## *Chem 111 2:30p section Evening Exam #3*

This exam is composed of 25 questions, 1 of which requires mathematics that *might* require a calculator. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations.

*As discussed in the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.*

*I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.*

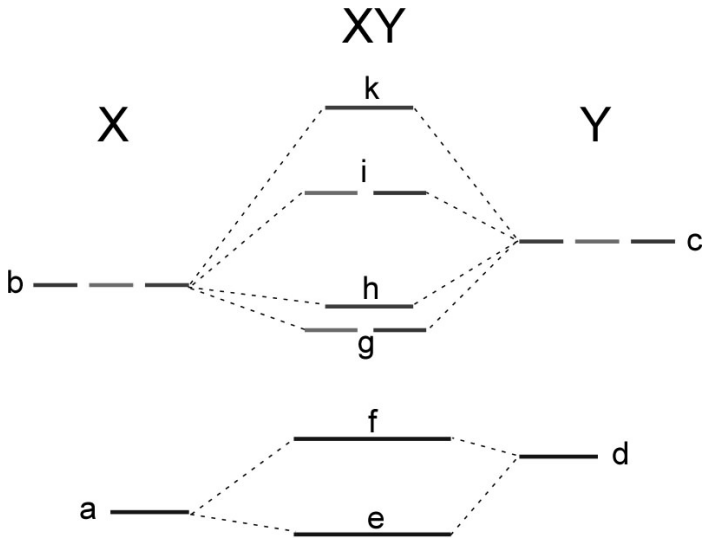
_____ ..
*Signature*

| | | |
|---|---|---|
| $E = h\nu = \frac{hc}{\lambda}$<br>$E_n^{H-atom} = -\frac{R_H hc}{n^2}$<br>1 mL = 1 $cm^3$ | **Some common ions:**<br>$PO_4^{3-}$ $CN^-$ $CH_3CO_2^-$<br>$NO_2^-$ $NO_3^-$ $CO_3^{2-}$<br>$SO_3^{2-}$ $SO_4^{2-}$ | $h = 6.626x10^{-34}\ J\ s$<br>$c = 2.9998x10^8\ m\ s^{-1}$<br>$N = 6.022x10^{23}\ mol^{-1}$<br>$R_H = 1.097x10^7\ m^{-1}$ |

**PERIODIC TABLE OF THE ELEMENTS**

| 1A | 2A | 3B | 4B | 5B | 6B | 7B | 8B | 8B | 8B | 1B | 2B | 3A | 4A | 5A | 6A | 7A | 8A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 3 Li 6.939 | 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 22.99 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 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 58.71 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 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 181.0 | 74 W 183.8 | 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 Unq (261) | 105 Unp (262) | 106 Unh (263) | 107 Uns (262) | 108 Uno (265) | 109 Une (266) | | | | | | | | | |

Questions 1 through 6 refer to the energy diagram below of a "first row" (n=2) diatomic:




1. The energy level denoted "**e**" refers to:
   1) a bonding molecular orbital
   2) a nonbonding molecular orbital
   3) an antibonding molecular orbital
   4) an atomic orbital

2. The energy level denoted "**g**" refers to:
   1) sigma bonding molecular orbitals
   2) π bonding molecular orbitals
   3) atomic orbitals
   4) sigma antibonding molecular orbitals
   5) π antibonding molecular orbitals

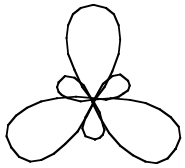
3. The electrons in the orbital represented by energy level "**e**":
   1) are distributed more toward X
   2) are distributed more toward Y
   3) are equally distributed between X and Y

4. If the letter designations represent energies of the orbitals, then:
   **a + d =** 1) f - e 2) e - f 3) e + f 4) none of these

5. The diatomic XY is $NO^-$. What is the overall diatomic bond order?
   1) 1.0 2) 1.5 3) 2.0 4) 2.5 5) 3.0

6. The diatomic XY is $NO^-$. The nitrogen atomic orbitals are represented by:
   1) X 2) Y 3) XY

7. The picture at right depicts which type of orbital hybridization?



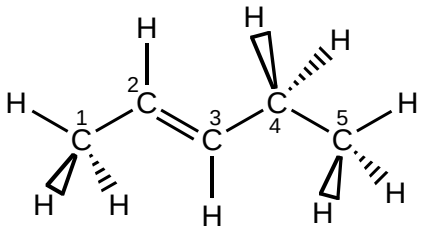
1) sp 2) $sp^2$ 3) $sp^3$ 4) $sp^4$

5) none of the above

8. In the orbital hybridization ***above***, how many atomic orbitals were used to create the resulting molecular orbitals?

1) 1 2) 2 3) 3 4) 4 5) 5

9. In the molecule 2-pentene, shown at right, the carbon labeled (2) has what hybridization?




1) sp 3) $sp^3$

2) $sp^2$ 4) $sp^4$

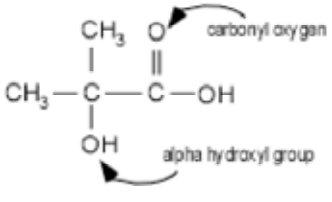
10. The angle describing $C_1$-$C_2$-$C_3$ (centered on carbon 2) is approximately:

1) 90° 2) 109.5° 3) 120° 4) 180°

11. A central atom in a molecule has a trigonal bipyramidal electron pair geometry. What is the orbital hybridization on that atom?

1) sp 2) $sp^2$ 3) $sp^3$ 4) $sp^3d$ 5) $sp^3d^2$

12. Trendy anti-wrinkle creams advertise the presence of "alpha hydrox" as a key component. A structure of an alpha hydroxy acid is shown at right. In this molecule, what is the hybridization at the ***carbonyl oxygen***? Hint: all C and O atoms have complete octets.




1) sp 2) $sp^2$ 3) $sp^3$ 4) $sp^3d$ 5) $sp^3d^2$

**Solubility Rules for some ionic compounds in water**

## Soluble Ionic Compounds

1. All sodium ($Na^+$), potassium ($K^+$), and ammonium ($NH_4^+$) salts are SOLUBLE.
2. All nitrate ($NO_3^-$), acetate ($CH_3CO_2^-$), chlorate ($ClO_3^-$), and perchlorate ($ClO_4^-$) salts are SOLUBLE.
3. All chloride ($Cl^-$), bromide ($Br^-$), and iodide ($I^-$) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) ($Pb^{2+}$,$Ag^+$, $Hg^{2+}$) which are NOT soluble.
4. All sulfate ($SO_4^{2-}$) salts are SOLUBLE - - EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead ($Ca^{2+}$, $Ag^+$, $Hg_2^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Pb^{2+}$) which are NOT soluble.

## Not Soluble Ionic Compounds

5. Hydroxide ($OH^-$) and oxide ($O^{2-}$) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium ($Na^+$, $K^+$, $Ba^{2+}$) which are soluble.
6. Sulfide ($S^{2-}$) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium ($Na^+$, $K^+$, $NH4^+$, $Ba^{2+}$) which are soluble.
7. Carbonate ($CO_3^{2-}$) and phosphate ($PO_4^{3-}$) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium ($Na^+$, $K^+$, $NH_4^+$), which are soluble.

13. Mixing **$Pb(NO_3)_2$** with **$CaCl_2$** in water leads to precipitation of:

    1) a $Cl^-$ salt  2) a $Ca^{2+}$ salt  3) a $NO_3^-$ salt

    4) everything precipitates  5) no precipitation

14. Gold can be dissolved from gold-bearing rock by treating the rock with sodium cyanide in the presence of oxygen.

    $4Au\ (s) + 8NaCN\ (aq) + O_2\ (g) + 2H_2O\ (l) \rightarrow 4NaAu(CN)_2\ (aq) + 4NaOH\ (aq)$

    For this reaction, what is the oxidizing agent on the left side of the reaction?

    1) Au  2) NaCN  3) $O_2$  4) $H_2O$  5) $H^+$

15. Ammonium sulfide, $(NH_4)_2S$, reacts with $Hg(NO_3)_2$ to produce HgS and $NH_4NO_3$ This reaction is best classified as:

    1) oxidation-reduction  2) gas evolving  3) acid-base

    4) precipitation  5) gas evolving and precipitation

16. Consider the unbalanced reaction:

$Mg(OH)_2$ (s) + $HNO_3$ (aq) → $Mg(NO_3)_2$ (aq) + $H_2O$ (l)

In the balanced, net ionic equation for this reaction, the coefficient preceding $NO_3^-$ is:

1) 1 2) 2 3) 3

4) $N0_3^-$ does not appear in the net ionic equation

17. Consider the unbalanced reaction:

$Mg(OH)_2$ (s) + $HNO_3$ (aq) → $Mg(NO_3)_2$ (aq) + $H_2O$ (l)

This reaction is best classified as:

1) oxidation-reduction 2) acid-base 3) precipitation
4) gas evolving 5) gas evolving and precipitation

18. Consider the following reaction that occurs within rechargeable "Ni-cad" batteries:

2 NiO(OH) (s) + 2 $H_2O$ (l) + Cd (s) → 2 $Ni(OH)_2$ (s) + $Cd(OH)_2$ (aq)

The oxidation number of Ni in NiO(OH) is:

1) +1 2) +2 3) +3 4) +4 5) +5

19. In the above reaction, the oxidizing agent on the left side of the reaction is:

1) NiO(OH) 2) $H_2O$ 3) Cd (s) 4) this is not a redox reaction

20. Which reaction below is a redox reaction?

1) $NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO_3\ (aq) + H_2O\ (l)$

2) $Na_2CO_3\ (aq) + 2\ HClO_4\ (aq) \rightarrow CO_2\ (g) + H_2O\ (l) + 2NaClO_4$

3) $CdCl_2\ (aq) + Na_2S\ (aq) \rightarrow CdS\ (s) + 2\ NaCl\ (aq)$

4) $Si\ (s) + 2Cl_2\ (g) \rightarrow SiCl_4\ (l)$

5) None of the above

21. The net ionic equation for the reaction of copper sulfate and sodium hydroxide is:

1) $Cu^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Cu(OH)_2\ (s) + Na_2SO_4\ (aq)$

2) $CuSO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Cu(OH)_2\ (aq) + Na_2SO_4\ (aq)$

3) $Cu^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Cu(OH)_2\ (s)$

4) $Cu^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Cu(OH)_2\ (aq)$

5) No *net* reaction occurs

22. Even though it is only slightly soluble, dissolving CaO (assume that it does dissolve) in water leads to:

1) a resulting basic solution

2) a resulting acidic solution

3) no change in pH of the solution

23. You add sufficient 2 M HCl to 1.0 L of water to yield a final pH=3.0. Which statement below is true regarding the resulting solution?

1) $[OH^-] = 10^{-14}$ M 2) $[Cl^-]$ = 1.0 mM 3) $[H^+]$ = 3.0 M

4) $[H^+] = 10^3$ M 5) none of the above

24. Write the balanced, ***net ionic equation*** corresponding to the unbalanced equation:

$AlCl_3 + Na_3PO_4 \rightarrow AlPO_4 + NaCl$

The numerical coefficient preceding $\mathbf{Na}^+$ (aq) is:

1) 1 2) 2 3) 3 4) 4

5) 0 ($Na^+$ doesn't occur in the net ionic equation)

25. What is the catalog number for this class?

1) 123 2) 345 3) 111 4) 3.14159 5) 68.6 g