Exam 3

# Part 1: Multiple Choice (2 points each)

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

1. Place the following elements in order of increasing atomic radius: P, Ba, Cl
2. Ba < P < Cl
3. P < Cl < Ba
4. Cl < P < Ba
5. Cl < Ba < P
6. none of the above
7. Which of the following processes are exothermic?
8. Cl2 (g) 🡪 2Cl- (g)
9. Br (g) + e- 🡪 Br- (g)
10. Li (s) 🡪 Li (g)
11. NaF (s) 🡪 Na+ (g) + F- (g)
12. none of the above
13. Identify the true statement(s) about noble gas trends.
14. The density of the noble gases increases down a column.
15. The atomic radius decreases down a column.
16. The ionization energy increases down a column.
    1. I
    2. II
    3. III
    4. I and III
    5. all of the above
17. Place the following in order of decreasing magnitude of lattice energy: K2O, Rb2S, Li2O
    1. Li2O > K2O > Rb2S
    2. Li­2O > Rb2S > K2O
    3. Rb2S > K2O > Li2O
    4. Rb2S > Li2O > K2O
    5. none of the above
18. Choose the bond below that is the strongest.
19. C-F
20. C=O
21. C-I
22. C≡N
23. all of the above
24. Which of the following is true about the nitrite ion?
25. contains one N-O single bond and one N=O double bond.
26. contains two N-O bonds that are equivalent to 1 ½ bonds.
27. contains two N=O double bonds.
28. contains two N-O single bonds.
29. none of the above
30. How many of the following molecules are polar?

XeO2 SiCl2Br2 C2Br2 SeCl6

1. 4
2. 3
3. 2
4. 1
5. none of the above
6. The electron geometry of a molecule containing a central atom with a sp3d2 hybridization is
7. octahedral
8. trigonal bipyramidal
9. tetrahedral
10. linear
11. none of the above
12. Which of the following statements are true?
13. The total number of molecular orbitals formed doesn’t always equal the number of atomic orbitals in the set.
14. A bond order of ½ represents a stable chemical bond.
15. Antibonding orbitals are filled with electrons first
16. none of the above
17. all of the above
18. What factors contribute to “messy labs” in academic environments?
    1. Many of the occupants are students with limited training in safety and cleanliness.
    2. Faculty mentors offer varying degrees of supervision in labs.
    3. “Productivity” can sometimes override “safety and cleanliness.”
    4. all of the above
    5. Academic labs are not messy.

# 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. Does the number of valence electrons in a neutral atom ever equal the atomic number? If so, what are they (2 points)?
2. Both vanadium and its 3+ ion are paramagnetic (6 points).
3. Write the complete electron configuration of vanadium.
4. Write the condensed electron configuration of the vanadium(III) ion.
5. Explain why vanadium and the vanadium(III) ion are paramagnetic.
6. Explain on the basis of atomic structure why trends in electronegativity are related to trends in atomic size (4 points).
7. 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+
8. How can we use electronegativity to predict whether a bond between two atoms is likely to be covalent or ionic (3 points)?
9. Below is a list of successive ionization energies in kJ/mol for a period 3 element. Identity the element and explain how you can to that conclusion (5 points).

IE1 = 1012; IE2 = 1900; IE3 = 2910; IE4 = 4960; IE5 = 6270; IE6 = 22,200

1. Using Lewis structures and formal charge, which of the following ions is the most stable? Explain your choice (8 points).

OCN- ONC- NOC-

1. Each of the following compounds has a nitrogen-nitrogen bond: nitrogen gas, dinitrogen tetrahydride, and dinitrogen difluoride. Match each compound with one of the following bond lengths: 110 pm, 122 pm, 145 pm. Describe the electronic and molecular geometry about one of the nitrogen atoms in each compound and show the bond angles. What hybrid orbitals are needed to describe the bonding in valence bond theory (9 points)?

1. Determine the energy of formation of magnesium bromide. Given (8 points):

Mg (s) → Mg (g) +147.7 kJ/mol

Mg (g) → Mg+(g) + 1 e- +737.7 kJ/mol

Mg+(g) → Mg2+ (g) + 1 e- +1,450.7 kJ/mol

Br2 (g) → 2 Br (g) +193 kJ/mol

Br (g) + 1 e- → Br- (g) -325 kJ/mol

Mg2+ (g) + 2 Br- (g) → MgBr2 (s) -2,440 kJ/mol

1. Use the bond energies provided to estimate ∆H°rxn for the reaction below (10 points).

2 Br2 (l) + C2H2 (g) 🡪 C2H2Br4 (l) ∆H°rxn = ?

Bond Bond Energy (kJ/mol)

Br-Br 193

C≡C 837

C-C 347

C-Br 276

C-H 414

1. Cyanogen is a gas which contains 46.2% C and 53.8% N by mass. At a temperature of 25 °C and a pressure of 750 mm Hg, 1.50 g of cyanogen occupies 0.714 L (15 points).

What is the molar mass of cyanogen?

What is the empirical formula of cyanogen?

What is the molecular formula of cyanogen?

Draw the best Lewis structure for cyanogen, and label the orbital geometry, molecular geometry, the bond angle of the central atom(s), and the hybridization.

Lewis structure:

Orbital geometry of central atom(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

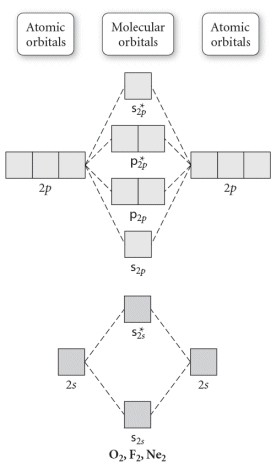
Molecular geometry of central atom(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bond angle \_\_\_\_\_\_\_\_\_\_\_\_

Hybridization of carbon atoms \_\_\_\_\_\_\_\_\_\_\_\_

1. Use the molecular orbital diagram shown to answer the following questions about

F22-, F2, O22+, F22+, Ne22+ (5 points).



1. Which one is the most stable?
2. Which one(s) has (have) a bond order of 1?
3. Which is paramagnetic?
4. Which one is the least stable?