LAST NAME: _____

FIRST NAME: _____

Student Number: _____

CHM 1311 A
Midterm #1 A
Fall 2011

Please keep your work covered at all times and keep your eyes on your own paper! Cheating or any appearance of cheating will result in an F in the course and possible expulsion from the university.

There are 10 pages in this test. A periodic table and data sheets are provided at the end. You may rip these pages off of the exam and use them to cover your work during the test. Any scratch work should be done on the back of these pages.

Please show all work to receive partial credit.

You have 75 minutes to complete the test.

Question	Points Possible	Points Earned	TA Initial
1	10		
2	10		
3	10		
4	10		
5	10		
TOTAL	50		

#1. (10 points) Short Answer Questions

a) Provide the name or formula for the following:

$CuNO_3$ _____

calcium sulfate tetrahydrate _____

b) The molar enthalpy of vaporization of sodium is 96.96 kJ/mol at 1156 K. The amount of heat (in kJ) needed to vaporize 1.00 g of sodium is: _____.

c) You take a 4.0 L volume of gas at 600 K. You compress the gas to a 1.0 L volume and simultaneously cool the vessel to 300 K. The pressure of the gas:

DOUBLES HALVES QUADRUPLES STAYS CONSTANT

d) The standard heat of formation of solid sodium carbonate is –1131 kJ. Write the chemical equation for the reaction to which this value applies (include phases).

e) The root-mean-square-speed of xenon is 237 m/s. A molecule of chlorine gas would beat a molecule of xenon gas in a race. TRUE FALSE

f) Write the equilibrium constant expression for the following reaction, and choose the best means by which you could encourage the formation of hydrogen gas.

$C(s) + H_2O(g) \leftrightarrows CO(g) + H_2(g)$ $\Delta H^o = 211$ kJ

i) Add steam and remove heat

ii) Remove carbon monoxide and decrease volume

iii) Increase volume and add heat

iv) Add hydrogen gas and increase volume

K =

g) Which of the following isotopes has the greatest number of neutrons?

$^{35}_{17}Cl$ $^{40}_{19}K$ $^{37}_{17}Cl$ $^{40}_{20}Ca$

h) Rank the following compounds in *increasing* order of oxidation state of chlorine:

NaOCl, HCl, Cl_2 _____

#2. (10 points) The following reaction, occurring in a sealed vessel, has a percent yield of 94.9%:

$$2NaN_3\ (s) \rightarrow 2\ Na\ (l) + 3\ N_2(g)$$

a) What volume of N_2, measured at 735 mmHg and 26.0°C, is produced when 75.0 g of sodium azide decomposes?

Answer: _____

b) After the reaction is complete, argon gas is added to the vessel until the final total pressure is 1000 mmHg. What is the mole fraction of nitrogen in the gas mixture?

Answer: _____

#3. (10 points). A calorimeter contains 24.0 mL of water at 13.0°C. When 2.20 g of X (molar mass 47.0 g/mol) is added, it dissolves via the reaction: X(s) → X(aq) and the temperature of the solution increases to 28.0°C.

a) Calculate the enthalpy change for the dissolution, in kJ/mol. You may assume the specific heat capacity and density of the solution are equal to those of pure water; however, you may NOT assume that the mass of the solution is equal to the mass of the water.

Answer: _____

b) Calculate the internal energy change for the dissolution, in kJ/mol.

Answer: _____

c) Determine the enthalpy change for the following reaction, using the provided data.

X (s) → 2Y (s) ΔH^o = ?

Y(s) → Y(aq)	**ΔH^o = +24.7 kJ**
2 Y(aq) → X(aq)	**ΔH^o = -1.44 kJ**

Answer: _____

#4. (10 points) In a reaction chamber, 0.1000 mol of H_2S is mixed with 0.0500 mol of methane and is brought to equilibrium at 700ºC and a total pressure of 1.000 bar.

$$H_2S(g) + CH_4(g) \leftrightarrows CS_2(g) + H_2(g)$$

Upon analysis, the equilibrium mixture was found to contain 3.34×10^{-2} mol carbon disulfide.

a) Determine the number of moles of each of the other species present at equilibrium.

H_2S = _____ CH_4 = _____ H_2 = _____

b) Calculate K_P at 700ºC.

c) Calculate K_C at 700ºC.

#5. (10 points) In an environmental analysis for lead in soils, the lead must first be oxidized to lead ions using permanganate ions in acidic solution, with the following half-reactions.

$$MnO_4^- \rightarrow Mn^{2+}$$

$$Pb \rightarrow Pb^{2+}$$

a) Determine the overall balanced redox reaction equation.

b) A 25.0 g sample of soil was found to react with 14.92 mL of a 0.150 M $KMnO_4$ solution. What was the percent composition by mass of lead in the soil sample?

Answer: _____

Gas Laws

$PV = nRT$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$P_T = P_1 + P_2 + P_3 + \ldots$

$P_A = \chi_A P_T$

$$d = \frac{m}{V} = \frac{P \cdot MM}{RT}$$

$$E_K = \frac{1}{2}mv^2$$

$$u_{rms} = \sqrt{\frac{3RT}{MM}}$$

$$\frac{Rate\ A}{Rate\ B} = \sqrt{\frac{MM_B}{MM_A}}$$

$$\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$

Equilibrium

$K_P = K_C(RT)^{\Delta n}$

Acid/Base

$pOH = -\log[OH^-]$

$pH = -\log[H^+]$

$pH + pOH = 14$

$K_a \times K_b = K_W$

$pH = pK_a + \log [A^-]/[HA]$

$$pH = \frac{pK_{a1} + pK_{a2}}{2}$$

Thermochemistry

$\Delta U = q + W$

$W_{system} = -P\Delta V = -\Delta nRT$

$\Delta H = \Delta U + P\Delta V$

$q_P = \Delta U + P\Delta V$

$q = ms\Delta T$

$q = n\Delta H$

$\Delta H_{rxn}^\circ = \sum n\Delta H_f^\circ(pdts) - \sum n\Delta H_f^\circ(rxts)$

The atom

$E = h\nu$

$c = \nu\lambda$

$E = -B/n^2$

Kinetics

$[A]_t = [A]_o - kt$

$\ln[A]_t = \ln[A]_o - kt$

$1/[A]_t = 1/[A]_o + kt$

$k = Ae^{(-Ea/RT)}$

$\ln(k_2/k_1) = (-Ea/R)(1/T_2 - 1/T_1)$

Other

$n = m/MM$

$C = n/V$

$$\%yield = \frac{actual\ yield}{theoretical\ yield} \times 100\%$$

$$\chi_A = \frac{n_A}{n_T}$$

Data For Water

Density = 1.00 g/mL (at 25°C)
$s = 2.13\ J\ g^{-1}\ K^{-1}$ (solid)
$s = 4.184\ J\ g^{-1}\ K^{-1}$ (liquid) $\Delta H°_{fus} = 6.02\ kJ\ mol^{-1}$
$s = 2.01\ J\ g^{-1}\ K^{-1}$ (gas) $\Delta H°_{vap} = 40.7\ kJ\ mol^{-1}$

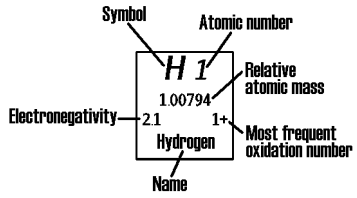
Constants and Conversion Factors

1 mmHg = 1 torr 760 mmHg = 1 atm 1 atm = 101.325 kPa 1 atm = 1.013125 bar
$1\ cm^3 = 1\ mL$ 1000 mL = 1 L 1000 L = $1\ m^3$

Avogadro's Number	*N*	$6.022 \times 10^{23}\ mol^{-1}$	
Boltzmann's constant	*k*	$1.30866 \times 10^{-23}\ J \cdot K^{-1}$	
Faraday's constant	*F*	$96{,}485\ C \cdot mol^{-1}$	
Gas constant	*R*	$8.31451\ J \cdot K^{-1} \cdot mol^{-1}$	
	R	$0.08206\ atm \cdot L \cdot K^{-1} \cdot mol^{-1}$	
	R	$8.31451\ m^3 Pa \cdot K^{-1} \cdot mol^{-1}$	
	R	$0.0831451\ bar\ L \cdot K^{-1} \cdot mol^{-1}$	
Planck's constant	*h*	6.62608×10^{-34}	$J \cdot s$
Speed of Light	*c*	2.99792458×10^{8}	$m \cdot s^{-1}$

Mokeur's Periodic table of the elements

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	***H 1*** 1.00794 2.1 1+ Hydrogen																	***He 2*** 4.002602 - - Helium
2	**Li 3** 6.941 1.0 1+ Lithium	**Be 4** 9.012182 1.5 2+ Beryllium											**B 5** 10.811 2.0 3+ Boron	**C 6** 12.011 2.5 4+,4- Carbon	***N 7*** 14.00674 3.0 3+,3- Nitrogen	***O 8*** 15.9994 3.5 2- Oxygen	***F 9*** 18.9984032 4.0 1- Fluorine	***Ne 10*** 20.1797 - - Neon
3	**Na 11** 22.989768 0.9 1+ Sodium	**Mg 12** 24.3050 1.2 2+ Magnesium											**Al 13** 26.981539 1.5 3+ Aluminum	**Si 14** 28.0855 1.8 4+ Silicon	**P 15** 30.973762 2.1 5+ Phosphorus	**S 16** 32.066 1.8 4+ Sulfur	***Cl 17*** 35.4527 3.0 1- Chlorine	***Ar 18*** 39.948 - - Argon
4	**K 19** 39.0983 0.8 1+ Potassium	**Ca 20** 40.078 1.0 2+ Calcium	**Sc 21** 44.955910 1.3 3+ Scandium	**Ti 22** 47.88 1.5 4+ Titanium	**V 23** 50.9415 1.6 5+ Vanadium	**Cr 24** 51.9961 1.6 3+ Chromium	**Mn 25** 54.93805 1.5 2+ Manganese	**Fe 26** 55.847 1.8 3+ Iron	**Co 27** 58.9332 1.8 2+ Cobalt	**Ni 28** 58.6934 1.8 2+ Nickel	**Cu 29** 63.546 1.9 2+ Copper	**Zn 30** 65.39 1.6 2+ Zinc	***Ga 31*** 69.723 1.6 3+ Gallium	**Ge 32** 72.61 1.6 4+ Germanium	**As 33** 74.92159 2.0 3+,3- Arsenic	**Se 34** 78.96 2.4 4+ Selenium	***Br 35*** 79.904 2.8 1- Bromine	***Kr 36*** 83.80 - - Krypton
5	**Rb 37** 85.4678 0.8 1+ Rubidium	**Sr 38** 87.62 1.0 2+ Strontium	**Y 39** 88.90585 1.3 3+ Yttrium	**Zr 40** 91.224 1.4 4+ Zirconium	**Nb 41** 92.90638 1.6 5+ Niobium	**Mo 42** 95.94 1.8 6+ Molybdenum	Tc 43 98.9063 1.9 7+ Technetium	**Ru 44** 101.57 2.2 3+,4+ Ruthenium	**Rh 45** 102.9055 2.2 3+ Rhodium	**Pd 46** 106.42 2.2 2+ Palladium	**Ag 47** 107.8682 1.9 1+ Silver	**Cd 48** 112.411 1.7 2+ Cadmium	**In 49** 114.82 1.7 3+ Indium	**Sn 50** 118.71 1.8 4+ Tin	**Sb 51** 121.757 1.9 3+,3- Antimony	**Te 52** 127.60 2.1 4+ Tellurium	**I 53** 126.90447 2.5 1- Iodine	***Xe 54*** 131.29 - - Xenon
6	***Cs 55*** 132.90543 0.7 1+ Cesium	**Ba 56** 137.327 0.9 2+ Barium	**La 57** 138.9055 1.1 3+ Lanthanum	**Hf 72** 178.49 1.3 4+ Hafnium	**Ta 73** 180.9479 1.5 5+ Tantalum	**W 74** 183.85 1.7 6+ Tungsten	**Re 75** 186.207 1.9 7+ Rhenium	**Os 76** 190.2 2.2 4+ Osmium	**Ir 77** 192.22 2.2 4+ Iridium	**Pt 78** 195.08 2.2 4+ Platinum	**Au 79** 196.96654 2.4 3+ Gold	***Hg 80*** 200.59 1.9 2+ Mercury	**Tl 81** 204.3833 1.8 1+ Thallium	**Pb 82** 207.2 1.8 2+ Lead	**Bi 83** 208.98037 1.9 3+ Bismuth	**Po 84** 208.9824 2.0 2+ Polonium	**At 85** 209.9871 2.2 1- Astatine	***Rn 86*** 222.0176 - - Radon
7	***Fr 87*** 223.0197 0.7 1+ Francium	**Ra 88** 226.0254 0.9 2+ Radium	**Ac 89** 227.0278 1.1 3+ Actinium	Rf 104 261.11 - - Rutherfordium	Db 105 262.11 - - Dubnium	Sg 106 263.12 - - Seaborgium	Bh 107 262.12 - - Bohrium	Hs 108 264 - - Hassium	Mt 109 266.1378 - - Meitnerium	Uun 110 269 - - Ununnilium	Uuu 111 272 - - Unununium	Uu 112 277 - - Ununbium		Uuq 114 289 - - Ununquadium		Uuh 116 289 - - Ununhexium		Uuo 118 293 - - Ununoctium



6	**Ce 58** 140.115 1.1 3+ Cerium	**Pr 59** 140.90765 1.1 3+ Praseodymium	**Nd 60** 144.24 1.1 3+ Neodymium	Pm 61 144.9127 1.1 3+ Promethium	**Sm 62** 150.36 1.2 3+ Samarium	**Eu 63** 151.965 1.2 3+ Europium	**Gd 64** 157.25 1.2 3+ Gadolinium	**Tb 65** 168.92534 1.2 3+ Terbium	**Dy 66** 162.50 1.2 3+ Dysposium	**Ho 67** 164.93032 1.2 3+ Holmium	**Er 68** 167.26 1.2 3+ Erbium	**Tm 69** 168.93421 1.2 3+ Thulium	**Yb 70** 173.04 1.1 3+ Ytterbium	**Lu 71** 174.967 1.2 3+ Lutetium
7	**Th 90** 232.0381 1.3 4+ Thorium	**Pa 91** 231.03588 1.5 5+ Protactinium	**U 92** 238.0289 1.4 6+ Uranium	Np 93 237.082 1.3 5+ Neptunium	Pu 94 244.0642 1.3 4+ Plutonium	Am 95 243.0614 1.3 3+ Americium	Cm 96 247 1.3 3+ Curium	Bk 97 247.0703 1.3 3+ Berkelium	Cf 98 251.0796 1.3 3+ Californium	Es 99 252.03 1.3 - Einsteinium	Fm 100 257.0951 1.3 - Fermium	Md 101 258.01 1.3 - Mendelevium	No 102 259.1009 1.3 - Nobelium	Lr 103 260.1053 - - Lawrencium

Under normal conditions, bold symbols correspond to solid state, bold italic correspond to liquid state, italic correspond to gaseous state and normal correspond to synthetic elements.