CHEM 1215
Exam III
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November 11, 1998

Name **KEY**

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 and 8 - 10.

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	Page 6	TOTAL
SCORES	_____	_____	_____	_____	_____	_____
	(30)	(16)	(30)	(12)	(12)	(100)

(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.

a) $\mathbf{2}H_3PO_{4(aq)} + \mathbf{3}Ca(OH)_{2(aq)} \rightarrow \mathbf{Ca_3(PO_4)_{2(s)}} + \mathbf{6H_2O_{(l)}}$

b) $\mathbf{2}Ba_{(s)} + \mathbf{2}H_2O_{(l)} \rightarrow 2\mathbf{Ba(OH)_{2(aq)}} + \mathbf{H_{2(g)}}$

c) $K_2CO_{3(aq)} + \mathbf{2}HCl_{(aq)} \rightarrow \mathbf{CO_{2(g)}} + \mathbf{H_2O_{(l)}} + \mathbf{2KCl_{(aq)}}$

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

1a, 1b or 1c)
Ionic equation:

$$\mathbf{3Ca^{2+}_{(aq)} + 6OH^{-}_{(aq)} + 6H^{+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6H_2O_{(l)}}$$

Net Ionic equation:

Same as ionic equation

1a, 1b or 1c)
Ionic equation:

$$\mathbf{2Ba_{(s)} + 2H_2O_{(l)} \rightarrow 2Ba^{2+}_{(aq)} + 2OH^{-}_{(aq)} + H_{2(g)}}$$

Net Ionic equation:

Same as ionic equation

1a, 1b or 1c)
Ionic equation:

$$\mathbf{2K^{+}_{(aq)} + CO_3^{2-}{}_{(aq)} + 2H^{+}_{(aq)} + 2Cl^{-}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + 2K^{+}_{(aq)} + 2Cl^{-}_{(aq)}}$$

1a, 1b or 1c)
Ionic equation:

$$\mathbf{CO_3^{2-}{}_{(aq)} + 2H^{+}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}}$$

(10) 3. Dopamine, $C_8H_{11}O_2N$, is a neurotransmitter. Determine the percent (by mass) composition of each of the elements in dopamine.

$$\mathbf{C:}\ \frac{\mathbf{96\ g\ C}}{\mathbf{153\ g\ C_8H_{11}O_2N}} \cdot \mathbf{100} = \mathbf{62.7\ \%\ C} \qquad \mathbf{N:}\ \frac{\mathbf{14\ g\ N}}{\mathbf{153\ g\ C_8H_{11}O_2N}} \cdot \mathbf{100} = \mathbf{9.15\ \%\ N}$$

$$\mathbf{H:}\ \frac{\mathbf{11\ g\ H}}{\mathbf{153\ g\ C_8H_{11}O_2N}} \cdot \mathbf{100} = \mathbf{7.19\ \%\ H} \qquad \mathbf{O:}\ \frac{\mathbf{32\ g\ O}}{\mathbf{153\ g\ C_8H_{11}O_2N}} \cdot \mathbf{100} = \mathbf{20.9\ \%\ O}$$

(10) 4. Find the empirical formula of a compound that is 48.38% carbon, 8.12% hydrogen, and 53.5% oxygen by mass.

$$48.38\ g\ C\left(\frac{1\ mol\ C}{12.0\ g\ C}\right) = 4.03\ mol\ C$$

$$8.12\ g\ H\left(\frac{1\ mol\ H}{1.01\ g\ H}\right) = 8.04\ mol\ H$$

$$53.5\ g\ O\left(\frac{1\ mol\ O}{16.00\ g}\right) = 3.34\ mol\ O$$

$$\left(\frac{4.03\ mol\ C}{3.34}\right) : \left(\frac{8.04\ mol\ H}{3.34}\right) : \left(\frac{3.08\ mol\ O}{3.34}\right)$$

1.21 C : 2.41 H : 1 O
1.21 x 5 C : 2.41 x 5 H : 1 x 5 O

= 6 C : 12 H : 5 O
$C_6H_{12}O_5$

(6) 5. The formula of the sulfate of an unknown metal, X, is $X_2(SO_4)_3$. The compound also is 41.7% X, 19.4% S and 38.9% O. Determine the atomic mass and the symbol of the element X.

$$19.4\ g\ S\left(\frac{1\ mol\ S}{32.0\ g\ S}\right) = 0.606\ mol\ S$$ **are in the compound.**

According to the formula there are 2 moles X for every 3 moles S. Since we know howmany moles of sulfur are in the compound we can determine how many moles of X are present,

$$0.606\ mol\ S\left(\frac{2\ mol\ X}{3\ mol\ S}\right) = 0.404\ mol\ X$$ **are in the compound.**

Since o.404 moles of X weigh 41.7 grams the molar mass of X must be,

$$\left(\frac{41.7\ g\ X}{0.404\ mol\ X}\right) = 103\ g \cdot mol^{-1}$$

The unknown element is Rhodium, Rh.

(20) 6. Complete the following table

Formula	*M*, Molar Mass $\left(\frac{g}{mol}\right)$	*m*, Mass of sample (g)	*n*, Moles of sample (mol)	*N*, Number of atoms, molecules, or formula units
$KClO_3$	**123**	**29.5**	**0.241**	1.45×10^{22} formula units
SO_2	**64**	399	**6.23**	**3.75×10^{24} molecules**
unknown	**78.2**	4.91	6.28×10^{-2}	**3.78×10^{22} formula units**
$Mg_3Al_2(SiO_4)_3$	403	**9.99**	2.48×10^{-2}	**1.49×10^{22} formula units**

(10) 7. The thermite reaction

$$\mathbf{8}Al_{(s)} + \mathbf{3}Fe_3O_{4(s)} \rightarrow 9Fe_{(s)} + \mathbf{4}Al_2O_{3(s)}$$

Calculate how many grams of iron can be produced when 14.0 g of Al are combined with excess Fe_3O_4.

$$\mathbf{14.0\ g\ Al}\left(\frac{\mathbf{1\ mol\ Al}}{\mathbf{27.0\ g\ Al}}\right)\left(\frac{\mathbf{9\ mol\ Fe}}{\mathbf{8\ mol\ Al}}\right)\left(\frac{\mathbf{55.6\ g\ Fe}}{\mathbf{1\ mol\ Fe}}\right) = \mathbf{10.8\ g\ Cl_2}$$

(12) 8. Acrylonitrile, C_3H_3N, is an important component for synthetic fibers and plastics. The compound is synthesized from propene (C_3H_6), ammonia and oxygen according to the equation,

$$\mathbf{2}C_3H_{6(g)} + \mathbf{2}NH_{3(g)} + \mathbf{3}O_{2(g)} \rightarrow \mathbf{2}C_3H_3N_{(l)} + \mathbf{6}H_2O_{(g)}$$

89.5 g of propene are added to an amount of ammonia and oxygen. After the reaction occurs 1.65 moles of C_3H_3N are produced. Answer each of the following,

a) the mass of C_3H_3N produced?

$$\mathbf{1.65\ mol\ C_3H_3N}\left(\frac{\mathbf{53.0\ g}}{\mathbf{1\ mol\ C_3H_3N}}\right) = \mathbf{87.5\ g\ C_3H_3N}$$

b) the mass of NH_3 reacting?

$$\mathbf{1.65\ mol\ C_3H_3N}\left(\frac{\mathbf{2\ mol\ NH_3}}{\mathbf{2\ mol\ C_3H_3N}}\right)\left(\frac{\mathbf{17.0\ g}}{\mathbf{1\ mol\ NH_3}}\right) = \mathbf{28.0\ g\ NH_3}$$

c) Is propene the limiting reagent in this reaction? Explain. (You may use a calculation to support your answer.)

Need to determine how many grams of propene are required to form 1.65 mol of acrylonitrile.

$$\mathbf{1.65\ mol\ C_3H_3N}\left(\frac{\mathbf{2\ mol\ C_3H_3}}{\mathbf{2\ mol\ C_3H_3N}}\right)\left(\frac{\mathbf{39.0\ g}}{\mathbf{1\ mol\ C_3H_3}}\right) = \mathbf{64.4\ g\ C_3H_3}$$

So 64.4 g C_3H_3 reacted. We began with 89.5 g of C_3H_3, therefore C_3H_3 is in excess.

(12) 9. The reaction which occurs when an Alka-Seltzer™ tablet is added to water,

$$3NaHCO_{3(aq)} + H_3C_6H_5O_{7(aq)} \rightarrow 3CO_{2(g)} + 3H_2O_{(g)} + Na_3C_6H_5O_{7(aq)}$$

One Alka-Seltzer tablet contains 1.92 g of sodium bicarbonate and 1.00 g of citric acid. What mass of carbon dioxide gas will fizz out when one tablet is plopped into water?

$$\mathbf{1.92\ g\ NaHCO_3\left(\frac{1\ mol}{84.0\ g}\right) = 0.229\ mol\ NaHCO_3}$$

$$\mathbf{1.00\ g\ H_3C_6H_5O_7\left(\frac{1\ mol}{192.0\ g}\right) = 0.00521\ mol\ H_3C_6H_5O_7}$$

$(moles\ NaHCO_3)_o$	$(moles\ H_3C_6H_5O_7)_{required}$	$(moles\ H_3C_6H_5O_7)_o$	Conclusion
0.229 mol	0.0733 mol	0.00521 mol	$H_3C_6H_5O_7$ limiting, $NaHCO_3$ excess

$$\mathbf{0.229\ mol\ NaHCO_3\left(\frac{1\ mol\ H_3C_6H_5O_7}{3\ mol\ NaHCO_3}\right) = 0.0733\ mol\ H_3C_6H_5O_7}$$

$$\mathbf{0.00521\ mol\ H_3C_6H_5O_7\left(\frac{3\ mol\ CO_2}{1\ mol\ H_3C_6H_5O_7}\right)\left(\frac{44.0\ g}{1\ mol\ CO_2}\right) = \boxed{0.688\ g\ CO_2}}$$

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	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	35 **Br** 79.90	36 **Kr** 83.80
5	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	53 **I** 126.9	54 **Xe** 131.3
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)	85 **At** (210)	86 **Rn** (222)
7	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

Ion	Solubility	Exceptions
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