ภาคผนวก

ตารางที่ 1 แสดงสีของสารอนินทรีย์ที่เป็นของแข็ง

COLOUR	SOLID (Bold type indicates that the solid is water-soluble)
Buff	MnS (flesh coloured)
Brown	Ag_2O (greyish); CdO (light); SnS (chocolate); Bi_2S_3 (dark); PbO_2 (dark)
Yellow-brown	**$FeCl_3$ hydrated**
Red-brown	Fe_2O_3; $Fe(OH)_3$; Cu_2O (often red); $Cu_2Fe(CN)_6$
Red	HgO (also yellow form); HgI_2 (yellow above 126°C); Ag_2CrO_4 (brick red); Cu_2O (sometimes brownish); **$K_3Fe(CN)_6$**; **CrO_3**
Pink	$CoCO_3$; **hydrated Co^{2+} salts** (very deep colour); **hydrated Mn^{2+} salts** (very pale, often almost white)
Red-orange	Pb_3O_4 (vivid colour); PbO (drab colour)
Orange	Sb_2S_3; SnS_2 (usually yellow); Hg_2CrO_4 (brownish)
Yellow	HgO (muddy) (often red); Bi_2O_3; PbO (often red-orange); HgI_2 (red below 126°C); CdS; SnS_2 (sometimes orange); PbI_2 (vivid colour); $PbCrO_4$ (vivid colour); $BaCrO_4$ (pale); AgI (pale); AgBr (very pale – cream); **soluble chromates CrO_4^{2-}**; **$FeCl_3$ hydrated** (brownish); **$K_4Fe(CN)_6$**
Green	Hg_2I_2 (yellowish); $NiCO_3$ (pale); $CuCO_3$ (pale); $Cr_2(CO_3)_3$ (muddy); Cr_2O_3; **hydrated Fe^{2+} salts** (pale); **hydrated Ni^{2+} salts**; **$CuCl_2$ hydrated**; **hydrated Cr^{3+} salts (sometimes purple)**; **occasionally $Cu(NO_3)_2$ hydrated**
Blue	**hydrated Cu^{2+} salts**; **anhydrous Co^{2+} salts**
Purple	**Chromium(III) (deep) and iron(III) (pale) alums**
Black	CuO; NiO; CoO; MnO_2; Fe_3O_4; CuS; NiS; CoS; HgS; PbS; Ag_2S; FeS; **$KMnO_4$** (purple lustre)

ตารางที่ 2 แสดงสีของสารอนินทรีย์ที่เป็นสารละลาย

COLOUR	ION(S) POSSIBLY PRESENT
Brown	I_3^-, i.e. a soln. of I_2 in I^- (yellow if very dilute); Fe^{3+} (yellowish) (pales on addition of acid)
Orange	$Cr_2O_7^{2-}$ Br_2aq. (soln. bleaches litmus) (yellow if dilute)
Yellow	Fe^{3+} (brownish) (soln. acid to litmus) CrO_4^{2-} (soln. alkaline to litmus) I_3^-, Br_2aq. (see above) (smell of free halogen)
Green	Ni^{2+} (see also under blue) Cr^{3+} (see also under purple) Fe^{2+} (very pale) Cu^{2+} (as a conc. soln. of $CuCl_2$ or, occasionally, of $Cu(NO_3)_2$) MnO_4^{2-} (rare, unless Mn definitely suspected) CrO_2^- (soln. very alkaline to litmus)
Blue	Cu^{2+} Co^{2+} (deep) (conc. soln.) $Cu(NH_3)_4^{2+}$, $Ni(NH_3)_6^{2+}$ (often deep) (soln. alkaline to litmus, and smell of ammonia)
Purple	MnO_4^- Cr^{3+} (concentrated solution)
Pink	Co^{2+} MnO_4^- (very dil. soln.)

ตารางที่ 3 การละลายของเกลือชนิดต่าง ๆ ในน้ำเย็น

In the following table

● = sparingly soluble
O = borderline case
OH^- (or other symbol) indicates the nature of the precipitate obtained when the expected compound is unstable or hydrolysed – if a K^+, Na^+ or NH_4^+ salt is used as the source of the anion, e.g. mixing solutions of an Al^{3+} salt and sodium carbonate gives $Al(OH)_3$ and not aluminium carbonate, which is hydrolysed

i.e. $2Al^{3+} + 3CO_3^{2-} + 3H_2O \rightarrow 2Al(OH)_3 + 3CO_2$

		OH^-	CO_3^{2-}	S^{2-}	Cl^-	Br^-	I^-	NO_3^-	SO_4^{2-}	Other insolubles
Aluminium	Al^{3+}	●	OH^-	OH^-						
Ammonium	NH_4^+									
Antimony	Sb^{3+}	●	OH^-	●						Basic chloride
Barium	Ba^{2+}	O	●	OH^- if conc.					●	CrO_4^{2-}
Bismuth	Bi^{3+}	●	●	●			●			Basic chloride
Cadmium	Cd^{2+}	●	●	●						
Calcium	Ca^{2+}	O	●	OH^- if conc.					O	
Chromium	Cr^{3+}	●	●	OH^-						
Cobalt	Co^{2+}	●	●	●						
Copper	Cu^{2+}	●	●	●						
Iron(III)	Fe^{3+}	●	OH^-	FeS + S						
Iron(II)	Fe^{2+}	●	●	●						
Lead	Pb^{2+}	●	●	●	●	●	●		●	CrO_4^{2-}
Magnesium	Mg^{2+}	●	●	OH^-						
Manganese	Mn^{2+}	●	●	●						
Mercury (II)	Hg^{2+}	HgO	●	●			●			
Mercury (I)	Hg_2^{2+}	HgO + Hg	●	HgS + Hg	●	●	●		●	CrO_4^{2-}
Nickel	Ni^{2+}	●	●	●						
Potassium	K^+									$Co(NO_2)_6^{3-}$
Silver	Ag^+	Ag_2O	●	●	●	●	●		O	CrO_4^{2-}
Sodium	Na^+									
Tin(IV)	Sn^{4+}	●	OH^-	●						
Tin(II)	Sn^{2+}	●	OH^-	●						
Zinc	Zn^{2+}	●	●	●						

ตารางที่ 4 ปฏิกิริยาแคตไอออนกับสารละลายแอมโมเนีย

Add the reagent to the test solution, observe any changes, then add the reagent in excess. Warm and then boil (taking care if 'bumping' occurs). **Read note at end of table.**

OBSERVATION	INFERENCE	
	Ion(s) probably present	Probable reaction
1. PRECIPITATE FORMED; INSOLUBLE IN EXCESS REAGENT	**Insoluble hydroxide or basic salt pptd; no complex ions of type $M(NH_3)_x^{n+}$ formed**	
(a) White	Bi^{3+}	Basic salt pptd
	Pb^{2+}, Al^{3+} Mg^{2+}, Sb^{3+} Sn^{2+}, Sn^{4+}	Hydroxide or hydrated oxide pptd
	Hg^{2+}	Mercury(II) aminochloride, $Hg(NH_2)Cl$, pptd
(b) Brownish-white (*N.B. may be white initially but soon darkens*)	Mn^{2+}	$Mn(OH)_2$ pptd; aerial oxidation to brown Mn(III) compound
(c) Rust-brown	Fe^{3+}	$Fe(OH)_3$ pptd
(d) Grey-green	Cr^{3+}	$Cr(OH)_3$ pptd
(e) Mud-green (may be initially whitish) darkening to grey on heating; slowly turns brown at surface	Fe^{2+}	$Fe(OH)_2$ pptd; aerial oxidation to brown Fe(III) compound
(f) Black	Hg_2^{2+}	Mixture of $Hg(NH_2)Cl$ and finely divided (black) Hg pptd
(g) Dirty-blue, darkening with excess reagent (*N.B. ppt may dissolve in excess reagent if this is fairly concentrated, to give a yellow-brown solution*)	Co^{2+}	Basic salt pptd

ตารางที่ 4 ปฏิกิริยาแคตไอออนกับสารละลายแอมโมเนีย (ต่อ)

2. PRECIPITATE FORMED; SOLUBLE IN EXCESS REAGENT	**Insoluble oxide or hydroxide pptd, dissolving in excess reagent by complex ion formation**	
(a) White ppt → colourless solution	Cd^{2+}, Zn^{2+}	$M(OH)_2$ pptd, then giving $M(NH_3)_4^{2+}$
(b) **Blue** ppt → very deep blue solution	Cu^{2+}	Ditto
(c) **Green** ppt → deep blue solution. *(N.B. this ppt is often transient and difficult to observe unless Ni^{2+} solution is concentrated)*	Ni^{2+}	$Ni(OH)_2$ pptd, then giving $Ni(NH_3)_6^{2+}$
(d) **Brown** ppt → colourless solution *(N.B. This ppt is often transient)*	Ag^+	Ag_2O pptd (hydroxide unstable) then giving $Ag(NH_3)_2^+$
(e) **Dirty blue** ppt (see 1(g) above)	Co^{2+}	
3. SOLUTION CHANGES COLOUR ORANGE → YELLOW	$Cr_2O_7^{2-}$	Dichromate converted to chromate $Cr_2O_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$
4. NO APPARENT CHANGE (though possibly a slight turbidity of $CaCO_3$ or $BaCO_3$ due to presence of CO_3^{2-} ions in ammonia solution)	(a) Na^+, K^+ Ca^{2+}, Ba^{2+} NH_4^+	Hydroxide soluble
	(b) No metals present	Possibly a solution of an acid or H_2O_2

NOTE: Hydroxides of the following have relatively high solubility products and are not precipitated by ammonia solution in the presence of ammonium salts (i.e. NH_4^+ ions):

Zn^{2+}, Mg^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}

ตารางที่ 5 แสดงสมบัติของตะกอนไฮดรอกไซด์

Hydroxide	Pptd by NaOH(aq.)	Sol. in excess NaOH(aq.)	Pptd by NH_3(aq)	Sol. in excess NH_3(aq)	Pptd by NH_3(aq) in presence of NH_4^+	Colour of Sulphide	Sulphide pptd by H_2S from
$Mg(OH)_2$	●		slight				not pptd
$Bi(OH)_3$	●		●		●	Brown	acid soln.
$Cd(OH)_2$	●		●	●	●	Yellow	all solns.
$Zn(OH)_2$	●	●	●	●		White	alkaline soln.
$Al(OH)_3$	●	●	●		●		not pptd
$Sn(OH)_2$	●	●	●		●	Brown	acid soln.
$Sn(OH)_4$	●	●	●		●	Yellow	
$Sb(OH)_3$	●	●	●		●	Orange	
$Pb(OH)_2$	●	●	●		●*	Black	all solns.

*N.B. If NH_4Cl is used this will partially precipitate Pb^{2+} as $PbCl_2$ – addition of NH_3(aq) then causes precipitation of $Pb(OH)_2$ from the supernatant solution.

ตารางที่ 6 ปฏิกิริยาแคตไอออนกับไฮโดรเจนซัลไฟด์

ก. ในสารละลายที่เป็นกลาง

OBSERVATION	INFERENCE	
	Ion(s) probably present	Probable reaction
1. NO PRECIPITATE	**Metal sulphide is soluble in water, is completely hydrolysed or is sparingly soluble and has a relatively high solubility product; or no metal ions present**	
(N.B. Solutions of Co^{2+}, Ni^{2+}, Fe^{2+} may darken slightly after passing H_2S, particularly if heated – possibly a sulphide sol is formed. An Fe^{2+} sample which has undergone sufficient aerial oxidation to Fe^{3+} may yield a faint white mistiness of S)	NH_4^+, K^+, Na^+, Ba^{2+}, Ca^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+}, H_2O_2	
2. PRECIPITATE FORMED	**Metal sulphide is sparingly soluble in water and has a relatively low solubility product; OR An oxidising agent is present oxidising H_2S to S**	
(i) *A colourless solution giving*		
(a) **black** ppt	Pb^{2+}, Hg_2^{2+} Ag^+	PbS, Hg + HgS, Ag_2S pptd
(b) **dark brown** ppt	Bi^{3+}, Sn^{2+}	Bi_2S_3, SnS pptd
(c) **yellow** ppt	Cd^{2+}, Sn^{4+}	CdS, SnS_2 pptd
(d) **orange** ppt	Sb^{3+}	Sb_2S_3 pptd
(e) **yellow-brown** ppt turning rapidly **black**	Hg^{2+}	Double salts (e.g. $HgCl_2$, HgS) first pptd, then converted to HgS
(f) **white** (fine) ppt	Zn^{2+}	ZnS pptd
(ii) *A yellow or orange solution giving*		
(a) **white to yellow** (fine) ppt	Fe^{3+}	H_2S oxidised to S and Fe^{3+} reduced to Fe^{2+}
(b) **muddy green** suspension from yellow solution	CrO_4^{2-}	H_2S oxidised to S, and green Cr^{3+} ions formed by reduction
(c) **muddy green** suspension from orange solution	$Cr_2O_7^{2-}$	
(iv) *A blue or green solution giving* **black** ppt	Cu^{2+}	CuS pptd
(v) *A purple solution giving*		
dirty white (fine) ppt and purple colour dispersed	MnO_4^-	H_2S oxidised to S, and MnO_4^- ions reduced to Mn^{2+}

ข. ในสารละลายที่เป็นกรด

Observations are essentially as for 'neutral' solutions. The following are important exceptions:
1. Zn^{2+} is not pptd from acid solutions.
2. Cd^{2+} will not be pptd as CdS from strongly acid solutions because the solubility product of the latter is not exceeded. If cadmium is suspected to be present in an acid solution and a test is to be made with H_2S, a portion of the solution should be diluted about 5 times before passing the gas

ค. ในสารละลายที่เป็นเบส

OBSERVATION	INFERENCE	
	Ion(s) probably present	Probable reaction
1. NO PRECIPITATE	Metal sulphide is soluble in water or is completely hydrolysed	
	NH_4^+, K^+, Na^+, Ba^{2+}, Ca^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}	
2. PRECIPITATE FORMED	Metal sulphide is sparingly soluble in water	
(i) *A colourless solution giving*		
(a) black ppt	Pb^{2+}, Ag^+	PbS, Ag_2S pptd; if PbS then Pb present as plumbate(II) (PbO_2^{2-}); if Ag_2S then Ag present as $Ag(NH_3)_2^+$
(b) dark brown ppt	Sn^{2+}	SnS pptd; Sn present as stannate(II) (SnO_2^{2-})
(c) yellow ppt	Cd^{2+}	CdS pptd; Cd present as $Cd(NH_3)_4^{2+}$
(d) white ppt	Zn^{2+}	ZnS pptd; Zn present as ZnO_2^{2-} or $Zn(NH_3)_4^{2+}$
(e) buff (or flesh coloured) ppt	Mn^{2+}	MnS pptd
(ii) *A blue solution giving*		
black ppt	Ni^{2+}, Cu^{2+}	NiS, CuS pptd; if NiS then Ni present as $Ni(NH_3)_6^{2+}$; if CuS then Cu present as $Cu(NH_3)_4^{2+}$
(iii) *A pink to gold solution giving* (N.B. the colour here depends on the concentration of ammonia)		
black ppt	Co^{2+}	CoS pptd; Co present eithe as Co^{2+} (pink) or $Co(NH_3)_4^{2+}$ (gold) depending on the ammonia concentration

ตารางที่ 7 Flame Test ของแคตไอออน

Flame tests are normally best performed on halides because these are the most volatile of salts.

If testing a solid, moisten a clean platinum or nichrome wire with concentrated hydrochloric acid and bring into contact with the solid so that some of the latter adheres to the wire. Hold the wire in the edge of a non-luminous bunsen flame.

If testing a solution, treat a little of this with one drop of concentrated hydrochloric acid, moisten the wire with the mixture, and hold in the bunsen flame.

N.B. (i) If potassium is suspected the flame should be observed through cobalt-blue glass (this filters off wavelengths which interfere with observation – particularly the yellow of sodium).

(ii) If a non-expendable wire is used it must be thoroughly cleaned by alternately placing it in concentrated hydrochloric acid **(not the reagent bottle)** and the bunsen flame.

COLOUR OF FLAME	ION PROBABLY PRESENT
Red	Li^+
Crimson	Sr^{2+}
Brick-red	Ca^{2+}
Yellow	Na^+ often interferes with others
Green (apple)	Ba^{2+}
(bluish)	Cu^{2+}
Lilac (purple through blue glass)	K^+

ตารางที่ 8 สมบัติการละลายของไอออนและของแข็ง

(Summary of Solubility Properties of Ions and Solids)

	Cl^-	SO_4^{2-}	CO_3^{2-}, PO_4^{3-}	CrO_4^{2-} yellow	OH^- O^{2-}	H_2S, pH = 0.5	S^{2-}, pH = 9
Na^+, K^+, NH_4^+	S	S	S	S	S	S	S
Ba^{2+}	S	I	A	A	S^-	S	S
Ca^{2+}	S	S^-	A	S	S^-	S	S
Mg^{2+}	S	S	A	S	A	S	S
Fe^{3+} (yellow)	S	S	A	A	A	S	A
Cr^{3+} (blue-violet)	S	S	A	A	A	S	A
Al^{3+}	S	S	A, B	A, B	A, B	S	A, B
Ni^{2+} (green)	S	S	A, N	A, N	A, N	S	A^+, O^+
Co^{2+} (pink)	S	S	A	A	A	S	A^+, O^+
Zn^{2+}	S	S	A, B, N	A, B, N	A, B, N	S	A
Mn^{2+} (lt. pink)	S	S	A	A	A	S	A
Cu^{2+} (blue)	S	S	A, N	A, N	A, N	O	O
Cd^{2+}	S	S	A, N	A, N	A, N	A^+, O	A^+, O
Bi^{3+}	A	A	A	A	A	O	O
Hg^{2+}	S	S	A	A	A	O^+, C	O^+, C
Sn^{2+}, Sn^{4+}	A, B	A, B	A, B	A, B	A, B	A^+, C	A^+, C
Sb^{3+}	A, B	A, B	A, B	A, B	A, B	A^+, C	A^+, C
Ag^+	A^+, N	S^-, N	A, N	A, N	A, N	O	O
Pb^{2+}	HW, B, A^+	B	A, B	B	A, B	O	O
Hg_2^{2+}	O^+	S^-, A	A	A	A	O^+	O^+

Key: S, soluble in water.
A, soluble in acid (6 M HCl or other nonprecipitating, nonoxidizing acid).
B, soluble in 6 M NaOH.
O, soluble in hot 6 M HNO_3.
N, soluble in 6 M NH_3.
I, insoluble in any common reagent.
S^-, slightly soluble in water.
A^+, soluble in 12 M HCl.
O^+, soluble in aqua regia.
C, soluble in 6 M NaOH containing excess S^{2-}.
HW, soluble in hot water.

Example: For Cu^{2+} and OH^- the entry is A, N. This means that $Cu(OH)_2(s)$, the product obtained when solutions containing Cu^{2+} and OH^- are mixed, will dissolve to the extent of at least 0.1 mole per liter when treated with 6 M HCl or 6 M NH_3. Since 6 M HNO_3, 12 M HCl, and aqua regia are at least as strongly acidic as 6 M HCl, $Cu(OH)_2(s)$ would also be soluble in those reagents.

ตารางที่ 9 ค่าคงที่ของผลคูณการละลายที่ 18-25 °ซ.

(Solubility Product Constants)

ACETATES	K_{sp}
$AgC_2H_3O_2$	4×10^{-3}
HALIDES AND CYANIDES	
AgCN	10^{-16}
AgCl	1.8×10^{-10}
AgBr	5×10^{-13}
AgI	8.5×10^{-17}
CuCl	3.2×10^{-7}
Hg_2Cl_2	1.1×10^{-18}
$PbCl_2$	1.6×10^{-5}
PbI_2	8.3×10^{-9}
MgF_2	8×10^{-8}
CaF_2	1.7×10^{-10}
CARBONATES	
Ag_2CO_3	8×10^{-12}
$BaCO_3$	1.6×10^{-9}
$CaCO_3$	4.8×10^{-9}
$CuCO_3$	2.5×10^{-10}
$FeCO_3$	2×10^{-11}
$MgCO_3$	4×10^{-5}
$MnCO_3$	9×10^{-11}
$PbCO_3$	1.5×10^{-13}
$SrCO_3$	7×10^{-10}

CHROMATES	K_{sp}
Ag_2CrO_4	2×10^{-12}
$BaCrO_4$	1.2×10^{-10}
$PbCrO_4$	2×10^{-16}
$SrCrO_4$	3.6×10^{-5}
HYDROXIDES	
$Al(OH)_3$	10^{-33}
$Ca(OH)_2$	1.3×10^{-6}
$Cr(OH)_3$	10^{-30}
$Cu(OH)_2$	2×10^{-19}
$Fe(OH)_2$	2×10^{-15}
$Fe(OH)_3$	10^{-37}
$Mg(OH)_2$	9×10^{-12}
$Mn(OH)_2$	2×10^{-13}
$Pb(OH)_2$	4×10^{-15}
$Sn(OH)_2$	10^{-27}
$Zn(OH)_2$	5×10^{-17}
OXALATES	
BaC_2O_4	1.5×10^{-8}
CaC_2O_4	1.3×10^{-9}
MgC_2O_4	8.6×10^{-5}
SrC_2O_4	5.6×10^{-8}

SULFATES	K_{sp}
Ag_2SO_4	1.7×10^{-5}
$BaSO_4$	1.5×10^{-9}
$CaSO_4$	2.4×10^{-5}
Hg_2SO_4	6×10^{-7}
$PbSO_4$	1.3×10^{-8}
$SrSO_4$	7.6×10^{-7}
SULFIDES	
Ag_2S	10^{-50}
CdS	10^{-26}
CoS	10^{-21}
CuS	10^{-36}
FeS	10^{-17}
HgS	10^{-50}
MnS	10^{-13}
NiS	10^{-22}
PbS	10^{-26}
SnS	10^{-27}
ZnS	10^{-20}

ตารางที่ 10 ค่าความต่างศักย์มาตรฐานของขั้วไฟฟ้าที่ 25 °ซ.

(Standard Electrode Potential at 25 °C)

Half-Reaction	$\mathcal{E}^\circ$ *(volts)*
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	+0.15
$S + 2H^+ + 2e^- \rightarrow H_2S(aq)$	+0.14
$S_4O_6^{2-} + 2e^- \rightarrow 2S_2O_3^{2-}$	+0.09
$AgBr(s) + e^- \rightarrow Ag(s) + Br^-$	+0.0713
$NO_3^- + H_2O + 2e^- \rightarrow NO_2^- + 2\,OH^-$	+0.01
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.0000
$Fe^{3+} + 3e^- \rightarrow Fe(s)$	−0.036
$CrO_4^{2-} + 4H_2O + 3e^- \rightarrow Cr(OH)_3(s) + 5\,OH^-$	−0.12
$Pb^{2+} + 2e^- \rightarrow Pb(s)$	−0.126
$Sn^{2+} + 2e^- \rightarrow Sn(s)$	−0.136
$O_2(g) + 2H_2O + 2e^- \rightarrow H_2O_2 + 2\,OH^-$	−0.146
$AgI(s) + e^- \rightarrow Ag(s) + I^-$	−0.152
$Cu(OH)_2(s) + 2e^- \rightarrow Cu(s) + 2\,OH^-$	−0.224
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	−0.25
$Co^{2+} + 2e^- \rightarrow Co(s)$	−0.28
$PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}$	−0.356
$Cd^{2+} + 2e^- \rightarrow Cd(s)$	−0.403
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	−0.41
$Fe^{2+} + 2e^- \rightarrow Fe(s)$	−0.44
$2CO_2(g) + 2H^+ + 2e^- \rightarrow H_2C_2O_4$	−0.49
$S(s) + 2e^- \rightarrow S^{2-}$	−0.508
$Cr^{2+} + 2e^- \rightarrow Cr(s)$	−0.557
$Ag_2S(s) + 2e^- \rightarrow 2Ag(s) + S^{2-}$	−0.705
$Ni(OH)_2(s) + 2e^- \rightarrow Ni(s) + 2\,OH^-$	−0.72
$Cr^{3+} + 3e^- \rightarrow Cr(s)$	−0.74
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	−0.763
$2H_2O + 2e^- \rightarrow H_2(g) + 2\,OH^-$	−0.8277
$SO_4^{2-} + H_2O + 2e^- \rightarrow SO_3^{2-} + 2\,OH^-$	−0.93
$Mn^{2+} + 2e^- \rightarrow Mn(s)$	−1.18
$Cr(OH)_3(s) + 3e^- \rightarrow Cr(s) + 3\,OH^-$	−1.3
$Ti^{2+} + 2e^- \rightarrow Ti(s)$	−1.63
$Al^{3+} + 3e^- \rightarrow Al(s)$	−1.66
$Be^{2+} + 2e^- \rightarrow Be(s)$	−1.85
$Ti^{3+} + e^- \rightarrow Ti^{2+}$	−2.0
$Sc^{3+} + 3e^- \rightarrow Sc(s)$	−2.08
$Mg^{2+} + 2e^- \rightarrow Mg(s)$	−2.363
$Na^+ + e^- \rightarrow Na(s)$	−2.714
$Ca^{2+} + 2e^- \rightarrow Ca(s)$	−2.866
$Sr^{2+} + 2e^- \rightarrow Sr(s)$	−2.89
$Ba^{2+} + 2e^- \rightarrow Ba(s)$	−2.90
$Cs^+ + e^- \rightarrow Cs(s)$	−2.92
$K^+ + e^- \rightarrow K(s)$	−2.924
$Li^+ + e^- \rightarrow Li(s)$	−3.045

ตารางที่ 10 ค่าความต่างศักย์มาตราฐานของขั้วไฟฟ้าที่ 25 °ซ.

(Standard Electrode Potential at 25 °C) (ต่อ)

Half-Reaction	$\mathcal{E}^{\circ}$ *(volts)*
$F_2(g) + 2e^- \rightarrow F^-$	+2.87
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$	+1.776
$PbO_2(s) + SO_4^{2-} + 4H^+ + 2e^- \rightarrow PbSO_4(s) + H_2O$	+1.685
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2(s) + 2H_2O$	+1.679
$HOCl + H^+ + e^- \rightarrow \frac{1}{2} Cl_2(g) + H_2O$	+1.63
$BrO_3^- + 6H^+ + 5e^- \rightarrow \frac{1}{2} Br_2 + 3H_2O$	+1.52
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51
$ClO_3^- + 6H^+ + 5e^- \rightarrow \frac{1}{2} Cl_2(g) + 3H_2O$	+1.47
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	+1.443
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.42
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.33
$O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O$	+1.229
$MnO_2(s) + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$	+1.23
$2 IO_3^- + 12H^+ + 10e^- \rightarrow I_2 + 6H_2O$	+1.195
$ClO_4^- + 2H^+ + 2e^- \rightarrow ClO_3^- + H_2O$	+1.19
$Br_2(aq) + 2e^- \rightarrow 2Br^-$	+1.087
$Br_2(\ell) + 2e^- \rightarrow 2Br^-$	+1.0652
$NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O$	+0.96
$NO_3^- + 3H^+ + 2e^- \rightarrow HONO + H_2O$	+0.94
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	+0.920
$Hg^{2+} + 2e^- \rightarrow Hg(\ell)$	+0.855
$Ag^+ + e^- \rightarrow Ag(s)$	+0.799
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(\ell)$	+0.789
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.771
$O_2(g) + 2H^+ + 2e^- \rightarrow H_2O_2$	+0.682
$Ag_2SO_4(s) + 2e^- \rightarrow 2Ag(s) + SO_4^{2-}$	+0.653
$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2(s) + 4 OH^-$	+0.588
$MnO_4^- + e^- \rightarrow MnO_4^{2-}$	+0.564
$I_2(s) + 2e^- \rightarrow 2 I^-$	+0.535
$Cu^+ + e^- \rightarrow Cu(s)$	+0.521
$Ag_2CrO_4(s) + 2e^- \rightarrow 2Ag(s) + CrO_4^{2-}$	+0.446
$O_2(g) + 2H_2O + 4e^- \rightarrow 4 OH^-$	+0.401
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	+0.337
$Hg_2Cl_2(s) + 2e^- \rightarrow 2Hg(\ell) + 2Cl^-$	+0.268
$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-$	+0.2223
$Co(OH)_3(s) + e^- \rightarrow Co(OH)_2(s) + OH^-$	+0.17
$Cu^{2+} + e^- \rightarrow Cu^+$	+0.153

ตารางที่ 11 น้ำหนักอะตอมของธาตุเทียบกับ ^{12}C = 12.0000 amu

(Atomic Weights of Elements (^{12}C = 12.0000 amu))

Element	Symbol	Atomic number	Atomic weight	Element	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	(227)	Mendelevium	Md	101	(256)
Aluminum	Al	13	26.98154	Mercury	Hg	80	200.59
Americium	Am	95	(243)	Molybdenum	Mo	42	95.94
Antimony	Sb	51	121.75	Neodymium	Nd	60	144.24
Argon	Ar	18	39.948	Neon	Ne	10	20.179
Arsenic	As	33	74.9216	Neptunum	Np	93	237.0482
Astatine	At	85	(210)	Nickel	Ni	28	58.70
Barium	Ba	56	137.33	Niobium	Nb	41	92.9064
Berkelium	Bk	97	(249)	Nitrogen	N	7	14.0067
Beryllium	Be	4	9.01218	Nobelium	No	102	(254)
Bismuth	Bi	83	208.9804	Osmium	Os	76	190.2
Boron	B	5	10.81	Oxygen	O	8	15.9994
Bromine	Br	35	79.904	Palladium	Pd	46	106.4
Cadmium	Cd	48	112.41	Phosphorus	P	15	30.97376
Calcium	Ca	20	40.08	Platinum	Pt	78	195.09
Californium	Cf	98	(251)	Plutonium	Pu	94	(242)
Carbon	C	6	12.011	Polonium	Po	84	(210)
Cerium	Ce	58	140.12	Potassium	K	19	39.0983
Cesium	Cs	55	132.9054	Praseodymium	Pr	59	140.9077
Chlorine	Cl	17	35.453	Promethium	Pm	61	(145)
Chromium	Cr	24	51.996	Protactinium	Pa	91	231.0359
Cobalt	Co	27	58.9332	Radium	Ra	88	226.0254
Copper	Cu	29	63.546	Radon	Rn	86	(222)
Curium	Cm	96	(247)	Rhenium	Re	75	186.207
Dysprosium	Dy	66	162.50	Rhodium	Rh	45	102.9055
Einsteinium	Es	99	(254)	Rubidium	Rb	37	85.4678
Erbium	Er	68	167.26	Ruthenium	Ru	44	101.07
Europium	Eu	63	151.96	Samarium	Sm	62	150.4
Fermium	Fm	100	(253)	Scandium	Sc	21	44.9559
Fluorine	F	9	18.998403	Selenium	Se	34	78.96
Francium	Fr	87	(223)	Silicon	Si	14	28.0855
Gadolinium	Gd	64	157.25	Silver	Ag	47	107.868
Gallium	Ga	31	69.72	Sodium	Na	11	22.98977
Germanium	Ge	32	72.59	Strontium	Sr	38	87.62
Gold	Au	79	196.9665	Sulfur	S	16	32.06
Hafnium	Hf	72	178.49	Tantalum	Ta	73	180.9479
Hahnium	Ha	105	(260)	Technetium	Tc	43	98.9062
Helium	He	2	4.00260	Tellurium	Te	52	127.60
Holmium	Ho	67	164.9304	Terbium	Tb	65	158.9254
Hydrogen	H	1	1.0079	Thallium	Tl	81	204.37
Indium	In	49	114.82	Thorium	Th	90	232.0381
Iodine	I	53	126.9045	Thulium	Tm	69	168.9342
Iridium	Ir	77	192.22	Tin	Sn	50	118.69
Iron	Fe	26	55.847	Titanium	Ti	22	47.90
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Kurchatovium	Ku	104	(257)	Uranium	U	92	238.029
Lanthanium	La	57	138.9055	Vanadium	V	23	50.9415
Lawrencium	Lr	103	(257)	Xenon	Xe	54	131.30
Lead	Pb	82	207.2	Ytterbium	Yb	70	173.04
Lithium	Li	3	6.941	Yttrium	Y	39	88.9059
Lutetium	Lu	71	174.967	Zinc	Zn	30	65.38
Magnesium	Mg	12	24.305	Zirconium	Zr	40	91.22
Manganese	Mn	25	54.9380				

*Values in parentheses are mass numbers of longest-lived or best-known isotopes.

พิมพ์ที่... สำนักพิมพ์มหาวิทยาลัยรามคำแหง
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