

CHEM 1314.02 and 1314.03  
Exam II  
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October 18, 2000

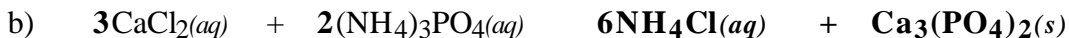
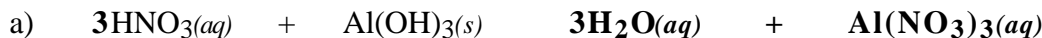
Name \_\_\_\_\_  
TA's Name \_\_\_\_\_  
Lab Section \_\_\_\_\_

### INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last two pages include a periodic table, a solubility table, a table of vapor pressure of water and some useful equations. All work should be done in this booklet.
2. PRINT your name, TA's name and your lab section number now in the space at the top of this sheet. DO NOT SEPARATE THESE PAGES.
3. Answer all questions that you can and whenever called for show your work clearly. Your method of solving problems should pattern the approach used in lecture. You do not have to show your work for the multiple choice or short answer questions.
4. No credit will be awarded if your work is not shown in problems 4 – 6.
5. Point values are shown next to the problem number.
6. Budget your time for each of the questions. Some problems may have a low point value yet be very challenging. If you do not recognize the solution to a question quickly, skip it, and return to the question after completing the easier problems.
7. Look through the exam before beginning; plan your work; then begin.
8. **Relax** and do well.

	Page 2	Page 3	Page 4	Page 5	TOTAL
SCORES	<u>(26)</u>	<u>(23)</u>	<u>(15)</u>	<u>(36)</u>	<u>(100)</u>

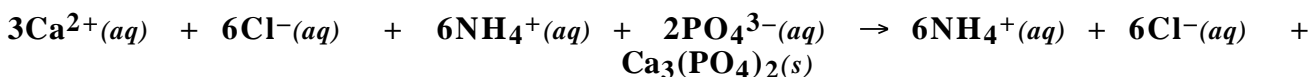
(12) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous. If no reaction occurs write NR.



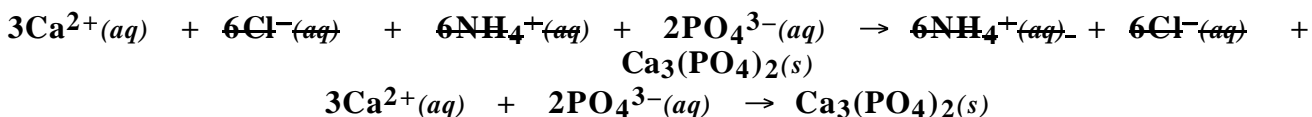
(8) 2. Write the ionic and net ionic chemical equations for 1b) and 1c).

1b)

Ionic equation:

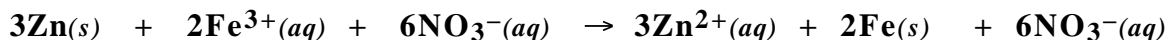


Net Ionic equation:

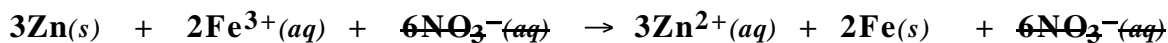


1c)

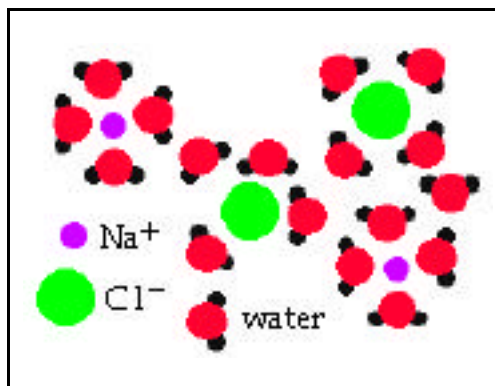
Ionic equation:



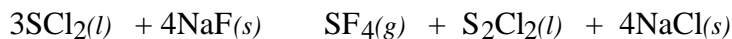
Net Ionic equation:



(6) 3. Use the box below to sketch a diagram depicting an atomic level view of  $\text{NaCl}(\text{aq})$ . Be sure to clearly label all species in your diagram



(15) 4. A preparation for disulfur dichloride is,



What is the maximum number of grams of disulfur dichloride that can be obtained when 5.15 g of sulfur dichloride is reacted with 3.15 g of sodium fluoride?

$$5.15 \text{ g SCl}_2 \frac{1 \text{ mol}}{103 \text{ g}} = 0.0490 \text{ mol SCl}_2$$

$$3.15 \text{ g NaF} \frac{1 \text{ mol}}{42.0 \text{ g}} = 0.0750 \text{ mol NaF}$$

(moles SCl <sub>2</sub> ) <sub>o</sub> 0.0490 mol	(moles NaF) <sub>required</sub> 0.0653 mol	(moles NaF) <sub>o</sub> 0.0750 mol	Conclusion SCl <sub>2</sub> limiting, NaF excess
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$$0.0490 \text{ mol SCl}_2 \frac{4 \text{ mol NaF}}{3 \text{ mol SCl}_2} = 0.0653 \text{ mol NaF}$$

$$0.0490 \text{ mol SCl}_2 \frac{1 \text{ mol S}_2\text{Cl}_2}{3 \text{ mol SCl}_2} \frac{135 \text{ g}}{1 \text{ mol S}_2\text{Cl}_2} = \boxed{2.20 \text{ g S}_2\text{Cl}_2}$$

Calculate the final mass of both reactants after the reaction has gone to completion.

0 g SCl<sub>2</sub> remaining (limiting reagent)

$$0.0653 \text{ mol NaF} \frac{42.0 \text{ g}}{1 \text{ mol NaF}} = 2.74 \text{ g NaF reacted}$$

$$(3.15 \text{ g NaF})_o - (2.74 \text{ g NaF})_R = \boxed{0.41 \text{ g NaF}}$$

(8) 5. A sample of gas occupies 135 mL at 22.5 °C and exerts a pressure of 165 mm Hg. Calculate the new pressure when the volume of the gas is raised to 250. mL and the temperature is lowered to -15.0 °C.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_2 = \frac{T_2}{V_2} \frac{P_1 V_1}{T_1} = \frac{258 \text{ K}}{250. \text{ mL}} \frac{165 \text{ mmHg} \cdot 135 \text{ mL}}{295.5 \text{ K}} = 77.8 \text{ mm Hg}$$

(15) 6. Diborane, B<sub>2</sub>H<sub>6</sub>, can be prepared according to the following reaction,



a) How many mL of 0.0875 M H<sub>2</sub>SO<sub>4</sub> should be used to completely react with 1.35 g of NaBH<sub>4</sub>?

$$\text{H}_2\text{SO}_4 \quad 1.35 \text{ g NaBH}_4 \frac{1 \text{ mol}}{37.8 \text{ g}} \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaBH}_4} \frac{1 \text{ liter}}{0.0875 \text{ mol H}_2\text{SO}_4} = 0.204 \text{ L}$$

b) Calculate the volume of hydrogen gas produced in the above reaction at 25.0 °C and 0.900 atm.

$$1.35 \text{ g NaBH}_4 \frac{1 \text{ mol}}{37.8 \text{ g}} \frac{2 \text{ mol H}_2}{2 \text{ mol NaBH}_4} = 0.0357 \text{ mol H}_2$$

To calculate the volume of H<sub>2</sub> gas we need the ideal gas equation PV = nRT

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{0.0357 \text{ mol} \cdot 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}{0.900 \text{ atm}} = 0.971 \text{ L}$$

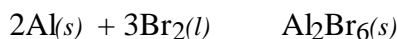
Multiple Choice: (36 points)

Print the letter (A, B, C, D, E) which corresponds to the answer selected.

7. **B**                      8. **C**                      9. **B**                      10. **C**                      11. **D**  
 12. **E**                      13. **B**                      14. **D**                      15. **C or D**

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 4 points.

7. An amount of Al is added to 80.0 g of Br<sub>2</sub>. After the reaction occurs 0.100 moles of Al<sub>2</sub>Br<sub>6</sub> are produced according to the equation



The mass of unreacted Br<sub>2</sub> is;

- A) 26.6 g  
 B) 32.0 g  
 C) 48.0 g  
 D) 53.4 g  
 E) all the Br<sub>2</sub> reacts
8. Nitrogen gas can be prepared in the laboratory according to the chemical reaction;
- $$3\text{CuO}(s) + 2\text{NH}_3(g) \rightarrow \text{N}_2(g) + 3\text{Cu}(s) + 3\text{H}_2\text{O}(l)$$
- The mass of nitrogen produced when 102 g of ammonia are passed over an excess of CuO is;
- A) 28.0 g  
 B) 42.0 g  
 C) 84.0 g  
 D) 143 g  
 E) 168 g
9. Which of the following reactions will produce a precipitate when 0.1 M aqueous solutions are mixed?
- A) NaOH(aq) + H<sub>2</sub>S(aq)  
 B) CaCl<sub>2</sub>(aq) + K<sub>2</sub>CO<sub>3</sub>(aq)  
 C) Al(NO<sub>3</sub>)<sub>3</sub>(aq) + Na<sub>2</sub>SO<sub>4</sub>(aq)  
 D) CuSO<sub>4</sub>(aq) + NH<sub>4</sub>Cl(aq)  
 E) Ba(OH)<sub>2</sub>(aq) + HNO<sub>3</sub>(aq)

10. Which gas(es) would be expected to have a density less than Ar at STP?

- I. CO<sub>2</sub>(g)  
 II. Cl<sub>2</sub>(g)  
 III. O<sub>2</sub>(g)

- A) I only  
 B) II only  
 C) III only  
 D) I and II  
 E) I and III

11. Calculate the volume of 0.200 M sodium sulfate solution that can be prepared by dissolving 14.2 g of  $\text{Na}_2\text{SO}_4$  in sufficient distilled water.

- A) 20.0 mL
- B) 100. mL
- C) 200. mL
- D) 500. mL
- E) 1.00 L

12. Which of the following is/are true when the temperature of a sample of gas is raised while the pressure and mol of gas of the sample are held constant?

- I. Increase in the number of collisions with the walls of the container;
- II. Increase in the average kinetic energy of the gas particles;
- III. Collisions with the walls are more energetic/forciful.

- A) I only
- B) III only
- C) I and II
- D) I and III
- E) I, II and III

13. Calculate the concentration of  $\text{Cl}^-(aq)$  in a solution prepared by mixing 100. mLs of 0.100 M  $\text{AgNO}_3$  with 300. mLs of 0.0500 M  $\text{NaCl}$ .

- A) 0 M, no  $\text{Cl}^-(aq)$  is in solution.
- B) 0.0125 M
- C) 0.0375 M
- D) 0.0500 M
- E) 0.0625 M

14. If 0.954 g of an unknown acid,  $\text{H}_2\text{A}$ , react with sodium hydroxide according to the equation,



Calculate the molar mass of the unknown acid when 36.04 mL of 0.509 M  $\text{NaOH}$  is required to react with all of the acid.

- A) 26.0 g  $\text{mol}^{-1}$
- B) 52.0 g  $\text{mol}^{-1}$
- C) 78.0 g  $\text{mol}^{-1}$
- D) 104 g  $\text{mol}^{-1}$
- E) 156 g  $\text{mol}^{-1}$

15. Equal mol of  $\text{N}_2$  and Ar are placed into separate containers at the same temperature and pressure. Which of the following statements is true?

- A) The volume of the container of Ar is greater than the volume of the container of  $\text{N}_2$ .
- B) More molecules of  $\text{N}_2$  are present than atoms of Ar.
- C) Ar atoms are moving slower than the  $\text{N}_2$  molecules.
- D) The  $\text{N}_2$  molecules collide more frequently with the walls of the container than do the atoms of Ar.
- E) All of the above statements are true.

Periodic Table of the Elements

	IA																	VIII A	
1	1 <b>H</b> 1.008																		2 <b>He</b> 4.00
		IIA										IIIA	IVA	VA	VIA	VIIA			
2	3 <b>Li</b> 6.94	4 <b>Be</b> 9.01										5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18		
3	11 <b>Na</b> 22.99	12 <b>Mg</b> 24.30										13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.06	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95		
			IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB							
4	19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.38	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80	
5	37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.1	45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.4	47 <b>Ag</b> 107.9	48 <b>Cd</b> 112.4	49 <b>In</b> 114.8	50 <b>Sn</b> 118.7	51 <b>Sb</b> 121.8	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.3	
6	55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.8	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209.0	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)	
7	87 <b>Fr</b> (223)	88 <b>Ra</b> 226.0	89 <b>Ac</b> 227.0	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (262)	108 <b>Hs</b> (265)	109 <b>Mt</b> (266)										

Lanthanides	58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.2	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0
Actinides	90 <b>Th</b> 232.0	91 <b>Pa</b> 231.0	92 <b>U</b> 238.0	93 <b>Np</b> 237.0	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)

## Useful Information

$$R = 0.08203 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \quad \text{or} \quad R = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}} \quad PV = nRT \quad K = ^\circ\text{C} + 273.15$$

$$1 \text{ atm} = 760 \text{ mm Hg}$$

$$u = \sqrt{\frac{3RT}{MM}}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{MM_2}{MM_1}}$$

## Table of Vapor Pressure for Water

Temperature (°C)	Vapor Pressure(mmHg)	Temperature (°C)	Vapor Pressure(mmHg)
-5	3.2	50	92.5
0	4.6	55	118.0
5	6.52	60	149.4
10	9.20	65	187.5
15	12.8	70	233.7
20	17.5	75	289.1
25	23.8	80	355.1
30	31.8	85	433.6
35	42.1	90	525.8
40	55.3	95	633.9
45	71.9	100	760

## Solubility Table

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
NO <sub>3</sub> <sup>-</sup>	soluble	none
ClO <sub>4</sub> <sup>-</sup>	soluble	none
Cl <sup>-</sup>	soluble	except Ag <sup>+</sup> , Hg <sub>2</sub> <sup>2+</sup> , *Pb <sup>2+</sup>
I <sup>-</sup>	soluble	except Ag <sup>+</sup> , Hg <sub>2</sub> <sup>2+</sup> , Pb <sup>2+</sup>
SO <sub>4</sub> <sup>2-</sup>	soluble	except Ca <sup>2+</sup> , Ba <sup>2+</sup> , Sr <sup>2+</sup> , Hg <sup>2+</sup> , Pb <sup>2+</sup> , Ag <sup>+</sup>
CO <sub>3</sub> <sup>2-</sup>	insoluble	except Group IA and NH <sub>4</sub> <sup>+</sup>
PO <sub>4</sub> <sup>3-</sup>	insoluble	except Group IA and NH <sub>4</sub> <sup>+</sup>
-OH	insoluble	except Group IA, *Ca <sup>2+</sup> , Ba <sup>2+</sup> , Sr <sup>2+</sup>
S <sup>2-</sup>	insoluble	except Group IA, IIA and NH <sub>4</sub> <sup>+</sup>
Na <sup>+</sup>	soluble	none
NH <sub>4</sub> <sup>+</sup>	soluble	none
K <sup>+</sup>	soluble	none

\*slightly soluble