CHEM 1515
Exam IV
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December 14, 1993

Name _____
TA's Name _____
Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last 4 pages include important mathematical equations and constants, a periodic table, and a table of solubility equilibrium constants, standard thermodynamic values and standard reduction potentials. All work should be done in this booklet. You may *carefully* remove the last 4 pages of the examination.

2. PRINT your name, your TA's name and your laboratory section now in the space at the top of this sheet. DO NOT SEPARATE THE 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 or short answer questions.

4. *No credit* will be awarded if your work is not shown in problems 2 – 5, 7 and 8. Please circle your final answer!

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	_____	_____	_____	_____	_____
	(21)	(24)	(26)	(29)	(100)

(9) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify the phase of each product as either (g)as, (l)iquid, (s)olid or (aq)ueous. Soluble ionic compounds should be written in the form of their component ions.

a) $Ca(OH)_{2(s)} + NH_4Cl_{(s)} \rightarrow$

b) $Zn_{(s)} + HCl_{(aq)} \rightarrow$

c) $Cu(NO_3)_{2(aq)} + Mg_{(s)} \rightarrow$

(12) 2. Balance the following oxidation-reduction reaction using the half-reaction method.

a) $ClO^-_{(aq)} + CrO_2^-{}_{(aq)} \rightarrow Cl^-_{(aq)} + CrO_4^{2-}{}_{(aq)}$ **basic solution**

identify the oxidizing agent _____ identify the reducing agent _____

(24) 3a. Calculate ΔG°_{rxn}, ΔH°_{rxn} and ΔS°_{rxn} for the reaction

$$NO_{2(g)} + N_2O_{(g)} \rightarrow 3NO_{(g)}$$

b) What would be the values of these three functions at 400 ˚C. (Note: State any assumptions.)

c) What is the magnitude of the equilibrium constant, K_p, for the reaction at 25 ˚C?

d) Is the reaction spontaneous at 25 ˚C? How would an increase in the temperature effect the spontaneity of the reaction? At what temperatures is the reaction spontaneous?

(16) 4a. Calculate the solubility of PbI_2 in pure water at 25 ˚C.

b) Calculate the solubility of PbI_2 in 0.0500 M CaI_2.

(10) 5. 100.0 mL of 0.100 M $AgNO_3$ are mixed with 100.0 mL of 0.100 M $ZnCl_2$.

a) Write the chemical equation which describes the reaction which will occur when the two solutions are mixed.

b) Calculate the equilibrium concentrations of $Ag^{+}_{(aq)}$, $NO_3^{-}{}_{(aq)}$, Zn^{2+}, and Cl^{-}.

(9) 6. Write the chemical formula(s) of the product(s) and balance the following reactions.

a) $Sr_{(s)} + Mg^{2+}_{(aq)} \rightarrow$

b) $Cl^-_{(aq)} + MnO_4^-{}_{(aq)} + H^+_{(aq)} \rightarrow$

c) $Ag_{(s)} + HCl_{(aq)} \rightarrow$

(4) 7. Write the half-reactions and determine E° for the electrochemical cell as described below, include the overall chemical equation.

$Zn_{(s)}|Zn^{2+}_{(aq)}||Cr_2O_7^{2-}{}_{(aq)}, H^+_{(aq)}, Cr^{3+}_{(aq)}|Pt_{(s)}$

(16) 8. Given the two half-reactions

$$MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)} \qquad E^\circ = +1.51 \text{ v}$$

$$O_{2(g)} + 2H^+_{(aq)} + 2e^- \rightarrow H_2O_2 \qquad E^\circ = +0.682 \text{ v}$$

Write the chemical equation for the spontaneous reaction which can occur. Calculate the E°, K and ΔG° for the spontaneous reaction.

Useful Information

Equations

$\Delta H^\circ_{rxn} = \sum(\Delta H_f^\circ(\text{products})) - \sum(\Delta H_f^\circ(\text{reactants}))$

$\Delta S^\circ_{rxn} = \sum(S^\circ(\text{products})) - \sum(S^\circ(\text{reactants}))$

$\Delta G^\circ_{rxn} = \sum(\Delta G_f^\circ(\text{products})) - \sum(\Delta G_f^\circ(\text{reactants}))$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$\Delta G^\circ = -RT \ln K$ $\quad \Delta G = \Delta G^\circ + RT \ln Q$

$pH = -\log[H^+]$ $\quad \Delta G^\circ = -nFE^\circ$

$E_{cell} = E^\circ - \frac{0.0257}{n} \ln Q$ $\quad E^\circ = \frac{0.0257}{n} \ln K$

$E_{cell} = E^\circ - \frac{0.059}{n} \log Q$ $\quad E^\circ = \frac{0.059}{n} \log K$

Constants

1 amp · sec = 1 coulomb

$F = 96{,}500 \frac{J}{volt \cdot mol} = 96{,}500$ coulombs

$R = 0.0821 \frac{L \cdot atm}{mole \cdot K} = 8.314 \frac{J}{mole \cdot K}$

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)

E. 3 SOLUBILITY-PRODUCT CONSTANTS FOR COMPOUNDS AT 25˚C

Name	Formula	K_{sp}
Barium carbonate	$BaCO_3$	5.1×10^{-9}
Barium chromate	$BaCrO_4$	1.2×10^{-10}
Barium Fluoride	BaF_2	1.0×10^{-6}
Barium hydroxide	$Ba(OH)_2$	5×10^{-3}
Barium oxalate	BaC_2O_4	1.6×10^{-7}
Barium phosphate	$Ba_3(PO_4)_2$	3.4×10^{-23}
Barium sulfate	$BaSO_4$	1.1×10^{-10}
Cadmium carbonate	$CdCO_3$	5.2×10^{-12}
Cadmium hydroxide	$Cd(OH)_2$	2.5×10^{-14}
Cadmium sulfide	CdS	8.0×10^{-27}
Calcium carbonate	$CaCO_3$	2.8×10^{-9}
Calcium chromate	$CaCrO_4$	7.1×10^{-4}
Calcium fluoride	CaF_2	3.9×10^{-11}
Calcium hydroxide	$Ca(OH)_2$	5.5×10^{-6}
Calcium phosphate	$Ca_3(PO_4)_2$	2.0×10^{-29}
Calcium sulfate	$CaSO_4$	9.1×10^{-6}
Cerium(III) fluoride	CeF_3	8×10^{-16}
Chromium(III) fluoride	CrF_3	6.6×10^{-11}
Chromium(III) hydroxide	$Cr(OH)_3$	6.3×10^{-31}
Cobalt(II) carbonate	$CoCO_3$	1.4×10^{-13}
Cobalt(II) hydroxide	$Co(OH)_2$	1.6×10^{-15}
Cobalt(III) hydroxide	$Co(OH)_3$	1.6×10^{-44}
Copper(I) bromide	CuBr	5.3×10^{-9}
Copper(I) chloride	CuCl	1.2×10^{-6}
Copper(I) sulfide	Cu_2S	2.5×10^{-48}
Copper(II) carbonate	$CuCO_3$	1.4×10^{-10}
Copper(II) chromate	$CuCrO_4$	3.6×10^{-6}
Copper(II) hydroxide	$Cu(OH)_2$	2.2×10^{-20}
Copper(II) phosphate	$Cu_3(PO_4)_2$	1.3×10^{-37}
Copper(II) sulfide	CuS	6.3×10^{-36}
Gold(III) chloride	$AuCl_3$	3.2×10^{-25}
Iron(II) carbonate	$FeCO_3$	3.2×10^{-11}
Iron(II) hydroxide	$Fe(OH)_2$	8.0×10^{-16}
Iron(II) sulfide	FeS	6.3×10^{-18}
Iron(III) hydroxide	$Fe(OH)_3$	4×10^{-38}
Lanthanum fluoride	LaF_3	7×10^{-17}
Lanthanum iodate	$La(IO_3)_3$	6.1×10^{-12}
Lead carbonate	$PbCO_3$	7.4×10^{-14}
Lead chloride	$PbCl_2$	1.6×10^{-5}
Lead chromate	$PbCrO_4$	2.8×10^{-13}
Lead fluoride	PbF_2	2.7×10^{-8}
Lead hydroxide	$Pb(OH)_2$	1.2×10^{-15}
Lead iodide	PbI_2	7.1×10^{-9}
Lead sulfide	PbS	8.0×10^{-28}
Magnesium hydroxide	$Mg(OH)_2$	1.8×10^{-11}
Magnesium oxalate	MgC_2O_4	8.6×10^{-5}
Manganese carbonate	$MnCO_3$	1.8×10^{-11}
Mercury(I) sulfide	Hg_2S	1.0×10^{-47}
Mercury(II) sulfide	HgS	4.0×10^{-53}
Silver chloride	AgCl	1.8×10^{-10}
Silver sulfide	Ag_2S	6.3×10^{-50}
Strontium fluoride	SrF_2	2.5×10^{-9}

Thermodynamic Values (25 ˚C)

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Carbon			
C(*s*) (graphite)	0	0	6
C(*s*) (diamond)	2	3	2
CO(*g*)	-110.5	-137	198
CO_2(*g*)	-393.5	-394	214
CH_4(*g*)	?	-51	186
CH_3OH(*g*)	-201	-163	240
CH_3OH(*l*)	-239	-166	127
H_2CO(*g*)	-116	-110	219
HCOOH(*g*)	-363	-351	249
HCN(*g*)	135.1	125	202
C_2H_2(*g*)	227	209	201
C_2H_4(*g*)	52	68	219
CH_3CHO(*g*)	-166	-129	250
C_2H_5OH(*l*)	-278	-175	161
C_2H_6(*g*)	-84.7	-32.9	229.5
C_3H_6(*g*)	20.9	62.7	266.9
C_3H_8(*g*)	-104	-24	270
Bromine			
Br_2(*l*)	0	0	152.
BrCl(*g*)	14.64	-0.96	240
Chlorine			
Cl_2(*g*)	0	0	223
Cl_2(*aq*)	-23	7	121
Cl^-(*aq*)	-167	-131	57
HCl(*g*)	-92	-95	187
Fluorine			
F_2(*g*)	0	0	203
F^-(*aq*)	-333	-279	-14
HF(*g*)	-271	-273	174
Hydrogen			
H_2(*g*)	0	0	131
H(*g*)217	203	115	
H^+(*aq*)	0	0	0
OH^-(*aq*)	-230	-157	-11
H_2O(*l*)	-286	-237	70
H_2O(*g*)	-242	-229	189
Magnesium			
Mg(s)	0	0	33
Mg(aq)	-492	-456	-118
MgO(s)	-601	-569	26.9
Oxygen			
O_2(*g*)	0	0	205
O(*g*)249	232	161	
O_3(*g*)	143	163	239

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Nitrogen			
N_2(*g*)	0	0	192
NCl_3(*g*)	230	271	-137
NF_3(*g*)	-125	-83.6	-139
NH_3(*g*)	?	-17	193
NH_3(*aq*)	?	-27	111
NH_2CONH_2(aq)	?	?	174
NO(*g*)	90	87	211
NO_2(*g*)	32	52	240
N_2O(*g*)	82	104	220
N_2O_4(*g*)	10	98	304
N_2O_5(*g*)	-42	134	178
$N_2H_3CH_3$(*l*)	54	180	166
HNO_3(*aq*)	-207	-111	146
HNO_3(*l*)	-174	-81	156
NH_4Cl(s)	-314	-201	95
NH_4ClO_4(*s*)	-295	-89	186
Silver			
Ag(*s*)	0	0	42.6
Ag^+(*aq*)	105.6	77.1	72.7
$Ag(S_2O_3)^{3-}$(*aq*)	-1285.7	--	--
AgBr(s)	-100.4	-96.9	107.1
AgCl(s)	-127.1	-109.8	96.2
Sulfur			
S(rhombic)	0	0	31.8
SO_2(g)	-296.8	-300.2	248.8
SO_3(g)	-395.7	-371.1	256.3
H_2S(g)	-20.17	-33.0	205.6
Titanium			
$TiCl_4$(*g*)	-763	-727	355
TiO_2(*s*)	-945	-890	50
Aluminum			
$AlCl_3$(*s*)	-526	-505	184
Barium			
$BaCl_2$(*aq*)	-872	-823	123
$Ba(OH)_2 \cdot 8H_2O$(s)	-3342	-2793	427
Iodine			
I_2(*s*)	0	0	116.7
HI(*g*)	25.94	1.30	206.3

Table of Standard Reduction Potentials (25 ˚C)

A. Acidic Solution	E^o(V)
$Li^+ + e^- \rightarrow Li(s)$	–3.045
$K^+ + e^- \rightarrow K(s)$	–2.925
$Ba^{2+} + 2e^- \rightarrow Ba(s)$	–2.906
$Sr^{2+} + 2e^- \rightarrow Sr(s)$	–2.888
$Ca^{2+} + 2e^- \rightarrow Ca(s)$	–2.866
$Na^+ + e^- \rightarrow Na(s)$	–2.714
$Mg^{2+} + 2e^- \rightarrow Mg(s)$	–2.363
$H_2(g) + 2e^- \rightarrow 2H^-$	–2.25
$Al^{3+} + 3e^- \rightarrow Al(s)$	–1.662
$Mn^{2+} + 2e^- \rightarrow Mn(s)$	–1.185
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	–0.763
$Cr^{3+} + 3e^- \rightarrow Cr(s)$	–0.744
$Fe^{2+} + 2e^- \rightarrow Fe(s)$	–0.440
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	–0.408
$Cd^{2+} + 2e^- \rightarrow Cd(s)$	–0.403
$PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}$	–0.359
$PbCl_2(s) + 2e^- \rightarrow Pb(s) + 2Cl^-$	–0.268
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	–0.250
$Sn^{2+} + 2e^- \rightarrow Sn(s)$	–0.136
$Pb^{2+} + 2e^- \rightarrow Pb(s)$	–0.126
$2H^+ + 2e^- \rightarrow H_2(g)$	0.000
$S(s) + 2H^+ + 2e^- \rightarrow H_2S(aq)$	0.142
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	0.15
$Sb_2O_3(s) + 6H^+ + 6e^- \rightarrow 2Sb(s) + 3H_2O(l)$	0.152
$Cu^{2+} + e^- \rightarrow Cu^+$	0.153
$SO_4^{2-} + 4H^+ + 2e^- \rightarrow H_2SO_3(aq) + H_2O(l)$	0.172
$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-$	0.222
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	0.337
$SO_4^{2-} + 8H^+ + 6e^- \rightarrow S(s) + 4H_2O(l)$	0.357
$H_2SO_3(aq) + 4H^+ + 4e^- \rightarrow S(s) + 3H_2O(l)$	0.450
$I_2(s) + 2e^- \rightarrow 2I^-$	0.536
$MnO_4^- + e^- \rightarrow MnO_4^{2-}$	0.564
$[PtCl_6]^{2-} + 2e^- \rightarrow [PtCl_4]^{2-} + 2Cl^-$	0.68
$O_2(g) + 2H^+ + 2e^- \rightarrow H_2O_2(aq)$	0.682
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	0.771
$Hg^{2+} + 2e^- \rightarrow Hg(l)$	0.788
$Ag^+ + e^- \rightarrow Ag(s)$	0.799
$2NO_3^- + 4H^+ + 2e^- \rightarrow N_2O_4(g) + 2H_2O(l)$	0.803
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	0.920
$NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O(l)$	0.96
$Pd^{2+} + 2e^- \rightarrow Pd(s)$	0.987
$Br_2(l) + 2e^- \rightarrow 2Br^-$	1.065
$Br_2(aq) + 2e^- \rightarrow 2Br^-$	1.087
$ClO_4^- + 2H^+ + 2e^- \rightarrow ClO_3^- + H_2O(l)$	1.19
$2IO_3^- + 12H^+ + 10e^- \rightarrow I_2(s) + 6H_2O(l)$	1.195
$Pt^{2+} + 2e^- \rightarrow Pt(s)$	~1.2
$ClO_3^- + 3H^+ + 2e^- \rightarrow HClO_2(aq) + H_2O(l)$	1.21
$O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O(l)$	1.229
$O_2(g) + 4H^+(pH = 7) + 4e^- \rightarrow 2H_2O(l)$	0.83
$MnO_2(s) + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O(l)$	1.23
$2HNO_2(aq) + 4H^+ + 4e^- \rightarrow N_2O(g) + 3H_2O(l)$	1.29
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O(l)$	1.33
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	1.360
$PbO_2(s) + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O(l)$	1.455
$Au^{3+} + 3e^- \rightarrow Au(s)$	1.498
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O(l)$	1.51
$2HClO(aq) + 2H^+ + 2e^- \rightarrow Cl_2(g) + 2H_2O(l)$	1.63
$HClO_2(aq) + 2H^+ + 2e^- \rightarrow HClO(aq) + H_2O(l)$	1.645
$H_2O_2(aq) + 2H^+ + 2e^- \rightarrow 2H_2O(l)$	1.776
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	2.00
$O_3(g) + 2H^+ + 2e^- \rightarrow O_2(g) + H_2O(l)$	2.07
$F_2(g) + 2e^- \rightarrow 2F^-$	2.87
$F_2(g) + 2H^+ + 2e^- \rightarrow 2HF(aq)$	3.06

B. Alkaline Solution	E^o(V)
$Mg(OH)_2(s) + 2e^- \rightarrow Mg(s) + 2OH^-$	–2.690
$Al(OH)_3(s) + 3e^- \rightarrow Al(s) + 3OH^-$	–2.30
$Zn(OH)_2(s) + 2e^- \rightarrow Zn(s) + 2OH^-$	–1.245
$Fe(OH)_2(s) + 2e^- \rightarrow Fe(s) + 2OH^-$	–0.877
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-$	–0.828
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(pH = 7)$	–0.43
$Cd(OH)_2(s) + 2e^- \rightarrow Cd(s) + 2OH^-$	–0.809
$Ni(OH)_2(s) + 2e^- \rightarrow Ni(s) + 2OH^-$	–0.72
$Fe(OH)_3(s) + e^- \rightarrow Fe(OH)_2(s) + OH^-$	–0.56
$2S(s) + 2e^- \rightarrow S_2^{2-}$	–0.447
$Cu_2O(s) + H_2O(l) + 2e^- \rightarrow 2Cu(s) + 2OH^-$	–0.358
$CrO_4^{2-} + 4H_2O(l) + 3e^- \rightarrow Cr(OH)_3(s) + 5OH^-$	–0.13
$MnO_2(s) + 2H_2O(l) + 2e^- \rightarrow Mn(OH)_2(s) + 2OH^-$	–0.05
$NO_3^- + H_2O(l) + 2e^- \rightarrow NO_2^- + 2OH^-$	0.01
$HgO(s) + H_2O(l) + 2e^- \rightarrow Hg(l) + 2OH^-$	0.098
$PbO_2(s) + H_2O(l) + 2e^- \rightarrow PbO(s) + 2OH^-$	0.247
$ClO_3^- + H_2O(l) + 2e^- \rightarrow ClO_2^- + 2OH^-$	0.33
$ClO_4^- + H_2O(l) + 2e^- \rightarrow ClO_3^- + 2OH^-$	0.36
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-$	0.401
$NiO_2(s) + 2H_2O(l) + 2e^- \rightarrow Ni(OH)_2(s) + 2OH^-$	0.490
$MnO_4^- + 2H_2O(l) + 3e^- \rightarrow MnO_2(s) + 4OH^-$	0.588
$BrO_3^- + 3H_2O(l) + 6e^- \rightarrow Br^- + 6OH^-$	0.61
$ClO^- + H_2O(l) + 2e^- \rightarrow Cl^- + 2OH^-$	0.89