



Standard Test Method for Grammage of Paper and Paperboard (Mass Per Unit Area)¹

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

1. Scope

1.1 This test method covers the determination of the grammage of paper and paperboard (mass per unit area). In English-speaking countries the customary or commercial practice of expressing the “weight” per unit area (more properly “mass per unit area”) of paper has been “basis weight,” “ream weight,” or “substance,” defined as the mass in pounds of a ream of a given sheet size and number of sheets (usually 500 sheets, occasionally 480 sheets). In most other countries and increasingly in English-speaking countries, the mass per unit area is expressed in grams per square metre. The French term for mass per unit area, “grammage,” is recommended by ISO Committee TC 6 on Paper for use in English as well as in French because of its convenience and clear relationship to grams per square metre.

1.2 The mass per unit area of paperboard has been expressed in the customary system as the mass in pounds per thousand square feet, and in the metric system as grams per square metre.

1.3 The SI metric units, in which grammage (mass per unit area) is expressed in grams per square metre (g/m^2), are the preferred units for ASTM test methods for paper and paperboard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 585 Practice for Sampling and Accepting a Single Lot of

Paper, Paperboard, Fiberboard, and Related Product²
D 685 Practice for Conditioning Paper and Paper Products
for Testing²

3. Summary of Test Method

3.1 The area of several sheets of the paper or paperboard is determined from linear measurements and the mass (commonly called “weight”) is determined by weighing. The grammage is calculated from the ratio of the mass to the area after conversion to metric units when necessary.

4. Significance and Use

4.1 Most paper is bought and sold in accordance with its mass per unit area, and therefore the grammage has great significance both to the consumer and the producer in defining price. Also the values of many physical properties such as bursting strength, thickness, and bulk are interpreted and specified with regard to the particular grammage involved.

5. Apparatus

5.1 *Weighing Device*, readable and accurate to within 0.25 % of the applied load. When in use, the weighing device shall be shielded from air currents.

5.1.1 Special sheet-weighing devices designed to weigh test specimens of a given size may be used, provided that the above conditions are fulfilled and that the total area of each test specimen (see 6.3) in a single weighing is not less than 500 cm^2 (80 in.^2).

5.1.2 For a test specimen of smaller total area, an analytical balance is essential to obtain the required accuracy.

5.2 *Cutting Device*, such as a “four square” cutter, or other device for ensuring parallelism of the opposite edges, normally capable of repeatedly cutting out test specimens whose area, in at least 95 instances out of 100, falls within ± 0.5 % of a known area, as determined by the method specified in 7.2.

5.2.1 When a template is used for preparing test specimens, the paper should be cut to exact size with a sharp knife on a hard surface, such as a hardwood board.

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This test method is related to TAPPI T 410 om-83, which is technically identical, and is similar to International Standard ISO 536, Paper and Board—Determination of Grammage.

² *Annual Book of ASTM Standards*, Vol 15.09.

5.3 *Scale*, such as a finely graduated steel rule reading in 0.5 mm ($\frac{1}{50}$ or $\frac{1}{64}$ in.), capable of measuring the dimensions of the test specimen to an accuracy of 0.2 %.

6. Sampling

6.1 Obtain the sample of the paper or paperboard to be tested in accordance with Method D 585.

6.2 From each test unit of the sample, cut a sufficient number of representative sheets for a total area per test unit of at least 5000 cm² (800 in.²). The dimensions and hence the area of each sheet will depend on the sheet cutting device available. If a template is used, a minimum dimension of 20.0 by 25.0 cm (8 by 10 in.) is recommended.

6.3 Select the number of sheets composing a test specimen (total area of each test specimen at least 500 cm²) to give the required weighing accuracy.

NOTE 1—As a consequence of the above rules, which allow for flexibility in the selection of sheet weighing and cutting devices, the number of test specimens representing a test unit and the number of sheets per test specimen will depend on the choice of weighing and cutting devices, as illustrated by the following examples:

(a) If for a particular sample of paper, the sheet weighing device requires the weighing together of two sheets at least 20.0 by 25.0 cm to obtain the requisite weighing accuracy, then each test specimen will consist of two sheets at least 20.0 by 25.0 cm, and five such test specimens (each a pair of sheets) will be needed to obtain the required total area of 5000 cm².

(b) If the available precise cutting device gives a sheet size of 4.00 by 4.00 in. (approximately 10 by 10 cm), then for the same paper and sheet weighing device used above, each of the needed five test specimens would require ten sheets.

NOTE 2—For some uses, the variation across the web or roll may be of interest; for example, the original wide role (or web) may be slit into narrow rolls, each 7.5 to 10 cm (3 to 4 in.) wide for medical packaging. A “tailing-off” of the grammage near the edge of the web could be unacceptable. In such cases, test units using narrow sheets should be taken from selected positions across the web and the grammage reported separately for each position.

7. Calibration

7.1 *Checking of Weighing Device:*

7.1.1 Check the accuracy of the weighing device frequently (7.3) by applying accurately measured masses with both increasing and decreasing loads. When using a sheet-weighing device, be sure that the device has been properly calibrated to the required accuracy (5.1).

7.1.2 Before each use, see that frictional effects are sufficiently minimal and that the zero reading is sufficiently correct as to assure the required weighing accuracy.

7.2 *Checking of Cutting Device*—Frequently (7.3) check the area cut by using the scale (5.3) to measure 20 test specimens. The cutting accuracy specified in 5.2 is attained when the standard deviation of the individual areas is less than 0.25 % of the mean area, in which case this mean area may be used for calculating grammage in subsequent tests.

7.3 *Frequency of Checking*—The frequency of checking in 7.1 and 7.2 should be based on experience. A new device should be checked several times before being put into use. Then, if in continuous use, it should be checked twice daily until stability is established, then weekly, monthly, or less frequently as indicated by its stability, unless moved or unduly

disturbed. Because of wear, the cutting device may require more frequent checking than the weighing device.

8. Conditioning

8.1 Condition and test the test specimens in an atmosphere in accordance with Practice D 685, unless grammage “as received” is required.

8.2 The precision of this work is such that hysteresis has important effects; therefore, precondition the test specimens so that the equilibrium moisture content is approached from the drier state.

9. Procedure

9.1 If the cutting accuracy specified in 5.2 is attained (see 7.2), use the mean area obtained in 7.2; otherwise, determine the area of each test specimen to within 0.3 %, that is, measure the dimensions of each sheet to within 0.2 %.

9.2 If the special sheet-weighing device is used, be sure that the dimensions of the sheets are within 0.2 % of the required size; otherwise, make a correction in accordance with the following equation:

$$G = G' \times (A'/A) \quad (1)$$

where:

G = corrected indicated mass per unit area,

G' = indicated mass per unit area of the test specimen,

A' = area of the test specimen for which the device is calibrated, and

A = area of the weighed test specimen.

9.3 Weigh each test specimen to within 0.25 %.

10. Calculation

10.1 From the measurements, calculate the mass per unit area of each test specimen. If M is the mass and A is the area of the test specimen in the units of measurements, then the grammage in grams per square metre may be calculated by the equation:

$$G = K \times (M/A) \quad (2)$$

where K is the conversion factor given in Table 1.

10.1.1 If the ream weight in pounds (BW) has been determined for a customary trade size of 500 sheets, the grammage in g/m² may be calculated as follows:

$$G = P \times BW \quad (3)$$

where P is the conversion factor given in Table 2.

10.2 Calculate the mean of the results for each test unit, and express in grams per square metre to three significant figures.

TABLE 1 Conversion Factors

	Units of Measurement		Conversion Factors K
	Mass (M)	Area (A)	
Gram		cm ²	10 000
Gram		in. ²	1 550
Indicated weight for 500-sheet ream, lb		cm ²	9 070
Indicated weight for 500-sheet ream, lb		in. ²	1 406

TABLE 2 Ream Weight Conversion Factors

Kind of Paper	Trade or Basic Size	Trade Size Area, ft ²	<i>P</i> (<i>BW</i> to <i>G</i>)	<i>Q</i> (<i>G</i> to <i>BW</i>)
Paperboard	1000 ft ²	1000.0	4.882	0.205
Writing and printing	17 × 22 – 500	1298.6	3.760	0.266
Blotting	19 × 24 – 500	1583.3	3.084	0.324
Cover	20 × 26 – 500	1805.6	2.704	0.370
Carbon paper	20 × 30 – 500	2083.3	2.344	0.427
Cardboard	22 × 28 – 500	2138.9	2.283	0.438
Bristol and tag	22½ × 28½ – 500	2226.6	2.193	0.456
Binder's board	25¼ × 30¼ – 500	2652.1	1.841	0.543
Index	25½ × 30½ – 500	2700.5	1.808	0.553
News, wrapping, tissue, carton board	24 × 36 – 500	3000.0	1.627	0.614
Tissue	24 × 36 – 480	2880.0	1.695	0.590
Book and offset	25 × 38 – 500	3298.6	1.480	0.676
Newsboard	26 × 38 – 500	3430.6	1.423	0.703
Former TAPPI standard size	25 × 40 – 500	3472.2	1.406	0.711

10.3 To convert grammage (*G*) to mass in pounds (*BW*) of custom trade sizes for 500-sheet reams or, for paperboard, 1000 ft², the following equation may be used:

$$BW = Q \times G \quad (4)$$

where *Q* is the conversion factor given in Table 2. Express the results in pounds to three significant figures.

11. Report

11.1 Report the grammage in grams per square metre to three significant figures for each test unit and, if required, for the average of the test units drawn from the lot.

11.2 If the test units have been taken from more than one position across a roll or sheet and information on grammage variation is required (for example, Note 2), report the average for each position separately.

11.3 If desired, the results may also be reported in pounds for customary trade sizes.

11.4 If the total area of a test unit is less than that specified, state the actual total area tested.

12. Precision and Bias

12.1 Precision

12.1.1 Repeatability of test results within a laboratory = 0.94 %.

12.1.2 Reproducibility of test results between laboratories = 2.84 %.

12.1.3 The above values of precision are averages calculated from 18 reports of the TAPPI Collaborative Reference Program for Paper. Each test result is an average for approximately 5000 cm² of paper and paperboard.

12.1.4 The user of this precision data is advised that it is based on actual mill testing, laboratory testing, or both. There is no knowledge of the exact degree to which personnel skills or equipment were optimized during its generation. The precision quoted provides an estimate of typical variation in test results which may be encountered when this standard method is routinely used by two or more parties.

12.2 *Bias*—The procedure in this test method has no bias because the value of grammage is defined only in terms of the conditions stated in the test method.

13. Keywords

13.1 basis weight; grammage; mass per unit area; paperboard

ANNEX

(Mandatory Information)

A1. REAM WEIGHT CONVERSION FACTORS

A1.1 Table 2 is for 500-sheet reams except as noted. If the trade size uses 480-sheet reams, then the factor *P* is multiplied by 50/48 or 1.042 for conversion and factor *Q* is multiplied by 48/50 or 0.960.

A1.2 The U.S. Government Printing Office has discontinued using twice the trade size and is now following tradepractice.

A1.3 To within 0.5 %, mass per unit area in g/m² is numerically equal to basis weight in pounds (35 by 40 - 500), so that by adjusting the size of the template most ream weight scales may be used to read directly in g/m².

APPENDIX
(Nonmandatory Information)
X1. PREFERRED GRAMMAGES

X1.1 A list of preferred grammages and their trade size equivalents is given in Table X1.1. This list is not intended to require changes in the grammages of currently manufactured products, but is recommended for consideration when product changes are made.

TABLE X1.1 Conversion of Grammage to Pounds per Ream (500 Sheets)

Grammage		1000 ft ² 0.205	17 by 22 0.266	19 by 24 0.324	20 by 26 0.370	20 by 30 0.427	22 by 28 0.438	22½ by 28½ 0.456	25½ by 30½ 0.553	24 by 36 0.614	25 by 38 0.676
A	B										
10		2.0	2.7	3.2	3.7	4.3	4.4	4.6	5.5	6.1	6.8
	10.5	2.2	2.8	3.4	3.9	4.5	4.6	4.8	5.8	6.5	7.1
11		2.3	2.9	3.6	4.1	4.7	4.8	5.0	6.1	6.8	7.4
	12	2.5	3.2	3.9	4.4	5.1	5.3	5.5	6.6	7.4	8.1
12.5		2.6	3.3	4.1	4.6	5.3	5.5	5.7	6.9	7.7	8.4
	13	2.7	3.5	4.2	4.8	5.5	5.7	5.9	7.2	8.0	8.8
14		2.9	3.7	4.5	5.2	6.0	6.1	6.4	7.7	8.6	9.5
	15	3.1	4.0	4.9	5.5	6.4	6.6	6.8	8.3	9.2	10.1
16		3.3	4.3	5.2	5.9	6.8	7.0	7.3	8.8	9.8	10.8
	17	3.5	4.5	5.5	6.3	7.3	7.4	7.8	9.4	10.4	11.5
18		3.7	4.8	5.8	6.7	7.7	7.9	8.2	10.0	11.1	12.2
	19	3.9	5.1	6.2	7.0	8.1	8.3	8.7	10.5	11.7	12.8
20		4.1	5.3	6.5	7.4	8.5	8.8	9.1	11.1	12.3	13.5
	21	4.3	5.6	6.8	7.8	9.0	9.2	9.6	11.6	12.9	14.2
22		4.5	5.9	7.1	8.1	9.4	9.6	10.0	12.2	13.5	14.9
	24	4.9	6.4	7.8	8.9	10.2	10.5	10.9	13.3	14.7	16.2
25		5.1	6.6	8.1	9.2	10.7	11.0	11.4	13.8	15.4	16.9
	26	5.3	6.9	8.4	9.6	11.1	11.4	11.9	14.4	16.0	17.6
28		5.7	7.4	9.1	10.4	11.9	12.3	12.8	15.5	17.2	18.9
	30	6.1	8.0	9.7	11.1	12.8	13.1	13.7	16.6	18.4	20.3
32		6.6	8.5	10.4	11.8	13.7	14.0	14.6	17.7	19.7	21.6
	34	7.0	9.0	11.0	12.6	14.5	14.9	15.5	18.8	20.9	23.0
36		7.4	9.6	11.7	13.3	15.4	15.8	16.4	19.9	22.1	24.3
	38	7.8	10.1	12.3	14.1	16.2	16.6	17.3	21.0	23.3	25.7
40		8.2	10.6	13.0	14.8	17.1	17.5	18.2	22.1	24.6	27.0
	42	8.6	11.2	13.6	15.5	17.9	18.4	19.2	23.2	25.8	28.4
45		9.2	12.0	14.6	16.6	19.2	19.7	20.5	24.9	27.7	30.4
	48	9.8	12.8	15.6	17.8	20.5	21.0	21.9	26.5	29.5	32.4
50		10.2	13.3	16.2	18.5	21.3	21.9	22.8	27.7	30.7	33.8
	53	10.9	14.1	17.2	19.6	22.6	23.2	24.2	29.3	32.6	35.8
56		11.5	14.9	18.2	20.7	23.9	24.5	25.5	31.0	34.4	37.8
	60	12.3	16.0	19.5	22.2	25.6	26.3	27.4	33.2	36.9	40.5
63		12.9	16.8	20.4	23.3	26.9	27.6	28.7	34.8	38.7	42.6
	67	13.7	17.8	21.7	24.8	28.6	29.4	30.6	37.1	41.2	45.3
71		14.5	18.9	23.0	26.3	30.3	31.1	32.4	39.3	43.6	48.0
	75	15.4	19.9	24.3	27.7	32.0	32.9	34.2	41.5	46.1	50.7
80		16.4	21.3	25.9	29.6	34.1	35.0	36.5	44.2	49.2	54.0
	85	17.4	22.6	27.6	31.4	36.3	37.2	38.8	47.0	52.2	57.4
90		18.4	23.9	29.2	33.3	38.4	39.4	41.0	49.8	55.3	60.8
	95	19.5	25.3	30.8	35.1	40.5	41.6	43.3	52.5	58.4	64.2
100		20.5	26.6	32.4	37.0	42.7	43.8	45.6	55.3	61.4	67.6
	105	21.5	27.9	34.1	38.8	44.8	46.0	47.9	58.1	64.5	70.9
110		22.5	29.3	35.7	40.7	46.9	48.2	50.2	60.8	67.6	74.3
	120	24.6	31.9	38.9	44.4	51.2	52.6	54.7	66.4	73.7	81.1
125		25.6	33.2	40.5	46.2	53.3	54.8	57.0	69.1	76.8	84.5
	130	26.6	34.6	42.2	48.1	55.5	57.0	59.3	71.9	79.9	87.8
140		28.7	37.2	45.4	51.8	59.7	61.3	63.8	77.4	86.0	94.6
	150	30.7	39.9	48.6	55.5	64.0	65.7	68.4	83.0	92.2	101.3
160		32.8	42.6	51.9	59.2	68.3	70.1	73.0	88.5	98.3	108.1
	170	34.8	45.2	55.1	62.9	72.5	74.5	77.5	94.0	104.5	114.9
180		36.9	47.9	58.4	66.6	76.8	78.9	82.1	99.6	110.6	121.6
	190	38.9	50.5	61.6	70.3	81.1	83.2	86.6	105.1	116.7	128.4
200		41.0	53.2	64.9	74.0	85.3	87.6	91.2	110.6	122.9	135.1
	210	43.0	55.9	68.1	77.7	89.6	92.0	95.8	116.2	129.0	141.9
220		45.1	58.5	71.3	81.4	93.9	96.4	100.3	121.7	135.2	148.6
	240	49.2	63.8	77.8	88.8	102.4	105.1	109.4	132.7	147.5	162.1
250		51.2	66.5	81.1	92.5	106.7	109.5	114.0	138.3	153.6	168.9

TABLE X1.1 *Continued*

Grammage		1000 ft ²	17 by	19 by	20 by	20 by	22 by	22½ by	25½ by	24 by	25 by
^A	^B	0.205	0.266	0.324	0.370	0.427	0.438	0.456	0.553	0.614	0.676
280	260	53.3	69.2	84.3	96.2	110.9	113.9	118.6	143.8	159.8	175.7
		57.3	74.5	90.8	103.5	119.5	122.7	127.7	154.9	172.0	189.2
320	300	61.4	79.8	97.3	110.9	128.0	131.4	136.8	165.9	184.3	202.7
		65.5	85.1	103.8	118.3	136.5	140.2	145.9	177.0	196.6	216.2
360	340	69.6	90.4	110.3	125.7	145.1	148.9	155.1	188.1	208.9	229.7
		73.7	95.8	116.7	133.1	153.6	157.7	164.2	199.1	221.2	243.2
400	380	77.8	101.1	123.2	140.5	162.1	166.5	173.3	210.2	233.5	256.7
		81.9	106.4	129.7	147.9	170.7	175.2	182.4	221.2	245.8	270.2

^A Preferred grammages.

^B For use when closer steps are essential.

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