Designation: D1223 – 93 (Reapproved 2006)

An American National Standard

Standard Test Method for Specular Gloss of Paper and Paperboard at 75°[1]

This standard is issued under the fixed designation D1223; 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.

1. Scope

1.1 This test method is for measuring the specular gloss of paper at 75° (15° from the plane of paper).

1.2 Although its chief application is to coated papers (**1**),[2] this test method may also be used for uncoated papers.

1.3 This test method is not a measure of image-reflecting quality and should not be used for cast-coated, lacquered, highly varnished (**2, 3, 4**) or waxed papers (**5**), and high-gloss ink films (**6**). For these purposes, TAPPI T 653 "Specular Gloss of Paper and Paperboard at 20 Degrees" is preferred, although the present method has been shown to be suitable for gloss measurements of most other ink films on paper or paperboard. Here, differences in the color and the diffuse reflectances of these ink films have a negligible effect on measured gloss. For example, on comparing white and black surfaces which are otherwise identical, the white surface will measure less than one gloss unit higher than the black.

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:*[3]

D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product

D685 Practice for Conditioning Paper and Paper Products for Testing

2.2 *TAPPI Standard:*

T 1200 Interlaboratory evaluation of test methods to determine TAPPI repeatability and reproducibility[4]

3. Significance and Use

3.1 This test method is widely used as a partial measure of the surface quality and shiny appearance of coated paper.

4. Apparatus

4.1 *Gloss Meter*—(see Fig. 1). It consists of a source of light, a lens giving a converging beam of rays incident on the test specimen, a suction plate to hold the specimen flat, and a light detector to receive and measure certain of the rays reflected by the test specimen. These components are combined in a light tight housing that is matte black inside and is structurally and optically stable during warming and at the operating temperature. Details of the geometric, spectral, and photometric characteristics of the instrument and of the specimen holder are given in Annex A1.

4.1.1 *Area of Specimen Illuminated*—The area illuminated is controlled by the dimensions of the aperture stop *A-A* specified in Fig. 1. If the outline of this spot is projected sharply onto the specimen, the illuminated area will be rectangular, $0.10d \pm 0.01d$ wide and $0.05 \pm 0.005d$ times 1/cos 75° long. When the value for d is 100 mm, the illuminated spot will have a width between 9.0 and 11.0 mm, and length between 17.4 and 21.3 mm, resulting in an illuminated area between 156 and 234 mm^2. On the assumption that approximately 2000 mm^2 of paper or board should be evaluated to obtain a representative gloss value for the sample, 10 separate sheets or 10 different areas on one sheet should be measured and averaged.

NOTE 1—No minimum value for d is specified since none is required when a sufficient number of measurements is made so that the average provides a gloss value representative of 2000 mm^2 of sample.

4.2 *Gloss Standards*—The theoretical specular-gloss standard is an ideal, completely reflecting, plane mirror having an assigned value of 384.4 gloss units. A flat, clean, and polished surface of black glass having a refractive index of 1.540 for the Sodium D line may be shown by the Fresnel equation (**7**) to measure 100 gloss units on this scale.

[1] This test method 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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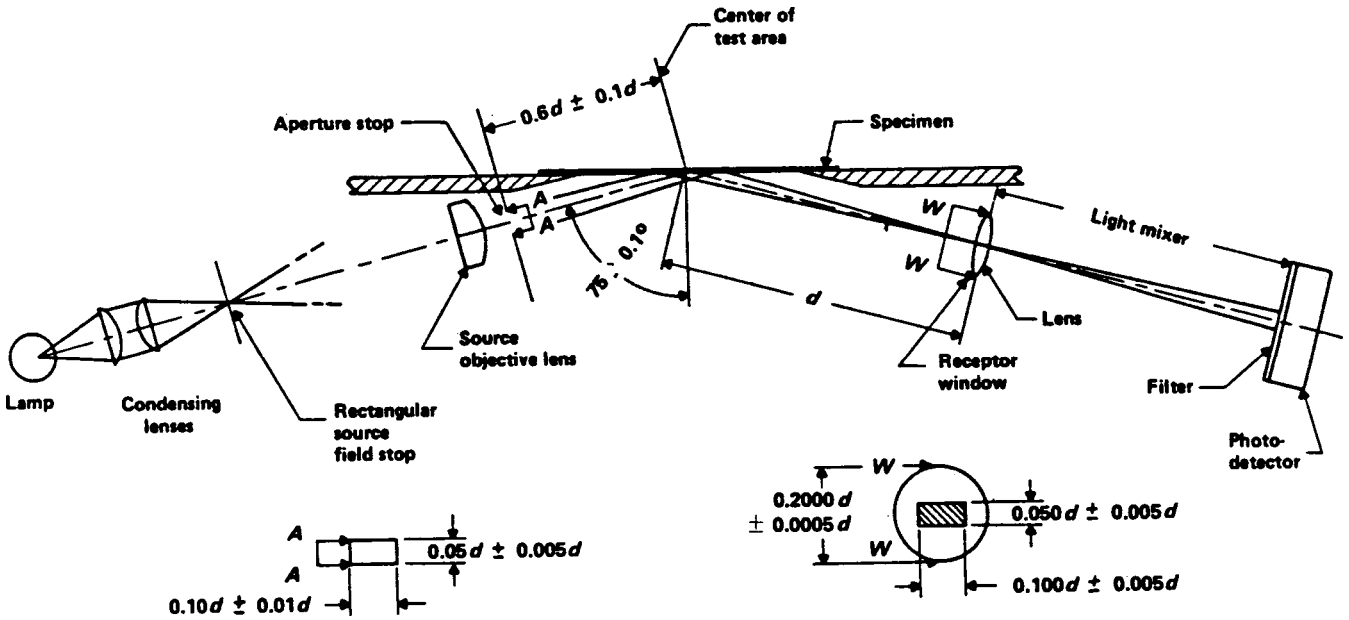
[2] The boldface numbers in parentheses refer to the list of references at the end of this test method.

[3] 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.

[4] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.



NOTE 1—Dimensions are given in terms of *d*, the distance between center of test area and receptor window.
NOTE 2—The cross-hatched rectangle in the *W-W* circle represents the image of the source field stop in the receptor window.

FIG. 1 Schematic Drawing of Glossmeter

4.2.1 *High-Gloss Working Standard*, a clean plaque of polished black glass for which the 75° specular reflectance has been computed from its refractive index as measured for the sodium D line.

4.2.2 *Intermediate-Gloss Standards*, having a reflected flux distribution comparable with that of the paper to be tested. Such standards may consist of ceramic tiles which are flat enough so that they do not rock when placed in the position of the specimen and are uniform in gloss over their central area. Each of these tiles is calibrated against the black glass standard on an instrument conforming with 4.1.

NOTE 2—Store standards in a closed container when not in use. Keep them clean and away from any dirt which might scratch or mar their surfaces. Never place standards face down on a surface which may be dirty or abrasive. Always hold standards at side edges to avoid getting oil from one's skin on the standard surface. Clean standards in warm water and a mild detergent solution, brushing gently with a soft nylon brush. Do not use soap solutions to clean standards because they can leave a film. Rinse standards in hot running water (temperature near 150°F (65°C) to remove detergent solution, followed by a final rinse in distilled water. Do not wipe intermediate standards. The polished black glass high-gloss standard may be dabbed gently with a lint-free paper towel or other lint-free absorbent material. Place rinsed standards in a warm oven to dry.

NOTE 3—Black glass standards may not be stable and may change a few percent over a period of several years (**8**). The refractive index or gloss value should be verified from time to time against a stable standard. Major standardizing laboratories such as the National Institute of Science and Technology (NIST), USA, or the National Research Council, Canada, are able to verify the gloss values of such black glasses.

5. Sampling

5.1 Select a sample to represent the shipment in accordance with Practice D585.

6. Test Specimens

6.1 From each test unit of the sample, cut at least ten test specimens free of folds or wrinkles or other blemishes and of sufficient size to cover completely the sample opening of the instrument with an adequate overlap. Keep the specimens clean and do not touch the area to be tested.

7. Conditioning

7.1 Condition and test the specimens in an atmosphere in accordance with Practice D685.

NOTE 4—The exposure of paper to relative humidities of about 65 % or above progressively and irreversibly decreases the gloss (**9**).

8. Procedure

8.1 Cover the specimen aperture with an opaque material and, with the instrument turned off, check the mechanical zero of the meter and adjust to zero if necessary. Then turn on the instrument and, after a 10-min warm-up period, insert the black glass standard and adjust the scale controls to give an instrument reading equal to the value of gloss for the standard.

8.2 Recheck the zero of the instrument with the specimen aperture covered with a black velvet-lined cavity to prevent external light from entering the receptor window. With the instrument turned on, the zero reading should agree with the mechanical zero setting. (Disagreement in the zero readings suggests that unwanted light rays are entering the receptor window.)

8.3 Reinsert the black glass standard and adjust the instrument as before, to give the correct value of gloss for the standard. Insert the intermediate standard and see that the instrument reads it correctly. (Correct readings on the black-glass and intermediate standards suggest that an instrument is in approximate, but not necessarily in exact, conformance with the above apparatus specification (**10**).) When readings differ by more than 1 gloss unit from assigned values, the instrument should be checked for conformance to the geometric, spectral, and photometric requirements.

8.4 Following this calibration check, insert each specimen one at a time and read the gloss value. Rotate each specimen 180° and read the gloss value at the same point a second time. Average the first and second readings for each specimen. In the absence of other information associated with the sample, perform the testing sequence in both the machine and cross directions for both the wire and felt sides of the sample. Insert the standards at frequent intervals to ensure that the instrument remains in adjustment throughout the period that the gloss measurements are being made and again at the end of the test.

8.5 Calculate for the ten specimens the four averages for the machine and cross directions and the wire and felt sides of the sample unless otherwise instructed.

9. Report

9.1 Report the average, maximum, and minimum gloss readings to the nearest unit for the felt side and for the wire side of the sample.

10. Precision and Bias

10.1 *Precision*:

10.1.1 The values in Table 1 are based on an interlaboratory study conducted in accordance with TAPPI T 1200. Eight papers at various gloss levels (ranging from approximately 10 to 80 gloss units) were tested by eleven laboratories. Twenty-five sheets of each paper were measured.

TABLE 1 Interlaboratory Study of Eight Papers Tested by Eleven Laboratories

Grand Mean	Repeatability	Reproducibility
10.94	1.84	2.22
26.71	3.25	4.01
29.99	3.86	4.93
42.48	5.27	7.28
60.32	8.60	9.31
66.20	4.18	5.40
72.29	9.54	9.87
80.40	5.58	6.53

10.1.2 Six of the eight papers from the interlaboratory study were also used in the CTS-TAPPI Collaborative Reference Program, Reports 119 through 124. Ten test determinations were made per sample and a minimum of 36 laboratories participated. The results were comparable to those obtained in the interlaboratory study and are as in Table 2.

10.1.2.1 The user of these precision data is advised that it is based on actual mill testing or 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 provides an estimate of typical variation in test results which may be encountered when the test method is routinely used by two or more parties.

10.1.3 In both the interlaboratory study and the Collaborative Reference analyses, it appears that the major contributing factor to the precision of the data is the material variability.

10.2 *Bias*—The procedure in this test method has no bias because the value of gloss at 75° is dependent upon the test conditions specified in terms of this test method.

11. Keywords

11.1 coated paper; gloss; paper; paperboard; specular gloss; uncoated paper

TABLE 2 CTS-TAPPI Collaborative Reference Program (Reports 119–124)

Grand Mean	Repeatability	Reproducibility
27.12	3.05	4.60
30.30	4.07	5.09
42.73	4.99	7.52
59.08	7.37	8.67
66.52	3.16	6.29
80.56	5.29	6.45

ANNEXES

(Mandatory Information)

A1. DESCRIPTION OF INSTRUMENT

A1.1 *Optical System*—Referring to Fig. 1, beginning at the lamp, the dashed line indicates the path of the ray of light passing through the condenser lens and the geometric center of a rectangular aperture which becomes the effective source of light: through the source objective lens, through the geometric center of the rectangular aperture stop and to the specimen. This axial ray of light intersects the specimen plane at a point defined as the center of the test area. (This is not necessarily the geometric center of the illuminated area of the specimen.) With a plane front-surfaced mirror as the specimen, the axial ray is specularly reflected and passes through the center of the receptor window. The source objective lens makes an image of the source aperture at the receptor window. The distance *d*, the distance from the center of the test area to the receptor window, is used as the basis from which to specify all other dimensions. The most critical dimensions are the angle of incidence, the position of the receptor window, and the diameter of the receptor window (**11**, **12**).

A1.2 To achieve uniform weighting of the rays taking different paths through the receptor window, a light mixer (**10**) is interposed between the receptor window and the photodetector. The positive lens is located adjacent to the receptor window and is arranged to collect all rays of light passing through the window and to form an image of the illuminated specimen surface on the photodetector sensitive surface, or on a diffusing screen immediately in front of this surface. No rays other than those reflected from the specimen surface are permitted to enter the receptor window.

A1.3 *Angle of Incidence*—The axial ray intersects the