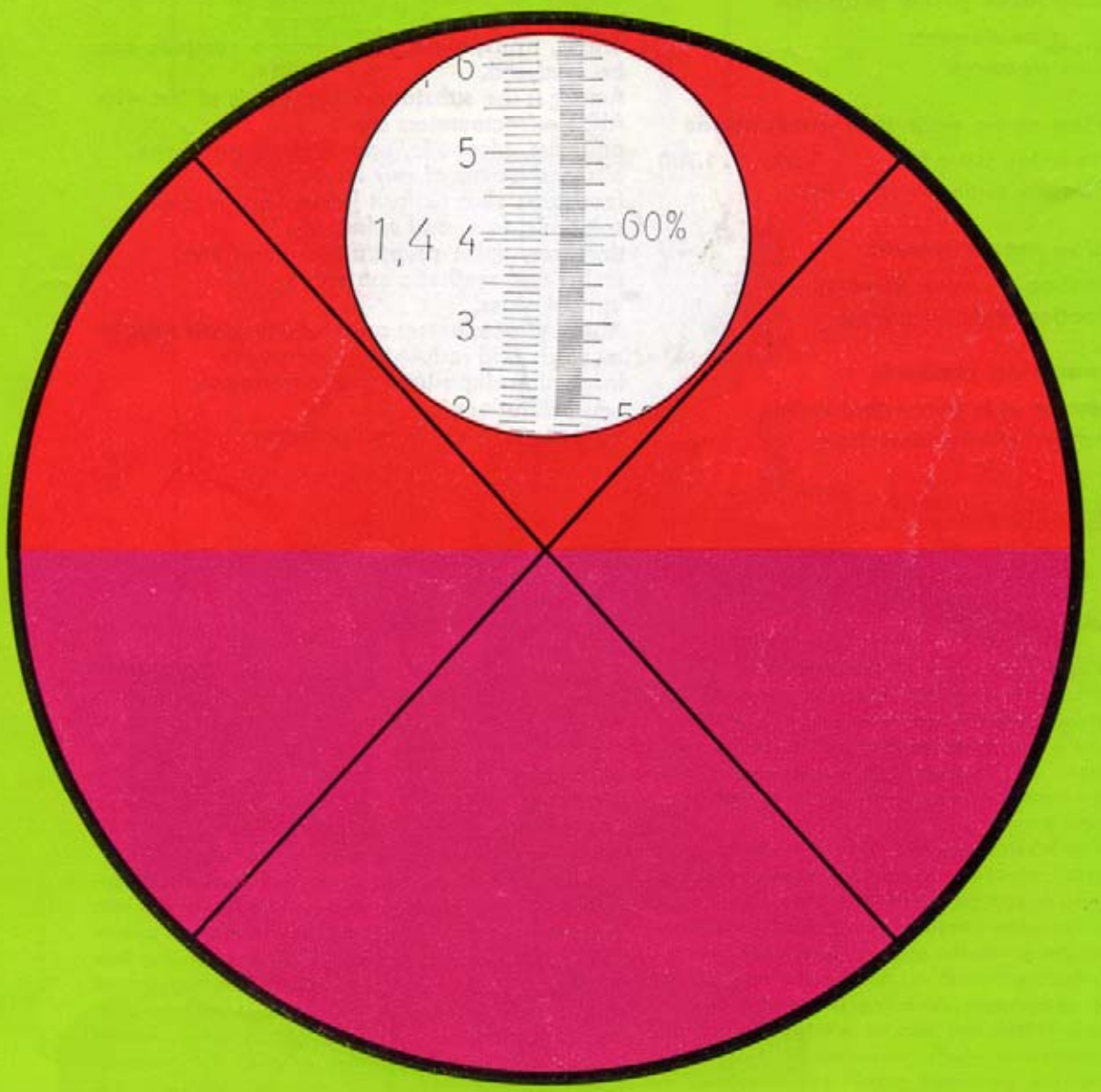
Abbe Refractometer

CARL ZEISS
JENA



Abbe Refractometer

The well approved standard instrument for fast determinations of liquid, solid, and plastic substances

Interchangeable prism elements

Standard prism elements
Flow prism elements

Measuring scale with two graduations

Refractive index scale for n_D = 1.300 ... 1.700
Dry substance scale for **0** ... 85 %

Dispersion measurement

Determination of mean dispersion n_F-nc
Determination of Abbe number *v*

Two measuring methods

Measurement with transmitted light
Measurement with incident light

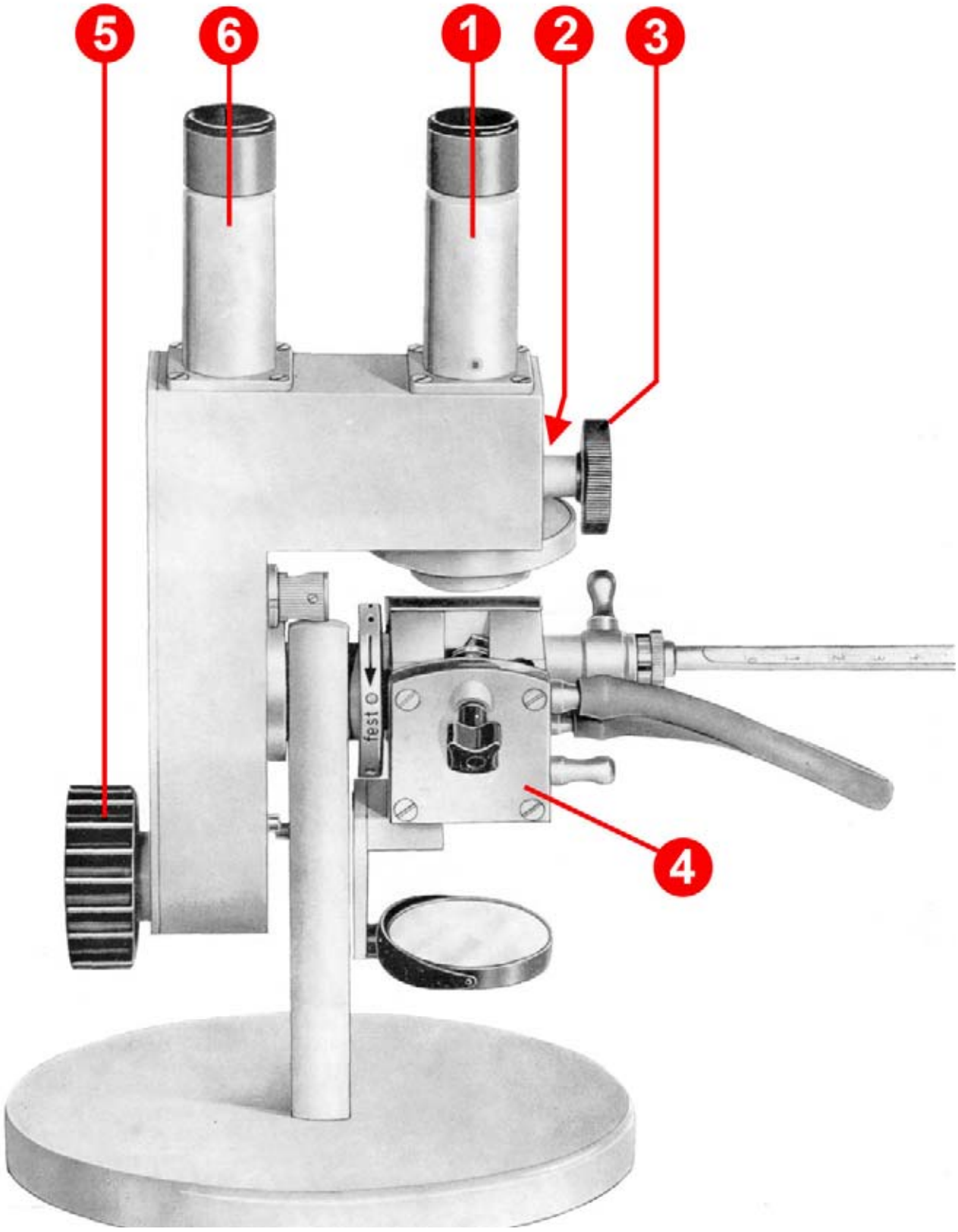
Application

The Abbe refractometer is employed
for determining the concentration of solutions,
for purity tests and quality checks of liquid, plastic, and solid substances,
and as an auxiliary instrument for investigating macromolecular substances.
Bright, transparent, and opaque samples can be analyzed.
Amongst the substances preferably tested with Abbe refractometers are
aqueous, alcoholic, and ethereal solutions,
oils and waxes of any kind,
foodstuffs such as fruit juices, syrups, sugar solutions, fats, and salad oils,
tinctures, spirit preparations, brandies,
resins and synthetic materials,
optical glass.
Abbe refractometers are predominantly used in research and industrial laboratories,
inspection departments of enterprises,
test institutions,
colleges and teaching institutions.

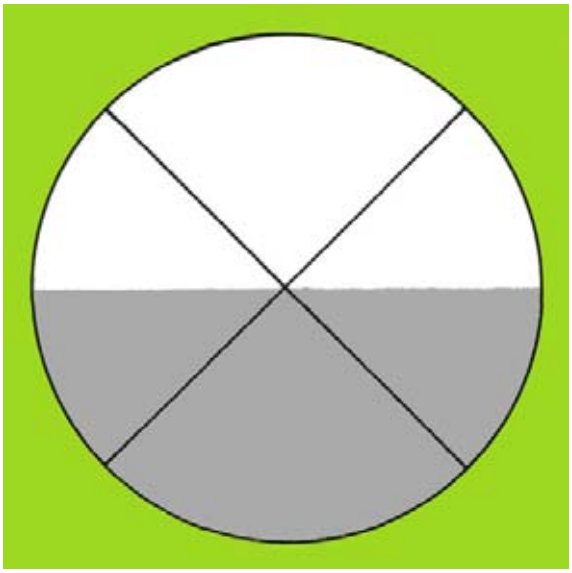
Description

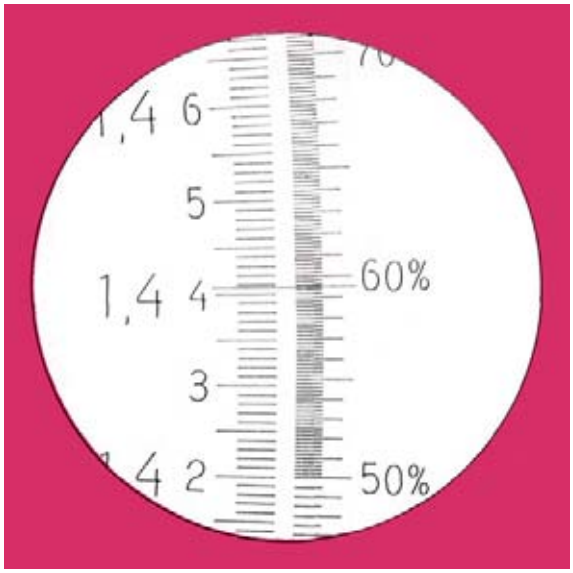
The main components of the Abbe refractometer are the prism body, the focusing telescope, and the graduated glass circle with reading microscope. The prism body is supplied as standard design and as flow prism body. Both designs can be controlled in temperature and contain the measuring and lighting prisms in chromium-plated metal mounts.
The focusing telescope serves for observing the boundary line of total reflection. The built-in compensator, an Amici prism, is used for eliminating the colour fringes along the boundary line and for measuring the mean dispersion. The graduated glass circle has one graduation for refractive indices n_D and another one for dry substance percentages according to the International Sugar Scale (1966) and can be watched through the reading microscope rigidly connected to the focusing microscope. The graduated glass circle is coupled to the prism body and protected by a dustproof housing from contamination and from damages.
The standard equipment of the Abbe refractometer includes the standard prism body which is suitable for individual measurement of liquid, solid, and plastic substances. 0.05 ml of a liquid sample are sufficient for one measuring operation. This liquid is situated as a thin film between the measuring and lighting prisms. The standard prism body permits also easily volatile samples to be measured if they are injected with a pipette into the inlet opening while the prism body is slightly opened. A mirror on the prism body illuminates the field of vision with daylight or with light from a filament lamp.
The flow prism body (Fig. 4) for continuously flowing, also for easily volatile liquids is attached like the standard prism body to the instrument. It consists of the measuring and lighting prisms. Both are tightly screwed with each other while a plastic foil has been laid between. This results in a small space above the measuring face through which the liquids *are* flowing. The temperature of the prism body can be controlled. Its separate light source 6 V 1.8 W can easily be attached with a lockable base in front of the measuring prism so that measurement with transmitted and with reflected light is possible.

Fig. 1. Abbe Refraktometer with standard prism body 1 focusing telescope, 2 colour compensator with graduated circle, 3 setting knob for colour compensator, 4 standard prism body, 5 setting knob for prism and graduated circle turn, 6 reading microscope


5
6
1
2
3
fest
4

2





3

Principle of measuring

Measurement with transmitted light:
Light is transmitted by the mirror or from the light source attached to the prism body into the lighting prism, passes through the sample, and enters into the measuring prism and into the telescope afther this.

Measurement with reflected light:
The light enters directly into the measuring prism. It is reflected by the measuring prism face wetted with the sample and then enters into the telescope. A bright and a dark field (Fig. 2) are visible in the telescope eyepiece (1 Fig. 1) in case of either method. The boundary line between these two fields corresponds to the critical angle of total reflection. Illumination with white light normally gives the boundary line a colour fringe in the beginning but it can be eliminated by means of the setting knob (3) for the compensator. The now colourless boundary line is set to the intersectina point of the hairline cross by setting knob (5) being actuated whereby the graduated circle, too, is turned. The refractive index n_D or the dry substance percentage of the investigated material can then be read for this setting in the microscope (Fig. 3). The mean dispersion n_F-n_C and the Abbe number *v* can be determined at the same time from the reading of the drum graduation of the compensator and by means of a special chart or a nomogram.

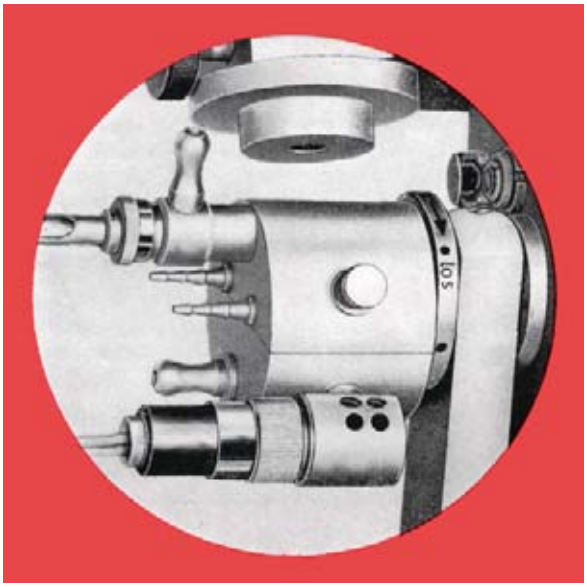
Turbid liquids, plastic substances, and heavily coloured samples can be measured with reflected light only. Glasses are measured with the lighting prism folded up. They must have two mutually orthogonal polished faces when they are measured with transmitted light while one of these faces is sufficient in case of reflected light (maximum size 10 mm X 25 mm). Glasses can easily be measured in reflected light also by means of the flow prism body.

Temperature control

The refractive index of liquids widely depends on their temperature so that this should always be listed together with the value (e. g. $n_D^{20^\circ}$). If, for instance, the temperature of ethyl alcohol is increased by 1 deg, its refractive index n_D varies by approximately 0.0004 units. Precise and comparable measured results require the temperature to be stabilized with accuracy of approx. ± 0.2 deg. For this purpose, the temperature of the prism bodies can be controlled and read on a thermometer provided. A suitable thermostat is for instance the Ultra thermostat U 1, which stabilizes a once adjusted temperature with ± 0.02 deg (Fig. 5). It is provided for 220 V a. c., 50/60 Hz, and equipped with a contact thermometer for the range of 0 . . . 100°C.

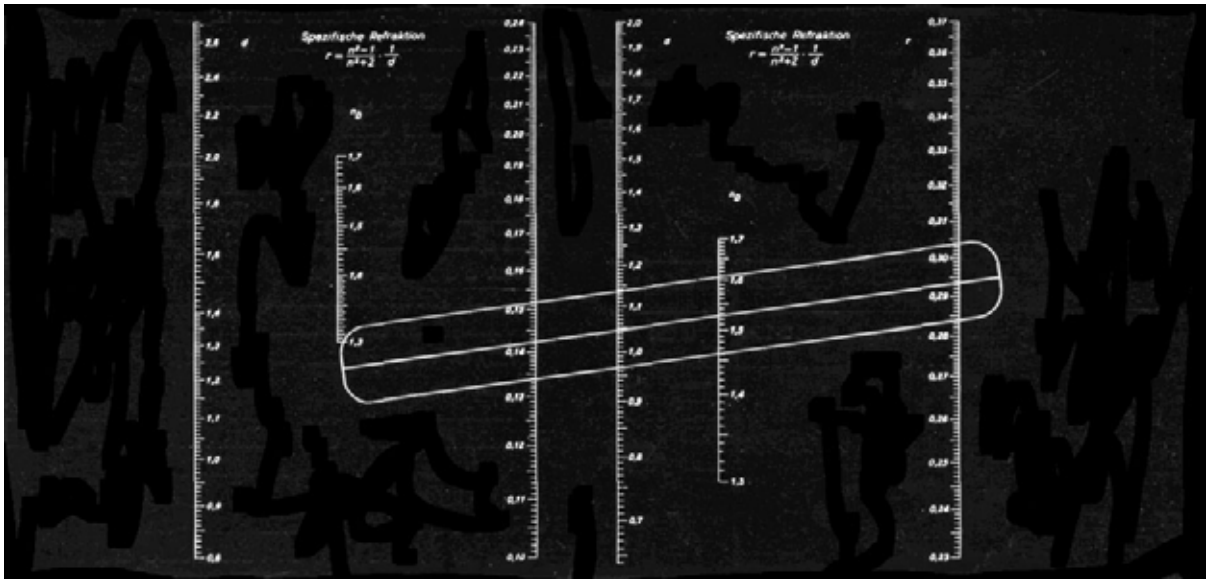
Fig. 2. Field of vision in the focusing telescope
Fig. 3. Field of vision in the reading microscope
Fig. 4. Flow prism body
Fig. 5. Ultra thermostat, type U 1
Fig. 6. Nomogram for determining the specific refraction

4



5

6



Auxiliary means

The dry substance scale of the Abbe refractometer directly indicates the percentage of fruit juices, sugar juices etc measured at 20 deg C. Measurement at other temperatures — between 10 deg C and 30 deg C — requires the **International Temperature Correction Table** to be considered. It will be found in the instruction manual. Determination of the mean dispersion from the refractive index n_D and the compensator setting (drum number z) makes use of he dispersion table supplied together with each of the instruments and containing the necessary tables and instructions for calculating $n_F - n_C$ and $r = \frac{n^2 - 1}{2} \cdot \frac{1}{}$ the Abbe number *v*. For fast evaluation at routine analyses, we recommend the **dispersion nomogram** to be used. It supplies the same results graphically without arithmetical operations.

We also supply a **nomogram for determining the specific refraction** which otherwise must be calculated with Lorentz-Lorenz' formula

$$r = \frac{n^2 - 1}{n^2 + 2} \cdot \frac{1}{d}$$

(d = density). Specific refraction and the molecular refraction R = M • r (M = molecular weight) are gaining ground as characteristic parameters for organic liquids in the fields of macromolecular chemistry, pharmacy, etc.

The linearity properties of molecular refraction can advantageously be utilized for concentration determination ((1) to (4)). A greater range of r can be covered by the nomogram since it has been made as a double nomogram with one part for r = 0.10 . . . 0.24 and another one for r = 0.23. . .0.37 (Fig. 6).

Instructions for orders

When subsequently ordering a prism body for the Abbe refractometer, correct relationship between designations of prism and measuring scale must be considered. Please, inform not only on the catalog number but also on the F-state (such as "F5") which will be found on the base of the graduated circle.
The same is applied to ordering nomograms for determination of mean dispersion.

Specification

	measuring range	error limit	scale division
refractive index n	1.300 ... 1.700	1 ... $2 \cdot 10^{-4}$	0.001
dry substance	0 ... 85 %	0.1 ...0.2%	up to 50% every 0.5% above 50% every 0.2%
mean dispersion $n_F - n_C$	0 ... 0.060	1 ... $2 \cdot 10^{-4}$	0.0005 in the nomogram
Abbe number ν	5 ... 500	—	—
temperature	0 . . . 75 deg C	—	1 deg

Standard prism body

substance required approx. 0.05 ml

Flow prism body

volume of the flow compartment 0.2 ml
maximum cross section of the flow compartment 2.5 sq. mm
minimum quantity required for displacing one sample by another one 0.5 ml

Dimensions of the Abbe refractometer 200X200X300 mm

Weight 5.0 kg

Bibliography

Summarizing treatises:

Roth, W. A., Eisenlohr, F., and Lowe, R.:
Refraktometrisches Hilfsbuch (Manual of refractometry)
Berlin 1952.
Lowe, F.:
Optische Messungen des Chemikers und des Mediziners
(Optical measurements by chemists and physicians)
6th ed. Dresden: Steinkopff 1954 (containing 170 references).
Joffe, B.W.:
Refractometric methods of chemistry (in Russian)
Leningrade 1960. 383 pages, 650 references).
Joffe, B.W.:
Die Refraktometrie in der modernen Chemie.
Sonderdruck aus Jenaer Rundschau 1972/4 32-S 100.
(Refractometry in modern chemistry, Off-print from JENA Review 1972/4)

References supplementing the contents of this leaflet:

(1) Gordijenko, A.: Neue Wege zur Erkennung hochmolekularer und flussiger Stoffe (New ways in detecting high-molecular and liquid substances)
Dt. Chem.-Ztg. 2 (1950), 1.

(2) Chatterji, A. C, and Chandra, U.: Lorentz-Lorenz Expression as a new Analytical Constant for Fats (Ghee) and Oils.
Z. anal. Cham. **153** (1955), 418, and **156** (1957), 1.

(3) Prod'homme, L.: Influence de la temperature sur la Refractivite Specifique (The influence of temperature on specific refraction)
Rev. d'Optique 40 (1961), 407.

(4) Ludde, K. H.: Anwendungsmöglichkeiten der Relativanalyse in einem modernen Arzneibuch (Applicability of relative analysis in an up-to-date pharmacopeia)
Pharmazie 19 (1964), p. 310-318 (267 references).

(5) Kaufmann, H. P., and Thieme, J.G.: Zur Refraktometrie der Fette (mehrere Arbeiten)
(On the refractometry of fats (several treatises))
Fette, Seifen, Anstrichmittel 1954-1957.

(6) Richter, S., and Kny, L.: Photometrie und Refraktometrie. Ausgewählte Arbeitsvorschriften für Laboratorien auf dem Gebiete des Gesundheitswesens unter besonderer Berücksichtigung der Arzneimittelprüfung
(Photometry and Refractometry. Selected operating instructions for laboratories in the public health service with special consideration of remedy testing)
Berlin: Akademie-Verlag 1967.

How to order description	catalog number	weight, kg
1. Standard equipment		
Abbe Refractometer with interchangeabie standard prism bodv, dust protection cover, thermometer for 0 . . . + 75 deg C, hooked wrench, adjusting wrench, adjusting plate, and 1 flask with 10 ml of *α*-bromonaphthalene, in container	320001:001.20/8	5.100
2. Completing elements		
(supplied to special order only) Ultra thermostat, type U 1, for 220 V, 50/60 c/s[1]), including contact thermometer, control thermometer, connecting hose and quick-action connectors	714/57/0	8.000
flow prism body[2]), complete, with lighting fixture including miniature lamp 6 V 1.8 W, hexagonal pin wrench, rubber hose, but without thermometer	320040:002.24/3	1.000
in addition: low voltage transformer A 5 VA 220 6 ZN 5045	680.25/4	1.500
nomogram for determining the mean dispersion n_F - n_C, with ruler (for F_2, F_4, F_5, F_6 and F_7)	320043:001.24/8	0.050
nomogram for determining the specific refraction with ruler	320044:001.24/7	0.150
3. Spare parts		
(supplied to special order only) standard prism body [2]), interchangeable, without thermometer	320031:031.14/4	0.900
thermometer for 0 ... +75 deg C, with sheath (for standard and flow prism body)	328751 :000.26/1	0.050
thermometer for 0 ... + 75 deg C, without sheath	328759:001.24/7	0.040
hooked wrench for interchanging the prism body	331101 :000.25/5	0.050
adjusting wrench	308508:013.10/2	0.010
adjusting plate, in box	320501:001.26/3	0.005
flask (10 ml) with *α*-bromonaphthalene	222.45/6	0.040
dust protection cover for Abbe refractometer	029510:031.24/0	0.100
Spare parts for flow prism bodies		
miniature lamp 01-6 V 1.8 W TGL 200-8170	681.96/2	0.005
hexagonal pin wrench 5 TGL 48-73215 Ni	044.63/0	0.025
rubber hose	320040:044.10/7	0.030
intermediate foil	320040:042.10/5	0.001
10 gaskets	320040:043.10/6	0.002
Listed weights are approximations only and not binding.		

[1]) Conversion to 110 V, 127 V or 240 V 50/60 Hz on special order.

[2]) Measuring scale, measuring prism, dispersion chart and nomogram must be characterized by the same F-state such as "F 5". When subsequently ordering prism bodies or the dispersion nomogram, please inform about the marking at the end of the graduated circle.

VEB Carl Zeiss JENA ▪ DDR

German Democratic Republic

Telephone: 83 0
Telex: Jena 058 86122
Publication No. **32-110f-2**
Printed in the GDR

Represented in this country by:

Ag 29-082-76 IV-26-10 3.5 (207)