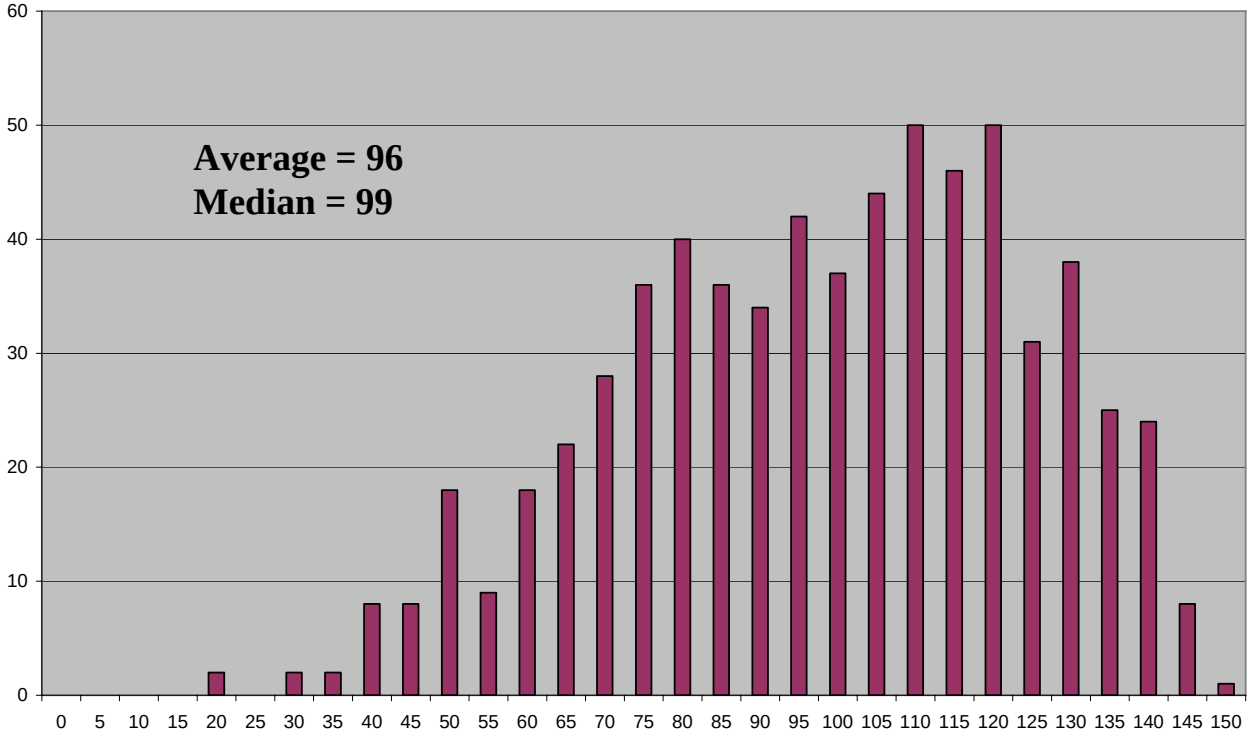
Name (print)_____ Chem ID#_____
Last first

Fall Break Assignment: Read "Naming Coordination Compounds" (one of the Related Tutorial in Tutorial #1) before Monday's (10/20/09) lecture.

Chem 151
MIDTERM EXAMINATION
October 15, 2008

Chem151 Midterm Exam Grade Distribution (Fall 2008)



All re-grade requests must be submitted to the blue locker on the 3rd floor of Lab Sciences Building before 5 pm on Monday (10/20/08).

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1. (4 pts.) In your lab, if you have spilled chemicals in your eye, where is the eye-wash?

   The eye wash is located over the sink next to the instructor's fume hood. Another one is in the common area between the A lab and the B lab.

2. (4 pts.) In your lab, where can you find the binder with the Material Safety Data Sheets (MSDS)?

   The MSDS binder is next to the lab phone on the shelf in the common area between the A lab and the B lab.

3. (6 points) On the right are four interhalogen diatomic molecules. ClF (BrF) BrCl IBr

   a) Circle the molecule with highest ionic character and enter its systematic name in the box below.

   Bromine fluoride

   b) The bonds between the halogen atoms in the above molecules are classified as (*ionic bond / covalent bond / polar covalent bond*). Circle the correct answer.

4. (4 pts.) Circle all the element(s) below that has electronegativity lower than 2.2 on Pauling scale.

   H, (Ag,) (Ca,) (Si,) Se, N, Cl

   2 pts. was deducted for each mistake.

5. (4 pts.) Based on the periodic trends of atomic sizes, arrange the following molecules in the order of increasing sizes. NO_2 H_2O O_3 SO_2

   H_2O < ***O_3*** < ***NO_2*** < ***SO_2***

   4 pts. No partial credit

6. (4 pts.) A diode in an LED was constructed using a semiconductor of germanium doped with gallium connected to a semiconductor of germanium doped with phosphorus. Which semiconductor should be connected to the negative terminal of a battery? Enter your answer in the box.

   Semiconductor of germanium doped with ***phosphorus***

   4 pts. No partial credit

7. (10 pts.) Jerry dissolves 5.00 g of sodium hydrogen phosphate (Na_2HPO_4, molar mass = 142.0 g/mol) in water to make 234 mL of solution.

   a) List the formula(s) of the major species (cations, anions, and/or molecules) besides water in the box below.

   Na^+ and HPO_4^{2-}

   4 pts;

   b) What is the molarity of sodium ions in solution? Enter your answer in the box and show your work in the space below.

   0.301 **M**

   Moles of Na_2HPO_4 = $\dfrac{5.00\ g}{142.0\ g/mol} = 0.0352\ mol$

   Moles of Na^+ = $(0.0352\ mol\ Na_2HPO_4)(\dfrac{2\ mol\ Na^+}{1\ mol\ Na_2HPO_4}) = 0.0704\ mol$

   Molarity of Na^+ = $\dfrac{0.0704\ mol}{0.234\ L} = 0.301\ mol/L$

   6 pts; 4 pts. was deducted for each conceptual mistakes and two pts. for math/careless error.

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8. Write a balanced net ionic equation in the appropriate box to illustrate the reaction taken place in each of the following procedures. Also list the spectator ion(s) of each reaction.

   a. (6 pts.) Hydrochloric acid is added to calcium carbonate powder. While calcium carbonate dissolves gradually, gas bubbles out from solution.

   $CaCO_3 + 2\ H^+ \rightarrow H_2O + CO_2 + Ca^{2+}$ — 4 pts.

   Spectator ion(s) = Cl^- — 2 pts.

   b. (8 pts.) Sodium hydroxide solution is added to aluminum sulfate solution and the solution turns cloudy

   $Al^{3+} + 3\ OH^- \rightarrow Al(OH)_3$ — 4 pts.

   Spectator ion(s) = Na^+ , SO_4^{2-} — 4 pts.

   c. (8 pts.) Hydrochloric acid is added to a 5% sodium hypochlorite solution to produce chlorine gas.

   $Cl^- + ClO^- + 2\ H^+ \rightarrow Cl_2 + H_2O$ — 6 pts.

   Spectator ion(s) = Na^+ — 2 pts.

9. (10 pts.) Joe finds two bottles of solutions with no clear labels in a lab. These can be 0.1 M solutions from the list of ten possibilities below:

   i. $CuSO_4$ solution
   ii. LiOH solution
   iii. $Ca(CH_3COO)_2$ solution
   iv. Li_2CO_3 solution
   v. H_2SO_4 solution
   vi. A solution of KOH and K_2CO_3
   vii. A solution of HCl and $CuCl_2$
   viii. A solution of $CuCl_2$ and H_2SO_4
   ix. A solution of $CaCl_2$ and HCl
   x. A solution of $CuCl_2$ and $BaCl_2$

   5 pts. was awarded for each correct identity of unknown. No partial credit.

   Solution A is colorless. The pH is approximately 11-12. The flame is red in the flame test.
   When A is added to 0.1 M KOH solution, no obvious changes are observed.
   When A is added to a 0.1 M $BaCl_2$ solution, the solution turns cloudy.
   When A is added to 2 M sulfuric acid, gas bubbles are formed.
   Choose from the above list to enter the most likely identity of A in the box.

   iv **Li_2CO_3**

   Solution B is light blue. The pH is approximately 1-2 and the flame color is green in the flame test.
   When B is added to 0.1 M KOH solution no obvious changes are observed.
   When B is added to a 0.1 M $BaCl_2$ solution, the solution turns cloudy
   When B is added to 2 M sulfuric acid, no obvious changes are observed.
   Choose from the above list to enter the most likely identity of B in the box.

   viii **$CuCl_2$ + H_2SO_4**

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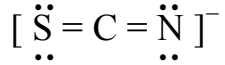
10. (8 pts.) Shown on the right is the Lewis dot structure of the polyatomic anion, thiocyanate, SCN^-.



a) Enter the systemic name of $Ca(SCN)_2$ in the box. ***Calcium thiocyanate*** — 2 pts.

b) Enter the oxidation numbers of S, C, and N in the boxes below.

2 pts. was deducted for each wrong ans.

O.N. of S = ***–2*** O.N. of C = ***+4*** O.N. of N = ***–3***

c) When thiocyanate reacts with other substances in a redox reaction, will it most likely act as a reducing agent or an oxidizing agent? Circle your answer. — 2 pts.

11. (8 pts.) Selenium and tellurium are in the same group of sulfur in the periodic chart.

a) What is the highest possible oxidation number of Te? Enter your answer in the box. ***+6*** — 2 pts.

b) Which of the three elements, Se, Te, or S, would have the greatest metallic character? ***Te*** — 2 pts.

c) Enter the systematic name of the acid, H_2SeO_3, in the box below

Selenous acid — 2 pts.

d) When H_2SeO_3 reacts with other substances in a redox reaction, it will

i. always be an oxidizing agent
ii. always be a reducing agent
iii. either be an oxidizing agent or a reducing agent

Circle one correct response — 2 pts.

12. (10 pts.) For the reactions listed below, circle the letter for each of the redox reactions, and list <u>all</u> the disproportionation reactions in the box below.

a) $2\ NH_4VO_3\ (s) \rightarrow V_2O_5\ (s) + 2\ NH_3\ (g) + H_2O\ (g)$

b) $5\ IF\ (g) \rightarrow IF_5\ (g) + 2\ I_2\ (g)$

c) $2\ ICl_3\ (g) \rightarrow I_2 + 3\ Cl_2$

d) $I_2\ (s) + 2\ S_2O_3\ (aq) \rightarrow 2\ I^-\ (aq) + S_4O_6^{2-}\ (aq)$

e) $2\ HNO_3\ (aq) \rightarrow N_2O_5\ (g) + H_2O\ (l)$

f) $N_2O_3\ (g) \rightarrow NO\ (g) + NO_2\ (g)$

2 pts. were deducted for each incorrect response.

The disproportionation reaction(s) is/are: ***b) and f)***

13. (4 pts.) In Exp 3, when a drop of glucose solution is added to the Tollens reagent, $Ag(NH_3)_2OH$, a silver mirror is coated onto the inner wall of the test tube. Which of the following is the strongest reducing agent? Which is the strongest oxidizing agent? Draw a circle around the strongest reducing agent and draw a square around the strongest oxidizing agent.

Glucose *Gluconic acid* *Tollens reagent* *Silver metal*

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14. Jenny dissolves $K_2Cr_2O_7$ crystals, in 2 M H_2SO_4 to make an orange solution. Then, she puts ~2 grams of granular zinc metal in the solution and stirs it on a stirring plate. She observes gas bubbling out from the solution and the color of the solution gradually turns green, the color of aqueous Cr^{3+} ions. The amount of zinc metal in the flask also decreases as the stirring continues.
This is a similar situation of stirring granula zinc metal in the dioxovanadium(V) solution(which is prepared in 2 M H_2SO_4) in Exp 3. There are two redox reactions occurring simultaneous. On one hand, zinc reduces dioxovanadium(V), on the other hand, zinc reduces H_2SO_4 to form hydrogen gas.

a) (2 pts.) What ion is responsible for the orange color in Jenny's solution? Enter the chemical formula of the ion in the box.

$Cr_2O_7^{2-}$ **2 pts.**

b) (2 pts.) What is the identity of the gas bubbling out of the solution? Enter the chemical formula of the gas in the box.

H_2 **2 pts.**

c) (4 pts.) In the box below, write an <u>unbalanced</u> (skeletal) net ionic equation to show the reactants and products of the reaction between potassium dichromate and zinc.
Potassium dichromate dissolves in water to make K^+ and $Cr_2O_7^{2-}$. $Cr_2O_7^{2-}$ is the oxidizing agent while zinc metal is the reducing agent.

$Cr_2O_7^{2-} + Zn \rightarrow Cr^{3+} + Zn^{2+}$

2 pts. were deducted for each wrong reactant/ product.

d) (4 pts) In the box below, write a <u>balanced</u> net ionic equation to illustrate the oxidation half-reaction.

$Zn \rightarrow Zn^{2+} + 2\,e^-$

2 pts. were awarded for putting the correct number of e^- on the correct side of the equation. 2 pts. for balancing the equation.

e) (4 pts) In the box below, write a <u>balanced</u> net ionic equation to illustrate the reduction half-reaction.

$14\,H^+ + Cr_2O_7^{2-} + 6\,e^- \rightarrow 2\,Cr^{3+} + 7\,H_2O$

2 pts. were awarded for putting the correct number of e^- on the correct side of the equation. 2 pts. for balancing the equation.

f) (2 pts) In the box below, write a <u>balanced</u> net ionic equation to illustrate the overall redox reaction between potassium dichromate and zinc.

$14\,H^+ + Cr_2O_7^{2-} + 3\,Zn \rightarrow 3\,Zn^{2+} + 2\,Cr^{3+} + 7\,H_2O$

15. (10 pts.) Write a <u>balanced net ionic reaction equation</u> to illustrate the oxidation of sodium chlorite by sodium hypobromite to form sodium chlorate and sodium bromide in a sodium hydroxide solution. Show your work in the space below and enter the balanced equation in the box.

$ClO_2^- + BrO^- \rightarrow ClO_3^- + Br^-$

2 pts. were deducted for each mistake.

Oxidation: $2\,OH^- + ClO_2^- \rightarrow ClO_3^- + 2\,e^- + H_2O$
Reduction: $H_2O + BrO^- + 2\,e^- \rightarrow Br^- + 2\,OH^-$

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16. Below is a balanced equation showing the reaction between $KMnO_4$ and KI in an acidic solution:

$$2\ MnO_4^- + 10\ I^- + 16\ H^+ \rightarrow 2\ Mn^{2+} + 5\ I_2 + 8\ H_2O$$

Joan and Dean each performed a procedure similar to the procedure in Exp 4. Described below are their procedures and observations.

Joan mixed 1.0 mL of 0.10 M KI solution and 1.0 mL of 2 M sulfuric acid in a small vial. She added one drop (that is 0.050 mL) of 0.060 M $KMnO_4$ solution to the vial and the solution turned light brown. Then, she added 1.0 mL of cyclohexane to the vial, shook the vial vigorously to mix the solution and set it on the lab bench. When the solution settled, it formed two layers, the top layer was purplish and the bottom layer was yellow.

Dean followed the same procedure as Joan except he used a 0.60 M $KMnO_4$ solution instead of the 0.060 M. Upon the addition of the one drop of $KMnO_4$, a dark color precipitate was form. The precipitate re-dissolved after shaking with 1 mL of cyclohexane. When the solution settled, both the top layer and the bottom layer of the solution were purplish.

a) (4 pts.) Calculate the number of moles of KI and moles of $KMnO_4$ that had been added to Joan's vial. Enter your answers in the appropriate boxes.

1.0 x 10^{-4} **moles of KI**	***3.0 x 10^{-6}*** **moles of $KMnO_4$**

b) (8 pts.) Calculate the number of moles of I_2 produced in Joan's procedure. Show your work in the space below and enter your answer in the box.

7.5 x 10^{-6} **moles of I_2**

Moles of KI needed to react with 3.0 x 10^{-6} mol $KMnO_4$ is:

= $(3.0\times10^{-6}\ mol\ KMnO_4)(\frac{10\ mol\ KI}{2\ mol\ KMnO_4}) = 1.5\times10^{-5}\ mol\ KI\ needed$

4 pts. were deducted for each conceptual error.

Since there is more KI in the vial than needed, $KMnO_4$ is the limiting reagent.

Moles of I_2 produced = $(3.0\times10^{-6}\ mol\ KMnO_4)(\frac{5\ mol\ I_2}{2\ mol\ KMnO_4}) = 7.5\times10^{-6}\ mol\ I_2$

c) (8 pts.) Calculate the number of moles of I_2 produced in Dean's procedure. Show your work in the space below and enter your answer in the box.

5.0 x 10^{-5} **moles of I_2**

Dean had added 10 times $KMnO_4$ of Joan, moles of KI needed to react with 3.0 x 10^{-5} mol $KMnO_4$ is also 10 times of Joan's:

= $(3.0\times10^{-5}\ mol\ KMnO_4)(\frac{10\ mol\ KI}{2\ mol\ KMnO_4}) = 1.5\times10^{-4}\ mol\ KI\ needed$

Since there is only 1.0 x 10^{-4} mol of KI in the vial, KI is the limiting reagent.

Moles of I_2 produced = $(1.0\times10^{-4}\ mol\ KI)(\frac{5\ mol\ I_2}{10\ mol\ KI}) = 5.0\times10^{-5}\ mol\ I_2$

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Question 16 continues

d) (6 pts.) In each of the box below, enter the chemical formula of the ion/molecule responsible for the color in the solutions.

The yellow color in the bottom layer of Joan's solution I_3^- **2 pts.**

The purplish color in the top layer of Joan's solution I_2 **2 pts.**

The purplish color in the bottom layer of Dean's solution MnO_4^- **2 pts.**

e) (2 pts.) Enter the formula of the dark color precipitate I_2 **2 pts.**

If you need more space to present your answer, indicate the question number and write your answer inside the box below.

~ The End ~

Have a Great Fall Break!!

Name (Last, First) _____

Periodic Table of the Elements

1 IA																	18 VIIIA
1 **H** 1.0079	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.01	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 —	9 VIIIB	10 —	11 IB	12 IIB	13 **Al** 26.982	14 **Si** 28.09	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.22	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.7	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	71 **Lu** 174.9	72 **Hf** 178.5	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	103 **Lr** (260)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **Uun** (269)	111 **Uuu** (272)	112 **Uub**	113 **Uut**	114 **Uuq**		116 **Uuh**		118 **Uuo**

Lanthanides	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	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
Actinides	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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)