CATALOGUE D

The Scientific Shop

Optical Parts

Telescopic Objectives
Telescopic Mirrors
Eyepieces
Test Planes
Plane Parallels
Prisms
Lenses
Echelon Gratings
Interferometer Plates
Iceland Spar Preparations
Quartz Preparations
Rock Salt Preparations
Diffraction Gratings
Microscopic Lenses
Photographic Lenses, etc.

THE SCIENTIFIC SHOP

ALBERT B. PORTER

324 DEARBORN STREET, CHICAGO, U. S. A.

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Introduction

¶ With the exception of a few of the smaller items, the optical materials listed in this catalogue are of our own manufacture. Our optical works, which are well equipped with modern machine tools, special glass working machinery, testing devices, etc., are located in Evanston, Ill., a suburb of Chicago, where pure air and quiet surroundings give the best working conditions. Mr. F. G. Pease, our superintendent, is a man of wide experience in large optical work and is a clever designer of special instruments for astronomical and physical research. He is a graduate of one of our large technical colleges, where he specialized in physics and mathematics, and has had the great advantage of a connection of six years with two of our largest research observatories, the Yerkes Observatory at Williams Bay, and the Carnegie Solar Observatory at Pasadena. His experience thus not only includes work on and with some of the largest telescopes in the world, but also the design and construction of complete observatory and spectroscopic equipments.

¶ We are prepared to make objectives and mirrors and to build complete astronomical telescopes of modern designs in the largest sizes, to submit estimates on domes and mountings, and to make all of the minor instruments such as transits, meridian circles, spectroscopes, coelostats, etc., which are needed in the modern observatory. Special physical apparatus will be made to order from sketches or drawings or to our own designs, and we are always ready to undertake the construction of instruments of precision for research work.

¶ In the following pages mirrors, specula, prisms, etc., are listed in several grades or degrees of precision. This is done in order that our customers may select optical parts suitable for the experiments in progress, without being compelled to pay the high prices necessarily charged for work of the most extreme precision. It is hoped that the paragraphs below on the accuracy required of optical surfaces may be of some assistance in selecting optical parts for specific purposes.

The Accuracy Required of Optical Surfaces

The skilled optical craftsman recognizes no limits to the accuracy of the optical surfaces he can make except those set by the methods of testing which are at his command, and those due to the physical properties of optical glass. Given a homogeneous glass disc so thick that flexure would introduce no appreciable error, given a constant temperature room in which to work, given time, given skill, and given patience, there would be no inherent difficulty in making an optical surface of almost any specified degree of precision, provided methods of testing the surface to within the required limits of error were available. Indeed, the methods of testing now practiced are so sensitive that flexure of the glass and distortion of the surface due to local temperature variations are among the chief bars to further progress. These difficulties are, however, not sufficient to prevent the production of surfaces meeting the most exacting requirements of the physicist and the astronomer.

The degree of accuracy required of optical surfaces has been investigated by Lord Rayleigh ("Scientific Papers," Vol. I, p. 436), who has shown that, in the formation of optical images in telescopes, spectroscopes, etc., a distortion or aberration of the wave front amounting to one-quarter of a wave-length or less does not sensibly impair the definition. In the case of the telescopic image of a star, for example, such an aberration merely has the effect of slightly diminishing the intensity of the central disc and slightly increasing the brightness of the first diffraction ring, but the result is not sufficient to injure the definition. It follows that any optical surface used in the formation of images is sensibly perfect if it introduces no distortion in the wave-front amounting to more than one-quarter wave-length (1/172000 inch).

In the case of a reflecting surface used at nearly perpendicular incidence the permissible error is hence one-eighth wave-length (1/344000 inch), for an error of this magnitude, being doubled in the reflection, will produce a quarter wave-length distortion in the wave-front. If the mirror is habitually used at larger angles of incidence the surface accuracy required is less, and diminishes in fact with the cosine of the angle of incidence. It will, of course, be understood that such refinements of workmanship are only required in instruments in which the finest attainable definition is sought, and in which the highest magnifications are used which are consistent with the aperture. Errors twice as great as those mentioned above are often permissible and, in low-powered instruments, aberrations of a whole wave-length are of no practical moment.

The accuracy required of a refracting surface is only about one-fourth as great as in the case of a reflecting surface. Suppose, for example, that there exists on the surface of a lens a local elevation one-half wave-length high. The path of the light passing through this elevation will be one-half wave-length shorter in air, and a corresponding distance longer in glass, than the path through neighboring portions of the lens. But, if we assume the refractive index of the glass to be 1.5, the waves in the glass will be but two-thirds as long as in air, so that the assumed elevation in the surface will increase the path in glass by three-fourths of a wave-length. The net increase in optical path due to the elevation is hence one-quarter wave-length, which measures the resulting deformation of the wave front. It therefore follows that the permissible error in a refracting surface is one-half wave-length, or four times as great as in the case of a mirror. Of course if the finest possible definition is not in question, considerably greater errors are allowable.

The well-known Foucault test, as developed by Professor G. W. Ritchey (Ritchey: "Modern Reflecting Telescopes," Chapters XI to XIV), is, in skillful hands, a sufficiently sensitive test to meet the requirements stated above, and is wonderfully flexible in its adaptation to surfaces of various forms. We use this method in testing plane mirrors above 18-inches in diameter, as well as in testing spherical, paraboloidal, and hyperboloidal mirrors and telescopic objectives. Our first quality surfaces are figured so that under the Foucault test they show perfectly uniform illumination when

the light is nearly extinguished.

Planes and parallel plates which are to be used in such instruments as interferometers and echelons are often required to have an accuracy considerably greater than that needed in telescopic work. Fortunately, however, interference methods of testing such surfaces to the required degree of precision have been developed by Rayleigh, Lummer, and others, so that we now find no very serious difficulty in making plane surfaces of moderate size which are true to within less than one-twentieth wave-length (1/860000 inch), or in making parallel plates of moderate thickness whose faces are flat and parallel to within the same limit of error. Indeed, the chief troubles connected with such work seem to arise from local changes of temperature during polishing, and from flexure of the glass. Owing to the latter cause the labor of making planes and parallel plates increases enormously when their thickness is decreased below certain limits. All of our parallel plates and all of our planes below 18 inches in diameter are tested by interference methods, and arrangements are contemplated which will enable us to similarly test planes up to the largest sizes.

Test Planes

These circular test planes are made for the purpose of testing the accuracy of other optical surfaces by the interference method. They are polished on both sides, and one side is figured to an accuracy of one-twentieth wave-length (1/860000 inch) in the Grade A, or to one-tenth wave-length (1/430000 inch) in Grade B, except at the extreme edges.

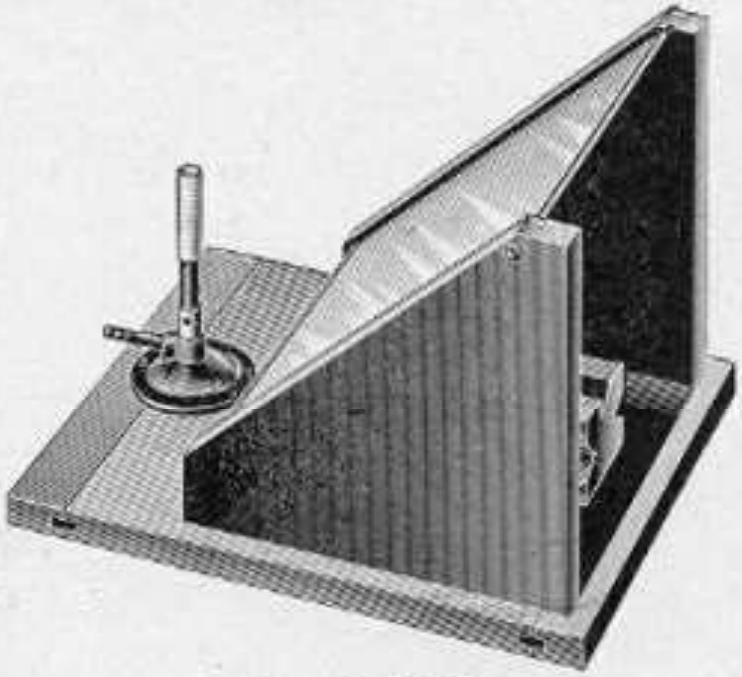


Fig. 1 D 140

To test an optical surface, such as that of a prism, it is placed under the ground glass diffusing screen of the testing device, Fig. 1 (D 140), in such a position that the surface to be tested lies horizontally. The test plane is then laid face down upon the surface, and the interference bands which show in the light of the sodium burner in the wedge-shaped air film between the two surfaces are examined. If these bands are straight and equidistant, as shown in Fig. 2, the surface is optically flat. If the bands are curved, as shown in Fig. 3, the surface is not perfectly plane. Since the difference in the path of the light in the air film between the two adjacent bands is one-half wave-length (1/86000 inch), it follows that, when the incidence is nearly normal, a curvature in one of the bands amounting to one-fifth the distance between the centres of two bands indicates an error of one-tenth wave-length (1/430000 inch) in the optical surface, and so plainly do the bands shows that an error of this magnitude can hardly escape the most casual observation. The appearance of the curved bands is shown in Fig. 3 where, since the curvature amounts to a whole band, the error of the lower surface is seen to be one-half wave-length (1/86000 inch).

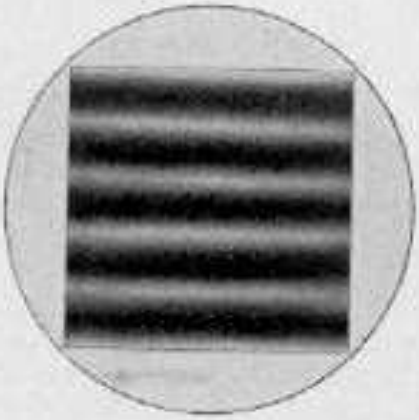


Fig. 2

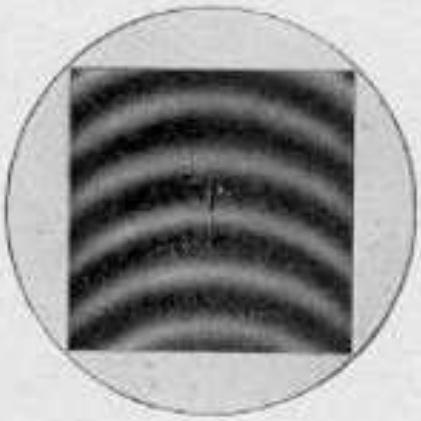


Fig. 3

The two surfaces must be quite clean when put together, and it is best to lightly wipe each with the palm of the hand, otherwise particles of dust or lint may hold the surfaces so far apart that the bands will be too narrow to be readily seen. If the surfaces are clean, the bands can be made of almost any desired width by lightly pressing down first on one point and then on another of the edge of the test plane. If the lower surface is sensibly convex or concave, the fringes may thus be made to assume a circular form, as shown in Fig. 4; the number of wave-lengths error in flatness of the surface from centre to edge is then given by half the number of the circular fringes, provided the incidence is nearly perpendicular. Dipping the head so as to increase the angle of incidence of the light which reaches the eyes, causes the fringes to move towards thicker parts of the air film; hence, if dipping the head causes the circular fringes to contract, the surface being tested is shown to be concave, and conversely in the case of a convex surface. In general, a motion of the fringes toward their centre of curvature, as shown by the arrow in Fig. 3, indicate concavity.

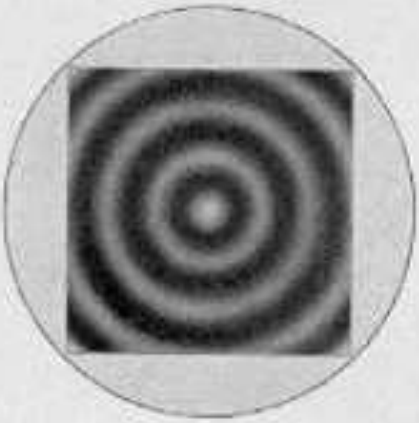


Fig. 4

The interference test is such an exceedingly sensitive one that care must be taken to avoid inequalities of temperature which might distort both the test plane and the surface to be tested. An instructive experiment may be made by letting the finger tips rest for a few moments on the upper surface of the test plane; it will be found that the heat from the fingers will distort the test plane so as to cause a marked curvature of the bands. It takes but half a minute to thus temporarily throw a 2½-inch test plane a half wave-length out of truth.

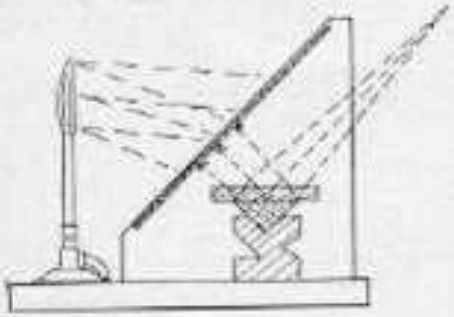


Fig. 5

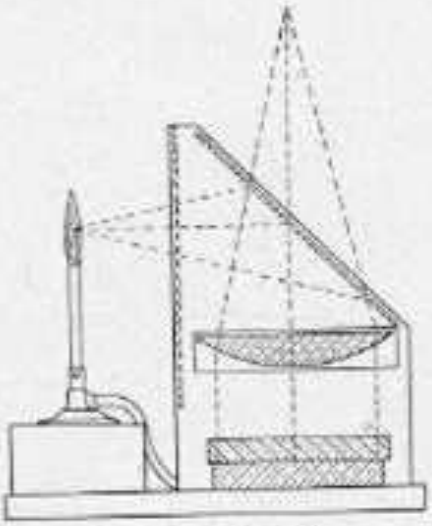
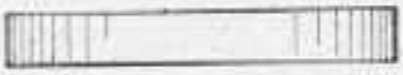


Fig. 6 D 141

In testing surfaces by the interference method, we use either the apparatus (D 140) shown in Fig. 1, or that shown in Fig. 6 (D 141), each of which includes a conveniently arranged sodium burner, a ground glass diffusing screen, and a movable grooved block so shaped as to hold 60° or 90° prisms in position for testing. Fig. 5 shows a sectional view of the apparatus (D 140) with a prism and test plane in position. The apparatus shown in Figs. 1 and 5 is used for ordinary tests; that shown in Fig. 6 is used when it is necessary to make the test with parallel light at normal incidence.

Test Planes, Grade A

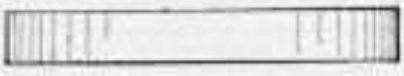


D 102–110

These test planes are circular, are polished on both sides, and one side is figured to an accuracy of one-twentieth wave-length (1/860000 inch), except at the extreme edges.

D 102.	**Test Plane, Grade A,** 2 inches in diameter, true to one-twentieth wave-length (1/860000 inch)	$10.00
D 103.	Same, 2½ inches	15.00
D 104.	Same, 3 inches	20.00
D 105.	Same, 3½ inches	25.00
D 106.	Same, 4 inches	30.00
D 108.	Same, 5 inches	47.00
D 110.	Same, 6 inches	65.00

Test Planes, Grade B



D 122–136

These test planes are circular, are polished on both sides, and one side is figured to an accuracy of one-tenth wave-length (1/430000 inch).

D 122.	**Test Plane, Grade B,** 2 inches in diameter, true to one-tenth wave-length (1/430000 inch)	$ 7.00
D 123.	Same, 2½ inches	10.00
D 124.	Same, 3 inches	13.00
D 125.	Same, 3½ inches	16.50
D 126.	Same, 4 inches	20.00
D 128.	Same, 5 inches	31.00

D 130.	Same, 6 inches	44.00
D 131.	Same, 7 inches	60.00
D 132.	Same, 8 inches	93.00
D 133.	Same, 9 inches	130.00
D 134.	Same, 10 inches	170.00
D 135.	Same, 11 inches	220.00
D 136.	Same, 12 inches	275.00

Testing Stands for Interference Tests

These stands are used with test planes in testing the accuracy of optical surfaces by the interference method described on page 5. Stand D 140 is used for ordinary tests; D 141 is used when it is necessary to secure perpendicular incidence, as in determining the exact curvature of surfaces which are almost flat. Each stand is supplied with a sodium burner or spirit lamp, a ground glass diffusing screen, and a support for prisms, while D 141 has in addition a 7-inch convex lens for securing parallel illumination.

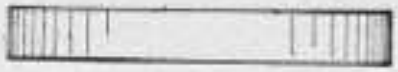
D 140. **Testing Stand,** simple form, for interference tests, with sodium burner, diffusing screen, and prism support..... $10.00

D 141. **Same,** arranged for tests at perpendicular incidence, with convex lens seven inches in diameter for securing parallel illumination 20.00

Plane Mirrors, Grade A

For Siderostats, Heliostats, etc.

These circular mirrors are made of glass which is homogeneous and free from strain. The thickness is usually about one-sixth or one-seventh the diameter of the disc. They are polished and silvered on both sides. All sizes up to 18 inches are tested by the interference method and figured on one side to an accuracy of one-eighth wave-length (1/344000 inch) except at the extreme edges. The larger sizes are tested by Foucault's method, with the aid of a spherical concave mirror, and figured so as to show perfectly uniform illumination when the light is nearly extinguished. The Foucault test is made with the mirror in a vertical position, supported by a band around the edge.



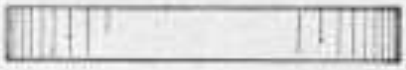
D 150–175

D 150.	**Plane Mirror, Grade A,** 1 inch in diameter, polished and silvered on both sides, with one side figured to an accuracy of one-eighth wave-length (1/344000 inch)... $	4.00
D 151.	Same, 1½ inches	5.00
D 152.	Same, 2 inches	6.50
D 153.	Same, 2½ inches	9.00
D 154.	Same, 3 inches	12.00
D 155.	Same, 3½ inches	15.00
D 156.	Same, 4 inches	18.00
D 158.	Same, 5 inches	28.00
D 160.	Same, 6 inches	40.00
D 161.	Same, 7 inches	55.00
D 162.	Same, 8 inches	85.00
D 163.	Same, 9 inches	120.00
D 164.	Same, 10 inches	160.00
D 165.	Same, 11 inches	200.00
D 166.	Same, 12 inches	250.00
D 167.	Same, 15 inches	475.00
D 168.	Same, 18 inches	750.00

D 169.	**Plane Mirror, Grade A,** 20 inches, figured by the Foucault test	1,000.00
D 170.	Same, 24 inches	1,600.00
D 171.	Same, 30 inches	2,800.00
D 172.	Same, 36 inches	4,400.00
D 173.	Same, 40 inches	5,700.00
D 174.	Same, 48 inches	9,000.00
D 175.	Same, 60 inches	16,000.00

Prices on larger sizes up to ten feet in diameter will be quoted on request.

Plane Mirrors, Grade B

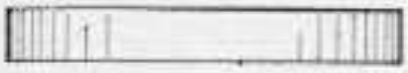


D 190–208

These circular mirrors are in every way similar to the mirrors of Grade A except in the accuracy of figuring. They are polished and silvered on both sides, tested by the interference method, and figured to an accuracy of one-fourth wave-length (1/172000 inch), except at the extreme edges.

D 190.	**Plane Mirror, Grade B,** 1 inch in diameter, polished and silvered on both sides, with one side figured to an accuracy of one-fourth wave-length (1/172000 inch)	$ 3.00
D 191.	Same, 1½ inches	4.00
D 192.	Same, 2 inches	5.00
D 193.	Same, 2½ inches	7.00
D 194.	Same, 3 inches	9.50
D 195.	Same, 3½ inches	12.00
D 196.	Same, 4 inches	15.00
D 198.	Same, 5 inches	24.00
D 200.	Same, 6 inches	34.00
D 201.	Same, 7 inches	47.00
D 202.	Same, 8 inches	70.00
D 203.	Same, 9 inches	100.00
D 204.	Same, 10 inches	135.00
D 205.	Same, 11 inches	170.00
D 206.	Same, 12 inches	215.00
D 207.	Same, 15 inches	400.00
D 208.	Same, 18 inches	640.00

Plane Mirrors, Grade C



D 220–234

These circular mirrors are made of good glass, are polished and silvered on one side, and are figured to an accuracy of one wave-length (1/43000 inch).

D 220.	**Plane Mirror, Grade C,** 1 inch in diameter, polished and silvered on one side, and figured to an accuracy of one wave-length (1/43000 inch)	$ 2.50
D 221.	Same, 1½ inches	3.00
D 222.	Same, 2 inches	4.00
D 223.	Same, 2½ inches	5.50
D 224.	Same, 3 inches	7.50
D 225.	Same, 3½ inches	9.50
D 226.	Same, 4 inches	12.00

D 228.	Same, 5 inches	18.50
D 230.	Same, 6 inches	27.00
D 231.	Same, 7 inches	38.00
D 232.	Same, 8 inches	55.00
D 233.	Same, 9 inches	80.00
D 234.	Same, 10 inches	110.00

Spherical Concave Mirrors, Grade A

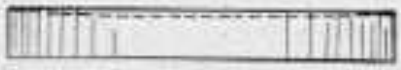
For the "Schlieren Method," etc.

D 260–268

These mirrors are of circular form, are ground flat on the back, and the concave front surface is polished and silvered. They are figured under the Foucault test so as to give uniform illumination when the light is nearly cut off. The focal lengths given below are approximate only.

D 260.	**Spherical Concave Mirror, Grade A,** 2 inches in diameter, 12 inches focal length	$ 5.00
D 261.	Same, 2½ inches, 15-inch focus	7.00
D 262.	Same, 3 inches, 18-inch focus	9.50
D 263.	Same, 4 inches, 24-inch focus	15.00
D 264.	Same, 5 inches, 30-inch focus	24.00
D 265.	Same, 6 inches, 36-inch focus	34.00
D 266.	Same, 8 inches, 48-inch focus	70.00
D 267.	Same, 10 inches, 60-inch focus	135.00
D 268.	Same, 12 inches, 72-inch focus	215.00

Spherical Concave Mirrors, Grade B



D 270–277

These are similar to the concave mirrors of Grade A, but are less carefully figured.

D 270.	**Spherical Concave Mirror, Grade B,** 2 inches in diameter, 12 inches focal length	$ 4.00
D 271.	Same, 2½ inches, 15-inch focus	5.50
D 272.	Same, 3 inches, 18-inch focus	7.50
D 273.	Same, 4 inches, 24-inch focus	12.00
D 274.	Same, 5 inches, 30-inch focus	18.50
D 275.	Same, 6 inches, 36-inch focus	27.00
D 276.	Same, 8 inches, 48-inch focus	55.00
D 277.	Same, 10 inches, 60-inch focus	110.00

Silver on Glass Specula, Flats, and Hyperboloids, for Reflecting Telescopes.

Paraboloidal Mirrors, Grade A

D 300–317

These mirrors are for use as specula in Newtonian and Cassegrainian telescopes. Diagonal flat mirrors for Newtonian telescopes are listed sepa-

rately below; prices of hyperboloidal mirrors for Cassegrains will be given on application.

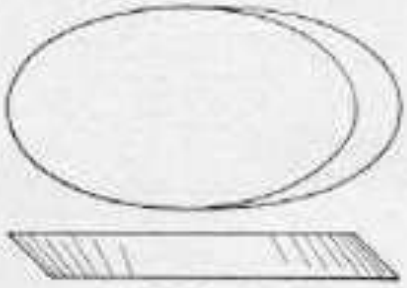
The paraboloidal mirrors of Grade A are made of glass which is homogeneous and free from strain. They are polished and silvered on both sides, and are tested by the Foucault method with the aid of a plane mirror of the same size, and figured to show a perfectly uniform illumination when the light is nearly extinguished. This method of testing ensures a perfection of figure and a freedom from zonal errors not otherwise attainable. The thickness of the mirrors is about one-sixth or one-seventh of the diameter, and all tests are made with the mirror in a vertical position, and supported by a band around its edge. The focal lengths given below are approximate only. When an exact focal length, or a very different focal length, is specified, an extra charge is made.

D 300.	**Paraboloidal Mirror, Grade A,** 6 inches in diameter, 5 feet focal length	$ 40.00
D 301.	**Same,** 7 inches, 6-ft. focus	55.00
D 302.	**Same,** 8 inches, 6¼-ft. focus	75.00
D 303.	**Same,** 9 inches, 6½-ft. focus	100.00
D 304.	**Same,** 10 inches, 7-ft. focus	150.00
D 305.	**Same,** 11 inches, 7½-ft. focus	200.00
D 306.	**Same,** 12 inches, 8-ft. focus	250.00
D 307.	**Same,** 15 inches, 10-ft. focus	375.00
D 308.	**Same,** 18 inches, 11-ft. focus	650.00
D 309.	**Same,** 20 inches, 12-ft. focus	1,000.00
D 310.	**Same,** 24 inches, 14-ft. focus	1,600.00
D 311.	**Same,** 30 inches, 16-ft. focus	2,800.00
D 312.	**Same,** 36 inches, 19-ft. focus	4,400.00
D 313.	**Same,** 40 inches, 21-ft. focus	5,700.00
D 314.	**Same,** 48 inches, 24-ft. focus	9,000.00
D 315.	**Same,** 60 inches, 29-ft. focus	16,000.00
D 316.	**Same,** 72 inches, 34-ft. focus	25,000.00
D 317.	**Same,** 84 inches, 40-ft. focus	38,000.00

Prices of other sizes up to ten feet in diameter will be quoted on request.

Diagonal Plane, Grade A

For Newtonian Telescopes



D 325–342

These planes are tested for flatness by the interference method, are figured to within an error of one-eighth wave-length, and after silvering are tried out in connection with the mirrors for which they are made.

D 325.	**Diagonal Plane, Grade A,** for 6-inch paraboloidal mirror	$ 8.00
D 326.	**Same,** for 7-inch mirror	9.00
D 327.	**Same,** for 8-inch mirror	9.50
D 328.	**Same,** for 9-inch mirror	10.00
D 329.	**Same,** for 10-inch mirror	15.00
D 330.	**Same,** for 11-inch mirror	20.00
D 331.	**Same,** for 12-inch mirror	25.00
D 332.	**Same,** for 15-inch mirror	37.00
D 333.	**Same,** for 18-inch mirror	60.00
D 334.	**Same,** for 20-inch mirror	90.00
D 335.	**Same,** for 24-inch mirror	140.00

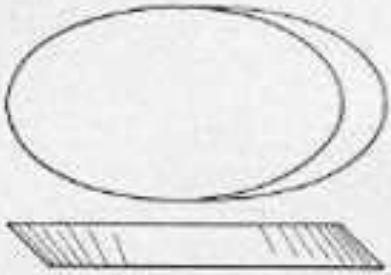
D 336.	Same, for 30-inch mirror	250.00
D 337.	Same, for 36-inch mirror	400.00
D 338.	Same, for 40-inch mirror	500.00
D 339.	Same, for 48-inch mirror	700.00
D 340.	Same, for 60-inch mirror	1,000.00
D 341.	Same, for 72-inch mirror	1,500.00
D 342.	Same, for 84-inch mirror	2,000.00

Paraboloidal Mirrors, Grade B

D 350–355

These are precisely similar to the Grade A mirrors except that they are not polished or silvered on the back, and are not figured to the same high degree of precision. They are suitable for use in Newtonian telescopes in cases where the finest possible definition is not needed, or where the necessarily high expense of a Grade A mirror cannot be borne.

D 350.	**Paraboloidal Mirror, Grade B,** 6 inches in diameter, 5 feet focal length	$ 35.00
D 351.	Same, 7 inches, 6-ft. focus	48.00
D 352.	Same, 8 inches, 6¼-ft. focus	65.00
D 353.	Same, 9 inches, 6½-ft. focus	85.00
D 354.	Same, 10 inches, 7-ft. focus	130.00
D 355.	Same, 12 inches, 8-ft. focus	215.00



D 360–365

Diagonal Planes, Grade B, for use with Grade B paraboloidal mirrors, figured to an accuracy of one-fourth wave-length.

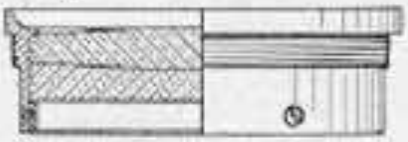
D 360.	**Diagonal Plane, Grade B,** for 6-inch paraboloidal mirror	$ 6.75
D 361.	Same, for 7-inch mirror	7.50
D 362.	Same, for 8-inch mirror	8.00
D 363.	Same, for 9-inch mirror	8.50
D 364.	Same, for 10-inch mirror	12.50
D 365.	Same, for 12-inch mirror	20.00

Resilvering Mirrors

Our plane, spherical, and paraboloidal mirrors are silvered when sent out, and with care the film should last for a year or more even if polished once or twice a week with wash leather and a trace of rouge. Instructions for resilvering by our potash process will be sent on request; we consider it best for the owner to do this work himself. Where time will not permit this, we can resilver mirrors at the prices given below. These prices include boxing and delivery of the mirrors on board cars at Chicago.

Any size up to 3 inches	$ 1.00
4 inches	1.25
5 inches	1.50
6 inches	1.75
7 inches	2.25
8 inches	2.50
9 inches	2.75
10 inches	3.25
11 inches	3.50
12 inches	4.00
15 inches	5.50
18 inches	7.00
20 inches	8.50
24 inches	12.00
30 inches	16.00
36 inches	25.00

Achromatic Objectives, Grade A

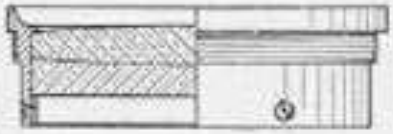


D 400–412

Mounted in cell, for astronomical telescopes, spectroscopes, etc., corrected either for visual or photographic work.

D 400.	**Achromatic Objective, Grade A,** 1 inch clear aperture, in cell	$ 6.00
D 401.	Same, 1¼ inches	7.50
D 402.	Same, 1½ inches	9.00
D 403.	Same, 1¾ inches	11.00
D 404.	Same, 2 inches	15.00
D 405.	Same, 2¼ inches	21.00
D 406.	Same, 2½ inches	28.00
D 407.	Same, 2¾ inches	36.00
D 408.	Same, 3 inches	45.00
D 409.	Same, 3½ inches	68.00
D 410.	Same, 4 inches	95.00
D 411.	Same, 4½ inches	130.00
D 412.	Same, 5 inches	175.00
D 413.	Same, 5½ inches	225.00
D 414.	Same, 6 inches	300.00
D 415.	Same, 6½ inches	375.00
D 416.	Same, 7 inches	475.00
D 417.	Same, 8 inches	675.00
D 418.	Same, 9 inches	900.00
D 419.	Same, 10 inches	1,100.00
D 420.	Same, 11 inches	1,450.00
D 421.	Same, 12 inches	1,850.00
D 422.	Same, 13 inches	2,400.00
D 423.	Same, 14 inches	3,000.00
D 424.	Same, 15 inches	3,600.00
D 425.	Same, 18 inches	6,200.00
D 426.	Same, 20 inches	8,500.00
D 427.	Same, 24 inches	13,500.00
D 428.	Same, 26 inches	17,000.00
D 429.	Same, 30 inches	24,000.00
D 430.	Same, 36 inches	35,000.00
D 431.	Same, 40 inches	50,000.00

Achromatic Objectives, Grade B

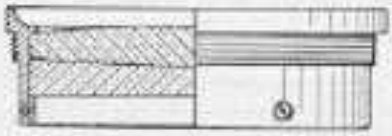


D 440–452

Mounted in cell. These objectives are similar to those of Grade A, except that they are not figured to as high a degree of precision. They are suitable for use in small astronomical telescopes for use of schools or amateurs, in spectroscopes of medium power, etc.

D 440.	**Achromatic Objective, Grade B,** 1 inch clear aperture, in cell	$ 4.75
D 441.	Same, 1¼ inches	6.00
D 442.	Same, 1½ inches	7.25
D 443.	Same, 1¾ inches	8.75
D 444.	Same, 2 inches	12.00
D 445.	Same, 2¼ inches	17.00
D 446.	Same, 2½ inches	22.50
D 447.	Same, 2¾ inches	30.00
D 448.	Same, 3 inches	38.00
D 449.	Same, 3½ inches	58.00
D 450.	Same, 4 inches	81.00
D 451.	Same, 4½ inches	110.00
D 452.	Same, 5 inches	150.00

Achromatic Objectives, Grade C



D 460–464

Mounted in cell. For low-power telescopes, reading telescopes, etc.

D 460.	**Achromatic Objective, Grade C,** 1 inch clear aperture, in cell	$3.75
D 461.	Same, 1¼ inches	4.75
D 462.	Same, 1½ inches	5.75
D 463.	Same, 1¾ inches	7.00
D 464.	Same, 2 inches	9.50

Objective Prisms

These prisms are for observing and photographing stellar spectra. Each prism is mounted in a cell, fitting the cell of the telescopic objective, and supplied with adjustment for minimum deviation. The prisms are made of fine annealed light flint glass.

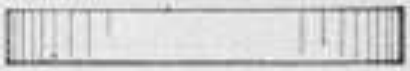
D 503.	**Objective Prism,** angle 3° to 7°, 3 inches clear aperture, in cell	$ 35.00
D 501.	Same, 3½ inches	45.00
D 502.	Same, 4 inches	60.00
D 503.	Same, 4½ inches	75.00
D 504.	Same, 5 inches	100.00
D 505.	Same, 5½ inches	130.00
D 506.	Same, 6 inches	170.00
D 507.	Same, 6½ inches	210.00
D 508.	Same, 7 inches	250.00

D 509.	Same, 8 inches	350.00
D 510.	Same, 9 inches	450.00
D 511.	Same, 10 inches	600.00
D 512.	Same, 11 inches	800.00
D 513.	Same, 12 inches	1,000.00
D 514.	Same, 13 inches	1,250.00
D 515.	Same, 14 inches	1,600.00
D 516.	Same, 15 inches	1,950.00
D 517.	Same, 18 inches	3,000.00
D 518.	Same, 20 inches	4,000.00
D 519.	Same, 24 inches	6,300.00
D 530.	Objective Prism, angle 40° to 45°, 3 inches clear aperture, in cell	$ 80.00
D 531.	Same, 3½ inches	100.00
D 532.	Same, 4 inches	135.00
D 533.	Same, 4½ inches	170.00
D 534.	Same, 5 inches	225.00
D 535.	Same, 5½ inches	290.00
D 536.	Same, 6 inches	380.00
D 537.	Same, 6½ inches	475.00

Plane Parallel Plates

We list four grades of these plates ranging in accuracy from one-twentieth to one wave-length. Plates of Grade B (1/10 w. l.) are suitable for practically all interferometer work; those of Grade A (1/20 w. l.) are intended for use in the interferometers of Lummer and of Fabry and Perot. Grade D plates (1 w. l.) answer many optical purposes, while plates of Grade C (¼ w. l.) are suited to all telescopic and spectroscopic work in which the best definition of the image must be secured. (See p. 4 on the accuracy required of optical surfaces.) The thickness of these parallel plates is from one-eighth to one-tenth of the diameter. Thin plates, and plate of specified thickness, are supplied at higher prices.

Plane Parallel Plates, Grade A

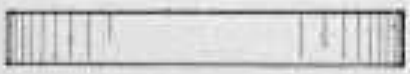


D 600–604

These plates are made of the best fine-annealed optical glass, and are plane and parallel to within one-twentieth wave-length (1/860000 inch), except at the extreme edges.

D 600.	Plane Parallel Plate, Grade A, 2 inches in diameter, true to 1/20 wave-length (1/860000 inch)	$20.00
D 601.	Same, 2½ inches	30.00
D 602.	Same, 3 inches	40.00
D 603.	Same, 3½ inches	50.00
D 604.	Same, 4 inches	60.00

Plane Parallel Plates, Grade B

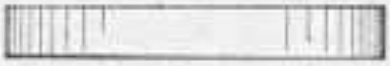


D 610–616

These plates are made of the best fine-annealed optical glass, and are plane and parallel to within one-tenth wave-length (1/430000 inch), except at the extreme edges.

D 610.	**Plane Parallel Plate, Grade B,** 2 inches in diameter, true to one-tenth wave-length (1/430000 inch)	$14.00
D 611.	Same, 2½ inches	20.00
D 612.	Same, 3 inches	26.00
D 613.	Same, 3½ inches	33.00
D 614.	Same, 4 inches	40.00
D 615.	Same, 5 inches	62.00
D 616.	Same, 6 inches	88.00

Plane Parallel Plates, Grade C



D 620–628

These plates are made of the best optical glass. They are plane to within one-fourth wave-length (1/172000 inch) except at the extreme edges, and parallel to within 10 seconds of arc.

D 620.	**Plane Parallel Plate, Grade C,** 2 inches in diameter, true to ¼ wave-length (1/172000 inch)	$ 10.00
D 621.	Same, 2½ inches	14.00
D 622.	Same, 3 inches	18.00
D 623.	Same, 3½ inches	24.00
D 624.	Same, 4 inches	30.00
D 625.	Same, 5 inches	46.00
D 626.	Same, 6 inches	66.00
D 627.	Same, 7 inches	90.00
D 628.	Same, 8 inches	140.00

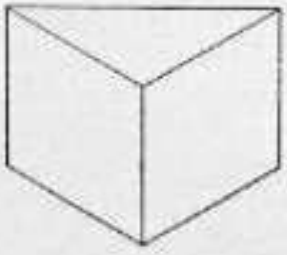
Plane Parallel Plates, Grade D

D 630–638

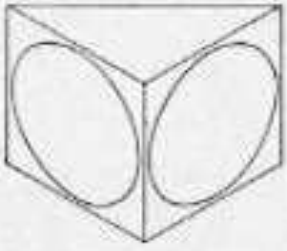
These plates are made of well-annealed optical glass. They are plane to within one wave-length (1/43000 inch), and parallel to within 30 seconds of arc.

D 630.	**Plane Parallel Plate, Grade D,** 2 inches in diameter, true to one wave-length (1/43000 inch)	$ 8.00
D 631.	Same, 2½ inches	11.00
D 632.	Same, 3 inches	15.00
D 633.	Same, 3½ inches	19.00
D 634.	Same, 4 inches	24.00
D 635.	Same, 5 inches	37.00
D 636.	Same, 6 inches	54.00
D 637.	Same, 7 inches	76.00
D 638.	Same, 8 inches	110.00

Right Angled Reflecting Prisms



D 650–669



D 670–683

We list these prisms with both round and rectangular faces, and in three grades. All are made of fine-annealed optical crown glass, with angles of 90°, 45° and 45°.

90° Reflecting Prisms, Grade A

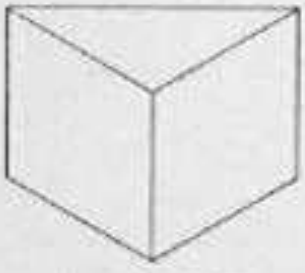
Reflecting prisms of Grade A have faces worked to an accuracy of one-eighth wave-length (1/344000 inch), the angles are true to within 30 seconds of arc, and the prisms are sensibly free from pyramidal errors.

1. Square Face

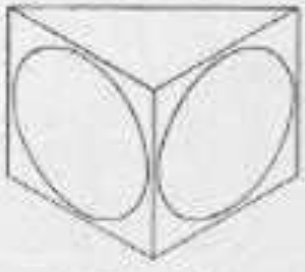
D 650.	Reflecting Prism, Square Faces, Grade A, ⅛ inch height and edge, faces accurate to one-eighth wave-length (1/344000 inch)	$ 5.00
D 651.	Same, 3/16 inch	4.00
D 652.	Same, ¼ inch	3.00
D 653.	Same, ⅜ inch	3.00
D 654.	Same, ½ inch	3.50
D 655.	Same, ⅝ inch	4.00
D 656.	Same, ¾ inch	5.50
D 657.	Same, ⅞ inch	7.00
D 658.	Same, 1 inch	8.50
D 659.	Same, 1¼ inches	11.00
D 660.	Same, 1½ inches	15.00
D 661.	Same, 1¾ inches	19.00
D 662.	Same, 2 inches	24.00
D 663.	Same, 2¼ inches	30.00
D 664.	Same, 2½ inches	37.50
D 665.	Same, 2¾ inches	54.00
D 666.	Same, 3 inches	72.00
D 667.	Same, 3½ inches	108.00
D 668.	Same, 4 inches	214.00
D 669.	Same, 4½ inches	312.00

2. Round Face

D 670.	Reflecting Prism, Round Faces, Grade A, faces ¾ inch in diameter, accurate to one-eight wave-length (1/344000 inch)	$ 5.00
D 671.	Same, ⅞ inch	6.50
D 672.	Same, 1 inch	7.50
D 673.	Same, 1¼ inches	10.00
D 674.	Same, 1½ inches	13.50
D 675.	Same, 1¾ inches	17.50
D 676.	Same, 2 inches	22.00
D 677.	Same, 2¼ inches	27.00
D 678.	Same, 2½ inches	34.00
D 679.	Same, 2¾ inches	49.00
D 680.	Same, 3 inches	66.00
D 681.	Same, 3½ inches	98.00
D 682.	Same, 4 inches	194.00
D 683.	Same, 4½ inches	285.00



D 690–709



D 710–731

90° Reflecting Prisms, Grade B

Reflecting prism of Grade B have faces worked to an accuracy of one-

fourth wave-length (1/172000 inch); the angles are true to within 2 minutes of arc, and the prisms are sensibly free from pyramidal errors.

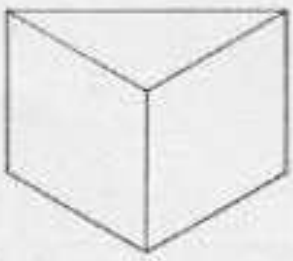
1. Square Face

D 690.	Reflecting Prism, Square Face, Grade B, accurate to one-fourth wave-length (1/172000 inch), ⅛ inch height and edge	$ 4.00
D 691.	Same, 3/16 inch	3.25
D 692.	Same, ¼ inch	2.25
D 693.	Same, ⅜ inch	2.25
D 694.	Same, ½ inch	2.75
D 695.	Same, ⅝ inch	3.00
D 696.	Same, ¾ inch	4.25
D 697.	Same, ⅞ inch	5.25
D 698.	Same, 1 inch	6.50
D 699.	Same, 1¼ inches	8.25
D 700.	Same, 1½ inches	11.50
D 701.	Same, 1¾ inches	14.50
D 702.	Same, 2 inches	18.50
D 703.	Same, 2¼ inches	23.00
D 704.	Same, 2½ inches	28.00
D 705.	Same, 2¾ inches	42.00
D 706.	Same, 3 inches	55.00
D 707.	Same, 3½ inches	83.00
D 708.	Same, 4 inches	162.00
D 709.	Same, 4½ inches	240.00

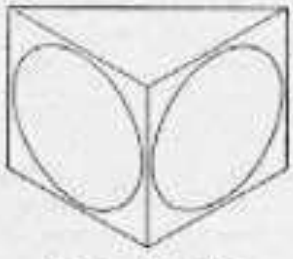
2. Round Face

D 720.	Reflecting Prism, Round Face, Grade B, faces 1 inch diameter, true to one-fourth wave-length (1/172000 inch)	$ 5.75
D 721.	Same, 1⅛ inches	7.50
D 722.	Same, 1½ inches	10.50
D 723.	Same, 1¾ inches	13.00
D 724.	Same, 2 inches	16.75
D 725.	Same, 2¼ inches	21.00
D 726.	Same, 2½ inches	25.50
D 727.	Same, 2¾ inches	36.50
D 728.	Same, 3 inches	50.00
D 729.	Same, 3½ inches	75.00
D 730.	Same, 4 inches	148.00
D 731.	Same, 4½ inches	215.00

90° Reflecting Prisms, Grade C



D 740–759



D 770–779

Reflecting prisms of Grade C have faces worked to an accuracy of one wave-length (1/43000 inch), and angles true to within 5 minutes of arc.

1. Square Face

D 740.	Reflecting Prism, Square Faces, Grade C, ⅛-inch face and edge, accurate to one wave-length (1/43000 inch)	$ 2.50
D 741.	Same, 3/16 inch	2.25
D 742.	Same, ¼ inch	2.00
D 743.	Same, ⅜ inch	2.00
D 744.	Same, ½ inch	2.00

D 745.	Same, ⅝ inch	2.25
D 746.	Same, ¾ inch	3.00
D 747.	Same, ⅞ inch	3.85
D 748.	Same, 1 inch	4.75
D 749.	Same, 1¼ inches	6.00
D 750.	Same, 1½ inches	8.25
D 751.	Same, 1¾ inches	10.50
D 752.	Same, 2 inches	13.25
D 753.	Same, 2¼ inches	16.00
D 754.	Same, 2½ inches	20.00
D 755.	Same, 2¾ inches	31.00
D 756.	Same, 3 inches	39.00
D 757.	Same, 3½ inches	60.00
D 758.	Same, 4 inches	118.00
D 759.	Same, 4½ inches	180.00

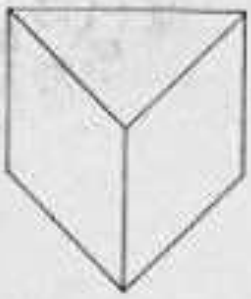
1. Round Face

D 770.	**Reflecting Prism, Round Faces, Grade C,** faces 1½ inches in diameter, true to one wave-length (1/43000 inch)	$ 7.50
D 771.	Same, 1¾ inches	9.75
D 772.	Same, 2 inches	12.00
D 773.	Same, 2¼ inches	15.00
D 774.	Same, 2½ inches	18.75
D 775.	Same, 2¾ inches	27.00
D 776.	Same, 3 inches	36.00
D 777.	Same, 3½ inches	54.00
D 778.	Same, 4 inches	105.00
D 779.	Same, 4½ inches	150.00

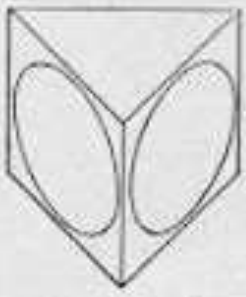
60° Extra Dense Flint Glass Prisms

These prisms are intended for spectroscopic use. They are made of fine-annealed, extra-dense flint glass of refractive index about 1.65 for the D line, and are polished on two faces. Three grades are listed, differing only in the accuracy to which the faces are worked.

Spectroscope Prisms, Grade A



D 800–813



D 820–833

These prisms are supplied either with round or square faces, and are worked to an accuracy of one-eighth wave-length (1/344000 inch).

1. Square Face

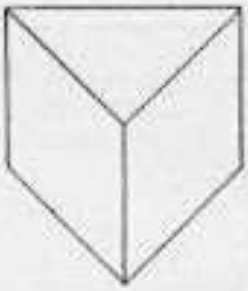
D 800.	**Spectroscopic 60° Prism of Extra Dense Flint Glass, Grade A,** height and edge ¾ inch, with two square polished faces accurate to one-eighth wave-length (1/344000 inch)	$ 3.25
D 801.	Same, ⅞ inch	4.25
D 802.	Same, 1 inch	5.00
D 803.	Same, 1¼ inches	6.50
D 804.	Same, 1½ inches	9.00
D 805.	Same, 1¾ inches	11.25
D 806.	Same, 2 inches	14.50

D 807.	Same, 2¼ inches	18.00
D 808.	Same, 2½ inches	22.50
D 809.	Same, 2¾ inches	32.50
D 810.	Same, 3 inches	43.00
D 811.	Same, 3½ inches	65.00
D 812.	Same, 4 inches	125.00
D 813.	Same, 4½ inches	180.00

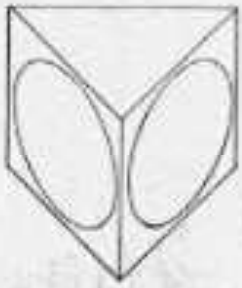
2. Round Face

D 820.	Spectroscopic 60° Prism of Extra Dense Flint Glass, Grade A, height and edge ¾ inch, with two round polished faces accurate to one-eighth wave-length (1/344000 inch)	$ 3.00
D 821.	Same, ⅞ inch	4.00
D 822.	Same, 1 inch	4.50
D 823.	Same, 1¼ inches	6.00
D 824.	Same, 1½ inches	8.00
D 825.	Same, 1¾ inches	10.00
D 826.	Same, 2 inches	13.00
D 827.	Same, 2¼ inches	16.00
D 828.	Same, 2½ inches	20.00
D 829.	Same, 2¾ inches	30.00
D 830.	Same, 3 inches	40.00
D 831.	Same, 3½ inches	60.00
D 832.	Same, 4 inches	110.00
D 833.	Same, 4½ inches	160.00

Spectroscope Prisms, Grade B



D 841–853



D 860–873

These prisms are supplied either with round or square faces, and are worked to an accuracy of one-fourth wave-length (1/172000 inch).

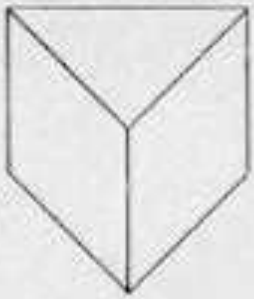
1. Square Face

D 840.	Spectroscopic 60° Prism of Extra Dense Flint Glass, Grade B, height and edge ¾ inch, with two square polished faces accurate to one-fourth wave-length (1/172000 inch)	$ 2.75
D 841.	Same, ⅞ inch	3.50
D 842.	Same, 1 inch	4.00
D 843.	Same, 1¼ inches	5.25
D 844.	Same, 1½ inches	7.25
D 845.	Same, 1¾ inches	9.00
D 846.	Same, 2 inches	11.50
D 847.	Same, 2¼ inches	14.50
D 848.	Same, 2½ inches	18.00
D 849.	Same, 2¾ inches	26.00
D 850.	Same, 3 inches	35.00
D 851.	Same, 3½ inches	54.00
D 852.	Same, 4 inches	100.00
D 853.	Same, 4½ inches	145.00

2. Round Face

D 860.	Spectroscopic 60° Prism of Extra Dense Flint Glass, Grade B, height and edge ¾ inch, with two round polished surfaces accurate to one-fourth wave-length (1/172000 inch)	$ 2.50
D 861.	Same, ⅞ inch	3.25
D 862.	Same, 1 inch	3.75
D 863.	Same, 1¼ inches	4.75
D 864.	Same, 1½ inches	6.50
D 865.	Same, 1¾ inches	7.00
D 866.	Same, 2 inches	10.00
D 867.	Same, 2¼ inches	13.00
D 868.	Same, 2½ inches	17.25
D 870.	Same, 3 inches	31.50
D 871.	Same, 3½ inches	50.00
D 872.	Same, 4 inches	90.00
D 873.	Same, 4½ inches	130.00

Spectroscope Prisms, Grade C

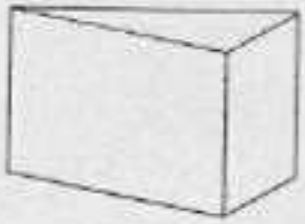


D 880–884

These prisms are intended for ordinary school work. They are made only in small sizes, and with two square polished faces accurate to one wave-length (1/43000 inch).

D 880.	Extra Dense Flint Glass 60° Prism, Grade C, ¾ inch height and edge, with two square polished faces accurate to one wave-length (1/43000 inch)	$2.50
D 881.	Same, ⅞ inch	3.00
D 882.	Same, 1 inch	3.25
D 883.	Same, 1¼ inches	4.00
D 884.	Same, 1½ inches	5.50

Extra Dense Flint Glass Half Prisms



DH 810

These prisms have angles of 30°, 60° and 90°. They are made in Grades A and B at the same prices as the 60° prisms of corresponding grade, and are designated by the same catalogue numbers, but the prefix D is followed by an H. Thus DH 810 denotes a 3-inch extra-dense flint half-prism.

Prisms of any angle less than 60° are supplied at the prices of the 60° prisms, but an extra charge of 50 per cent. is made in cases where the angle must be exact to within 10 seconds of arc.

Prisms of Crown, Light Flint and Densest Flint Glasses

Crown glass and light flint glass prisms are supplied at the prices of dense flint glass prisms. For prisms of densest flint glass an extra charge is made on account of the higher cost of the glass and the greater difficulty in working it.

Set of Eight 60° Prisms to Illustrate Properties of Various Optical Glasses

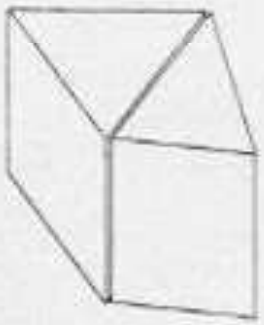
These prisms are made either of Grade A or Grade B in one-inch size only, and are sold only in sets at the prices given below. The prisms are made of the following Jena glasses:

Jena No.	Name	n=Ref. Index for D line	Dispersion C to F	n-1 / Δ n
O 802	Boro silicate Crown	1.497	0.0077	64.9
O 203	Ordinary silicate Crown	2.518	0.0088	59.0
O 3775	Densest baryta Crown	1.612	0.0110	55.7
O 3419	Telescope flint of low dispersive power	1.515	0.0094	54.6
O 569	Ordinary light flint	1.574	0.0139	41.4
O 93	Ordinary flint	1.625	0.0174	35.8
O 102	Dense flint	1.649	0.0192	33.8
O 198	Densest flint	1.778	0.0294	26.5

D 890. **Set of Eight 60° Prisms** of various glasses as above, 1-inch face, Grade A..... $45.00

D 891. **Same,** Grade B..... 37.50

Achromatic Prism

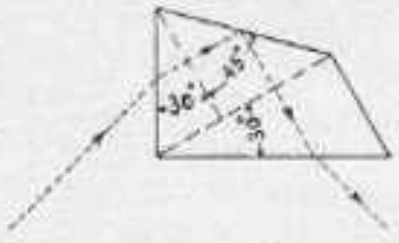


D 895

This consists of a 1¼-inch crown glass 60° prism of Grade B, combined with a flint glass prism of proper angle to secure achromatism. The prisms may be used singly or in combination.

D 895. **Achromatic Prism,** 1¼-inch, Grade B..... $10.00

Constant Deviation Prisms



D 900–902

These constant deviation prisms are used in cases where it is desirable to have both the telescope and collimator of the spectroscope fixed, and to

run through the spectrum by turning the prism. This prism may be considered as a combination of two 30° prisms and one 90° prism. It will be seen from the illustration that it is equivalent to one 60° prism in its dispersive power but that, with the telescope and collimator fixed at right angles to each other, any part of the spectrum may be brought into view by rotating the prism, and that the portion of the spectrum in the middle of the field is seen at minimum deviation.

These prisms are ordinarily made in one piece; but the large sizes are built up in three pieces when extra dense glass is used, the reflecting element being then made of a nonabsorptive crown glass.

D 900. **Constant Deviation Prism,** Dense Flint Glass, 1 inch..... $18.50
D 901. **Same,** 1¼ inches..... 24.00
D 902. **Same,** 1½ inches..... 33.00

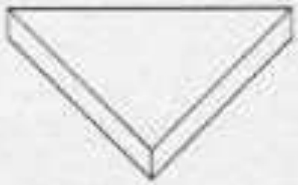
Wedge Prisms

D 920–925

These prisms are useful in many cases for diverting a portion of a beam of light. They are made of crown glass with ordinary polished surfaces, and are about 1⅜ inches square.

D 920. **Wedge Prism,** about 1⅜ inches square, 2° angle..... $1.00
D 921. **Same,** 4° angle..... 1.25
D 922. **Same,** 6° angle..... 1.25
D 923. **Same,** 8° angle..... 1.50
D 924. **Same,** 10° angle..... 1.50
D 925. **Same,** 12° angle..... 1.75

Student's Prisms



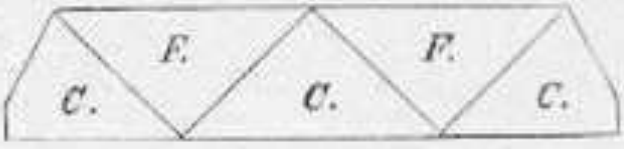
D 927–928

These prisms are for use in tracing the path of light by the "pin method" in the elementary laboratory. The prisms are about 3 inches on the edge, ⅜ inch thick, and are polished on three faces and one base, the other base being fine ground.

D 927. **Student's Prism** made of good plate glass..... $1.25
D 928. **Same,** made of optical crown glass..... 2.50

Direct Vision Prisms

D 930–934

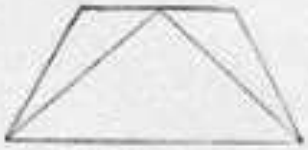


D 940–944

D 930. **Direct Vision Triple Prism,** 10 mm. on the side..... $ 7.50
D 931. **Same,** 15 mm. side..... 10.50

D 932. Same, 20 mm. side..... 14.50
D 933. Same, 25 mm. side..... 19.00
D 934. Same, 30 mm. side..... 24.00
D 940. Direct Vision Quintuple Prism, 10 mm. on the side..... 10.50
D 941. Same, 15 mm. side..... 16.00
D 942. Same, 20 mm. side..... 24.00
D 943. Same, 25 mm. side..... 32.00
D 944. Same, 30 mm. side..... 40.00

Rutherford's Compound Prisms



D 950–953

D 950. Rutherford Prism, 30 mm. edge..... $16.50
D 951. Same, 40 mm. edge..... 28.00
D 952. Same, 50 mm. edge..... 48.00
D 953. Same, 60 mm. edge..... 80.00

Abbe Reflecting Prisms

D 960–961

These consist of two right-angled prisms cemented together on the slant faces. One of these faces is silvered except for a small spot at the centre. The eye, looking through the prism, sees the direct and the reflected images superposed. Used as a camera-lucida, etc.

D 960. Abbe Reflecting Prism, 6.5 mm. on the edge..... $2.75
D 961. Same, 9.5 mm. edge..... 3.75

Brace Spectrophotometer Prisms

D 970

The Brace prism consists of two 30° prisms, cemented together (usually with Canada balsam) and part silvered on one of the two abutting faces.

D 970. Brace Prisms, pair 30x60 mm., balsam cemented..... $22.50

Hollow Prisms, 60° Angle, Grade A

These prisms are made from a solid block of glass, bored and optically faced. The cover plates are plane parallel and are attached by pressure to the polished faces of the prism after the contacting surfaces have been thoroughly cleaned. The cover plates are readily detached by quickly heating the outer surfaces.

D 980–981

D 980. Hollow Prism, Grade A, ¾-inch bore $25.00
D 981. Same, 1-inch bore 32.00

Hollow Prisms, Grade B

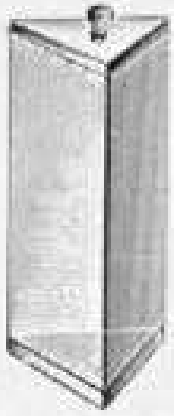
D 985

These are of similar construction to the Grade A prisms, except that the cover plates are made of a good grade of mirror glass, and the prism faces are not polished. The cover plates are held in place by rubber bands. These prisms are very satisfactory for student's work.

D 985. Hollow Prism, Grade B, ¾-inch bore $5.50

Prices of larger sizes on application.

Hollow Prisms, Grade C



D 990–991

These prisms are made of the best mirror glass, the pieces being fused together by means of an enamel which resists all ordinary reagents. These prisms are suited for use as bisulphide prisms in lantern work, etc.

D 990. Hollow Prism, Grade C, 2⅜ inches high, 2⅜ inches wide $5.25
D 991. Same, 4 inches high, 3⅛ inches wide 8.00

Trough Prisms

These are made of pieces of mirror glass fused together with a resistant enamel. Each compartment is 2 inches long and 2 inches on the side. These trough prisms are useful for showing refraction and dispersion of liquids in the lantern, with horizontal slit.

D 995. **Trough Prism,** 3 compartments..... 6.50

Wedge Shaped Absorption Troughs

D 988

D 1000

These troughs are made of pieces of mirror glass fused together with a resistant enamel. Being wedge-shaped, and supplied in pairs, they enable one to secure a layer of liquid of variable thickness in absorption experiments.

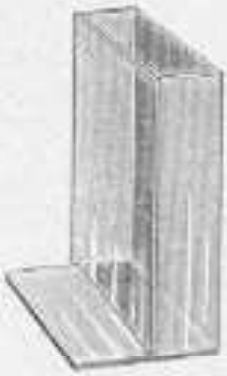
D 998. **Wedge Shaped Absorption Troughs,** per pair, 6x2 inches 8.00
D 1000. **Wedge Shaped Troughs for Colorimeters,** 6x1½ inches, each 5.00

Spectroscopic Absorption Cells

D 1002–1004

D 1006–1008

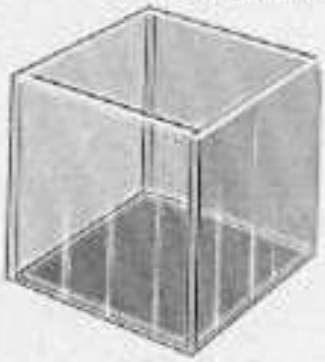
D 1010–1012



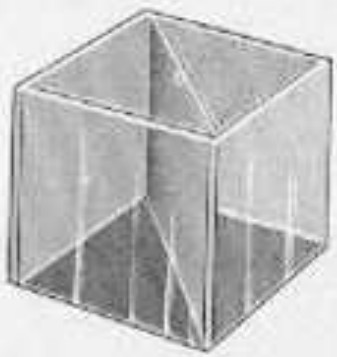
D 1014–1015

These cells are of glass, faced with pieces of the best mirror glass fused on with a resistant enamel.

D 1002. **Absorption Cell, U-Shaped,** 1¼x¾ inches, ⅜ inch thick.. 1.25
D 1004. **Same,** 4x3⅛x3/16 inches..... 2.00
D 1006. **Absorption Cell with Circular Cavity,** 2x5/32 inches..... 1.50
D 1007. **Same,** 3⅛x5/32 inches 2.50
D 1008. **Same,** 4x5/32 inches..... 3.00
D 1010. **Absorption Cell with Circular Cavity and Stopper,** 2x⅜ inches 3.50
D 1011. **Same,** 3⅛x⅜ inches..... 4.25
D 1012. **Same,** 4x⅜ inches..... 5.00
D 1014. **Rectangular Absorption Cell with Cover,** 3⅛x2x⅜ inches 1.25
D 1015. **Same,** 4x2⅛x⅜ inches..... 1.75

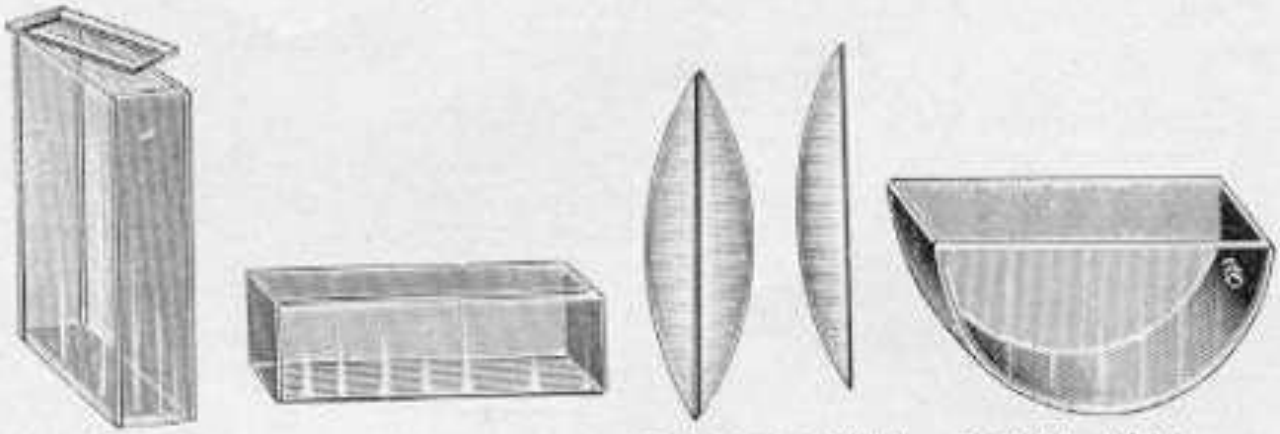


D 1016–1018



D 1020–1021

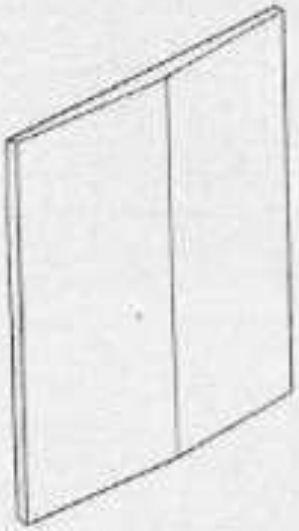
D 1016.	**Cubical Glass Box with Cover,** 1½x1½x1½ inches	1.25
D 1017.	**Same,** 2⅜x2⅜x2⅜ inches	1.50
D 1018.	**Same,** 4x4x4 inches	5.00
D 1020.	**Cubical Glass Box with Diagonal Partition,** forming two prisms, 1½x1½x1½ inches	3.50
D 1021.	**Same,** 2⅜x2⅜x2⅜ inches	4.00



D 1023–1025 D 1027 D 1030 D 1031 D 1033–1034

D 1023.	**Rectangular Glass Box with Cover,** 4x4x⅜ inches	1.50
D 1024.	**Same,** 4x4x1⅛ inches	2.25
D 1025.	**Same,** 4x2x2 inches	1.75
D 1027.	**Rectangular Glass Trough,** without cover, 6x2x1⅛ inches	2.00
D 1030.	**Double Convex Hollow Lens,** 4 inches in diameter, with hole for filling	3.50
D 1031.	**Plano Convex Hollow Lens,** 4 inches in diameter, with hole for filling	3.50
D 1033.	**Hollow Half Cylinder,** with one ground side, and hole for filling, for experiments on refraction in liquids, 1½ inches diameter	4.25
D 1034.	**Same,** 3⅛ inches diameter	8.00
D 1907.	**Glass Discs for Observation Tubes,** of best white glass free from strain, usual size 15 mm., each	.10

Fresnel's Biprisms



D 1050–1052

D 1050.	**Fresnel's Biprism,** 1⅛x1½ inches, unmounted	$5.00
D 1051.	**Same,** 1½x2 inches	6.00
D 1052.	**Same,** 2x2¼ inches	9.50

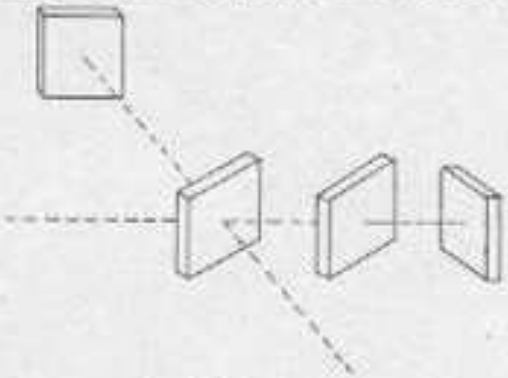
Plates for Newton's Rings

D 1060–1063

This apparatus consists of two glass plates polished on both sides. One side of one of the plates is a true plane, corrected to one-tenth wave-length (1/430000 inch). The second plate has one face convex by about 20 fringes. The Newton's rings given by these plates are quite truly circular, so that accurate measurements can be made with them.

D 1060. **Newton's Rings Plates,** 1 inch in diameter, the pair..... $ 8.00
D 1061. **Same,** 1½ inches..... 9.00
D 1062. **Same,** 2 inches..... 11.00
D 1063. **Same,** 3 inches..... 21.00

Interferometer Plates



D 1070–1073

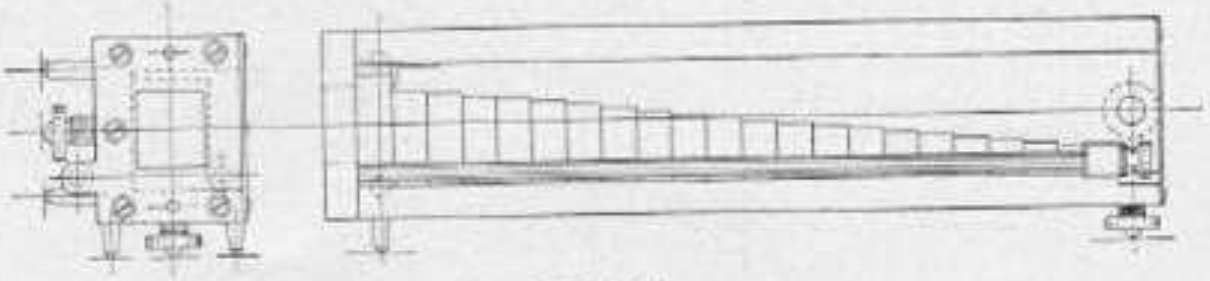
These plates are used in Michelson interferometers. Each set consists of two silvered mirrors worked true to one-tenth wave-length (1/430000 inch), and two plane parallel plates accurate to within the same limit of error. Plates and mirrors accurate to one-twentieth wave-length can be supplied at an advance of fifty per cent. on prices given below.

D 1070. **Set of Interferometer Plates,** consisting of two plane parallel plates ⅝x⅞ inches, and two mirrors ⅝x⅝ inches $ 8.25
D 1071. **Same,** with plates ¾x1 3/16 inches, and mirrors ¾x¾ inches 13.75
D 1072. **Same,** with plates 1x1 9/16 inches, and mirrors 1x1 inches 16.50
D 1073. **Same,** with plates 1½x2⅜ inches, and mirrors 1½x1½ inches 38.50

Michelson Echelon Gratings

These echelons are substantially mounted by clamping the plates in a special frame which enables the echelon to be used with the edges of the plates either vertical or horizontal. The plates are cut from plane parallel discs about 10 mm. thick. The width of the step is made 1 mm. in all sizes, and the height of the plates is such as to give a square aperture the length of whose edge in millimetres is equal to the number of plates in the echelon. Echelons cut from discs 15 mm. thick are supplied at an advance of 30 per cent.; the extra charge for plates 20 mm. thick is 60 per cent.

D 1100. **Michelson Echelson Grating,** 10 plates, each about 10 mm. thick, aperature 10 mm. square, resolving power about 100,000 lines, mounted so that the echelon can be used with edges vertical or horizontal..... $ 65.00



D 1101

D 1101. **Same,** 20 plates, 20 mm. aperture, resolving power about 200,000 lines 140.00

D 1102. **Same,** 30 plates, 30 mm. aperture, resolving power about 300,000 lines 275.00

D 1103. **Same,** 40 plates, 40 mm. aperture, resolving power about 400,000 lines 600.00

Lummer Plates

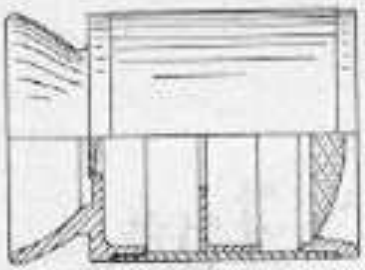
These are strips of accurately plane-parallel glass 10 mm. thick. One of these plates used with any spectroscope of suitable size forms the powerful spectroscopic combination described by Lummer and Gehrcke. Complete instruments will be quoted on application.

D 1110. **Lummer Plate,** 100 mm. long, 30 mm. high, and 10 mm. thick ..... $ 50.00

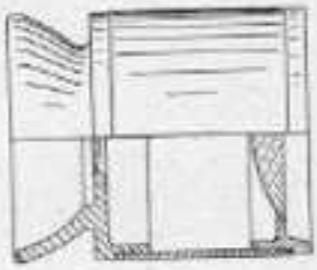
D 1111. **Same,** 200x35x10 mm. 125.00

D 1112. **Same,** 300x40x10 mm. 200.00

Eyepieces for Telescopes



D 1253



D 1273

The shorter focal lengths have mounts of our standard size, 1¼ inches in diameter. Eyepieces of focal lengths above 1½ inches must generally be supplied with special adapters.

Huygenian Eyepieces for Telescopes

D 1250. **Huygenian Eyepiece,** ¼-inch focus ..... $ 5.00

D 1251. **Same,** ½-inch focus 5.00

D 1252. **Same,** ¾-inch focus 5.00

D 1253. **Same,** 1-inch focus 5.00

D 1254. **Same,** 1¼-inches focus 6.00

D 1255. **Same,** 1½-inches focus 6.00

D 1256. **Same,** 1¾-inches focus 7.00

D 1257. **Same,** 2-inches focus 8.00

D 1258. **Same,** 2½-inches focus 12.00

D 1259. **Same,** 3-inches focus 20.00

Ramsden Eyepieces for Telescopes

D 1270. **Ramsden Eyepiece,** ¼-inch focus ..... $ 5.00

D 1271. **Same,** ½-inch focus 5.00

D 1272. **Same,** ¾-inch focus 5.00

D 1273. Same, 1-inch focus 5.00
D 1274. Same, 1¼-inches focus 6.00
D 1275. Same, 1½-inches focus 6.00
D 1276. Same, 1¾-inches focus 7.00
D 1277. Same, 2-inches focus 8.00
D 1278. Same, 2½-inches focus 12.00
D 1279. Same, 3-inches focus 20.00

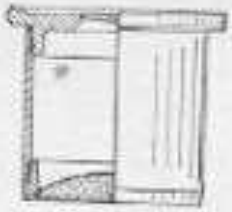
Terrestrial Eyepieces for Telescopes

D 1282

Standard 1¼-inch size to fit our telescopes.

D 1280. Terrestrial Eyepiece, ½-inch focus $10.00
D 1281. Same, ¼-inch focus 10.00
D 1282. Same, 1-inch focus 10.00

Ramsden Eyepieces for Spectroscopes

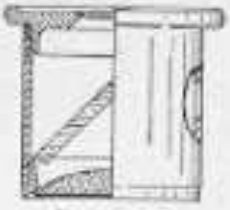


D 1287

These eyepieces are of the standard diameter adopted by the Continental makers of microscopes, viz., 0.91 inches, fitting a 15/16-inch tube.

D 1285. Ramsden Eyepiece, ¼-inch focus $2.50
D 1286. Same, ½-inch focus 2.50
D 1287. Same, 1-inch focus 2.50
D 1288. Same, 1½-inches focus 2.50
D 1289. Same, 2-inches focus 3.00

Gauss Eyepieces for Spectroscopes



D 1295

These are similar to the Ramsden eyepieces but are bored on one side and fitted with diagonal reflectors.

D 1295. Gauss Eyepiece, 1-inch focus $5.50

Eyepiece Lenses

D 1300–1310

These lenses are made of optical crown glass, are carefully polished, and accurately centered.

D 1300. Plano Convex Eyepiece Lens, ¼-inch diameter, ½-inch focus $1.00

D 1301.	Same, 2/5-inch diameter, 4/5-inch focus	1.00
D 1302.	Same, ½-inch diameter, 1-inch focus	1.00
D 1303.	Same, ⅝-inch diameter, 1¼-inches focus	1.00
D 1304.	Same, ¾-inch diameter, 1½-inches focus	1.00
D 1305.	Same, 1-inch diameter, 1¾-inches focus	1.00
D 1306.	Same, 1-inch diameter, 2-inches focus	1.00
D 1307.	Same, 1-inch diameter, 2¼-inches focus	1.00
D 1308.	Same, 1¼-inches diameter, 2½-inches focus	1.00
D 1309.	Same, 1¼-inches diameter, 2¾-inches focus	1.00
D 1310.	Same, 1¼-inches diameter, 3-inches focus	1.00

Convex Lenses

Diam. Inches	Focus Inches	Double Convex Lenses Centered Cat. No.	Price	Double Convex Lenses Not Centered Cat. No.	Price	Plano Convex Lenses Centered Cat. No	Price	Plano Convex Lenses Not Centered Cat. No.	Price
⅛	½	D1400	$1.00	D1420	$0.75	D1440	$0.90	D1460	$0.65
¼	½	D1401	1.00	D1421	.75	D1441	.90	D1461	.65
⅜	½	D1462	1.00	D1422	.75	D1442	.90	D1462	.65
½	¾	D1403	1.00	D1423	.90	D1443	1.00	D1463	.75
⅝	¾	D1404	1.00	D1424	.90	D1444	1.00	D1464	.75
¾	1	D1405	1.00	D1425	.90	D1445	1.00	D1465	.75
⅞	1¼	D1406	1.25	D1426	.95	D1446	1.10	D1466	.80
1	1½	D1407	1.25	D1427	.95	D1447	1.15	D1467	.80
1	2	D1408	1.25	D1428	.95	D1448	1.15	D1468	.80
1½	3	D1409	.85	D1429	.50	D1449	1.25	D1469	.85
2	4	D1410	1.00	D1430	.65	D1450	1.40	D1470	1.00
2½	5	D1411	1.25	D1431	.95	D1451	1.75	D1471	1.25
3	6	D1412	1.75	D1432	1.25	D1452	2.00	D1472	1.50
4	12–72	D1413	2.50	D1433	2.00				
5	18–72	D1414	3.75	D1434	3.00				
6	24–72	D1415	5.00	D1435	4.00				
7	30–72	D1416	7.70	D1436	6.00				
8	40–72	D1417	10.00	D1437	8.00				

Concave Lenses

Diam. Inches	Focus Inches	Double Concave Lenses Centered Cat. No.	Price	Double Concave Lenses Not Centered Cat. No.	Price	Plano Concave Lenses Centered Cat. No.	Price	Plano Concave Lenses Not Centered Cat. No.	Price
⅛	½	D1480	$1.00	D1500	$0.75	D1520	$0.90	D1540	$0.65
¼	½	D1481	1.00	D1501	.75	D1521	.90	D1541	.65
⅜	½	D1482	1.00	D1502	.75	D1522	.90	D1542	.65
½	¾	D1483	1.00	D1503	.90	D1523	1.00	D1543	.75
⅝	¾	D1484	1.00	D1504	.90	D1524	1.00	D1544	.75
¾	1	D1485	1.00	D1505	.90	D1525	1.00	D1545	.75
⅞	1¼	D1486	1.25	D1506	.95	D1526	1.10	D1546	.80
1	1½	D1487	1.25	D1507	.95	D1527	1.15	D1547	.80
1	2	D1488	1.25	D1508	.95	D1528	1.15	D1548	.80
1½	3	D1489	.85	D1509	.50	D1529	1.25	D1549	.85
2	4	D1490	1.00	D1510	.65	D1530	1.40	D1550	1.00
2½	5	D1491	1.25	D1511	.95	D1531	1.75	D1551	1.25
3	6	D1492	1.75	D1512	1.25	D1532	2.00	D1552	1.50
4	12–72	D1493	2.50	D1513	2.00				
5	18–72	D1494	3.75	D1514	3.00				
6	24–72	D1495	5.00	D1515	4.00				
7	30–72	D1496	7.50	D1516	6.00				
8	40–72	D1497	10.00	D1517	8.00				

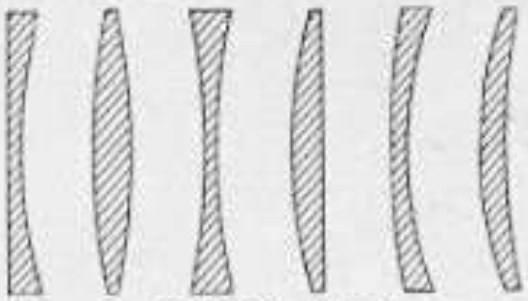
Meniscus Lenses

Diam. Inches	Focus Inches	Convex Meniscus Lenses				Concave Meniscus Lenses			
		Centered		Not Centered		Centered		Not Centered	
		Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
1	2	D1560	$2.00	D1570	$1.50	D1580	$2.00	D1590	$1.50
1½	3	D1561	2.25	D1571	1.75	D1581	2.25	D1591	1.75
2	4	D1562	2.50	D1572	2.00	D1582	2.50	D1592	2.00
2½	5	D1563	3.00	D1573	2.50	D1583	3.00	D1593	2.50
3	6	D1564	3.75	D1574	3.00	D1584	3.75	D1594	3.00
4	12-72	D1565	5.00	D1575	4.00	D1585	5.00	D1595	4.00
5	18-72	D1566	7.50	D1576	6.00	D1586	7.50	D1596	6.00
6	24-72	D1567	10.00	D1577	8.00	D1587	10.00	D1597	8.00
7	30-72	D1568	12.50	D1578	10.00	D1588	12.50	D1598	10.00
8	40-72	D1569	15.00	D1579	12.50	D1589	15.00	D1599	12.50

Cylindrical Lenses 1 1-2 Inches Square or Round

Focus Inches	Plano Convex				Plano Concave			
	Edged Round		Square Rough		Edged Round		Square Rough	
	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
40	D1800	$1.25	D1810	$0.50	D1820	$1.25	D1830	$0.50
30	D1801	1.25	D1811	.50	D1821	1.25	D1831	.50
20	D1802	1.25	D1812	.50	D1822	1.25	D1832	.50
15	D1803	1.25	D1813	.50	D1823	1.25	D1833	.50
10	D1804	1.25	D1814	.50	D1824	1.25	D1834	.50
8	D1805	1.35	D1815	.55	D1825	1.35	D1835	.55
6	D1806	1.50	D1816	.75	D1826	1.50	D1836	.75
5	D1807	1.60	D1817	.90	D1827	1.60	D1837	.90

Demonstration Lenses



D 1850–1852

These lenses are made up in sets for the purpose of showing the various shapes of simple lenses and for demonstrating their optical properties. The edges of the lenses are smooth ground.

D 1850. **Demonstration Lenses,** set of six lenses 1½ inches in diameter, in box. The lenses are respectively double convex, double concave, plano convex, plano concave, meniscus convex, and meniscus concave..... $1.25

D 1851. **Same,** lenses 2 inches in diameter..... 2.50

D 1852. **Same,** lenses 3 inches in diameter..... 4.50

D 1855. **Demonstration Lenses,** set of ten lenses 1½ inches in diameter, in box. The lenses are respectively double convex, double concave, plano convex, plano concave, meniscus convex, meniscus concave, cylindrical convex, cylindrical concave, sphero-cylindrical, and prismatic 2.00

Double Convex and Double Concave Lenses

1 1-2 Inches in Diameter

Focus	Double Convex						Double Concave					
	Centered		Edged		Rough		Centered		Edged		Rough	
Inches	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price
320	D1650	$0.75	D1670	$0.40	D1690	$0.15	D1710	$0.75	D1730	$0.40	D1750	$0.15
160	D1651	.75	D1671	.40	D1691	.15	D1711	.75	D1731	.40	D1751	.15
80	D1652	.75	D1672	.40	D1692	.15	D1712	.75	D1732	.40	D1752	.15
60	D1653	.75	D1673	.40	D1693	.15	D1713	.75	D1733	.40	D1753	.15
40	D1654	.75	D1675	.40	D1694	.15	D1714	.75	D1734	.40	D1754	.15
30	D1655	.75	D1675	.40	D1695	.15	D1715	.75	D1735	.40	D1755	.15
25	D1656	.75	D1676	.40	D1696	.15	D1716	.75	D1736	.40	D1756	.15
20	D1657	.75	D1677	.40	D1697	.15	D1717	.75	D1737	.40	D1757	.15
18	D1658	.75	D1678	.40	D1698	.15	D1718	.75	D1738	.40	D1758	.15
15	D1659	.75	D1679	.40	D1699	.15	D1719	.75	D1739	.40	D1759	.15
12	D1660	.75	D1680	.40	D1700	.15	D1720	.75	D1740	.40	D1760	.15
10	D1661	.75	D1681	.40	D1701	.15	D1721	.75	D1741	.40	D1761	.15
8	D1662	.80	D1682	.45	D1702	.20	D1722	.80	D1742	.45	D1762	.20
6	D1663	.80	D1683	.45	D1703	.20	D1723	.80	D1743	.45	D1763	.20
5	D1664	.80	D1684	.45	D1704	.20	D1724	.80	D1744	.45	D1764	.20
4	D1665	.80	D1685	.45	D1705	.25	D1725	.80	D1745	.45	D1765	.25
3	D1666	.85	D1686	.50	D1706	.35	D1726	.85	D1746	.50	D1766	.35
2	D1667	1.25	D1687	.75	D1707	.50	D1727	1.25	D1747	.75	D1767	.50

D 1856. Same, lenses 2 inches in diameter..... 3.50

D 1857. Same, lenses 3 inches in diameter..... 7.50

D 1860. Half Lenses, set of six 2 inches in diameter..... 3.75

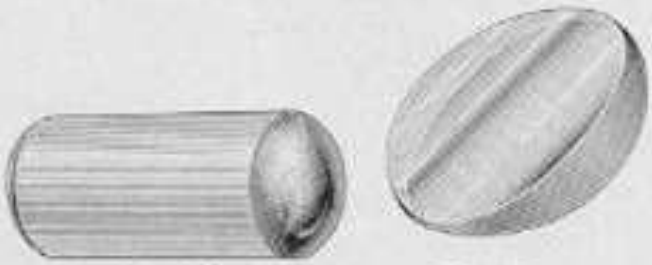
D 1861. Same, 3 inches in diameter..... 7.00

Plano Convex Condensing Lenses

These lenses are made of selected crown glass, well annealed. The surfaces are finely polished, and the edges are ground.

Diameter Inches	Focus Inches	Single Lens Unmounted		Pair of Lenses Mounted	
		Cat. No.	Price	Cat. No.	Price
4	5½ or 6½	D 1900	$ 1.00	D 1920	$ 3.25
4⅛	5½ or 6½	D 1901	1.10	D 1921	4.00
4½	5½ or 6½	D 1902	1.25	D 1922	4.80
5	6½	D 1903	1.40	D 1923	5.75
5½	8	D 1904	1.80	D 1924	7.25
6	10	D 1905	2.40	D 1925	9.75
6½	10	D 1906	3.20	D 1926	14.50
7	12	D 1907	4.60	D 1927	19.50
8	12	D 1908	6.00	D 1928	26.00
9	14	D 1909	8.00	D 1929	32.50
10	15	D 1910	11.00	D 1930	40.00
12	18	D 1911	22.00	D 1931	65.00
14	21	D 1912	33.00	D 1932	97.50

Two Odd and Instructive Lenses



C 916 C 917

In the necessarily brief treatment of geometrical optics given in courses on physics, it is customary to limit the discussion to infinitely thin lenses and to omit all mention of the properties of cylindrical surfaces. In practice, thickness must be taken into account in computing lens combinations and there are many uses to which cylindrical lenses are put. Although these matters cannot often be gone into in the limited time allotted to lecture room work, yet the exhibition of one or two striking illustrations of points like these, which can only be briefly touched, may serve to stimulate the students' curiosity and act as an incentive to further study. The two oddities in lenses illustrated above are offered for these purposes. (See the Physical Review, June, 1905, pp. 384-385.)

The lens shown in Fig. C 916 is designed to supply an extreme illustration of the effect of thickness on the focal length of a convex lens. The theory of thick lenses shows the focal length of a double convex lens to be

$$f = \frac{n}{n-1}, \quad \frac{r^2}{2nr-(n-1)d},$$

where **r** is the radius of the curved faces, **n** is the refractive index, and **d** is the thickness of the lens. The focal length is positive or negative, i. e., the lens is convergent or divergent, according as **d** is greater or less than **2nr / (n-1)**. If **d=2nr / (n-1)**, the focal length is infinite. Such a lens is neither convergent nor divergent, but gives inverted virtual images without magnification. The thick lens of Fig. C 916 satisfies this condition; although its faces are sharply curved it acts like a piece of flat glass, except that objects seen through it appear inverted. It is an interesting puzzle to a student who has been "brought up" on thin lenses.

The lens shown in Fig. C 917 has cylindrical surfaces, one concave and the other convex, with axes crossed. The curvatures of the two surfaces are so chosen that, when the lens is held at arms' length, one sees through it an undistorted image of distant objects. If the lens, when thus held, is rotated in its own plane, the image also rotates but with an angular velocity twice as great, so that when the lens is turned through 180 degrees the image turns a complete somersault. The image is peculiar in that it is a purely visual combination of two astigmatic images, one real, the other virtual; one lying behind the lens, the other in front. The image can neither be projected on a screen nor viewed through a telescope; it can be seen by the naked eye merely because of the short focus, and consequent depth of focus, of the eye.

C 916 **Porter's Thick Lens** $4.00
C 917 **Porter's Rotating Image Lens** 2.00

Observation Tubes for Polariscopes

Glass tubes with brass end pieces and screw caps, cover glasses, and rubber rings.

D 1900. **Observation Tube,** 5 cm. long ..... $ 4.00
D 1901. **Same,** 10 cm. long 4.00
D 1902. **Same,** 20 cm. long 4.00
D 1904. **Same,** 40 cm. long 4.25

Black Glass Mirrors

For polarisers, in mahogany frames.

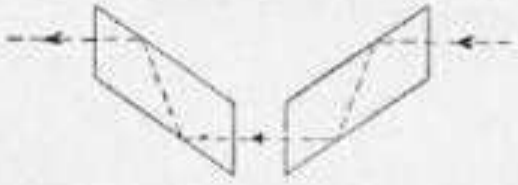
D 1910. **Black Glass Mirror,** 10x20 cm ..... $ 4.00
D 1911. **Same,** 15x30 cm 7.00
D 1912. **Same,** 20x40 cm 12.00

Unannealed Glass Plates for Polariscopic Experiments

D 1920–1928

D 1920. **Square Unannealed Plate** $1.80
D 1922. **Round Unannealed Plate** 1.80
D 1924. **Triangular Unannealed Plate** 1.80
D 1926. **Hexagonal Unannealed Plate** 2.35
D 1928. **Star-shaped Unannealed Plate** 4.50

Fresnel's Parallelepipeds



D 1930

To show the transformation of plane polarised light into circularly polarised light, and vice versa, by reflection. Supplied only in pairs.

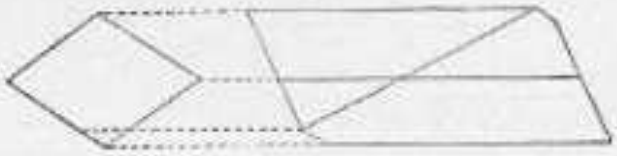
D 1930. **Fresnel's Parallelepipeds,** per pair, unmounted $11.00
D 1931. **Same,** per pair, mounted in brass 17.50

Plane Galvanometer Mirrors

These mirrors are silvered on the back, and the surfaces are sufficiently accurate to give clean images under the magnifications used in practice. The thickness of the mirrors is from ½ to ¾ mm.

D 1940.	**Plane Galvanometer Mirror,** ⅜-inch diameter	$0.75
D 1941.	Same, ½-inch diameter	.75
D 1942.	Same, ⅝-inch diameter	1.00
D 1943.	Same, ¾-inch diameter	1.00

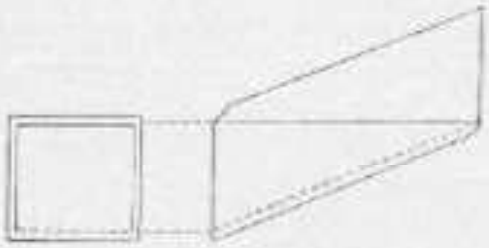
Preparations of Iceland Spar



D 2100–2106

Nicol's Polarising Prisms, rhomboidal section with oblique end faces. Angular extent of the polarised field about 22°. The sizes given below are measured across the sides of the prisms.

D 2100.	**Nicol's Prism,** 5 mm. aperture	$ 2.25
D 2101.	Same, 7 mm. aperture	2.75
D 2102.	Same, 8 mm. aperture	3.25
D 2103.	Same, 10 mm. aperture	4.25
D 2104.	Same, 15 mm. aperture	10.00
D 2105.	Same, 20 mm. aperture	26.00
D 2106.	Same, 25 mm. aperture	55.00



D 2120–2123

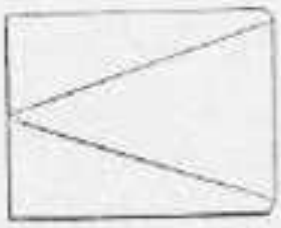
Nicol's Prisms, Rectangular Section with oblique end faces. Angular extent of the polarised field about 23°.

D 2120.	**Rectangular Nicol Prism,** 6 mm. aperture	$ 3.25
D 2121.	Same, 8 mm. aperture	4.25
D 2122.	Same, 10 mm. aperture	6.50
D 2123.	Same, 15 mm. aperture	18.00

D 2130–2124

Thompson's Polarising Prisms of square section with square ends. Angular extent of polarised field about 30°. The aperture, or width of the side, is one-third of the length.

D 2130.	**Thompson Polarising Prism,** length 15 mm	$ 3.75
D 2131.	Same, length 20 mm	6.75
D 2132.	Same, length 25 mm	13.50
D 2133.	Same, length 35 mm	40.00
D 2134.	Same, length 45 mm	85.00



D 2140–2142

Ahren's Polarising Prisms of square section with square ends. The length is 1 2/3 times the aperture, and the angular extent of the polarised field is about 32°.

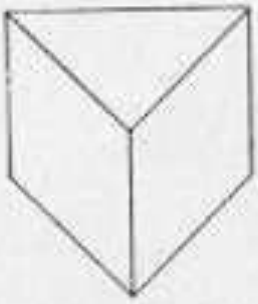
D 2140.	**Ahren's Prism,** 10 mm. aperture	$17.50
D 2141.	**Same,** 15 mm. aperture	25.00
D 2142.	**Same,** 20 mm. aperture	60.00

Lippish Half Prisms for polariscopes.

D 2150.	**Lippish Half-Prism,** 9 mm. edge	$ 7.75
D 2151.	**Same,** 10 mm. edge	9.00
D 2152.	**Same,** 12 mm. edge	13.25

Double Image Prisms of Iceland Spar and glass, achromatic. Octagonal form.

D 2160.	**Double Image Prism,** 10 mm. aperture	$ 3.25
D 2161.	**Same,** 15 mm. aperture	5.50
D 2162.	**Same,** 20 mm. aperture	7.75
D 2163.	**Same,** 25 mm. aperture	11.50
D 2164.	**Same,** 30 mm. aperture	13.50



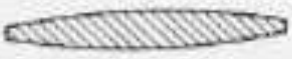
D 2170–2183

Sixty Degree Prisms of Iceland Spar, with refracting edge parallel to the optic axis, showing two spectra and enabling measurements to be made of both the ordinary and the extraordinary refractive indices.

D 2170.	**Sixty Degree Spar Prism,** refracting edge parallel to the axis, length of edge 10 mm	$ 3.75
D 2171.	**Same,** 15 mm. edge	6.75
D 2172.	**Same,** 20 mm. edge	13.50
D 2173.	**Same,** 25 mm. edge	27.00

Sixty Degree Prisms of Iceland Spar, with refracting edge perpendicular to the optic axis.

D 2180.	**Sixty Degree Spar Prism,** refracting edge perpendicular to the axis, length of edge 10 mm	$ 3.75
D 2181.	**Same,** 15 mm. edge	6.75
D 2182.	**Same,** 20 mm. edge	13.50
D 2183.	**Same,** 25 mm. edge	27.00



D 2200–2202

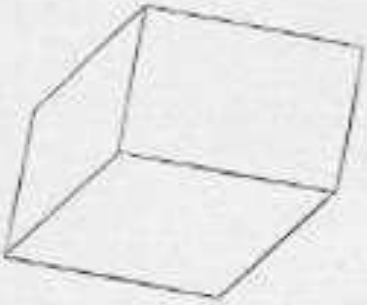
Biconvex Lenses of Iceland Spar, cut perpendicular to the axis. The prices given below apply only to lenses not thicker than 5 mm.; thicker lenses can be supplied at higher prices.

D 2200.	**Biconvex Spar Lens,** 20 mm. diameter	$ 6.75
D 2201.	**Same,** 25 mm. diameter	9.00
D 2202.	**Same,** 30 mm. diameter	12.50

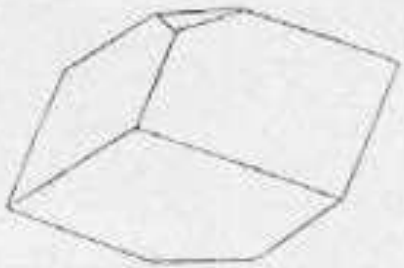
D 2210–2212

Plano-convex Lenses of Iceland Spar, cut perpendicular to the axis, and not more than 5 mm. thick.

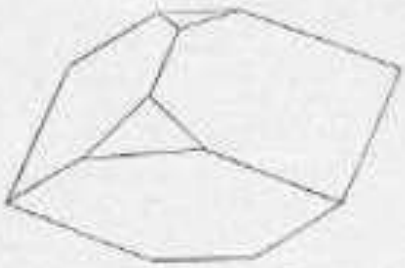
D 2210.	**Plano-convex Spar Lens,** 20 mm. diameter	$ 6.75
D 2211.	**Same,** 25 mm. diameter	9.00
D 2212.	**Same,** 30 mm. diameter	12.50



D 2220–2223



D 2230–2232



D 2240–2241

Rhombohedrons of Iceland Spar with six polished cleavage planes.

D 2220.	**Spar Rhombohedron,** with six polished faces, edge 15 mm. long	$ 4.50
D 2221.	**Same,** 20 mm. edge	6.75
D 2222.	**Same,** 25 mm. edge	10.00
D 2223.	**Same,** 30 mm. edge	16.00

Rhombohedrons of Iceland Spar, with six polished cleavage planes, and two polished surfaces perpendicular to the axis.

D 2230.	**Spar Rhombohedron,** with eight polished faces, edge 20 mm. long	$ 8.00
D 2231.	**Same,** 25 mm. edge	11.50
D 2232.	**Same,** 30 mm. edge	18.00

Rhombohedrons of Iceland Spar, with six polished cleavage planes, two polished surfaces perpendicular to the axis, and two polished surfaces parallel to the axis.

D 2240.	**Spar Rhombohedron** with ten polished faces, edge 25 mm. long	$12.50
D 2241.	**Same,** edge 30 mm. long	19.00

Spheres of Iceland Spar.

D 2245.	**Spar Sphere,** 20 mm. diameter	$8 00
D 2246.	**Same,** 25 mm. diameter	17.50
D 2247.	**Same,** 30 mm. diameter	27.50

Plates of Iceland Spar cut perpendicular to the optic axis.

D 2250.	**Spar Plate,** cut perpendicular to the optic axis, about 10 mm. diameter by 2 mm. thick	$2.00
D 2251.	**Same,** about 3 mm. thick	2.00
D 2252.	**Same,** about 4 mm. thick	2.00

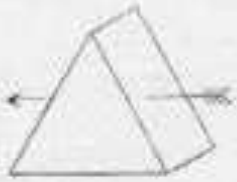
Miscellaneous Spar Preparations.

D 2260.	**Brecina Spar Plate**	$3.75
D 2261.	**Calderon Spar Plate**	4.50
D 2262.	**Dichroiscopic Magnifier**	9.00

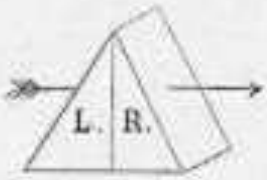
Preparations of Quartz

Sixty Degree Quartz Prisms with refracting edge perpendicular to the optic axis.

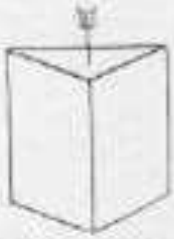
D 2300.	**Sixty Degree Quartz Prism,** refracting edge perpendicular to axis, 15 mm. edge	$ 5.50
D 2301.	**Same,** 20 mm. edge	6.75
D 2302.	**Same,** 25 mm. edge	9.00
D 2303.	**Same,** 30 mm. edge	13.00
D 2304.	**Same,** 35 mm. edge	17.00



D 2300–2305



D 2310–2311



D 2320–2323

D 2305. Same, 40 mm. edge 22.50

Sixty Degree Quartz Prisms, with refracting edge parallel to the optic axis.

D 2310. **Sixty Degree Quartz Prism** with refracting edge parallel to axis, 15 mm. edge $5.50
D 2311. Same, 25 mm. edge 9.00

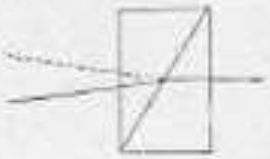
Cornu Double Quartz Prisms, 60° angle, of right and left handed quartz, giving at minimum deviation a spectrum devoid of double refraction, and hence showing no doubling of the Frauenhofer lines.

D 2320. **Cornu Double Quartz Prism**, 60° angle, edge 25 mm. long $22.50
D 2321. Same, 30 mm. edge 30.00
D 2322. Same, 35 mm. edge 37.50
D 2323. Same, 40 mm. edge 55.00

D 2330–2332

Rochon's Double Image Quartz Prisms.

D 2330. **Rochon Prism**, 15 mm. aperture ..... $ 7.00
D 2331. Same, 20 mm. aperture 9.00
D 2332. Same, 25 mm. aperture 11.50



D 2340–2342

Wollaston's Double Image Quartz Prisms.

D 2340. **Wollaston Prism**, 15 mm. aperture ..... $ 7.00
D 2341. Same, 20 mm. aperture 9.00
D 2342. Same, 25 mm. aperture 11.50

D 2350–2354

D 2360–2364

Biconvex and Plano-convex Lenses, cut perpendicular to the optic axis. The minimum focal length to which the prices given below will apply is 15 cm. for biconvex lenses, and 20 cm. for plano-convex lenses; lenses of shorter focal length, or with exactly specified focal lengths, are charged at higher prices.

D 2350. **Biconvex Quartz Lens**, 30 mm. diameter ..... $ 6.75
D 2351. Same, 35 mm. diameter 7.75
D 2352. Same, 40 mm. diameter 9.00
D 2353. Same, 45 mm. diameter 11.50
D 2354. Same, 50 mm. diameter 16.00
D 2360. **Plano-convex Quartz Lens**, 30 mm. diameter 6.75
D 2361. Same, 35 mm. diameter 7.75
D 2362. Same, 40 mm. diameter 9.00
D 2363. Same, 45 mm. diameter 11.50

D 2364. Same, 50 mm. diameter 16.00

Cylindrical Quartz Lenses of from 15 cm. to 30 cm. focal length.

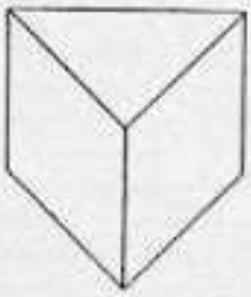
D 2370. Cylindrical Quartz Lens, 30 mm. square $11.50
D 2371. Same, 35 mm. square 12.75
D 2372. Same, 40 mm. square 15.00
D 2374. Same, 45 mm. square 20.00

D 2380

Miscellaneous Quartz Preparations.

D 2380. Fresnel's Triple Prism to show double refraction and separation of circularly polarised rays along the axis. $25.00
D 2382. Soleil's Compensator, consisting of two wedges cut perpendicular to the axis, and a compensating plate, unmounted 13.50
D 2384. Babinet's Compensator, consisting of two wedges with axes crossed, unmounted 8.25
D 2386. Quartz Wedge, 5x40 mm. mounted on glass slip 5x45 mm., showing colors of first two orders 8.25
D 2387. Same, showing first three orders 5.50
D 2388. Same, showing first five orders 4.25
D 2390. Klein's Quartz Plate, 3.75 mm. thick, about 10 mm. aperture 2.25
D 2392. Biquartz Plate, of R. and L. quartz, 3.75 mm. thick, about 10 mm. on the edge 4.25
D 2394. Savart's Double Plate, showing Savart's bands, a sensitive test for partial polarisation 4.25
D 2396. Bertrand's Plate, 2.5 mm. thick, about 14 mm. square ... 9.00
D 2398. Laurent's Plate for Sodium light, 5x7 mm 2.75
D 2400. Quartz Sphere, 20 mm. diameter 5.00
D 2402. Same, 30 mm. diameter 9.00
D 2404. Same, 40 mm. diameter 15.00
D 2406. Pair of Natural Quartz Crystals, R. and L., showing the hemihedral planes 3.00
D 2408. Same, larger 9.00
D 2420. Selenite Film, 11x60 mm., showing red of the first order $2.50
D 2422. Selenite Wedge, 15x30 mm., showing colors of the first three orders 4.75
D 2424. Same, showing colors from the third to the fifth order .. 4.75
D 2426. Bravais' Double Plate 4.75
D 2440. Quarter Wave Plate, 11x60 mm $1.50
D 2442. Set of Three Plates, ¼, ¾, and 9/4 wave retardation which can be combined to give thirteen different retardations. Adjusted for white light 7.50
D 2444. Same, adjusted for sodium light 8.50
D 2446. Von Mohl's Set of Eight Selenite and Mica Films 6.50

Preparations of Rock Salt



D 2500–2502

D 2500.	**Sixty Degree Rock Salt Prism,** about 20x30 mm. on the side	$ 5.50
D 2501.	Same, about 30x40 mm.	8.25
D 2502.	Same, about 40x50 mm.	12.50
D 2505.	**Biconvex Rock Salt Lens,** diameter 30 mm., focus about 30 cm.	$ 5.50

Biconvex Rock Salt Lenses

D 2506–2513

D 2506.	Same, 40 mm. diam., 30 cm. focus	8.25
D 2507.	Same, 50 mm. diam., 30 cm. focus	11.00
D 2508.	Same, 60 mm. diam., 30 cm. focus	15.00
D 2510.	Same, 30 mm. diam., about 15 cm. focus	5.50
D 2511.	Same, 40 mm. diam., 15 cm. focus	8.25
D 2512.	Same, 50 mm. diam., 15 cm. focus	11.50
D 2513.	Same, 60 mm. diam., 15 cm. focus	16.00

Cylindrical Rock Salt Lenses

D 2515.	**Cylindrical Rock Salt Lens,** 30 mm. aperture, about 15 cm. focus	$ 6.75
D 2516.	Same, 40 mm.	9.50
D 2517.	Same, 50 mm.	13.00
D 2518.	Same, 60 mm.	16.50

Round Plates of Rock Salt

D 2520.	**Rock Salt Plate,** 25 mm. diameter	$2.75
D 2521.	Same, 30 mm.	4.00
D 2522.	Same, 40 mm.	6.75
D 2523.	Same, 50 mm.	9.50

Ives Diffraction Gratings

Patented April 24, 1906.

These are transparent replicas of Rowland's quality A diffraction gratings. They consist of cast films, with the ruled surface in optical contact with a flat glass plate, and sealed up under a second plate with a balsam mixture of the same refractive index as the film. This procedure ensures a flat diffracting surface, protects the delicate film from injury, and overcomes all aberrations due to inequalities in thickness of the film.

The Ives' replicas are practically equal in resolving and defining powers to average quality A originals, are much less expensive, and are not liable to injury since the film is entirely enclosed between glass plates. Even the smallest and least expensive of these gratings will clearly resolve the solar triplet at 5227, in the second order, if used with a sufficiently powerful spectroscope. The lines of this triplet are separated by about one-twentieth the distance between the D lines.

A fuller description of these gratings, together with a copy of a photograph taken with one of them, will be found in the fourth edition of our Circular 325.

C 140. **Ives' Grating,** about 15,050 lines to the inch, with one-inch ruled surface, "passed" on clear resolution of the triplet at wave-length 5,227 at full aperture in the second order spectrum ..... $ 5.00

C 141. **Ives' Grating,** about 15,050 lines to the inch, same size as C 140, but made from a different and unique original, and remarkable for the brilliancy of the first order spectra. The second order spectra are practically the same as with C 140, and the grating is passed on the same test of resolution..... 6.50

C 145. **Ives' Grating,** about 15,050 lines to the inch, ruled surface 1⅜x1⅞ inches, giving excellent definition with moderate powers 9.00

C 146. **Ives' Grating,** about 15,050 lines to the inch, same dimensions as C 145, but bearing highest eyepiecing at full aperture 12.00

C 147. **Ives' Direct Vision Brilliant Grating.** This is a one-inch C 141 grating mounted between prisms so as to give direct vision in the brilliant first order spectrum. This grating is "passed" on good definition of the D lines and the nickel line of the first order..... 10.00

C 481. **Ives' Grating,** 1 inch surface, 20,050 lines to the inch. This grating gives a brilliant first order spectrum, but is weak in the second order. It is, however, capable of just distinctly resolving the test triplet 5,227 in the first order spectrum, by using sunlight, condenser, full aperture, and a power of 30 diameters—a really marvelous performance for a cast replica..... 6.00

Second Class Grating Replicas

Owing to the demand for low-priced gratings for purposes which do not call for the high quality represented by Mr. Ives' tested standards, and because a percentage of those regularly turned out have been hitherto destroyed, it has been decided to mark these rejected gratings "Second Class" and to offer them at about half the price of the standard gratings. The only guarantee given with these second-class replicas is that they can be made to show the nickel line between the D's with direct sunlight, and the only advantage claimed for them over Thorp-process replicas is that the films are protected from injury by careless handling. This supply is limited.

C 150. **Second Class Grating Replica,** with one-inch surface ruled 15,050 lines to the inch..... $2.50

C 151. **Second Class Grating Replica,** 15,050 lines to the inch, ruled surface 1⅜x1⅞ inches..... 4.50

C 482. **Second Class Grating Replica,** 1 inch, 20,050 lines to the inch 3.00

Photographic Diffraction Gratings

These gratings are photographic copies of originals ruled on Rowland's engine, and are much more brilliant than any photographic gratings hitherto made. The 3,610 line gratings handsomely resolve the D line in the first order, and clearly show the nickel line in the second order, with one inch aperture. The 7,219 line grating will show the nickel line in the first order. The 2,888 line gratings are mounted lantern-slide fashion and are intended for lantern demonstrations, measurement of the wave-lengths by Kelvin's simple method, etc.

C 485. **Ives' Photospectroscopic Grating,** 1x1 inch, 3,610 lines to the inch $1.75

C 486. **Same,** 1¾x1¾ inch, 3,610 lines to the inch..... 2.50

C 487. **Same,** 1 3/16x1 3/16 inches, 7,219 lines to the inch..... 2.00

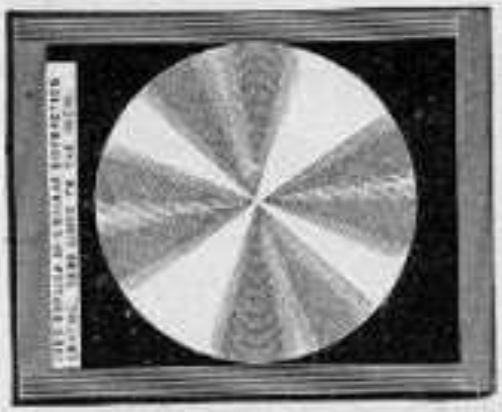
C 153. **Photographic Diffraction Grating,** ruled surface 2½x2½ inches, 2,888 lines to the inch..... 1.50

C 154. **Same,** 1x1 inch, 2,888 lines to the inch..... .75

For other diffraction gratings, including "freaks" showing colored central images, etc., see Circular 325, fourth edition.

Circular Diffraction Grating for Lantern Projection

These photographic gratings have a ruled surface three inches in diameter, with five thousand lines to the inch. By projecting an image of the electric arc upon the screen and then placing the circular grating centrally over the objective a circular rainbow is obtained. These circular gratings are mounted between selected plate glasses and finished like lantern slides; they show considerable periodic error, which does not, however, injure them for demonstrations with the optical lantern.



C 152

C 152. **Circular Diffraction Grating,** 3 inches diameter, 5,000 lines to the inch $3.00

Porter's Multiple Crossed Diffraction Gratings

See the Physical Review, January 1907, page 126

These brilliant optical novelties are made by a patented process which enables us to secure on one plate a large number of diffraction gratings crossing at various angles so as to give a most gorgeous display of colors. They are equally good for hand use or for projection. Held in the hand, close to the eye, while looking at a small and brilliant source of light (preferably an electric arc) they show a dazzling series of radiating spectra. The effects are especially fine when two of the crossed gratings are superposed and slowly rotated in opposite directions.

To show the radiating spectra to advantage with the projecting lantern the following arrangement should be used: A round hole about 5mm. in diameter is drilled in a sheet metal plate, and the plate is placed in the lantern in such a position that the hole lies at the focus of the condensing lenses so that as much light as possible may pass through. The image of the hole is then focused on the screen, and the crossed grating is then merely held in the hand against the front of the mount of the projecting lens. The spectra then appear on the screen. The effects are particularly fine if the light forming the direct image of the hole is screened off by means of a blackened card held in a clamp anywhere between the projecting lens and the screen. When this is done, the spectra appear to be more brilliant, for the eye is no longer dazzled by the light from the central spot.

These crossed gratings are made in two sizes, and are sold in sets of four having respectively 4, 8, 16, and 32 gratings crossing at symmetrical angles. The individual gratings have about 2888 lines to the inch.

C 913. **Porter's Multiple Crossed Diffraction Gratings,** set of four, with 2¼ inch circular ruled surfaces, having respectively 4, 8, 16, and 32 crossed gratings..... $8.00

C 914. **Same,** set of four, with ruled surfaces 1 inch square..... 4.00

Black Line Gratings

These coarse black line gratings are original rulings intended for the experiments on images described in the "Physical Review," March, 1907, pp. 303-306. The ruling is so "sharp" that the gratings show spectra of thirty or thirty-five orders when a sodium flame is used as source.

D 3000.	**Black Line Grating,** ½ inch square, 400 lines to the inch, mounted on glass slip 3x1 inches without cover glass..	$3.50
D 3001.	**Same,** 1 inch square.....	7.50

Selected Color Screens

These screens are made by Mr. Ives, who was a pioneer in orthochromatic and color photography. They consist of stained films, balsam-sealed between selected glass plates for use with photographic lenses of large aperture. The esculin screens suppress the ultraviolet rays for which ordinary achromatic lenses are not corrected; the esculin-tartrazine screens are the most efficient of light yellow screens.

C 536.	**Selected Esculin Screens,** 2x2 inches.....	$2.00
C 537.	**Same,** 3¼x4 inches.....	3.00
C 538.	**Selected Esculin-Tartrazine Screens,** 2x2 inches.....	2.00
C 539.	**Same,** 3¼x4 inches.....	3.00

Other screens are listed in Circular 325.

Zeiss Microscope Objectives

The prices of the Zeiss objectives given below are for delivery from stock. When imported to order for educational institutions, they can be brought in free of duty at 30 per cent. discount from these prices.

The objectives are corrected for a tube-length of 160 mm., and a cover-glass thickness of 0.15 to 0.20 mm.

Apochromatic Objectives

D 5000.	**Zeiss Apochromatic Objective,** 16 mm. focus, 0.30 numerical aperture	$ 30.40
D 5001.	**Same,** 8 mm., 0.65 N. A.....	38.00
D 5002.	**Same,** 4 mm., 0.95 N. A., adjustable.....	53.20
D 5003.	**Same,** 3 mm., 0.95 N. A., adjustable.....	60.80
D 5004.	**Same,** 2.5 mm., 1.25 N. A., water immersion, adjustable..	95.00
D 5005.	**Same,** 3 mm., 1.30 N. A., homogeneous immersion.....	114.00
D 5006.	**Same,** 3 mm., 1.40 N. A., homogeneous immersion.....	152.00
D 5007.	**Same,** 2 mm., 1.30 N. A., homogeneous immersion.....	114.00
D 5008.	**Same,** 2 mm., 1.40 N. A., homogeneous immersion.....	152.00
D 5009.	**Same,** 1.5 mm., 1.30 N. A., homogeneous immersion.....	133.00

Achromatic Objectives

D 5010.	**Zeiss Achromatic Objective,** "a_0," 45 mm. focal length..	$ 4.60
D 5011.	**Same,** "a_1," 39 mm.....	4.60
D 5012.	**Same,** "a_2," 37 mm.....	4.60
D 5013.	**Same,** "a_3," 28 mm.....	4.60
D 5014.	**Same,** "a*," focal length adjustable from 29 to 43 mm....	15.20
D 5015.	**Same,** "aa," 26 mm. focal length, 0.17 numerical aperture	10.30
D 5016.	**Same,** "A," 15 mm. 0.20 N. A.....	7.60
D 5017.	**Same,** "AA," 17 mm., 0.30 N. A.....	11.40
D 5018.	**Same,** "B," 12 mm., 0.35 N. A.....	11.40
D 5019.	**Same,** "C," 7 mm., 0.40 N. A.....	11.40
D 5020.	**Same,** "D," 4.2 mm., 0.65 N. A.....	13.30
D 5021.	**Same,** "DD," 4.3 mm., 0.85 N. A.....	19.00
D 5022.	**Same,** "DD," 4.3 mm., 0.85 N. A., adjustable.....	26.60
D 5023.	**Same,** "E," 2.8 mm., 0.90 N. A.....	22.80
D 5024.	**Same,** "E," 2.8 mm., 0.90 N. A., adjustable.....	30.40

D 5025.	Same, "F," 1.8 mm., 0.90 N. A.	28.50
D 5026.	Same, "F," 1.8 mm., 0.90 N. A., adjustable	36.10
D 5027.	Same, "Pl," 25 mm., 0.11 N. A., water immersion	7.60
D 5028.	Same, "D*," 4.4 mm., 0.75 N. A., water immersion	28.50
D 5029.	Same, "J," 1.8 mm., 1.18 N. A., water immersion	41.80
D 5030.	Same, "J," 1.8 mm., 1.18 N. A., water immersion, adjustable	49.40
D 5031.	Same, 1/12 inch, 1.8 mm., 1.30 N. A., homogeneous immersion	47.50

Zeiss Microscopic Eyepieces

Oompensating Eyepieces for use with Achromatic Objectives

D 5035.	Zeiss Compensating Eyepiece, No. 2, 90 mm. focus	$ 7.60
D 5036.	Same, No. 4, 45 mm	7.60
D 5037.	Same, No. 6, 30 mm	7.60
D 5038.	Same, No. 8, 22.5 mm	11.40
D 5039.	Same, No. 12, 15 mm	11.40
D 5040.	Same, No. 18, 10 mm	9.50

Huygenian Eyepieces for use with Achromatic Objectives

D 5045.	Zeiss Huygenian Eyepiece, No. 1, 50 mm. focus	$2.30
D 5046.	Same, No. 2, 40 mm	2.30
D 5047.	Same, No. 3, 30 mm	2.30
D 5048.	Same, No. 4, 25 mm	2.30
D 5049.	Same, No. 5, 20 mm	2.30

A complete catalogue of Zeiss Microscopes and Accessories will be sent on request.

Zeiss Photographic Lenses

These lenses are not carried in stock in Chicago, but are imported to order from the factory in Jena. We list below the lenses most in demand. A complete catalogue of Zeiss photographic lenses and cameras will be sent on request.

Zeiss Tessar f=3.5

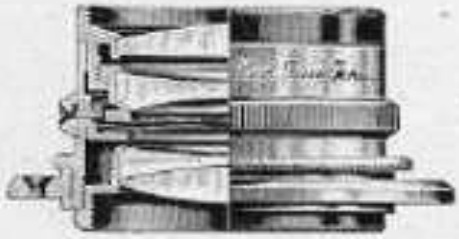
For Cinematography and Portraiture
In Standard Mount with Iris Diaphragm

Catalogue Number	Series Number	Size of Plate Covered with Largest Stop Inches	Equivalent Focus Inches	Diameter of Lens Inches	Price	
					Duty-free	Duty-paid
D5100	Ic,1	¾ x ¾	2	0.6	$ 20.25	$ 28.80
D5101	Ic,1s	1¼ x 1¼	3	0.9	25.00	36.00
D5102	Ic,6	2½ x 3½	8¼	2.4	75.50	108.00
D5103	Ic,7	3½ x 4¼	10	2.8	101.00	144.00
D5104	Ic,8	4¼ x 6½	12	3.4	126.00	180.00

Zeiss Tessar f-4.5

For Portraiture and Instantaneous Photography
In Standard Mount with Iris Diaphragm

Catalogue Number	Series Number	Size of Plate Covered with Largest Stop Inches	Equivalent Focus Inches	Diameter of Lens Inches	Price	
					Duty-free	Duty-paid
D5105	Ic,13	2½ x 3½	4½	1.0	$ 25.00	$ 36.00
D5106	Ic,15	3¼ x 4¼	6	1.3	33.00	47.00
D5107	Ic,15a	4¼ x 6½	7	1.6	40.50	57.75
D5108	Ic,16	5 x 7	8¼	1.9	50.50	72.00
D5109	Ic,17	5 x 8	10	2.2	81.00	115.00
D5110	Ic,18	6½ x 8½	12	2.6	115.00	162.00
D5111	Ic,19	7 x 9	16	3.5	176.00	252.00
D5112	Ic,20	10 x 12	20	4.3	250.00	360.00



Zeiss Tessar f-6.3

For Instantaneous Photography, Copying and Process Work
In Standard Mount and Iris Diaphragm

Catalogue Number	Series Number	Size of Plate Covered with Largest Stop Inches	Equivalent Focus Inches	Diameter of Lens Inches	Price	
					Duty-free	Duty-paid
D5115	IIb,4	3¼ x 4¼	5½	⅞	$ 24.00	$ 34.25
D5116	IIb,5	4 x 5	6½	1	29.00	41.50
D5117	IIb,5a	4¼ x 6½	7	1¼	35.50	50.50
D5118	IIb,6	5 x 7	8½	1⅜	43.00	61.00
D5119	IIb,7	5 x 8	10	1⅝	68.50	83.00
D5120	IIb,8	6½ x 8½	12	2	86.00	122.50
D5121	IIb,9	8 x 10	14	2⅜	111.00	158.50
D5122	IIb,10	10 x 12	19½	3¼	176.00	252.00
D5123	IIb,11	12 x 15	23⅝	3 11/16	228.00	324.00

Zeiss Protar f-9

For Wide Angle Instantaneous Exposures.
In Standard Mount with Iris Diaphragm

Catalogue Number	Series Number	Size of Plate Covered with Largest Stop Inches	Equivalent Focus Inches	Diameter of Lens Inches	Price	
					Duty-free	Duty-paid
D5130	IIIa,3	4¼ x 6	6¾	⅞	$24.00	$32.50
D5131	IIIa,4	5 x 7	7¾	1	25.00	36.00
D5132	IIIa,5	6½ x 8½	9	1¼	33.00	47.00
D5133	IIIa,6	6½ x 8½	10 11/16	1 7/16	40.50	57.50
D5134	IIIa,7	7 x 9	12 3/16	1⅝	50.50	72.00
D5135	IIIa,8	8 x 10	16	2	76.00	108.00

Zeiss Apochromat-Tessar

For Color Printing, Reproductions, Etc.
In Standard Mount with Rotating Diaphragm

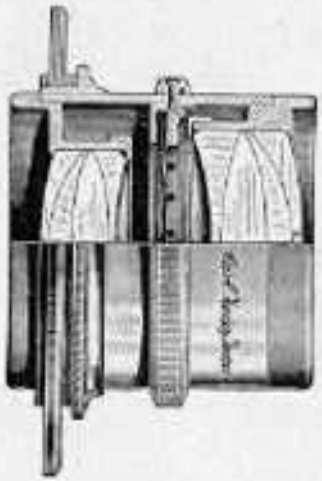
Catalogue Number	Series Number	Size of Plate Covered with Largest Stop Inches	Equivalent Focus Inches	Diameter of Lens Inches	Speed	Price	
						Duty-free	Duty-paid
D5125	VIII 1	14 x 18	18½	2	f-10	$100.00	$144.00
D5126	VIII 2	20 x 24	25	2 13/16	f-10	163.00	234.00
D5127	VIII 3	27 x 31	33	3½	f-10.3	238.00	342.00
D5128	VIII 4	31 x 35	46	3 13/16	f-12.5	375.00	540.00
D5129	VIII 5	48 x 60	71	4¾	f-15	875.00	1225.00

Zeiss Micro-Planars

For Microscopical Enlargement and Reduction
In Standard Mount with Iris Diaphragm

Catalogue Number	Series Number	Equivalent Focus Inches	Diameter of Lens Inches	Speed	Price	
					Duty-free	Duty-paid
D5165	Ia,1	¾	5/16	f-4.5	$23.00	$36.00
D5166	Ia,2	1⅛	5/16	f-4.5	25.00	36.00
D5167	Ia,3	2	½	f-4.5	25.00	36.00
D5168	Ia,4	3	11/16	f-4.5	30.00	43.00
D5169	Ia,5	4	1	f-4.5	30.00	43.00

OSSERVATORIO ASTRONOMICO PALERMO
Inv. n. 13558



Zeiss Convertible Protars

Convertible Anastigmats of Universal Applicability
In Standard Mount with Iris Diaphragm

Catalogue Number	Series Number	Size of Plate Covered at Full Aperture	Combined Equivalent Focus	Equivalent Focus of Each Lens		Diameter of Lens	Speed	Price	
				Front Lens	Back Lens				
		Inches	Inches	Inches	Inches	Inches		Duty-free	Duty-paid
D5140	VIIa,1	2¼ x 4	4⅛	7 3/8	7 3/16	5/8	f-6.3	$ 36.50	$ 52.25
D5141	VIIa,2	3¼ x 4¼	4½	8 1/16	7 5/16	11/16	f-7.0	39.25	56.00
D5142	VIIa,3	4 x 5	5	11 1/16	7 3/16	1	f-7.7	42.75	61.00
D5143	VIIa,4	4 x 5	5 1/16	8 1/4	8 3/16	3/4	f-6.3	41.75	59.60
D5144	VIIa,5	4¼ x 6	5⅜	11 3/16	8 1/2	1	f-7.0	45.50	65.00
D5145	VIIa,6	5 x 6	6⅛	13 3/4	8 3/4	1¼	f-7.7	50.50	72.00
D5146	VIIa,7	5 x 6½	6⅜	11 3/16	11 3/16	1	f-6.3	49.50	70.50
D5147	VIIa,8	5 x 7	7	13 1/4	11 5/16	1¼	f-7.0	54.50	77.50
D5148	VIIa,9	5 x 8	7 1/4	16 1/8	11 5/16	1½	f-7.7	63.00	90.00
D5149	VIIa,10	5 x 8	7 7/8	13 7/8	13 1/4	1¼	f-6.3	59.00	84.50
D5150	VIIa,11	6½ x 8½	8½	16 1/8	13 1/4	1½	f-7.0	68.00	97.00
D5151	VIIa,12	6½ x 8½	8 7/8	18 1/8	13 3/4	1⅝	f-7.7	83.50	119.00
D5152	VIIa,13	6½ x 8½	9¼	16 1/8	16 1/8	1⅝	f-6.3	77.00	110.00
D5153	VIIa,14	7 x 9	10	18 1/8	16 1/8	1⅝	f-7.0	92.00	131.50
D5154	VIIa,15	7 x 9	10⅜	23 1/8	16 1/8	2	f-7.7	107.00	153.00
D5155	VIIa,16	7 x 9	10 1/16	18 1/8	18 1/8	1⅞	f-6.3	106.00	151.00
D5156	VIIa,17	8 x 10	11⅛	23 1/8	18 1/8	2	f-7.0	121.00	173.00
D5157	VIIa,18	8 x 10	12¼	27	18 1/8	2⅛	f-7.7	143.00	204.00
D5158	VIIa,19	8 x 10	13¼	23 1/8	23 1/8	2	f-6.3	136.50	195.00
D5159	VIIa,20	10 x 12	14 5/16	27	23 1/8	2⅜	f-7.0	158.00	225.00
D5160	VIIa,22	10 x 12	15½	27	27	2⅜	f-6.3	180.00	256.00
D5161	VIIa,25	10 x 12	18¼	30 1/8	30 1/8	2 11/16	f-6.3	250.00	357.00
D5162	VIIa,28	11 x 13½	20⅛	33 1/8	33 1/8	3¼	f-6.3	326.00	465.00
D5163	VIIa,30	12 x 15	23⅜	39 1/4	39 1/4	3 11/16	f-6.3	427.00	609.00

Rates for Duty Free Importation

¶ The Scientific Shop makes the following rates for duty free importation on orders of ordinary size. On account of the economies arising from the volume of our business, these rates are somewhat lower than the cost of direct importation; they represent the cost of the instruments plus our own expenses. Our profits come from commissions paid us by the manufacturers.

¶ In a few cases where higher rates must be charged, the customer is notified before the order is accepted. In the absence of instructions to the contrary, we bill all shipments at Rate B.

Rate	Net Charge per Mark or Shilling	Net Charge per Franc	CHARACTER OF SERVICE, including fast weekly ocean steamship service and fast freight from the seaboard.
Rate A	26½ cents	21½ cents	Free delivery on board cars at Chicago, boxing charged extra at cost.
Rate B	27 cents	22 cents	Free delivery on board cars at Chicago, boxing and cartage charges paid by us.
Rate C	27 cents	22 cents	Free delivery to any point East of the Rocky Mountains, boxing charged extra at cost.
Rate D	27½ cents	22½ cents	Free delivery to any point East of the Rocky Mountains, boxing and cartage charges paid by us.

Foreign Physical Apparatus

¶ Among the many foreign instrument makers whose products are imported by The Scientific Shop, the following representative firms, for whom we act as special agents, may be mentioned.

Paul Bunge
Cambridge Scientific Instrument Co.
Dr. M. Th. Edelmann
F. Ernecke
R. Fuess
Sir Howard Grubb
Hartmann & Braun A. G.
Hans Heele
Adam Hilger
Fr. Klingelfuss & Co.
Rudolph Koenig's Successor
Max Kohl
A. Kruess
E. Leybold's Nachfolger
Nalder Bros. & Co.
Newton & Co.
Pulsometer Engineering Co.
Robert W. Paul
W. G. Pye & Co.
Cl. Riefler
Siemens & Halske
Societe Genevoise
Dr. Steeg & Reuter
C. A. Steinheil Soehne
W. Wilson
Otto Wolff
Carl Zeiss Optical Works