Name: _____

Instructor: Mills

Chemistry 102: 2nd Practice Examination

Answer all five questions. Each question is worth 30 points. Please ensure you have all *five* pages of questions, as well as a formula sheet and a copy of the periodic table, *before* starting.

SHOW ALL WORK

Question	Score
1	
2	
3	
4	
5	
Total	

"Gibbs"

Question 1 (30 points): Using the thermodynamic information given in the data sheet, calculate ΔG^o for the following reaction:

$$Fe_2O_{3\,(s)} + 6\,HCl_{(g)} \rightarrow 2\,FeCl_{3\,(s)} + 3\,H_2O_{(g)}$$

"What's the pH?"

Question 2 (30 points): Calculate the pH of each of the following solutions:

1. 0.015 M HCl (aq) (assume complete dissociation)

2. 0.015 M H_2SO_4 (aq) (assume complete dissociation)

3. 0.015 M NaOH (aq) (assume complete dissociation)

4. 0.015 M $HC_2H_3O_2$ (aq), $K_a = 1.8 \times 10^{-5}$

"Weak Acid"

Question 3 (30 points): A 0.200 M solution of a weak acid HA (aq) is 9.4 % ionized (dissociated) at equilibrium. Use this information to calculate $[H^+]$, [HA] and K_a for HA.

"Weak Base"

Codeine ($C_{18}H_{21}NO_3$) is a weak organic base. A 5.0×10^{-3} M solution of codeine has a pH of 9.95.

Question 4a (30 points): Calculate K_b for codeine.

Question 4b (5 points): Calculate pK_b for codeine.

"Common Ion"

Question 5 (30 points): A solution contains 2.5×10^{-4} M $Ag^{+}(aq)$ and 1.7×10^{-3} M $Pb^{2+}(aq)$.

A. If NaI (aq) is added, will AgI ($K_{sp} = 8.3 \times 10^{-17}$) or PbI_2 ($K_{sp} = 7.9 \times 10^{-9}$) precipitate first?

B. Specify the concentration of I^{-} (aq) needed to begin precipitation of the material you determined would precipitate first in part A.

"REDOX"

Question 5a (10 points): State the oxidation state of the specified atom in each of the chemical species listed below:

Cr in $Cr_2O_7^{2-}$ I in IO_3^-

Question 5b (20 points): Balance the following REDOX reaction. Assume acidic conditions.

$$Cr_2O_7^{2-}{}_{(aq)} + I^-_{(aq)} \rightarrow Cr^{3+}{}_{(aq)} + IO_3^-{}_{(aq)}$$

Data sheet

Molar volume: $V_m = 22.41\ L.mol^{-1}$ at STP (0.00^oC, 1.00 atm)

Ideal gas law: $PV = nRT$

Combined gas law: $P_1V_1/T_1 = P_2V_2/T_2$

Boyle's Law: $P \propto 1/V$ (at fixed T and n)

Charles's Law: $P \propto T$ (at fixed V and n)

Avagadro's Law: $V = nV_m$

1st order rate equations
$\ln([A]_t/[A]_o) = -kt$
$t_{1/2} = 0.693/k$

Arrhenius equation
$\ln(k_2/k_1) = E_a(1/T_1 - 1/T_2) / R$

$K_w = [H^+][^-OH] = 1 \times 10^{-14}$
$pH + pOH = 14$
$\Delta G = \Delta H - T\Delta S$

Daltons law of partial pressures:
$P_{Tot} = P_a + P_b + P_c \ldots.$

Beer's law
$A = \log(I_o/I) = \varepsilon bc$

$R = 0.0821\ L\ atm\ mol^{-1}\ K^{-1}$
$= 8.315\ Jmol^{-1}K^{-1}$

$d = m/v$

1.00 atm = 760 mmHg = 101.5 kPa

$\rho H_2O = 1.00\ gmL^{-1}$

2nd order rate equations
$1/[A]_t = kt + 1/[A]_o$
$t_{1/2} = 1/k[A]_o$

Equilibrium constants: $K_p = K_c(RT)^{\Delta n}$

$pH = -\log [H^+]$
$K_aK_b = K_w$
$\Delta H_{rxn} = \Delta H_f$ (products) $- \Delta H_f$ (reactants)

Substance	$S^o\ (Jmol^{-1}K^{-1})$
H_2O (g)	188.83
Fe_2O_3 (s)	89.96
$FeCl_3$ (s)	142.3
HCl (g)	186.69

Substance	$\Delta H^o_f\ (kJmol^{-1})$
H_2O (g)	- 241.8
Fe_2O_3 (s)	- 822.16
$FeCl_3$ (s)	- 400.0
HCl (g)	- 92.30