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An American National Standard

Standard Test Methods for Chemical Analysis of Graphite[1]

This standard is issued under the fixed designation C560; 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.

ε[1] NOTE—Updated 57.1 editorially in May 2010.

1. Scope Scope*

1.1 These test methods cover the chemical analysis of graphite.

1.2 The analytical procedures appear in the following order:

	Sections
Silicon by the Molybdenum Blue (Colorimetric) Test Method	8 to 14
Iron by the *o*-Phenanthroline (Colorimetric) Test Method	15 to 21
Calcium by the Permanganate (Colorimetric) Test Method	22 to 28
Aluminum by the 2-Quinizarin Sulfonic Acid Test Method	29 to 35
Titanium by the Peroxide (Colorimetric) Test Method	36 to 43
Vanadium by the 3,3'-Dimethylnaphthidine (Colorimetric) Test Method	44 to 51
Boron by the Curcumin-Oxalic Acid (Colorimetric) Test Method	52 to 59

1.3 The preferred concentration of sought element in the final solution, the limits of sensitivity, and the precision of the results are given in Table 1.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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 and health practices and determine the applicability of regulatory limitations prior to use.* See 56.1 for specific caution statement.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C561 Test Method for Ash in a Graphite Sample

D1193 Specification for Reagent Water

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 *Definitions:*

3.1.1 *calibration curve, n*—graphical or mathematical representation of the relationship between known concentrations of an element in a series of standard calibration solutions and the measured response from the measurement system.

3.1.2 *calibration solutions, n*—solutions of accurately known concentrations of the chemical element to be determined using the calibration curve method.

3.1.3 *colorimetric analysis, n*—photometric analysis method of using absorption of monochromatic light in the visible spectrum.

3.1.4 *photometric analysis, n*—analytical chemistry method for quantitative chemical analysis based on the relationship between solution concentrations and the absorption of monochromatic light, as expressed by the Beer law.

[1] These test methods are under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and are the direct responsibility of Subcommittee D02.F0 on Petroleum Products Products, Liquid Fuels, and Lubricants

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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.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Concentration of Elements, Limits of Sensitivity, and Reproducibility

Element	Concentration Range, µg/mL Solution	Sensitivity Limit, µg/mL Solution	Reproducibility, Relative, % (σ/*x* × 100)
~~Silicon~~	~~10 to 100 µg/100 mL~~	~~1 µg/100 mL~~	~~±4~~
Iron	100 to 600 µg/100 mL	40 µg/100 mL	±5
~~Calcium~~	~~600 to 3000 µg/100 mL~~	~~50 µg/100 mL~~	~~±5~~
~~Aluminum~~	~~10 to 100 µg/100 mL~~	~~2 µg/100 mL~~	~~±0.1~~
~~Titanium~~	~~600 to 3000 µg/100 mL~~	~~200 µg/100 mL~~	~~±2~~
~~Vanadium~~	~~10 to 130 µg/50 mL~~	~~5 µg/50 mL~~	~~±5~~
~~Boron~~	~~0.5 to 1.4 µg/50 mL~~	~~0.1 µg/50 mL~~	~~±20~~

TABLE 1 Concentration of Elements, Limits of Sensitivity, and Reproducibility

Element	Concentration Range, µg/mL Solution	Sensitivity Limit, µg/mL Solution	Reproducibility, Relative, % (σ/*x* × 100)
Silicon	10 µg ⁄100 mL to 100 µg/ 100 mL	1 µg/100 mL	±4
Iron	100 µg ⁄100 mL to 600 µg/100 mL	40 µg/100 mL	±5
Calcium	600 µg ⁄100 mL to 3000 µg/100 mL	50 µg/100 mL	±5
Aluminum	10 µg ⁄100 mL to 100 µg/ 100 mL	2 µg/100 mL	±0.1
Titanium	600 µg ⁄100 mL to 3000 µg/100 mL	200 µg/100 mL	±2
Vanadium	10 µg ⁄50 mL to 130 µg/50 mL	5 µg/50 mL	±5
Boron	0.5 µg ⁄50 mL to 1.4 µg/50 mL	0.1 µg/50 mL	±20

4. Significance and Use

4.1 These test methods provide a practical way to measure the concentration of certain trace elements in graphite. Many end uses of graphite require that it be free of elements which may be incompatible with certain nuclear applications. Other elemental contamination can affect the rate of oxidative degradation.

4.2 These test methods allow measurement of trace amounts of contaminants with a minimal amount of costly equipment. The colorimetric procedures used are accessible to most laboratories.

4.3 Other instrumental analysis techniques are available, capable of simultaneous quantitative analysis of 76 stable elements in a single run, with detectability limits in the parts per million range. Standards are currently being developed for elemental analysis of impurities in graphite using glow discharge mass spectrometry (GDMS), inductively coupled plasma optical emission spectroscopy (ICP-OES), combustion ion chromatography (CIC).

5. Reagents

5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 When available, National Institute of Standards and Technology (NIST) certified reagents should be used as standards in preparing calibration curves.

5.3 Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D1193.

5.4 National Institute of Standards and Technology certified reagents specified in certain steps of this procedure may no longer be available. If NIST reagents are not available, then the highest purity reagent grade shall be substituted.

6. Sampling

6.1 The entire sample of graphite should be crushed and ground to pass a No. 60 ~~(250-µm)~~(250 µm) sieve in a roll crusher. The sample may have been reduced in size initially by drilling the test bar with silicon carbide-tipped drills.

[3] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

NOTE 1—The 75 g to 250 g graphite should be crushed and ground to pass the 250 µm sieve, before combustion, which will eventually result in 75 g ash as needed in 13.1.

7. Rounding Calculated Values

7.1 Calculated values shall be rounded to the desired number of places in accordance with Practice E29.

8. Precision and Bias

8.1 No statement is being made about either the precision or bias of these test methods. At this time Committee C05 is investigating new standard methods of chemical analysis of graphite that will eventually replace these test methods. For this reason, no statistical study of these test methods has been planned.

8.2 The relative reproducibility data in Table 1 has no supportive research report on file and does not conform to ASTM precision and bias standards.

SILICON BY THE MOLYBDENUM BLUE TEST METHOD

9. Summary of Test Method

9.1 Silicomolybdic acid is formed by adding ammonium molybdate to soluble silicates in acid solution. The heteropoly acid is reduced with stannous chloride to form a deep blue colloidal solution. Photometric measurement is made at ~~765 nm.~~ 765 nm. Regular classical gravimetric methods for silica using sodium carbonate fusion followed by hydrofluoric acid volatilization may be suitable for use.

10. Stability of Color

10.1 The blue colored solution should be disposed of and the determination repeated if a period of ~~12 h~~ 12 h has elapsed between color development and measurements.

11. Interferences

11.1 There is no interference from the ions usually present in graphite.

12. Reagents

12.1 *Ammonium Molybdate (50 g/L)*—Dissolve ~~50 g~~ 50 g of ammonium molybdate $((NH_4)_6\text{-}Mo_7O_{24}\cdot 4H_2O)$ in water and dilute to ~~1 L.~~ 1 L.

12.2 *Hydrochloric Acid (HCl) (1+1)*—Mix equal volumes of concentrated HCl, sp gr 1.19 and water.

12.3 *Silicon, Standard Solution ~~(1 mL = 1 mg~~ (1 mL = 1 mg Si)*—Dissolve ~~10.1 g~~ 10.1 g of sodium silicate $(Na_2SiO_3\cdot 9H_2O)$ in water and dilute to ~~1 L~~ 1 L in a volumetric flask. Store in a polyethylene bottle. Determine exact concentration by the standard gravimetric procedure.

12.4 *Silicon, Working Solution ~~(1 mL = 0.01 mg~~ (1 mL = 0.01 mg Si)*—Dilute ~~10 mL~~ 10 mL of standard silicon solution ~~(1 mL~~ (1 mL = mg Si) to ~~1 L~~ 1 L in a volumetric flask. Transfer to a polyethylene bottle.

12.5 *Sodium Carbonate Solution ~~(100~~ (100 g ~~g/L)~~ /L)*—Dissolve ~~100 g~~ 100 g of sodium carbonate (Na_2CO_3) in water and dilute to ~~1 L.~~ 1 L. Store in a polyethylene bottle.

12.6 *Stannous Chloride Solution*—Dissolve ~~2.5 g~~ 2.5 g of stannous chloride $(SnCl_2\cdot 2H_2O)$ in ~~5 mL~~ 5 mL of hot concentrated HCl (sp gr 1.19) and dilute to ~~250 mL~~ 250 mL with water. Prepare a fresh solution every ~~2 weeks.~~ 2 weeks.

12.7 *Sulfuric Acid (H_2SO_4) (1+3)*—Carefully mix 1 volume of concentrated H_2SO_4, sp gr 1.84 with 3 volumes of water.

13. Preparation of Calibration Curve

13.1 *Calibration Solutions*—Transfer ~~0, 1.0, 3.0, 5.0, 7.0, and 10 mL~~ 0 mL, 1.0 mL, 3.0 mL, 5.0 mL, 7.0 mL, and 10 mL of silicon working solution ~~(1 mL~~ (1 mL = 0.01 mg Si) to ~~100-mL~~ 100 mL volumetric flasks. Add 5 drops of H_2SO_4 (1+3) and dilute to approximately ~~10 mL.~~ 10 mL.

13.2 *Color Development*—Add ~~2.5 mL~~ 2.5 mL of $(NH_4)_6Mo_7O_{24}$ solution to each flask and let stand ~~5 min.~~ 5 min. Then add ~~5.0 mL~~ 5.0 mL of H_2SO_4 (1+3), mix well, and add 5 drops of $SnCl_2$ solution. Dilute to volume and let stand ~~5 min.~~ 5 min.

13.3 *Photometry*—Transfer a suitable portion of the reagent blank solution to a ~~1-cm~~ 1 cm absorption cell and adjust the photometer to the initial setting, using a wavelength of ~~765 nm.~~ 765 nm. While maintaining this photometer adjustment, take the photometric readings of the calibration solutions.

13.4 *Calibration Curve*—Plot the photometric readings (absorbance) of the calibration solution against micrograms of silicon per ~~100 mL~~ 100 mL of solution.

14. Procedure for Carbonate Fusion

14.1 *Sample Solution*—Rinse the ash (from a ~~50~~50 g to ~~75-g~~75 g ash sample) from the platinum dish into a mullite mortar with three ~~0.5-g~~0.5 g portions of Na_2CO_3 passing a No. 100 ~~(150-μm)~~(150 μm) sieve (see Test Method C561). Grind the resulting mixture to pass a No. 200 ~~(75-μm)~~(75 μm) sieve to ensure intimate contact of the ash with the flux. Then transfer the mixture to a platinum crucible (containing ~~0.5 g~~ 0.5 g of Na_2CO_3) with three ~~0.5-g~~0.5 g rinses of Na_2CO_3. Add sufficient Na_2CO_3 to bring the total Na_2CO_3 content to ~~6 g.~~ 6 g. Cover the crucible, and fuse gently over a bunsen burner.

NOTE 2—In order to get 75 g ash, one needs to combust 250 kg high puruty graphite (300 ppm ash) or 75 kg low purity graphite (1000 ppm ash).

14.1.1 When fusion is complete (usually ~~30 min to 1 h),~~ 30 min to 1 h), remove the crucible from the burner, swirl to distribute the melt on the sides of the crucible, and allow to cool. Then place the crucible and contents in a ~~200-mL~~200 mL high-form beaker and add ~~25 mL~~ 25 mL of water. Cover the beaker with a watch glass, and cautiously add HCl (1+1) to decompose the melt. When solution of the melt is complete, boil for several minutes on a hot plate and cool.

14.1.2 Transfer to a ~~100-mL~~100 mL volumetric flask, dilute to volume, and mix. Transfer a suitable aliquot of this solution to a ~~100-mL~~100 mL volumetric flask.

14.2 *Color Development*—Adjust the pH of the aliquot to 6 to 8 with Na_2CO_3 solution, then proceed in accordance with ~~13.2~~14.2.

14.3 *Photometry*—Proceed in accordance with ~~12.3~~13.3.

14.4 *Calibration*—Convert the photometric reading of the sample solution to micrograms of silicon by means of the calibration curve.

15. Calculation

15.1 Calculate the parts per million (ppm) of silicon in the original sample as follows:

$$\text{Silicon, ppm } (A \times B)/W$$

where:

~~*A* = silicon per 100 mL of solution found in the aliquot used, μg,~~
A = silicon per 100 mL of solution found in the aliquot used, μg,
B = aliquot factor = original volume divided by aliquot taken for analysis, and
W = original sample weight, g.

IRON BY THE ORTHO-PHENANTHROLINE (PHOTOMETRIC) TEST METHOD

16. Summary of Test Method

16.1 After suitable dilution of an aliquot from the carbonate fusion is adjusted to a pH of 3.0, the iron is reduced with hydroxylamine hydrochloride. The ferrous ortho-phenanthroline complex is formed, and its absorption is measured at a wavelength of 490 nm.

17. Stability of Color

17.1 The color becomes stable within ~~15 min~~ 15 min and does not change for at least ~~48 h.~~ 48 h.

18. Interferences

18.1 No interfering elements are normally present in graphite.

19. Reagents

19.1 *Ammonium Hydroxide (NH_4OH) (1+1)*—Mix equal volumes of concentrated NH_4OH, sp gr 0.90 and water.

19.2 *Bromine Water*—Add ~~10 mL~~ 10 mL of bromine to ~~1 L~~ 1 L of water. Allow to stand for ~~24 h.~~ 24 h.

19.3 *Hydrochloric Acid (HCl) (1+1)*—Mix equal volumes of concentrated HCl, sp gr 1.19 and water.

19.4 *Hydroxylamine Hydrochloride Solution*—Dissolve ~~10 g~~ 10 g of hydroxylamine hydrochloride ($NH_2OH·HCl$) in water and dilute to ~~100 mL.~~ 100 mL. Discard the solution if color develops on standing for long periods of time.

19.5 *Iron, Standard Solution ~~(1~~(1 mL = 0.1 mg Fe)*—Into a ~~100-mL~~100 mL beaker, weigh ~~0.1000 g~~ 0.1000 g of iron wire. Dissolve the wire in ~~50 mL~~ 50 mL of HCl (1+1). Add ~~1 mL~~ 1 mL of bromine water to oxidize the iron to the ferric state. Boil the solution to expel the excess bromine and dilute to ~~1 L~~ 1 L in a volumetric flask.

19.6 *Iron Wire,* primary standard, over 99.9 % pure.

19.7 *o-Phenanthroline*—Dissolve ~~2 g~~ 2 g of 1,10-phenanthroline in ethyl alcohol and dilute to ~~250 mL~~ 250 mL with ethyl alcohol in a volumetric flask. Discard this solution if color develops upon long standing.

20. Preparation of Calibration Curve

20.1 *Calibration Solutions*—Transfer ~~0.0, 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0 mL~~ 0.0, mL 1.0 mL, 2.0 mL, 3.0 mL, 4.0 mL, 5.0 mL, and 6.0 mL of iron solution ~~(1 mL~~ (1 mL = 0.1 mg Fe) to ~~100-mL~~100 mL volumetric flasks. Add NH_4OH (1+1) until the brown hydrous precipitate of ferric hydroxide ($Fe(OH)_3$) is just visible. Then add HCl (1+1) drop-wise, while stirring, until the precipitate just dissolves. Bring the pH of the solution to 3.0 by adding 2 additional drops of HCl (1+1). Then add ~~2 mL~~ 2 mL of $NH_2OH·HCl$ solution.

20.2 *Color Development*—Heat the solutions in the flasks almost to boiling. Add ~~1 mL~~ 1 mL of *o*-phenanthroline solution and allow the solutions to cool. Then dilute to the mark with water.

20.3 *Photometry*—Transfer a suitable portion of the reagent blank solution to a ~~1-cm~~1 cm absorption cell, and adjust the spectrophotometer to the initial setting using a wavelength of ~~490 nm.~~ 490 nm. While maintaining this photometer adjustment, take the photometric readings of the calibration solutions.

20.4 *Calibration Curve*—Plot the absorbance of the calibration solution against micrograms of iron per ~~100 mL~~ 100 mL of solution.

21. Procedure

21.1 *Sample Solution*—Proceed in accordance with ~~13.1~~14.1.

21.2 *Color Development*—Proceed in accordance with ~~19.2~~20.2.

21.3 *Photometry*—Proceed in accordance with ~~19.2~~20.2.

21.4 *Calibration*—Convert the photometric reading of the sample solution to micrograms of iron by means of the calibration curve.

22. Calculation

22.1 Calculate the ppm of iron in the original sample as follows:

$$\text{Fe, ppm} \left(A \times B\right)/W$$

where:

~~*A* = iron per 100 mL of solution in the aliquot used, µg,~~
A = iron per 100 mL of solution in the aliquot used, µg,
B = aliquot factor = original volume divided by aliquot taken for analysis, and
W = original sample weight, g.

CALCIUM BY THE PERMANGANATE (COLORIMETRIC) TEST METHOD

23. Summary of Test Method

23.1 Calcium is precipitated as the oxalate, filtered off, and dissolved in sulfuric acid. The acid solution is added to a dilute potassium permanganate solution, and the decrease in absorption is measured at a wavelength of ~~528 nm.~~ 528 nm.

24. Stability of Color

24.1 Potassium permanganate solution is decomposed rapidly by exposure to air or light. Photometric readings should be made at once.

25. Interferences

25.1 Ashed graphite samples are normally free of significant concentrations of possible interfering ions.

26. Reagents

26.1 *Ammonium Hydroxide (NH_4OH_2) (1+6)*—Mix 1 volume of concentrated NH_4OH_2, sp gr 0.90 with 6 volumes of water.

26.2 *Ammonium Oxalate Solution*—Prepare a saturated solution of ammonium oxalate ($(NH_4)_2C_2O_4·2H_2O$).

26.3 *Bromocresol Green Indicator Solution*—Use the water soluble sodium salt. Dissolve ~~0.040 g~~ 0.040 g in water and dilute to ~~100 mL.~~ 100 mL. Store in a glass-stoppered brown bottle.

26.4 *Formate Buffer Solution (pH 3.7)*—Dissolve ~~31.5 g~~ 31.5 g of ammonium formate in about ~~200 mL~~ 200 mL of water and transfer to a ~~1-L~~1 L volumetric flask. Add ~~20.8 mL~~ 20.8 mL of formic acid, dilute to volume, and mix well.

26.5 *Hydrochloric Acid (HCl) (1+1)*—Mix equal volumes of concentrated HCl, sp gr 1.19 and water.

26.6 *Oxalate, Standard Solution (1 mL (1 mL = 0.125 mg Ca)*—Dry approximately 2 g 2 g of sodium oxalate ($Na_2C_2O_4$) at 105°C105 °C for 1 h, 1 h, and cool in a desiccator. Weigh accurately 0.2090 g 0.2090 g into a 250-mL250 mL beaker, dissolve in boiled water, and dilute to 500 mL 500 mL in a volumetric flask.

26.7 *Potassium Permanganate, Standard Solution*—Dissolve 3.25 g 3.25 g of NIST potassium permanganate ($KMnO_4$) in 1 L 1 L of hot water. Let stand in the dark for 12 h. 12 h. Filter through inert filter medium into a dark colored bottle.

26.7.1 Standardize as follows: dissolve 3.0 g 3.0 g of dried NIST sodium oxalate ($Na_2C_2O_4$) in boiled water and dilute to 500 mL 500 mL in a volumetric flask. Pipet 25-mL25 mL aliquots of the oxalate solution into 600-mL600 mL beakers. Add 250 mL 250 mL of H_2SO_4 (1+33), heat to 5555 °C to 60°C,60 °C, and titrate to a faint pink end point that persists for 30 s. 30 s. For a blank, add permanganate solution, dropwise, to 250 mL 250 mL of H_2SO_4 (1+33). Note the volume required to impart a pink color. Calculate the normality of the permanganate solution.

26.7.2 Prepare 0.0200 *N* $KMnO_4$ solution by appropriate dilution of the standardized solution.

26.8 *Sulfuric Acid (H_2SO_4) (1+3)*—Carefully mix 1 volume of concentrated H_2SO_4, sp gr 1.84 with 3 volumes of water.

27. Preparation of Calibration Curve

27.1 *Calibration Solutions*—Transfer 0.0, 5.0, 10.0, 15.0,0.0 mL, 5.0 mL, 10.0 mL, 15.0 mL, and 25.0 mL of standard oxalate solution into 100-mL100 mL volumetric flasks. Add 40 mL 40 mL of H_2SO_4 (1+3) and 10 mL 10 mL of boiled and cooled water. Place the flasks in a water bath at 5555 °C to 60°C60 °C for 5 min.

27.2 *Color Development*—Pipet into each flask 10.0 mL 10.0 mL of the 0.0200 *N* $KMnO_4$ solution. Remove from the bath and allow to stand at room temperature for 5 min 5 min for the color change to be completed. Place in a cold-water bath, and cool to room temperature. Dilute to volume with CO_2-free water and mix.

27.3 *Photometry*—Transfer a portion of the reagent blank solution to a 1-cm1 cm absorption cell. Transfer a portion of the first standard into a second absorption cell. Adjust the spectrophotometer to zero, with the standard in the light path. Then measure the absorbance of the reference solution. Repeat the procedure using the other standard solutions.

27.4 *Calibration Curve*—Plot the absorption of the calibration solutions against micrograms of calcium per 100 mL 100 mL of solution.

28. Procedure

28.1 *Sample Solution*—Proceed in accordance with 13.114.1. However, after the sample solution has been diluted to volume and mixed, proceed as follows: pipet a suitable aliquot (usually 25 mL) 25 mL) into a 50-mL50 mL beaker. Add 1 or 2 drops of bromocresol green indicator, 1 mL of formate buffer, and 1 mL of saturated $(NH_4)_2C_2O_4$ solution. Add, dropwise, NH_4OH (1+6) to the appearance of a faint blue color (pH = about 4.6). Then add HCl (1+1) dropwise with stirring, to obtain a very light yellow color (pH = 3.8). Digest in a water bath at a temperature of 90°C90 °C for 1010 min to 15 min. 15 min. Remove from the water bath and allow to digest at room temperature for at least 30 min. 30 min. Filter through a 15-mL,15 mL, medium-porosity fritted-glass crucible, and wash with four 2-mL2 mL portions of cold water. Remove the crucible from the holder and rinse off the outside and bottom thoroughly. Discard all filtrates and washings. Place the crucible back on the filtration assembly. Pour four 10-mL10 mL portions of hot H_2SO_4 (1+3) (slowly with stirring) into the beaker and then into the crucible. Collect the solution and four 2.5-mL2.5 mL hot water washings in a 100-mL100 mL volumetric flask, and place in a hot water bath at 5555 °C to 60°C60 °C for 5 min. 5 min.

28.2 *Color Development*—Proceed in accordance with 26.227.2.

28.3 *Photometry*—Proceed in accordance with 26.327.3.

28.4 *Calibration*—Convert the photometric reading of the sample solution to micrograms of calcium by means of the calibration curve.

29. Calculation

29.1 Calculate the ppm of calcium in the original sample as follows:

$$Ca, ppm = (A \times B)/W$$

where:

A = calcium per 100 mL of solution in the aliquot used, µg,
A = calcium per 100 mL of solution in the aliquot used, µg,
B = aliquot factor = original volume divided by the aliquot taken for analysis, and
W = original sample weight, g.