

Name (print) Master
Last first

Chem ID# _____

Student Signature _____

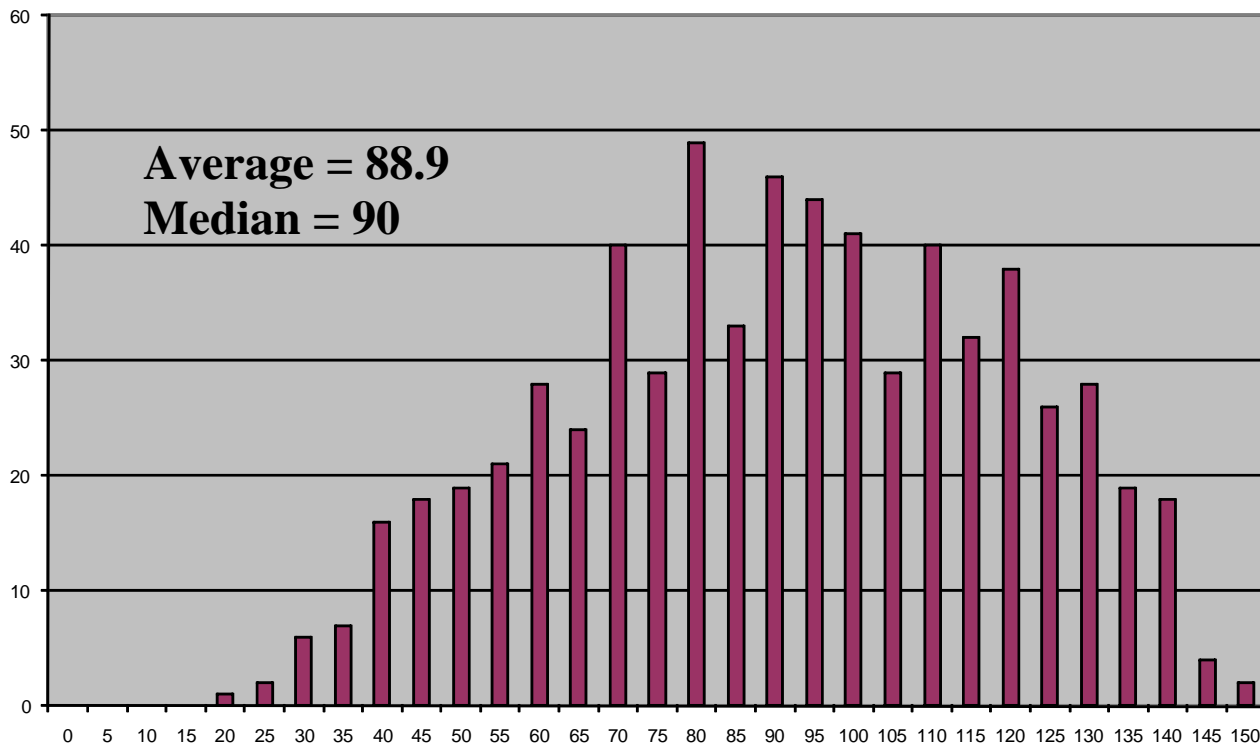
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Chem 151
MIDTERM EXAMINATION
October 14, 2009

All re-grade requests must be in writing, stapled to the original document and submitted to the blue locker on the 3rd floor of Lab Sciences Building before 5 pm on Monday (10/19/09). DO NOT write on the exam!!

Be sure to check all the recorded grades!!

Chem151 Midterm Exam Grade Distribution (Fall 2009)



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2 pts were deducted for each incorrect response.

1. (4 pts.) Joan has a bottle of drinking water in her book-bag as she goes to lab. Circle response in the questions below.
- a) If Joan keeps her water bottle inside her book-bag and place the book-bag under her lab bench, has Joan violate the safety rule? (YES/NO)
- b) If Joan puts her water bottle next to the lab phone on the shelves near the lab entrance, has Joan violate the safety rule? (YES/NO)

2. (2 pts.) How many de-ionized water faucets are there in your lab? Enter your answer in the box.

4

3. (4 pts.) In the lab, a thick binder labeled MSDS is located on the shelves near the lab entrance. What does MSDS stand for? Enter your answer in the box below.

Material Safety Data Sheet

4. (6 pts.) In each of the following groups of atoms and ions, circle the atom/ion that is largest in size and draw a rectangle around the one that is smallest.

a) Ar, Cl⁻, Cl, S²⁻

b) Al³⁺, Ne, Ar, Kr

5. (6 pts.) In each of the following groups of elements, circle the one that is most electronegative and draw a rectangle around the one that is most electropositive.

a) Al, Si, Ca, Br

b) Ge, Ga, P, In

6. Jerry prepares three solutions:

- I. 55 mL of 0.10 M NaCl
II. 95 mL of 0.10 M MgCl₂
III. 45 mL of 0.10 M glucose

- a) (2 pts.) If the probes of a LED circuit board similar to the one used in Experiment 1 are dipped into each solution, in which solution that the LED will be brightest? Enter your answer in the box.

II

- b) (8 pts.) If Jerry mixes all three solutions in a beaker, what is the molarity of chloride ions in the resultant solution? Enter your answer in the box and show your work in the space below.

0.126 M

$$\text{Moles of chloride ions} = (0.055 \text{ L})(0.10 \text{ mol/L}) + 2 \times (0.095 \text{ L})(0.10 \text{ mol/L}) = 0.0245 \text{ mol}$$

$$\text{Total volume of solution} = 0.055 + 0.095 + 0.045 = 0.195 \text{ L}$$

$$\text{Molarity of Cl}^- = \frac{0.0245 \text{ mol}}{0.195 \text{ L}} = 0.126 \text{ M}$$

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7. (6 pts.) When a mercury(I) nitrate solution is bubbled into a potassium iodide solution, a yellow precipitate is formed. Enter the molecular formula of the precipitate in the box on the right, and enter a balanced net ionic equation to describe the reaction in the box below.



Note that HgI is incorrect. Please recall Tutorial 1 reading that the mercury(I) ion is Hg_2^{2+} .

8. (16 pts.) In a chemistry contest, each contestant is assigned to find a solution in a lab containing 8 bottles of 0.10 M solutions with no labels. Listed below are the identities of the eight solutions.

CaCl₂ solution

HCl solution

BaCl₂ solution

KMnO₄ solution

AgNO₃ solution

K₂CO₃ solution

H₂SO₄ solution

LiBr solution

In order to find the assigned solution, a contestant can pick only one test method listed below and perform the same test to each of the eight solutions.

- A. Add hydrochloric acid
- B. Add barium chloride solution
- C. Add sodium carbonate solution
- D. Do a flame test
- E. Check the pH with pH test papers

*2 pts. for each correct letter;
2 pts. for each correct
identification result. No
credit was awarded if the test
method is incorrect.*

Which test method you would pick if you were assigned to find each of the solutions listed below? Enter the letter of the test method in the box and briefly explain how the test can help you to identify the correct solution. Enter "NR" if none of the method is applicable/necessary.

- a) BaCl₂ solution.

D

Only BaCl₂ solution on the list will give green color in a flame test.

- b) K₂CO₃ solution

E or A

Only K₂CO₃ solution will produce a gas (CO₂) with hydrochloric acid and it is also the only solution that will give a very basic pH test (pH > 10)

- c) AgNO₃ solution

A

Only AgNO₃ solution will form precipitate with hydrochloric acid

- d) KMnO₄ solution

NR

No test is necessary because KMnO₄ is the only solution on the list that is purple in color.

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9. (8 pts.) Joe finds two bottles of colorless solutions with no clear labels in a lab. It can be 0.1 M solutions from the list of ten possibilities below:

- | | |
|---|---|
| i. Li_2SO_4 solution | vi. A solution of KOH and LiCl |
| ii. $\text{Zn}(\text{NO}_3)_2$ solution | vii. A solution of ZnSO_4 and NaCl |
| iii. NaBr solution | viii. A solution of CaCl_2 and HCl |
| iv. Li_2CO_3 solution | ix. A solution of NaOH and KCl |
| v. NaOH solution | x. A solution of KI and MgCl_2 |

The pH of the solution A is approximately 12-13 and the flame color is red in the flame test.
When A is added to a 0.1 M BaCl_2 solution, the solution turns slightly cloudy.
When A is added to 0.1 M silver nitrate solution, the solution turns cloudy.
When A is added to 2 M hydrochloric acid, no obvious change is observed.
Choose from the list and enter the most likely identity of Solution A in the box.

vi

The pH of the solution B is approximately 6-8 and the flame color is yellow in the flame test.
When B is added to a 0.1 M BaCl_2 solution, no obvious change is observed.
When B is added to 0.1 M silver nitrate solution, the solution turns cloudy.
When B is added to 2 M hydrochloric acid, no obvious change is observed.
Choose from the list and enter the most likely identity of Solution B in the box.

iii

10. Boron oxide, B_2O_3 , dissolves in water to make boric acid, H_3BO_3 .

a) (2 pts.) Enter a balanced reaction equation in the box to illustrate this reaction.



b) (2 pts.) Many detergents contain $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$ crystals. Enter the systematic name of this compound in the box.

Sodium borate tetrahydrate

c) (2 pts.) Boric acid loses water upon heating to become HBO_2 . Circle the correct name of HBO_2 from the following choices:

borous acid *hydroboric acid* ***metaboric acid*** *hydrogen borite*

Please recall the difference between vanadate (VO_4^{3-}) and metavanadate (VO_3^-) in the lecture note of Exp 3. The oxidation number of vanadium remains +5. It is different from we normally name polyatomic ions ending with -ate or -ite.

d) (8 pts.) For each of the compounds listed below, enter its systematic name and the oxidation number of boron in the appropriate boxes.

B_2H_6

Diboron hexahydride

Boron and hydrogen form many compounds: B_2H_6 , B_4H_{10} , B_5H_9 , etc. They are called boranes. B_2H_6 is commonly called diborane.

O.N. = +3

NaB_6

sodium boride or sodium hexaboride

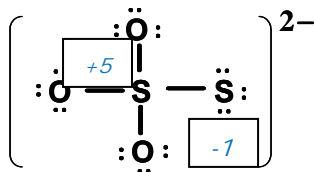
Compounds of boron with elements less electronegative than itself are called borides. There are many metal borides of the formulas: MB_4 , MB_6 , or M_4B , etc. Therefore, one needs to designate the number of atoms in a molecule.

O.N. = -1/6

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11. Shown below is the Lewis dot structure of the polyatomic anion, thiosulfate, $S_2O_3^{2-}$.

a) (4 pts.) Enter the oxidation number of each sulfur atom in the boxes next to the atoms.



b) (2 pts.) Thiosulfate can react with an oxidizing agent and turn into tetrathionate, $S_4O_6^{2-}$. Entered the average oxidation number of sulfur in tetrathionate in the box on the right.

+5/2

c) (4 pts.) In the box below, enter a balanced oxidation half-reaction equation to illustrate the change of thiosulfate to tetrathionate in an acidic medium.



d) (6 pts.) Addition of a sodium thiosulfate solution to a yellow potassium triiodide solution turns the solution to colorless. Enter a balanced net ionic equation in the box below to illustrate the reaction occurred.



12. When hydrogen gas is bubbled through an acidic solution containing VO_2^+ , the solution turns blue gradually, indicating the formation of VO^{2+} .

a) (2 pts.) Enter the chemical formula of the reducing agent of the above reaction in the box.

H_2

b) (4 pts.) In the box below, write a balanced net ionic equation to illustrate the oxidation half-reaction.



4 points were deducted for those switched the oxidation and reduction half reactions but making no other mistakes.

c) (4 pts.) In the box below, write a balanced net ionic equation to illustrate the reduction half-reaction.



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13. Chlorine gas was first prepared in 1774 from the reaction of MnO_2 powder with sodium chloride in a sulfuric acid solution as illustrated by the following equation:



- a. (4 pts.) Write the above reaction equation as a balanced net ionic equation in the box below. You may assume that sulfuric acid completely dissociates into 2H^+ and SO_4^{2-} in solution.



- b. (2 pts.) Enter all the spectator ion(s) in the box on the right.



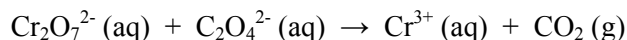
- c. (2 pts.) Enter the oxidizing agent of the reaction in the box on the right.



- d. (4 pts.) Enter the balanced reduction half-reaction in the box below.



14. Shown below is a skeletal (unbalanced) redox reaction equation:



- a) (4 pts.) In the box below, enter the systematic names of the two anions in the reactant.

Dichromate and oxalate

- b) (6 pts.) If the reaction takes place in an acidic medium, enter the balanced net ionic equation in the box below.



15. (6 pts.) At elevated temperature, hydrogen peroxide will disproportionate. Enter a balanced reaction equation showing the disproportionation of hydrogen peroxide in the box below.



No partial credit if the products are incorrect.

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16. In Experiment 4, bromine is prepared by the reaction of sodium bromide and sodium bromate in an acidic medium. The product is then extracted into cyclohexane. When the cyclohexane solution is added to an aqueous solution of potassium iodide, the cyclohexane layer turns purple and the aqueous layer turns yellow.

- a) (4 pts.) In the box below, enter a balanced reaction equation to illustrate the preparation reaction of bromine.



Both ionic equation and molecular equations are acceptable.

- b) (2 pts.) What is the substance causing the yellowish color in the aqueous layer? Enter the chemical formula of this substance in the box on the right.



- c) (2 pts.) Rank Br_2 , I_2 , and BrO_3^- in the order of decreasing oxidizing strength.



Weakest oxidizing agent

- d) (2 pts.) Rank Br_2 , I^- , and Br^- in the order of decreasing reducing strength.



Weakest reducing agent

17. (10 pts.) How many moles of $Pb(NO_3)_2$ is needed in order to precipitate all the iodide from 75.0 mL of a 15.0% (by mass) KI solution? Given that the density of the KI solution is 1.12 g/mL and the molar mass of KI is 166.0 g/mol. Show your work in the space below and enter your answer in the box.

0.0380 moles

$$\text{Mass of KI in 75.0 mL solution} = (75.0 \text{ mL})(1.12 \text{ g/mL})(15.0\%) = 12.6 \text{ g}$$

$$\text{Moles of KI} = \frac{12.6 \text{ g}}{166.0 \text{ g/mol}} = 0.0759 \text{ mol}$$

Answer reported in box must be supported by the work shown.

Since it takes two moles of KI to react with one mole $Pb(NO_3)_2$ to produce one mole PbI_2 ,

$$\text{moles of } Pb(NO_3)_2 \text{ needed} = (0.0759 \text{ mol KI}) \left(\frac{1 \text{ mol } Pb(NO_3)_2}{2 \text{ mol KI}} \right) = 0.0380 \text{ mol}$$

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18. (4 pts.) Would the conductivity of tellurium (Te) be enhanced by doping with tin? What type of semi-conductor would be formed, p-type or n-type?

The conductivity of Te will be enhanced by doping with Sn. The doping will form a p-type semiconductor.

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													13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.0079												5 B 10.811	6 C 12.01	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
3 Li 6.941	4 Be 9.0122											13 Al 26.982	14 Si 28.09	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948	
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	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80	
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)