Chemistry 141 Name

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Exam 3A November 7. 2015

Multiple Choice (30 points)

Page 5 (14 points)

Page 6 (21 points)

Page 7 (22 points)

Page 8 (15 points)

Page 9 (12 points)

Total (114 points)

Chemistry Formulas and Constants

Kinetic energy = ½ mv2

w = -PΔV

ΔGo = -nFEo

ΔG = - RTlnK

w=dxF

E = mc2

Ptotal = P1+P2+P3+…

u = (3RT/MW)½

HΨ=EΨ

M1V1 = M2V2

u = (3RT/MW)½

ΔG = ΔH - TΔS

Ptotal = P1 + P2 + P3 + …

PV = nRT

Rate ∝ (MW)-½

P1=X1\*Ptotal

Π= iMRT

C = q/ΔT

Ptotal = P1 + P2 + P3 + …



Constants

F = 9.65 x 104 C

h = 6.626 x 10-34 J sec

c= 2.9979 x 108 m/sec

mass electron = 9.109 x 10-31 kg RE = 2.18 x 10-18 J

e = 1.602 x 10-19 C

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. Which statement is always true according to VSEPR theory?
2. The shape of a molecule is determined by the polarity of its bonds.
3. The shape of a molecule is determined by the repulsions among all electron groups on the central atom (or interior atoms if there is more than one).
4. The shape of a molecule is determined only by repulsions among nonbonding electron groups.
5. The shape of a molecule is determined only be repulsions among bonding electron groups.
6. none of the above
7. Arrange the ions P3-, S2-, Ca2+, K+, and Cl- in order of **increasing** ionic radius, starting with the smallest first.

|  |  |
| --- | --- |
| 1. Ca2+, K+, Cl-, S2-, P3- | 1. P3-, S2-, Ca2+, Cl-, K+ |
| 1. P3-, Ca2+, S2-, K+, Cl- | 1. K+, Ca2+, Cl-, S2-, P3- |
| 1. P3-, S2-, Cl-, K+, Ca2+ |  |

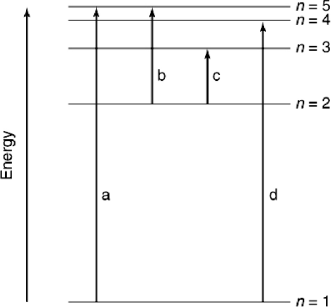
1. Which one of the following ground-state orbital diagrams **only violates Hund's rule**?

a. http://wps.prenhall.com/wps/media/objects/3081/3155040/18b_new.gif b. http://wps.prenhall.com/wps/media/objects/3081/3155040/18a_new.gif

c. http://wps.prenhall.com/wps/media/objects/3081/3155040/18c_new.gif d. http://wps.prenhall.com/wps/media/objects/3081/3155040/17c_new.gif

e. http://wps.prenhall.com/wps/media/objects/3081/3155040/18d_new.gif

1. Which of the transitions in the hydrogen atom energy-level diagram shown here requires the **longest wavelength** photon?



|  |  |  |
| --- | --- | --- |
| 1. a | 1. b | 1. d |
| 1. c | 1. none of the above |  |

1. Which bond should have the longest length?

|  |  |  |
| --- | --- | --- |
| 1. N=N | 1. N-N | 1. N≡N |
| 1. All three bond lengths should be about the same. | 1. Impossible to determine from the data given | |

1. If each of the following metals is exposed to light with a wavelength of 240 nm, which will emit photoelectrons with the greatest kinetic energy?

|  |  |
| --- | --- |
| * 1. iron ( = 7.2  10–19 J) | * 1. palladium ( = 8.2  10–19 J) |
| * 1. platinum ( = 9.1  10–19 J) | * 1. nickel ( = 8.3  10–19 J) |
| * 1. sodium ( = 4.4  10–19 J) |  |

1. Which of these statements correctly describes the **use of formal charge** in choosing between possible Lewis structures to describe a molecule?
   * 1. Formal charge on all the atoms should be zero, or at least the smallest possible value.
     2. The sum of the formal charges on all the atoms should equal the charge on the molecule or ion.
     3. The formal charge on an atom is *not* affected by the electronegativity of the atom.
     4. In an anion containing nitrogen and oxygen, the Lewis structures with a negative charge on the nitrogen will contribute the most to the description of the bonding.

|  |  |  |
| --- | --- | --- |
| 1. III and IV only | 1. I and III only | 1. II and III only |
| 1. II and IV only | 1. I and II only |  |

1. In general, resonance \_\_\_\_\_\_\_\_ electrons and \_\_\_\_\_\_\_\_ molecules.

|  |  |  |
| --- | --- | --- |
| * 1. delocalizes; destabilizes | * 1. delocalizes; stabilizes | * 1. destabilizes; destabilizes |
| * 1. localizes; stabilizes | * 1. localizes; destabilizes |  |

1. Which type of molecular orbital is used to describe electron density building up above and below the internuclear axis to form a bond?

|  |  |  |
| --- | --- | --- |
| 1. π | 1. **\* | 1. **\* |
| 1. ** | 1. s |  |

1. The reason Fe3+ has a smaller ionic radius than Fe2+ is because

|  |  |  |
| --- | --- | --- |
| 1. Fe2+ has a low electron affinity | 1. n is smaller for Fe2+ | 1. Fe3+ contains more protons |
| 1. Fe3+ has a higher Zeff | 1. Fe3+ has a higher ionization energy | |

1. List the elements Cs, Ca, Ne, Na, Ar in order of **increasing** first ionization energy.

|  |  |
| --- | --- |
| * 1. Ne > Na > Cs > Ca > Ar | * 1. Ne > Ar > Na > Cs > Ca |
| * 1. Ar > Ca > Cs > Na > Ne | * 1. Ne > Ar > Ca > Na > Cs |
| * 1. None of the above |  |

1. Which of the following atoms is diamagnetic?

|  |  |  |
| --- | --- | --- |
| * 1. B | * 1. Mg | * 1. C |
| * 1. Na | * 1. O |  |

1. In quantum mechanics, an atomic orbital \_\_\_\_\_\_\_\_
   1. Provides the position of an electron at any instant of time in the space around an atomic nucleus.
   2. Provides the probability of finding an electron at any point in the space around an atomic nucleus.
   3. Locates all the electrons in an atom.
   4. Is identical to the orbits Bohr used in his analysis of the hydrogen atom.
   5. Identifies the most probable position of an atomic nucleus.
2. Which of the following sets of quantum numbers (n, l, ml, and ms) **could not occur**?
3. 3, 2, 2, -1/2 b. 3, 2, 0, -1/2 c. 1, 0, 0, -1/2 d. 2, 1, 2, +1/2 e. 2, 0, 0, +1/2
4. The greater the electronegativity difference between two bonded atoms, the

|  |  |
| --- | --- |
| * 1. Greater the bond order. | * 1. Greater the ionic character of the bond. |
| * 1. More unstable the bond. | * 1. Greater the covalent character of the bond. |
| * 1. None of the above |  |

**Problems and short answer**

1. (8 points) How many photons at 580 nm must be absorbed to melt 4.0 x 102g of ice? (Hint: It takes

334 J to melt 1 gram of ice at 0oC.)

* 1. On average, how many H2O molecules does one photon convert from ice to water?

1. (6 points)An electron in a hydrogen atom relaxes to the *n* = 4 level, emitting light of 114 THz (1 THz =1 x 1012 Hz). What is the value of *n* for the level in which the electron originated?
2. (9 points) Write the electron configurations for the following atoms or ions as predicted by the periodic table
   1. Si (complete configuration) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Platinum (Pt) (shorthand configuration) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Cobalt(II) ion (shorthand configuration)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. (8 points) As you move across a row on the periodic table, the atomic radius decreases. As you move down a column on the periodic table, the atomic radius increases. However, in both cases (across a row and down a column) the number of protons increases.

Provide a **complete** explanation (**and define your terms**) explaining how while the number of protons increases in both cases, the change in atomic radius is different. **A complete response will address both trends.**

1. (4 points) Why is SF4 a stable molecule, while the molecule OF4 does not exist?
2. (18 points) Write the best 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.

|  |  |  |
| --- | --- | --- |
| NS2Cl |  | orbital geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  molecular geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Bond angle\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Polar or Nonpolar\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| SeOF2 |  | orbital geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  molecular geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Bond angle\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Polar or Nonpolar\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| XeF2 |  | orbital geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  molecular geometry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Bond angle\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Polar or Nonpolar\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. (4 points) Compare and contrast valence bond theory and molecular orbital theory.
2. (15 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
   2. Rank these species in order of decreasing bond strength
   3. 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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. In terms of the molecular orbital model, which species would be the most likely to gain an electron if any:

O2, O2-2 , O2-1 , O2+1. Rationalize your answer.

1. (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 to draw a 3D representation of the orbitals.



1. (4 points) NH3 is a polar molecule but BH3 is not. Explain this observation in terms of the structures of the two molecules.

Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| f1q52g1 | f1q52g1  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
|  |  |
| f1q52g1  Molecule/ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | f1q52g1 |

What is Bubba dog’s favorite color\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_