



Designation: D4826 – 88 (Reapproved 2007)

An American National Standard

Standard Practice for Units of Measurement and Conversion Factors for Pulp, Paper, and Paperboard¹

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1. Scope

1.1 This practice covers the application of the International System of Units (abbreviated SI) within the field of pulp, paper, and paperboard. The SI units have been adopted by ISO, ASTM, and TAPPI as the preferred units for use in their standards and test methods.

1.2 Details of SI are given in various parts of ISO Standards 31 and 1000, and in ASTM Practice [IEEE/ASTM SI 10](#). Application of this information is not always easy, as some properties cannot at this time be expressed in SI, some can be expressed in various units all within SI, and various multiples can be used. Such variation can lead to confusion in reporting test results and in quoting values for properties.

1.3 In order to overcome such problems within the pulp, paper, and paperboard field, ISO/TC6 has recommended appropriate units in ISO Standard 5651. These recommendations are reproduced in this practice, together with other information and recommendations.

2. Referenced Documents ²

2.1 ASTM Standards:

[IEEE/ASTM SI 10](#) American National Standard for Use of the International System of Units (SI): The Modern Metric System^{3,4}

2.2 ISO Standards:

ISO 31 Quantities, Units and Symbols, Parts 0–13⁴

ISO 1000 SI Units and Recommendations for the Use of Their Multiples and of Certain Other Units⁴

¹ This practice is under the jurisdiction of ASTM Committee [D06](#) on Paper and Paper Products and is the direct responsibility of Subcommittee [D06.92](#) on Standard Documents Relating to Paper and Paper Products.

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² For the full titles of the standards and other documents listed in the table, see the ISO, ASTM, and TAPPI indexes.

³ Available from ASTM International, www.astm.org (Excerpts in Related Material section of all ASTM volumes.)

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

3. Summary of Practice

3.1 This practice covers the units recommended for use in expressing the properties of pulp, paper, and paperboard and other quantities found in the pulp, paper, and paperboard documents. It also provides the conversion factors for converting customary units to metric units or other recommended units, and marks with an asterisk (*) when the conversion factor is exact.

3.2 Units recommended in ISO 5651 are marked (+) or (#), with the latter indicating that the recommended unit for pulp, paper, and paperboard is not a preferred SI unit.

3.3 The international symbol for each unit is given in square brackets [] following the name of the unit.

4. Significance and Use

4.1 Uniformity in expressing the results of testing and in quoting property values is needed for improved communication in commerce and research.

4.2 The table of recommended units and symbols and the rules for using them provided in this practice will aid in achieving uniformity.

5. Procedure

5.1 In converting from the customary units to the recommended form, multiply the test value expressed in customary units by the conversion factor to obtain the test value in the recommended form. As an example, suppose that the property of interest is the thickness of a sheet of paper, and that this has been determined to be 5.3 mils. Examination of the table shows that in Section 1.2, Thickness, the conversion factor from mils to micrometres, is exactly 25.4. Multiplying 5.3 by 25.4, the test value in the recommended units is 134.62 μm . Generally, the converted value should be rounded to the same number of significant figures or one more than in the value in customary units, depending, respectively, on whether the first digit of the new value is more or less than that of the original value. Thus, in this case, the converted value would be 135 μm .

NOTE 1—The rounding rule given here is easy to remember and does not result in the loss of significant information. For more detailed information on rounding, see Practice [IEEE/ASTM SI 10](#).

5.2 If the property of interest had been the thickness of corrugated board of, for example, 180 mils, the value would be converted to millimetres, not micrometres. The conversion factor is 0.0254 and the value in the recommended form is 4.57 or 4.6 mm, depending on whether the zero in the last digit of 180 is significant or simply holding the decimal place.

5.3 Generally, if the table allows a choice in the recommended form, choose that form that would have no more than three significant figures in front of the decimal point for most of the values and only one place after the decimal point. However, use, for example, 0.13 mm, not 130 μm , if the zero in 130 is not significant.

5.4 To minimize variety, it is recommended (and the table generally shows) that only prefixes representing 1000 raised to an integral power be used. Thus use:

10^9	giga-	G
10^6	mega-	M
10^3	kilo-	k
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n

However, in expressing area or volume, the prefixes hecto-, deka-, deci-, and centi- may be needed, for example, cubic centimetres.

6. Notation

6.1 The quantities given in square brackets in the second and fourth columns are symbols, not abbreviations. Hence, do

not use abbreviation marks. When two of these symbols are multiplied, as in Section 9.18, dynamic viscosity in pascal seconds, use a raised (center) dot between the symbols, thus Pa·s.

6.2 The same symbol is used for the plural, so adding an s for the plural is incorrect. Thus, write fifty-two grams as 52 g. Also the symbol for per is a slash (/), not the letter *p*, and scientific notation is used for squares, cubes, and higher powers. Thus, write fifty-two grams per square metre as 52 g/m^2 , not gpsm nor gsm.

6.3 The symbols and the names of units are not mixed in the same expression. Therefore, g per square metre, grams/square metre, grams/m^2 , g/sq m, and g per m^2 are all incorrect.

6.4 In the text, write out the name of the unit, except when preceded by a numerical value. Thus use “determine the mass in grams to the nearest 0.1 g.” However, expressions like “one gram” or “two to three grams” may be used when the value as well as the unit of measurement must be written out.

7. Keywords

7.1 conversion factors; paper; paperboard; pulp; units of measure

TABLE *Continued*

Property and ISO Standard		To Convert Values Expressed in Customary Units	Multiply by	To Obtain Values Expressed in Recommended Form
		Name [Symbol]	*exactly	Name [Symbol]
1. General Properties				
1.1	Grammage (mass per unit area in g/m^2)	pounds per ream, $17 \times 22 - 500$ [lb/ream, $17 \times 22 - 500$]	3.7597	+ grams per square metre [g/m^2]
	Basis weight (mass per unit area on ream basis)	pounds per ream, $24 \times 36 - 500$ [lb/ream, $24 \times 36 - 500$]	1.6275	grams per square metre [g/m^2]
		pounds per ream, $25 \times 38 - 500$ [lb/ream, $25 \times 38 - 500$]	1.4801	grams per square metre [g/m^2]
	ISO 536, 3039, 5270, 5638	pounds per ream, $25 \times 40 - 500$ [lb/ream, $25 \times 40 - 500$]	1.4061	grams per square metre [g/m^2]
	ASTM D646	pounds per 1000 square feet [lb/1000 ft^2]	4.8824	grams per square metre [g/m^2]
	TAPPI T 410	pounds per 3000 square feet [lb/3000 ft^2]	1.6275	grams per square metre [g/m^2]
		pounds per 3300 square feet [lb/3300 ft^2]	1.4795	grams per square metre [g/m^2]
1.2	Thickness (caliper)	mils (or points or thousandths of an inch)	*25.4	+ micrometres [μm]
	ISO 534, 3034	mils [mil or 0.001 in.]	*0.0254	+ ⁿ millimetres [mm]
	ASTM D374, D645			ⁿ for corrugated fiberboard
	TAPPI T411			
1.3	Apparent density	pounds per cubic foot [lb/ ft^3]	16.01846	kilograms per cubic metre [kg/m^3]
	ISO 534, 5270	pounds per cubic foot [lb/ ft^3]	27679.90	kilograms per cubic metre [kg/m^3]
	ASTM D202	pounds per cubic inch [lb/in. ³]	27.67990	# ⁿ grams per cubic centimetre [g/cm^3]
				ⁿ for paper and paperboard
1.4	Bulking thickness	mils [mil or 0.001 in.]	*25.4	+ micrometres [μm]
	ISO 534			
	TAPPI T 220			
1.5	Book bulk	mils [mil or 0.001 in.]	*0.0254	millimetres [mm]
	ASTM D2175			
	TAPPI T 500			
1.6	Hygroexpansivity			+ percent [%] (by length)
	ISO 8226			
1.7	Dimensional change after immersion in water			+ percent [%] (by length)
	ISO 5635			
1.8	Drainability of pulp (freeness):			
1.8.1	Canadian standard freeness			+ numerical value (CSF) [no. (CSF)]
	ISO 5267/2			