Chemistry 141 Name key

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Exam 3A April 22, 2010

Multiple Choice (30 points)

Page 1 (24 points)

Page 2 (20 points)

Page 3 (24 points)

Page 4 (12 points)

Total (110 points)

Chemistry Formulas and Constants

Kinetic energy = ½ mv2

w = -PΔV

Ptotal = P1+P2+P3+…

u = (3RT/MW)½

ΔG = ΔH - TΔS

PV = nRT

Rate ∝ (MW)-½

P1=X1\*Ptotal

C = q/ΔT

Ptotal = P1 + P2 + P3 + …

M = mol/L

K = oC + 273.16

m = mol/kg solvent

Xi = moli/ moltotal





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

Standard Temperature and Pressure = 0oC and 1 atm

760 torr = 760 mm Hg = 1.00 atm = 101 kPa = 14.6 psi = 30 in Hg

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 Questions (30 points)

1. A quantized variable
   1. can only assume certain values.
   2. consists of photons.
   3. is extremely small.
   4. can be continuously varied.
   5. none of the above
2. How many electrons can a single orbital hold?
   1. 2
   2. 8
   3. 2*l* + 1
   4. 2*n*
   5. none of the above
3. Which of the following statements is TRUE?
   1. The emission spectrum of a particular element is always the same and can be used to identify the element.
   2. Part of the Bohr model proposed that electrons in the hydrogen atom are located in "stationary states" or particular orbits around the nucleus.
   3. The uncertainty principle states that we can never know both the exact location and speed of an electron.
   4. An orbital is the volume in which we are most likely to find an electron.
   5. All of the above are true.
4. 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
5. Which of the following have their valence electrons in the same shell?
   1. B, Si, As
   2. N, As, Bi
   3. K, As, Br
   4. He, Ne, F
   5. none of the above
6. 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. Form 90o bond angles
   5. Depend on the identity of the central atom
7. Of the following, which element has the highest first ionization energy?
   1. magnesium
   2. silicon
   3. sodium
   4. aluminum
   5. phosphorus
8. Which of the following statements are TRUE?
   1. The principal quantum number (*n*) describes the shape of an orbital.
   2. The angular momentum quantum number (*l*) describes the size and energy associated with an orbital.
   3. The magnetic quantum number (*ml*) describes the orientation of the orbital.
   4. An orbital is the path that an electron follows during its movement in an atom.
   5. All of the above are true.
9. Compare the energies of molecular orbitals of homonuclear diatomic molecules with the energies of the atomic orbitals with which they correlate.
   1. Both bonding and antibonding molecular orbitals lie lower in energy than the atomic orbitals.
   2. Bonding orbitals are higher and antibonding orbitals are lower in energy than the atomic orbitals.
   3. Bonding orbitals are lower and antibonding orbitals are higher in energy than the atomic orbitals.
   4. Both bonding and antibonding molecular orbitals are higher in energy than the atomic orbitals.
   5. none of the above
10. 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-
    5. none of the above
11. Which bond should have the highest bond dissociation energy?
    1. N-N
    2. N=N
    3. N≡N
    4. All three bonds should have about the same dissociation energy.
    5. Impossible to determine from the data given
12. Which reaction below represents the **electron affinity** of Li?



















Use the molecular orbital diagrams drawn at the bottom of the page to answer the following three questions (They are both the same).

1. Determine which of the following is **most** stable.
   1. F2
   2. F2+2
   3. Ne2+2
   4. O2+2
   5. F2-2
2. Use the molecular orbital diagram shown to determine which of the following are paramagnetic.
   1. O2-2
   2. Ne2+2
   3. O2+2
   4. F2+2
   5. None of the above are paramagnetic.
3. Determine which of the following has the shortest bond length.
   1. O2-2
   2. Ne2+2
   3. O2+2
   4. F2+2
   5. . F2

|  |  |
| --- | --- |
| f1q52g1 | f1q52g1 |

Problems (80 points)

1. (4 points) Describe the difference between a pure covalent bond and a polar covalent bond.

Answer: A pure covalent bond occurs when bonding electrons are shared equally (or very close to it) as in the N-N bond. A polar covalent bond is formed between 2 atoms of differing electronegativities. The bonding electrons are unequally shared between the two atoms as in the CO molecule.

1. (4 points) Explain why the lattice energy of MgS is approximately 4 times larger than that of NaCl.

Answer: The Mg+2 and Na+1ion are similar in size as are the S-2 and Cl-1 ions. Therefore, the major difference in the lattice energies for these two compounds is due to the difference in the magnitude of the ionic charge on each ion. According to Coulomb's law, Mg and S ions have 4× the attractive force (2+ × 2-) than the Na and Cl ions (1+ × 1-).

1. (4 points) How does the concept of an orbit in the Bohr model of the hydrogen atom differ from the concept of an orbital in quantum theory?

In the Bohr model, the electrons circle the nucleus in a circular orbit whereas in quantum we recognize that the electron exists in an orbital or a volume in space and it does not have a particular path.

1. (6 points) Write the complete electron configuration for an atom of S and of S-2.

S

1s2 2s2 2p6 3s2 3p4

S-2

1s2 2s2 2p6 3s2 3p6

1. (6 points) Write the shorthand electronic configuration for an atom of Mn, of Mn+2.

Re

[Xe] 6s2 5d5 4f14

Re+2

[Xe] 5d5 4f14

1. (4 points) The first ionization energy of the noble gas neon is 2081 kJ/mol. The sodium ion(Na+) is isoelectronic with neon, but the energy required to take one electron from the sodium ion is 4560 kJ/mol. Why is it so much harder to remove an electron from a sodium ion than from a neon atom if the two are isoelectronic?

Although both particles are isoelectronic or have the same electron configuration, the sodium ion has more protons and a higher positive charge in the nucleus so it is more difficult to remove an electron from the sodium and it has a higher ionization energy.

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 N 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.

N



N

1. (8 points) Draw Lewis structures for NOF3 and POF3 in which the group 15 element is the central atom and the other atoms are bonded to it. What differences are there in the types of bonding in these molecules? Why are they different?

NOF3 is unable to form an expanded octet and therefore has formal charges on both N and O



POF3 is able to expand the octet of P thereby reducing the formal charge in the molecule.

1. (4 points) Jasmone is a compound obtained from the jasmine flower and is used as a fragrance for perfumes



* 1. How many pi bonds are there in jasmone?

3

* 1. How many sigma bonds are there in jasmone?

28, but may show 24 if don’t know CH2’s in ring

1. (4 points) Why do C, N, O, and F atoms in covalently bonded molecules and ions have no more than 8 valence electrons (4 bonds)?

These elements do not have any available d orbitals in their valence shell into which the extra electrons can be placed. For this reason they are unable to expand their valences.

1. (16 points) Complete the following table

|  |  |
| --- | --- |
| Molecule | Lewis Diagram |
| IF5  Orbital geometry  octahedral  Molecular geometry  Square pyramidal  Hybridization of iodine  sp3d2 |  |
| NO3-1  (show formal charges on atoms and any resonance structures)  Orbital geometry  Trigonal planar  Molecular geometry  Trigonal planar  Hybridization of iodine  sp3 |  |

1. (12 points) Answer the following questions for the structure below
   1. What is the hybridization of N?

sp3

What is the formal charge on N?

+1

* 1. What is the orbital geometry of Xe?

Trigonal bipyramidal

What is the molecular geometry of Xe

See-saw

* 1. What is the charge on Br?

+1

What is the molecular geometry of Br?

Bent

* 1. What is the orbital geometry of C?

Linear

What is the hybridization of N?

sp

* 1. What is the hybridization of chlorine?

sp3d

What is the molecular geometry of Cl?

Linear

What is the formal charge on Cl?

-1

* 1. What is the molecular geometry of carbon?

Tetrahedral



|  |  |
| --- | --- |
| f1q52g1 | f1q52g1 |
| f1q52g1 | f1q52g1 |