This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: E50 – 17

Standard Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials[1]

This standard is issued under the fixed designation E50; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These practices cover laboratory apparatus and reagents that are required for the chemical analysis of metals, ores and related materials by standard methods of ASTM. Detailed descriptions of recommended apparatus and detailed instructions for the preparation of standard solutions and certain nonstandardized reagents will be found listed or specified in the individual methods of analysis. Included here are general recommendations on the purity of reagents and protective measures for the use of hazardous reagents.

1.2 These recommendations are intended to apply to the ASTM methods of chemical analysis of metals when definite reference is made to these practices, as covered in Section 4.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific hazards are given in Section 8.

NOTE 1—The use of the verb "shall" (with its obligatory third person meaning) in this standard has been confined to those aspects of laboratory safety where regulatory requirements are known to exist. Such regulations, however, are beyond the scope of these practices.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water
E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
E100 Specification for ASTM Hydrometers
E126 Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers
E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials
E287 Specification for Laboratory Glass Graduated Burets
E288 Specification for Laboratory Glass Volumetric Flasks
E438 Specification for Glasses in Laboratory Apparatus
E542 Practice for Calibration of Laboratory Volumetric Apparatus
E694 Specification for Laboratory Glass Volumetric Apparatus
E969 Specification for Glass Volumetric (Transfer) Pipets
E1044 Specification for Glass Serological Pipets (General Purpose and Kahn)
E1621 Guide for Elemental Analysis by Wavelength Dispersive X-Ray Fluorescence Spectrometry

2.2 *ISO Standard*[3]

DIN EN ISO 1042 Laboratory glassware -- One-mark volumetric flasks

3. Terminology

3.1 For definitions of terms used in these practices, refer to Terminology E135.

4. Significance and Use

4.1 The inclusion of the following paragraph, or a suitable equivalent, in any standard (preferably after the section on

[1] These practices are under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and are the direct responsibility of Subcommittee E01.20 on Fundamental Practices.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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TABLE 1 Chemical Reagents Specified in ASTM Methods for Chemical Analysis of Metals

Name	Formula
* Acetic acid	CH_3COOH
Acetone	CH_3COCH_3
Acetylacetone (2,4-pentanedione)	$CH_3COCH_2COCH_3$
Alizarin-Red-S	$C_6H_4COC_6H$-1,2-$(OH)_2$-3-SO_3NaCO
Aluminon (aurintricarboxylic acid-ammonium salt)	$(4\text{-}HOC_6H_3\text{-}3\text{-}COONH_4)_2C{:}C_6H\text{-}3\text{-}(COONH_4){:}O$
Aluminum metal (99.9 % min)	Al
* Aluminum metal (sheet or rolled foil)	Al
Aluminum ammonium sulfate	$Al_2(NH_4)_2(SO_4)_4 \cdot 24H_2O$
Aluminum nitrate	$Al(NO_3)_3 \cdot 9H_2O$
Aluminum sulfate	$Al_2(SO_4)_3 \cdot 18H_2O$
Aluminum oxide, fused (Alundum)	
1-Amino-2-naphthol-4-sulfonic acid	$NH_2C_{10}H_5(OH)SO_3H$
Ammonium acetate	CH_3COONH_4
Ammonium benzoate	$C_6H_5COONH_4$
Ammonium bifluoride	NH_4FHF
Ammonium bisulfate	NH_4HSO_4
Ammonium bisulfite	NH_4HSO_3
Ammonium carbonate	$(NH_4)_2CO_3$
* Ammonium chloride	NH_4Cl
* Ammonium citrate	$CH_2(COONH_4)C(OH)(COOH)CH_2COONH_4$
Ammonium fluoride	NH_4F
* Ammonium hydroxide[A]	NH_4OH
Ammonium iodide	NH_4I
Ammonium molybdate	$(NH_4)_2MoO_4$
* Ammonium heptamolybdate tetrahydrate	$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$
Ammonium nitrate	NH_4NO_3
* Ammonium oxalate	$NH_4OCOCOONH_4 \cdot H_2O$
* Ammonium phosphate, dibasic (diammonium acid phosphate)	$(NH_4)_2HPO_4$
* Ammonium persulfate (ammonium peroxydisulfate)	$(NH_4)_2S_2O_8$
* Ammonium sulfate	$(NH_4)_2SO_4$
* Ammonium tartrate	$NH_4OCO(CHOH)_2COONH_4$
Ammonium thiocyanate	NH_4SCN
Ammonium vanadate	NH_4VO_3
Antimony metal (powder)	Sb
Antimony trichloride	$SbCl_3$
* Arsenic trioxide	As_2O_3
Asbestos (for use with Gooch crucible)	
Barium Chloride	$BaCl_2 \cdot 2H_2O$
Barium diphenylamine sulfonate	$(C_6H_5NHC_6H_4\text{-}4\text{-}SO_3)_2Ba$
* Benzoic acid	C_6H_5COOH
α-Benzoin oxime (benzoin anti-oxime)	$C_6H_5CHOHC{:}NOHC_6H_5$
Beryllium sulfate	$BeSO_4 \cdot 4H_2O$
Bismuth metal (99.9 % min)	Bi
Boric acid	H_3BO_3
Bromocresol green (3',3″,5',5″-tetrabromo-*m*-cresolsulfonephthalein)	$C_6H_4SO_2OC(C_6H\text{-}3,5\text{-}Br_2\text{-}2\text{-}CH_3\text{-}4\text{-}OH)_2$
Bromocresol purple (5',5″-Dibromo-*o*-cresolsulfonephthalein)	$C_6H_4SO_2OC(C_6H_2\text{-}3\text{-}CH_3\text{-}5\text{-}Br\text{-}4\text{-}OH)_2$
Bromine (liquid)	Br_2
Bromophenol blue (3',3″,5',5″-tetrabromophenolsulfonephthalein)	$C_6H_4SO_2OC(C_6H_2\text{-}3,5\text{-}Br_2\text{-}4\text{-}OH)_2$
1-Butanol	$CH_3CH_2CH_2CH_2OH$
Butyl acetate (normal)	$CH_3COOCH_2CH_2CH_2CH_3$
* Cadmium chloride	$CdCl_2 \cdot 2½\ H_2O$
Cadmium chloride, anhydrous	$CdCl_2$
* † Calcium carbonate (low-boron)	$CaCO_3$
Carbon dioxide (gas)	CO_2
Carbon dioxide (solid)	CO_2
Carbon tetrachloride	CCl_4
Carminic acid	$1,3,4\text{-}(HO)_3\text{-}2\text{-}C_6H_{11}O_6C_6COC_6H\text{-}5\text{-}COOH\text{-}6\text{-}OH\text{-}8\text{-}CH_3CO$
* Chloroform	$CHCl_3$
Cinchonine	$C_{19}H_{22}N_2O$
Citric acid	$HOC(COOH)(CH_2COOH)_2$
Cobalt metal	Co
Cobalt sulfate	$CoSO_4$
Coke	
Congo red test paper	
Copper metal (99.9 % min)	Cu
* Copper metal (powder or turnings)	Cu

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TABLE 1 *Continued*

Name	Formula
Copper metal (P-free)	Cu
Copper metal (Mn, Ni, and Co-free, less than 0.001 % of each)	Cu
Copper-rare earth oxide mixture	
m-Cresol purple (*m*-cresolsulfonephthalein)	$C_6H_4SO_2OC(C_6H_3\text{-}2\text{-}CH_3\text{-}4\text{-}OH)_2$
Cupferron	$C_6H_5N(NO)ONH_4$
Cupric chloride	$CuCl_2{\cdot}2H_2O$
* Cupric nitrate	$Cu(NO_3)_2{\cdot}3H_2O$
* Cupric oxide (powder)	CuO
Cupric potassium chloride	$CuCl_2{\cdot}2KCl{\cdot}2H_2O$
* Cupric sulfate	$CuSO_4{\cdot}5H_2O$
Curcumin	$(2\text{-}CH_3OC_6H_3\text{-}1\text{-}OH\text{-}4\text{-}CH{:}CHCO)_2CH_2$
Devarda's alloy	50Cu-45Al-5Zn
Diethylenetriamine pentaacetic acid ([[(carboxymethyl)imino]bis(ethylenenenitrilo)] tetraacetic acid)	$((HOCOCH_2)_2NCH_2CH_2)_2NCH_2COOH$
* Dimethylglyoxime	$CH_3C{:}NOHC{:}NOHCH_3$
N,N' Diphenylbenzidine	$C_6H_5NHC_6H_4C_6H_4NHC_6H_5$
Diphenylcarbazide (1,5-diphenylcarbohydrazide)	$C_6H_5NHNHCONHNHC_6H_5$
* Disodium (ethylenedinitrilo) tetraacetate dihydrate	See (ethylenedinitrilo) tetraacetic acid disodium salt
Dithiol (toluene-3,4-dithiol)	$CH_3C_6H_3(SH)_2$
Dithizone (diphenylthiocarbazone)	$C_6H_5NHNHCSN{:}NC_6H_5$
Eriochrome black-T (1(1-hydroxy-2-naphthylazo)-6-nitro-2-naphthol-4-sulfonic acid sodium salt)	$1\text{-}HOC_{10}H_6\text{-}2\text{-}N{:}N\text{-}1\text{-}C_{10}H_4\text{-}2\text{-}OH\text{-}4\text{-}SO_3Na\text{-}6\text{-}NO_2$
* EDTA (Disodium salt)	See (ethylenedinitrilo) tetraacetic acid disodium salt
* Ethanol	C_2H_5OH
* Ethyl ether (diethyl ether)	$C_2H_5OC_2H_5$
* (Ethylenedinitrilo) tetraacetic acid disodium salt	$HOCOCH_2(NaOCOCH_2)NCH_2N(CH_2COONa)CH_2COOH{\cdot}2H_2O$
Ethylene glycol monomethyl ether (2-methoxy-ethanol)	$CH_3OCH_2CH_2OH$
* Ferric chloride	$FeCl_3{\cdot}6H_2O$
* Ferric nitrate	$Fe(NO_3)_3{\cdot}9H_2O$
Ferric sulfate	$Fe_2(SO_4)_3{\cdot}nH_2O$
* Ferrous ammonium sulfate	$Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O$
* Ferrous sulfate	$FeSO_4{\cdot}7H_2O$
Fluoroboric acid	HBF_4
Fluorescein, sodium salt	$2NaOCOC_6H_4C{:}C_6H_3\text{-}3(:O)OC_6H_3\text{-}6\text{-}ONa$
Formaldehyde	HCHO
* Formic acid[A]	HCOOH
Gelatin	
Graphite	C
Glass wool	
Glycerol	$CH_2OHCHOHCH_2OH$
Hydrazine sulfate	$NH_2NH_2{\cdot}H_2SO_4$
* Hydrobromic acid[A]	HBr
* Hydrochloric acid[A]	HCl
* Hydrofluoric acid[A]	HF
Hydrogen chloride gas	HCl
* Hydrogen peroxide	H_2O_2
Hydrogen sulfide gas	H_2S
Hydroquinone	$1,4\text{-}(OH)_2C_6H_4$
* Hydroxylamine hydrochloride	$NH_2OH{\cdot}HCl$
* Hypophosphorous acid[B]	H_3PO_2
Invert sugar	
* Iodine	I_2
Iron metal or wire (99.8 % min)	Fe
Isopropyl ether	$(CH_3)_2CHOCH(CH_3)_2$
Lead metal	Pb
* Lead acetate	$Pb(CH_3COO)_2$
Lead chloride	$PbCl_2$
* Lead nitrate	$Pb(NO_3)_2$
Litmus	
Lithium fluoride	LiF
Magnesium metal (Sn-free)	Mg
Magnesium perchlorate, anhydrous	$Mg(ClO_4)_2$

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TABLE 1 *Continued*

Name	Formula
* Magnesium sulfate	$MgSO_4 \cdot 7H_2O$
Manganese metal (99.8 % min)	Mn
Manganous nitrate	$Mn(NO_3)_2$
Manganous sulfate	$MnSO_4 \cdot H_2O$
Mannitol	$CH_2OH(CHOH)_4CH_2OH$
Marble chips	
* Mercuric chloride	$HgCl_2$
* Mercury	Hg
* Methanol	CH_3OH
Methyl isobutyl ketone (4-methyl-2-pentanone)	$CH_3COCH_2CH(CH_3)_2$
* Methyl orange (*p*[[*p*-dimethylamino)phenyl]azo]benzenesulfonic acid sodium salt)	$4\text{-}NaOSO_2C_6H_4N{:}NC_6H_4\text{-}4\text{-}N(CH_3)_2$
Methyl purple	formula unknown, patented
* Methyl red (*o* -[[(*p*-dimethylamino)phenyl]azo]benzoic acid)	$4\text{-}(CH_3)_2NC_6H_4N{:}NC_6H_4\text{-}2\text{-}COOH$
Molybdenum metal (99.8 % min)	Mo
Molybdic acid, anhydride (molybdenum trioxide)	MoO_3
Molybdic acid (ammonium paramolybdate)	Assay: as MoO_3—85 %
Morin, anhydrous (2',3,4',7-penta hydroxyflavone)	$5,7\text{-}(HO)_2C_6H_2\ OC(C_6H_3\text{-}2,4\text{-}(OH)_2){:}C(OH)CO$
β-Naphthoquinoline (5,6-benzoquinoline)	$C_{10}H_6CH{:}CHCH{:}N$
Neocuproine (2,9-dimethyl-1,10-phenanthroline)	$(CH_3)_2C_{12}H_6N_2 \cdot {}_{12}H_2O$
Nickel metal (99.8 % min)	Ni
Nickel metal (sheet)	Ni
Nickelous nitrate	$Ni(NO_3)_2 \cdot 6H_2O$
Nickelous sulfate	$NiSO_4 \cdot 6H_2O$
* Nitric acid[A]	HNO_3
Nitrogen gas (oxygen-free)	N_2
Nitrogen, liquid	N_2
m-Nitrophenol	$NO_2C_6H_4OH$
1-Nitroso-2-naphthol(α-nitroso-β-naphthol)	$NOC_{10}H_6OH$
Nitroso-R-salt (1-nitroso-2-naphthol-3,6-disulfonic acid disodium salt)	$1\text{-}NOC_{10}H_4\text{-}2\text{-}(OH)\text{-}3,6\text{-}(SO_3Na)_2$
Osmium tetraoxide	OsO_4
Oxalic acid	$(COOH)_2$
Oxygen gas	O_2
* Perchloric acid[A]	$HClO_4$
1,10-Phenanthroline (*o* -phenanthroline)	$CH{:}CHCH{:}NC{:}CCH{:}CHC{:}CN{:}CHCH{:}CH \cdot H_2O$
* Phenolphthalein	$C_6H_4COOC(C_6H_4\text{-}4\text{-}OH)_2$
* Phosphoric acid	H_3PO_4
Piperidine	$NH(CH_2)_4CH_2$
Platinized quartz	
Platinized silica gel	
Platinum gauze	Pt
* Potassium biphthalate	$1\text{-}KOCOC_6H_4\text{-}2\text{-}COOH$
Potassium bisulfate	$KHSO_4$
* Potassium bromate	$KBrO_3$
* Potassium bromide	KBr
* Potassium chlorate	$KClO_3$
* Potassium chloride	KCl
* Potassium chromate	K_2CrO_4
Potassium columbate	$4K_2O \cdot 3Cb_2O_5 \cdot 16H_2O$
* Potassium cyanide	KCN
* Potassium dichromate	$K_2Cr_2O_7$
* Potassium ferricyanide	$K_3Fe(CN)_6$
Potassium ferrocyanide	$K_4Fe(CN)_6 \cdot 3H_2O$
* Potassium fluoride	$KF \cdot 2H_2O$
* Potassium hydroxide	KOH
* Potassium iodate	KIO_3
* Potassium iodide	KI
Potassium iodide starch paper	
* Potassium nitrate	KNO_3
* Potassium *m*-periodate	KIO_4
* Potassium permanganate	$KMnO_4$
Potassium persulfate	$K_2S_2O_8$
Potassium phosphate, monobasic	KH_2PO_4
* Potassium pyrosulfate	$K_2S_2O_7$
* Potassium sulfate	K_2SO_4
Potassium tantalum fluoride	K_2TaF
Potassium thiocarbonate	K_2CS_3
* Potassium thiocyanate	KSCN

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