BRITISH STANDARD

BS 1428-D4: 1963

(Also listed as BS 797)
Incorporating
Amendment No. 1

Specification for

Capillary pipettes —

Microchemical apparatus —

Group D: Volumetric apparatus

Confirmed January 2010

Co-operating organizations

The Laboratory Apparatus Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Agricultural Research Council
Air Ministry
Association of British Chemical Manufacturers*
Association of Scientific Workers
Board of Trade
British Association for the Advancement of Science
British Chemical Ware Manufacturers' Association*
British Laboratory Ware Association*
British Lampblown Scientific Glassware Manufacturers' Association*
British Pharmacopœia Commission
British Scientific Instrument Research Association*
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D.S.I.R. — Laboratory of the Government Chemist*
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Admiralty
Association of Clinical Pathologists
Medical Research Council
Physiological Society
War Office
Individual manufacturers

This British Standard, having been approved by the Laboratory Apparatus Industry Standards Committee and endorsed by the Chairman of the Chemical Divisional Council, was published under the authority of the General Council on 26 February 1963

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Second revision BS 1428-D4 (BS 797) February 1963

The following BSI references relate to the work on this standard:
Committee references LBC/11 and LBC/11/2
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29	July 1968	Indicated by a sideline in the margin

Contents

Foreword

This standard makes reference to the following British Standard:

BS 1797, *Tables for use in the calibration of volumetric glassware.*

This British Standard was first published in 1938 as BS 797, "*One-mark capillary pipettes*", the 1954 revision was published under the same number but in order to include it also in the BS 1428, "*Microchemical apparatus*" series (see list in Appendix C), it was allotted the additional number BS 1428-D4. A further step has now been taken and first place given to this latter number, the original number, BS 797, being relegated to the status of a subsidiary reference. In this revision a further category of two-mark content pipettes (Type 4) has been added and several changes in dimensions have been made. All the dimensions are now mandatory except for the overall lengths of the pipettes which are recommended for the guidance of manufacturers. Because of the desirability that Types 3 and 4 pipettes of capacity 0.02 ml and above should be suitable for use with both aqueous solutions and biological fluids such as blood, a relatively narrow range of jet diameter is permitted for these pipettes.

All the one-mark pipettes may now be made from soda-lime or borosilicate glass. Enamel-back tubing and lead glass may also be used.

In preparing this revision, account has been taken of International Standardization work in the field of laboratory glassware and this has led to the inclusion of a subsidiary standard temperature of 27 °C for the convenience of tropical countries and to the use of the inscription "Ex" in place of "D" to indicate that the pipette is to be used to deliver, or the inscription "In" instead of "C" to indicate that the pipette is to be used to contain.

Appendix A describes methods of determining capacity using water for pipettes of Types 2, 3 and 4, and a method using mercury for pipettes of Type 3.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 9 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies ranges of graduated, one-mark and two-mark capillary pipettes suitable for general laboratory use.

2 Types and sizes

Four types of capillary pipette are specified, as follows:

Type 1. Graduated pipettes calibrated for delivery from the zero line down to any graduation line as illustrated in Figure 1. Three sizes are specified, as follows:

Nominal capacity 0.1 ml, subdivided into 0.005 ml intervals;

Nominal capacity 0.2 ml, subdivided into 0.01 ml intervals;

Nominal capacity 0.5 ml, subdivided into 0.02 ml intervals.

Type 2. Graduated pipettes calibrated for content from the jet to any graduation line, as illustrated in Figure 2. Three sizes are specified, as follows:

Nominal capacity 0.1 ml, subdivided into 0.005 ml intervals;

Nominal capacity 0.2 ml, subdivided into 0.01 ml intervals;

Nominal capacity 0.5 ml, subdivided into 0.02 ml intervals.

Type 3. One-mark pipettes calibrated for content, as illustrated in Figure 3. Four sizes are specified, of nominal capacity 0.005, 0.01, 0.02 and 0.05 ml.

Type 4. Two-mark pipettes calibrated for content, as illustrated in Figure 4. Two sizes are specified, of nominal capacity 0.2 ml, subdivided into 0.1 ml intervals, and 0.1 ml, subdivided into 0.05 ml intervals.

3 Definition of capacity

3.1 pipettes of type 1

the capacity corresponding to any graduation line is defined as the volume of water at 20 °C, expressed in millilitres, delivered by the pipette at 20 °C, when emptied from the zero line to that graduation line, as described in Appendix A

3.2 pipettes of types 2, 3 and 4

the capacity corresponding to any graduation line is defined as the volume of water at 20 °C, expressed in millilitres, contained by the pipette at 20 °C, when filled from the jet to that graduation line, the lowest point of the water meniscus being set in the horizontal plane containing the top edge of the graduation line, with the pipette vertical. The capacity can be determined by the methods described in Appendix A

NOTE When a pipette of any type is required for use in a country which has adopted a standard temperature of 27 °C, this figure is to be substituted for 20 °C.

4 Tolerances on capacity

Tolerances on capacity for all the pipettes shall be as shown in Table 1.

The tolerance represents the maximum error allowed at any point and also the maximum difference allowed between the errors at any two points.

5 Material

All capillary pipettes shall be made from either soda-lime or borosilicate glass. One-mark and two-mark pipettes shall be made from either clear or enamel-back glass tubing; other pipettes shall be made from clear glass tubing. In either case, the glass shall be as free as possible from visible defects and shall be well annealed. The manufacturer shall state the type of glass used.

Table 1 — Tolerances on capacity

Nominal capacity of pipette, ml	0.005	0.01	0.02	0.05	0.1	0.2	0.5
Tolerance, ml	± 0.0002	± 0.0002	± 0.0004	± 0.001	± 0.002	± 0.004	± 0.006

Table 2 — Mandatory dimensions

All dimensions are in millimetres except where otherwise stated

Dimensions	Type 1 Delivery (graduated)			Type 2 Content (graduated)			Type 3 Content (one-mark)				Type 4 Content (two-mark)	
	0.1 ml	0.2 ml	0.5 ml	0.1 ml	0.2 ml	0.5 ml	0.005 ml	0.01 ml	0.02 ml	0.05 ml	0.1 ml	0.2 ml
Distance from top of pipette to nearest graduation line min.	80	80	80	80	80	80	80	40	40	50	40	40
Distance from highest to lowest numbered line	70 to 120	70 to 120	100 to 150	63 to 108	53 to 90	80 to 120	—	—	—	—	—	—
Distance from lowest graduation line to tip of jet	30 to 35	20 to 25	20 to 25	—	—	—	—	—	—	—	—	—
Distance from graduation line to tip of jet	—	—	—	—	—	—	20 to 40	40 to 80	50 to 80	60 to 100	—	—
Distance from highest graduation line to tip of jet	—	—	—	—	—	—	—	—	—	—	70 to 160	70 to 160
External diameter	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6
External diameter at top of bevel	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5	—	—	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5	2.0 to 3.5
Internal diameter at tip	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.3 to 0.5	0.4 to 0.55	0.4 to 0.55	0.4 to 0.55	0.4 to 0.55
Wall thickness at tip of jet	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50	0.25 to 0.50
Included angle of bevel	35° to 45°	35° to 45°	35° to 45°	35° to 45°	35° to 45°	35° to 45°	—	—	35° to 45°	35° to 45°	35° to 45°	35° to 45°
Included angle of taper	10° to 25°	10° to 25°	10° to 25°	10° to 25°	10° to 25°	10° to 25°	25° to 30°	25° to 30°	10° to 25°	10° to 25°	10° to 25°	10° to 25°

6 Dimensions

The pipettes shall comply with the dimensions given in Table 2.

It is recommended that the overall lengths of the pipettes should comply with the dimensions given in Table 3.

Table 3 — Recommended overall length

Type and nominal capacity	Overall length
Type 1. Delivery (graduated)	
0.1, 0.2, 0.5 ml	270
Type 2. Content (graduated)	
0.1, 0.2, 0.5 ml	240
Type 3. Content (one-mark)	
0.005, 0.01, 0.02 ml	120
0.05 ml	150
Type 4. Content (two-mark)	
0.1, 0.2 ml	200

7 Finish of top of pipette

The top of the pipette shall be finished at right angles to the axis of the pipette and shall be free from any blemishes that would interfere with the required accurate control by the finger in setting the meniscus. The top 1 or 2 cm of the pipette may taper slightly to facilitate the attachment of rubber tubing.

8 Jet

For one-mark pipettes of nominal capacity less than 0.02 ml the jet shall consist of a tapered portion formed by grinding, as shown in Figure 5 *a*. There shall be no sudden constriction of the bore at the orifice.

For pipettes of nominal capacity 0.02 ml and above of all types, the jet shall consist of a tapered portion formed by drawing and a bevel formed by grinding, as shown in Figure 5 *b*. The tapered portion may be slightly concave. There shall be no sudden constriction of the bore at the orifice.

For all pipettes, the end of the jet shall be ground smooth at right angles to the axis of the pipette and the tapered portion of the jet shall be polished.

9 Graduation lines

The graduation lines shall be clean permanent lines lying in planes at right angles to the axis of the pipettes.

For graduated pipettes the lines shall be of uniform thickness and evenly spaced. The lowest graduation line shall be above the tapered portion of the jet. The numbered graduation lines shall extend completely round the circumference of the pipette; the length of the shorter lines shall be approximately one-sixth of the circumference of the pipette. The scale shall be divided and numbered as shown in Figure 1 and Figure 2.

For one-mark and two-mark pipettes each graduation line shall extend completely round the circumference of the pipettes except in the case of enamel-back pipettes where it shall extend over at least the clear portion of the circumference of the pipette. The numerical value of the nominal capacity, e.g. 0.05, shall be marked immediately above each graduation line.

10 Inscriptions

The following inscriptions shall be permanently and legibly marked on all capillary pipettes.

a) The abbreviation “ml” to indicate the unit in terms of which the pipette is calibrated.

b) The abbreviation 20 °C to indicate the standard temperature.

NOTE Where the pipette is required for use in a country which has adopted a standard temperature of 27 °C, this figure is to be substituted for 20 °C.

c) The letters “Ex” (for pipettes of Type 1) to indicate that the pipette is to be used “to deliver” or the letters “In” (for pipettes of Types 2, 3 and 4) to indicate that it is to be used “to contain”.

d) The maker’s or vendor’s name or mark.

e) The number of this British Standard, i.e. "BS 1428"[1)].

f) If required, an identification number.

11 Colour coding

If a colour coding system is used to identify the nominal capacity and unit of subdivision of a pipette complying with this British Standard, such coding shall comply with the appropriate provisions of BS 3996[2)].

[1)] The mark BS 1428 on the product is a claim by the manufacturer that it complies with the requirements of the standard.

The British Standards Institution is the owner of the registered certification trade mark shown below. This mark can be used only by manufacturers licensed under the certification mark scheme operated by the BSI. The presence of this mark on a product is an assurance that the goods have been produced to comply with the requirements of the British Standard under a system of supervision, control and testing operated during manufacture and including periodical inspections at the manufacturer's works in accordance with the certification mark scheme operated by the BSI.

Further particulars of the terms of licence may be obtained from the Director, British Standards Institution, 2 Park Street, London, W.1.

[2)] BS 3996, "*Colour coding for one-mark and graduated pipettes*."

Appendix A Determination of capacity

Type 1. When determining the capacity corresponding to any graduation line of a pipette of Type 1, the following procedure is to be observed, the pipette having first been thoroughly cleaned.

The pipette is clamped in a vertical position with the jet downwards, filled with distilled water to a short distance above the zero line, and the water is retained in the pipette by pressing a finger on to the top of the pipette. The outside of the delivery jet is wiped free from water. By reducing the pressure of the finger, water is allowed to run out slowly. As the descending water surface approaches the zero line, the pressure of the finger is increased so that the water surface is brought to rest with the lowest point of the meniscus[3] in the horizontal plane containing the top edge of the graduation line. The drop of water then adhering to the jet is removed by allowing the jet to touch the surface of water in a suitable container[4]. The pipette is then allowed to deliver into a beaker containing some water; the beaker and water having been previously counter-poised against a beaker of the same diameter also containing water. The beakers are uncovered throughout the test.

During delivery, the pipette just touches the surface of the water. The rate of outflow is uniformly controlled by pressing the finger on to the top of the pipette until the water surface is within 1 cm of the graduation line to be tested. The pressure of the finger is then increased so that an accurate setting can be made on the line. The time occupied by delivery of the total capacity shall be not less than 20 seconds and for smaller volumes the minimum time of delivery shall be in proportion. After the setting is made the beaker is withdrawn without allowing any drainage period.

The volume of water thus delivered is determined by re-weighing the beaker. The volume of water delivered at 20 °C is calculated by applying a correction for water temperature and, where necessary, for air temperature and pressure (see BS 1797[5]).

Type 2. The weight of the empty dry pipette is determined. The pipette is clamped in a vertical position with the jet downwards and is filled with distilled water to a short distance above the graduation line, the water being retained in the pipette by pressing a finger on to the top of the pipette. Any water remaining on the outside of the delivery jet is removed. By reducing the pressure of the finger, water is allowed to run out slowly. As the descending water surface approaches the graduation line the pressure of the finger is increased so that the water surface is brought to rest with the lowest point of the meniscus[3] in the horizontal plane containing the top edge of the graduation line. The drop of water then adhering to the jet is removed by bringing it just into contact with a water surface and removing it without jerking. The pipette and its contents are weighed and the weight of the water contained is determined. From this the capacity of the pipette is calculated by applying a correction for water temperature, and where necessary, for air temperature and pressure (see BS 1797[5]).

Precautions should be taken to guard against evaporation of the contents of the pipette between the time of setting the meniscus and of recording the weight. As control of the setting has been carried out by a finger on top of the suction tube it will not be possible to retain all the water in the pipette for the weighing. That portion which runs out when the finger pressure is released should be contained in a vessel which can be closed by an airtight lid, e.g. a weighing bottle, and weighed with the pipette and the remaining contents.

The capacity of the 0.1 ml pipette only may alternatively be determined with mercury as described for the Type 3 pipettes below.

Type 3. The capacity of any size of Type 3 pipette is determined most conveniently by filling with mercury,

When mercury is used, the meniscus should be set so that the *bottom* of the meniscus (i.e. where the meniscus meets the wall of the tube) coincides with the *top* edge of the graduation line. The volume of mercury then contained does not differ significantly from the volume of water which would be contained using a normal meniscus setting. The mercury should then be weighed and its weight converted to pipette capacity by means of a factor dependent on the temperature of the mercury (see BS 1797[5]).

[3] The meniscus can be clearly defined by folding a strip of black paper round the pipette, the top edge of the paper being not more than 1 mm below the graduation line. The meniscus so shaded is viewed against a white background.
[4] In use, the liquid adhering to the jet after setting the meniscus may be removed by touching it against a wet glass surface. Also delivery of the contents may take place with the jet in contact with such a surface.
[5] BS 1797, "*Tables for use in the calibration of volumetric glassware*".

It is not possible to control the mercury in the same way as water because of its physical properties. Filling the pipette by suction (using an auxiliary flexible tube) is best carried out with the pipette in a near horizontal position. The pipette is filled to excess and a small amount of air is allowed into the jet which enables the pipette to be taken from the mercury reservoir without spilling mercury. The jet is then placed against a smooth piece of wood or the finger nail and by raising the pipette to a more vertical position the mercury is made to expel the air without itself escaping. The mercury can then be made to escape through the jet in a controlled manner by tapping the jet against the pad or finger nail. This is best done with the pipette in an inclined position, the setting being checked when necessary after bringing the pipette into a vertical position. The pipette is brought to a near horizontal position again in order to run the mercury away from the jet before delivering its contents into a beaker for weighing.

A convenient and simple apparatus for manipulating pipettes when calibrating with mercury is described in *J.Sci.Instr.,* 36, 45 (1959).

Type 4. The capacity of Type 4 pipettes is determined in the manner described for Type 3 pipettes; alternatively water may be used in the manner described for Type 2 pipettes.

Appendix B Testing of British Standards capillary pipettes

The National Physical Laboratory is prepared to examine capillary pipettes for compliance with the requirements of this British Standard, provided they are marked with an identification number. Particulars of the test arrangements and fees charged can be obtained on application to the Director, National Physical Laboratory, Teddington, Middlesex.

Appendix C Parts of BS 1428 Microchemical apparatus

Group A. *Combustion trains for the determination of elements.*

— Part A1: Carbon and hydrogen combustion train (Pregl type);

— Part A2: Nitrogen combustion train (micro-Dumas);

— Part A3: Halogens and sulphur combustion train (Pregl). (Withdrawn 1960 as no longer required);

— Part A4: Halogens and sulphur combustion train (micro-Grote);

— Part A5: Rapid method combustion tubes (Belcher and Ingram type).

Group B. *Apparatus for the determination of elements by other than combustion methods.*

— Part B1: Nitrogen determination apparatus (micro-Kjeldahl);

— Part B2: Ammonia distillation apparatus (Markham);

— Part B3: Nitrogen determination apparatus (non-transference micro-Kjeldahl).

Group C. *Apparatus for the determination of organic groups.*

— Part C1: Alkoxyl and alkylimino group determination apparatus;

— Part C2: Acetyl group determination apparatus (Wiesenberger).

Group D. *Volumetric apparatus.*

— Part D1: Burettes with pressure-filling device and automatic zero;

— Part D2: Washout pipettes;

— Part D3: Micro-nitrometer (Pregl type);

— Part D4: Capillary pipettes;

— Part D5: Syringe pattern micro-pipette;

— Part D6: Micrometer-operated burette.

Group E. *General accessory apparatus.*

— Part E1: Crucibles for microchemical analysis;

— Part E2: Micro-beakers;

— Part E3: Micro-centrifuge accessories;

— Part E4: Crucible holder, micro-burner, spatulas and forceps.

Group F. *Filtration accessories.*

— Part F1: Filtration apparatus for microchemical analysis.

Group G. *Heating, cooling and drying accessories.*

— Part G1: Heating and cooling blocks for microchemical purposes;

— Part G2: Vacuum drying ovens for microchemical purposes.

Group H. *Weighing accessories.*

— Part H1: Weighing vessels for microchemical analysis.

Group I. *Combustion accessories.*

— Part I1: Combustion boats and sheath for microchemical analysis.

Group J. *Electrolytic accessories.*

— Part J1: Micro-electrolytic apparatus.

Group K. *Accessories for physical methods.*

— Part K1: Vaporimetric molecular weight determination apparatus.

Group L. *Extraction accessories.*

— Part L1: Micro-extraction apparatus.

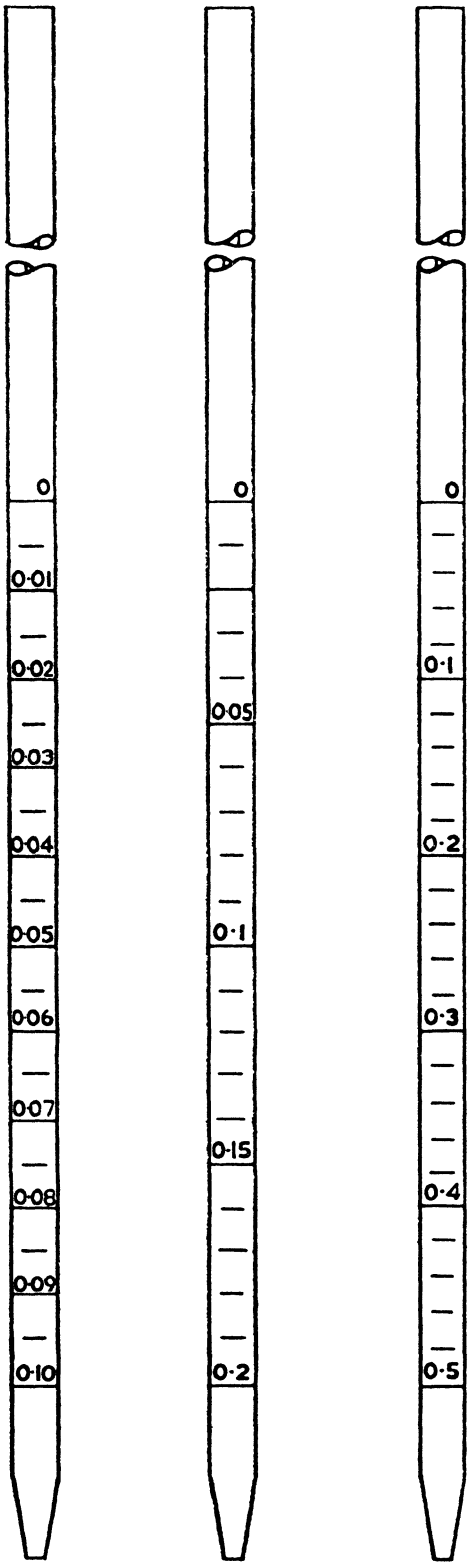


Figure 1 — Type 1 capillary pipettes
Calibrated for delivery from zero line to graduation line

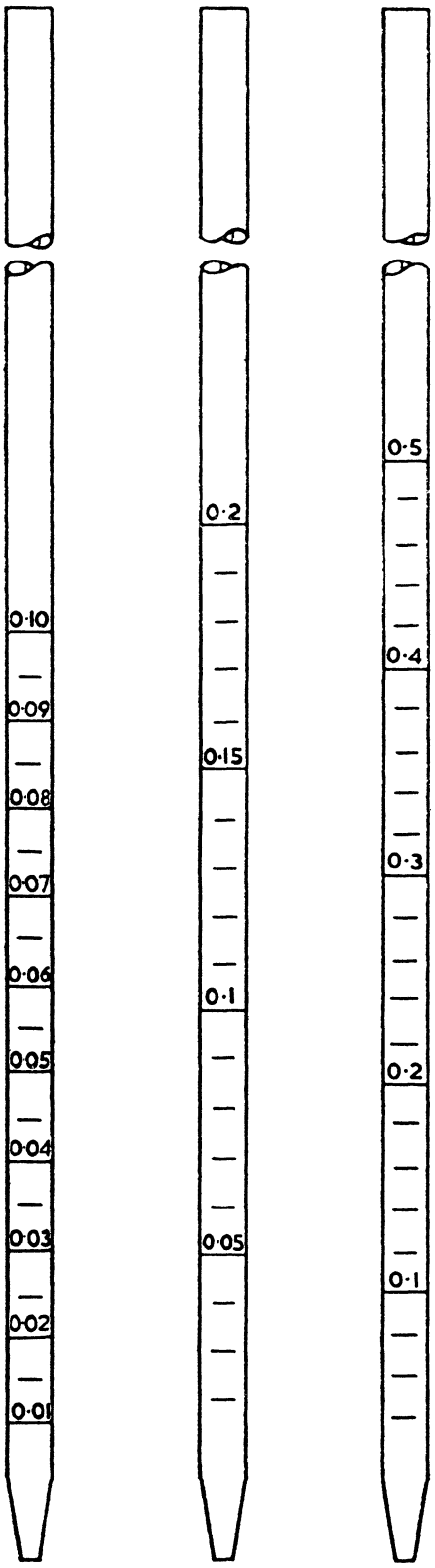


Figure 2 — Type 2 capillary pipettes
Calibrated for content

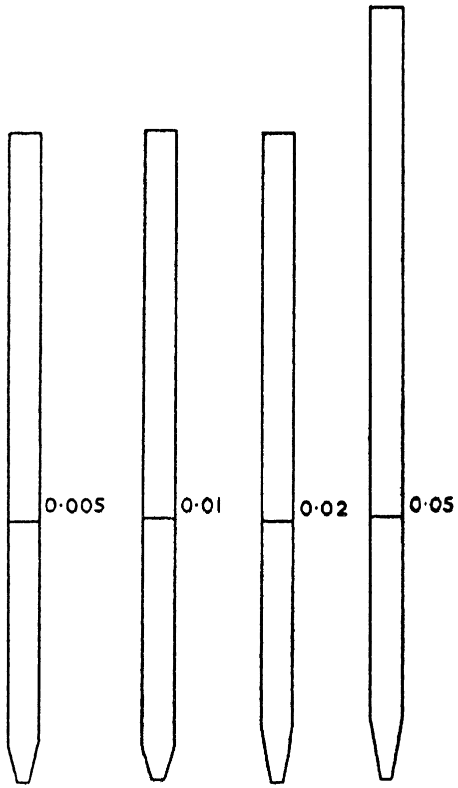


Figure 3 — Type 3 capillary pipettes
Calibrated for content

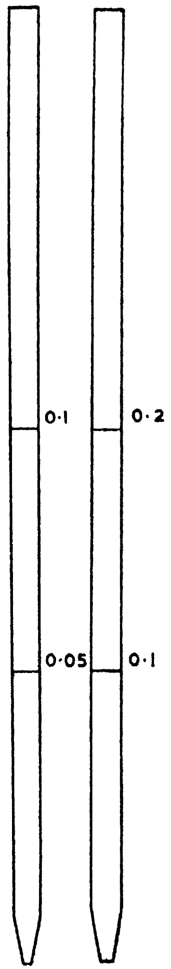
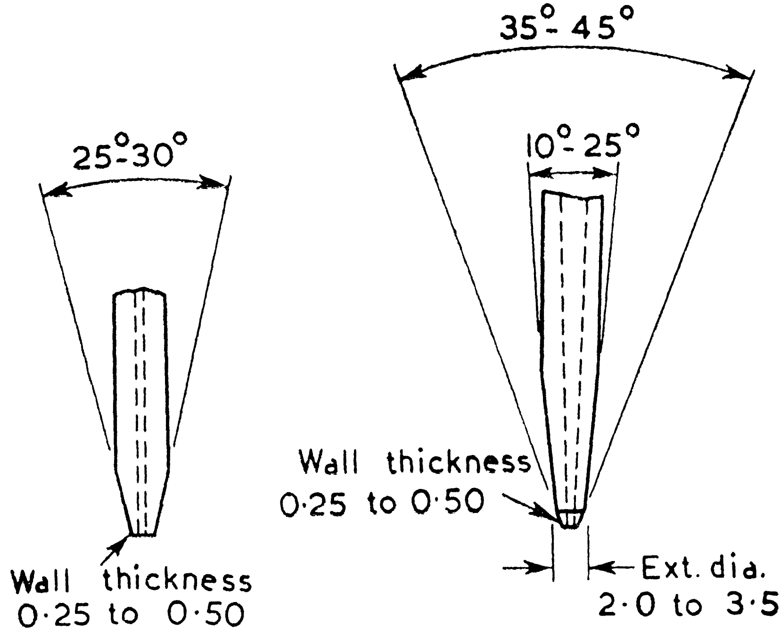


Figure 4 — Type 4 capillary pipettes
Calibrated for content



All dimensions are in millimetres

a. For pipettes of nominal capacity less than 0.02 ml

b. For pipettes of nominal capacity 0.02 ml and above

Figure 5 — Jets for capillary pipettes

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