the following orbitals {specify the direction of the axes used and include sign of the phase (+ or -) of each lobe}: [7]

(i) 2p_x(ii) 3p_z(iii) 3d_{yz}**Question #3 [15]**

(a) What is the ground state electron configuration of B(+4)? [1]

(b) What is the ground state electron configuration of arsenic? [1]

(c) What is the difference in energy between the ground state and the third excited state of Li(+2)?[3]

(d) Balance the following equation:[5]



(e) Use the Frost diagram at the end of the test to predict the outcome of the following reactions (there is no need to balance the equations):[5]

(i) Ni (+2) + Cu °

(ii) Cl₂ + H₂S °

(iii) I₂ + V(+3) °

Question #4 [10]

(a) What is the trend in atomic radii for the group 17 elements (use “>”, “<” or “.”)? [2]

(b) Why do the atomic radii for the group 17 elements vary in this way? [4]

(c) Is the trend in atomic radii for the group 13 elements the same? Briefly, why or why not? [4]

Question #5 [25]

Use the localized bonding models (**Lewis, VSEPR, and valence bond theory**) to describe the bonding in the following molecules:

(*remember to indicate the geometry, shape and hybridization of all non-terminal atoms; * you only have to draw one example of the orbital overlap for each different type of bond)

(a) XeF_4 [8]

(b) $[\text{ClO}_4]^{-1}$ (what is the bond order of the Cl-O bonds and what is the formal charge on each oxygen atom) [9]

(c) Acetaldehyde, $\text{H}_3\text{CC}(\text{O})\text{H}$ (the oxygen atom is terminal and the H is bonded to the carbon atom) [8]

