Application Note H-1

Princeton Applied Research

Subject: A Table of Selected Half-Wave Potentials for Inorganic Substances

KEY:

All potentials are referenced to the Saturated Calomel Electrode.

***** - Potentials which have an asterisk are differential pulse peak potentials. All other potentials are half-wave potentials.

[ ] – Where a working electrode other than the Dropping Mercury Electrode is used, the electrode material is indicated by brackets.

( ) – Potential values in parentheses indicate that the electrode reaction is an oxidation.

Acetate (4.5) – Numbers in parentheses next to a supporting electrolyte are the pH values for that electrolyte.

Abbreviated electrolytes are explained following the table.

ION	SUPPORTING ELECTROLYTES			
Ag (I)	0.1M KNO_3: 0.10 [Pt]	NH_3–NH_4Cl: -0.24		
Al (III)	SVRS-Ac (4.5): -0.46*	0.1M TMAC: -0.75		
As (III)	1M HCl: -0.42*, -0.84*	1M H_2SO_4: -0.43, -0.81	1M NaOH: -0.3	H_2SO_4-NaCl: -0.20
As (V)	$HClO_4$-Pyrogallol: -0.11			
Au (I)	0.1M KOH: -0.1.16			
Au (III)	1M HCl: 0.37 [GCE]			
Ba (II)	0.1M LiCl: -1.92			
Bi (III)	1M HCl: -0.09	Tartrate(4.4): -0.14	NH_4Cit(3): -0.19	
Br^-	0.1M KNO_3: (0.12)	KNO_3-MeOH: (0.15) [Ag]		
BrO_3^-	H_2SO_4- KNO_3: -0.41	0.1M KCl: -1.78		
Cd (II)	NH_4Cit(3): -0.63*	Acetate(4.5): -0.65	1M HCl: -0.64	NH_4Tart(9): -0.59*
Ce (III)	2M K_2CO_3: (0.16)			
Ce (IV)	2M K_2CO_3: -0.16			
Cl^-	0.1M KNO_3: (0.25)	KNO_3-MeOH: (0.28) [Ag]		
ClO^-	0.5M K_2SO_4(7): 0.08			
ClO_2^-	1M NaOH: -1.0			
CN^-	Borate(9.75): (-0.27)*	0.1M NaOH: (-0.36)		
Co (II)	NH_3–NH_4Cl: -1.30	Py-PyHCl: -1.06	5M $CaCl_2$: -0.82	NH_4Cit(9): -1.39
Cr (III)	KSCN(3.2): -0.75*			
Cr (VI)	NH_3–NH_4Cl: -0.30*	1M NaOH: -0.84*	NH_4Tart(9): -0.24	
Cu (I)	NH_3–NH_4Cl: (-0.22), -0.50			
Cu (II)	NH_4Cit(3): -0.06*	Acetate(4.5): -0.07	1M HCl: -0.22	NH_4Tart(9): -0.36*
Eu (III)	0.1M NH_4Cl: -0.67			

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Fe (II)	Oxalate(4): (-0.23)*	$Na_4P_30_7$(9): (-0.37)*		
Fe (III)	Oxalate(4): -0.23*	NaOH-TEA: -1.01*	NH_4Tart(9): -1.45*	$Na_4P_30_7$(9): -0.99
Ga (III)	1M NaSCN(2): -0.83			
Ge (II)	6M HCl: -0.45			
Hg (II)	1M HCl: 0.44 [Au]			
H_2O_2	PO_4-Cit(7): (0.18), -1.0			
I^-	0.1M KNO_3: (-0.03)	KNO_3-MeOH: (0.0) [Ag]		
In (III)	Acetate(4.5): -0.71	1M HCl: -0.56		
IO_3^-	Phosphate(6.4): -0.79	1M KCl: -1.16		
IO_4^-	K_2SO_4- H_2SO_4: -0.12			
Ir (IV)	1M HCl: 0.65 [GCE]			
K (I)	0.1M TBAOH: -2.14			
Li (I)	0.1M TBAOH: -2.33			
Mn (II)	NH_3–NH_4Cl: -1.66	NH_4Tart(9): -1.55*		
Mo (VI)	0.3M HCl: -0.26, -0.63	H_3Cit: 0.04, -0.44		
Na (I)	0.1M TBAOH: -2.12			
Nb (V)	8M HCl: -0.46, -0.70			
Ni (II)	NH_3–NH_4Cl: -1.10	NH_4Tart(9): -0.98*	Py-PyHCl: -0.75	
NH_3OH	1M NaOH: (-0.43)			
N_3^-	0.1M KNO_3: (0.25)			
NO_2^-	DPA-SCN(1): -0.54*	2M Cit(2.5): -1.06*	U(VI)-Ac-KCl(2): -0.98*	
NO_3^-	U(VI)-Ac-KCl(2): -0.54*			
O_2	0.1M KNO_3: -0.05, -0.90			
Pb (II)	NH_4Cit(3): -0.48*	Acetate(4.5): -0.50	1M HCl: -0.44	NH_4Tart(9): -0.52*
Pd (II)	NH_3–NH_4Cl: -0.75			
Rb (I)	0.1M TBAOH: -2.03			
Rh (III)	NH_3–NH_4Cl: -0.93			
Ru (IV)	1M $HClO_4$: 0, 0.02, -0.34			
S^{2-}	0.1M NaOH: (-0.78)*			
Sb (III)	6M HCl: -0.23*	1M HCl: -0.15		
Sb (V)	6M HCl: -0.23*			
Se (IV)	1M HCl: -0.10, -0.40			
Sn (II)	1M HCl: (-0.1), -0.47	NH_4Cit(3): (-0.21), -0.54	NH_3Tart(9): -(0.53), -0.77	1M NaOH: (-0.73), -1.22
Sn (IV)	HCl-NH_4Cl: -0.25, -0.52	1M HCl: -0.1, -0.47		
SO_3^{2-}	Acetate(5): (-0.62)*			
$S_2O_3^{2-}$	Acetate(5): (-0.21)*			
Te (IV)	NH_4Tart(9): -0.71	NH_3–NH_4Cl: -0.67		
Ti (III)	H_2Tart: (-0.44)			
Ti (IV)	0.1M HCl: (-0.81)			
Tl (I)	Acetate(4.5): -0.47	1M HCl: -0.48	Ac-EDTA(4.5): -0.50	
U (VI)	0.1M HCl: -0.18, -0.94			
V (V)	H_2SO_4-KSCN: -0.52*			
W (VI)	10M HCl: 0, -0.60			
Zn (II)	NH_4Cit(3): -1.05*	Acetate(4.5): -1.1	NH_3–NH_4Cl: -1.35	NH_4Tart(9): -1.24*

Supporting Electrolytes are listed in approximate order of preference. These supporting electrolytes were selected from commonly available literature sources are not meant to be all-inclusive.

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SUPPORTING ELECTROLYTES

The list below includes only those supporting electrolytes which were abbreviated for the table.

1. Ac-EDTA(4.5): 0.1M Sodium Acetate - 0.1M Acetic Acid – 0.1M Disodium Ethylenediamine tetraacetic acid, Ph 4.5
2. Acetate(4.5): 0.1M Sodium Acetate – 0.1M Acetic Acid, pH 4.5
3. Acetate(5): 0.1M Sodium Acetate + Acetic Acid to pH 5
4. Borate(9.75): 0.1M Boric Acid + NaOH to pH 9.75
5. 2M Cit(2.5): 2M Citric Acid + NaOH to pH 2.5
6. DPA-SCN(1): 1.3×10^{-4} M Diphenylamine (DPA) – 0.01M NaSCN – 0.04M $HClO_4$
7. H_3Cit: Saturated Citric Acid
8. HCl-NH_4Cl: 1M HCl – 4M NH_4Cl
9. $HClO_4$-Pyrogallol: 2M $HClO_4$ – 0.5M Pyrogallol
10. H_2SO_4-KNO_3: 0.1M H_2SO_4 – 0.2M KNO_3
11. H_2SO_4-KSCN: 0.1M H_2SO_4 – 0.1M KSCN
12. H_2SO_4-NaCl: 2M H_2SO_4 – 2M NaCl
13. H_2Tart: Saturated Tartaric Acid
14. KNO_3-MeOH: 0.1M KNO_3 in 50% MeOH
15. KSCN(3.2): 0.2M NaSCN – 0.2M Acetic Acid, pH 3.2
16. K_2SO_4- H_2SO_4: 0.16M K_2SO_4 – 1M H_2SO_4
17. NaOH-TEA: 0.3 Triethanolamine 0.2M NaOH
18. $Na_4P_3O_7$(9): 0.2M Sodium Pyrophosphate + H_3PO_4 to pH 9
19. NH_3-NH_4Cl: 1M NH_3 – 0.1M NH_4Cl
20. NH_4Cit(3): 0.1M Citric Acid + NH_4OH to pH 3
21. NH_4Cit(9): 0.1M Citric Acid + NH_4OH to pH 9
22. NH_4Tart(9): 0.1M Tartaric Acid + NH_4OH to pH 9
23. Oxalate(4): 0.1M Oxalic Acid + NaOH to pH 4
24. Phosphate(6.4): 0.2M Sodium Dihydrogen Phosphate + NaOH to pH 6.4
25. PO_4-Cit(7): 0.1M Sodium Dihydrogen Phosphate – 0.1M Sodium Citrate adjusted to pH 7
26. Py-PyHCl: 0.1M Pyridine – 0.1M Pyridine-HCl
27. SVRS-Ac(4.5): 0.1M Acetate Buffer, pH 4.7 – 1.4×10^{-6} M Solochrome Violet RS – 12% Ethanol
28. Tartrate(4.4): 0.1M $Na_2Tartrate$, pH 4.4
29. 0.1M TBAOH: 0.1M Tetramethylammonium hydroxide
30. 0.1M TMAC: 0.1M Tetramethylammonium chloride
31. U(VI)-Ac-KCl(2): 20 ppm U(VI) – 0.2M KCl – 0.1M Acetic Acid

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