

Name: \_\_\_\_\_

# EXAM 3

CHEM 1411

November 30, 2007



Grade:

100

### Instructions:

1. There are **7 pages** in this exam. Put your initials on every page.
2. You have 1 hour to complete the exam.
3. You may use calculators.
4. **Write only in ink!** Exams taken in pencil will not be accepted for regrades.
5. **Write all answers to the multiple-choice questions on p. 4-6 on the answer sheet on page 2.**
6. For non-multiple choice problems on p. 2 and 3, *show all work*; report answers to the correct number of significant figures. Partial credit will be given on these problems, when possible.

## Answer Page

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	18.		4

- A. Write the complete electron configuration and an draw orbital diagram for the element **aluminum**. Is aluminum diamagnetic or paramagnetic? (4 pts)

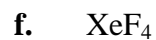
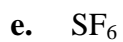
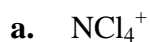
1. electron configuration: \_\_\_\_\_

2. orbital diagram

3. diamagnetic or paramagnetic? \_\_\_\_\_

- B. Draw two resonance structures for **nitrate**,  $\text{NO}_3^-$ . Identify the most stable (lowest energy) and least stable (highest energy) resonance structures, or whether they are equal in energy. For all atoms, write the formal charge if it is not zero. (4 pts)

C. Draw the most stable Lewis dot structure for the following compounds. For all atoms, write the formal charge if it is not zero. The central atom of the compounds in questions a-d satisfies the octet rule; in questions e and f, the central atom does not satisfy the octet rule. (20 pts)



D. **Bonus.** Write a structure for the molecule  $\text{HArF}$ , in which all of the atoms have zero formal charge. (It will be necessary to violate the octet rule on the central Ar atom.) (+3 pts)

1. How many 5s orbitals does an atom possess? (4 pts)

- \_\_\_\_\_ (a) 1  
(b) 5  
(c) 6  
(d) 8

2. Which of the following are **correctly** arranged with respect to the size of the atom/ion?(4 pts)

- (i)  $K^+ < Ar < Cl^-$   
(ii)  $Br^- < Br < Br^+$   
(iii)  $O < S < P$   
(iv)  $S^{2-} < Cl^- < F^-$
- \_\_\_\_\_ (a) i only  
(b) iii only  
(c) i and iii only  
(d) ii only  
(e) iv only  
(f) ii and iv only

3. What physical feature of an orbital is related to the angular momentum quantum number,  $l$ ?(4 pts)

- \_\_\_\_\_ (a) the orientation in space of the orbital.  
(b) the orientation of the spin axis of the electron.  
(c) the size and energy of the orbital.  
(d) the shape of the orbital.

4. What is the energy in kJ/mol of light that has a frequency of  $3.76 \times 10^{18}$  Hz? (4 pts)

- \_\_\_\_\_ (a)  $7.99 \times 10^{-11}$  kJ/mol  
(b)  $2.49 \times 10^{-15}$  kJ/mol  
(c)  $3.85 \times 10^3$  kJ/mol  
(d)  $1.50 \times 10^6$  kJ/mol

5. What is the maximum number of electrons that can be held in a set of 5d orbitals? (4 pts)

- \_\_\_\_\_ (a) 2  
(b) 6  
(c) 10  
(d) 14

6. Which atom would have a fourth-ionization energy very much greater than the third? (4 pts)

- \_\_\_\_\_ (a) Na  
(b) Mg  
(c) Al  
(d) Si

7. An atom emits a photon of light having a frequency of  $4.86 \times 10^{14} \text{ s}^{-1}$ . Find the wavelength of this light, in units of nm. (4 pts)
- \_\_\_\_\_ (a) 617 nm  
(b) 162 nm  
(c) 333 nm  
(d) 136 nm
8. Which of the following elements have **two** unpaired electrons in the ground state electron configuration? (4 pts)
- \_\_\_\_\_ (a) Mg and Ar  
(b) Na, Al, and Cl  
(c) Si and S  
(d) P
9. What is the abbreviated electron configuration for the element **selenium** (Se,  $Z=34$ )? (4 pts)
- \_\_\_\_\_ (a)  $[\text{Ar}] 4d^{10} 4s^2 4p^4$   
(b)  $[\text{Ar}] 3d^{10} 4s^2 4p^4$   
(c)  $[\text{Zn}] 4d^4$   
(d)  $[\text{Ar}] 3s^2 4d^{10} 5p^4$
10. Which of the following does **not** arrange the elements shown below in order of **increasing ionization energy**? (4 pts)
- \_\_\_\_\_ (a) Cs, Rb, Sr, Ca  
(b) Mg, Ca, K, Be  
(c) B, C, N, O  
(d) I, Br, Cl, F
11. Chlorine tends to form only one covalent bond because it needs just one electron to complete its octet. What is the formula for the simplest compound (i.e., containing only single bonds) formed by chlorine with the element **carbon (C)**? (4 pts)
- \_\_\_\_\_ (a)  $\text{CCl}_2$   
(b)  $\text{CCl}_3$   
(c)  $\text{CCl}_4$   
(d)  $\text{CCl}_5$
12. Which of the following is **not** an acceptable set of quantum numbers? (4 pts)
- \_\_\_\_\_ (a)  $n = 2, l = 1, m_l = -2$   
(b)  $n = 2, l = 0, m_l = 0$   
(c)  $n = 3, l = 1, m_l = 0$   
(d)  $n = 3, l = 2, m_l = -1$

13. Which ONE of the following lists is **correctly** arranged in order of **increasing electronegativity**? (4 pts)

- \_\_\_\_\_ (a) O, N, C  
 (b) Br, F, Cl  
 (c) P, As, S  
 (d) Se, S, Cl

14. Which of the following electron configurations is written **incorrectly**? (4 pts)

- \_\_\_\_\_ (a) Br: [Ar]  $3d^{10} 4s^2 4p^5$   
 (b) Os: [Xe]  $6f^{14} 6d^6 6s^2$   
 (c) Co: [Ar]  $3d^7 4s^2$   
 (d) In: [Kr]  $4d^{10} 5s^2 5p^1$

15. What is the ground-state electron configuration of the  $Mn^{3+}$  ion? (4 pts)

- \_\_\_\_\_ (a) [Ar]  $3d^5 4s^2$   
 (b) [Ar]  $3d^2 4s^2$   
 (c) [Ar]  $3d^4$   
 (d) [Ar]  $3d^8 4s^2$

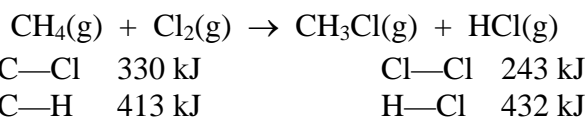
16. In which of the following lists are the bonds arranged in order of **increasing length**? (4 pts)

- \_\_\_\_\_ (a)  $C=O < C-O < C-S$   
 (b)  $C-O < C-S < C=O$   
 (c)  $C-S < C=O < C-O$   
 (d) all of the bonds are the same length

17. What is the velocity of an electron with a de Broglie wavelength of 385 nm? The mass of an electron is  $9.11 \times 10^{-31}$  kg. (4 pts)

- \_\_\_\_\_ (a)  $3.57 \times 10^9$  m/s  
 (b)  $2.21 \times 10^4$  m/s  
 (c)  $4.49 \times 10^6$  m/s  
 (d)  $1.89 \times 10^3$  m/s

18. Use Lewis structures and average bond energies listed below to calculate the enthalpy change of the following reaction: (4 pts)



- \_\_\_\_\_ (a) +39 kJ  
 (b) +87 kJ  
 (c) -106 kJ  
 (d) -125 kJ

 **Physical Constants** 

Avogadro's number	$N_A = 6.022 \times 10^{23}$ units/mol
Planck's Constant	$h = 6.626 \times 10^{-34}$ J s
Speed of light	$c = 3.00 \times 10^8$ m/s
Universal gas constant	$R = 0.08206$ L atm K <sup>-1</sup> mol <sup>-1</sup>

**Conversion Factors**

*(Conversion factors are exact except where indicated.)*

1 in = 2.54 cm	$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$	1 mmHg = 1 torr
3.281 ft = 1 m (not exact)	$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$	1 atm = $1.01325 \times 10^5$ Pa
1.609 km = 1 mi	$\text{K} = ^{\circ}\text{C} + 273.15$	1 atm = 760 mmHg
5280 ft = 1 mi	1 atm = 101 kPa (not exact)	1 atm = 760 torr
1 gal = 3.785 L (not exact)		1 atm = 14.7 lb / in <sup>2</sup>