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General rules for chemical analysis

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Society for Analytical Chemistry (JSAC)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS K 0050**:2005 is replaced with this Standard.

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General rules for chemical analysis

1 Scope

This Japanese Industrial Standard specifies the general matters of chemical analysis.

The chemical analysis for the purpose of this Standard refers to the operation and technique to carry out the qualitative and/or quantitative analysis of chemical species of a substance, which can be generally based on either chemical methods or physical methods, but in this Standard, qualitative and quantitative analyses based on chemical methods are mainly specified.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS A 1960 *Indoor air — General aspects of sampling strategy*

JIS B 7411 *Solid-stem general purpose liquid-in-glass thermometers*

JIS B 7601 *Trip balances*

JIS B 7609 *Weights*

JIS B 7611-1 *Nonautomatic weighing instruments — Metrological and technical requirements and tests — Part 1 : General measuring instruments*

JIS B 7611-2 *Non-automatic weighing instruments — Metrological and technical requirements and tests — Part 2 : Measuring instruments used in transaction or certification*

JIS B 7611-3 *Nonautomatic weighing instruments — Metrological and technical requirements and tests — Part 3 : Weights and poises used in transaction or certification*

JIS C 1602 *Thermocouples*

JIS C 1604 *Resistance thermometer sensors*

JIS K 0055 *General rules for calibration method of gas analyzer*

JIS K 0060 *Sampling method of industrial wastes*

JIS K 0094 *Sampling methods for industrial water and industrial wastewater*

JIS K 0095 *Methods for sampling of flue gas*

JIS K 0113 *General rules for methods of potentiometric, amperometric, coulometric, and Karl Fischer titrations*

- JIS K 0211 *Technical terms for analytical chemistry (General part)*
- JIS K 0212 *Technical terms for analytical chemistry (optical part)*
- JIS K 0213 *Technical terms for analytical chemistry (Electrochemistry part)*
- JIS K 0214 *Technical terms for analytical chemistry (Chromatography part)*
- JIS K 0215 *Technical terms for analytical chemistry (Analytical instrument part)*
- JIS K 0216 *Technical terms for analytical chemistry (Environmental part)*
- JIS K 0410-3-1 *Water quality — Sampling — Part 1 : Guidance on the design of sampling programmes*
- JIS K 0410-3-2 *Water quality — Sampling — Part 2 : Guidance on sampling techniques*
- JIS K 0410-3-3 *Water quality — Sampling — Part 3 : Guidance on the preservation and handling of samples*
- JIS K 0410-3-4 *Water quality — Sampling — Part 4 : Guidance on sampling from lakes, natural and man-made*
- JIS K 0410-3-6 *Water quality — Sampling — Part 6 : Guidance on sampling of rivers and streams*
- JIS K 0410-3-7 *Water quality — Sampling — Part 7 : Guidance on sampling of water and steam in boiler plants*
- JIS K 0410-3-8 *Water quality — Sampling — Part 8 : Guidance on the sampling of wet deposition*
- JIS K 0410-3-9 *Water quality — Sampling — Part 9 : Guidance on sampling from marine waters*
- JIS K 0410-3-10 *Water quality — Sampling — Part 10 : Guidance on sampling of waste waters*
- JIS K 0410-3-11 *Water quality — Sampling — Part 11 : Guidance on sampling of groundwaters*
- JIS K 0410-3-12 *Water quality — Sampling — Part 12 : Guidance on sampling of bottom sediments*
- JIS K 0557 *Water used for industrial water and wastewater analysis*
- JIS K 0970 *Piston operated micro-volumetric apparatus*
- JIS K 8001 *General rule for test methods of reagents*
- JIS K 8005 *Reference materials for volumetric analysis*
- JIS K 8085 *Ammonia solution (Reagent)*
- JIS K 8180 *Hydrochloric acid (Reagent)*
- JIS K 8223 *Perchloric acid (Reagent)*

- JIS K 8230 *Hydrogen peroxide (Reagent)*
- JIS K 8355 *Acetic acid (Reagent)*
- JIS K 8509 *Hydrobromic acid (Reagent)*
- JIS K 8541 *Nitric acid (Reagent)*
- JIS K 8819 *Hydrofluoric acid (Reagent)*
- JIS K 8917 *Hydriodic acid (Reagent)*
- JIS K 8951 *Sulfuric acid (Reagent)*
- JIS K 9005 *Phosphoric acid (Reagent)*
- JIS M 8100 *Particulate materials — General rules for methods of sampling*
- JIS R 3503 *Glass apparatus for chemical analysis*
- JIS R 3505 *Volumetric glassware*
- JIS Z 8202-0 *Quantities and units — Part 0 : General principles*
- JIS Z 8202-1 *Quantities and units — Part 1 : Space and time*
- JIS Z 8202-2 *Quantities and units — Part 2 : Periodic and related phenomena*
- JIS Z 8202-3 *Quantities and units — Part 3 : Mechanics*
- JIS Z 8202-4 *Quantities and units — Part 4 : Heat*
- JIS Z 8202-5 *Quantities and units — Part 5 : Electricity and magnetism*
- JIS Z 8202-6 *Quantities and units — Part 6 : Light and related electromagnetic radiations*
- JIS Z 8202-7 *Quantities and units — Part 7 : Acoustics*
- JIS Z 8202-8 *Quantities and units — Part 8 : Physical chemistry and molecular physics*
- JIS Z 8202-9 *Quantities and units — Part 9 : Atomic and nuclear physics*
- JIS Z 8202-10 *Quantities and units — Part 10 : Nuclear reactions and ionizing radiations*
- JIS Z 8202-12 *Quantities and units — Part 12 : Characteristic numbers*
- JIS Z 8202-13 *Quantities and units — Part 13 : Solid state physics*
- JIS Z 8203 *SI units and recommendations for the use of their multiples and of certain other units*
- JIS Z 8301 : 2008 *Rules for the layout and drafting of Japanese Industrial Standards*
- JIS Z 8401 *Guide to the rounding of numbers*
- JIS Z 8402-1 *Accuracy (trueness and precision) of measurement methods and results — Part 1 : General principles and definitions*

- JIS Z 8402-2 *Accuracy (trueness and precision) of measurement methods and results — Part 2 : Basic method for the determination of repeatability and reproducibility of a standard measurement method*
- JIS Z 8402-3 *Accuracy (trueness and precision) of measurement methods and results — Part 3 : Intermediate measures of the precision of a standard measurement method*
- JIS Z 8402-4 *Accuracy (trueness and precision) of measurement methods and results — Part 4 : Basic methods for the determination of the trueness of a standard measurement method*
- JIS Z 8402-6 *Accuracy (trueness and precision) of measurement methods and results — Part 6 : Use in practice of accuracy values*
- JIS Z 8704 *Temperature measurement — Electrical methods*
- JIS Z 8705 *Method of temperature measurement by liquid-in-glass thermometers*
- JIS Z 8706 *Methods of temperature measurement by optical pyrometers*
- JIS Z 8707 *Method of temperature measurement by filled-system thermometers and bimetallic thermometers*
- JIS Z 8710 *Temperature measurement — General requirement*
- JIS Z 8802 *Methods for determination of pH of aqueous solutions*
- JIS Z 8805 *Glass electrodes for measurement of pH*
- JIS Z 8816 *Particulate materials — General requirements for methods of sampling*
- JIS Z 9002 *Single sampling inspection plans having desired operating characteristics Part 1. Sampling by attributes*
- JIS Z 9003 *Single sampling inspection plans having desired operation characteristics by variables (standard deviation known)*
- JIS Z 9004 *Single sampling inspection plans having desired operating characteristics by variables (standard deviation unknown and single limit specified)*
- JIS Z 9015-0 *Sampling procedures for inspection by attributes — Part 0 : Introduction to the JIS Z 9015 attribute sampling system*
- JIS Z 9015-1 *Sampling procedures for inspection by attributes — Part 1 : Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*
- JIS Z 9015-2 *Sampling procedures for inspection by attributes — Part 2 : Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*
- JIS Z 9015-3 *Sampling procedures for inspection by attributes — Part 3 : Skip-lot sampling procedures*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS K 0211**, **JIS K 0212**, **JIS K 0213**, **JIS K 0214**, **JIS K 0215** and **JIS K 0216**, and the following shall apply.

3.1 chemical species

elements constituting substance, or the structural or systematic form of compounds

3.2 analyte

constituents to be analyzed, contained in analysis sample or sample solution

It is also called target constituents for analysis.

3.3 analytical sample

a sample weighed out from a sample for analysis or a sample conditioned to be ready for measurement, which is supplied for a chemical analysis

It is also called the sample for measurement.

3.4 quantitative value

the value obtained by an operation which clarifies the quantity of chemical species

3.5 analytical value

the value obtained as the result of chemical analysis

3.6 measured value

the value obtained by measurement

4 Quantities and units

The expression of quantities and units shall follow the SI units (including the units whose parallel use with the SI units is permitted) which are specified in **JIS Z 8203**, and **JIS Z 8202-0** to **JIS Z 8202-10**, **JIS Z 8202-12**, and **JIS Z 8203-13**, and the followings. However, this does not apply in cases where there are corresponding International Standard(s) and/or compulsory laws and regulations which stipulate otherwise.

- a) Mass fraction, volume fraction or amount of substance fraction (mol fraction) shall be expressed by an absolute number as in mass fraction 0.05 (see example 1). It may also be expressed by %, which signifies 0.01 or ‰ (permil), which signifies 0.001 attached after a numeral with a blank in between (see example 2). Another alternative is to indicate which fraction the value is based on after % or ‰ (see example 3).

Example 1 Mass fraction 0.05

Example 2 Mass fraction 5 %

Example 3 5 % (mass fraction)

NOTE 1 In NOTE 2 in 2.3.3 of **JIS Z 8202-0**, it is specified that “mass fraction and volume fraction may be also expressed by the form of 5 µg/g or 4.2 ml/m³”, and for the mass fraction and volume fraction the use of de-

rived unit is permitted.

NOTE 2 In 2.3.3 of JIS Z 8202-0, it is specified that “the abbreviation such as ppm, pphm and ppb shall not be used”.

However, the Measurement Law stipulates the use of the units, “mass percentage (%), mass parts per thousand ‰, mass parts per million (ppm), mass parts per billion (ppb), mass parts per trillion (ppt), mass parts per quadrillion (ppq), volume percentage (vol % or ‰), volume parts per thousand (vol ‰ or ‰), volume parts per million (vol ppm or ppm), volume parts per billion (vol ppb or ppb), volume parts per trillion (vol ppt or ppt), volume parts per quadrillion (vol ppq or ppq) and (pH)”, and since this qualifies as the “cases where there are compulsory laws and regulations which stipulate otherwise”, in legal-related analyses, the use of ppm, etc. is permitted.

- b) When, in a table, compositions expressed with % are given in an entire row or a column, the index column shall state any one of the mass fraction, volume fraction or amount of substance fraction as in mass fraction (%), or % (mass fraction). In this case, the indication such as mass fraction (%) may be given as the symbol of unit for the whole table.

In the case of composition of solid which is clearly to be expressed by percentage of mass fraction, it may be expressed by only %, without the indication of “mass fraction”. In this case, % may be given as a unit symbol for the whole table.

- c) In the description of the mass concentration (a value of mass divided by the volume of mixture) or the amount of substance concentration (a value of amount of substance divided by the volume of mixture), the measuring condition of volume shall be clearly indicated. However, in the case of the volume of liquid at 20 °C or the volume of gas at 101.325 kPa and 0 °C, it is not required to be indicated.
- d) The common logarithm of the reciprocal of hydrogen ion activity is expressed by “pH”.
- e) For the reagents indicated in table 1, when the name of the reagent or the chemical formula is marked, the marked purity or concentration of reagent shall be in accordance with table 1.
- f) When the volume a of a reagent shown in table 1 and the volume b of water are mixed, it may be marked as the “reagent name (a + b)” or the “chemical formula (a + b)”.

Table 1 Reagents which can be expressed by mixture ratio with water

Name of reagent	Chemical formula	Purity or concentration % (mass fraction)	Amount of substance concentration (about) mol/L	Density (20 °C) g/cm ³ (g/ml)	Applicable standard of reagent
Hydrochloric acid ^{a)}	HCl	35.0 to 37.0	11.7	1.18	JIS K 8180
Nitric acid	HNO ₃	60 to 61	13.3	1.38	JIS K 8541
Perchloric acid	HClO ₄	60.0 to 62.0	9.4	1.54	JIS K 8223
Hydrofluoric acid	HF	46.0 to 48.0	27.0	1.15	JIS K 8819
Hydrobromic acid	HBr	47.0 to 49.0	8.8	1.48	JIS K 8509
Hydriodic acid	HI	55.0 to 58.0	7.5	1.70	JIS K 8917
Sulfuric acid	H ₂ SO ₄	95.0 min.	17.8 min.	1.84 min.	JIS K 8951
Phosphoric acid	H ₃ PO ₄	85.0 min.	14.7 min.	1.69 min.	JIS K 9005
Acetic acid	CH ₃ COOH	99.7 min.	17.4 min.	1.05 min.	JIS K 8355
Aqueous ammonia	NH ₃	28.0 to 30.0	15.4	0.90	JIS K 8085
Hydrogen peroxide	H ₂ O ₂	30.0 to 35.5	—	1.11	JIS K 8230
NOTE : When the reagents with purity or concentration other than those shown in this table are used, the purity, concentration or density shall be indicated after the name of the reagent or chemical formula. In such case, the marking of (a + b) specified in f) of clause 4 shall not be applied. Note ^{a)} Of the guaranteed grade and the arsenic analytical grade specified for the hydrochloric acid (reagent) in JIS K 8180, the hydrochloric acid indicated in this table is of guaranteed grade. However, for the arsenic analytical grade, the marking of (a + b) specified in f) of clause 4 is applicable by describing it as hydrochloric acid (arsenic analytical grade).					

5 Expression and rounding of numerical values

5.1 Expression of numerical values

When designating numerical values, expression and method of rounding shall be in accordance with I.1.1 of **JIS Z 8301** : 2008 and the following.

- When numerical values such as “1”, “1.1”, or “1.23” are indicated, it means that the rounded value should be the indicated figure.
- When the tolerance is expressed with the symbol “±” as in “5.0 ± 0.2”, it means that the rounded value is permitted to be in the range of 4.8 to 5.2.
- When a range is designated by using “to” or a dash such as in “10 to 15” or “10 -15”, it means that the rounded value is permitted to be any value between 10 and 15. For example, when the range of 10 over up to and including 15 is to be indicated accurately, the necessary number of digits are clearly indicated so as to be “10.00 to 15.00”. However, when the temperature range is designated as “10 °C to 15 °C”, the minimum value of the range shall be the temperature obtained by rounding down the numerical value of graduation less by one figure, and the maximum value means the temperature obtained by rounding up.
- When a numerical value is designated by appending “about”, such as in “about 2.0”,

it means that the value obtained should be close to the designated value. When a range tolerance is required, it shall be either $\pm 10\%$ of the given numerical value or the rounding error to the given numerical value, whichever is the wider range.

Example The range tolerance $\pm 10\%$ given on “about 100 g” is 90 g to 110 g and that of rounding error is 99.5 g to 100.5 g. Consequently, the tolerance on “about 100 g” is 90 g to 110 g because it is the wider one.

- e) When the method in **a)** is used to indicate temperature or temperature difference with an integer without designation below the decimal point, for Celsius scale ($^{\circ}\text{C}$), the indicated temperature $\pm 1^{\circ}\text{C}$ or $\pm 5\%$ of the indicated temperature, whichever is greater, is allowed and for Kelvin scale (K), the indicated temperature $\pm 1\text{ K}$ or $\pm 5\%$ of the value obtained by subtracting 273.15 from the indicated temperature, whichever is greater, is allowed.
- f) For designating a numerical value, the digit to which reading is to be performed can be indicated, such as in “Read about 1 g to the nearest 0.1 mg”.
- g) For designating a volume, in the case of indicating as “10 ml accurately”, it means the measurement of liquid is to be performed by using a volumetric flask, a volumetric pipette, a burette, etc. with the accuracy provided in the volumeter.
- h) For designating a mass, the distinction shall be clearly recognized between the designations such as “10.0 g accurately” and such as “about 10 g is accurately measured to the nearest 1 mg”. The former means that the rounded result is to be 10.0 g and the latter means that measurement is to be such that the result is, for example, 9.856 g.

5.2 Rounding of numerical values

Rounding of measured values and calculated values shall be in accordance with **JIS Z 8401**.

6 Types of chemical analyses

6.1 General matters

There are a lot of chemical analyses based on various chemical and/or physical principles, and a suitable analysis to be performed should be selected based on full understanding of the aim of the analysis and characteristics of the sample and chemical species. General matters of analysis using an instrument shall be in accordance with individual Japanese Industrial Standards (hereafter referred to as “**JIS**”). Main types of chemical analyses shall be as follows.

6.2 Qualitative analysis

6.2.1 Qualitative analysis by chemical method

The qualitative analysis by the chemical method shall be as follows. The summary of a general method is indicated in Annex A for reference.

- a) **Qualitative analysis for cation** The qualitative analysis for cation can be per-

formed by the confirmation by generation or dissolution of precipitation with sodium hydroxide or ammonia, the method of precipitation generation by reacting with chloride ion, sulfide ion, chromate etc., the method of precipitation of analyte by oxidation-reduction reaction or separation as gas component and the like. Further, for the preliminary test of dry system, there are the observation of physical properties in which colour, crystal form, density, hardness, etc., are examined, the method in which salts are put in colourless flame, ignited and the characteristic colour of element is confirmed by flame reaction, and the like.

- b) **Qualitative analysis for anion** The qualitative analysis for anion can be performed by confirmation by the generation or dissolution of precipitation by barium ion or silver ion, the method based on the characteristic colouring by coloured ion, the method by using liquidity, odour, carbonization, and the like.
- c) **Others** There are colorimetric analysis, paper chromatography, spot analysis, microscopic analysis, etc.

6.2.2 Qualitative analysis by the physical method

The principle of qualitative analysis can be based on : the spectrum in photometric analysis by using a reference material, the X-ray fluorescence in X-ray irradiation, the characteristic X-ray in electron beam analysis, the potential of the precipitation and elution of metallic element in electro analysis, the mass spectrum and isotope ratio in mass spectrometry, the retention time in chromatography, the glass transition temperature in thermal analysis, the melting point, and the like.

6.3 Quantitative analysis

6.3.1 Gravimetric analysis

The target component is separated to be determined as a pure substance with a fixed ratio. From the separated mass or the residual mass, the amount of the analyte is found. The gravimetric analyses are classified into the following three types according to the separating method adopted. The summaries of respective analyses are as follows.

- a) **Precipitation gravimetric analysis** The analyte in sample solution is separated as a precipitation, and the mass of the precipitation is weighed for determination. General operation of precipitation gravimetric analysis are shown in Annex B.
- b) **Gas gravimetric analysis** Sample solution is directly heated, or reagent is reacted with the sample to separate the analyte in sample as gas. The separated gas is allowed to be absorbed in absorbent, and the mass increased by absorption is measured for determination.
- c) **Electrogravimetric analysis** Electrolysis is performed on a sample solution to make the analyte deposit on the electrode, and the mass of the deposit is measured for determination.

6.3.2 Volumetric analysis

For volumetric analysis, titration is carried out to find the volume of a titrant (solu-

tion for titration) which reacts with the whole quantity of analyte, and this volume is used to determine the analyte. General operation of volumetric analysis is shown in Annex C. The methods of potentiometric, amperometric, coulometric and Karl-Fischer titration shall be in accordance with **JIS K 0113**.

The titration procedures are classified into the following four according to the type of chemical reaction.

- a) **Neutralization titration (acid-base titration)** The method to make determination by means of the neutralization titration between acid and base.
- b) **Oxidation and reduction titration** The method to make determination by the titration making use of oxidation-reduction reaction.
- c) **Complexometric titration** The method to make determination by the titration by means of the generation and decomposition of complex.
- d) **Precipitation titration** The method to make determination by the titration by means of the generation and disappearance of precipitation.

NOTE : Titration is classified into the following two types by the procedure.

- 1) **Direct titration** Titration method in which titrant is allowed to drop directly in the sample solution.
- 2) **Back titration** Titration method in which a certain excessive quantity of a standard solution is added to a sample solution, the excess quantity is titrated with another type of titrant, and the amount of analyte is obtained indirectly. This method is employed where the direct titration is not practicable due to slow reaction, precipitation or unnecessary reaction is expected to occur, or where a suitable indicator is not available.

6.3.3 Photometric analysis

Photometric analysis is the analysis method which makes use of radiation, absorption, or scattering of light. There are such types as : ultraviolet and visible spectrochemical analysis, vacuum ultraviolet spectrochemical analysis, infrared spectrochemical analysis, near infrared spectrochemical analysis, Raman spectrochemical analysis, fluorometric analysis, atomic absorption spectrometry, flame photometric analysis, emission spectrochemical analysis (high frequency inductively coupled plasma emission spectrochemical analysis, spark discharge atomic emission spectrometric analysis), chemiluminescence analysis, and so on.

6.3.4 Electromagnetic analysis

Electromagnetic analysis is the analysis method to obtain information about molecules and atoms by means of the action of such electromagnetic effect as X-ray, electron ray, electric field, or magnetic field on the analyte. There are such types as : X-ray fluorescence analysis, electron probe microanalysis, nuclear magnetic resonance analysis, electron spin resonance analysis, mass spectrometer (gas chromatograph mass spectrometer, high performance liquid chromatograph mass spectrometer, high frequency inductively coupled plasma emission mass spectrometer), and so on.

6.3.5 Electroanalysis

Electroanalysis is the analysis method which makes direct or indirect use of the electric property or electrochemical property of substance. There are such types as: potentiometric titration, amperometric titration, coulometric titration, ion-selective electrode testing method, polarography, voltammetry, electric conductivity testing method, and so on.

6.3.6 Chromatography

Chromatography is the method in which the sample is introduced in the mobile phase flowing in contact with the stationary phase and the separation is carried out by the difference between the characteristic of component to the stationary phase and the mobile phase. There are such types as gas chromatography, high performance liquid chromatography, ion chromatography, supercritical fluid gas chromatography, and so on.

6.3.7 Thermal analysis

Thermal analysis is the analysis method using a series of techniques, by which the specific physical properties of target substance and/or the products prepared by reaction with it are measured as a function of its temperature while temperature of the substance is controlled according to the set program. There are such types as differential thermal analysis, differential scanning calorimetry, thermogravimetry, thermomechanical analysis, and so on.

6.3.8 Others

There are flow analysis, electrophoresis analysis, radiometric analysis, and so on.

6.4 Automatic analysis and continuous analysis

The automatic analysis and continuous analysis are carried out with instrument, and generally they consist of: sampling and preparation of sample, pretreatment of sample, adjustment and calibration of instrument, detection and recording, and data processing. The instrument method can be an automatic analysis in which a part of the processes of detection and recording is performed by instrument, or the entire or a large part of the processes is performed by instrument, or a continuous analysis in which the concentration of sample or other conditions are automatically and continuously detected and recorded.

7 Water, reagents, instruments and measuring instruments used for chemical analysis

7.1 Water and reagents

Water and reagents shall be follows.

- a) **Water** Water to be used shall be as described in Annex D, unless otherwise specified in the individual **JIS** standard of the chemical analysis concerned. The method of preparing and storing water for special use, such as water with dissolve oxygen removed and the water with carbon dioxide removed, is described in Annex E.

Water is classified as follows according to the temperature at which it is em-

ployed.

Cold water (water at 15 °C or lower)

Warm water (water at 40 °C or over up to and including 60 °C)

Hot water (water at 60 °C or higher)

- b) **Reagent** Reagents specified in **JIS** or those at least equivalent in quality thereto shall be used, and in the case of no **JIS** specification, that which is not detrimental to test shall be used. For methods which determine only a minute amount, such as the electric heating atomic absorption spectrometry or the high frequency inductively coupled plasma mass spectrometry, reagents of high purity shall be used.

7.2 Instruments

Instruments to be used are such as glass wares, porcelain wares, quartz glass wares, platinum utensils, synthetic resin wares, filter paper, and so on, and they shall be as specified in **JIS** (for instance, **JIS R 3503**) or shall have at least equivalent performance thereto. In the case of employing instruments not specified in **JIS** (for instance, desiccator made of synthetic resin), they shall be pertinent to the analysis.

Moreover, when silicon, boron, sodium, potassium, arsenic, zinc, etc. are analyzed, care shall be sufficiently taken of the elusion of these components from borosilicate glass.

NOTE : Instruments used for chemical analysis shall be washed prior to test. The washing method for glass instrument, ceramic instrument, quartz glass instrument, platinum instrument and synthetic resin instrument is indicated in Annex F for reference.

7.3 Measuring instruments

The measuring instrument shall be as follows.

- a) **Mass measuring instruments** Mass shall be measured by measuring instruments such as analytical balance, precision balance, even balance, electrobalance and so on. The balance shall be in accordance with the trip balance specified in **JIS B 7601** and the nonautomatic balance specified in **JIS B 7611-1** to **JIS B 7611-3**. For the setting of a balance, a place where the balance can be maintained horizontal and free from influence by wind, temperature change or vibration shall be selected. The balance shall be periodically inspected and calibrated. The buoyancy correction in air for measurements conducted with a balance shall be carried out according to Annex G.
- b) **Volume measuring instruments** The volume of liquid, gas, and others shall be measured by using the following volumeter. For measurements requiring extra precision, a calibrated volumeter shall be used.
- 1) **Liquid** For measuring the volume of liquid, utensils such as burette, measuring pipette, transfer pipette, volumetric flask, thick-necked measuring flask, and measuring cylinder which are specified in **JIS R 3505**, or a push-button-type liquid micro-volumeter specified in **JIS K 0970** shall be used. In addition to these, a