

Grating Spectroscope

หนังสืออ้างอิงสำหรับเขียนทฤษฎีและเพื่อการค้นคว้าทั่วไป

- Anderson, E.E., *Modern Physics and Quantum Mechanics*, 1st ed., Philadelphia : Saunders, 1971.
- Blatts, F.J., *Principles of Physics*, 1st ed., Boston : Allyn and Bacon, Inc., 1983.
- Borowitz, S. and Bornstein, L.A. *A Contemporary View of Elementary Physics*, 1st ed., New York : McGraw-Hill, 1968.
- Chang, R., *Basic Principle of Spectroscopy*, 1st ed., New York : McGraw-Hill, 1971.
- Crawford, Jr., F.S., *Waves*, 1st ed., New York : McGraw-Hill, 1968.
- Eisberg, R.M. and Lerner, L.S., *Physics*, 1st ed., New York : McGraw-Hill, 1982.
- Eyring, H. and Others. *Quantum Chemistry*, 1st ed., New York : Wiley, 1944.
- Gartenhaus, S. *Physics*, 1st ed., New York : Holt, Rinehart and Winston, Inc., 1975.
- Giancoli, D.C., *General Physics*, 1st ed., New Jersey : Prentice-Hall, Inc., 1984.
- Marion, J.B. and Hornyak, W.F., *Principles of Physics*, 1st ed., Philadelphia : Saunders, 1984.
- Sears and Others, *College Physics*, 5th ed., Mass. : Addison-Wesley, 1980.
- White, H.E., *Modern College Physics*, 6th ed., New York : D. Van Nostrand, 1966.
- White H.E., *Introduction to Atomic Spectra*, 1st ed., New York : McGraw-Hill, 1934.
- Wichmam, E.W., *Quantum Physics*, 1st ed., New York : McGraw-Hill, 1967.

GRATING SPECTROSCOPE

CENCO NO. 086950

1. INTRODUCTION

The Cenco No. 086950 Grating Spectroscope is a direct reading instrument which employs a replica, transmission-type grating to produce spectra. This instrument is well suited for classroom use in conducting demonstrations in

- line spectra from gases
- absorption bands in continuous spectra
- elementary qualitative spectra analysis and measurements on the wavelength of light

2. DESCRIPTION

2.1 Apparatus : The Grating Spectroscope consists of a light-proof case which has an adjustable slit at one end and an eyepiece at the other end. Mounted inside the case is a wave length scale. The scale conforms to a curve which was computed to eliminate parallax reading between the slit images and the scale. The spectral lines of the light source appear on the scale at positions corresponding to their wave lengths.

Inside the case, mounted between the slit and the eyepiece is a light shield. Positioned directly behind the eyepiece are two clips used to hold the transmission grating. Two other clips are mounted on the side opposite the scale between the slit and the light shield.

These clips are used to hold a frosted glass slide. Mounted outside the case are : a knurled screw for adjusting the width of the slit up to one millimeter, a pair of clips for holding spectra tubes directly in front of the slit, and a side window fitted with a shutter which may be opened to admit light that diffuses through the frosted glass slide to illuminate the scale when readings are taken. The spectroscope is supported by a sturdy column on a base. See Fig. 1.

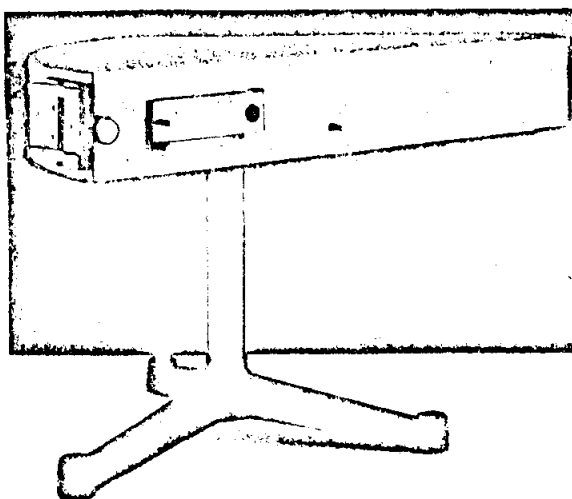


FIG. 1 - GRATING SPECTROSCOPE
CENCO NO. 086950

3. SET UP AND OPERATION

3.1 General : Position the column on top of the tripod base. Slip the cap screw through the washer and insert the screw through the hole in the tripod and into the column; tighten the screw.

Take the cover off the spectroscope case. **Position** the case on the column so that the three holes in the bottom of the case and those on the column are aligned. Insert the Phillips head screws into the holes and tighten them. Inside the shipping carton is a case containing a replica grating. An operating instruction sheet, "Transmission and Reflection Gratings, Cenco Nos. 086250 086887," is folded around the slide-out case. **READ THIS OPERATING INSTRUCTION BEFORE HANDLING THE GRATING.** Pay special attention to **Section 3, Use and Maintenance.** Then remove the grating and carefully insert it in the clips near the eyepiece with the label facing the slit and pointing toward the bottom of the case. Replace the cover on the case.

3.2 Full Normal Spectrum : Set up the Grating Spectroscope with a source of bright light, such as **sunlight** or the Cenco No. 085261 Illuminator, in back of the slit and in such a position that light passing through the slit reaches the eyepiece of the Spectroscope. With a suitable support, mount a ground glass plate between the source of light and the slit. The glass plate diffuses the light to produce a better spectrum on the scale. With this arrangement the full spectrum of the light source can be seen on the scale. Adjust the slit to admit that amount of light which gives a full normal spectrum. If the scale is too dim, open the side window to illuminate the scale sufficiently so that it can be read easily.

3.3 Spectrum of Elements from Spectrum Tubes : Slide a spectrum tube (Cenco No. 087260 Mercury Tube, for example) in the groove in front of the slit. Connect the spectrum tube to an appropriate power supply, such as Cenco's No. 087208. The output of this power supply is 18 milliamperes at 5,000 volts. Connect to the power supply a rheostat, such as the Cenco No. 082910-I 1 or -12. The rheostat is used to adjust the power supply to a suitable operating level for the particular spectrum tube.

The exciting current of the power supply should be adjusted to the lowest value that will give a sufficiently bright spectrum. A higher current may be used for short periods, but the life of the tube will be considerably lengthened by use of the lowest possible current level. When excessive current is used for excitation, heat is generated which may cause the release of vapors from the glass and possibly from the electrodes. Spectra produced by these vapors may obscure the spectrum of the gas with which the tube was originally filled, thus making the spectrum tube useless. Since the spectra tubes of the halogen family have a short life, they should be operated only when needed.

Start the discharge in the spectrum tube and adjust the slit of the spectroscope to the width which gives best results on the scale. Since the glass envelope of the spectrum tube may be

of uneven thickness, it is suggested that the tube be rotated part way around in its groove until the best spectrum is found. Observe that only a limited number of wave lengths is emitted, and the spectrum consists of a series of colored images of the slit separated by dark regions. The colored images of the slit appear as bright lines. Four bright lines appear which should fall on the scale at the following graduations :

Blue	405
Blue	436
Green	546
Yellow	577

If it is necessary to adjust the scale, say to the position of the green line at the 546 mark, loosen the Phillips head screws and move the scale to coincide.

3.4 Spectrum with a Monochromatic Flame : Use a source of bright monochromatic light, such as a Bunsen burner, with a piece of glass rod suspended in the flame; or a Meker burner with a small piece of glass lying on the grid; or better yet the Cenco-Harcourt flame attachment with a sodium salt of a metal burning in one of its six pockets. Set the burner just behind the groove and at a height that will bring the colored flame at the slit level. The sodium spectrum will then be visible on the scale. Spectra of other elements may be made visible with the Bunsen burner or other monochromatic flame devices used in a similar manner.

3.5 Absorption Spectra : Pour the solution to be examined in a glass vial which is 6- or 7-mm in diameter and 8 or 10 cm long. Place the vial in the groove in back of the slit. Place a carbon-arc lamp or other source of bright light directly behind the vial and mount a piece of frosted glass in between so as to throw a strong diffused light through the solution and into the slit in the instrument. The spectrum seen on the scale will be the absorption spectrum, or the normal spectrum minus whatever lines have been absorbed by the solution. If the tube is pushed down in the groove until the solution covers only the lower half of the slit the normal spectrum will be seen on the upper half of the scale and the absorption lines will appear on the lower half. A 1/120 of 1 percent solution of potassium permanganate will give excellent results in this experiment.

4. READING OF SCALES AND GRATINGS

As of January 1968 the spectroscope has been furnished with a replica grating of nominally 15,000 lines/inch and a scale calibrated for that grating. Instruments manufactured prior to that date were furnished with a grating of 568 lines/mm and a correspondingly calibrated scale. If an owner of one of the older instruments purchases a replacement grating, he obtains one of either 600 or 610 lines/mm. In this event the readings of the spectroscope must be corrected. The tables on the following page show corrections for any particular scale and grating which may be used.

Table 1, Scale 5710 lines/cm

Grating	Readings in Å						
	4000	4500	5000	5500	6000	6500	7000
568	+15	+10	+5	0	----	----	----
600	+120	+70	+20	-30	-60	-90	-130
610	+10	-40	-90	-140	-205	-270	-340

Table 2, Scale 15,000 lines/inch

Grating	Readings in Å						
	4000	4500	5000	5500	6000	6500	7000
568	-20	-10	-5	0	+25	+50	+80
600	+90	+60	+30	0	-5	-10	-20
610	+90	+60	+30	0	-40	-80	-120

The + or - indicate values to be added to or subtracted from the reading to obtain a true wavelength in angstrom units (Å)

The gratings with 600 lines/mm and 610 lines/mm are both labeled, "Approximately 15,000 lines/inch." To differentiate between these two gratings, it is necessary to utilize a Helium Gas Spectrum Tube, such as Cenco No. 087215. First, align the scale with the green line of mercury, following the procedure given in Section 3.3. Then replace the mercury spectrum tube with a Helium tube. Excite the Helium and observe the position of the red line, which has a wave length of 6700 Å. When the 15,000 lines/inch scale is used, the red line will appear at

- about 6715 Å with the 600 line/mm grating, and
- about 6790 Å with the 610 line/mm grating

5. MAINTENANCE

Handle the various components of the Spectroscope with care and store the instrument in a safe place when it is not in use. If difficulties should occur which cannot be corrected easily, contact the nearest Cenco Branch Office, giving all symptoms of the malfunction. Wait for further instructions ; do not return the Spectroscope or any of its components without written authorization from Cenco.

6. REPLACEMENT SPECTRA TUBES

Description	Cenco No.
Argon Gas	087210
Helium Gas	087215
Neon Gas	087220
Carbonic Acid Gas	087225
Chlorine Gas	087230
Nitrogen Gas	087240
Air	087242
Oxygen Gas	087245
Iodine Vapour	087255
Mercury Vapor	087260
Water Vapor	087265

7. ACCESSORIES

Description	Cenco No.
Power Supply	087208
Rheostat	082910-011 or -012
Carbon Arc Illuminator with fixed rheostat, connecting cord with socket and attachment plug for use on 115 volts ac or dc and 12 carbons	085261
Absorption tube set, 10 tubes of liquids for observation of continuous spectra	086952
Multi-monochromatic flame attachment, Cenco-Harcourt for burning Chemical salts so characteristic spectra can be observed	087180
Ground glass plates 150 mm square, 3 mm thick	017735-4

To enable observations of the red line of Hydrogen, wave length of 6560 Å, the following accessories are advised.

Balmer Tube (Atomic Hydrogen)	087206
Power Supply	087207

OPERATING INSTRUCTIONS

CSC SPECTRA TUBES
NOS. 87210 through 87265

1. INTRODUCTION

The CSC Spectra Tubes are used as light sources for spectroscopes and wavelength spectrometers. The tubes concentrate a gaseous discharge in a narrow capillary tube to produce a brilliant line source of light.

2. DESCRIPTION

The Spectra Tubes consist of glass tubing which has a thick-walled capillary portion and is filled with highly purified gas. Firmly sealed to the ends of each tube is a platinum wire welded in a metal cap. Protruding through the metal caps is a wire loop for electrical connection. The capillary portion of the glass tube concentrates the luminescence in a narrow column for maximum intensity.

The gas contents of the spectra tubes have been highly purified to assure spectra that are free from unwanted lines.

3. DIMENSIONS

Overall length	25 cm
Capillary portion length	8.5 to 10 cm

4. SETUP AND OPERATION

Support a spectrum tube vertically in the clamps provided on the high potential rod-terminals of the CSC No. 87208, Spectrum Tube Power Supply. The output of this power supply is 18 milliamperes at 5,000 volts. To the power supply connect a 720 ohm rheostat, such as the CSC No. 82910-007. The rheostat is used to adjust the power supply to a suitable operating level for the spectrum tube. These tubes may also be operated by means of a CSC No. 79800 or 80730 Induction Coil energized by three CSC No. 79145 Dry Batteries connected in series, but the use of the special power supply is preferred.

The exciting current of the power supply should be adjusted to the lowest value that will give a sufficiently bright spectrum. A higher current may be used for short periods, but **the life of the tube will be considerably lengthened by use of the lowest possible current.** When excessive current is used for excitation, heat is generated which may cause the release of vapors from the glass and possibly from the electrodes. Spectra produced by these vapors may obscure the spectrum of the gas with which the tube was originally filled, thus making the spectrum tube useless. Since the spectra tubes of the halogen family have a relatively short life, even when operated conservatively, they should be energized only when needed.

5. REPLACEMENT SPECTRA TUBES

Description	CSC No.
Argon Gas	87210
Helium Gas	87215
Neon Gas	87220
Carbonic Acid Gas	87225
Chlorine Gas	87230
Nitrogen Gas	87240
Air	87242
Oxygen Gas	87245
Iodine Vapor	87255
Mercury Vapor	87260
Water Vapor	87265

6. ACCESSORIES

Description	CSC NO.
Power Supply	87208
Rheostat	82910-007
Induction Coil	79800
Dry Battery	79145
Power Supply	79561

OPERATING INSTRUCTIONS

LABORATORY RHEOSTATS AIR-COOLED AND WATER-COOLED CENCO NOS. 82910 AND 82935

1. INTRODUCTION

Cenco Laboratory Rheostats, both air-cooled and water-cooled models, are devices which provide a variable resistance in electrical circuits for laboratory demonstration of electrical phenomena. A total of thirteen air-cooled models and five water-cooled models are available to provide a variety of resistances ranging from 5700 ohms to 2.8 ohms.

2. SPECIFICATIONS

Cenco Number	Resistance, Ohms	Maximum Current, Amperes	
		Air-Cooled	Water-Cooled
82910-3	5700	0.27	—
82910-4	4100	0.32	—
82910-5	2900	0.38	—
82910-6	1400	0.55	—
82910-7	720	0.78	—
82910-8	360	1.1	—
82910-10	180	1.6	—
82910-11	90	2.2	—
82910-12	44	3.1	—
82910-13	22	4.4	—
82910-14	11	6.2	—
82910-15	5.6	8.7	—
82910-17	2.8	12.0	—
82935-12	44	3.0	7.1
82935-13	22	4.3	10
82935-14	11	5.0	12.4
82935-15	5.6	8.4	20
82935-17	2.8	12.0	28

3. DESCRIPTION

A Cenco Laboratory Rheostat consists of copper winding on a vitreous enameled tube held between cast-aluminum end supports. A nickel-silver alloy slide bar is held between the end supports by means of insulated bushings.

A cast-aluminum, sliding-contact carriage, mounted on the slide bar, carries a solid bronze contact. Electrical connection between the contact and the carriage frame is made by means of a copper ligament. The resistance and measuring current rating of the rheostat is stamped on the upper surface of the contact carriage. Three binding posts, one at each end of the copper winding and the other at one end of the slide bar, are provided for electrical connection.

The tube ends on the water-cooled models are closed and provided with tubulation to permit the entrance and the exit of cooling water.

4. OPERATION

The Cenco No. 82935 Water-Cooled Rheostats may be used as either air-cooled or water-cooled rheostats. For water cooling operation, simply connect one nipple to cold, tap water and the other to a drain. A water flow of about 1 liter per minute is sufficient.

In addition to their use as rheostats, Cenco Nos. 82935-12 and 82935-13 are ideal as sources of heated water. Use the 82935-12 model on a 220-volt circuit and the 82935-13 model on a 115-volt circuit.

5. MAINTENANCE

Cenco Laboratory Rheostats require no maintenance and, if given reasonable care, will provide years of satisfactory service. Should any difficulty occur which cannot be corrected, contact the Cenco Service Department or the nearest Cenco Branch Office for further instructions. Do not return any rheostat without written authorization from Cenco.

