CHEM 1215
Exam III
John III. Gelder
April 5, 2000

Name _____

TA's Name _____

Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 6 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 4 - 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	_____	_____	_____	_____	_____
	(42)	(22)	(26)	(10)	(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) $Ca(NO_3)_{2(aq)} + K_2S_{(aq)} \rightarrow \mathbf{CaS_{(aq)} + 2KNO_{3(aq)}}$

b) $\mathbf{2}C_7H_{14(l)} + \mathbf{21}O_{2(aq)} \rightarrow \mathbf{14CO_{2(g)} + 14H_2O_{(l)}}$

c) $H_2SO_{4(aq)} + \mathbf{2}LiOH_{(aq)} \rightarrow \mathbf{Li_2SO_{4(aq)} + 2H_2O_{(l)}}$

d) $\mathbf{2}Fe_{(s)} + O_{2(aq)} \rightarrow \mathbf{FeO_{(s)}}$

(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:

$$\mathbf{Ca^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + S^{2-}_{(aq)} \rightarrow Ca^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + S^{2-}_{(aq)}}$$

Net Ionic equation:

No net ionic equation

1c)

Ionic equation:

$$\mathbf{2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2Li^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2Li^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2H_2O_{(l)}}$$

Net Ionic equation:

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

(22) 3. 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
CF_2Cl_2	**121**	**42.3**	0.350	**2.11×10^{23} molecules**
$C_4H_8O_2$	**88**	1.75×10^{-21}	**1.99×10^{-23}**	**12 molecules**
unknown	**55.8**	1.05	0.0188	**1.13×10^{22} atoms**
$C_{10}H_{19}O_6PS_2$	330	**38.5**	**0.117**	7.03×10^{22}

If the unknown is an element, indicate the symbol…..**Fe**

(12)4. Short answer

a) Calculate the mass, in grams, of a single molecule of glucose, $C_6H_{12}O_6$.

$$\left(\frac{180\ g\ C_6H_{12}O_6}{1\ mol\ C_6H_{12}O_6}\right)\left(\frac{1\ mol\ C_6H_{12}O_6}{6.02\ x\ 10^{23}\ molecules\ C_6H_{12}O_6}\right)$$

$$2.99\ x\ 10^{-22}\ g \cdot molecules^{-1}$$

b) Calculate the number of atoms of nitrogen in 3.45 g $CoC_4H_{19}N_5Cl$.

$$3.45\ g\ CoC_4H_{19}N_5Cl\left(\frac{1\ mol}{231.4\ g}\right)\left(\frac{6.023\ x\ 10^{23}\ molecule}{1\ mol}\right)\left(\frac{5\ N\ atoms}{1\ molecule}\right) =$$

$$4.49\ x\ 10^{22}\ N\ \ atoms$$

c) Calculate the number of formula units and the number of grams in 1.75×10^{-21} mol of $Na_2Cr_2O_7$.

$$1.75\ x\ 10^{-21}\ mol\ \ Na_2Cr_2O_7\left(\frac{6.023\ x\ 10^{23}\ formula\ units}{1\ mol}\right)\ = 1054\ formula\ units$$

$$1.75\ x\ 10^{-21}\ mol\ \ Na_2Cr_2O_7\left(\frac{262\ g}{1\ mol}\right)\ = 4.59\ x\ 10^{-19}\ grams\ \ Na_2Cr_2O_7$$

(10) 5. Urea, a common component in fertilizer, has the formula CH_4N_2O. Calculate the percentage composition by mass of the elements in urea.

$$C: \left(\frac{12.0\ g\ C}{60.0\ g\ CH_4N_2O}\right) \cdot 100 = 20.0\ \%\ C$$

$$H: \left(\frac{1.008\ g\ Cl}{60.0\ g\ CH_4N_2O}\right) \cdot 100 = 6.73\ \%\ H$$

$$N: \left(\frac{14.0\ g\ O}{60.0\ g\ CH_4N_2O}\right) \cdot 100 = 46.7\ \%\ N$$

$$O: \left(\frac{16.0\ g\ O}{60.0\ g\ CH_4N_2O}\right) \cdot 100 = 26.7\ \%\ O$$

(10) 6. Ibuprofen is a headache remedy. Ibuprofen is 75.69% C, 8.80% H and 15.51% O. Calculate the empirical formula for Ibuprofen.

$$\mathbf{75.69\ g\ C}\left(\frac{\mathbf{1\ mol\ C}}{\mathbf{12.0\ g\ C}}\right) = \mathbf{6.308\ mol\ C}$$

$$\mathbf{8.80\ g\ H}\left(\frac{\mathbf{1\ mol\ H}}{\mathbf{1.01\ g\ H}}\right) = \mathbf{8.713\ mol\ H}$$

$$\mathbf{15.51\ g\ O}\left(\frac{\mathbf{1\ mol\ O}}{\mathbf{16.00\ g}}\right) = \mathbf{0.9694\ mol\ O}$$

$$\left(\frac{\mathbf{6.308\ mol\ C}}{\mathbf{0.9694}}\right) : \left(\frac{\mathbf{8.713\ mol\ H}}{\mathbf{0.9694}}\right) : \left(\frac{\mathbf{0.9694\ mol\ O}}{\mathbf{0.9694}}\right)$$

6.51 C : 8.99 H : 1.0 O = 1 C : 1 H : 1 O
2 · (6.51 C : 8.99 H : 1.0 O) = 13 C : 18 H : 2 O
$C_{13}H_{18}O_2$

(16) 7a. In laboratory last week everyone reacted copper with nitric acid, according to the equation

$$3Cu_{(s)} + 8HNO_{3(aq)} \rightarrow 2NO_{(g)} + 3Cu(NO_3)_{2(aq)} + 4H_2O_{(l)}$$

Calculate the number of moles and the number of grams of NO formed when 1.17 grams of copper metal reacted with excess nitric acid.

$$\mathbf{1.17\ g\ Cu}\left(\frac{\mathbf{1\ mol\ Cu}}{\mathbf{63.55\ g}}\right)\left(\frac{\mathbf{2\ mol\ NO}}{\mathbf{3\ mol\ Cu}}\right)\left(\frac{\mathbf{30.0\ g\ NO}}{\mathbf{1\ mol\ NO}}\right) = \mathbf{0.368\ g\ NO}$$

$$\mathbf{1.17\ g\ Cu}\left(\frac{\mathbf{1\ mol\ Cu}}{\mathbf{63.55\ g}}\right)\left(\frac{\mathbf{2\ mol\ NO}}{\mathbf{3\ mol\ Cu}}\right) = \mathbf{0.0123\ mol\ NO}$$

b) NO is a colorless gas which reacts immediately with O_2 in the atmosphere according to the equation

$$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$$

Calculate the number of grams of NO_2 formed when the 1.17 gram sample of copper in part a) reacts.

$$\mathbf{0.0123\ mol\ NO}\left(\frac{\mathbf{2\ mol\ NO_2}}{\mathbf{2\ mol\ NO}}\right)\left(\frac{\mathbf{46.0\ g\ NO_2}}{\mathbf{1\ mol\ NO_2}}\right) = \mathbf{0.565\ grams\ NO_2}$$

(10) 8. An interesting reaction which is postulated as occurring in the atmosphere on this planet is,

$$2NH_{3(g)} + 3O_{2(g)} + 2CH_{4(g)} \rightarrow 2HCN_{(g)} + 6H_2O_{(g)}$$

A sample is prepared by mixing 45.6 g of ammonia with some amounts of oxygen and methane. An electrical arc is used to initiate the reaction. After the reaction occurs 81.3 grams of H_2O is produced. Answer each of the following,

a) the mol of H_2O produced?

$$\mathbf{81.3\ g\ H_2O \left(\frac{1\ mol\ H_2O}{18.0\ g}\right) = 4.52\ mol\ H_2O\ produced}$$

b) the mass of CH_4 reacted?

$$\mathbf{81.3\ g\ H_2O \left(\frac{1\ mol\ H_2O}{18.0\ g}\right)\left(\frac{2\ mol\ CH_4}{6\ mol\ H_2O}\right)\left(\frac{16.0\ g\ CH_4}{1\ mol\ CH_4}\right) = 24.1\ g\ CH_4\ reacted}$$

c) the mass of ammonia remaining after the reaction occurred?

$$\mathbf{81.3\ g\ H_2O \left(\frac{1\ mol\ H_2O}{18.0\ g}\right)\left(\frac{2\ mol\ NH_3}{6\ mol\ H_2O}\right)\left(\frac{7.0\ g\ NH_3}{1\ mol\ NH_3}\right) = 25.6\ g\ NH_3\ reacted}$$

$$\mathbf{(45.6\ g\ NH_3)_{initially} - (25.6\ g\ NH_3)_{reacted} = 20.0\ g\ NH_3\ unreacted}$$

Periodic Table of the Elements

	IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008	IIA																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	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	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