

CHEM 1215
Exam III
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November 10, 1999

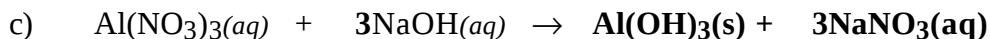
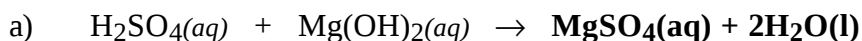
Name _____
TA's Name _____
Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 7 different pages. The last page includes a periodic table and a solubility table. 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 (if any) or short answer questions.
4. No credit will be awarded if your work is not shown in problems 3, 5 - 7 and 8.
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	_____ (29)	_____ (34)	_____ (23)	_____ (14)	_____ (100)

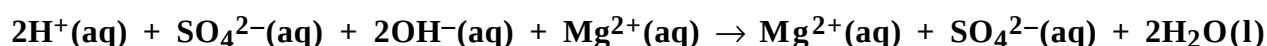
- (9) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous.



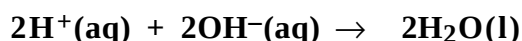
- (8) 2. Write the balanced ionic and balanced net ionic chemical equations for the reactions a) and c) in Problem 1. (Remember to include the correct charges on all ions and the phase of each species.)

1a)

Ionic equation:

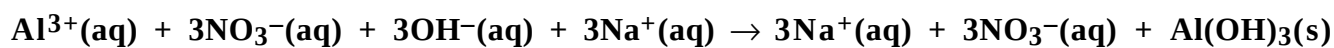


Net Ionic equation:

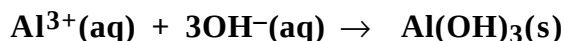


1c)

Ionic equation:



Net Ionic equation:



- (12)3a. Determine the empirical formula of a compound that is 69.8% carbon, 11.7% hydrogen, and 18.6% oxygen by mass.

$$69.8 \text{ g C} \left(\frac{1 \text{ mol C}}{12.0 \text{ g C}} \right) = 5.82 \text{ mol C}$$

$$11.7 \text{ g H} \left(\frac{1 \text{ mol H}}{1.01 \text{ g H}} \right) = 11.6 \text{ mol H}$$

$$18.6 \text{ g O} \left(\frac{1 \text{ mol O}}{16.00 \text{ g}} \right) = 1.16 \text{ mol O}$$

$$\left(\frac{5.82 \text{ mol C}}{1.16} \right) : \left(\frac{11.6 \text{ mol H}}{1.16} \right) : \left(\frac{1.16 \text{ mol O}}{1.16} \right)$$

$$5.00 \text{ C} : 10.0 \text{ H} : 1.0 \text{ O} = 5 \text{ C} : 10 \text{ H} : 1 \text{ O}$$

$$\text{C}_5\text{H}_{10}\text{O}$$

- b) If the molar mass of this compound is 172 g mol^{-1} , determine the molecular formula.

$$\text{Empirical mass} \cdot n = \text{molecular mass} \quad n = \left(\frac{\text{molecular mass}}{\text{Empirical mass}} \right) = \left(\frac{172}{86} \right) = 2$$

$$\text{Molecular formula} = (\text{C}_5\text{H}_{10}\text{O})_2 = \text{C}_{10}\text{H}_{20}\text{O}_2$$

(22)4. Complete the following table

Formula	M , Molar Mass $\left(\frac{\text{g}}{\text{mol}}\right)$	m , Mass of sample (g)	n , Moles of sample (mol)	N , Number of atoms, molecules, or formula units
SO_3	80	4.13×10^{-2}	5.16×10^{-4}	3.11×10^{20} molecules
$\text{Na}_2\text{C}_2\text{O}_4$	134	186	1.39	8.37×10^{23} formula units
unknown	95.8	9.41×10^2	9.82	5.91×10^{24} atoms
$\text{KPtCl}_3(\text{C}_2\text{H}_4)$	369	7.03×10^{-4}	1.91×10^{-6}	1.15×10^{18} formula units

Provide the symbol of the unknown element

Mo

(12) 5. Calculate the following,

c) the mass, in grams, of a single atom of mercury.

$$\left(\frac{200.6 \text{ g}}{1 \text{ mol}}\right) \left(\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atom}}\right) = 3.33 \times 10^{-22} \frac{\text{g}}{\text{atom}}$$

d) the number of molecules of water in 1.0 mol of the hydrate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

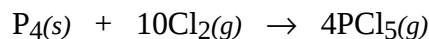
$$1.0 \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O} \left(\frac{5 \text{ mol H}_2\text{O}}{1 \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O}}\right) \left(\frac{6.02 \times 10^{23} \text{ molecule}}{1 \text{ mol}}\right) = 3.01 \times 10^{24} \text{ molecules}$$

c) the number of CH_4 molecules and the number of hydrogen atoms in 9.22 g of methane, CH_4 .

$$9.22 \text{ g CH}_4 \left(\frac{1 \text{ mol CH}_4}{16 \text{ g}}\right) \left(\frac{6.02 \times 10^{23} \text{ molecule CH}_4}{1 \text{ mol}}\right) = 3.47 \times 10^{23} \text{ molecules}$$

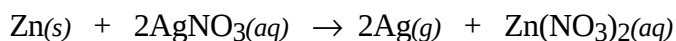
$$3.47 \times 10^{23} \text{ molecules} \left(\frac{4 \text{ atoms H}}{1 \text{ molecule CH}_4}\right) = 1.39 \times 10^{24} \text{ H atoms}$$

(13) 6. For the reaction



Calculate how many grams of chlorine that must react to produce 32.5 g of PCl_5 . (Assume phosphorus is in excess.)

$$32.5 \text{ g PCl}_5 \left(\frac{1 \text{ mol PCl}_5}{208 \text{ g}} \right) \left(\frac{10 \text{ mol Cl}_2}{1 \text{ mol PCl}_5} \right) \left(\frac{70.9 \text{ g Cl}_2}{1 \text{ mol Cl}_2} \right) = 27.7 \text{ g Cl}_2$$

(10) 7. Calculate the mass of silver produced when 3.22 g of Zn react with 4.35 g of AgNO_3 .

$$3.22 \text{ g Zn} \left(\frac{1 \text{ mol}}{65.4 \text{ g}} \right) = 0.049 \text{ mol Zn}$$

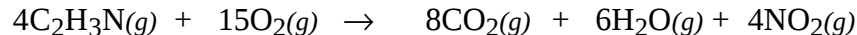
$$4.35 \text{ g AgNO}_3 \left(\frac{1 \text{ mol}}{170.0 \text{ g}} \right) = 0.026 \text{ mol AgNO}_3$$

(moles Zn) _o 0.049 mol	(moles AgNO ₃) _{required} 0.098 mol	(moles AgNO ₃) _o 0.026 mol	Conclusion AgNO ₃ limiting, Zn excess
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$$0.049 \text{ mol Zn} \left(\frac{2 \text{ mol AgNO}_3}{1 \text{ mol Zn}} \right) = 0.098 \text{ mol AgNO}_3$$

$$0.026 \text{ mol AgNO}_3 \left(\frac{2 \text{ mol Ag}}{2 \text{ mol AgNO}_3} \right) \left(\frac{107.9 \text{ g}}{1 \text{ mol Ag}} \right) = \boxed{2.81 \text{ g Ag}}$$

- (14) 8. Acetonitrile, $\text{C}_2\text{H}_3\text{N}$, is an important nonaqueous solvent. The compound reacts with O_2 according to the equation,



47.6 g of acetonitrile are added to an amount of oxygen. After the reaction occurs 28.4 grams of H_2O and 48.4 g of NO_2 are produced. Answer each of the following,

- a) the mol of H_2O produced?

$$28.4 \text{ g H}_2\text{O} \left(\frac{1 \text{ mol H}_2\text{O}}{18 \text{ g}} \right) = 1.58 \text{ mol H}_2\text{O}$$

- b) the mass of CO_2 produced?

$$1.58 \text{ mol H}_2\text{O} \left(\frac{8 \text{ mol CO}_2}{6 \text{ mol H}_2\text{O}} \right) \left(\frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} \right) = 92.7 \text{ g CO}_2$$

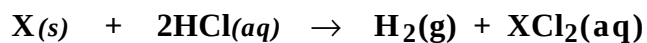
- c) Could O_2 be the limiting reagent or is it in excess in this reaction? Explain. (You may use a calculation to support your answer.)

$$1.58 \text{ mol H}_2\text{O} \left(\frac{4 \text{ mol C}_2\text{H}_3\text{N}}{6 \text{ mol H}_2\text{O}} \right) \left(\frac{41.0 \text{ g C}_2\text{H}_3\text{N}}{1 \text{ mol C}_2\text{H}_3\text{N}} \right) = 43.2 \text{ g C}_2\text{H}_3\text{N}$$

Since we began with 47.8 g of $\text{C}_2\text{H}_3\text{N}$ and only 43.2 g reacted, the acetonitrile must be in excess, therefore oxygen is the limiting reagent.

- (5) 9. THIS IS EXTRA CREDIT. DO NOT ATTEMPT UNTIL AFTER YOU ARE THROUGH DOING THE FIRST 9 QUESTIONS.

A 2.24 gram sample of an unknown metal reacts with HCl to produce 0.0808 g of H₂ gas. Identify the metal assuming all of it reacts. (Show ALL your work!)



$$0.0808 \text{ g H}_2 \left(\frac{1 \text{ mol H}_2}{2.02 \text{ g}} \right) \left(\frac{1 \text{ mol X}}{1 \text{ mol H}_2} \right) = 0.04 \text{ mol X}$$

$$\left(\frac{2.24 \text{ g X}}{0.04 \text{ mol X}} \right) = 56 \frac{\text{g}}{\text{mol}} \quad \text{probably Fe}$$

Periodic Table of the Elements															
1	2											3	4	5	6
1 H 1.008															
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96
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 (98)	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
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	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)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)							

Lanthanides	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 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	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)	103 Lr (260)

Solubility Table

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+ , Hg_2^{2+} , Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+} , Ba^{2+} , Sr^{2+} , Hg^{2+} , Pb^{2+} , Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
CrO_4^{2-}	insoluble	except Group IA, IIA and NH_4^+
OH^-	insoluble	except Group IA, Ca^{2+} , Ba^{2+} , Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble

