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CONOCO INC.

PONCA CITY, OKLAHOMA
REFINING TECHNICAL SERVICES LABORATORY

Plt.: PC
File: 662.1
924
Date: 9/4/84

LABORATORY NO.: I-5-84
CHARGES: PC 49
SUBJECT: Summary of Benzene Content of Finished Gasolines and In-Plant Streams - 1977 to 1984 - Ponca City Refinery

CONCLUSION:

No. Ponca City Refinery finished gasolines or in-plant streams contain as much as 10.0 wt.% benzene. Therefore, the control provisions of EPA regulation 40 CFR 61, Subpart J, do not apply.

DISCUSSION:

A recently promulgated regulation from EPA mandates controls on benzene fugitive emissions at petroleum refineries. A key definition in the regulation is: "In benzene service means that a piece of equipment either contains or contacts a fluid that is at least 10 percent benzene by weight as determined according to the provisions of §61.245(d)." Unless fluids produced or used in the refinery contain at least 10 wt.% benzene, the controls in the regulation do not apply.

At R. L. Thorstenberg's request of 8/29/84, the results of previous laboratory studies of benzene in Ponca City Refinery streams are summarized in this report. Five major studies on this topic were made from 1977 through 1984. Benzene content of all the streams measured in them was lower than 10 wt.%.

Attachment II is a laboratory crosscheck comparing benzene concentrations determined using gas chromatography and infra-red analytical methods. The benzene results included in this report were obtained using both methods at different times. The method described in the regulation at §61.245(d) is gas chromatography.

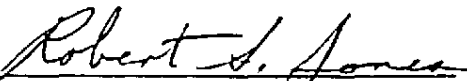
ANALYTICAL DATA:

Attachment I.

REFERENCE:

1. Memo from R. L. Thorstenberg to R. S. Jones, dated 8/29/84.
2. Several laboratory reports dated in 1977, 1980, and 1984.

Approved:


Senior Technologist
bp
cc: GAO-RLT-EW-PLY-RSJ-KCH-F
Att: 2

MCD 000019289

Benzene

LABORATORY NO.: I-5-84
9/4/84
Attachment I

Attachment I

Benzene Content of Ponca City Refinery Finished
Products and In-Plant Streams

<u>Stream Description</u>	<u>Sample Date</u>	<u>Benzene Wt. %</u>
<u>Finished Gasolines</u>		
Regular Gasoline	7/84	1.3
Unleaded Gasoline	7/84	1.1
Super Unleaded Gasoline	7/84	0.6
Regular Gasoline	2/84	1.0
Unleaded Gasoline	2/84	0.7
Super Unleaded Gasoline	2/84	0.4
Regular Gasoline	7/80	1.3
Unleaded Gasoline	7/80	0.7
Regular Gasoline	1/80	1.4
Premium Gasoline	1/80	1.1
Unleaded Gasoline	1/80	0.9
Regular Gasoline	5/77	1.1
Premium Gasoline	5/77	0.5
Regular Gasoline	5/77	1.0
Regular Gasoline	5/77	1.1
Regular Gasoline	5/77	1.3
Premium Gasoline	5/77	0.4
Regular Gasoline	5/77	1.2
Regular Gasoline	5/77	0.8
Regular Gasoline	5/77	1.3
Premium Gasoline	5/77	0.3
Regular Gasoline	5/77	1.1
Regular Gasoline	5/77	1.3
Regular Gasoline	5/77	0.8
Regular Gasoline	5/77	1.0
Regular Gasoline	5/77	1.0
Regular Gasoline	5/77	1.1
Premium Gasoline	5/77	0.4
Premium Gasoline	5/77	0.7
Unleaded Gasoline	5/77	0.7
Conotane Gasoline	5/77	1.3
Regular Gasoline	5/77	1.0
Regular Gasoline	5/77	1.3
Regular Gasoline	5/77	1.0
Unleaded Gasoline	5/77	0.7
Regular Gasoline	5/77	1.3
Premium Gasoline	5/77	0.7
Regular Gasoline	5/77	1.0
Premium Gasoline	5/77	0.2
Unleaded Gasoline	5/77	0.7
Regular Gasoline	5/77	1.1
Regular Gasoline	5/77	1.3
Regular Gasoline	5/77	1.0
Premium Gasoline	5/77	0.3
Regular Gasoline	5/77	1.0
Premium Gasoline	3/77	0.7

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Attachment I (Cont'd)

<u>Stream Description</u>	<u>Sample Date</u>	<u>Benzene Wt. %</u>
<u>Finished Gasolines (cont'd)</u>		
Regular Gasoline	3/77	1.2
Unleaded Gasoline	3/77	0.7
<u>Jet Fuels</u>		
JP-4, military	6/77	0.1
Q-Grade, commercial	5/77	<0.1
<u>In-Plant Streams</u>		
- #5 FCC Lt. Gasoline	7/84	1.0
#5 FCC Hvy. Gasoline	7/84	0.3
- #4 FCC Lt. Gasoline	7/84	0.8
#4 FCC Hvy. Gasoline	7/84	<0.1
#2 Reformer Charge	7/84	0.2
#2 Reformer Reformate (94 RON)	7/84	2.3
Alkylate	7/84	<0.1
#3 Reformer Charge	7/84	0.2
#3 Reformer Reformate (97 RON)	7/84	3.9
Straight Run Gasoline	7/84	1.3
Coker Gasoline	7/84	0.1
Cat Poly Gasoline	7/84	<0.1
- #5 FCC Lt. Gasoline	2/84	1.1
#5 FCC Hvy. Gasoline	2/84	0.4
- #4 FCC Lt. Gasoline	2/84	1.0
#4 FCC Hvy. Gasoline	2/84	<0.1
#2 Reformer Charge	2/84	0.2
#2 Reformer Reformate (89.5 RON)	2/84	2.0
Alkylate	2/84	0.3
#3 Reformer Charge	2/84	0.4
#3 Reformer Reformate (87.7 RON)	2/84	2.7
#3 Reformer Reformate (97.3 RON)	2/84	4.5
Straight Run Gasoline	2/84	1.4
Regular Coker Gasoline	2/84	0.1
Cat Poly Gasoline	2/84	<0.1
Casinghead Gasoline	7/80	0.5
Regular Coker Gasoline	7/80	0.2
Premium Coker Gasoline	7/80	0.4
Cat Poly Gasoline	7/80	<0.1
- #4 FCC Lt. Gasoline	7/80	1.3
#4 FCC Hvy Gasoline	7/80	0.1
- #5 FCC Lt. Gasoline	7/80	1.1
#5 FCC Hvy. Gasoline	7/80	0.2
Alkylate	7/80	<0.1
#2 Reformer Charge	7/80	0.2

Attachment II(Cont'd)

<u>Stream Description</u>	<u>Sample Date</u>	<u>Benzene Wt. %</u>
<u>In-Plant Streams (cont'd)</u>		
#2 Reformer Reformate (89.4 RON)	7/80	1.9
#3 Reformer Charge	7/80	0.2
#3 Reformer Reformate (89.5 RON)	7/80	2.0
Straight Run Gasoline	7/80	1.2
Straight Run Gasoline	1/80	1.3
Casinghead Gasoline	1/80	0.7
Regular Coker Gasoline	1/80	0.2
Premium Coker Gasoline	1/80	0.5
Hydro-treater Gasoline	1/80	0.2
Cat Poly Gasoline	1/80	<0.1
-#4 FCC Lt. Gasoline	1/80	1.1
#4 FCC Hvy. Gasoline	1/80	<0.1
-#5 FCC Lt. Gasoline	1/80	1.2
#5 FCC Hvy. Gasoline	1/80	0.1
Alkylate	1/80	<0.1
#2 Reformer Charge	1/80	0.1
#2 Reformer Reformate (90 RON)	1/80	1.2
#3 Reformer Charge	1/80	0.5
#3 Reformer Reformate (90 RON)	1/80	3.1
#2 Reformer Reformate	10/77	1.8
#3 Reformer Reformate	10/77	1.9
Total Alkylate	7/77	<0.1
Casinghead Gasoline	7/77	0.5
#1 CTU Raw Crude	6/77	0.1
North Texas		
#2 CTU Raw Crude	6/77	<0.1
West Texas and Foreign		
#4 CTU Raw Crude	6/77	0.1
Oklahoma-Kingfisher		
#5 CTU Raw Crude	6/77	0.1
West Texas and Foreign		
#2 Reformer Reformate	5/77	1.3
Straight Run Gasoline	5/77	1.3
Cat Poly Gasoline	5/77	<0.1
#5 FCC Gasoline	5/77	0.6
-#5 FCC Lt. Gasoline	4/77	0.6
#5 FCC Hvy. Gasoline	4/77	0.6
Coker Gasoline	4/77	0.1
#4 FCC Hvy. Gasoline	4/77	<0.1
-#4 FCC Lt. Gasoline	4/77	0.4
#3 Reformer Charge	4/77	0.2
#3 Reformer Reformate	4/77	1.5
Straight Run Gasoline	4/77	1.8

MCD 000019292

21
File

CONOCO INC.
PONCA CITY, OKLAHOMA
REFINING TECHNICAL SERVICES LABORATORY

Plt.: PC & LC
File: 610.3
Date: 10/31/80

LABORATORY NO.: J-103-80
CHARGE: PC 49, LC 49
SUBJECT: Polynuclear Aromatic Analysis of Coker Feed - Ponca City and Lake Charles Refineries.

ANALYTICAL DATA:

Sample No.:	PC 1564	PC 1565	PC 1567	PC 1568	PC 1569
	LC 649	LC 650	LC 652	LC 653	LC 654
Sample:	Vacuum	Ethelene	Monsanto	Shell	Thermal
	Jug Btms	Hvy Aromatics	Tar	Tar	Tar
	Lake	Lake	Lake	Lake	Lake
	Charles	Charles	Charles	Charles	Charles
Benzene Solubles,					
wt.%*	99+	99+	99+	99+	99+
Polynuclear Aromatics, wt. %	2.0	4.2	20.6	14.8	38.2

Sample No.:	PC 1570	PC 1572	PC 1821	PC 1822	PC 1823
	LC 655	LC 657	----	----	----
	Vacuum	FCC	Vacuum	Decant	DuoSol
	Resid.	Slurry Oil	Resid	Oil	Extract
	Lake	Lake	Ponca	Ponca	Ponca
	Charles	Charles	City	City	City
Benzene Solubles,					
wt.%*	99+	99+	99+	99+	99+
Polynuclear Aromatics, wt. %	3.1	39.1	1.1	33.9	0.3

* The polynuclear aromatics of the benzene soluble fraction, as determined by a liquid chromatographic (HPLC) system in the R&D Analytical Research Section, includes all 3 and greater membered-ring-type PNA compounds.

REFERENCE:

Letter from O. R. Barresi to K. C. Hunt dated 9/9/80.

Approved:

John O'Neill
Senior Technologist
bp

cc: ORB-LHB-WF-MJ-KCH-F

from Box 5

21 = 20001

Analysis of Res
Sum = # 2 Coker
1/3 way down

Patricia Morgan
Analytical Chemist
MCD 000019426

RECEIVED

NOV 31, 1980

Ref'y Pers P.C.

VII. APPENDIX I

METHOD FOR

SAMPLING AND ANALYTICAL PROCEDURES

FOR DETERMINATION OF BENZENE

The following sampling and analytical method for analysis of benzene in air employs adsorption on charcoal, followed by desorption, and gas chromatographic measurement. This is a modified method derived from White et al [136] and Kupel and White. [137] Additional data are contained in Part IV under Sorbability of Benzene on Charcoal and Accuracy and Precision Data.

Atmospheric Sampling

(a) Equipment Used

The sampling train is composed of a charcoal tube, a vacuum pump, and a flowmeter. A personal sampler pump or a dependable hand pump, eg, a detector tube pump may be calibrated to produce the desired volume of air.

(b) Calibration of Sampling Instruments

Air sampling instruments may be calibrated with a wet test meter or other suitable reference over a normal range of flowrates and pressure drops. The calibration is conducted at least annually and at any time following repairs or modifications to the sampling system. Similarly, wet test meters should be calibrated upon procurement, at least annually, and after each repair. Calibration curves shall be established for each sampling pump and shall be used in adjusting the pumps prior to field use. The volumetric flowrate through the sampling system shall be spot checked

and the proper adjustments made before and during each study to assure obtaining accurate airflow data.

(1) Flowmeter Calibration Test Method

(A) With the wet test meter in a level position, check to ascertain that the water level just touches the calibration point on the meter. If the water level is low, add water 1 to 2 F warmer than room temperature to the fill point and run the meter for 30 minutes before calibration.

(B) Check the voltage of the pump battery with a voltmeter to assure adequate voltage for calibration. Charge the pump battery if needed.

(C) Break the tips of a charcoal tube to produce openings of a least 2 mm in diameter.

(D) Assemble the calibration train in series, with the test meter, then the charcoal tube, and finally the pump.

(E) Turn the pump on, adjusting the rotameter float to a selected reading on the rotameter scale. Wait until the float indicates a steady reading.

(F) The pointer on the meter should turn clockwise and indicate a pressure drop of not more than 1.0 inch of water. Operate the system for 10 minutes before starting the calibration. If the pressure is greater, recheck the system.

(G) Data for the calibration include the serial number; meter reading, start and finish; starting time, finish time, and elapsed time; air temperature; barometric pressure; serial number of the

pump and rotameter; the name of the person performing the calibration; and the date.

(H) Adjust the rotameter float to at least 3 other readings and record the pertinent data in step G at each reading.

(I) Correct the readings to standard conditions of pressure and temperature by means of the gas law equation.

(J) Use graph paper to plot the actual airflow and the rotameter readings. Determine the rotameter reading which will result in a 1 liter/minute flowrate for the pump being calibrated.

(c) Sampling Procedure

The equipment should be set up in a proper locale. The tips of the charcoal tube are broken off producing openings of at least 2 mm in diameter; the filled end of the tube is inserted toward the pump. The tube should always be in a vertical position during sampling. The pump is started and a 10-liter sample is taken at a flowrate of 1 liter/minute. Slower flowrates may be used to lengthen the sampling period but the 1 liter/minute rate should not be exceeded. After the sample is taken, each end of the tube should be capped (plastic caps are provided with commercial tubes). The samples will remain stable for at least 2 weeks which permits shipment for analysis; however, samples should be analyzed as soon as possible in keeping with good laboratory practices.

Analytical

(a) Principle of the Method

A known volume of air is drawn through a charcoal tube to trap the organic vapors present. The charcoal in the tube is transferred to a small

test tube and desorbed with carbon disulfide and an aliquot of the desorbed sample is injected into a gas chromatograph. The area of the resulting peak is determined and compared with areas obtained from the injection of standards.

(b) Range and Sensitivity

The lower limit for benzene with instrument attenuation and splitter techniques is 0.01 mg for each sample. This value can be lowered by reducing the attenuation or by eliminating the splitter. The upper limit value for benzene is 6.0 mg/sample. This value is the number of milligrams of benzene which the front section will collect before a significant amount passes to the backup section. The charcoal tube consists of 2 sections of activated charcoal separated by a section of urethane foam [see description in (f)(2)]. If a particular atmosphere is suspected of containing a large amount of contaminant, it is recommended that a smaller than normal sampling volume be taken.

(c) Interferences

(1) When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped. Only water present as a mist is a problem, not water vapor.

(2) Any compound with the same retention time in the gas chromatograph as benzene at the operating conditions described in this method could be considered an interference. This type of interference can be overcome by changing the operating conditions of the instrument.

(d) Accuracy and Precision

The accuracy and precision determined by a representative laboratory test with benzene (see also Accuracy and Precision Data in Part IV) was found to be:

	<u>Accuracy</u>	<u>Precision</u>
Motor driven laboratory pump	7.6%	4.2%
Approved coal mine personal sampling pump (calibrated with no in-line resistance)	13.6%	10.1%
Approved coal mine personal sampling pump (calibrated with charcoal tube in line)	8.8%	11.6%

The accuracy includes single-day systematic error by 1 operator. Precision represents the single-day accuracy on several different tubes and includes tube-to-tube deviation under controlled laboratory conditions. [138]

(e) Advantages and Disadvantages of the Method

The sampling device is small, portable, and involves no liquids: one basic method is provided for determining many different organic solvents. Interferences are minimal and most can be eliminated by altering chromatographic conditions. In addition, the analysis is accomplished using a rapid instrumental method.

One disadvantage of the method is that the amount of sample which can be obtained is limited by the amount of benzene which the tube will hold before overloading as indicated by benzene recovery at the outlet end of the tube. Also, the precision is limited by the reproducibility of the pressure drop across the tubes, which affects the flowrate, thus causing the volume to be imprecisely measured.

(f) Apparatus consists of:

(1) An approved coal mine dust personal sampling pump or any vacuum pump whose flow can accurately be determined at 1 liter/minute or less for an area sample.

(2) Charcoal tubes: Glass tubes with both ends flame-sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing two sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The absorbing section contains 100 mg of charcoal, the backup section, 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of glass wool is placed in front of the absorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flowrate of 1 liter/minute. Tubes with the above specifications are commercially available.

(3) Gas chromatograph equipped with a flame ionization detector.

(4) Column (20 ft x 1/8 in) with 10% FFAP stationary phase on 80/100 mesh acid washed DMCS Chromosorb W solid support.

(5) A mechanical or electronic integrator or a recorder and some method for determining peak area.

(6) Small glass-stoppered test tubes or equivalent tubes.

(7) Syringes: 10 μ l syringe, and other convenient sizes for preparation of standards.

(g) Reagents

- (1) Spectroquality carbon disulfide
- (2) Benzene, preferably chromatquality grade.
- (3) Bureau of Mines Grade A helium.
- (4) Prepurified hydrogen.
- (5) Filtered compressed air.

(h) Procedure

(1) Cleaning of Equipment

All equipment used for the laboratory analysis should be washed in detergent followed by tap and distilled water rinses.

(2) Collection and Shipping of Samples

Both ends of the charcoal tube are broken to provide openings of at least 2 mm (one-half the I.D. of the tube). The smaller section of charcoal in the tube is used as a backup section and is, therefore, placed nearest the sampling pump. Tubing may be used to connect the back of the tube to the pump, but no tubing must ever be placed on the front of the charcoal tube. Because of the high resistance of the charcoal tube, the sampling method places a heavy load on the personal sampling pump; therefore, it should not be assumed that the pump will run a full 8 hours without a recharging of the battery.

One or more charcoal tubes serving as blanks are treated in the same manner as the sample tubes (break, seal, ship) except that no air is drawn through them.

If bulk samples are submitted in addition to charcoal tubes, they are to be shipped in a separate container.

(3) Analysis of Samples

(A) Preparation

Each charcoal tube is scored with a file and broken open in front of the first section of charcoal. The glass wool is removed and discarded, the charcoal in the first (larger) section is transferred to a small stoppered test tube, the foam separating section is removed and discarded, and the second section is transferred to another test tube. The two charcoal sections are then analyzed separately.

(B) Desorption

Prior to analysis, 0.5 ml of carbon disulfide is pipetted into each test tube to desorb the benzene from the charcoal. Desorption is complete in 30 minutes if the sample is stirred occasionally.

EXTREME CAUTION MUST BE EXERCISED AT ALL TIMES WHEN USING CARBON DISULFIDE BECAUSE OF ITS HIGH TOXICITY AND FIRE AND EXPLOSION HAZARDS. IT CAN BE IGNITED BY HOT STEAM PIPES. ALL WORK WITH CARBON DISULFIDE MUST BE PERFORMED UNDER AN EXHAUST HOOD.

(C) Gas chromatographic conditions

Typical operating conditions for a gas chromatograph are:

- (i) 85 cc/min (70 psig) helium carrier gas flow.
- (ii) 65 cc/min (24 psig) hydrogen gas flow to detector.
- (iii) 500 cc/min (50 psig) airflow to detector.
- (iv) 200 C injector temperature.
- (v) 200 C manifold temperature (detector).

- (vi) 90 C oven temperature isothermal.
- (vii) Use either dual column differential operation or uncompensated mode.

(D) Injection

To eliminate difficulties arising from blowback or distillation within the syringe needle, the solvent flush injection technique is employed to inject the sample into the gas chromatograph. The 10- μ l syringe is first flushed with solvent several times to wet the barrel and plunger, then 3 μ l of solvent is drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. Next, the needle is removed from the solvent and the plunger is pulled back about 0.2 μ l to separate the solvent flush from the sample with an air pocket to be used as a marker. The needle is then immersed in the sample and a 5- μ l aliquot is withdrawn. Prior to injection in the gas chromatograph, the plunger is pulled back a short distance to minimize sample evaporation from the needle tip. Duplicate injections should be made of each sample and the standard. No more than a 3% difference should result in the peak areas that are recorded.

(E) Measurement of area

The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement and preliminary sample results are read from a standard curve prepared as outlined below.

(i) Standards Preparation and Desorption Efficiency

(1) Preparation of Standards

It is convenient to prepare standards in terms of mg/ 0.5 ml of carbon disulfide because this is the quantity used for benzene desorption from the charcoal. To prepare a 0.3 mg/ 0.5 ml standard, 6.0 mg of benzene (converted to microliters for easy measurement) is injected into exactly 10 ml of carbon disulfide in a glass-stoppered flask. The excess quantity of benzene is used to minimize error due to carbon disulfide volatility. A series of standards is then prepared, varying in concentration over the desired range, and analyzed under the same gas chromatographic conditions and during the same time period as the unknown samples. Curves are established by plotting concentration vs average peak area.

(2) Determination of Desorption Efficiency

The desorption efficiency, ie, the percentage of benzene desorbed from the charcoal, is determined only once, provided the same batch of charcoal is always used.

Activated charcoal, equivalent to the amount in the first section of the sampling tube (100 mg), is measured into a 2-in, 4-mm I.D. glass tube, flame-sealed at one end, and capped with a paraffin film or equivalent at the open end. A known volume of benzene, usually equivalent to that present in a 10-liter sample at a concentration equal to the federal standard, is injected directly into the activated charcoal with a microliter syringe and the tube again capped with more paraffin film. A minimum of 5 tubes are prepared in this manner and allowed to stand for at least 1 day to assure complete adsorption of the benzene onto the charcoal.

These tubes are desorbed and analyzed in exactly the same manner as the sampling tubes.

The results of each analysis are compared to the standards to determine the average percentage (desorption efficiency) that is desorbed. The desorption efficiency is then used as a factor in all sample analyses. The desorption efficiency, determined in this manner, has been shown to be essentially the same as that obtained by analysis of a known amount of benzene vapor trapped on the charcoal and the determined value, therefore, is used because of its simplicity. Each laboratory should determine its own desorption efficiency. For comparison purposes, NIOSH determined a value of 96% for benzene on one batch of charcoal.

(j) Calculations

(1) Read the weight in milligrams corresponding to each peak area from the standard curve. No correction is necessary for the volume injected, since it is the same for both the sample determination and the standard curve.

(2) The weight of benzene on the front section of the blank is subtracted from the weight determined for the front section of each sample; a similar procedure is followed for the backup sections. Amounts present on the front and backup sections of the same tube are then added together to determine the total amount detected in the sample. This total weight is then divided by the desorption efficiency to determine the corrected total number of milligrams in the sample. Milligrams are converted into ppm by volume in the air sampled by the following equation at 25 C and 760 mm Hg:

$$\text{ppm} = \frac{24,450 \text{ ml/mole} \times \text{mg/liter}}{\text{molecular wt}}$$

For a 10-liter air sample of benzene:

$$\text{ppm} = \frac{24,450 \text{ ml/mole} \times \text{mg in sample/10 liters}}{78.11 \text{ g/mole}}$$

$$\text{ppm} = 31.30 \times \text{mg in sample}$$

VIII. APPENDIX II
METHODS FOR DETERMINATION OF
EXPOSURE AREAS TO BENZENE

Estimation of Concentration with Detector Tubes

(a) Atmospheric Sampling

(1) Equipment Used

A typical sampling train consists of a detector tube with a corresponding sampling pump. A specific manufacturer's pump may only be used with his detector tubes.

(2) Sampling Procedures

A specific procedure depends on the manufacturer's instructions but normally consists of breaking both tips off a detector tube, inserting the tube into the pump, and making a specific number of strokes with the pump.

(3) Handling and Shipping of Samples

Detector tubes are not stable with time; the stain in some tubes fades in a few minutes. The tubes should be read immediately in accordance with the manufacturer's instructions and charts; no attempt should be made to save the used tubes.

(b) General Principles

Gas detector tubes contain a chemically impregnated packing which indicates the concentration of a contaminant in the air by means of a chemically produced color change. The color changes are not permanent or stable, so the stained tubes must be read immediately after the samples are taken. The length of stain or the color intensity is read according to the

manufacturer's instructions. This may involve comparing the stain with a chart, a color comparator, or a direct concentration reading from calibration marks on the tube. Detailed descriptions are provided by individual manufacturer's instructions.

Tubes obtained from commercial sources which bear the certified seal of NIOSH are considered to adhere to the requirements as specified for Approval of Gas Detector Tube Units in 42 CFR Part 84 (37 F.R. 19643). A user may perform his own calibration on commercially acquired tubes by generating accurately known concentrations of benzene in air and correlating concentration with stain length or color intensity.

(c) Range and Sensitivity

Certification standards require that certified tubes have a range from 1/2-5 times the time-weighted average concentration. The sensitivity varies with tube brands.

(d) Interferences

Interferences vary with tube brands. The manufacturer's instructions must be consulted.

(e) Accuracy

Certification standards by NIOSH under the provisions of 42 CFR Part 84 (37 F.R. 19643) specify reliability to within $\pm 25\%$ of the actual concentration in the range 0.75-5 times the standard and $\pm 35\%$ in the range from 0.5 up to, but not including, 0.75 times the standard.

(f) Advantages and Disadvantages

Unlike the charcoal tube method, the use of detector tubes (and portable instruments) is relatively inexpensive and rapid; there is far less time lag than that experienced with laboratory analytical results.

Rapid detecting units are valuable for determining whether a hazardous condition exists at a given location so that workers may be evacuated or suitable protective devices provided. In addition, industrial operators and process engineers need inexpensive and rapid tools for day-to-day evaluation of the atmospheric levels in a work area.

The accuracy of detector tubes is limited; at best they give only an indication of the contaminant concentration. In evaluating measurements performed with detector tubes, interferences, difficulty of end-point readings, and possible calibration inaccuracies must all be considered.

Measurement with Portable Instruments

(a) Atmospheric Sampling

(1) Equipment Used

Two classifications of portable meters that are applicable to atmospheric sampling are direct reading instruments and analytical instruments. Combustible gas meters and flame ionization meters are portable, direct reading instruments; portable variable-path infrared analyzers and gas chromatographs are both field analytical instruments. Any of the 4 meters mentioned are acceptable for benzene determinations if they are properly calibrated before use.

(2) Sampling Procedures

The most important sampling step is the meter calibration. Careful calibration must be performed either in the laboratory prior to on-site use or in the field using a container of specific benzene concentration. If calibration charts are inaccurate, erroneous readings will be made.

The actual field sampling is conducted according to the manufacturer's instructions. Readings should be corrected, if necessary for variables such as temperature, humidity, atmospheric pressure, etc, and recorded along with time, place, temperature, etc.

(b) General Principles

Analysis is dependent on the type of meter used. The portable direct reading meters require no analysis because they usually provide usable concentration readings directly. Results obtained from the variable-path infrared analyzer and the gas chromatograph must be recorded, further analyzed, and compared with standards to obtain concentration values.

(c) Range and Sensitivity

The range and sensitivity vary with the instrument used; in general, the portable analysis meters are more sensitive than direct reading units.

(d) Interferences

Again, these vary with the instrument used. Water vapor or combustible gases interfere with benzene identification using combustible gas meters. Mixtures of any carbon containing compounds, other than benzene, will interfere in flame ionization determinations.

(e) Advantages and Disadvantages

The benefits and drawbacks of portable instruments are essentially the same as for detector tubes discussed previously. Where recording capability is possible, direct reading instruments have the advantage of continuous record availability.

IX. APPENDIX III
BIOLOGIC METHOD FOR SAMPLING
AND ANALYSIS OF BENZENE

The recommended biologic method for urinalysis is derived from Sherwood and Carter. [102] It has been designed to determine the concentration of phenol and its conjugates, sulfate and glucuronide, in urine. It also determines orthocresol and meta- and paracresols. Urine is hydrolyzed with perchloric acid at 95 C, and the phenols and cresols are extracted with isopropyl ether and determined by gas chromatography.

Collection of Urine Samples

"Spot" urine specimens of about 100 ml are collected as close to the end of the working day as possible. If any worker's urine phenol level exceeds 75 mg/liter, procedures are instituted immediately to determine the cause of the elevated urine phenol levels and to reduce benzene exposure to the worker. Weekly specimens are collected as described above until 3 consecutive weekly determinations indicate that urinary phenol levels are below 75 mg/liter.

After thoroughly washing their hands with soap and water, workers shall collect urine samples from single voidings in clean, dry specimen containers having tight closures and at least a 120-ml capacity. Collection containers may be glass, waxcoated paper, or other disposable types if desired. Following collection of urine specimens, 1 ml of a 10% copper sulfate solution is added to each sample as a preservative, and samples are immediately stored under refrigeration, preferably at 0-4 C.

Refrigerated specimens will remain stable for approximately 90 days. If shipment of samples is necessary to perform analyses, the most rapid method available shall be employed utilizing acceptable packing procedures as specified by the carrier. Proper identification of each specimen shall include as a minimum, the worker's name, date, and time of collection.

Analytical

(a) Principle of the Method

Urine samples are treated with perchloric acid at 95 C to hydrolyze the phenol conjugates, phenyl sulfate, and phenyl glucuronide, formed as detoxification products following benzene absorption. The total phenol is extracted with diisopropyl ether and the phenol concentration is determined by gas chromatography analysis of the diisopropyl ether extract.

(b) Apparatus

(1) Gas chromatograph with a flame ionization detector and equipped with a 5-foot x 3/16-inch column packed with 2 w/w polyethylene glycol adipate on universal 'B' support. Operating conditions are as follows:

Column temperature	150 C
Detector temperature	200 C
Injection port temperature	200 C
Carrier gas	Nitrogen
Carrier gas flowrate	6) ml/min

(2) Water bath

(3) Glass-stoppered, 10-ml volumetric flasks

(4) 1-ml, 2-ml, and 5-ml volumetric pipets

(5) 5- μ l syringe

(c) Reagents

(1) Phenol

(2) Perchloric acid

(3) Diisopropyl ether

(4) Distilled water

(d) Procedure

(1) Hydrolysis of Phenol Conjugates

Pipet 5 ml of urine into a 10-ml, glass-stoppered, volumetric flask. Add perchloric acid, mix by swirling, and transfer the lightly stoppered flask to a water bath at 95 C. After 2 hours, remove the flask from the water bath and allow to cool at room temperature.

(2) Diisopropyl ether extraction of phenol and cresols.

Pipet 1 ml of diisopropyl ether into the flask and adjust the volume to 10 ml with distilled water. Shake vigorously for 1 minute to extract the phenol and cresols. Allow the aqueous and ether layers to separate.

(3) Gas chromatographic analysis for phenol

Inject 5 μ l of the diisopropyl ether layer into the gas chromatograph and record the attenuation and area of the phenol peak. Under the conditions described, phenol is eluted in 100 seconds, orthocresol in 130 seconds, and meta- and paracresols in 320 seconds.

(e) Standards Preparation

A 50 mg/liter standard aqueous solution of phenol is prepared. A 5-ml aliquot of the standard solution is then subjected to the hydrolysis, extraction, and gas chromatographic analysis procedures described under Procedure above.

(f) Calculations

Determine the phenol concentration in the urine by comparing the gas chromatographic peak area of the sample with that of the 50 mg/liter standard and adjust the value to a specific gravity of 1.024.

(g) Specific Gravity Correction

Due to the magnitude of correction which is required, samples having uncorrected specific gravities less than 1.010 shall be rejected and another sample shall be obtained.

Based on a survey of a large population in the United States in connection with urinary lead excretion, Levene and Fahy [139] found the mean specific gravity to be 1.024. Many investigators throughout the world now use this figure. Buchwald [130] in 1969 determined the mean specific gravity for residents in the United Kingdom to be 1.016, a value now frequently used for Northern Europeans. The importance of specific gravity adjustments can be seen in that a specific gravity of 1.016 will give results having two-thirds the value of those corrected to 1.024. It is important, therefore, that a value be chosen for standardization; since greater acceptance seems to be for 1.024, this value has been selected for adjustment of urinary concentrations of benzene recommended for biological monitoring.

$$\text{corrected concentration} = \frac{\text{observed concentration} \times 24}{\text{last 2 digits of sp gr (eg, 1.021)}}$$

X. APPENDIX IV
SPECIAL MEDICAL CONSIDERATIONS

The literature on the subject of benzene intoxication, both acute and chronic, has been reviewed elsewhere in this document. Levels of exposure permitted in the standards set by this document have been shown to reduce the danger of acute intoxications to a minimum. [1,24,23] Barring accidental exposure, the need for constant monitoring for signs and symptoms of acute intoxication is unnecessary. The toxic effects of chronic low level exposures are not as well documented and, as has been discussed, exposures to 40 ppm have caused hematologic changes in animals. [66] The need for constant and complete monitoring of the organ systems known to be affected by chronic benzene exposure is, therefore, prudent and necessary.

The hematologic system is especially singled out by benzene's toxic effects. There is no agreement in the literature as to which parameter of hematologic function is the first indicator of early benzene intoxication. Monitoring a number of components, therefore, becomes necessary.

The life span of the erythrocyte has been calculated by various methods to be approximately 120 days. [140] This means that if erythrocyte production were to stop suddenly, as in the development of aplastic anemia, 0.83% of the red cell mass would be lost daily. In the asymptomatic individual exposed to very low concentrations of benzene, measurements of the red cell mass could safely be done every 3 months. In workers exposed to higher concentrations, the risk of developing aplastic anemia increases, and more frequent determinations become necessary. In the event of red

cell agenesis, 2 weeks would be a sufficient time to reduce the red cell mass by 12%. A longer delay in discovering this condition would be deleterious to the prognosis; thus, monitoring the red cell mass in individuals with higher levels of exposure to benzene should be done at intervals not exceeding 2 weeks. Macrocytosis has also been stated to be the second most frequent toxic effect of benzene on the bone marrow [140]: therefore, bone marrow monitoring for macrocytosis by the measurement of appropriate corpuscular indices at the most frequent practical period is indicated.

No such simple means for estimating the decay of the white blood cell mass in the case of WBC agenesis is available because, to date, the life span of neutrophils has not been measured successfully, despite estimates of less than 12 days. [140] It is difficult to rationally set a maximum period beyond which it would be dangerous to delay measurement. Quarterly intervals in exposed individuals are felt to be maximum intervals prudent in this situation, reflecting the expense and difficulty of the differential WBC count, but measurement at shorter intervals is desirable where practical.

The life span of platelets has been variously estimated as from 9-12 days. These data are imprecise because of the difficulty inherent in the measurements. For those individuals exposed to greater than the maximum suggested TWA, a bimonthly measurement would seem sufficient to find a marked platelet reduction by estimation of platelets from a smear of peripheral blood. This finding might precede symptoms. However, by the time the abnormality is sufficiently advanced, the worker may already be complaining of symptoms caused by a decreased clotting function; therefore,

no test more frequently than quarterly is recommended for a platelet determination.

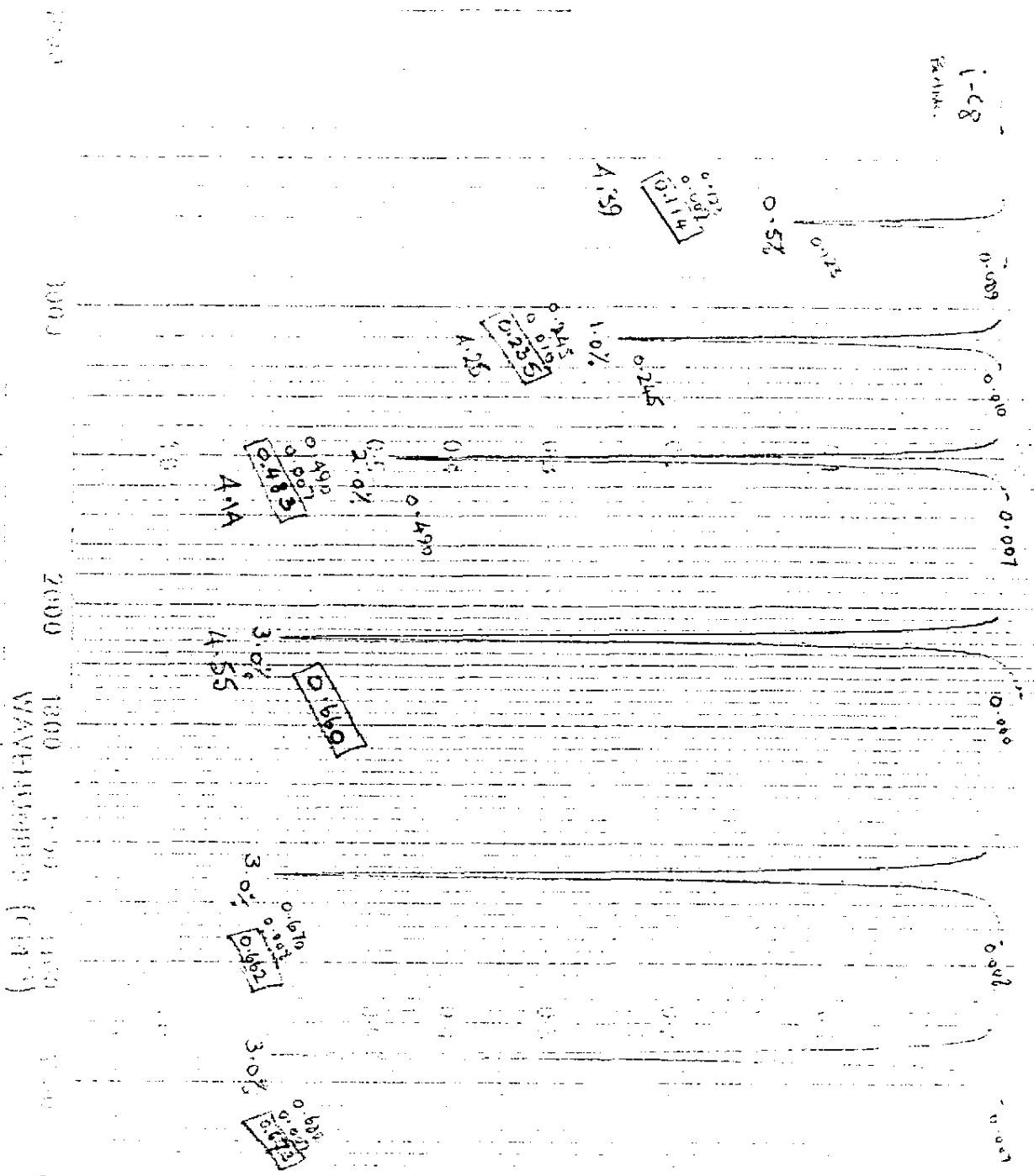
Increased turnover of erythrocytes, probably through hemolysis, has been reported. [140,141] Counts of reticulocytes (immature, still nucleate red blood cells) give a rough estimate of the rapidity of erythrocyte turnover. Obtaining this value on a quarterly basis is suggested in workers having exposures from 1-10 ppm of benzene and annually in others. Hemolysis is discovered early by laboratory estimation of the breakdown products of hemoglobin, of which bilirubin is the easiest to measure. Again, the frequency of the determination is predicated upon the level of individual exposure.

Normal Hematologic Values

The generally accepted ranges of normal for the hematologic tests discussed in the body of this document are presented in Table XII-14 and are derived from values reported by Conn. [142] It should be noted that these values do not represent a definition of normal, but are only a rough guideline. Interpretation of laboratory results should be made on the basis of that laboratory's established normal range for the procedure as performed there. The values listed in Table XII-14 are applicable only to adults.

1-68
Faint

B2 in 108 3644444



1348-12
394-100%
1350-0.1
1351-0.2
1352-0.5
1353-0.8
1354-0.1
1355-1.3

49 (24)
50 (25)
51 (26)
52 (27)
53 (28)
54 (29)
55 (30)

P1348 29

0 = 0.04 ~ 0.09
1 = 0.13
1.0 = 0.28
2.0 = 0.48
3.0 = 0.64 ~ 0.8

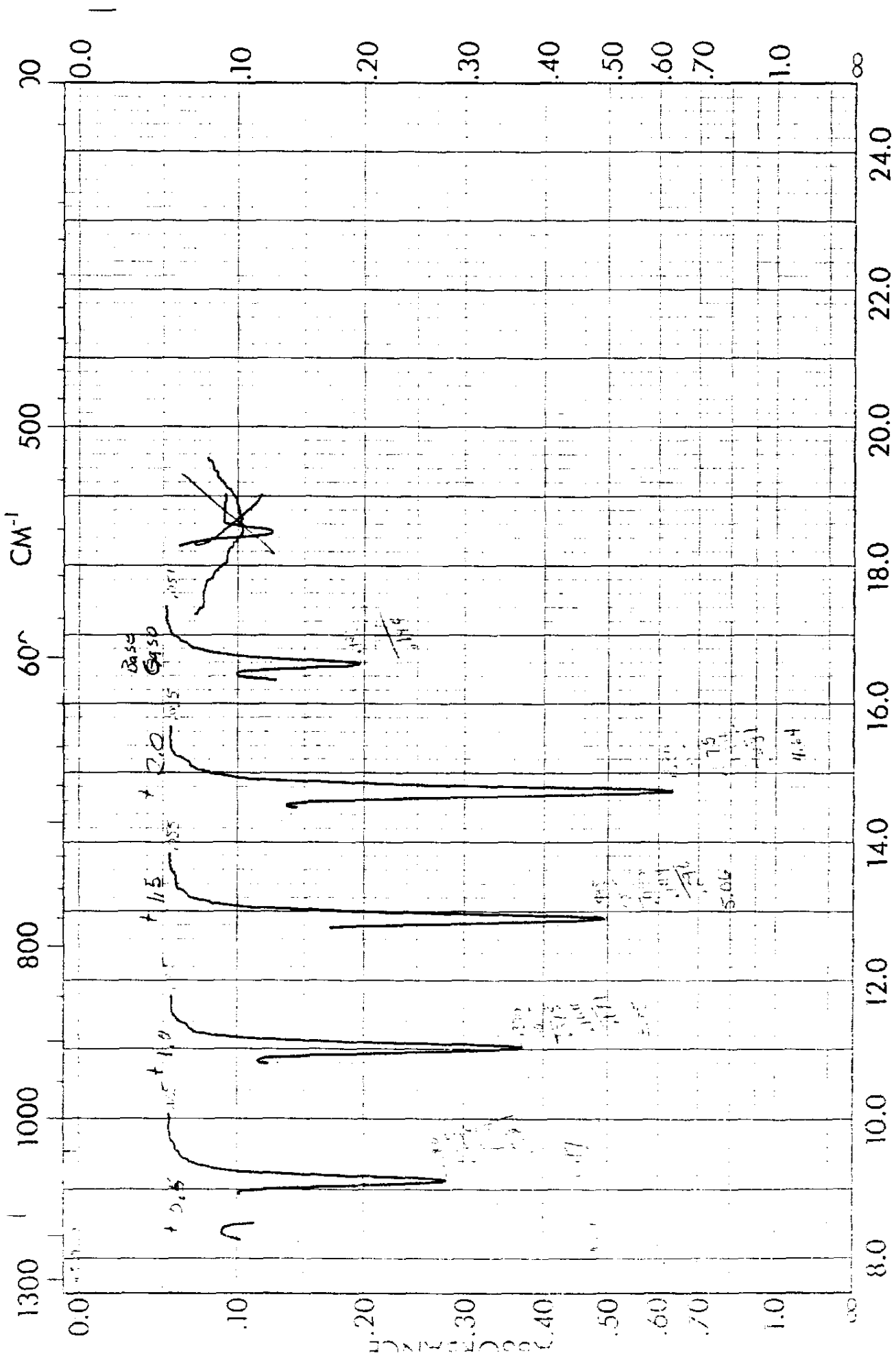
0 = 0
1 = 0.4
1.0 = 0.9
2 = 0.39
3 = 0.55

1350 1351 1352 1353 1354 1355

1356 1357 1358 1359 1360

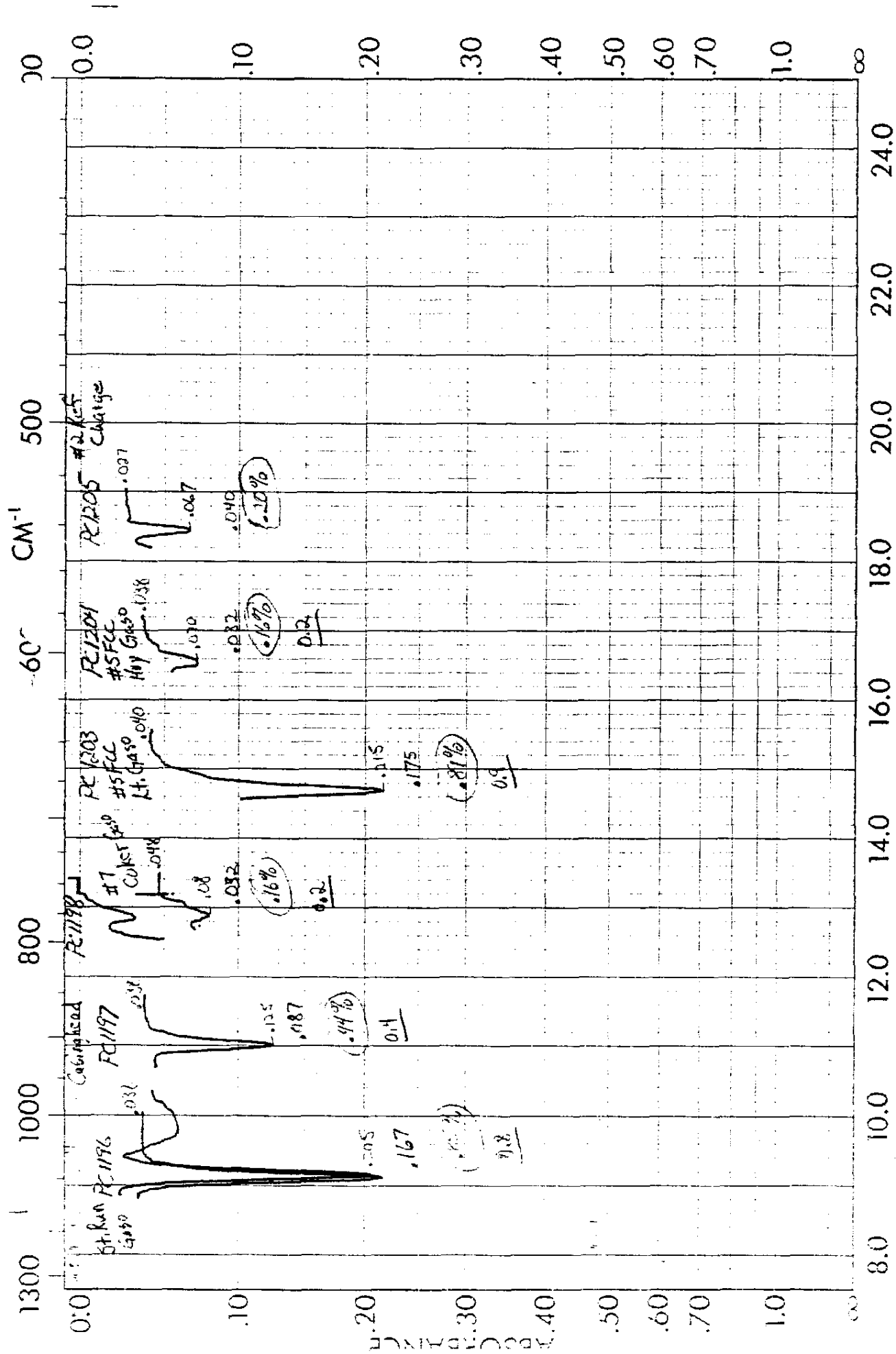
1361 1362 1363 1364 1365

1366 1367 1368 1369 1370



888610000 MCD 000019883

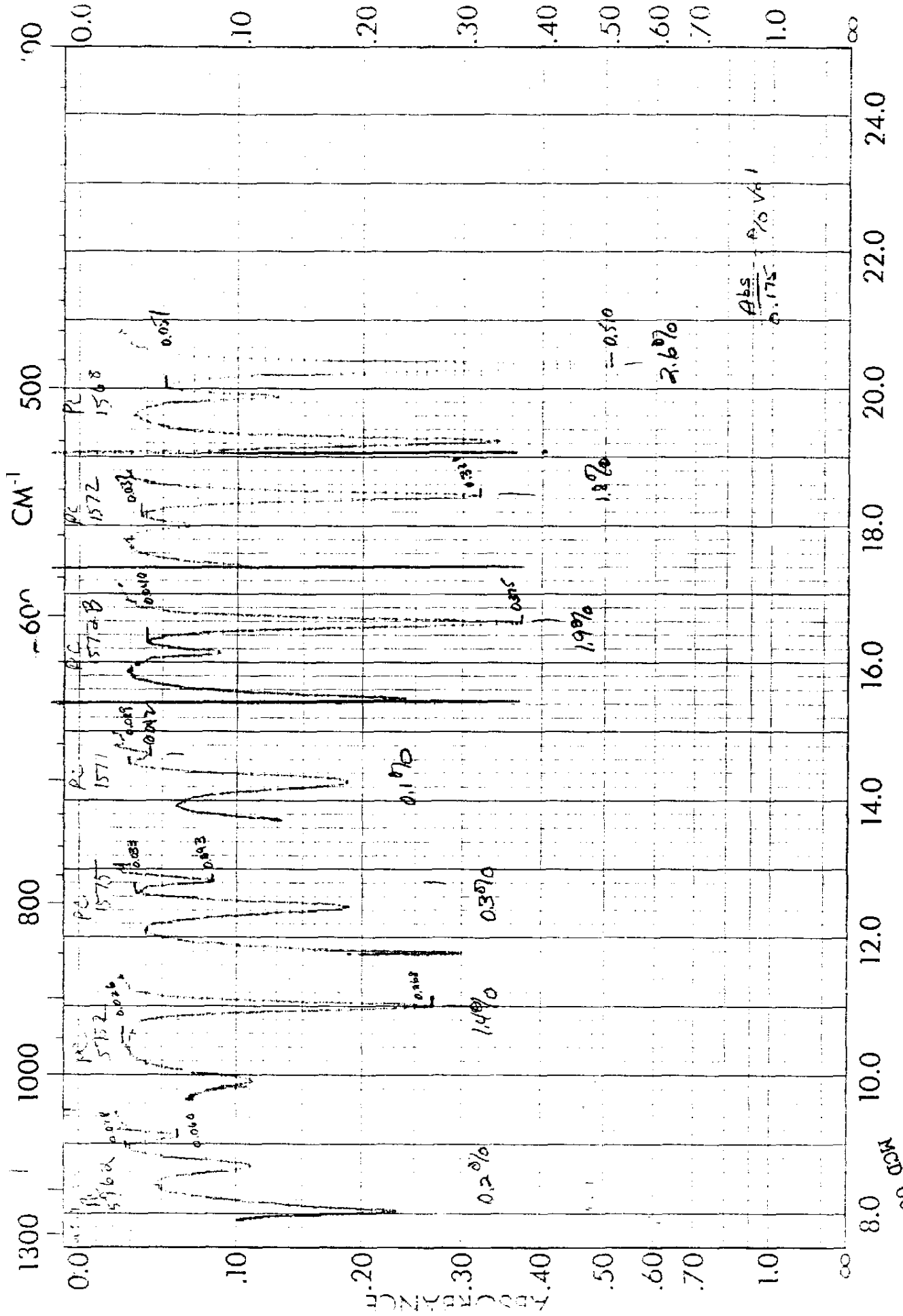
SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC. 1.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0	SLIT 1	DATE 1-12-79
ORIGINAL	CELL PATH 0.5 cm	REMARKS	
COPY	REFERENCE		



4886100019884

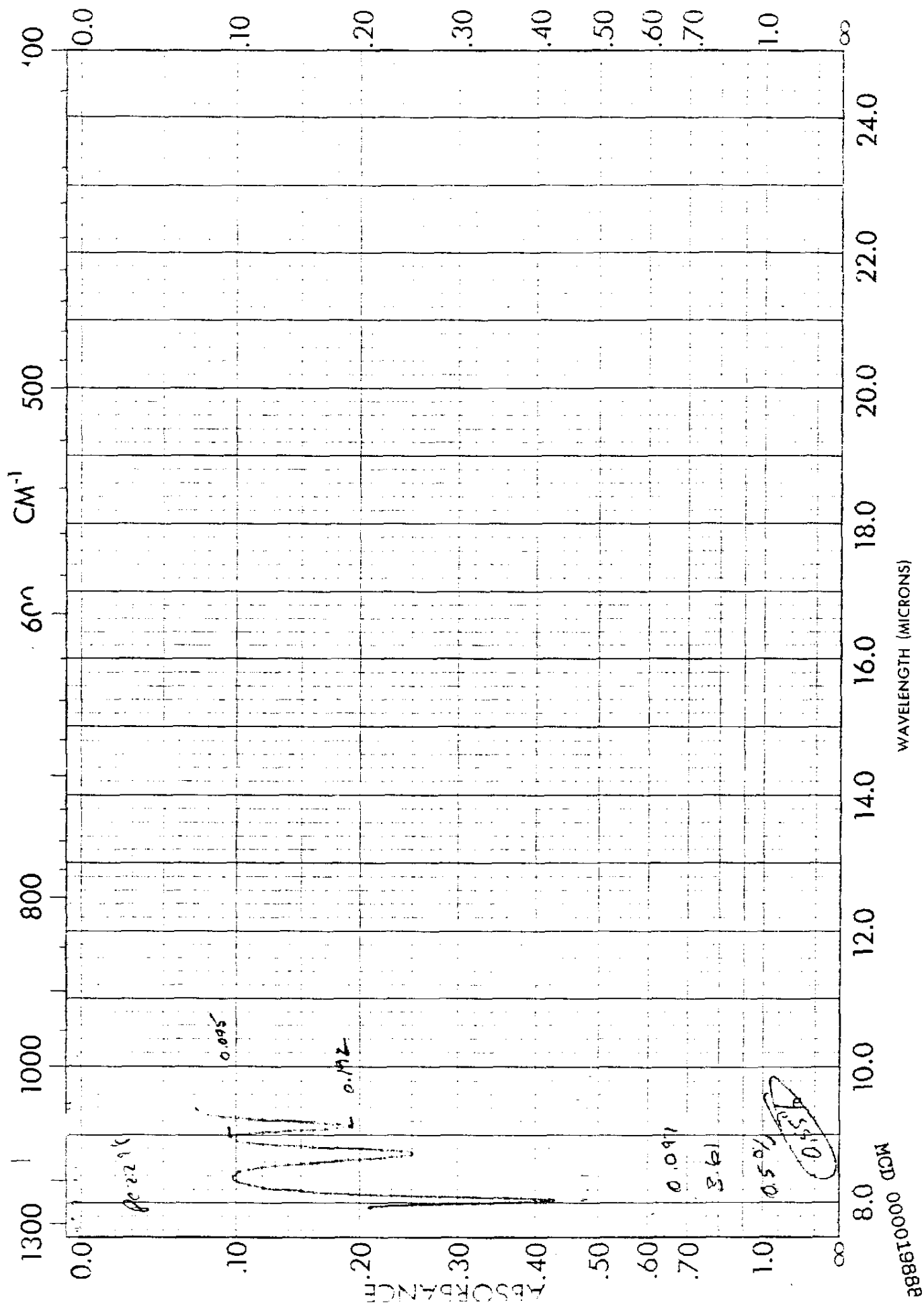
WAVELENGTH (MICRONS)

SAMPLE	CURVE NO.	SCAN SPEED <i>fast</i>	OPERATOR <i>SL</i>
	CONC.	SLIT <i>N</i>	DATE <i>6-12-79</i>
ORIGIN	CELL PATH <i>0.2588</i>	REMARKS	
ADVERT	REFERENCE		

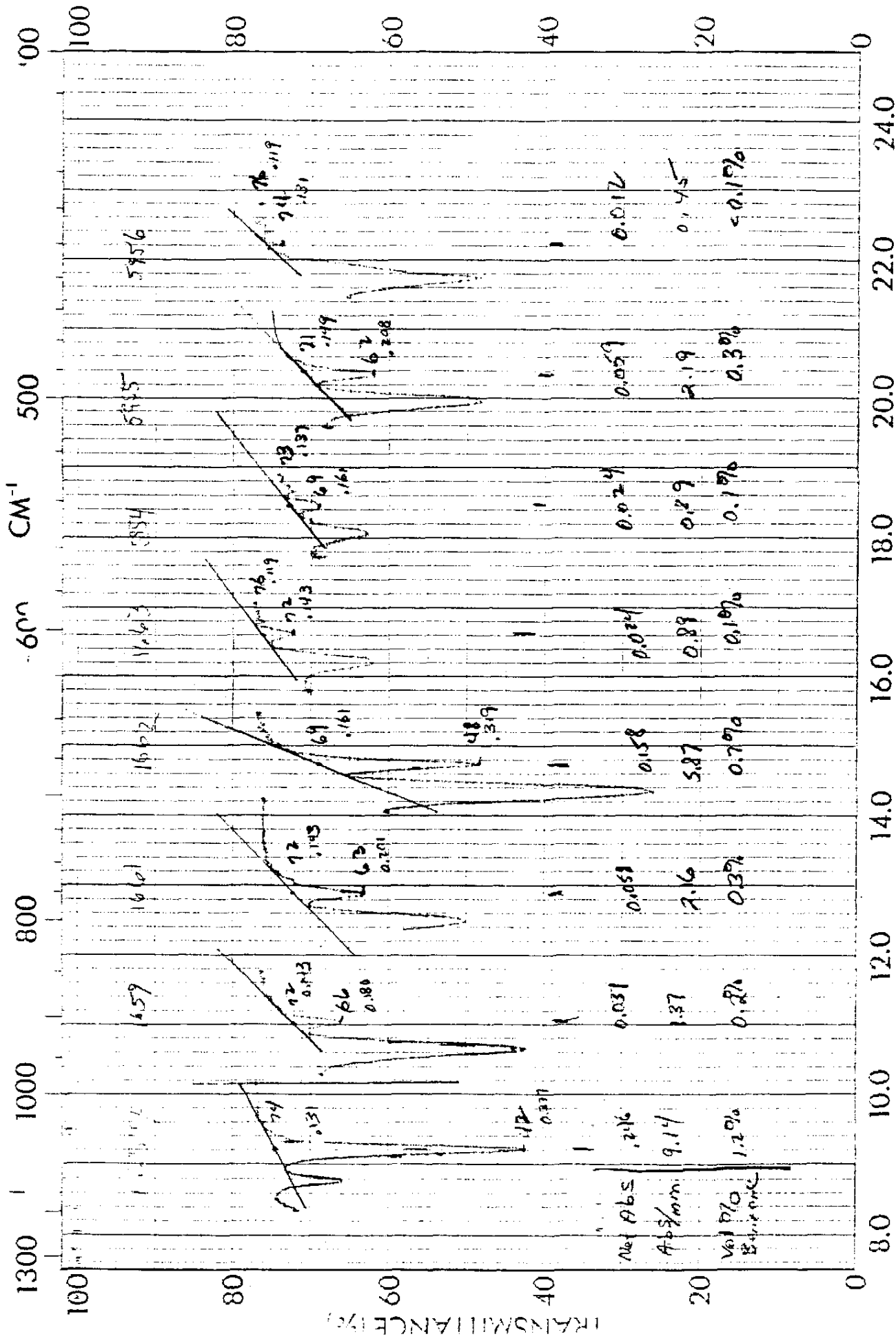


WAVELENGTH (MICRONS)

SAMPLE <u>Benzene</u>	CURVE NO. <u>77-63</u>	SCAN SPEED <u>F</u>	OPERATOR <u>PM</u>
	CONC.	SUT <u>11</u>	DATE <u>5-6-17</u>
ORIGIN	CELL PATH <u>0.0269</u>	REMARKS	
SOURCE	REFERENCE		



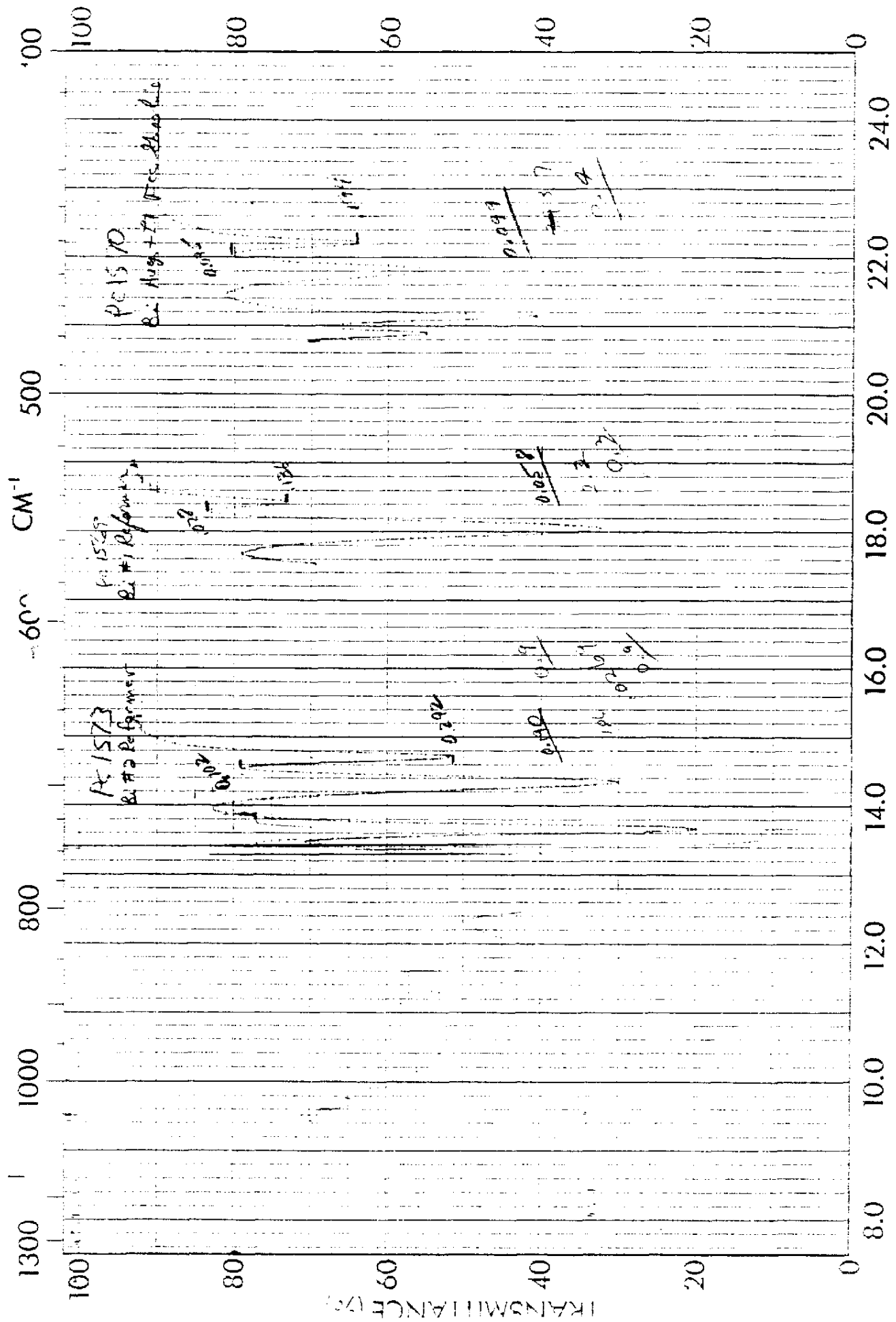
SAMPLE	8886T0000	CURVE NO.	77-62	SCAN SPEED	F	OPERATOR	P.M.
ORIGIN	U.S. 103 (Sanger)	CONC.		SPLIT	N	DATE	5-6-71
SOLVENT		CELL PATH	0.0267	REMARKS			
REFERENCE							



MCD 000019892

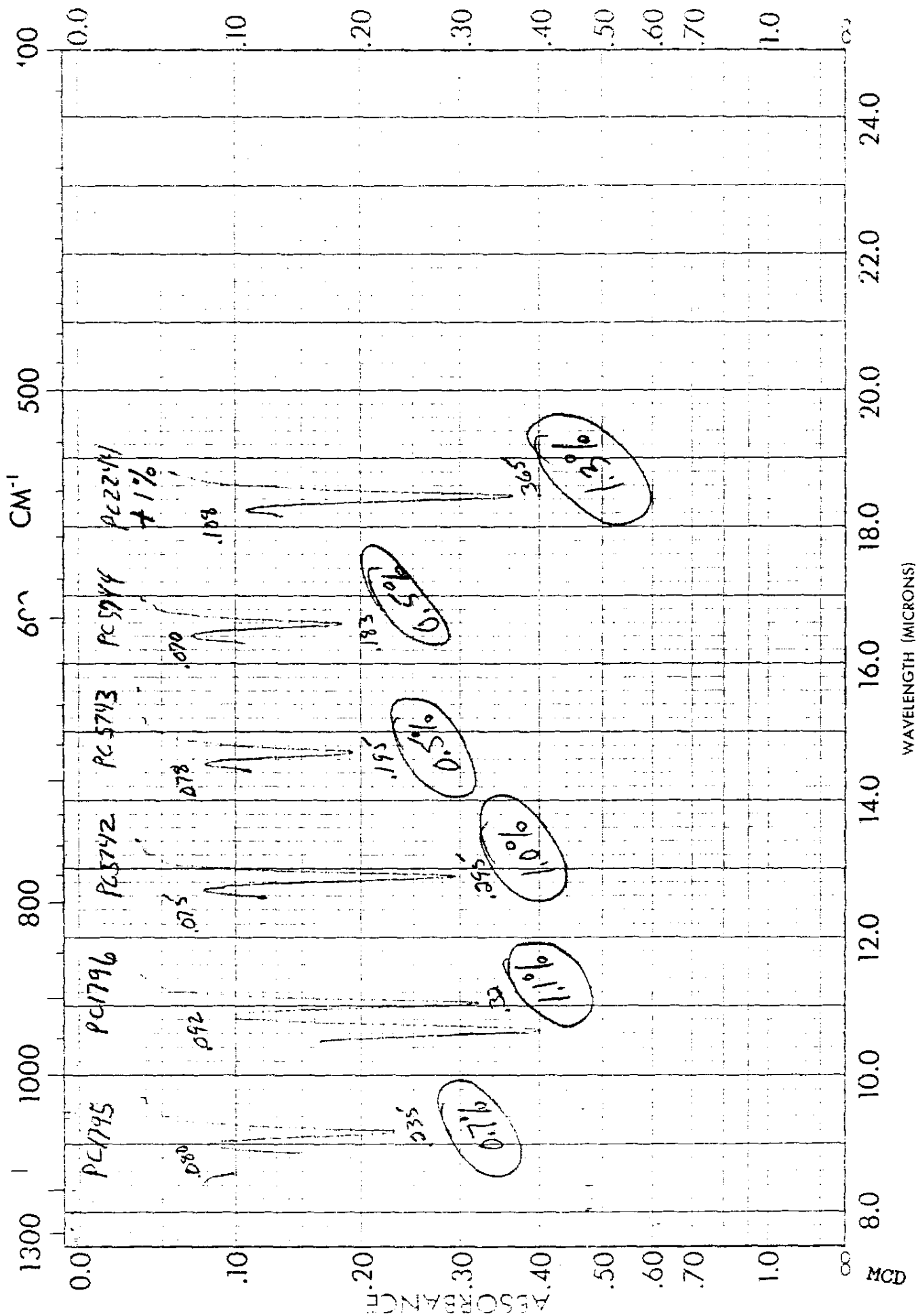
WAVELENGTH (MICKONS)

SAMPLE	C2 1652, 1619, 1602	CURVE NO.	77-57	SCAN SPEED	F	OPERATOR	RMG
	5954, 2918, 2956	CONC.		SIT	N	DATE	4-19-77
ORIGIN	20-42-21 5000	CELL PATH	0.02 69	REMARKS			
SOLVENT		REFERENCE					



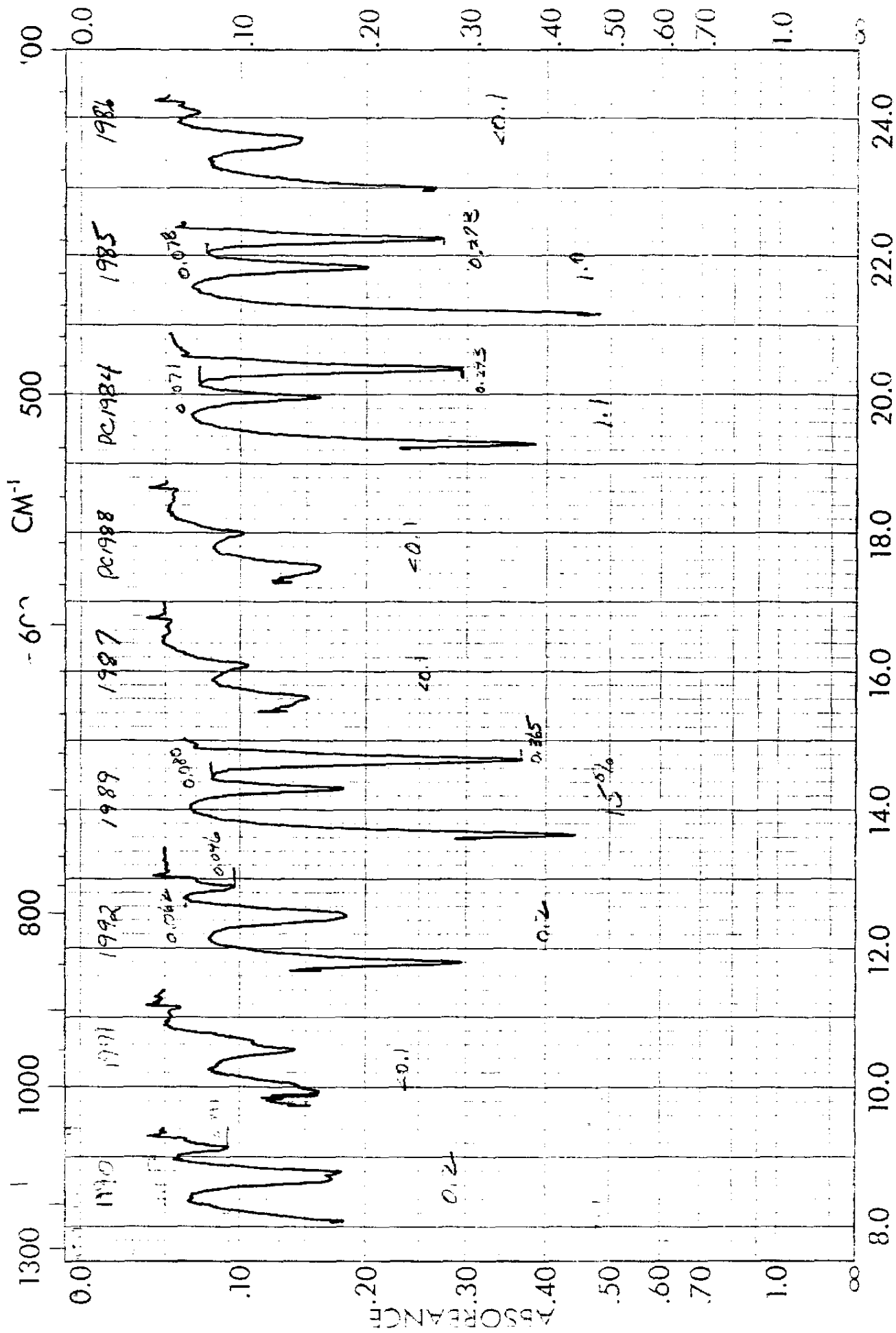
668610000 MCD

SAMPLE <u>PC 1573</u>	CURVE NO. <u>17-47</u>	SCAN SPEED <u>1</u>	OPERATOR <u>fm</u>
ORIGIN <u>PC 1573</u>	CELL PAIR <u>1573-1573</u>	REMARKS <u></u>	



MCD 000019894

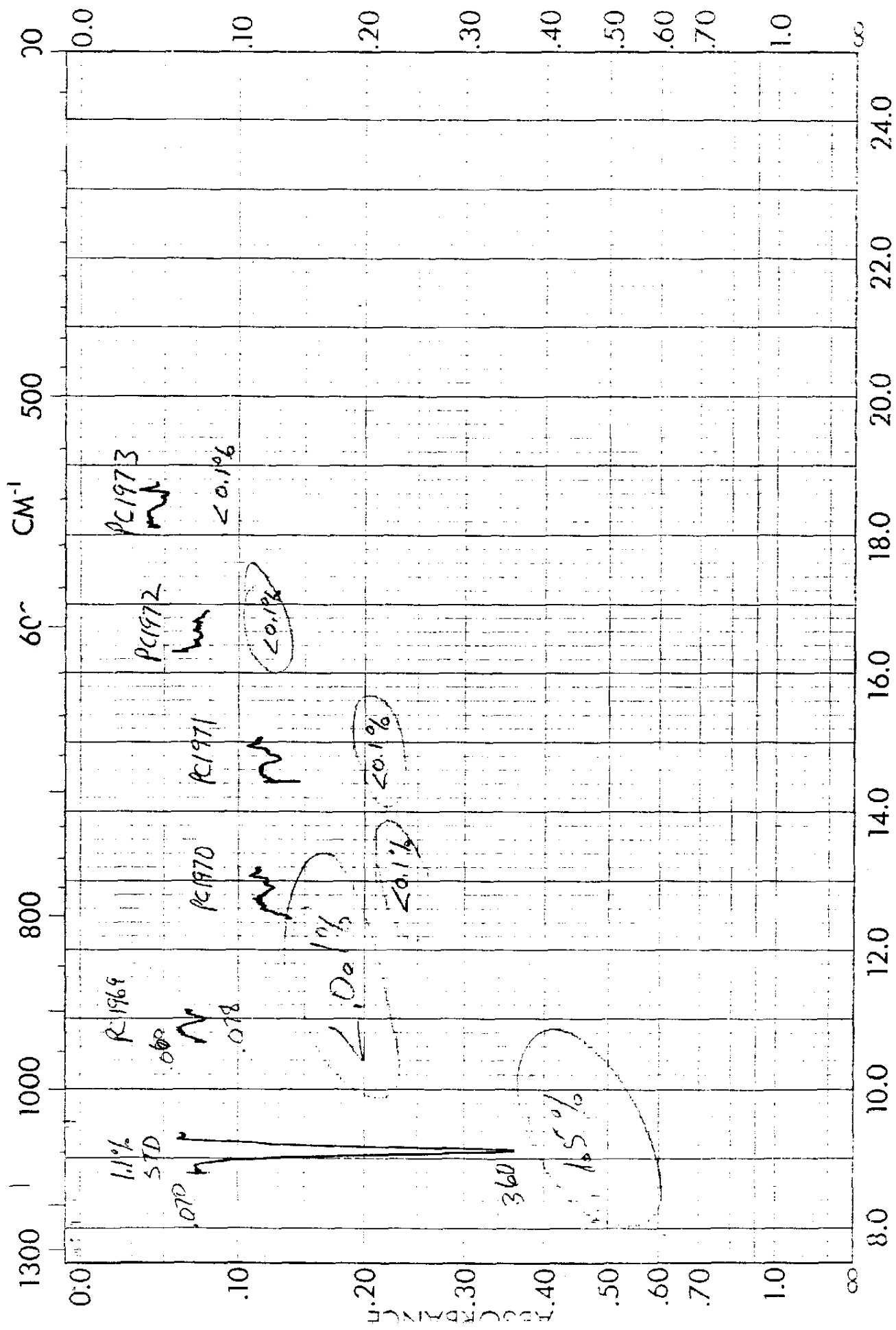
SAMPLE <i>Barium Chloride</i>	CURVE NO. <i>27-37</i>	SCAN SPEED. <i>F</i>	OPERATOR <i>M.F.</i>
ORIGIN.	CONC.	SUIT <i>N</i>	DATE <i>3-11-77</i>
SOLVENT	CELL PATH <i>0.0269 mm KBr</i>	REMARKS	



96B6T0000 MCD

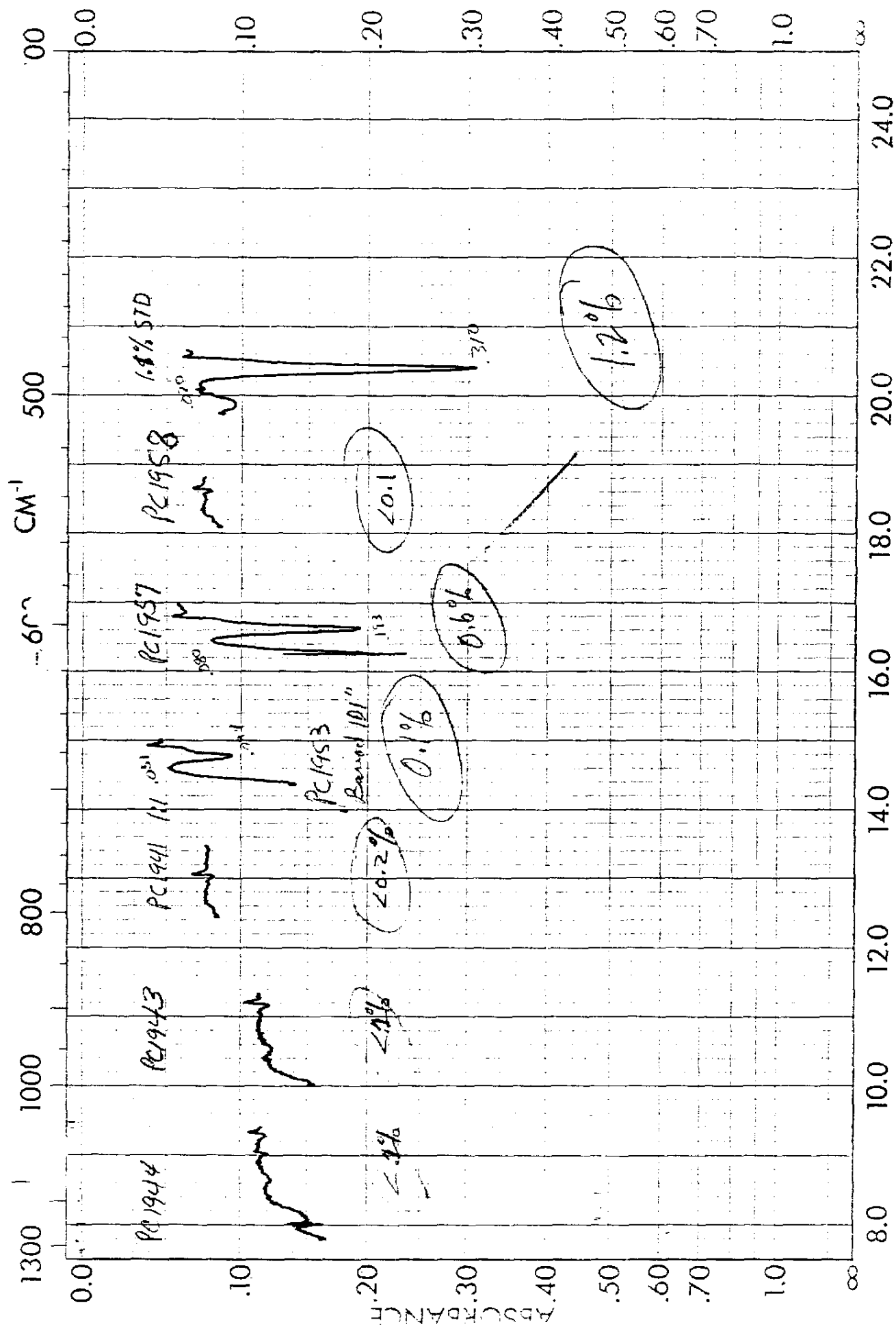
WAVELENGTH (MICRONS)

SAMPLE <i>Carbazone + Carbazole</i> <i>50 mg - 100 g</i>	CURVE NO.	SCAN SPEED <i>15</i>	OPERATOR <i>MH</i>
	CONC.	SLIT <i>1</i>	DATE <i>7/1/84</i>
ORIGIN	CELL PATH <i>0.08523</i>	REMARKS	
SOLVENT	REFERENCE		



WAVELENGTH (MICRONS) 68610000 0000

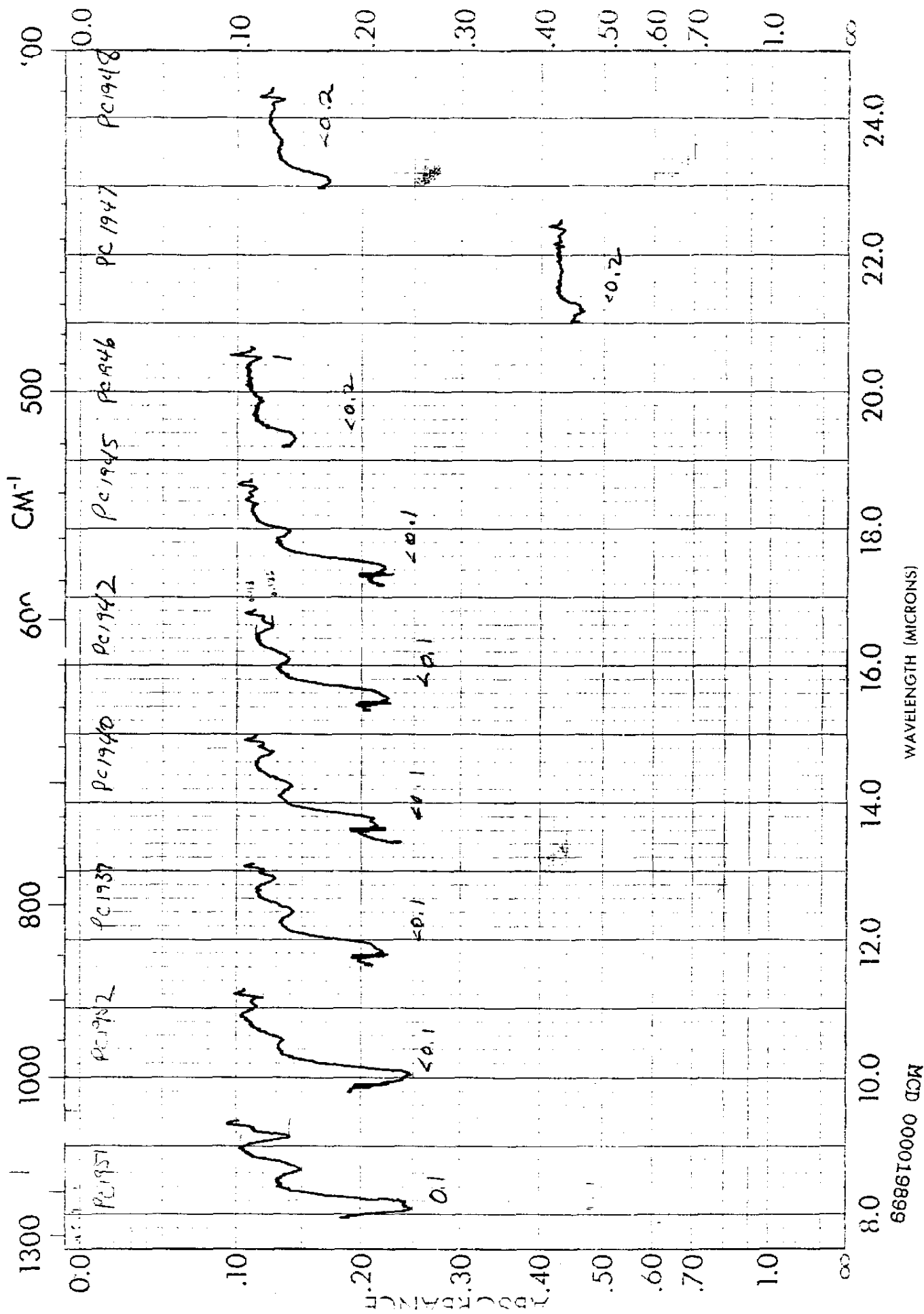
SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SUIT	DATE
SOLVENT	CELL PATH	REMARKS	
	REFERENCE		



WAVELENGTH (MICRONS)

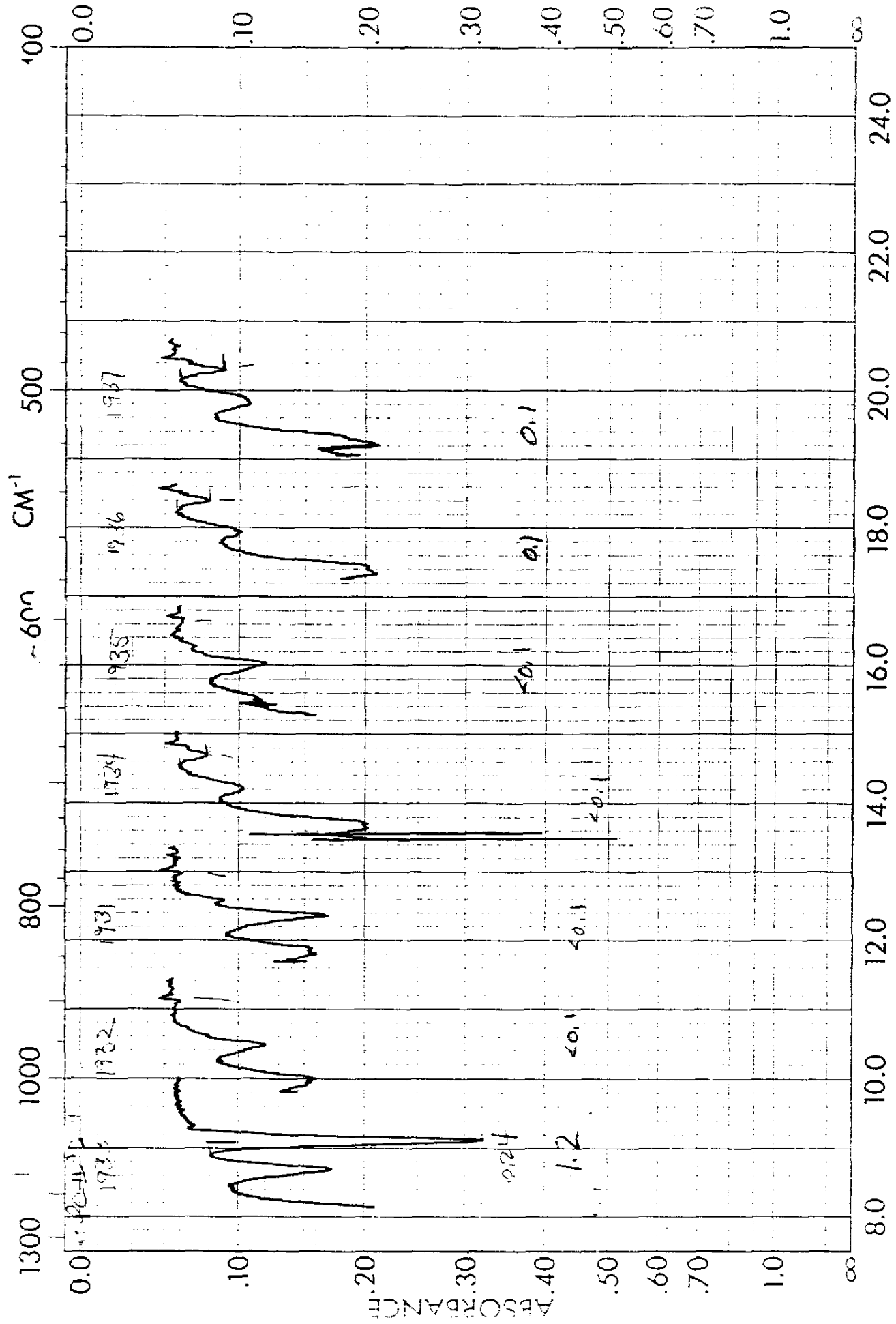
868610000 CCM

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SUIT	DATE
SOLVENT	CELL PATH	REMARKS	
	REFERENCE		



668610000 MCD 000016989 WAVELENGTH (MICRONS)

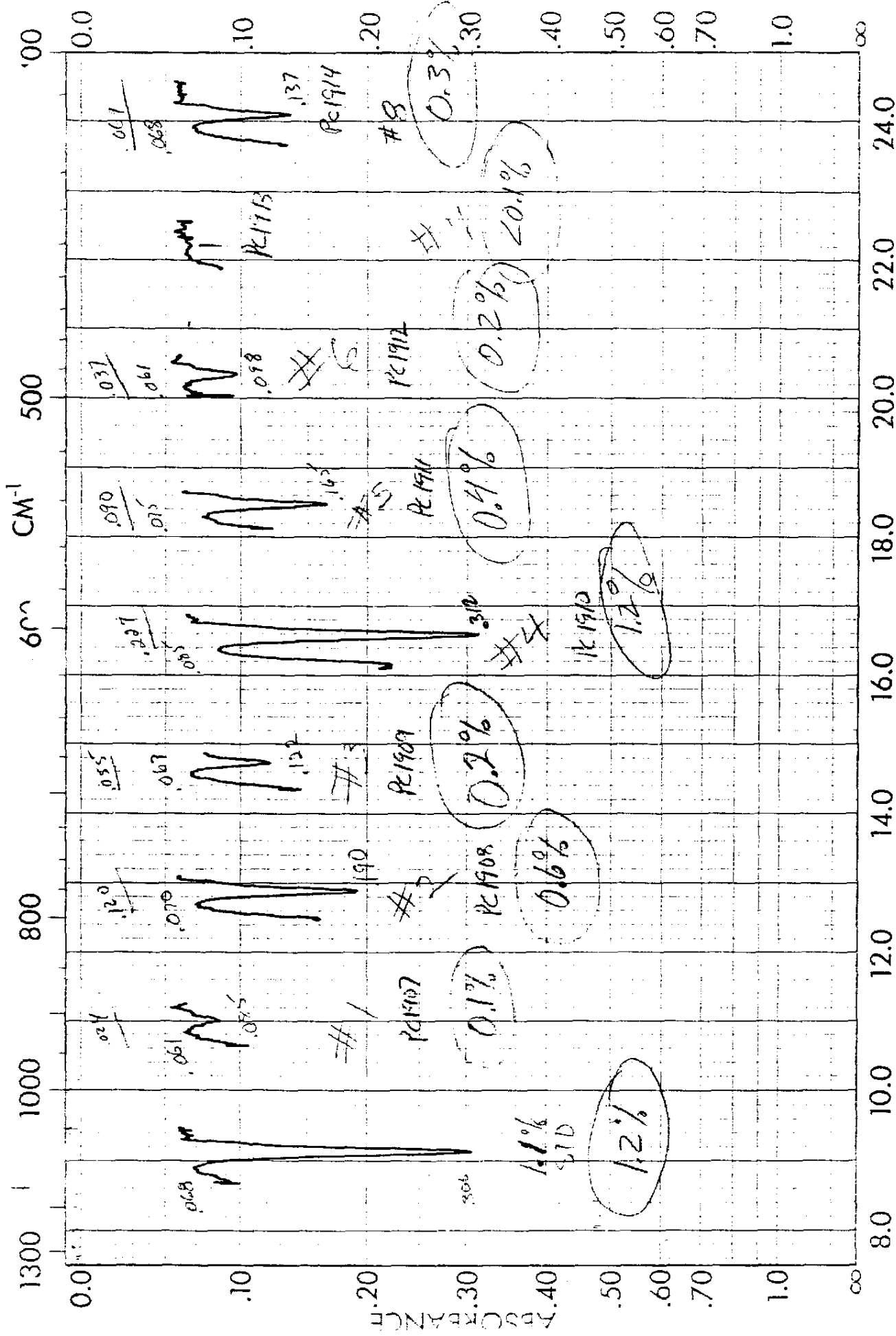
SAMPLE <i>Benzenide</i>	CURVE NO.	SCAN SPEED <i>F</i>	OPERATOR <i>RM</i>
	CONC.	SUIT <i>N</i>	DATE <i>6-20-77</i>
ORIGIN	CELL PATH <i>0.02368 mm CR</i>	REMARKS	
SOLVENT	REFERENCE		



006610000 GCM

WAVELENGTH (MICRONS)

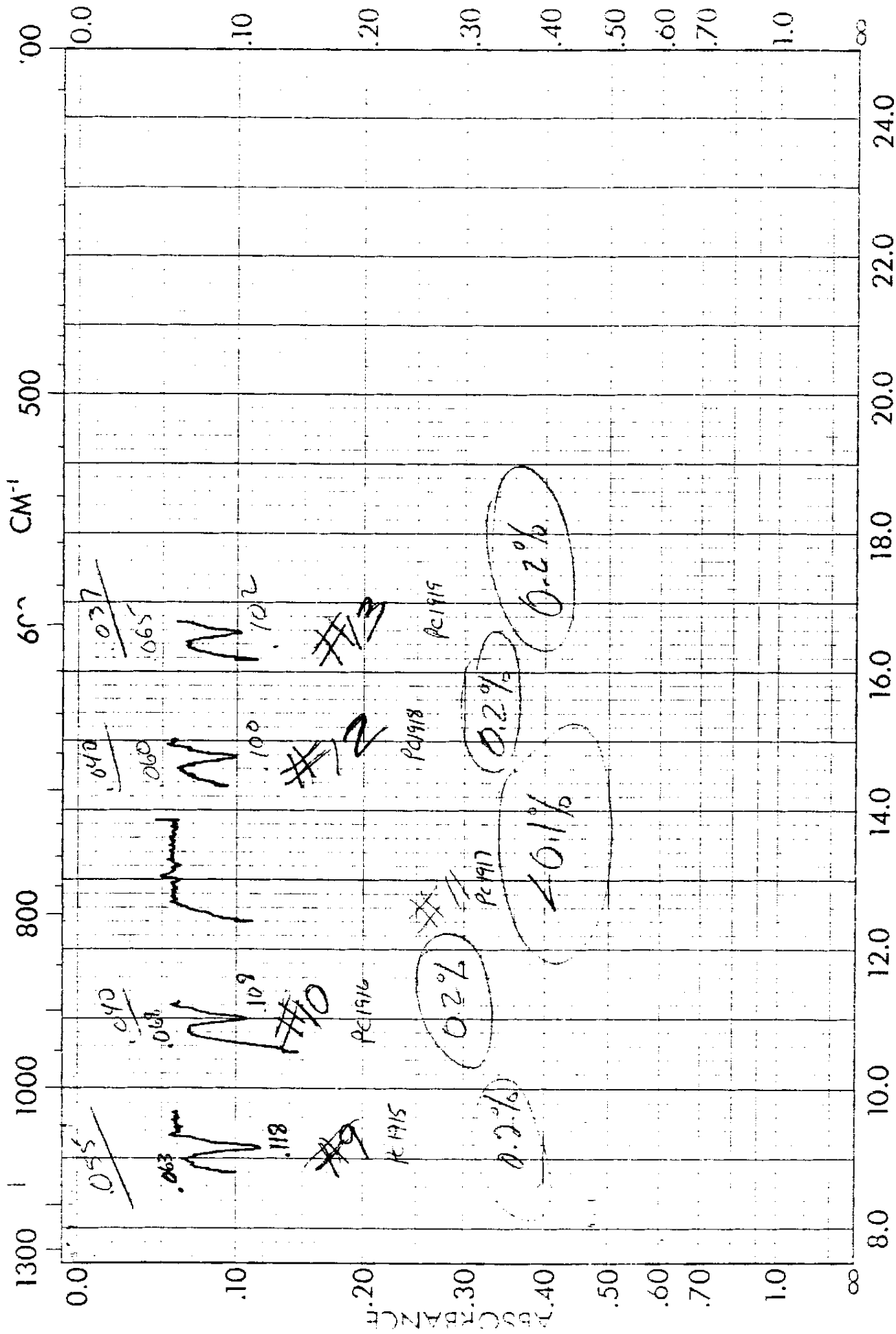
SAMPLE <u>Benzal</u>	CURVE NO. <u>72-99</u>	SCAN SPEED <u>F</u>	OPERATOR <u>R.H.H.</u>
ORIGIN	CONC.	SUIT <u>L</u>	DATE <u>2-16-62</u>
SOLVENT	CELL PATH. <u>2.02768 16.5</u>	REMARKS	
REFERENCE			



106610000 GCM

WAVELENGTH (MICRONS)

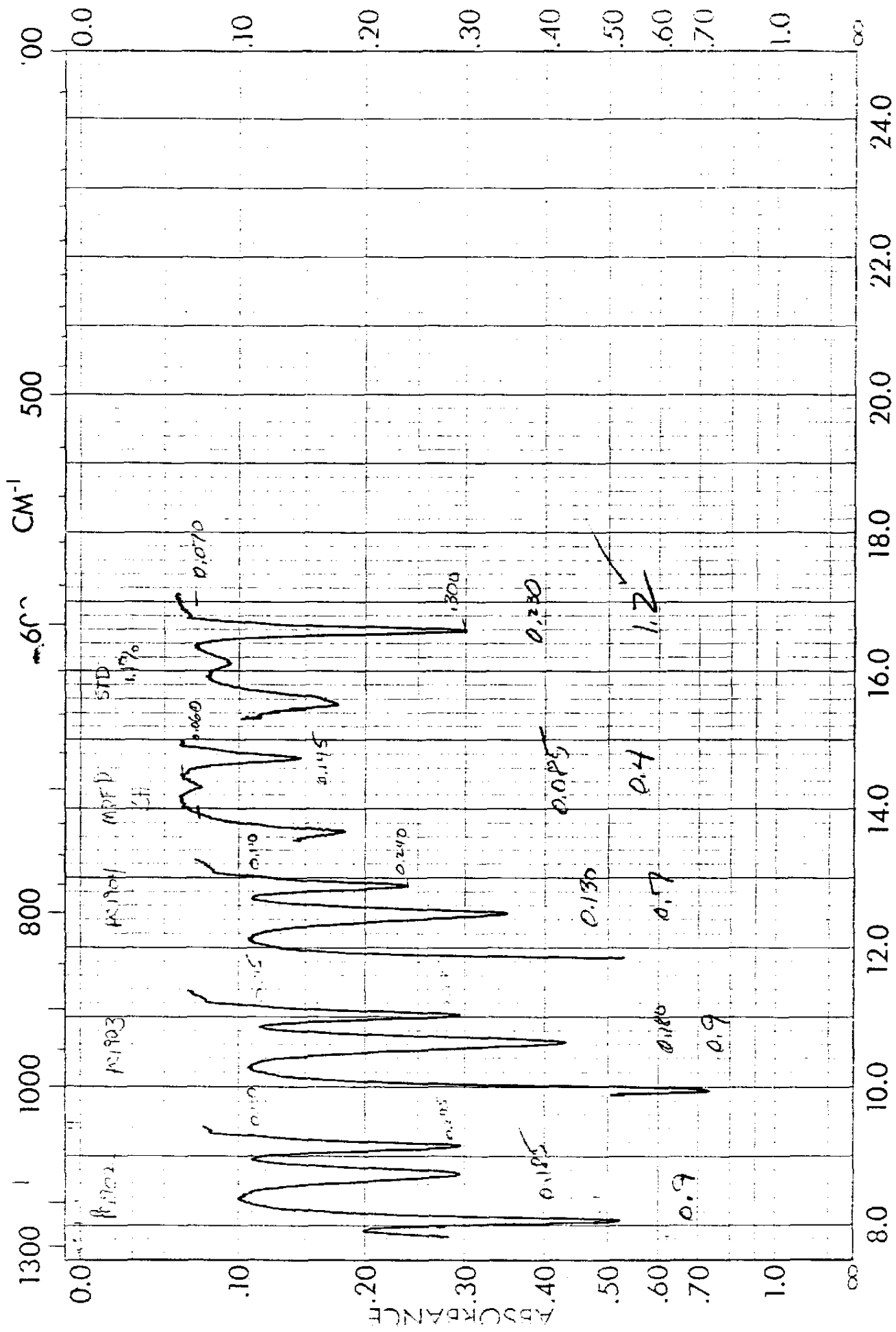
SAMPLE: <u>Hot to 22 ml Carbide</u>	CURVE NO. <u>02368</u>	SCAN SPEED <u>1</u>	OPERATOR <u>APF</u>
			DATE <u>6-14-21</u>
ORIGIN <u>X</u>	CONC.	SLIT	REMARKS
SOLVENT	CELL PATH		
	REFERENCE		



Z066T0000 MCD

WAVELENGTH (MICRONS)

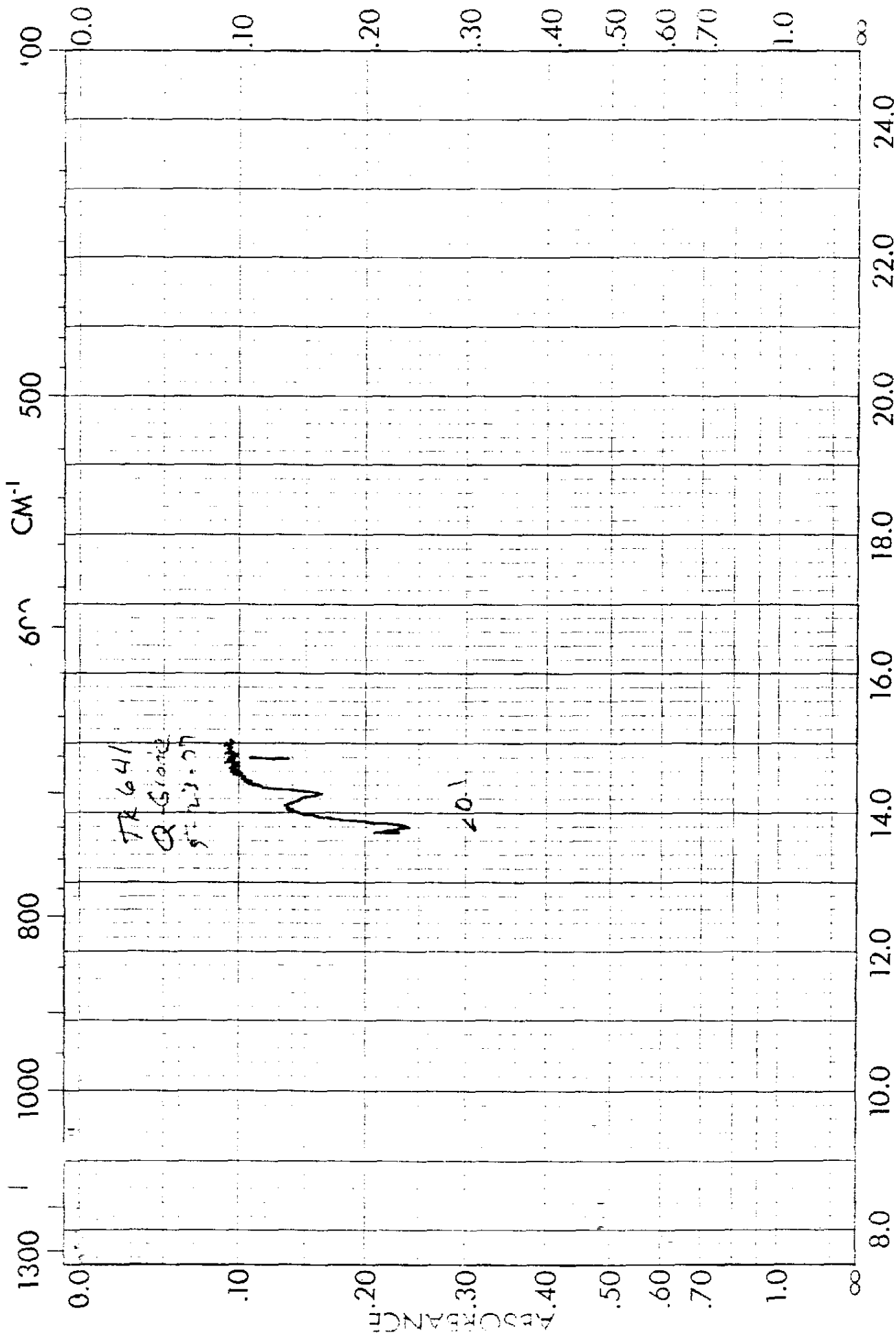
SAMPLE <u>Not to 22.211</u> OPERATOR <u>111</u>	SCAN SPEED <u>11</u> SUT <u>11</u>	CURVE NO. _____ CONC. _____ CELL PATH <u>0.2368 mm</u> REFERENCE <u>Br</u>	DATE <u>12-7</u> REMARKS _____
ORIGIN _____ SOLVENT _____		REMARKS _____	



806610000 MCD 000019903

WAVELENGTH (MICRONS)

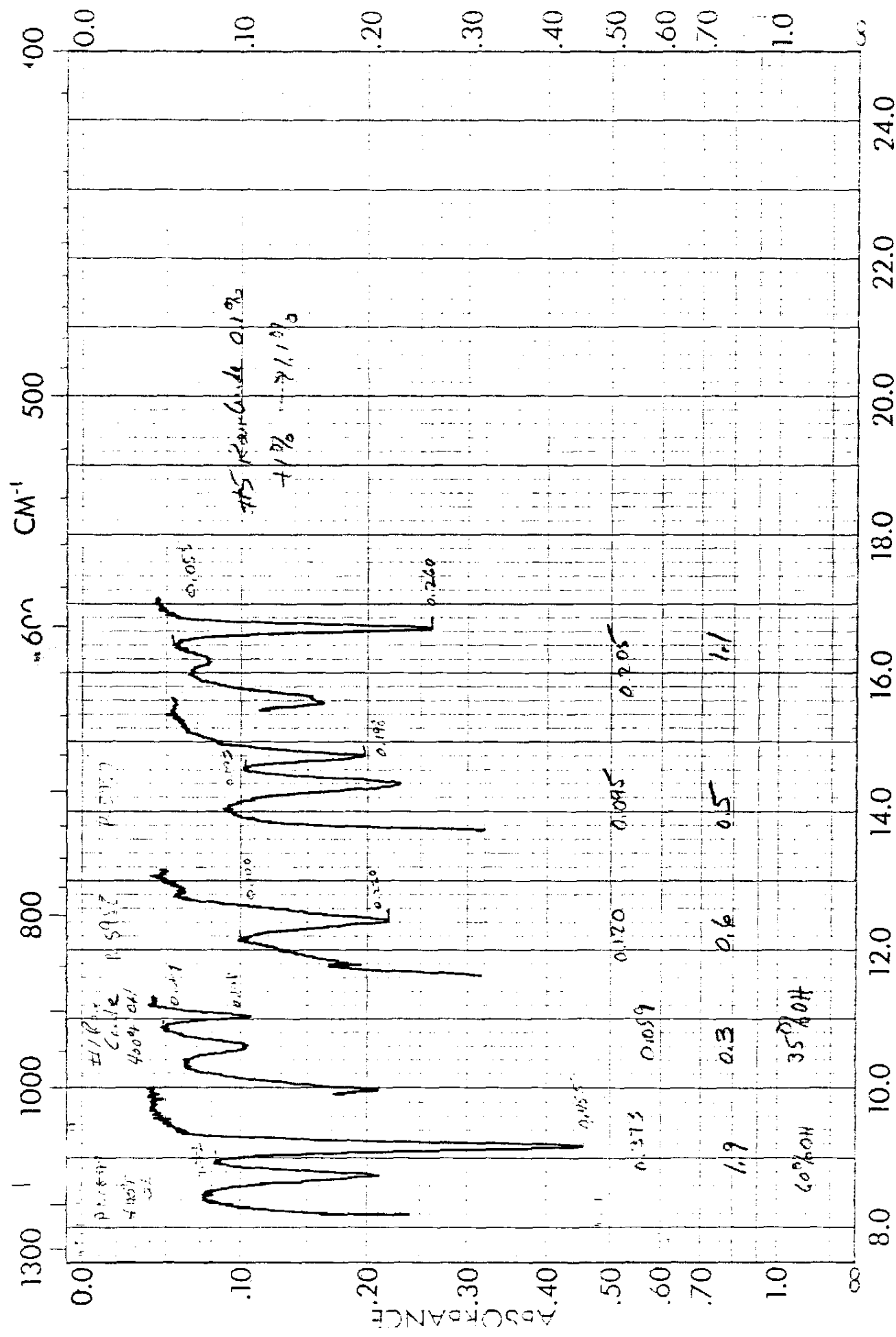
SAMPLE	101903	CURVE NO.	11-93	SCAN SPEED	1	OPERATOR	1/1/5
ORIGIN		CONC.		SUIT	1	DATE	
SOLVENT		CELL PATH	3.00000	REMARKS			



906610000 MCD

WAVELENGTH (MICRONS)

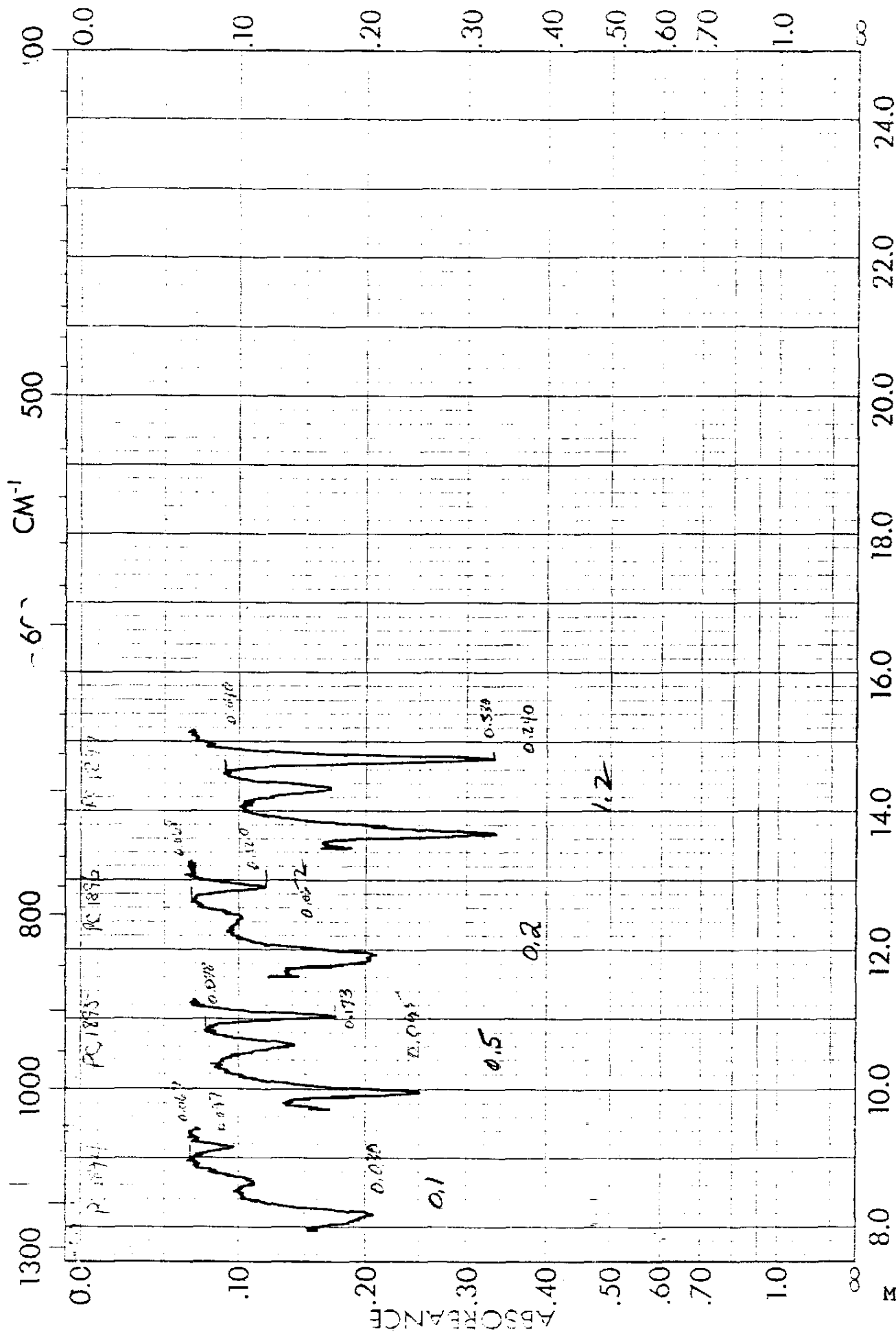
SAMPLE	CURVE NO. 27-91	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SPLIT	DATE
SOLVENT	CELL PATH 0.02568	REMARKS	
	REFERENCE		



906610000 QM

WAVELENGTH (MICRONS)

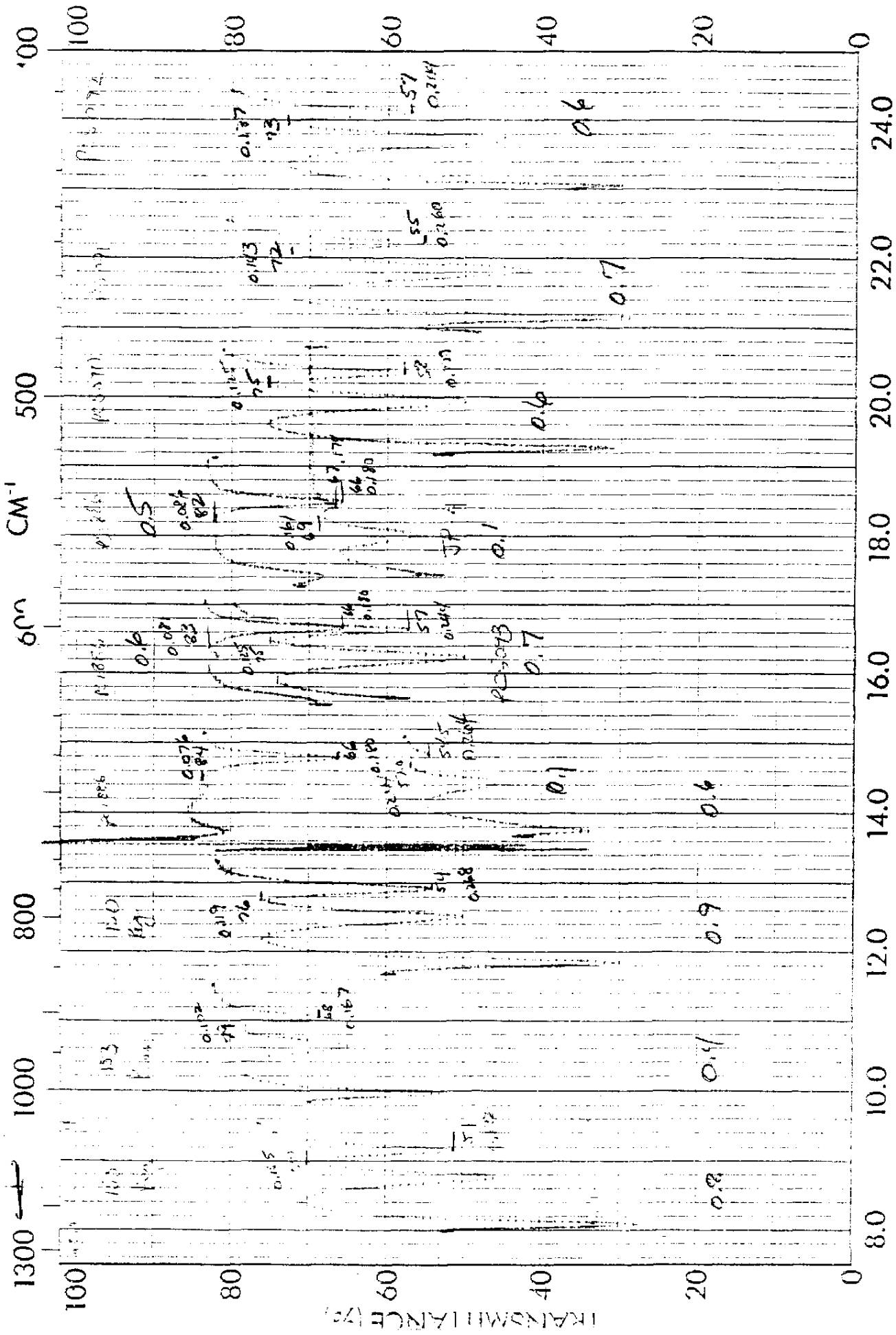
SAMPLE	CURVE NO. 77-90	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SUIT	DATE
SOLVENT	CELL PATH	REMARKS	



WAVELENGTH (MICRONS)

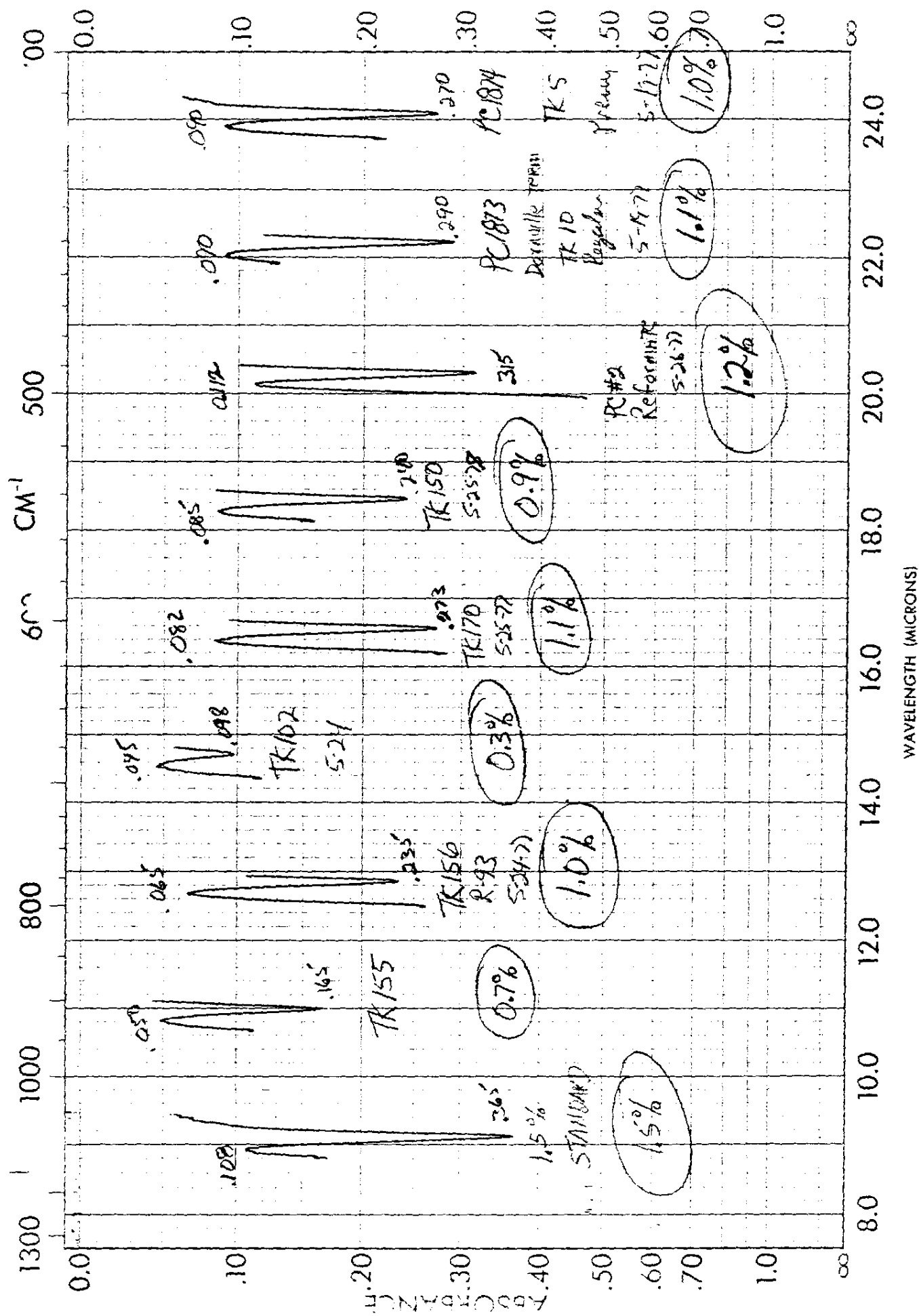
SAMPLE	CURVE NO. 77-82	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SIT	DATE
SOLVENT	CELL PATH	REMARKS	

806610000 MCD



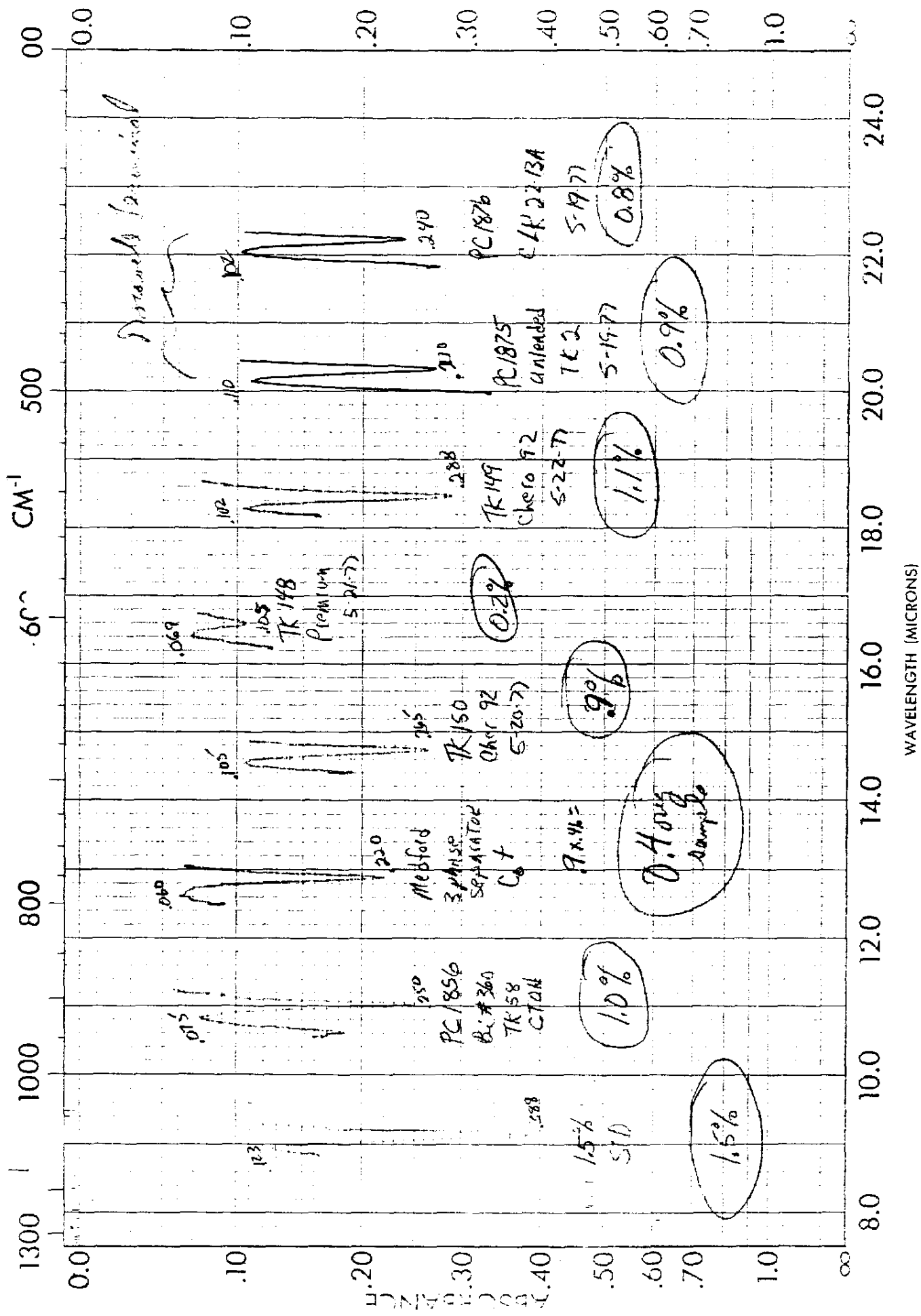
MCD 000019909

SAMPLE	77-2	CURVE NO.	77-2	SCAN SPEED	1	OPERATOR	5/1
ORIGIN	00267	CONC.	1.8	SIT	1	DATE	5/1
SOURCE	1.8	CELL PATH	1.8	REMARKS			



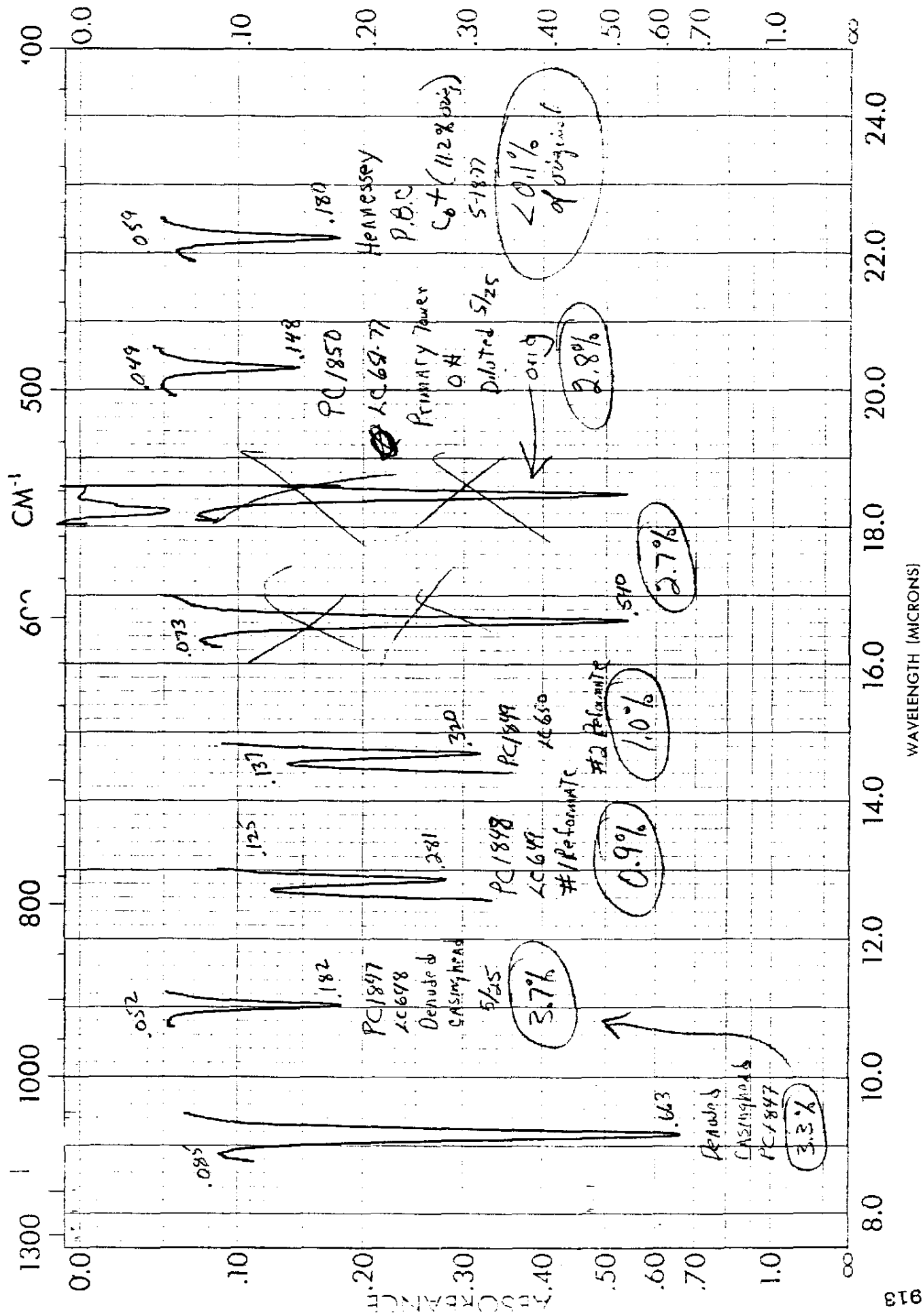
4CD 000019910

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SUIT	DATE
SOLVENT	CELL PATH	REMARKS	
	REFERENCE		



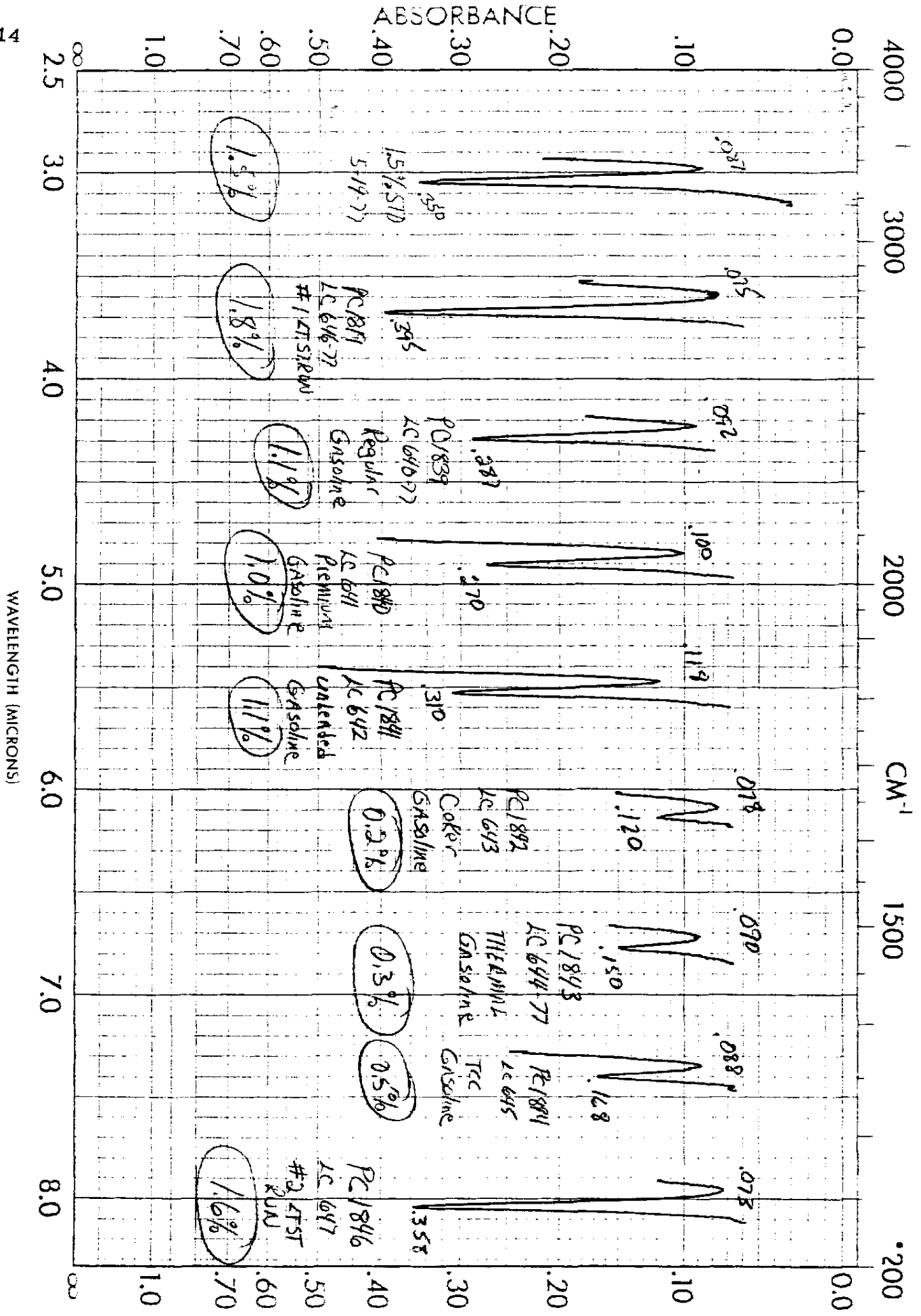
ICD 000019911

SAMPLE	CURVE NO.	SCAN SPEED		OPERATOR
		SLIT	DATE	
ORIGIN	CONC	REMARKS		
SOLVENT	CELL PATH	REFERENCE		

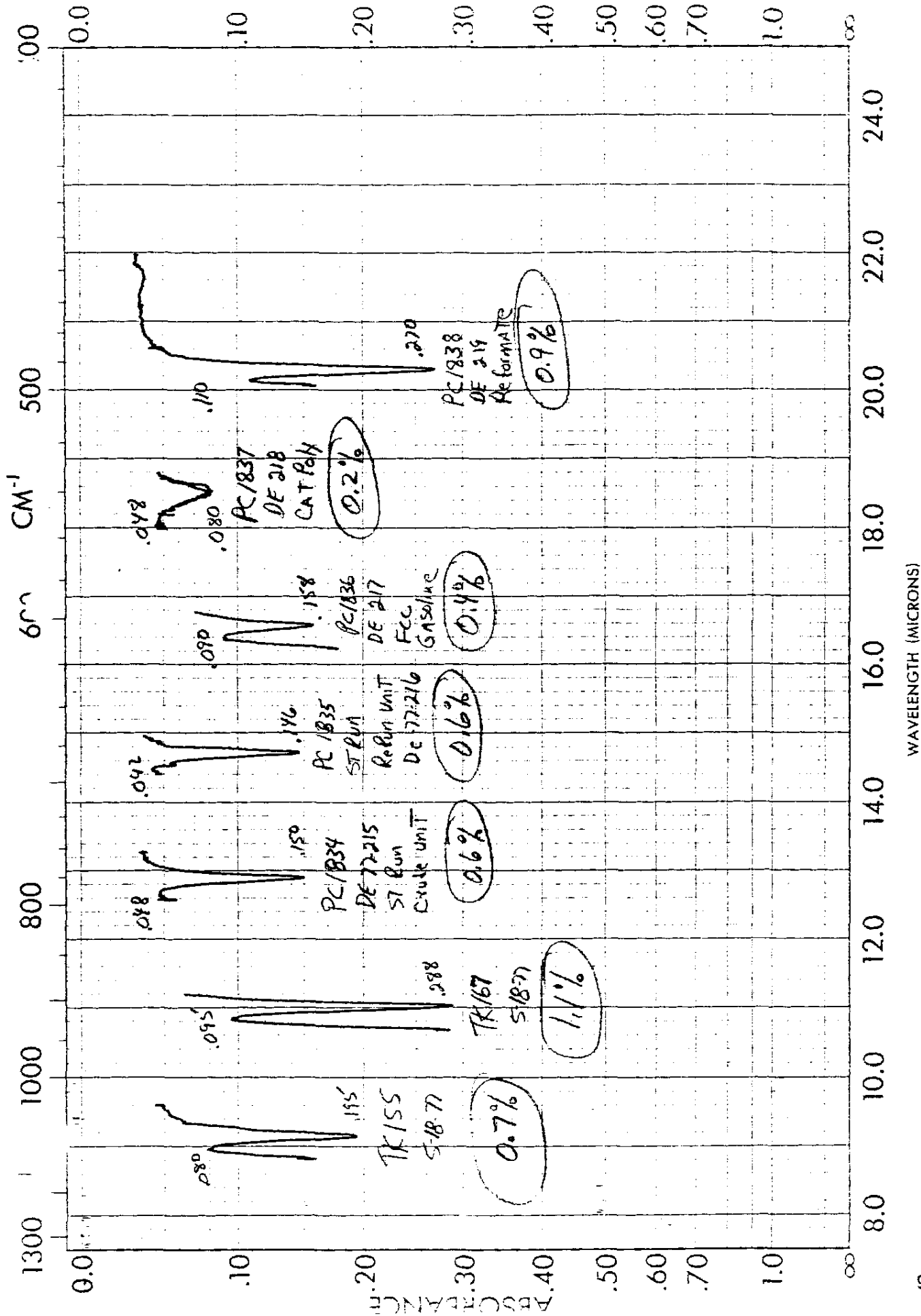


SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
		SUIT	DATE
ORIGIN	CONC	REMARKS	
SOLVENT	CELL PATH		

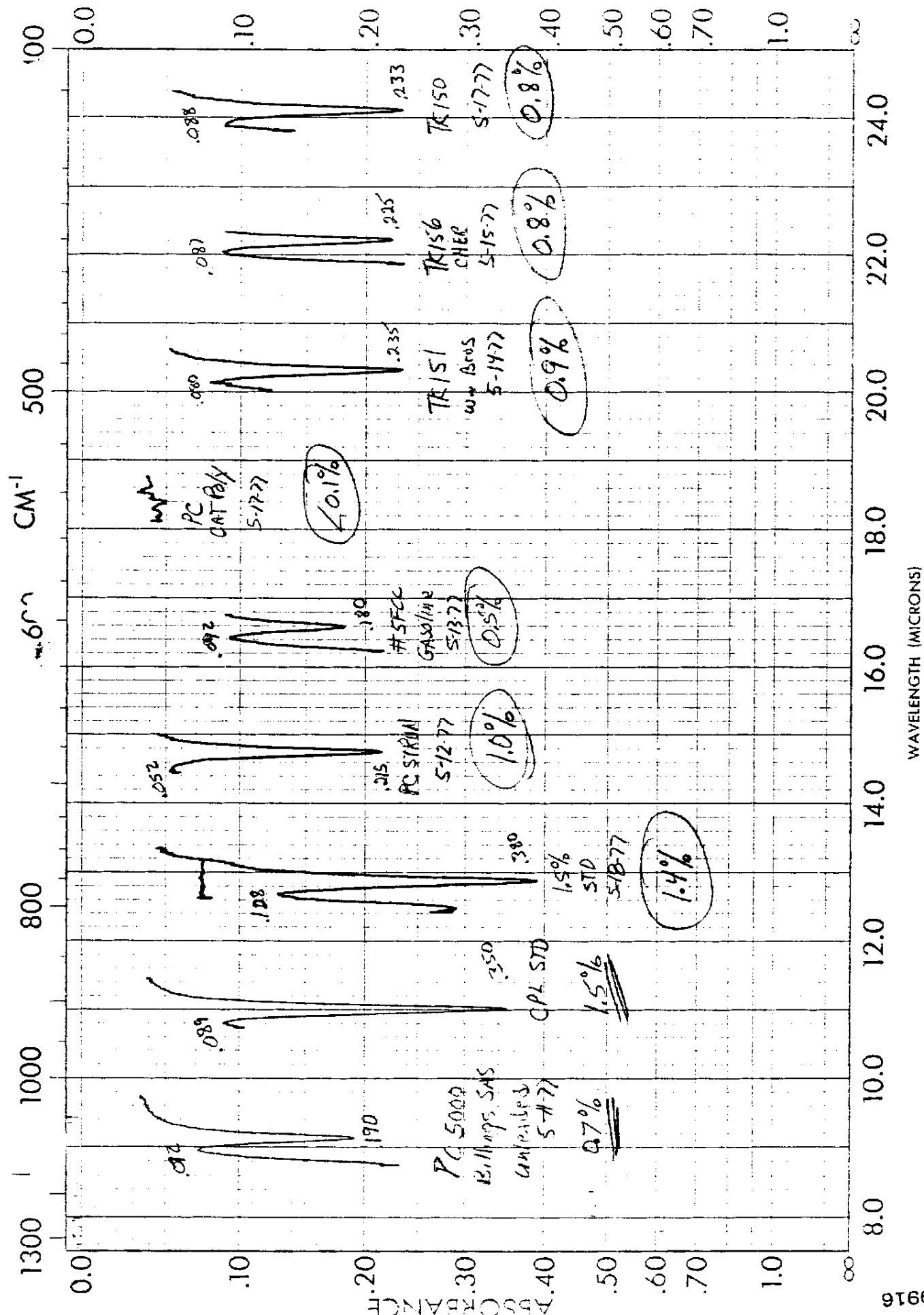
MCD 000019913



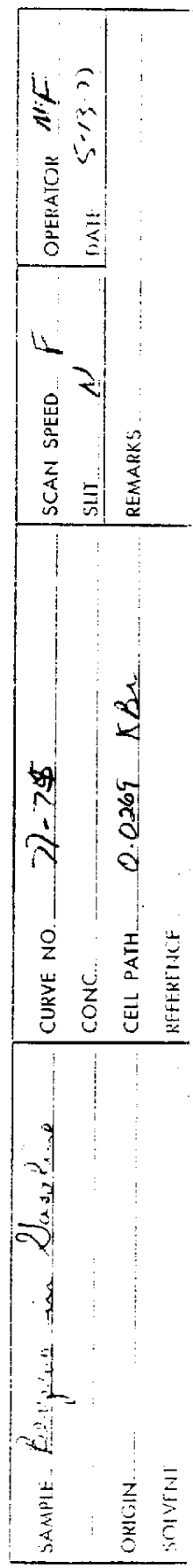
SAMPLE <i>Bay gas in Mustang</i>		CURVE NO. _____	SCAN SPEED <i>F</i>	OPERATOR <i>MLF</i>
ORIGIN _____	CONC. _____	CELL PATH <i>226</i>	SPLIT <i>AJ</i>	DATE <i>5-15-77</i>
SOLVENT _____	REFERENCE _____	REMARKS _____		

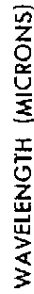


SAMPLE <i>PC/1838 in 2-butanone</i>	CURVE NO.	SCAN SPEED.	OPERATOR <i>ALF</i>
	CONC.	SPLIT	DATE <i>5-18-77</i>
ORIGIN	CELL PATH <i>0.269 mm KBr</i>	REMARKS	
SOVENT	REFERENCE		



SAMPLE <i>Crystalline NaOH</i>	CURVE NO. <i>77-75</i>	SCAN SPEED <i>F</i>	OPERATOR <i>HIF</i>
	CONC.	SUIT <i>N</i>	DATE <i>5-11-77</i>
ORIGIN	CELL PATH	REMARKS	
SOVENT	REFERENCE		

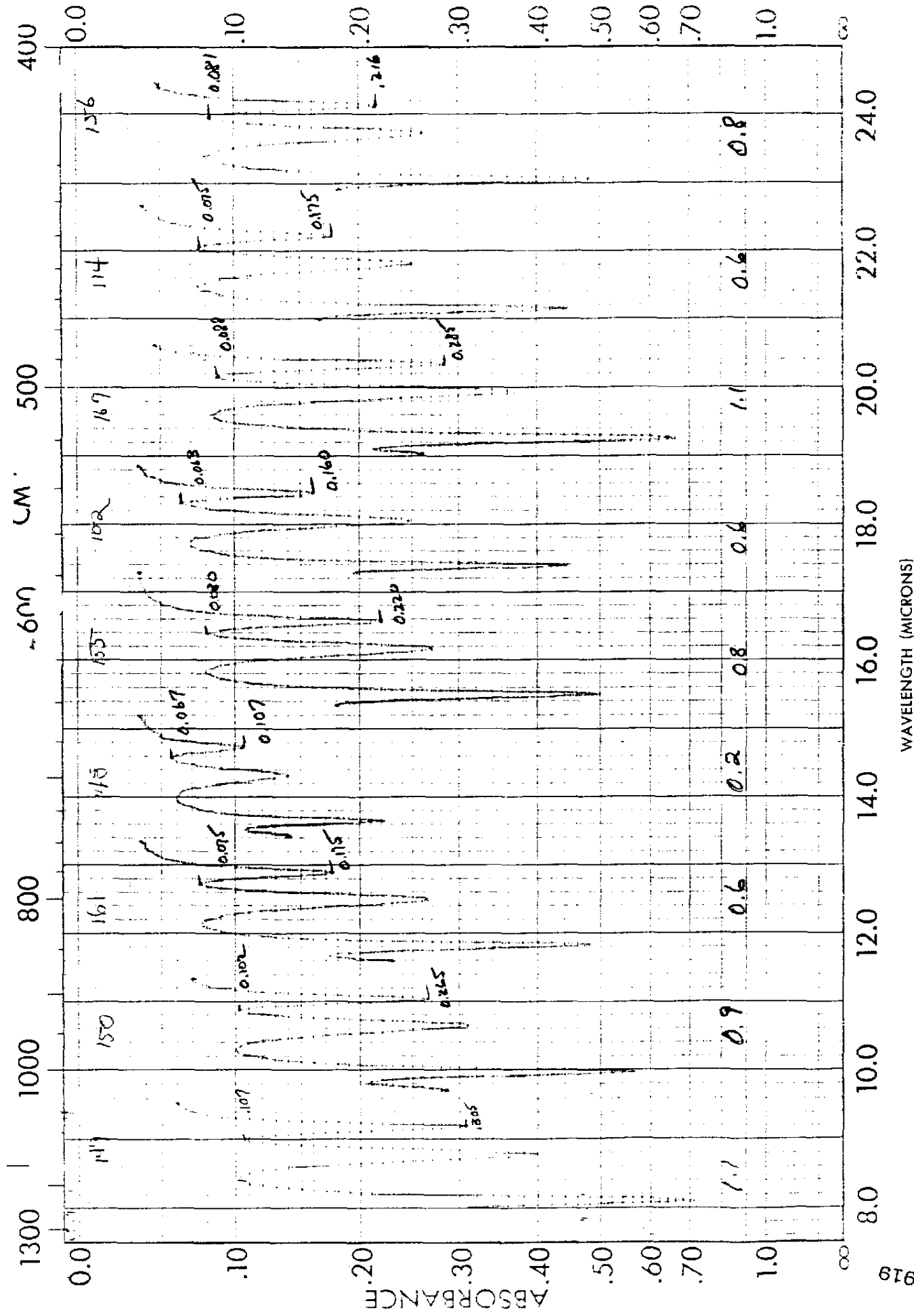




SAMPLE	PC 4407500, 5000, 5000, 5000
ORIGIN	THE 155 Beryllium in Carbon
SOLVENT	

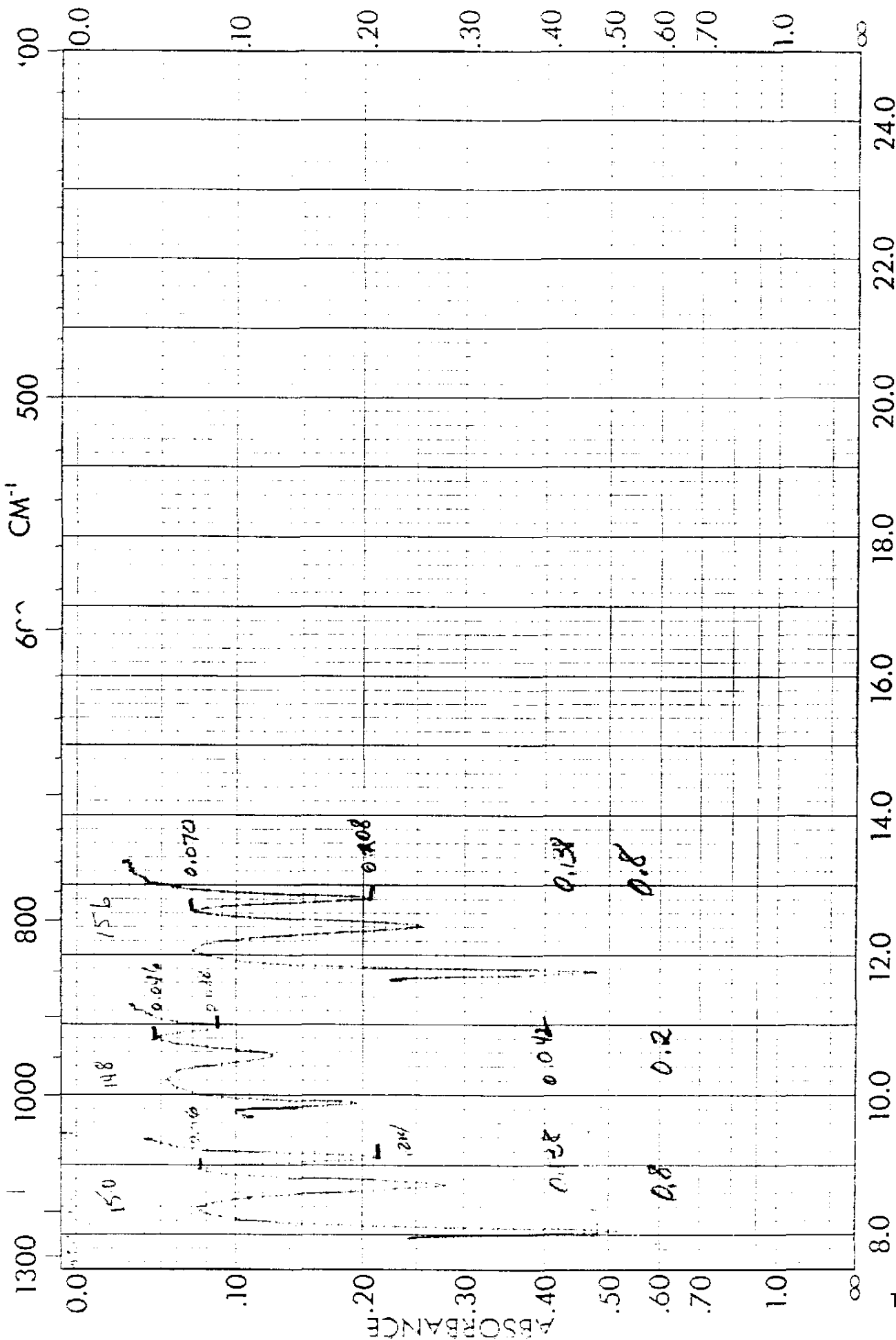
CURVE NO. 17-70
CONC. _____
CELL PATH 0.0269
REFERENCE _____

SCAN SPEED	F	OPERATOR	RMH
SPLIT	N	DATE	5-12-77
REMARKS			



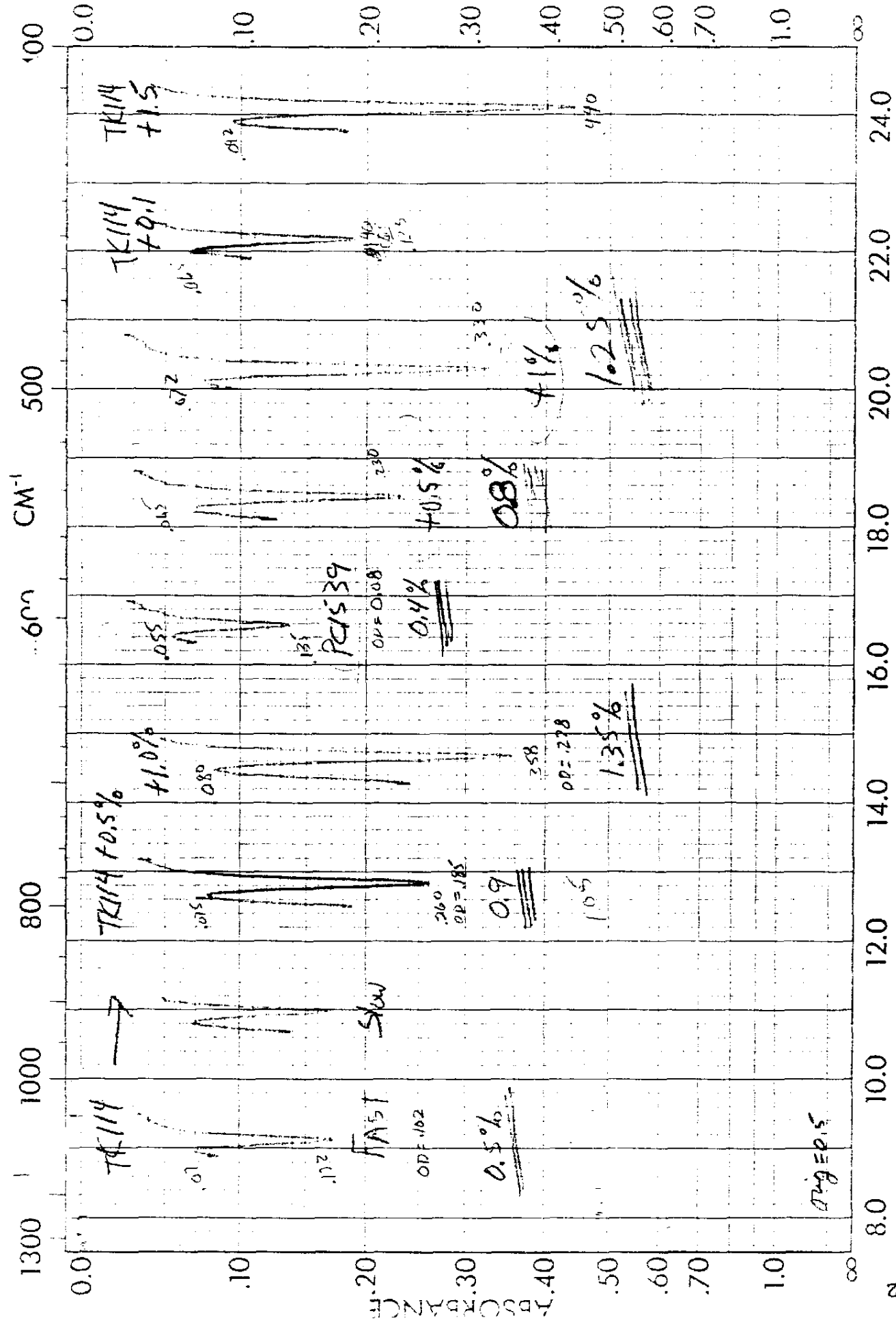
SAMPLE <i>Triglyceride</i>	CURVE NO. <i>27-66</i>	SCAN SPEED <i>F</i>	OPERATOR <i>Rm</i>
	CONC.	SUIT <i>N</i>	DATE <i>5-10-77</i>
ORIGIN	CELL PATH <i>0.0267</i>	REMARKS	
SOLVENT	REFERENCE		

MCD 000019919



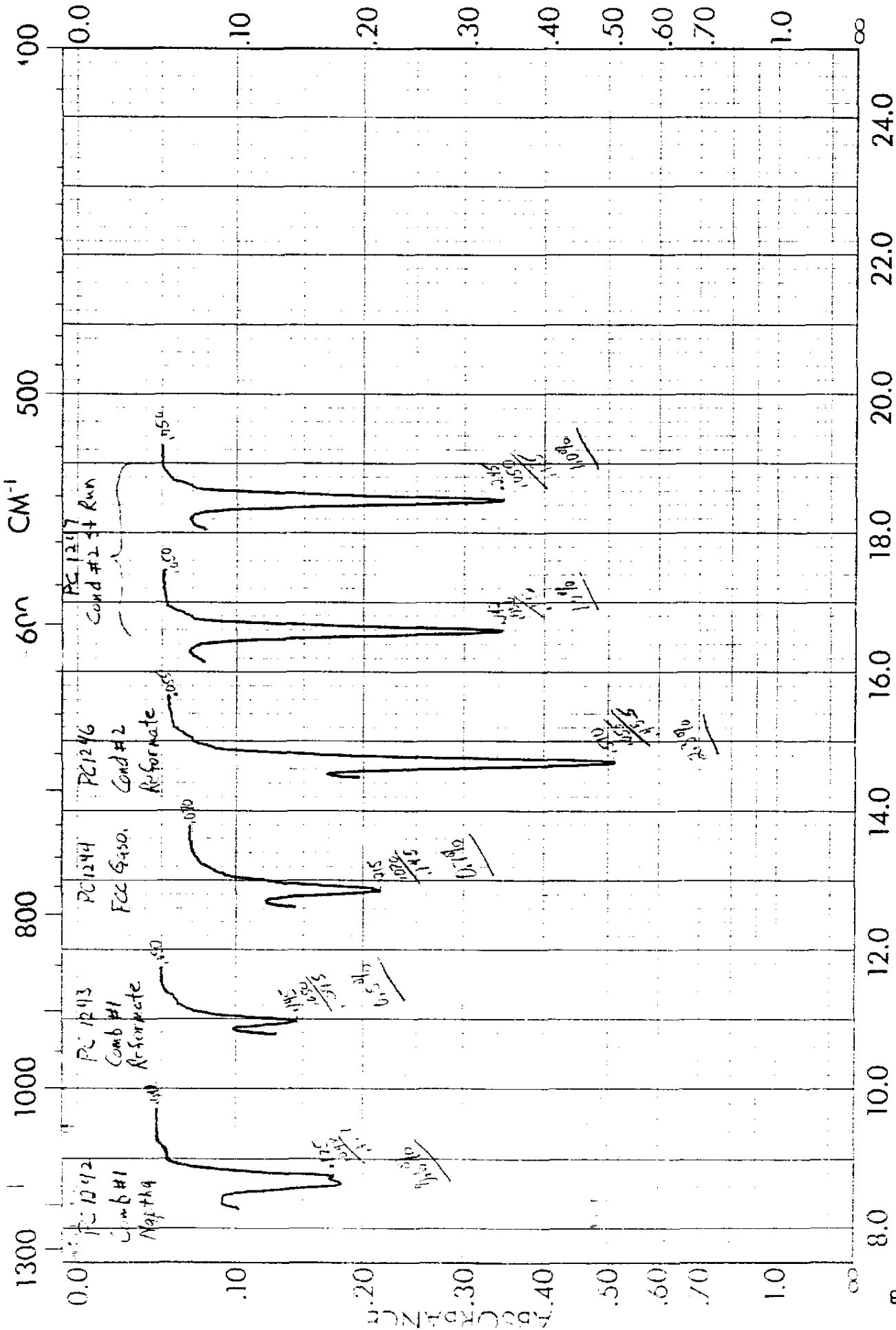
WAVELENGTH (MICRONS)

SAMPLE <u>1.5 JK 1012</u>	CURVE NO. <u>77-65</u>	SCAN SPEED <u>F</u>	OPERATOR <u>DM</u>
		SUIT <u>N</u>	DATE <u>9-11</u>
ORIGIN <u>TRAC 1012</u>	CONC.	REMARKS	
SOLVENT <u>0.0001</u>	CELL PATH		



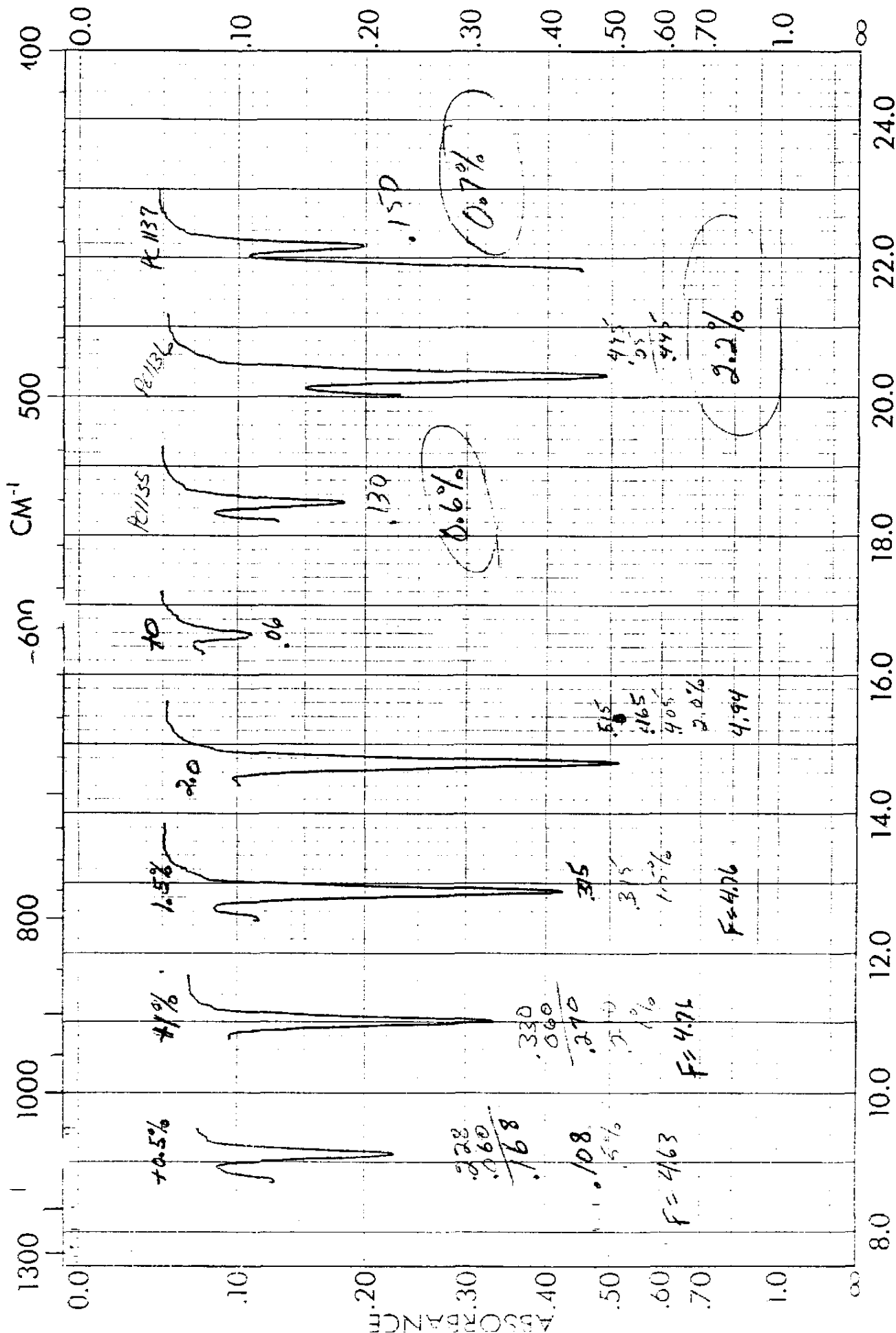
MCD 000019922

SAMPLE <i>Polystyrene in Benzene</i>	CURVE NO. <i>27-64</i>	SCAN SPEED <i>F</i>	OPERATOR <i>LLF</i>
	CONC.	SUIT <i>11</i>	DATE <i>5-6-77</i>
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		



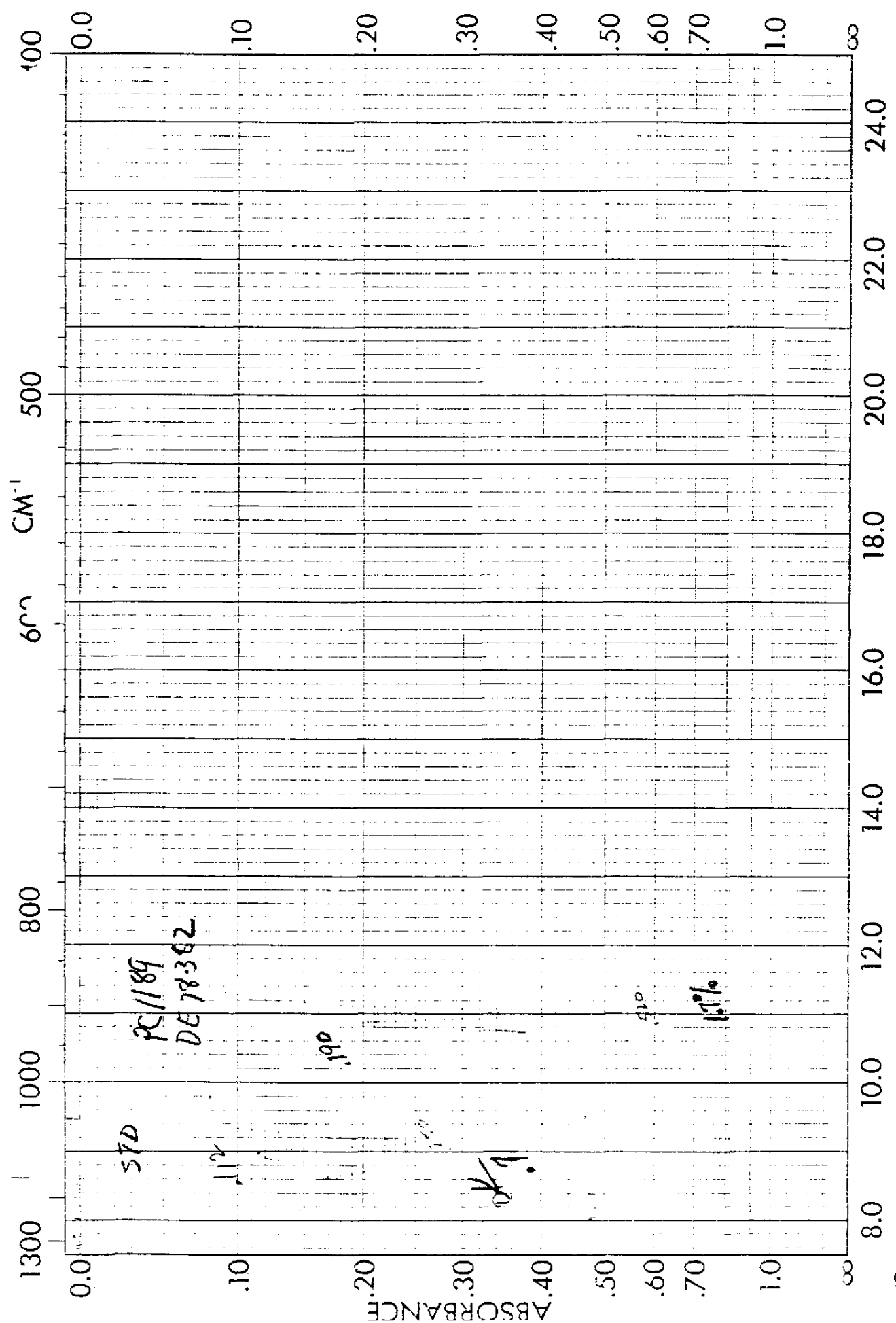
WAVELENGTH (MICRONS)

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
		SLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SUBJECT	REFERENCE		



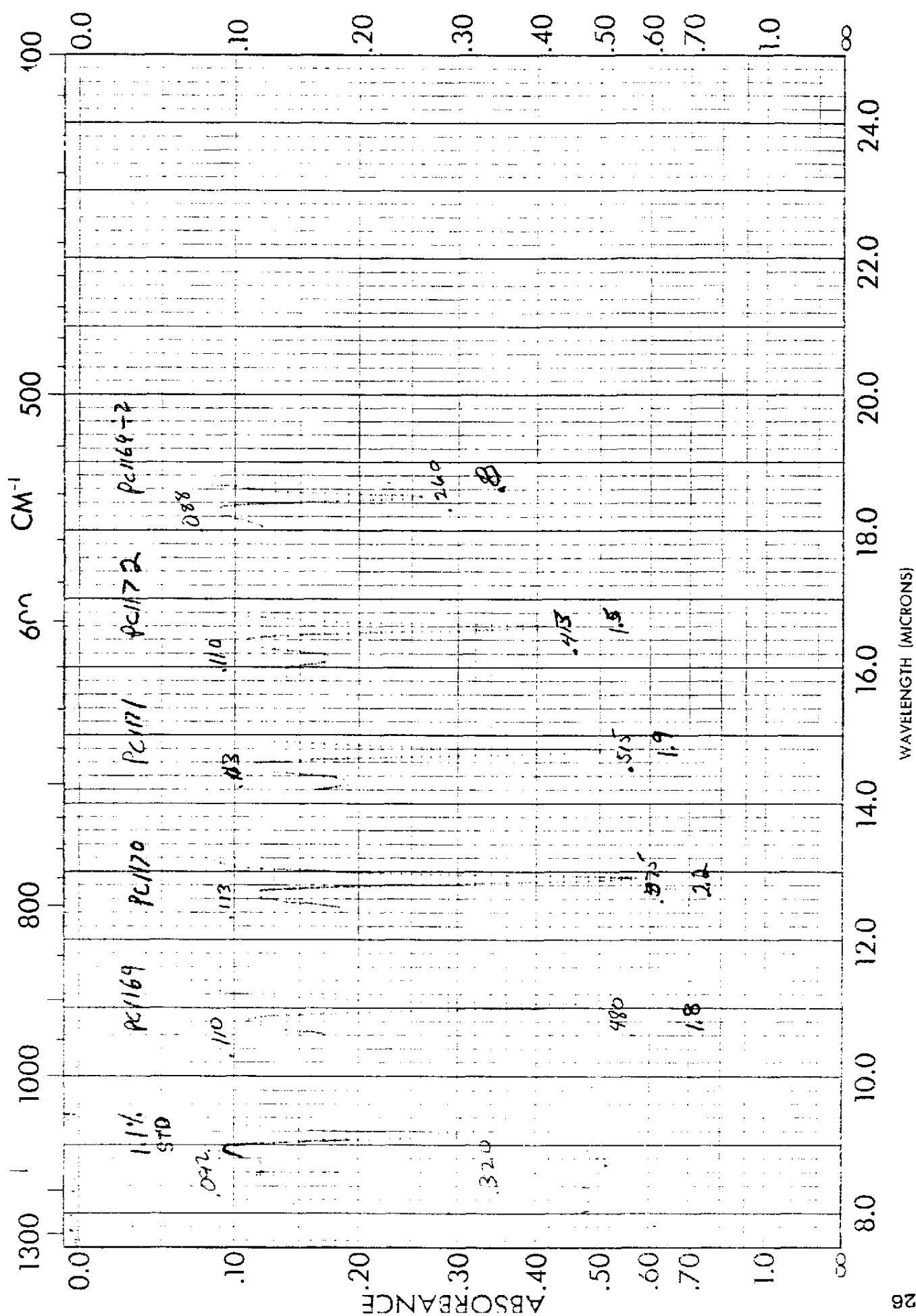
WAVELENGTH (MICRONS)

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SUIT	DATE
ORIGIN	CELL PATH	REMARKS	
COMMENT			



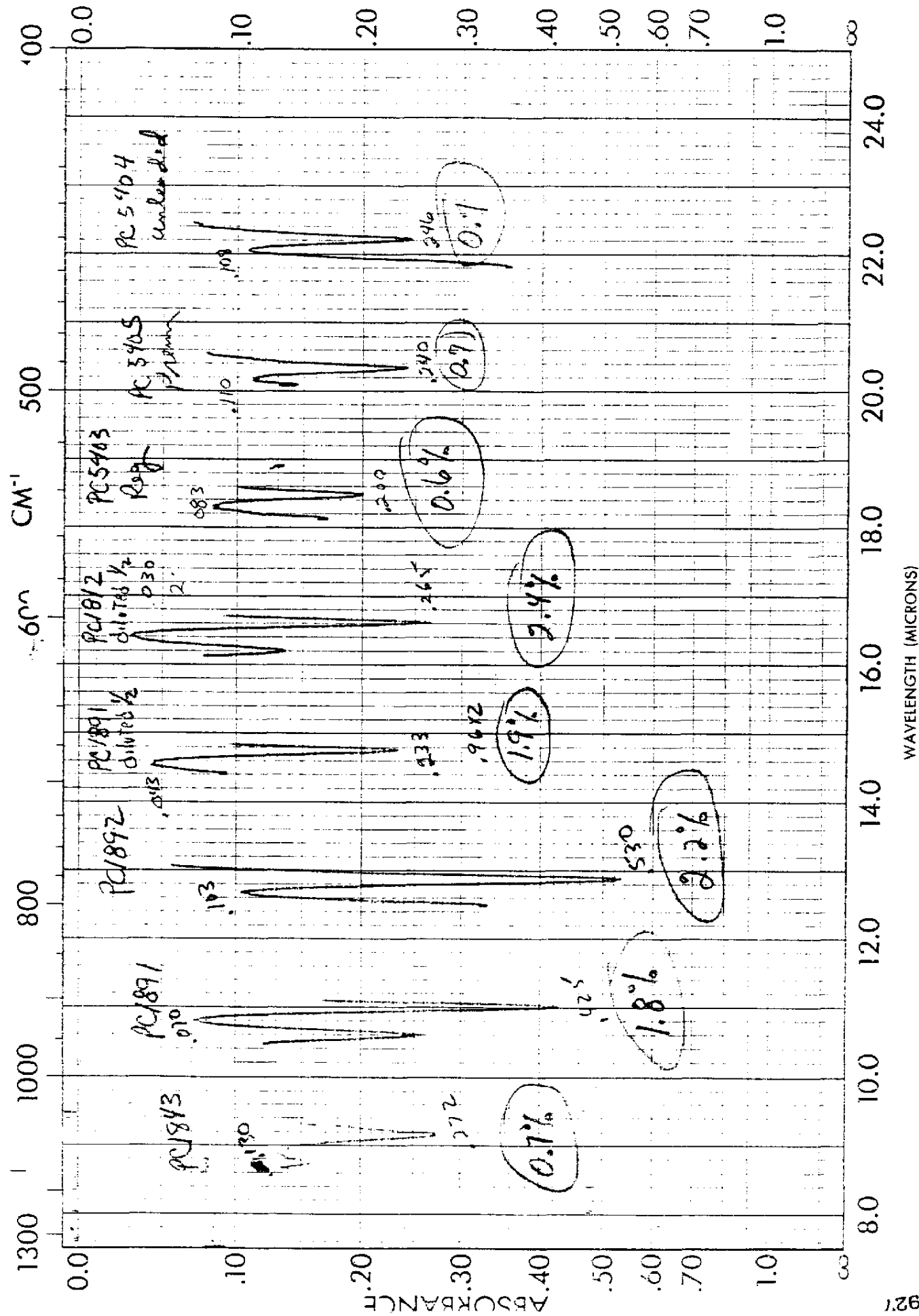
MCD 000019925

SAMPLE _____	CURVE NO. _____	SCAN SPEED _____		OPERATOR _____
		SLIT _____		DATE _____
ORIGIN _____	CELL PATH _____	REMARKS _____		
SAMPLE _____	REFERENCE _____			



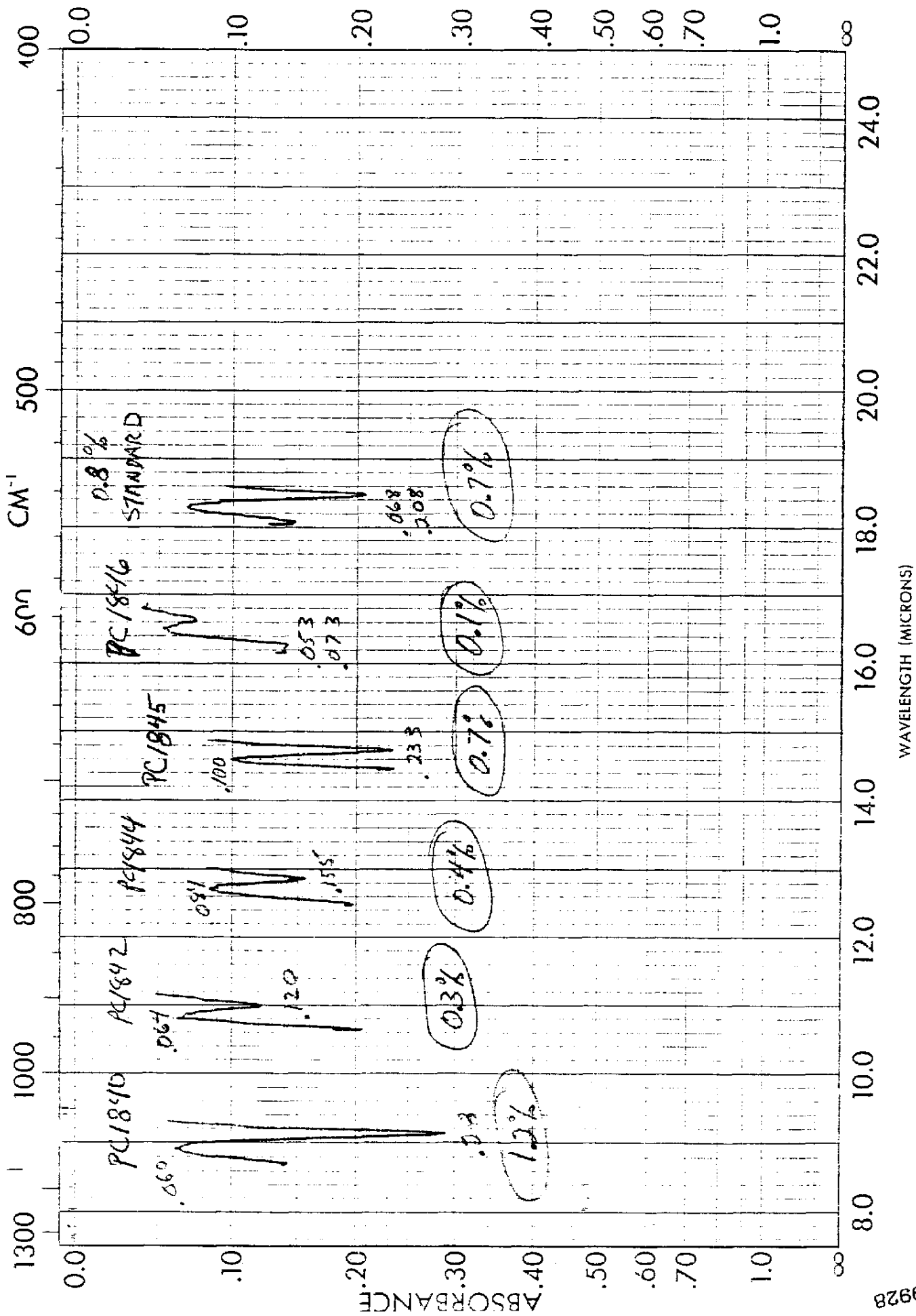
MCD 000019926

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
		SPLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		



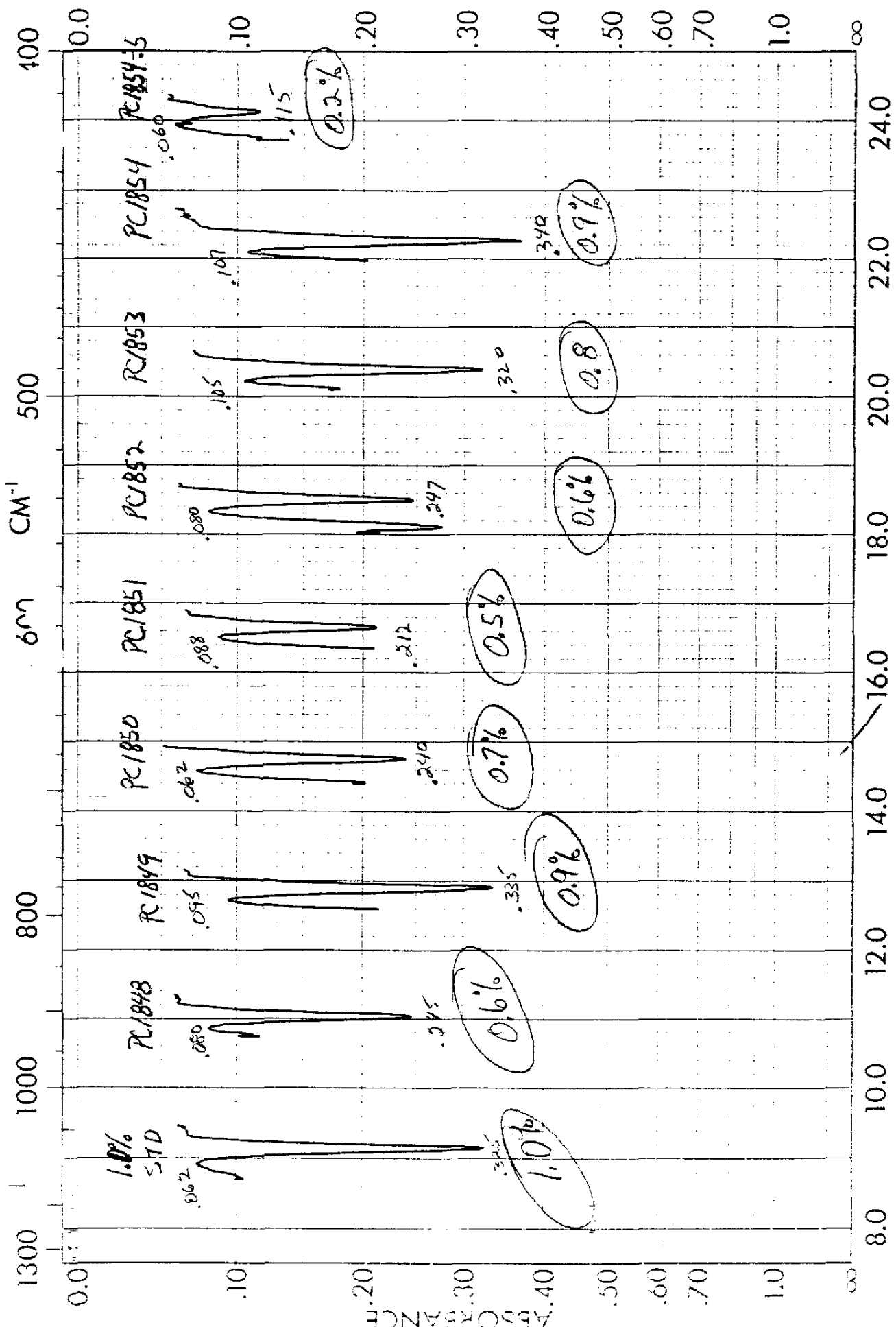
SAMPLE	CURVE NO.	SCAN SPEED		OPERATOR
		CONC.	SPLIT	DATE
ORIGIN	CELL PATH	REMARKS		
SOLVENT	REFERENCE			

MCD 000019927

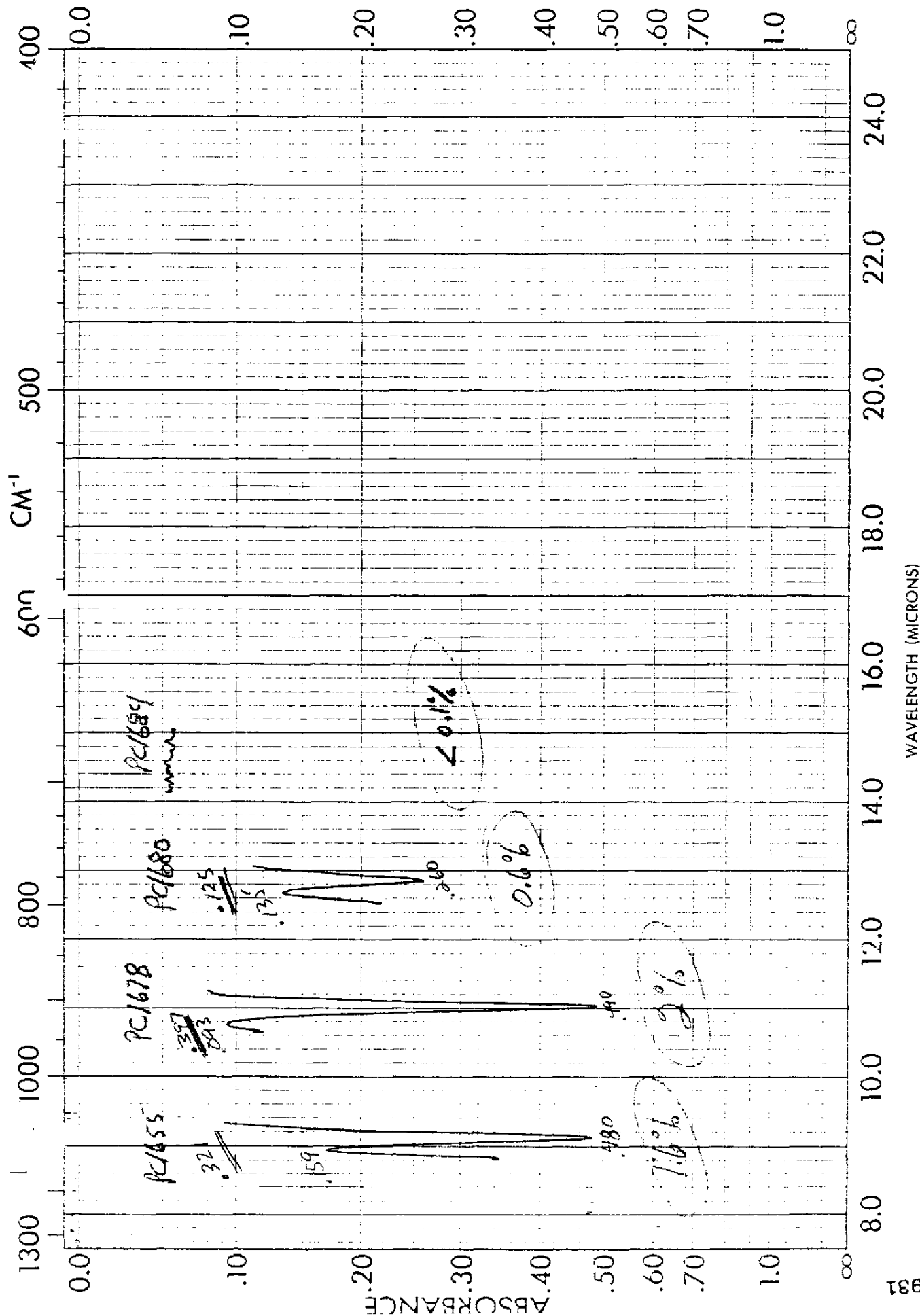


MCD 000019928

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
		SLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		

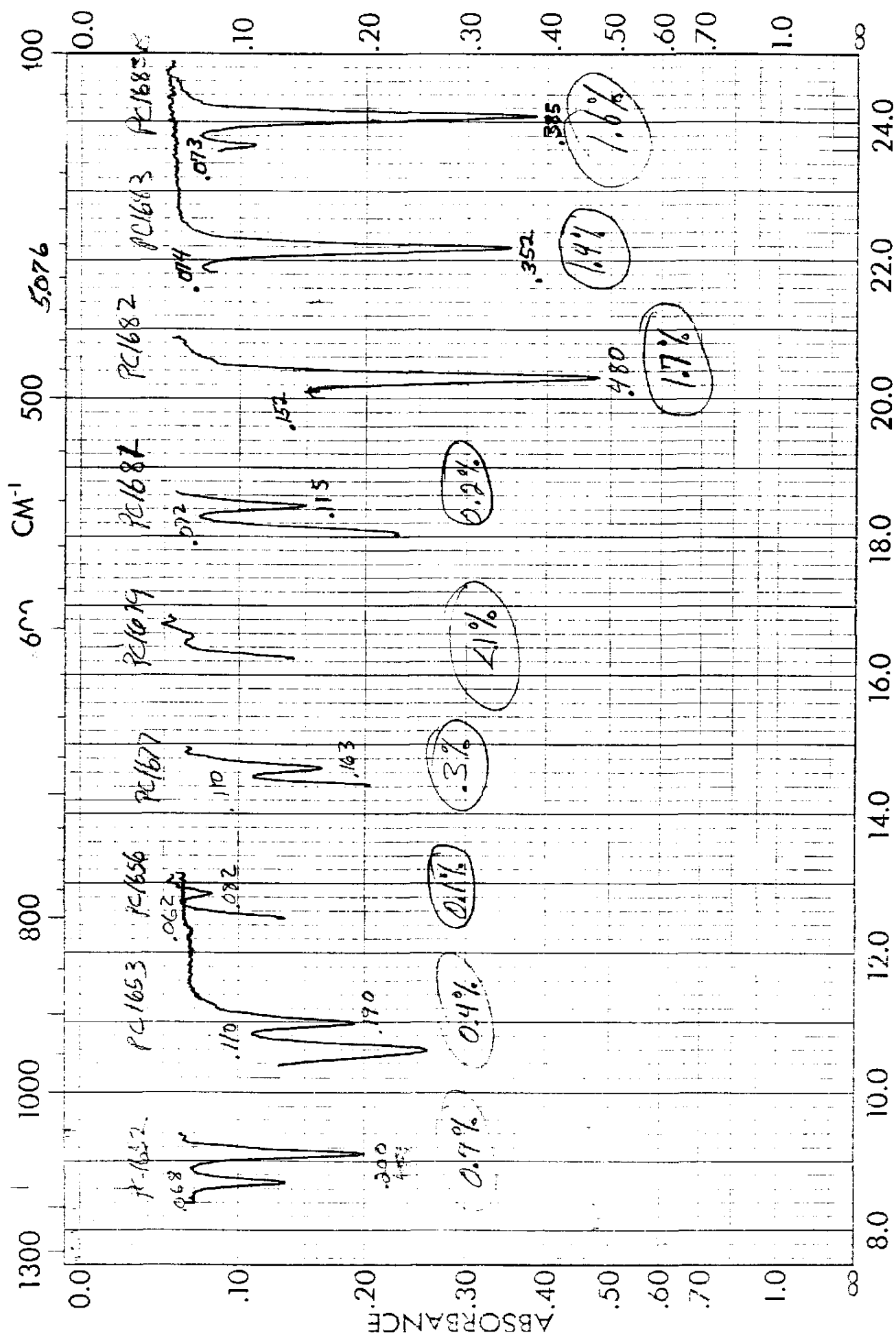


SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SUIT	DATE
ORIGIN	CELL PATH	REMARKS	
COMMENTS			



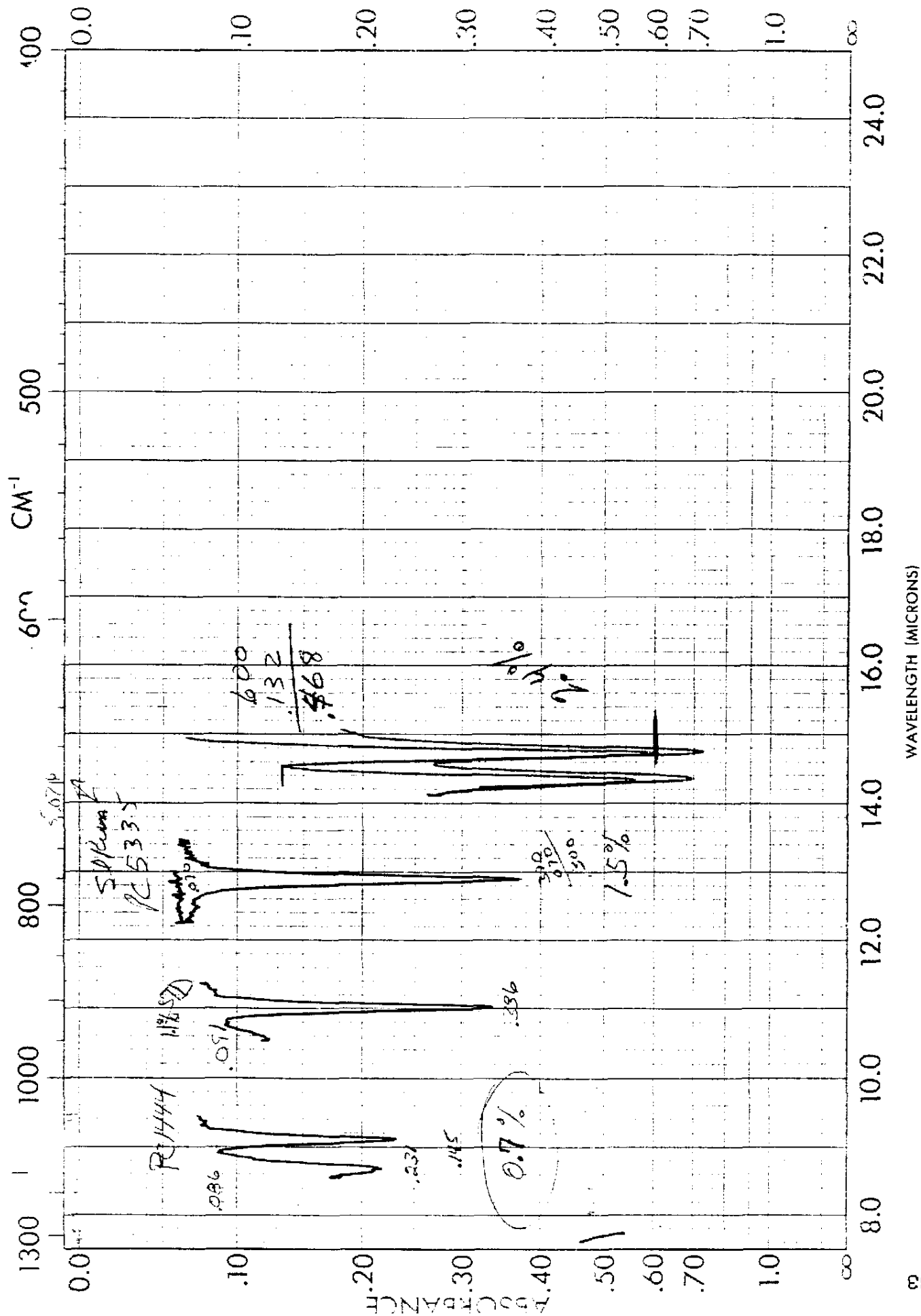
SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SPLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		

MCD 000019981

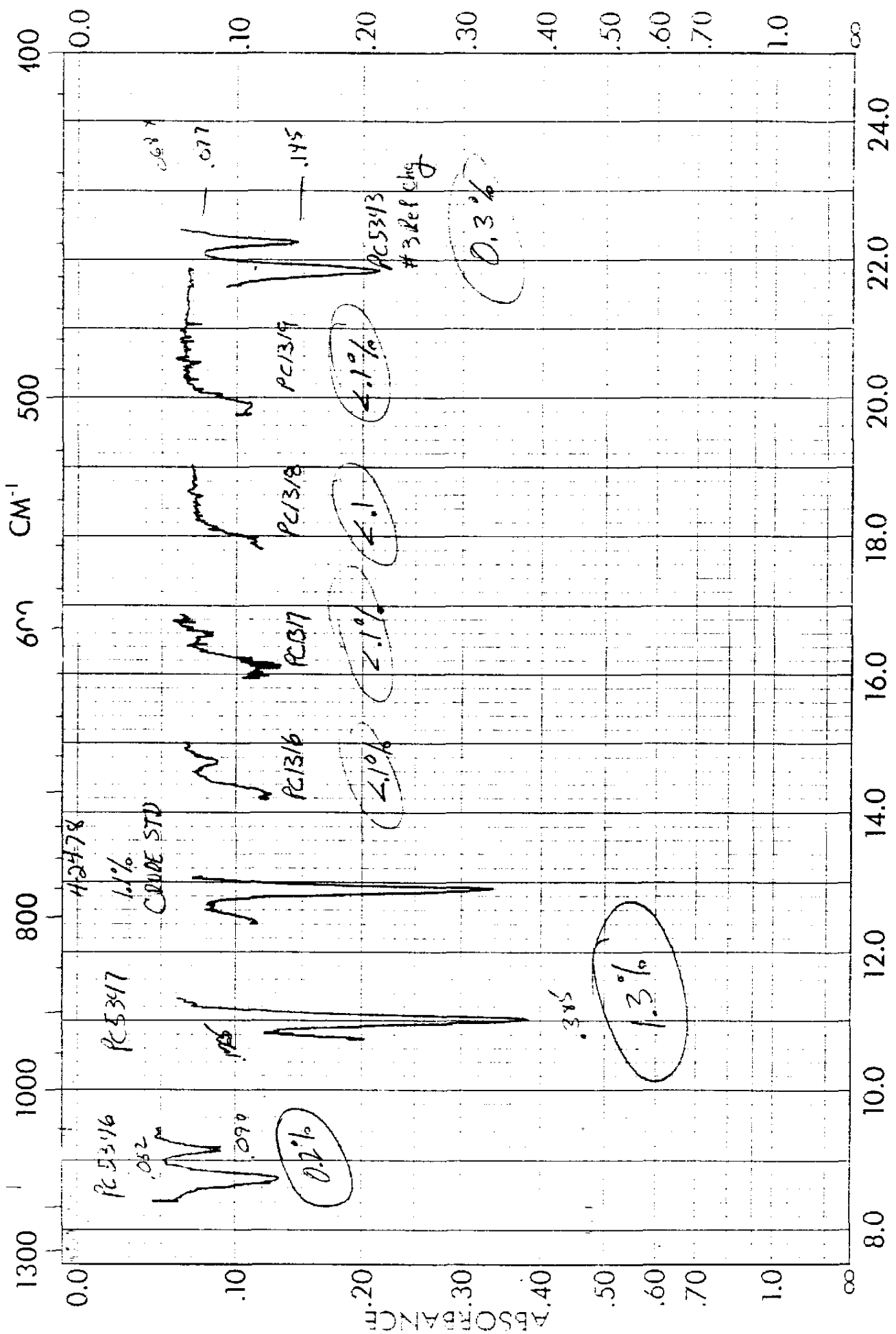


MCD 000019932

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
		SIT	DATE
ORIGIN	CELL PATH	REMARKS	
REFERENCE _____ _____ _____			

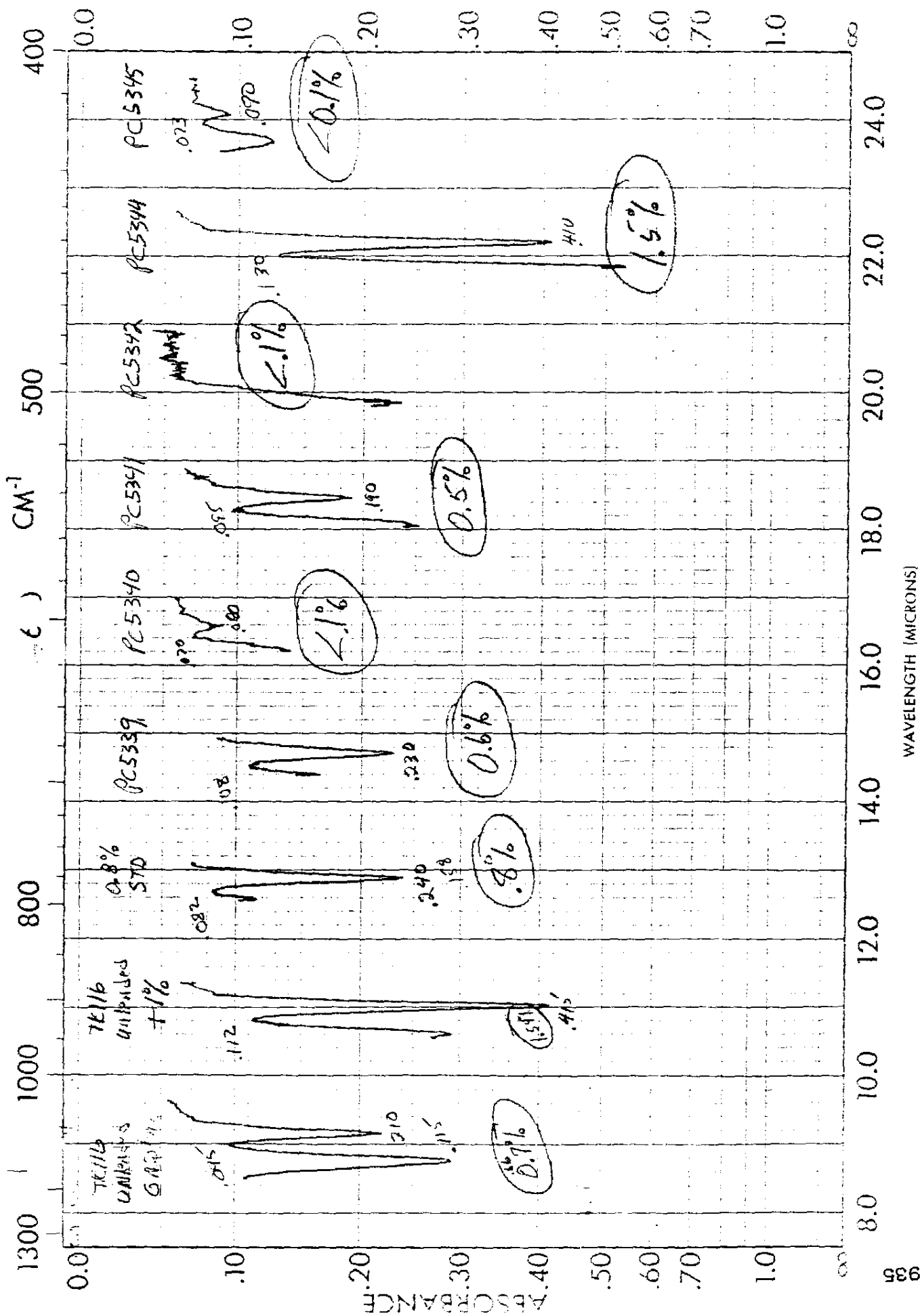


SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SUIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		



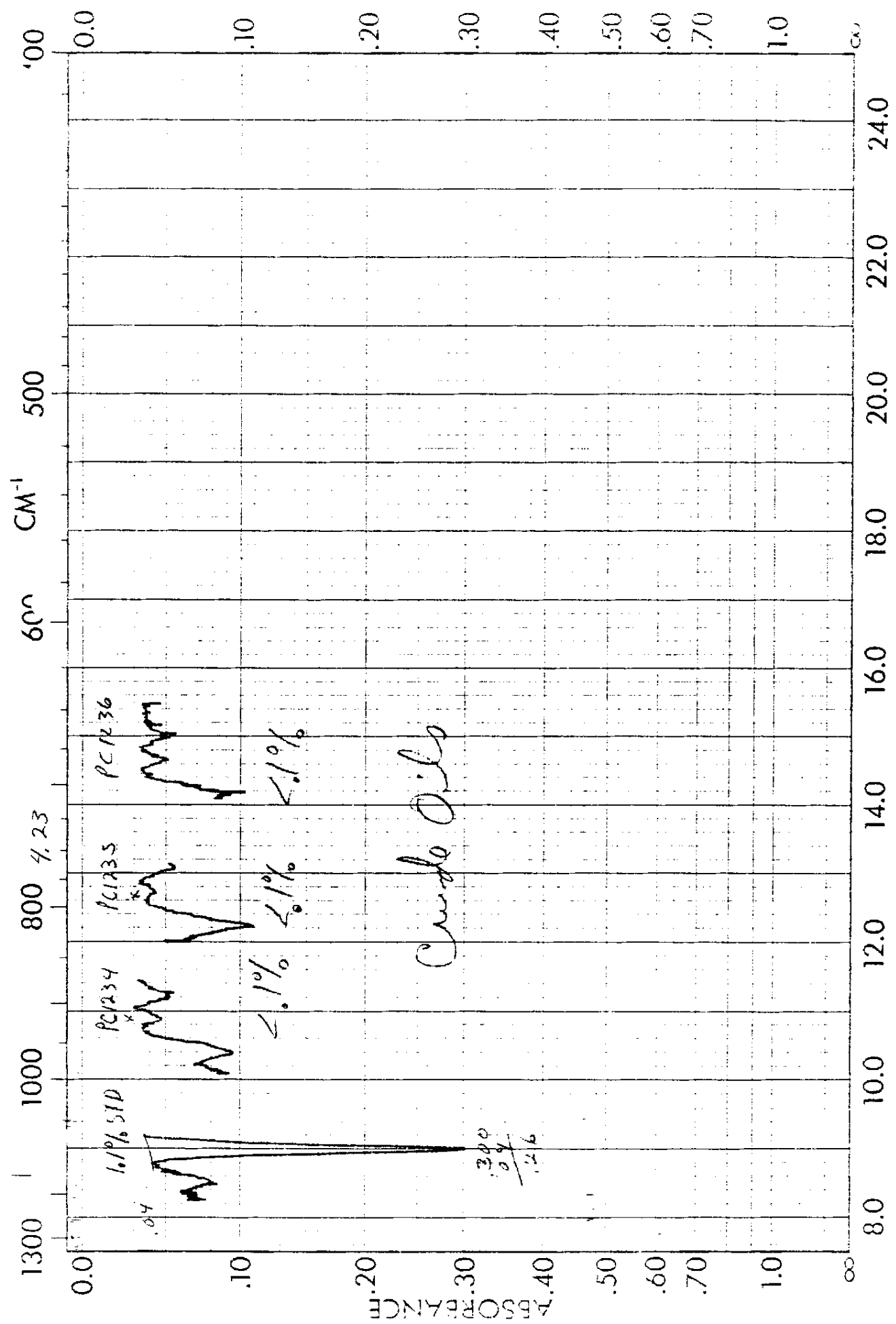
MCD 000019934

SAMPLE <u>PC 5347</u>	CURVE NO. _____	SCAN SPEED _____	OPERATOR <u>MIF</u>
	CONC. _____	SPLIT _____	DATE <u>4-17-78</u>
ORIGIN _____	CELL PATH _____	REMARKS _____	
SOLVENT _____	REFERENCE _____		



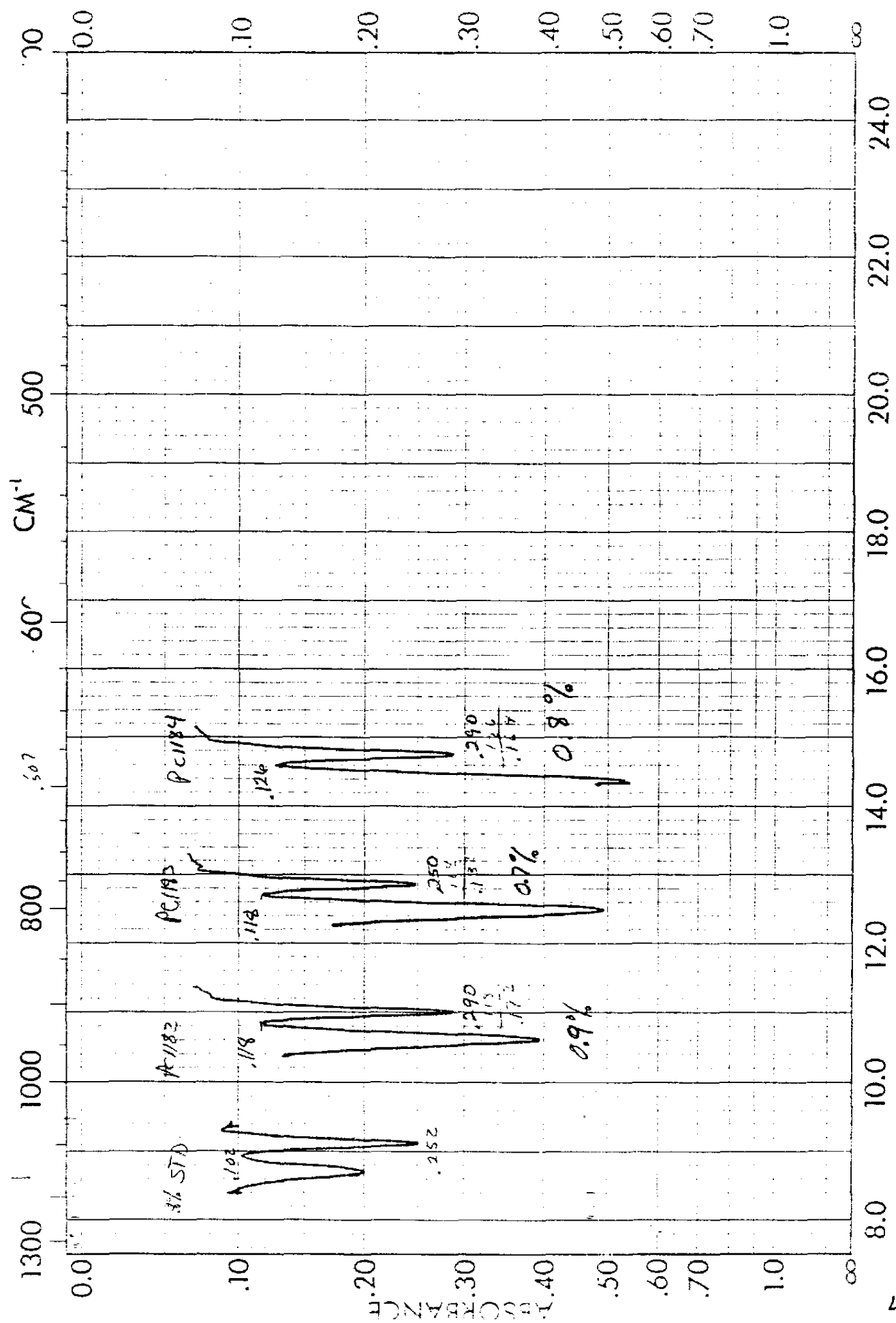
MCD 000019935

SAMPLE <u>PC SAS 605.12</u>	CURVE NO.	SCAN SPEED <u>F</u>	OPERATOR <u>MF</u>
	CONC.	SUIT <u>N</u>	DATE <u>11/7/78</u>
ORIGIN	CELL PATH	REMARKS	
REMARKS			



MCD 000019900

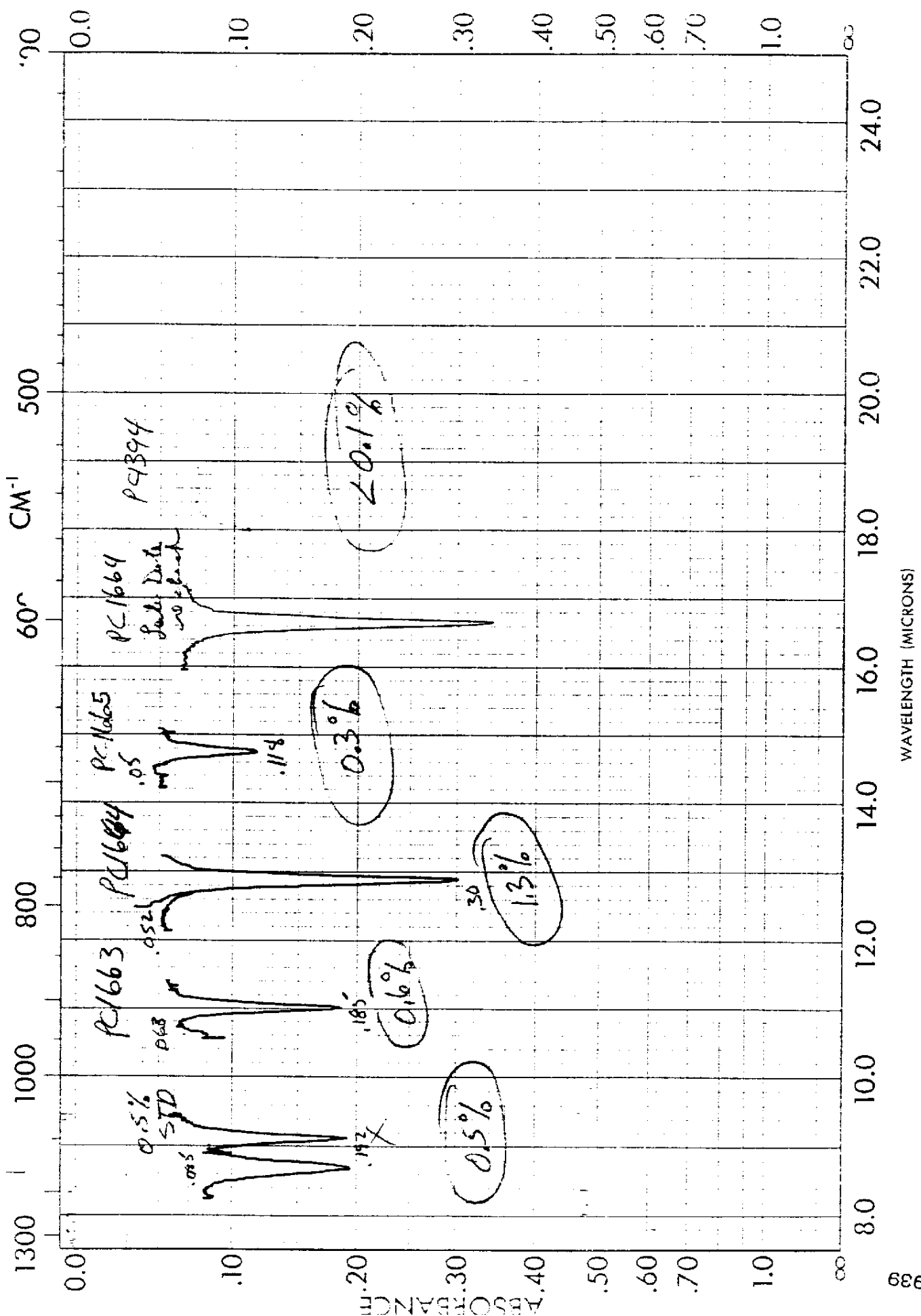
SAMPLE	CURVE NO.	SCAN SPEED		OPERATOR
		SLIT	DATE	
ORIGIN	CELL PATH	REMARKS		
SOLVENT	REFERENCE			



MCD 000019937

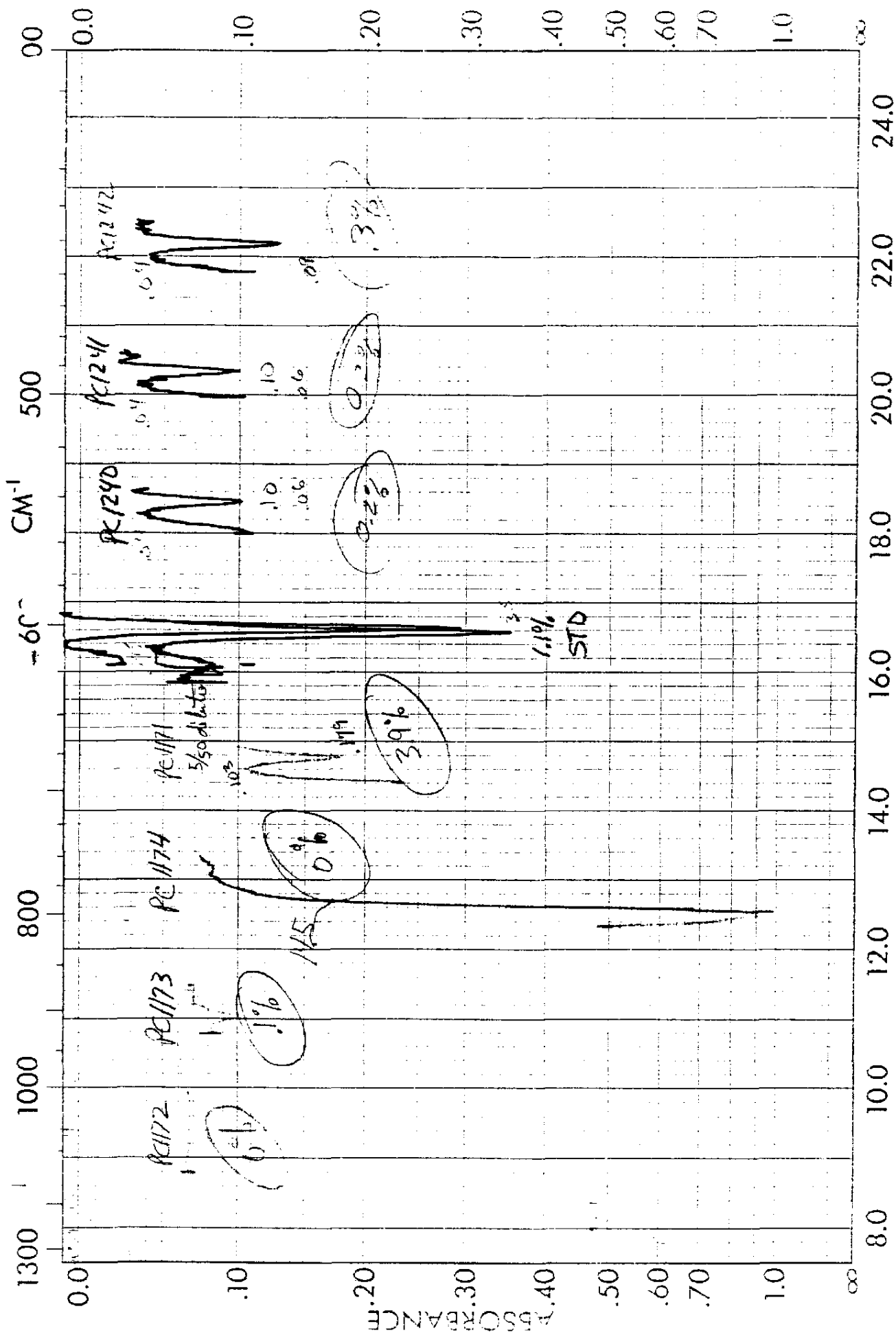
WAVELENGTH (MICRONS)

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SPLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		



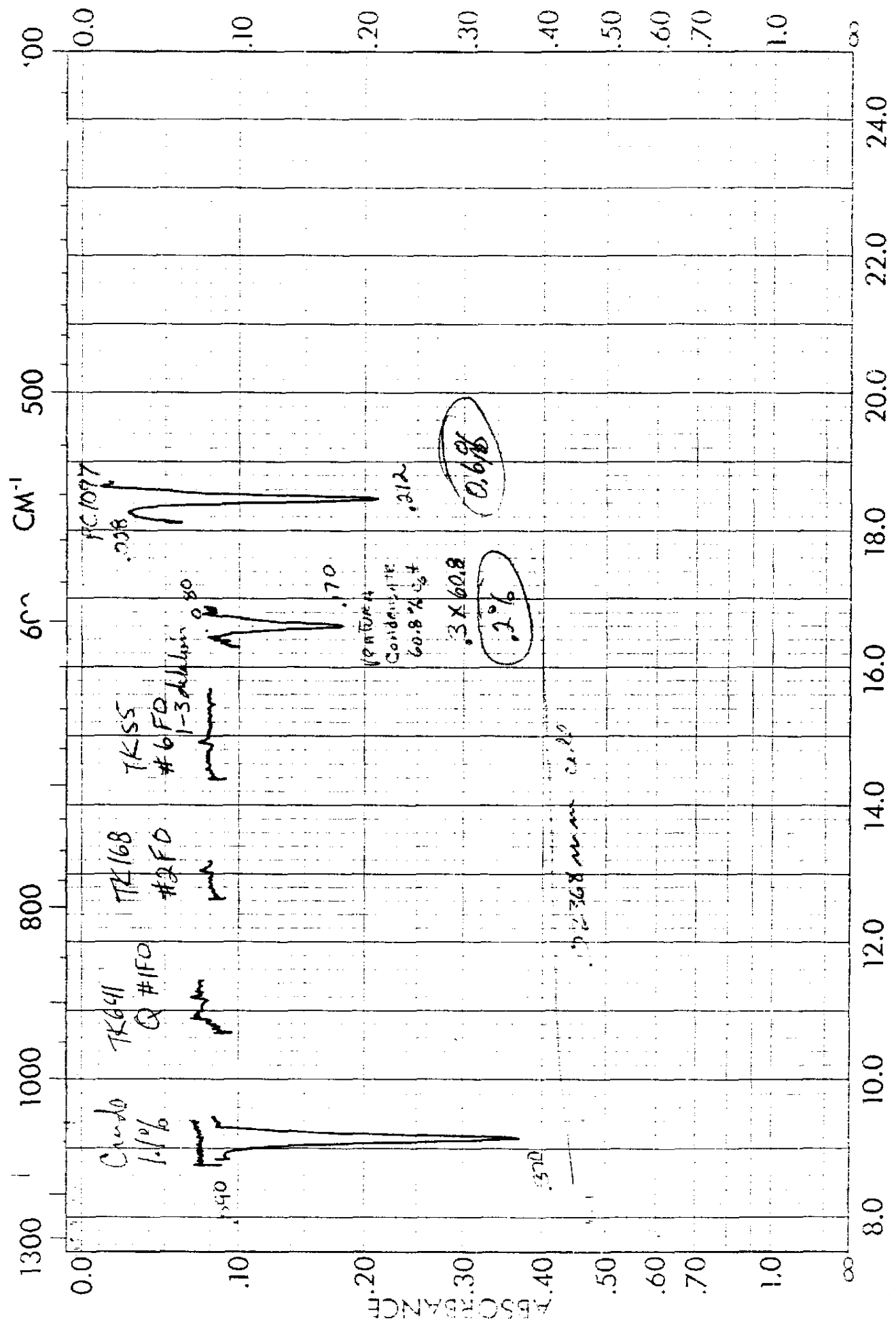
MCD 000019939

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
ORIGIN	CONC.	SUIT	REMARKS
SOLVENT	CELL PATH		



WAVELENGTH (MICRONS)

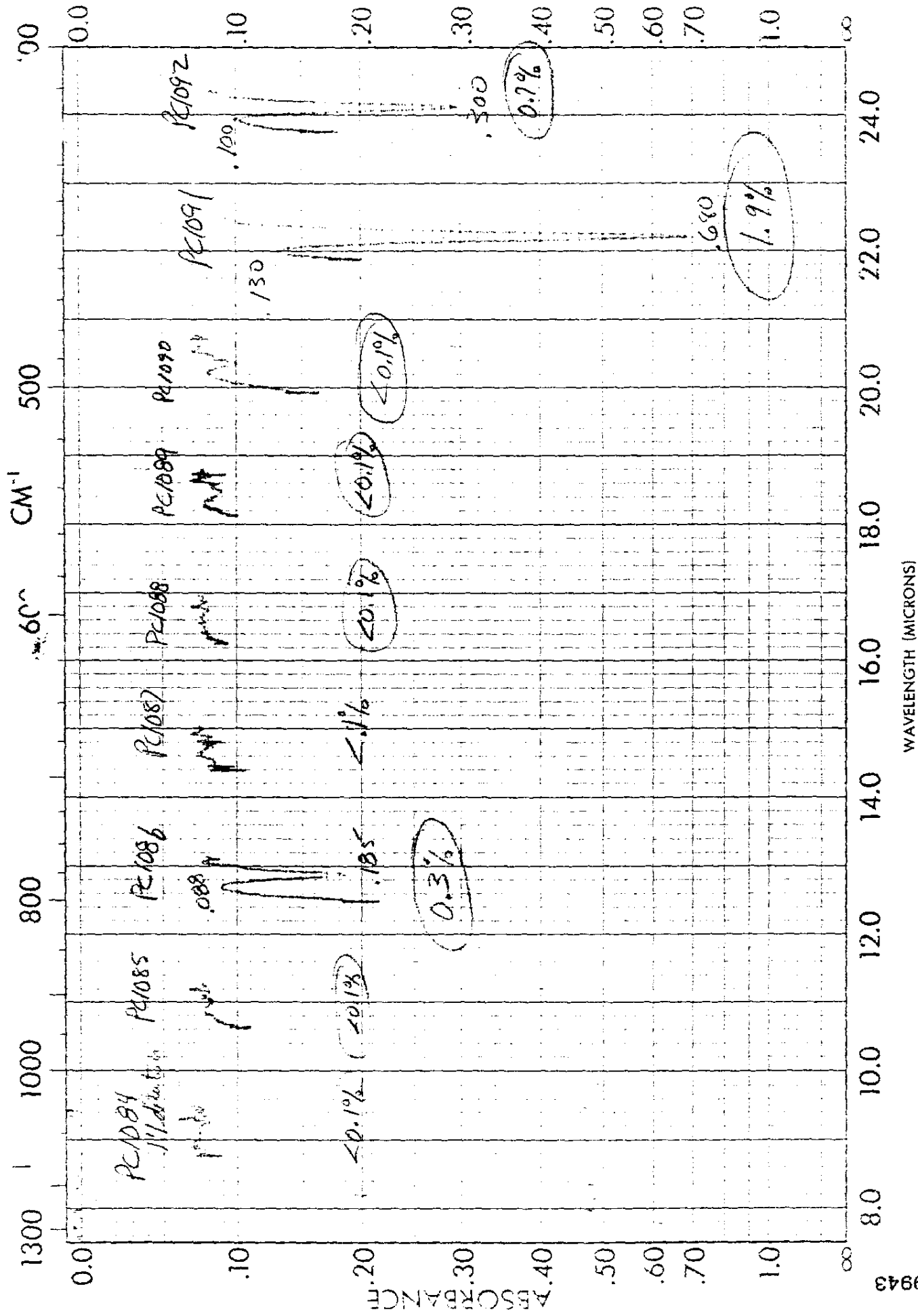
SAMPLE <u>Polystyrene in Chloroform</u>	CURVE NO. _____	SCAN SPEED _____	OPERATOR _____
	CONC. _____	SLIT _____	DATE _____
ORIGIN _____	CELL PATH _____	REMARKS _____	
SOLVENT _____	REFERENCE _____		



MCD 000019942

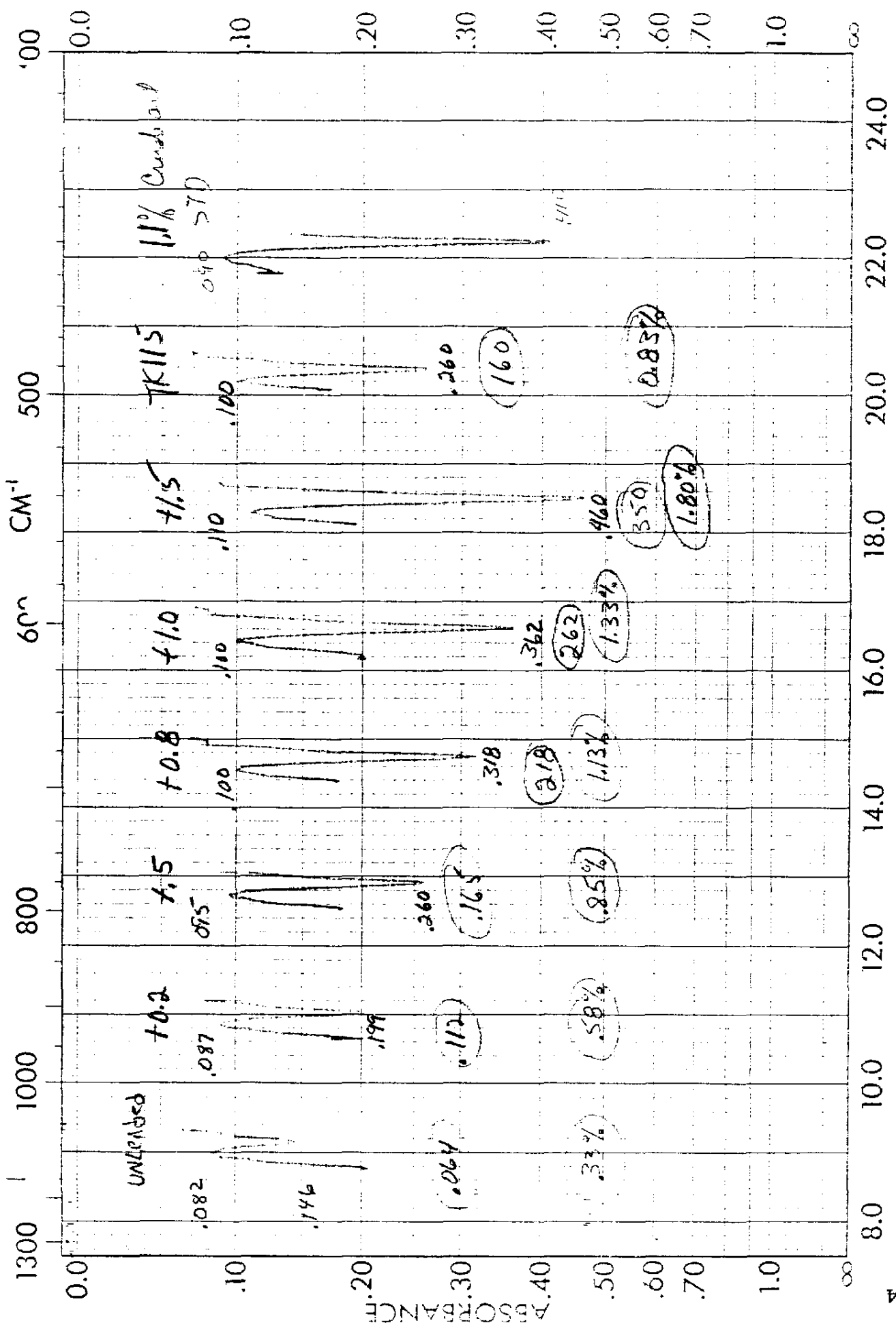
WAVELENGTH (MICRONS)

SAMPLE	CURVE NO.	SCAN SPEED	OPERATOR
	CONC.	SPLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		



MCD 000019943

SAMPLE <i>Diethylamine Oxide</i>	CURVE NO.	SCAN SPEED <i>F</i>	OPERATOR <i>III'E</i>
	CONC.	SPLIT <i>41</i>	DATE <i>7-19-77</i>
ORIGIN	CELL PATH <i>0.2368 mm</i>	REMARKS	
SOLVENT	REFERENCE		



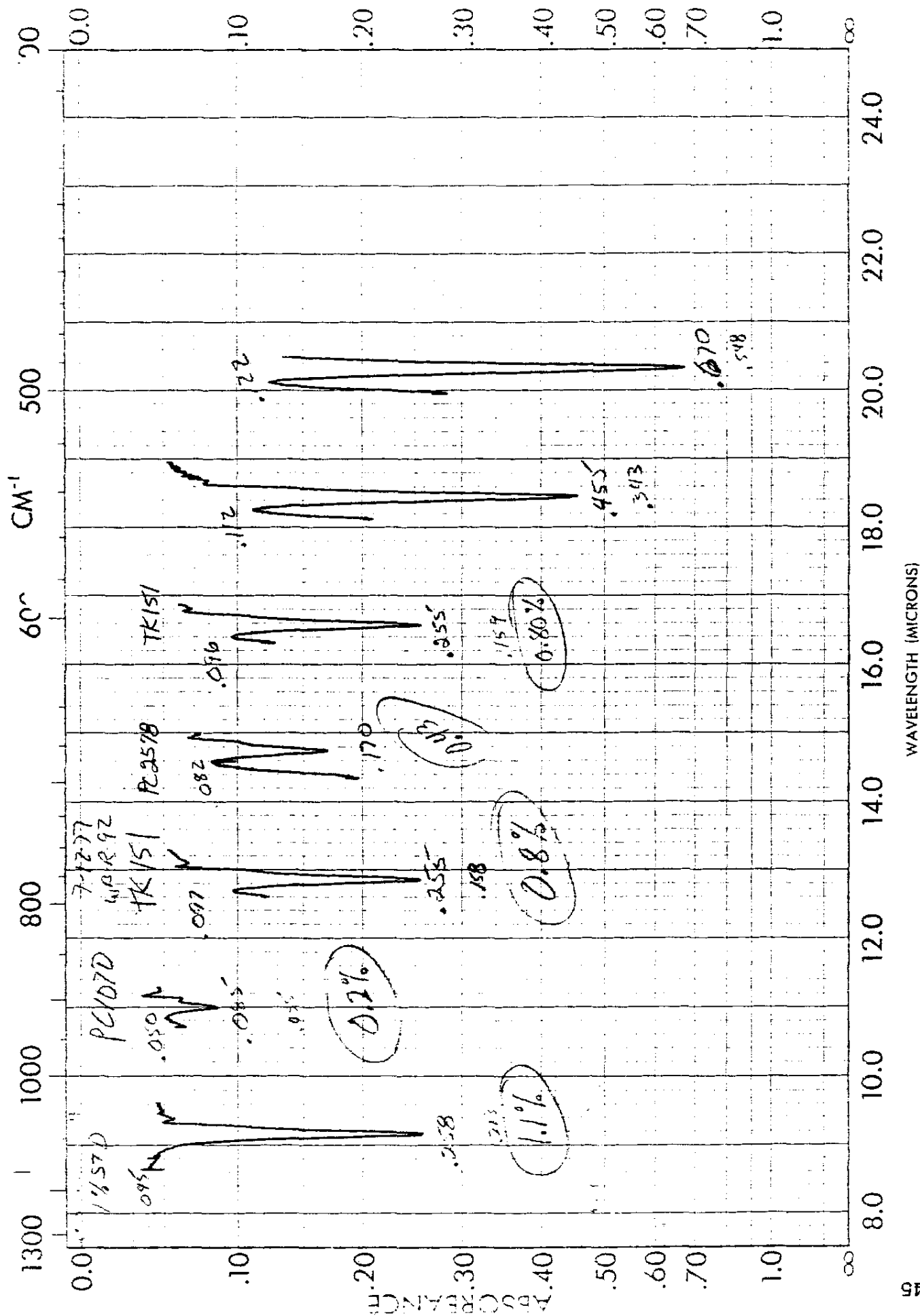
MCD 000019944

WAVELENGTH (MICRONS)

5.076

5.93

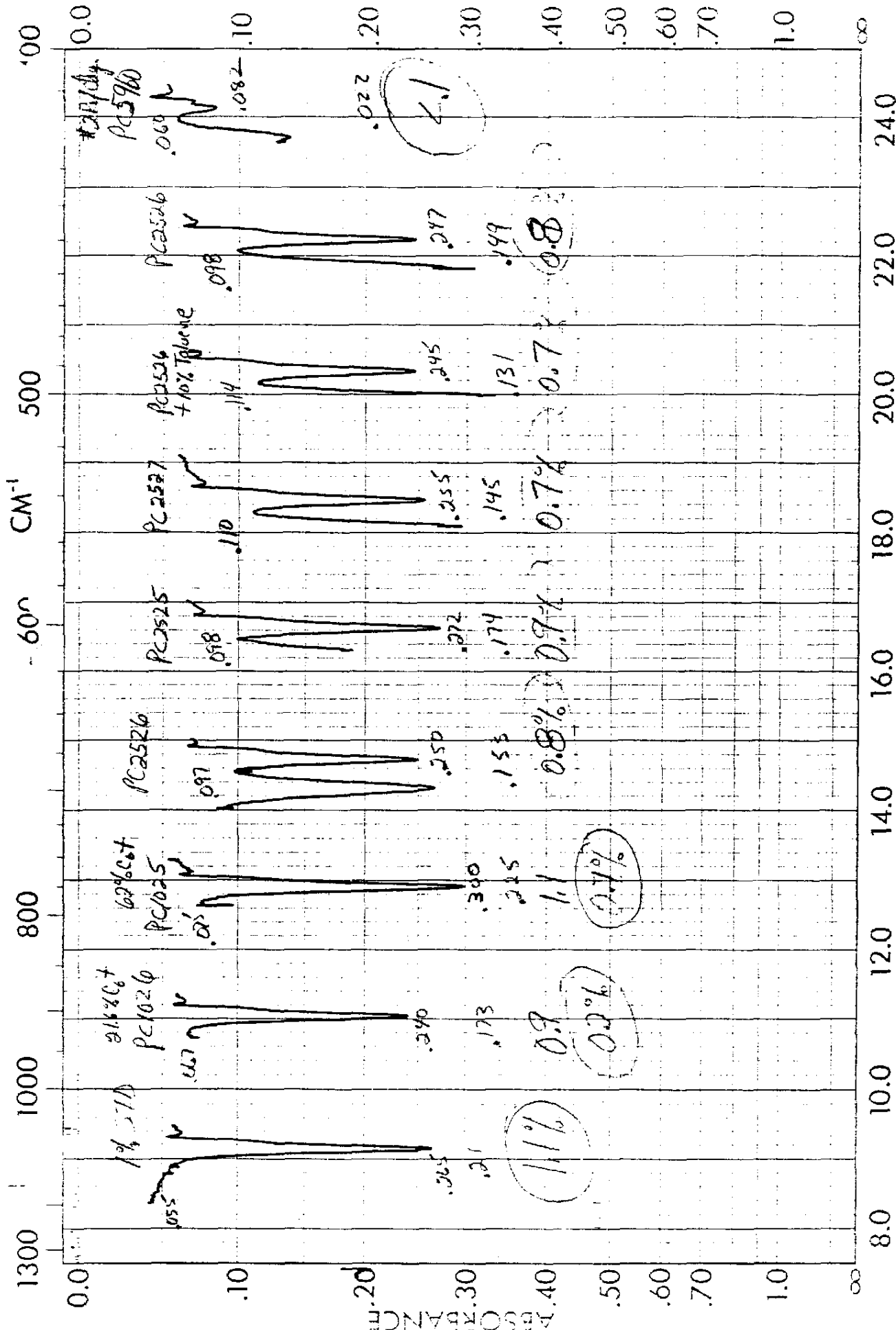
SAMPLE <u>BENZENE in Gasoline</u> <u>Standards</u>	CURVE NO. _____ CONC. _____	SCAN SPEED <u>F</u>	OPERATOR <u>N.F.</u>
		SLIT <u>N</u>	DATE <u>7-19-77</u>
ORIGIN _____ SOLVENT _____	CELL PATH <u>0.2508</u>	REMARKS _____	



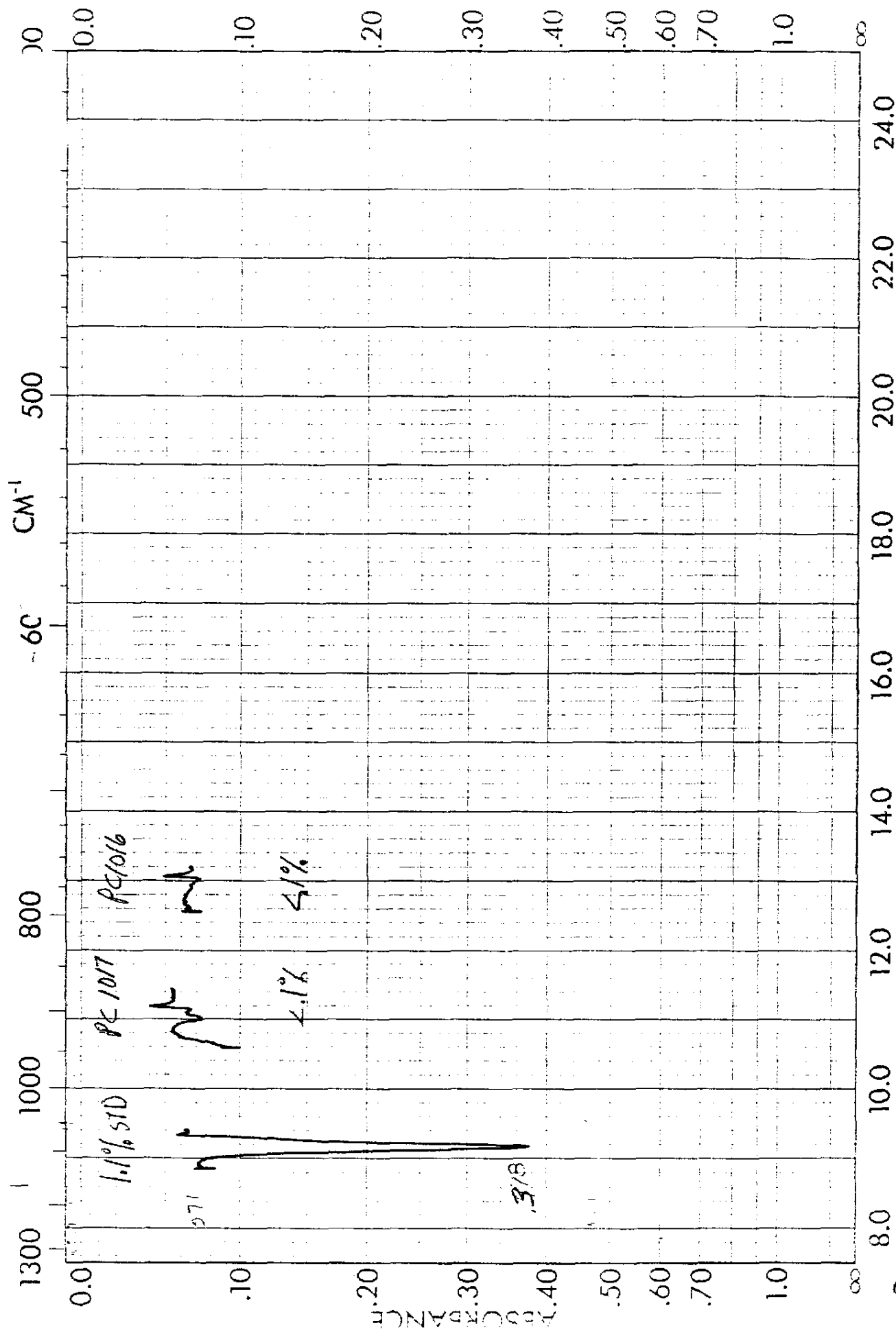
SAMPLE <i>Li₂S in X-toluene</i>	CURVE NO.	SCAN SPEED <i>F</i>	OPERATOR <i>1117</i>
	CONC.	SLIT <i>11</i>	DATE <i>115-77</i>
ORIGIN	CELL PATH	REMARKS	
SOLVENT	REFERENCE		

SAMPLE <i>Benzene in Camell</i>	CURVE NO. _____	SCAN SPEED _____	OPERATOR _____
	CONC. _____	SPLIT _____	DATE _____
ORIGIN _____	CELL PATH _____	REMARKS _____	
SOLVENT _____	REFERENCE _____		

SAMPLE	Curve in Mass	CURVE NO.	SCAN SPEED	OPERATOR	DATE
ORIGIN		CONC.	SUIT		7-7-77
SOLVENT		CELL PATH	REMARKS		
		REFERENCE			

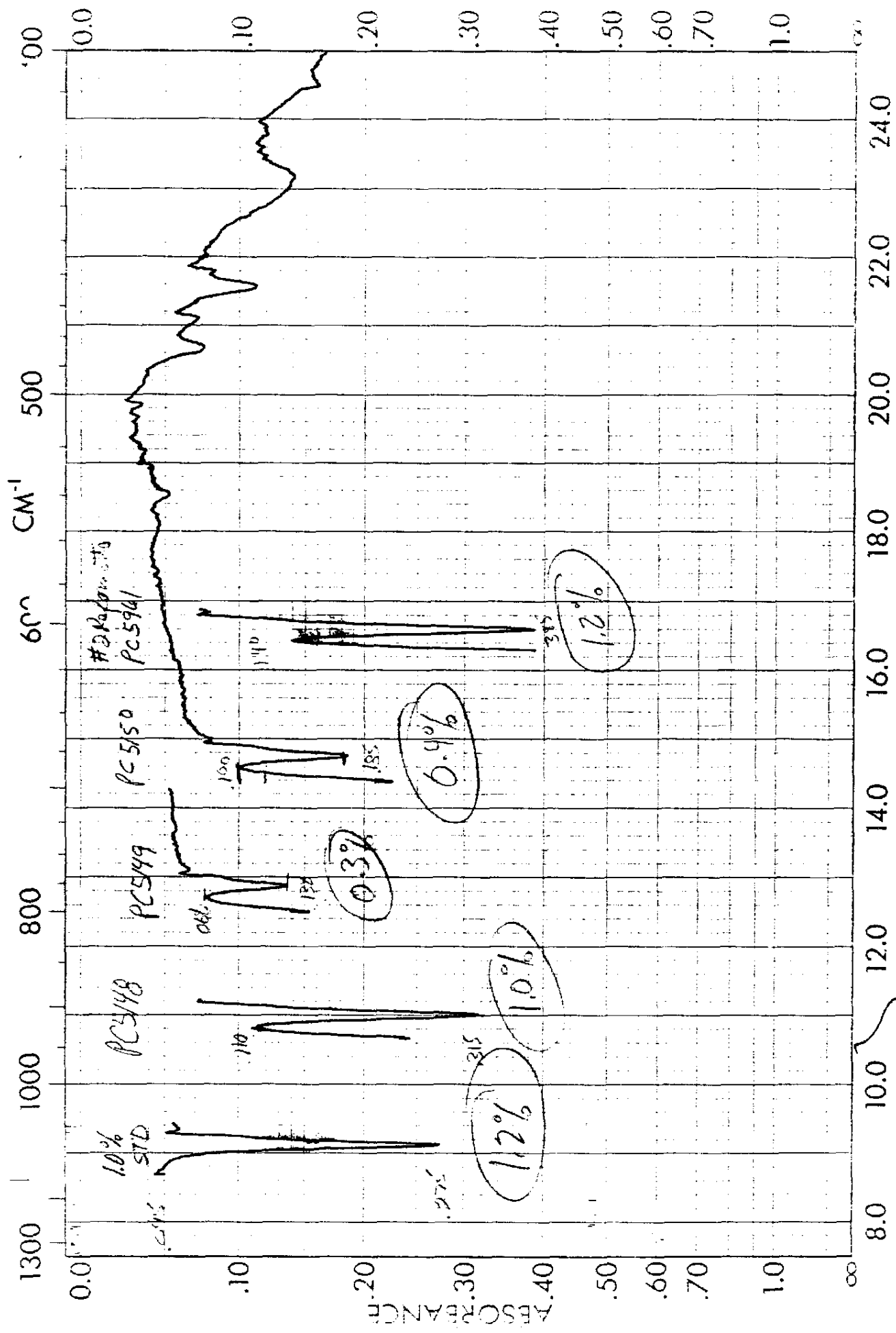


SAMPLE <i>271dy</i>	CURVE NO. _____	SCAN SPEED _____	OPERATOR <i>DPF</i>
			DATE <i>7-2-77</i>
ORIGIN _____	CONC. _____	SPLIT _____	REMARKS _____
SOLVENT _____	CELL PATH _____	REFERENCE _____	



MCD 000019949

SAMPLE <u>P. 1017</u>	CURVE NO. <u>1</u>	SCAN SPEED. <u>100</u>	OPERATOR <u>DATE</u>
ORIGIN <u>1017</u>	CONC. <u>1.1%</u>	SPLIT <u>100</u>	REMARKS
SOLVENT <u>1017</u>	CELL PATH <u>1017</u>	REFERENCE <u>1017</u>	



096810000 000

WAVELENGTH (MICRONS)

SAMPLE <i>Naproxen Std</i>	CURVE NO.	SCAN SPEED.	OPERATOR
	CONC.	SLIT	DATE
ORIGIN	CELL PATH	REMARKS	
SOLVENT			