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.

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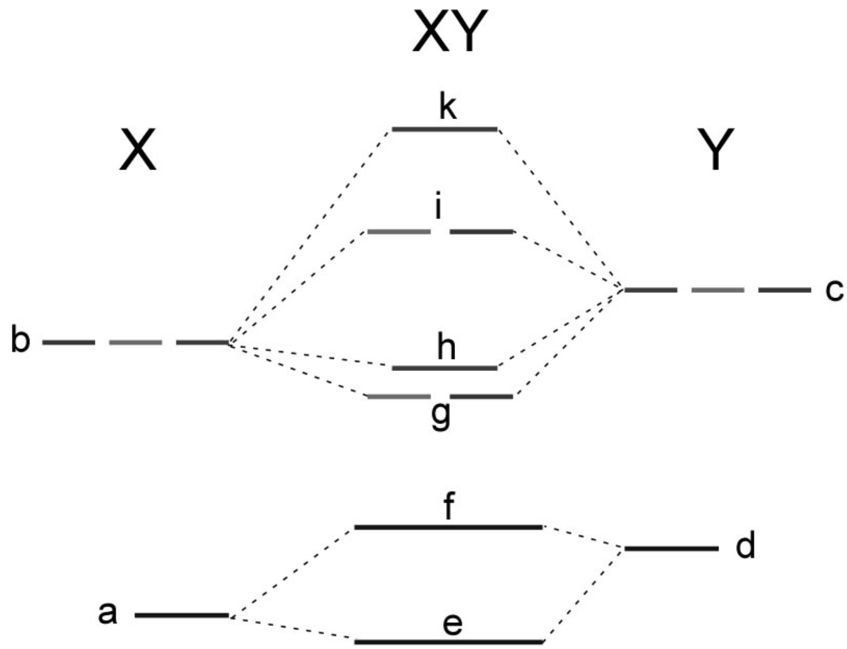
Signature

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

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 x through y 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

   (1) **(OWL question)**

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

   (2) **(OWL question)**

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

   (1)

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

(3)

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

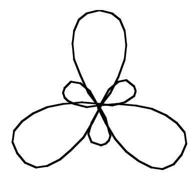
(3)

6. The diatomic XY is NO^-. The nitrogen atomic orbitals are represented by:

1) X 2) Y 3) XY

(2)

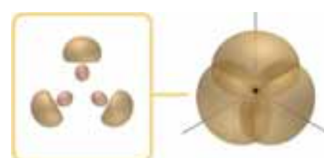
7. The picture at right depicts which type of orbital hybridization?



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

5) none of the above

(2) from OWL 10-2b. The above is a traditional way (and one used in class) to represent the hybrid orbital described in the book by the picture at right

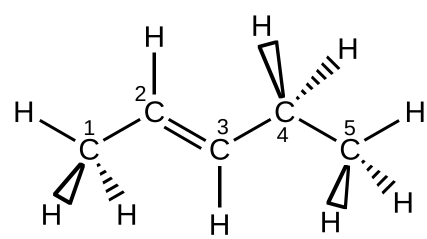


8. In the orbital hybridization ***above***, how many atomic orbitals were used to create the resulting molecular orbitals?

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

(3) from OWL 10-2b

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

(2) requires 3 orbitals **(OWL question)**

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°

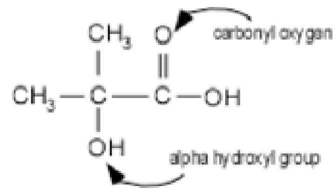
(3) bond angles for sp^2

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

(4) requires 5 hybrid orbitals

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

(2) To complete the octet on O and make it "happy," we need to add two pairs of electrons. This places 3 "electron groupings" around O and therefore we need hybridization that gives us 3 hybrid orbitals. (Chapter 10)

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 $\mathbf{Pb(NO_3)_2}$ with $\mathbf{CaCl_2}$ 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

(1) inspired by OWL 5-2d

Pb^{2+} **(aq) + 2**NO_3^{2-} **(aq) +** Ca^{2+} **(aq) + 2**Cl^- **(aq) →** $PbCl_2$ **(s) +** Ca^{2+} **(aq) + 2**NO_3^{2-} **(aq)**

Pb^{2+} **(aq) + 2**Cl^- **(aq) →** $PbCl_2$ **(s)**

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) → 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^+

(3) O_2 **K&T 5-122** Au^0 **→** Au^{3+} O_2 **->** OH^- **(O oxid no -2)**

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

(4) HgS is insoluble (rule 6, above). NH_4NO_3 **is clearly soluble, not a gas.**

K&T 5-97 $(NH_4)_2S$ **(aq) +** $Hg(NO_3)_2$ **(aq) → HgS (s) + 2** NH_4NO_3 **(aq)**

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

(4) $Mg(OH)_2$ (s) + 2 HNO_3 (aq) → $Mg(NO_3)_2$ (aq) + 2 H_2O (l)

Mg^{2+} (aq) + 2 OH^- (aq) + 2 H^+ + 2 NO_3^- (aq) → Mg^{2+} (aq) + 2 NO_3^- (aq) + 2 H_2O (l)

2 OH^- (aq) + 2 H^+ → 2 H_2O (l)

OH^- (aq) + H^+ → H_2O (l)

OH^- (aq) + H^+ → H_2O (l)

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

(2) see above

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

(3) O^{2-} and $(OH)^-$ "get their way"

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

(1) Ni(III)O(OH) + H_2O + Cd(0) → $Ni(II)(OH)_2$ + $Cd(II)(OH)_2$

20. Which reaction below is a redox reaction?

1) NaOH (aq) + HNO_3 (aq) → $NaNO_3$ (aq) + H_2O (l)

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

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

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

5) None of the above

(4) Look at redox changes **Chapt 5 inspired by book**

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

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

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

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

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

5) No *net* reaction occurs

(3) hydroxide salts are generally insoluble **(OWL 5-2c)**

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

(1)

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

(2) HCl dissociates completely $[H^{+}] = 10^{-(3.0)}$ M = $[Cl^{-}]$

The question below was fine as written, but one of the versions of the exam had an error in wording. Consequently, everyone will get full credit.

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)

Al^{3+} **(aq) +** PO_4^{3-} **(aq)** $\rightarrow$ $AlPO_4$ **(s)**

(5) Na+ cancels out of the net ionic equation **OWL 10-xx**

25. What is the catalog number for this class?

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

(3)