Exam 3

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. Cations are \_\_\_\_\_\_\_\_\_\_\_\_\_ than their corresponding parent.
2. much smaller
3. much larger
4. the same size
5. not related in size to the atom from which they are formed.
6. none of the above
7. Which of the following is true of an endothermic reaction?
   * + 1. Strong bonds break and weak bonds form.
       2. Weak bonds break and strong bonds form.
       3. The bonds that break and those that form are approximately the same strength.
       4. Triple bonds are formed
       5. none of the above
8. How many of the following elements have 2 unpaired electrons in the ground state? C, O, Ti, Si
9. 0
10. 1
11. 2
12. 3
13. 4
14. The ground state electron configuration for Cr3+ is
15. [Ar] 4s2 3d1
16. [Ar] 3d3
17. [Ar]
18. [Ar] 4s2 3d6
19. [Ar] 4s1 3d2
20. \_\_\_\_\_\_ is the most polar bond.
21. C-O
22. C-N
23. C-C
24. F-F
25. C-F
26. Place the following in order of decreasing dipole moment:
27. cis-CHCl=CHCl;
28. II. trans-CHCl=CHCl;
29. III. cis-CHF=CHF
30. I = III > II
31. III > I > II
32. II > III > I
33. II > I > III
34. I > III > II
35. Out of C2Cl2, CO2, O3, H2O, there are \_\_\_\_\_ with sp hybridization on the central atom?
36. 4
37. 3
38. 2
39. 1
40. none of the above
41. A chemical equation may sometimes be balanced with fractional coefficients. This is not appropriate when utilizing what interpretation of the reaction?
    1. Macroscopic
    2. Molar
    3. Particulate
    4. Both macroscopic and molar
    5. Both molar and particulate
42. Which statement is true?
43. When two atomic orbitals come together to form two molecular orbitals, one molecular orbital will be lower in energy than the two separate atomic orbitals and one molecular orbital will be higher in energy than the separate atomic orbitals.
44. The total number of molecular orbitals formed doesn’t always equal the number of atomic orbital in the set.
45. A bond order of 0 represents a stable chemical bond.
46. Electrons placed in antibonding orbitals stabilize the ion/molecule.
47. all of the above
48. What is the most important part of laboratory safety?
49. Recognizing hazards
50. Assess the risk level
51. Minimizing risks
52. Preparing for emergencies
53. all of the above

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. Use your knowledge of electron configurations to explain the following observations (8 points):
   1. Silver tends to form ions with a charge of +1, but the element to the right of silver in the periodic table tends to form ions with +2 charge.
   2. The heavier group 13 elements (Ga, In, Tl) tend to form ions with charges of +1 or +3, but not +2.
   3. The heavier elements of group 14 (Sn, Pb) and group 4 (Ti, Zr, Hf) tend to form ions with charges of +2 or +4.
2. Does the number of valence electrons in a neutral atom ever equal the atomic number? If so, what are they (2 points)?
3. What is meant when two or more orbitals are said to be degenerate (3 points)?
4. How can we use electronegativity to predict whether a bond between two atoms is likely to be covalent or ionic (3 points)?
5. Explain on the basis of atomic structure why trends in electronegativity are related to trends in atomic size (4 points).
6. Pick the larger species from each of the following pairs (4 points):
   * + - 1. Se2- or Sr2+ b. Rh2+ or Rh c. N3- or N d. Ba or Ba2+

1. Effective nuclear charge (Zeff) is related to atomic number by a parameter called the shielding parameter (S) (5 points).
2. Calculate Zeff for the outermost s electrons of Ne and Ar given that S = 4.24 for Ne and 11.24 for Ar.
3. Explain why the shielding parameter is much greater for Ar than for Ne.
4. Consider the electron configuration of a carbon atom. After sp3 hybridization, which of the following statements are true about the carbon atom (5 points)?

\_\_\_\_\_\_\_\_\_\_no unpaired electrons

\_\_\_\_\_\_\_\_\_\_hybrid orbitals of two distinctly different energies

\_\_\_\_\_\_\_\_\_\_hybrid orbitals with energy between that of the 2s and 2p orbitals

\_\_\_\_\_\_\_\_\_\_the ability to form four bonds

\_\_\_\_\_\_\_\_\_\_three hybrid orbitals and an unhybridized p orbital

1. Synthesis of the first compound of argon was reported in 2000. HArF was made by reacting Ar with HF. Draw a Lewis structure for HArF, and determine the orbital geometry, molecular geometry, approximate bond angle(s), polarity, and hybridization (9 points).
2. A molecular compound is composed of 60.4% Xe, 22.1% O, and 17.5% F by mass. If the molecular weight is 217.3 amu, what is the molecular formula? What is the Lewis structure? Predict the electron and molecular geometry using the VSPER model. Is this a polar or nonpolar molecule? Describe the bonding using valence bond theory (15 points).

|  |  |
| --- | --- |
| Bond | Energy (kJ/mol) |
| N-N | 163 |
| N=N | 418 |
| N≡N | 941 |
| H-H | 436 |
| N-H | 388 |

1. Nitrogen and hydrogen gases can react to form hydrazine, H2NNH2. Hydrazine is used as a foaming agent in the preparation of polymer forms as well as used in many rocket fuels. Hydrazine is produced according to the following equation (10 points):

N2(g) + 2 H2 (g) ⎯→ H2NNH2 (g)

From bond energies, calculate the standard enthalpy change for the reaction.

1. The odd-electron molecule ClO affects the atmospheric chemistry of chlorofluorocarbons as illustrated by the reaction (where the \* indicates an excited-state oxygen atom) (12 points):

CF2Cl2 (g) + O\* (g) → ClO (g) + CF2Cl (g)

* 1. Draw a molecular orbital diagram for ClO.
  2. Is the odd electron in a bonding or antibonding orbital? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  3. What is the bond order?
  4. Is the molecule paramagnetic or diamagnetic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_