Chemistry 141 Name

Dr. Cary Willard

Exam 3a November 16, 2010

Multiple Choice (30 points)

Page 4 (12 points)

Page 5 (13 points)

Page 6 (20 points)

Page 7 (16 points)

Page 8 (24 points)

Page 9 (12 points)

Total (127 points)

Percent (100 %)

All work must be shown to receive credit. Give all answers to the correct number of significant figures

Avogadros number = 6.022 x 1023 /mol

Grossmont College

Periodic Table

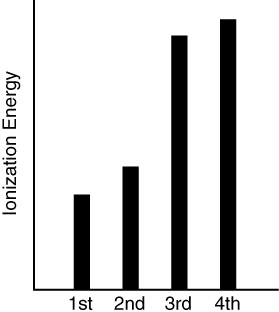
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| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | NOBLE GASES |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 3  **Li**  6.941 | 4  **Be**  9.012 |  |  |  |  |  |  |  |  |  | |  | 5  **B**  10.81 | 6  **C**  12.01 | 7  **N**  14.01 | 8  **O**  16.00 | 9  **F**  19.00 | 10  **Ne**  20.18 |
| 11  **Na**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 17  **Cl**  35.45 | 18  **Ar**  39.95 |
| 19  **K**  39.10 | 20  **Ca**  40.08 | 21  **Sc**  44.96 | 22  **Ti**  47.90 | 23  **V**  50.94 | 24  **Cr**  52.00 | 25  **Mn**  54.94 | 26  **Fe**  55.85 | 27  **Co**  58.93 | 28  **Ni**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 33  **As**  74.92 | 34  **Se**  78.96 | 35  **Br**  79.90 | 36  **Kr**  83.80 |
| 37  **Rb**  85.47 | 38  **Sr**  87.62 | 39  **Y**  88.91 | 40  **Zr**  91.22 | 41  **Nb**  92.91 | 42  **Mo**  95.94 | 43  **Tc**  (99) | 44  **Ru**  101.1 | 45  **Rh**  102.9 | 46  **Pd**  106.4 | 47  **Ag**  107.9 | | 48  **Cd**  112.4 | 49  **In**  114.8 | 50  **Sn**  118.7 | 51  **Sb**  121.8 | 52  **Te**  127.6 | 53  **I**  126.9 | 54  **Xe**  131.3 |
| 55  **Cs**  132.9 | 56  **Ba**  137.3 | 57  **La**  138.9 | 72  **Hf**  178.5 | 73  **Ta**  180.9 | 74  **W**  183.9 | 75  **Re**  186.2 | 76  **Os**  190.2 | 77  **Ir**  192.2 | 78  **Pt**  195.1 | 79  **Au**  197.0 | | 80  **Hg**  200.6 | 81  **Tl**  204.4 | 82  **Pb**  207.2 | 83  **Bi**  209.0 | 84  **Po**  (209) | 85  **At**  (210) | 86  **Rn**  (222) |
| 87  **Fr**  (223) | 88  **Ra**  226.0 | 89  **Ac**  227.0 | 104  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

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| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  162.5 | 67  **Ho**  164.9 | 68  **Er**  167.3 | 69  **Tm**  168.9 | 70  **Yb**  173.0 | 71  **Lu**  175.0 |
| 90  **Th**  232.0 | 91  **Pa**  231.0 | 92  **U**  238.0 | 93  **Np**  (237) | 94  **Pu**  (244) | 95  **Am**  (243) | 96  **Cm**  (247) | 97  **Bk**  (247) | 98  **Cf**  (251) | 99  **Es**  (252) | 100  **Fm**  (257) | 101  **Md**  (258) | 102  **No**  (259) | 103  **Lr**  (260) |

Lanthanide series

Actinide series

Part I – Multiple Choice (30 points)

1. Which of the following elements is isoelectronic with the Pb4+ ion?
   1. Rn
   2. Xe
   3. Hg
   4. Pt
2. The atomic radius of germanium is smaller than the atomic radius of potassium due to
   1. a change in the *n* quantum number.
   2. an increase in the effective nuclear charge.
   3. the fact that *p* and *d* orbitals have the same orbital penetration.
   4. a decrease in the effective nuclear charge.
3. Which arrangement is in the correct order of increasing radii?
   1. Mn > Mn2+ > Cs
   2. P < P3– < As3–
   3. Li+ > Li > Ra
   4. Cr < Cr3+ < Ca
4. Which of the following elements would you expect to have the greatest first ionization energy?
   1. C
   2. Li
   3. O
   4. Be
5. The first four ionization energies for an element are as follows. Identify the correct element from the list.
   1. Sr
   2. K
   3. S
   4. Al
6. A covalent bond results when
   1. electrons are transferred from one atom to another atom.
   2. atoms pool their electrons to form a “sea” of electrons.
   3. atoms have outer electrons with the same principal quantum number.
   4. electrons are shared between atoms.
7. Which of the following properties is typically used to predict the type of bond that forms between two elements?
   1. electronegativity
   2. atomic radius
   3. ionization energy
   4. electron affinity
8. Which of the following are listed in order of decreasing electronegativity?
   1. F, S, Na, H
   2. N, P, Si, Mg
   3. F, N, P, O
   4. F, Cl, Br, C
9. Indicate which of the following elements has the largest effective nuclear charge (*Z*eff) based on the data given.
   1. Mg (ionization energy = 738 kJ/mol)
   2. Na (ionization energy = 496 kJ/mol)
   3. Be (ionization energy = 899 kJ/mol)
   4. Li (ionization energy = 520 kJ/mol)
10. Which of the following is most likely a polar covalent bond?
    1. Na–Cl
    2. C–N
    3. H–H
    4. K–F
11. Which of the following atoms can have an expanded octet?
    1. As
    2. N
    3. C
    4. B
12. Bond length and bond strength are
    1. inversely proportional.
    2. opposite one another.
    3. directly proportional.
    4. unrelated.
13. The greatest repulsive forces in molecules are due to
    1. bonding–bonding.
    2. bonding–lone pair.
    3. unpaired–lone pair.
    4. lone pair–lone pair.
14. The H–X–H bond angle is larger in CH4 than in NH3,and ammonia has a larger angle than H2O. This trend is due to
    1. the effective nuclear charge’s decrease.
    2. an increase in the number of lone pairs, the lone pair repulsion causing the decrease in angle.
    3. the fact that carbon has a larger atom volume than nitrogen or oxygen.
    4. the change in polarity of the molecules.
15. All homonuclear diatomic molecules
    1. have polar bonds.
    2. are polar.
    3. are nonpolar.
    4. cannot vibrate.

Part 2 - Problems

1. (6 points) Write the complete electron configuration for an atom of N and of N-3.
   1. N
   2. N-3
2. (6 points) Write the shorthand electronic configuration for an atom of Ta, of Ta+3.
   1. Ta
   2. Ta+3
3. (5 points) Given the graphical representation of the first 21 ionization energies for zinc (in MJ/mol), explain the general trend in the curve, and any deviations from that general trend. (Larger graph on front of exam.)
4. (8 points) Two structures may be drawn for C4H5N2Br:

Structure a Structure b

* 1. Are these two resonance structures of the same molecule? Explain.
  2. How many sigma bonds are in structure a? \_\_\_\_\_\_\_\_How many pi bonds?\_\_\_\_\_\_\_\_
  3. Which bonds are longer, the CC bonds in structure a or b? Explain.
  4. Which bonds are stronger, the CN bonds in a or b? Explain.

1. (20 points) Write reasonable Lewis Electron Dot Structures for the following molecules or ions (Central atom is listed first). Tell the orbital and molecular geometry for each molecule/ion. Show formal charges for all non-zero charges. If resonance structures exist, show them.

|  |  |  |
| --- | --- | --- |
| NO2F  N is central atom |  | orbital geometry  molecular geometry |
| COS (C is central atom) |  | orbital geometry  molecular geometry |
| AlF6-3  Cryolite – used in the manufacture of aluminum |  | orbital geometry  molecular geometry |
| XeF2 |  | orbital geometry  molecular geometry |

1. (6 points) Although I3-1 is known, F3-1 is not. Using Lewis structures, explain why F3-1 does not form.
2. (10 points) Answer the following questions for the structure below:



|  |  |
| --- | --- |
| What is the molecular geometry of I (arrow a)? | What is the hybridization of Kr (arrow g)? |
| What is the formal charge of Rn (arrow c)? | What is the hybridization of C (arrow h)? |
| What is the hybridization of N (arrow d)? | What is the hybridization of Br (arrow i)? |
| What is the orbital geometry of N (arrow e)? | What is the formal charge on Sb (arrow j)? |
| What is the molecular geometry of P (arrow f)? | What is the formal charge on S (arrow k)? |

1. (9 points) Nitrosyl fluoride (NOF) has an atom sequence in which all atoms have formal charges of zero. Draw all possible skeleton structures and identify the structure which meets these criteria.
2. (5 points) Explain how sigma and pi bonds differ.
3. (4 points) Describe the difference between a pure covalent bond and a polar covalent bond.
4. (6 points) Look at the compound pictured below. Explain the bonding in terms of valence bond theory. That is show the atomic orbitals on the Xe atom, describe any electron promotion and hybridization necessary, and show the orbitals involved in both sigma and pi bonding as well as the orbital holding the lone pair of electrons



1. (12 points) Some species with two oxygen atoms only are the oxygen molecule, O2, the peroxide ion, O2-2, the superoxide ion, O2-1, and the dioxgenyl ion, O2+1. Draw an MO diagram for each, on the following page and answer the questions. Note that each box is labeled with a particular species.
   1. Rank these species in order of increasing bond length

\_\_\_\_\_\_>\_\_\_\_\_\_>\_\_\_\_\_\_>\_\_\_\_\_\_

* 1. Rank these species in order of increasing bond strength

\_\_\_\_\_\_>\_\_\_\_\_\_>\_\_\_\_\_\_>\_\_\_\_\_\_

* 1. Give the bond order in all species

O2 O2-2

O2-1 O2+1

* 1. Identify each species as diamagnetic or paramagnetic

O2 O2-2

O2-1 O2+1

|  |  |
| --- | --- |
| f1q52g1  Oxygen gas, O2 | Peroxide ion, O2-2  f1q52g1 |
|  |  |
| f1q52g1  Superoxide ion, O2-1 | Dioxygenyl ion, O2+1  f1q52g1 |