Chemistry 141 Name

Martin Larter

Exam 3A Spring, 2013

Multiple Choice (30 points)

Page 4 (17 points)

Page 5 (18 points)

Page 6 (12 points)

Page 7 (12 points)

Page 8 (16 points)

Page 9 (12 points)

Total (117 points)

Chemistry Constants

1 kcal = 4.184 kJ

NA = 6.02 x 1023 /mol

R = 0.0821 L atm/mol K = 62.4 L torr/mol K = 8.31 kJ/mol K

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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

Multiple choice (30 points)

1. The bonding in a molecule
   1. Must be either totally ionic or totally covalent
   2. May be more ionic-like or more covalent-like, depending on the atoms bonding
   3. Is the same mixture of ionic-like and covalent-like bonds, regardless of the atoms involved
   4. There is no difference between ionic and covalent bonding
2. The bond length between atoms involved in resonance
   1. Changes between bonds every microsecond or so within the molecule
   2. Has one preferred position so that one bond is shorter than the other, which is the same for each molecule; however, the shorter bond can only be detected experimentally
   3. Has one preferred position so that one bond is shorter than the other, but its position varies between molecules so that the average bond length over a mole is the same for all resonance positions
   4. Is exactly the same for all bond lengths
3. For an atom to expand its octet, it must
   1. Have an available d orbital in its valence shell
   2. Have a minimum of four valence electrons as an atom
   3. Have a maximum of four valence electrons as an atom
   4. Be a metalloid
4. The effect of lone pairs on bond angle is that the bonds
   1. Get farther apart
   2. Get closer together
   3. Remain at the same angle
   4. Depend on the identity of the central atom
5. According to the Heisenberg uncertainty principle,
   1. neither the position nor the momentum of a particle can be measured precisely.
   2. the position of a particle cannot be measured precisely.
   3. the momentum of a particle cannot be measured precisely.
   4. the position and momentum of a particle can be measured precisely, but not at the same time.
6. What are the possible values of *n* and *ml* for an electron in a 5*d* orbital?
   1. *n* = 5 and *ml* = 2
   2. *n* = 1, 2, 3, 4, or 5 and *ml* = 2
   3. *n* = 5 and *ml* = -2, -1, 0, +1, or +2
   4. *n* = 1, 2, 3, 4, or 5 and *ml* = -2, -1, 0, +1, or +2
7. Which of the following is *not* a valid set of quantum numbers?
   1. *n* = 3, *l* = 0, *ml* = 0, and *ms* = 1/2
   2. *n* = 3, *l* = 2, *ml* = 3, and *ms* = 1/2
   3. *n* = 2, *l* = 1, *ml* = -1, and *ms* = -1/2
   4. *n* = 2, *l* = 1, *ml* = 0, and *ms* = -1/2
8. Of the following, which atom has the smallest atomic radius?
   1. Sr
   2. Te
   3. S
   4. Mg
9. Arrange the ions N3-, O2-, Mg2+, Na+, and F- in order of increasing ionic radius, starting with the smallest first.
   1. N3-, Mg2+, O2-, Na+, F-
   2. N3-, O2-, Mg2+, F-, Na+
   3. N3-, O2-, F-, Na+, Mg2+
   4. Mg2+, Na+, F-, O2-, N3-
10. List the elements Cs, Ca, Ne, K, Ar in order of decreasing first ionization energy.
    1. Ne > K > Cs > Ca > Ar
    2. Ne > Ar > K > Cs > Ca
    3. Ar > Ca > Cs > K > Ne
    4. Ne > Ar > Ca >K > Cs
11. In the reaction of sodium metal with chlorine gas which of the following processes releases energy?
    1. Cl2(*g*) 🡪 2 Cl(*g*)
    2. Na(*g*) 🡪 Na+(*g*) + e-
    3. Na(*s*) 🡪 Na(*g*)
    4. Cl(*g*) + e- 🡪 Cl-(*g*)
12. The greater the electronegativity difference between two bonded atoms, the
    1. greater the bond order.
    2. greater the ionic character of the bond.
    3. more unstable the bond.
    4. greater the covalent character of the bond.
13. Which of the following occur as the wavelength of a photon increases?
    1. the frequency decreases
    2. the energy increases
    3. the speed decreases
    4. Planck's constant decreases
14. Choose the statement that is TRUE.
    1. Outer electrons efficiently shield one another from nuclear charge.
    2. Core electrons efficiently shield outer electrons from nuclear charge.
    3. Valence electrons are most difficult of all electrons to remove.
    4. Core electrons are the easiest of all electrons to remove.
15. Which of the following elements can form compounds with an expanded octet?
    1. Se
    2. C
    3. Li
    4. F

Problems (87 points)

1. (9 points) The blue color of the sky results from the scattering of sunlight by air molecules. The blue light has a frequency of about 7.5 x 1014 Hz.
   1. Calculate the wavelength, in nm, associated with this radiation.
   2. Calculate the energy, in J, of a single photon associated with this frequency.
   3. The retina of a human eye can detect light when radiant energy incident on it is at least 4.0 x 10-17 J. How many photons of “sky blue” light does this correspond to?
2. (8 points) How many photons at 660 nm must be absorbed to melt 5.0 x 102g of ice? (Hint: It takes 334 J to melt 1 gram of ice at 0oC.)
3. (5 points) The ionization energy of gold is 890.1 kJ/mol. Is light with a wavelength of 225 nm capable of causing the photoelectric effect to occur, explain?
4. (4 points) What is the main difference in the way valence bond theory and molecular orbital theories view the bonds in a molecule.
5. (9 points) Write electron configurations for the following atoms and ions.
   1. Silicon (complete configuration)
   2. Platinum (shorthand configuration)
   3. Cobalt(II) ion (shorthand configuration)
6. (4 points) Which ion has a larger radius, Sr2+ or Rb+? Explain your choice.
7. (4 points) The ionization energies for aluminum are IE1 = 580 kJ/mol, IE2 = 1815 kJ/mol, IE3 = 2740 kJ/mol, and IE4 = 11,600 kJ/mol. Why does the ionization energy increase as we remove successive electrons and why is there such a big increase in ionization energy to remove the 4th electron?
8. (4 points) Explain based on structure the difference between sigma and pi bonds?
9. (12 points) Complete the following table

|  |  |
| --- | --- |
| Molecule | Lewis Diagram |
| AsBr3  Orbital geometry  Molecular geometry  Hybridization of arsenic |  |
| SF4  Orbital geometry  Molecular geometry  Hybridization of sulfur |  |

1. (8 points) Draw Lewis electron dot structures for all resonance forms of SO2. Evaluate each of the structures and tell why each is favored or disfavored.
2. (8 points) Look at the compound pictured below. Explain the bonding in terms of valence bond theory. That is show the atomic orbitals on the Br atom, describe any electron promotion and hybridization necessary, and label the orbitals involved in both sigma and pi bonding as well as the orbital holding the lone pair of electrons on Br. You do not need to draw a 3D representation of the orbitals.



(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 decreasing bond length

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

* 1. Rank these species in order of decreasing 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  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | f1q52g1  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
|  |  |
| f1q52g1  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | f1q52g1 |