Reactivity of Inorganic Substances

Handbook

Revised and Augmented Edition

R.A. Lidin

V.A. Molochko

L.L. Andreeva

Edited by

R.A. Lidin

All of the

M.V. Lomonosov Academy
of Fine Chemical Technology
Moscow, Russia

begell house, inc.
New York, Wallingford (UK)

Library of Congress Cataloging-in-Publication Data

Lidin, R. A. (Rostislav Aleksandrovich)
Reactivity of inorganic substances : handbook / R.A. Lidin, V.A. Molochko, L.L. Andreeva. -- Rev. and augm. ed / edited by Rostislav A. Lidin.
p. cm.
Includes index.
ISBN 1-56700-050-9 (hardcover)
1. Inorganic compounds--Handbooks, manuals, etc. 2. Reactivity (Chemistry)--Handbooks, manuals, etc. I. Andreyeva, Larisa L. II. Molochko, Vadim A. III. Title
QD155.5.L528 1996
546--dc20 96-6024
CIP

Authorized translation from Russian language edition
Р.А.Лидин, В.А.Молочко, Л.Л.Андреева
Химические свойства неорганических веществ
Химия, Москва, 1995

To my first and best teacher,
prominent Russian professor and scientist,
Ph. D. in inorganic chemistry,
Konstantin V. Astakhov

R. L.

Periodic Table of the Elements

Period	I A B	II A B	III A B	IV A B	V A B
1	**H** 1 1.008 Hydrogen				
2	**Li** 3 6.941 Lithium	**Be** 4 9.012 Beryllium	**B** 5 10.811 Boron	**C** 6 12.011 Carbon	**N** 7 14.007 Nitrogen
3	**Na** 11 22.990 Sodium	**Mg** 12 24.305 Magnesium	**Al** 13 26.982 Aluminum	**Si** 14 28.086 Silicon	**P** 15 30.974 Phosphorus
4	**K** 19 39.098 Potassium	**Ca** 20 40.078 Calcium	21 **Sc** 44.956 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.942 Vanadium
4	29 **Cu** 63.546 Copper	30 **Zn** 65.39 Zinc	**Ga** 31 69.723 Gallium	**Ge** 32 72.61 Germanium	**As** 33 74.922 Arsenic
5	**Rb** 37 85.468 Rubidium	**Sr** 38 87.62 Strontium	39 **Y** 88.906 Yttrium	40 **Zr** 91.224 Zirconium	41 **Nb** 92.906 Niobium
5	47 **Ag** 107.868 Silver	48 **Cd** 112.411 Cadmium	**In** 49 114.82 Indium	**Sn** 50 118.710 Tin	**Sb** 51 121.75 Antimony
6	**Cs** 55 132.905 Cesium	**Ba** 56 137.327 Barium	^{57}**La** – ^{71}**Lu** *	72 **Hf** 178.49 Hafnium	73 **Ta** 180.948 Tantalum
6	79 **Au** 196.967 Gold	80 **Hg** 200.59 Mercury	**Tl** 81 204.383 Thallium	**Pb** 82 207.2 Lead	**Bi** 83 208.980 Bismuth
7	**Fr** 87 223.020 Francium	**Ra** 88 226.025 Radium	^{89}**Ac** – ^{103}**Lr** **	104 **Ku** [261] Kurchatovium	105 **Ns** [262] Nielsbohrium

* Lanthanoids

57 **La** 138.906 Lanthanum	58 **Ce** 140.115 Cerium	59 **Pr** 140.908 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.913 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.965 Europium	64 **Gd** 157.25 Gadolinium

** Actinoids

89 **Ac** 227.028 Actinium	90 **Th** 232.038 Thorium	91 **Pa** 231.036 Protactinium	92 **U** 238.029 Uranium	93 **Np** 237.048 Neptunium	94 **Pu** 244.064 Plutonium	95 **Am** 243.061 Americium	96 **Cm** 247.070 Curium

According to IUPAC Commission (1995 year):

element 104	Dubnium	Db	element 107	Bohrium	Bo
element 105	Joliotium	Jl	element 108	Hahnium	Hn
element 106	Rutherfordium	Rf	element 109	Meitnerium	Mt

A VI B	A VII B	A VIII		B
	(H)	**He** 2 4.003 Helium	Symbol — Atomic number **Na** 11 22.990 Sodium Name — Relative atomic mass	
O 8 15.999 Oxygen	**F** 9 18.998 Fluorine	**Ne** 10 20.180 Neon		
S 16 32.066 Sulfur	**Cl** 17 35.453 Chlorine	**Ar** 18 39.948 Argon		
24 **Cr** 51.996 Chromium	25 **Mn** 54.938 Manganese	26 **Fe** 55.847 Iron	27 **Co** 58.933 Cobalt	28 **Ni** 58.69 Nickel
Se 34 78.96 Selenium	**Br** 35 79.904 Bromine	**Kr** 36 83.80 Krypton		
42 **Mo** 95.94 Molybdenum	43 **Tc** 97.907 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.906 Rhodium	46 **Pd** 106.42 Palladium
Te 52 127.60 Tellurium	**I** 53 126.904 Iodine	**Xe** 54 131.29 Xenon		
74 **W** 183.85 Tungsten	75 **Re** 186.207 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum
Po 84 208.982 Polonium	**At** 85 209.987 Astatine	**Rn** 86 222.018 Radon		
106 — [263] —	107 — [262] —	108 — [265] —	109 — [266] —	110 — [269] —

65 **Tb** 158.925 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.930 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.934 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.967 Lutetium

97 **Bk** 247.070 Berkelium	98 **Cf** 251.080 Californium	99 **Es** 252.083 Einsteinium	100 **Fm** 257.095 Fermium	101 **Md** 258.099 Mendelevium	102 **No** 259.101 Nobelium	103 **Lr** 260.105 Lawrencium

Relative atomic masses are based on ^{12}C = 12 and conform to the 1987 IUPAC report values rounded to the third decimal figure. Number in [ ] indicate the most stable isotope.

CONTENTS

PREFACE

Inorganic chemistry comprises several hundreds of thousands of compounds. This Handbook includes the data about more than 7000 substances, chosen because of their scientific and technological importance.

Today, the number of chemical elements amounts to 111. The Handbook includes the elements of the Periodic System with the numbers from 1 to 105, their conventional chemical symbols, reactivity, and properties studied to a higher or lower degree.

The most universal, stable, and simple characteristic of a chemical substance is its *composition* reflected by the corresponding chemical *formula*. All the substances in the Handbook are entered in alphabetical order of chemical formulas from Ac to $Zr(WO_4)_2$.

The list of substances is divided into several *chapters* describing the chemical properties of a single element, *viz.*, the reactions undergone by a simple substance and various compounds of this element. The chapters consist of *entries* describing individual substances whose formulas begin with the symbol of the title element. Each Chapter is preceded by a list of the formulas of substances that include the title element but are considered in other chapters.

Each entry provides the chemical *name* of the substance adequate to its formula and uniquely reflecting its composition followed by a concise *verbal characteristic* of the substance including its color, aggregate state, thermal stability, specific features of its structure, existence of crystal hydrates, its solubility in water and organic solvents, the degree of its reactivity, propensity to hydrolysis, relation to most widely used reagents (acids, alkalies, ammonia hydrate, hydrogen, oxygen, etc.), specific properties, and its qualitative detection.

Then the methods of the substance *synthesis* on an industrial scale and under the laboratory conditions are given (as references to the corresponding chemical reactions considered in other entries) together with the most important substance *constants* necessary for correct interpretation of the chemical properties and everyday practical use of the reactions (molar mass, density, melting, boiling, and decomposition points, coefficient or product of solubility, etc.). Some additional constants are indicated directly in the reaction equations.

Finally, the numbered *reaction equations* are given in which the substance under question plays the part of a reactant (for the detailed description of the reaction types, *see* the Introduction). The entry is completed with the list of references to equations of other entries, in which the formula of the substance under question also participates as a reactant. Altogether, there are more than 1200 such entries containing rather complete substance characteristics.

In addition, there are *concise data* on the substances not considered in their own entries. These data include the names, most important constants, relation to water, and the methods of substance preparation (in the form of references). The total number of substances with such concise characteristics is ca. 1000. Moreover, there are *cross references* on the substances (more than 3600) not considered in the entries and concise data. The references provide the necessary information about some chemical properties of the substances, as a rule, the data on their reactions with water, acids, and alkalies.

The chemical formulas and the names of substances are given in accordance with the nomenclature recommended by the International Union of Pure and Applied Chemistry (IUPAC), *see*, e.g. R. A. Lidin, L. L. Andreeva, V. A. Molochko. Constants of Inorganic Substances, Handbook. Begell House Inc., New York, 1995.

The formulas of the compounds with complex anions are written in the inverted order (anion, cation) to make them closer to the chemistry of the title element. Thus the entry describing the potassium dicyanoargentate(I) is in the chapter devoted to silver compounds in accordance with its inverted formula $[Ag(CN)_2],K$. Various formulas not recommended for use but still encountered in the literature are also given in references. Thus for the old-fashioned Fe_3O_4 formula we refer the reader to the nomenclature formula $(Fe^{II}Fe_2^{III})O_4$.

When preparing this Handbook, my co-authors, D. Sc., V. A. Molochko and L. L. Andreeva, and I myself used our many years of experience in research work and university-level teaching. I express my cordial gratitude to our colleagues who helped us with their valuable advises and consultations; an important contribution was made by the students of our Academy who participated in discussions of individual reactions and their practical verification. The people who contributed to this work are too many to be mentioned here, but the merits of this book, if any, are due to their valuable help.

Of course, we realize that this Handbook is not free of shortcomings as well, and I am the only person responsible for them. Therefore I should be grateful for all the remarks, notes, and suggestions that would improve this book.

Rostislav A. Lidin,
Editor

INTRODUCTION

Reactivity and chemical properties of substances manifest themselves in chemical reactions. The number of chemical reactions occurring with the participation of each substance in enormous. Nevertheless, there are always some theoretical or practical criteria that provide the selection of most important reactions and structurization of the whole set of chemical information.

In the general case, the chemical properties of a substance can be divided into several groups of chemical reactions, namely:

(1) Thermal decomposition;
(2) Formation of crystal hydrates, their dehydration, and decomposition;
(3) Reactions with water, *viz.*, electrolytic dissociation, reversible or irreversible protolysis and hydrolysis, and other reactions with cold and hot water and steam;
(4) Reactions with most widely used acids, *viz.*, hydrochloric, sulfuric, and nitric (as a rule, if these reactions are of the same type, it is sufficient to consider the reactions with the hydrochloric acid alone);
(5) Reactions with alkalies (with the sodium hydroxide as a model alkali);
(6) Reactions with ammonia hydrate;
(7) Reactions with hydrogen;
(8) Reactions with oxygen;
(9) Reactions with other nonmetals;
(10) Reactions with metals;
(11) Exchange reactions;
(12) Redox reactions;
(13) Complex-formation reactions;
(14) Reactions with ethanol and other organic substances;
(15) Electrochemical reactions (electrolysis in solution and melt);
(16) Various substance transformations in the solid, liquid, and gaseous states, *viz.*, polymorphic transitions, ionic dissociation in the melt, molecular association and dissociation, etc.

In each entry, the types of interactions described in the chemical literature and characterizing the title substance are listed in the above indicated order.

The equations of chemical reactions are written in the conventional "reagents = products" form. As a rule, the reaction equations are molecular, except of the cases where the chemical interaction can be described by the ionic equation alone (electrolytic dissociation, protolysis, salt hydrolysis, ionic dissociation in melt).

The equations of chemical reactions include the formulas of reactants and the products and also some data concerning the conditions of their conduction and the course of the reactions in all the cases where when these data are important for understanding the chemical aspect and the degree of irreversibility of these reactions.

These data include:

(a) the aggregate state of the substance in the cases where it is not obvious, e.g. in equilibrium heterogeneous reactions in solution, conversion of insoluble substances into the solution, etc.;
(b) the state of the solution, *viz.*, diluted, concentrated, or saturated (sometimes with the indication of mass fraction of the substance or the solution molarity) in the cases when the type of the occurring reaction and the composition of the products depend on the solution state;
(c) reaction duration in time, if this factor characterizes the chemical passivity of the reactant in the reaction;
(d) for the reactions in solutions, the formation of a precipitate or a gas, which makes the reaction in an open system almost irreversible;
(e) for the reactions proceeding in aqueous solution, the name of the precipitant for the product (if the latter is not the only product remaining in the solution upon the reaction);
(f) for the reactions proceeding in nonaqueous solutions, the name of the solvent (water in not indicated as a solvent for aqueous solutions, although, as a rule, it is implied that it plays this part);
(g) the physical parameters and the conditions of reaction occurrence, *viz.*, the temperature range, excess pressure, vacuum, electrical discharge, UV irradiation, etc.;
(h) possible impurities or side products of the reaction, if their formulas are not included into the reaction equation;
(i) necessary refinement of the formulas of the reaction products with the aim of more precise description of their structure;
(j) the indication of the substance color, if it was not indicated in the substance characteristic, but might be of interest for the synthesis and analytical chemistry.

Such an arrangement of the material makes the Handbook rather informative. The Handbook will satisfy the various needs of the reader because it can answer any specific question as well as provide the detail information about the chemical properties of a substance. This book can be useful to lecturers and students, and also to researchers and engineers who have immediate need to know the properties of a substance to be able to take a correct decision in each concrete scientific or technological situation.

ABBREVIATIONS AND NOTATIONS

activ.	activated
amorph.	amorphous
anhydr.	anhydrous
bl.	blue
blk.	black
bp.	boiling point at 760 mm pressure
brn.	brown
ca.	*circa* (approximately)
cat.	catalyst
cl.	colorless
conc.	concentrated
cryst.	crystal(line)
d	density of liquid *or* solid substance relative to water at 4°C
dild.	diluted
dk-	dark
e^-	electron
edta	ethylenediaminetetraacetate ion, $C_{10}H_{12}O_8N_2^{4-}$
e.g.	*exempli gratia* (for example)
el.	electric(al)
en	ethylenediamine, $C_2H_8N_2$
ether	diethyl ether
(g)	gaseous (*subscript*)
gas.	gaseous
g/l	gram per litre
grn.	green
Hdmg	dimethylglyoximate ion, $C_4H_7O_2N_2^-$
higher	greater than *or* equal to t (specified temperature value)
hydr.	(cristal) hydrate, hydrated
immisc.	immiscible
impur.	impurity, impurities
insol.	insoluble
k	mass solubility coefficient in g/100 g H_2O
K_a	acidity constant at 25°C, $pK_a = -\log K_a$
K_b	basicity constant at 25°C, $pK_b = -\log K_b$
K_c	concentration equilibrium constant, $pK_c = -\log K_c$
K_{inst}	instability constant of complex in aqueous solution at 25°C, $pK_{inst} = -\log K_{inst}$
K_{solv}	ion product constant of solvent
K_{st}	stability constant of complex in aqueous solution at 25°C
K_w	ion product constant of water
L	solubility product constant
(l)	liquid (*subscript*)
lower	less than *or* equal to t (specified temperature value)
lq.	liquid
lt-	light
M_r	relative molecular mass (formula weight)
misc.	miscible
mp.	melting point
n/react.	does not react
ntp.	normal temperature and pressure
p	under excess pressure
pH	$-\log[H_3O^+]$ value (in aqueous solution)
py	pyridine, C_5H_5N
react.	reacts (*viz.*, completely hydrolyzes, oxidizes, *or* reduces by water)
room t	room temperature, in room conditions
(s)	solid (*subscript*)
satd.	saturated
sk-bl.	sky-blue
sld.	solid
sl. sol.	slightly soluble
sol.	readily soluble
soln.	aqueous solution
t	temperature
t_{dec}	decomposition temperature
t_{dehydr}	dehydration temperature
t_{depol}	depolymerization temperature
t_{polym}	polymerization temperature

t_{soft}	softening temperature
t_{subl}	sublimation temperature
UV irradn.	ultraviolet irradiation
v	volume solubility coefficient in ml(ntp)/100 g H_2O
vac.	vacuum
v. dild.	very diluted
vitr.	vitreous
viz.	*videlicet* (that is)
wh.	white
yel.	yellow

α	equilibrium degree of forward reacting
ρ	density of gaseous substance in g/l
τ	sluggish reacting
φ°	standard electrode potential in aqueous solution (in volt, V)
$>$	greater than
$\geq$	greater than or equal to
$<$	less than
$\leq$	less than or equal to
$\ll$	much less than

Ac ACTINIUM

Redox properties

Reduction half-reaction	φ°, V (25°C)
$Ac^{3+} + 3e^- = Ac$	−2.130
$Ac(OH)_3 + 3e^- = Ac + 3OH^-$	−2.600

Ac ACTINIUM

A silvery-white heavy soft radioactive metal. In humid air, covered with an oxide film. A strong reductant, reacts with water and acids. Milligram amounts of actinium (the most long-living isotope is ^{227}Ac) are synthesized by neutrons bombardment of radium in nuclear reactor, separated in the form of fluoride. Preparation: AcF_3(3)

M_r 227.028; *d* 10.07; mp 1050°C; bp 3300°C

1. $2Ac + 6H_2O = 2Ac(OH)_3\downarrow + 3H_2\uparrow$
2. $2Ac + 6HCl(dild) = 2AcCl_3 + 3H_2\uparrow$
3. $8Ac + 30HNO_3(dild) = 8Ac(NO_3)_3 + 3N_2O\uparrow + 15H_2O$
4. $4Ac + 3O_2 = 2Ac_2O_3$ (air combustion)
5. $2Ac + 3F_2 = 2AcF_3$ (1300–1350°C)

$AcBr_3$ ACTINIUM(III) BROMIDE

M_r 466.74; wh; *d* 5.85; t_{subl} 800°C; H_2O sol. Preparation: Ac_2O_3(4)

$Ac_2(C_2O_4)_3$, *see* $Ac(NO_3)_3$(8)

$AcCl_3$ ACTINIUM(III) CHLORIDE

A white hygroscopic solid, sublimates without melting when heated. Sparingly soluble in water, hydrolyzes with respect to cation. Ethanol- and ether-insoluble. Reacts with acids. Preparation: Ac(2), Ac_2O_3(1), $Ac(OH)_3$(2, 3)

M_r 333.39; *d* 7.81; t_{dehydr} ca. 300°C

1. $AcCl_3 \cdot nH_2O\downarrow \rightleftharpoons AcCl_3(satd) + nH_2O$ (room *t*)
2. $AcCl_3(dild) + nH_2O = [Ac(H_2O)_n]^{3+} + 3Cl^-$

   $[Ac(H_2O)_n]^{3+} + H_2O \rightleftharpoons [Ac(H_2O)_{n-1}(OH)]^{2+} + H_3O^+$
3. $AcCl_3 + H_2O = Ac(Cl)O + 2HCl$ (1000°C)
4. $2AcCl_{3(s)} + 3H_2SO_4(conc) = Ac_2(SO_4)_3 + 6HCl\uparrow$ (boiling)
5. $AcCl_3 + 3NaOH(dild) = Ac(OH)_3\downarrow + 3NaCl$
6. $AcCl_3 + 2NH_3 + H_2O = Ac(Cl)O + 2NH_4Cl$ (1000°C)

Ac(Cl)O ACTINIUM CHLORIDE-OXIDE

M_r 278.48; wh; *d* 7.23; H_2O n/react. Preparation: $AcCl_3$(3,6)

AcF_3 ACTINIUM(III) FLUORIDE

A white solid, sublimates without melting when heated at high temperatures. Almost water-insoluble. Does not form crystal hydrates. Ethanol-insoluble. Reacts with acids and steam. Preparation: Ac(5), $Ac(NO_3)_3$(5), Ac_2O_3(2), $Ac(OH)_3$(4)

M_r 284.02; *d* 7.88

1. $2AcF_3 + 3H_2SO_4(conc) = Ac_2(SO_4)_3 + 6HF\uparrow$ (boiling)
2. $AcF_3 + H_2O(steam) = Ac(O)F + 2HF$ (lower 1000°C)
3. $AcF_3 + 3Li = 3LiF + Ac$ (1300–1350°C, argon)
4. $AcF_3 + 2NH_3 + H_2O = Ac(O)F + 2NH_4F$ (900–1000°C)

$Ac(NO_3)_3$ ACTINIUM(III) NITRATE

A white hygroscopic solid, decomposes without melting when heated. Readily soluble in water (hydrolyzes with respect to cation) and ethanol. Enters in double-exchange reactions. Preparation: Ac(3), Ac_2O_3(1, HNO_3), $Ac(OH)_3$(2, HNO_3)

M_r 413.04; $t_{dec} > 600°C$

1. $4Ac(NO_3)_3 = 2Ac_2O_3 + 12NO_2 + 3O_2$ (600–800°C)
2. $Ac(NO_3)_3 \cdot nH_2O\downarrow \rightleftarrows Ac(NO_3)_3(satd) + nH_2O$ (room *t*)
3. $Ac(NO_3)_3(dild) + nH_2O = [Ac(H_2O)_n]^{3+} + 3NO_3^-$

   $[Ac(H_2O)_n]^{3+} + H_2O \rightleftarrows [Ac(H_2O)_{n-1}(OH)]^{2+} + H_3O^+$
4. $Ac(NO_3)_3 + 3NaOH(dild) = Ac(OH)_3\downarrow + 3NaNO_3$
5. $Ac(NO_3)_3 + 3NaF = AcF_3\downarrow + 3NaNO_3$
6. $Ac(NO_3)_3 + K_3PO_4 + 0{,}5H_2O = AcPO_4 \cdot 0{,}5H_2O\downarrow + 3KNO_3$
7. $2Ac(NO_3)_3 + 6H_2O + 3Na_2S = 2Ac(OH)_3\downarrow + 3H_2S\uparrow + 6NaNO_3$
8. $2Ac(NO_3)_3 + 3K_2C_2O_4 = Ac_2(C_2O_4)_3\downarrow + 6KNO_3$

Ac_2O_3 ACTINIUM(III) OXIDE

A white refractory thermally stable solid. Does not react with water. Has basic properties, reacts with acids. Preparation: Ac(4), $Ac(NO_3)_3$(1), $Ac(OH)_3$(1)

M_r 502.05; *d* 9.19; mp ca. 2500°C

1. $Ac_2O_3 + 6HCl(dild) = 2AcCl_3 + 3H_2O$
2. $Ac_2O_3 + 6HF = 2AcF_3 + 3H_2O$ (700°C)
3. $Ac_2O_3 + 3H_2S = Ac_2S_3 + 3H_2O$ (1400°C)
4. $Ac_2O_3 + 2AlBr_3 = 2AcBr_3 + Al_2O_3$ (750°C)

Ac(O)F ACTINIUM OXIDE-FLUORIDE

M_r 262.03; wh; *d* 8.28; H_2O n/react. Preparation: AcF_3(2, 4)

Ac(OH)₃ ACTINIUM(III) HYDROXIDE

A white solid, decomposes without melting when heated. Water- and ethanol-insoluble. Has basic properties, reacts with acids. Preparation: Ac(1), $Ac(NO_3)_3$(4, 7)

M_r 278.05; *L* $2.1 \cdot 10^{-19}$(18°C)

1. $2Ac(OH)_3 = Ac_2O_3 + 3H_2O$ (1100°C)
2. $Ac(OH)_3 + 3HCl(dild) = AcCl_3 + 3H_2O$
3. $2Ac(OH)_3 + 3CCl_4 = 2AcCl_3 + 3CO_2 + 6HCl$ (500°C)

   $Ac(OH)_3 + 3NH_4Cl = AcCl_3 + 3NH_3 + 3H_2O$ (lower 400–450°C)
4. $Ac(OH)_3 + 3HF_{(g)} = AcF_3 + 3H_2O$ (70°C)

AcPO₄ ($\cdot 0.5H_2O$) ACTINIUM(III) ORTHOPHOSPHATE

M_r 322.00; wh; *d* 5.48(hydr); H_2O insol. Preparation: $Ac(NO_3)_3$(6)

Ac₂S₃ ACTINIUM(III) SULFIDE

M_r 550.25; blk; *d* 6.75; H_2O react. Preparation: Ac_2O_3(3)

$Ac_2(SO_4)_3$, *see* $AcCl_3$(4), AcF_3(1)

Ag SILVER

Redox properties

Reduction half-reaction	φ°, V(25°C)
1. $Ag^+ + 1e^- = Ag$	+0.799
2. $(Ag^IAg^{III})O_2 + H_2O + 2e^- = Ag_2O + 2OH^-$	+0.599
3. $AgBr + 1e^- = Ag + Br^-$	+0.071
4. $AgBrO_3 + 1e^- = Ag + BrO_3^-$	+0.558
5. $AgCN + 1e^- = Ag + CN^-$	−0.040
$[Ag(CN)_2]^- + 1e^- = Ag + 2CN^-$	−0.430
6. $Ag_2CO_3 + 2e^- = 2Ag + CO_3^{2-}$	+0.471
7. $AgCl + 1e^- = Ag + Cl^-$	+0.222
8. $Ag_2CrO_4 + 2e^- = 2Ag + CrO_4^-$	+0.465
9. $AgI + 1e^- = Ag + I^-$	−0.151