

Lecture1

Advanced Analysis for Pharmacy Students

By

Professor Dr. Mohie Sharaf El Din



Infrared Spectroscopy

IR spectroscopy

IR spectroscopy (which is short for infrared spectroscopy) deals with the infrared region of the electromagnetic spectrum, i.e. light having a longer wavelength and a lower frequency than visible light.

Infrared Spectroscopy generally refers to the analysis of the interaction of a molecule with infrared light.

The IR spectroscopy concept can generally be analyzed in three ways:

by measuring reflection, emission, and absorption.

The major use of infrared spectroscopy is to determine the functional groups of molecules, relevant to both organic and inorganic chemistry

What is IR Spectroscopy?

An IR spectrum is essentially a graph plotted with the infrared light absorbed on the Y-axis against frequency or wavelength or wavenumber on the X-axis.

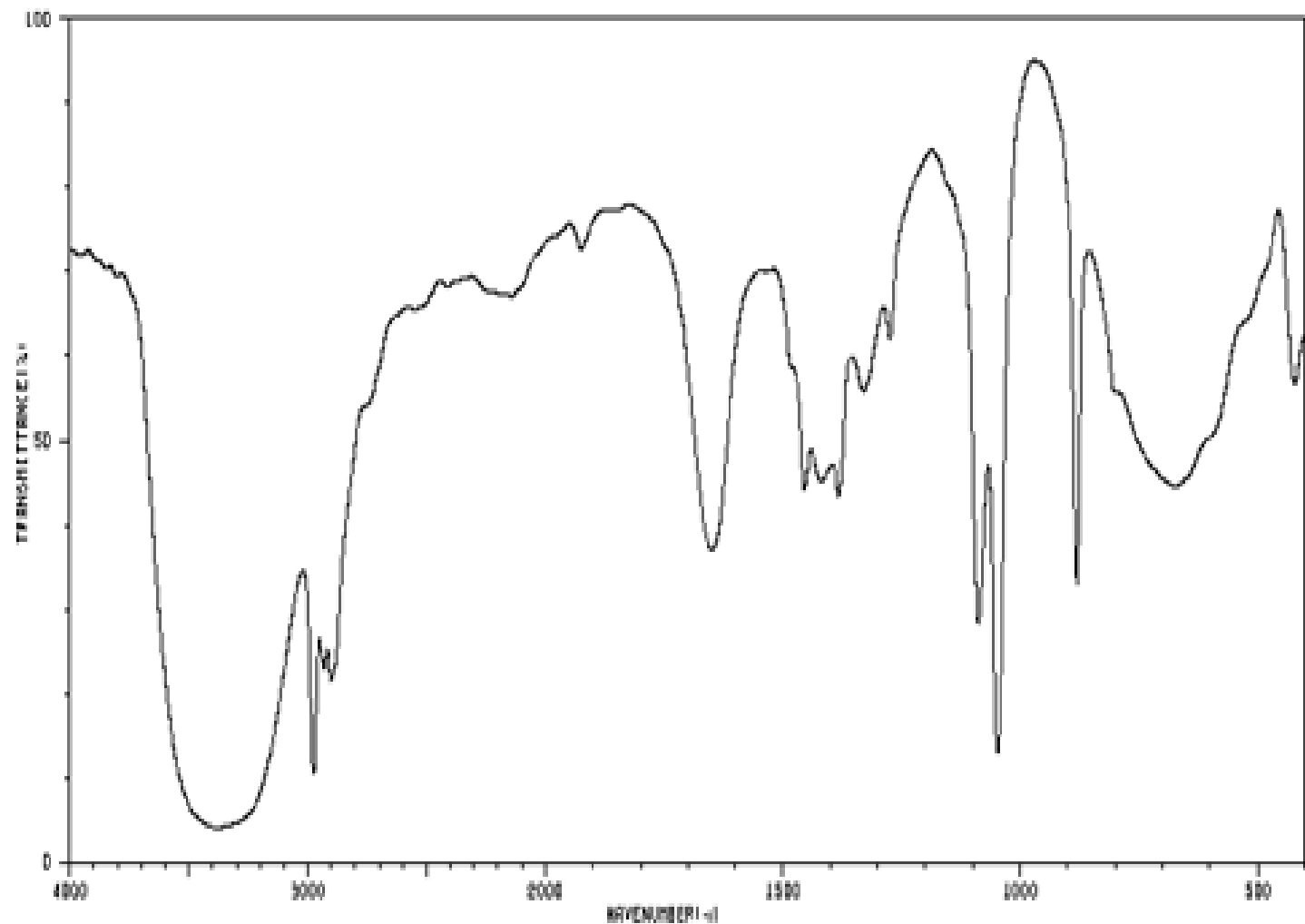
An illustration highlighting the different regions that light can be classified into is given below.

IR Spectroscopy detects frequencies of infrared light that are absorbed by a molecule. Molecules tend to absorb these specific frequencies of light since they correspond to the frequency of the vibration of bonds in the molecule.

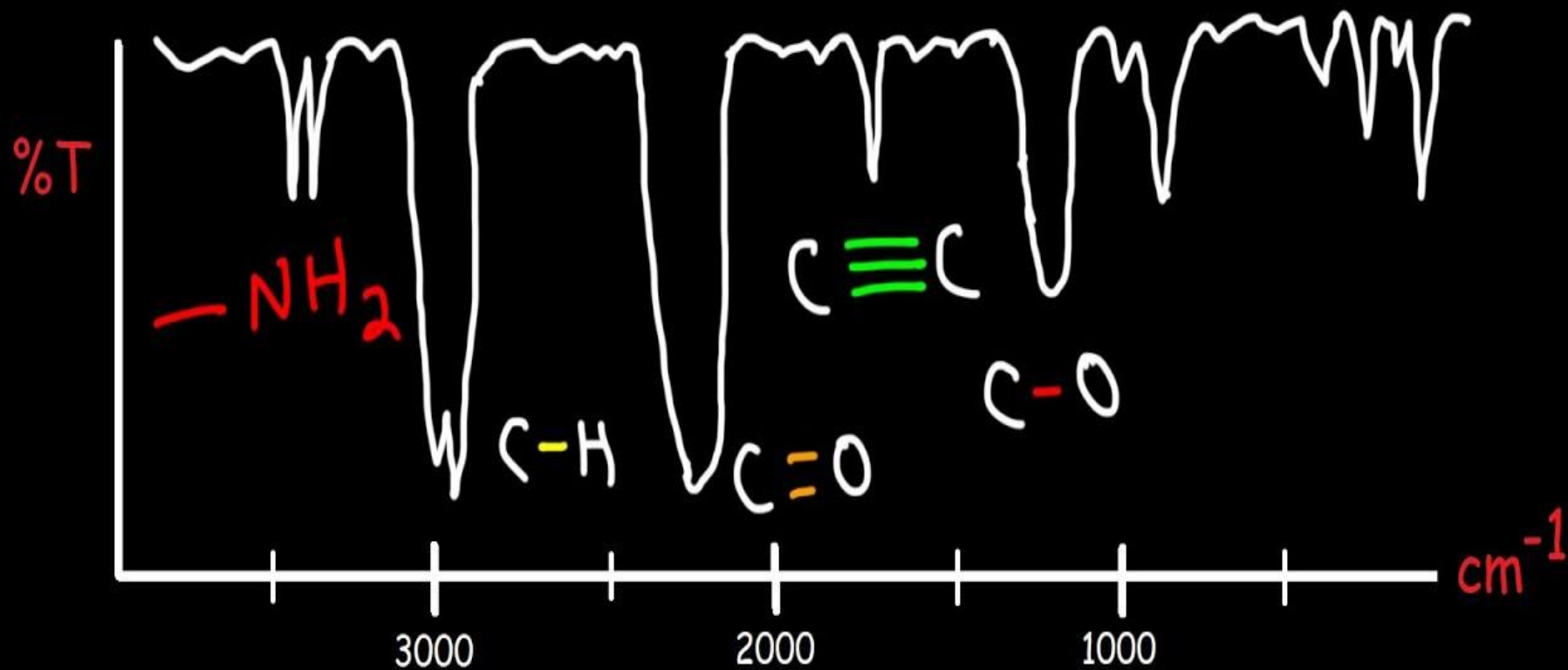
HIT-NO=1374 SCORE= () S0BS-NO=1300 | IR-NIDA-21941 : LIQUID FILM

ETHYL ALCOHOL

C_2H_6O



IR Spectroscopy



VISIBLE

ULTRAVIOLET



INFRARED



FUNCTIONAL GROUP REGION

FINGERPRINT REGION

$4000\text{ cm}^{-1} - 1300\text{ cm}^{-1}$

$1300\text{ cm}^{-1} - 400\text{ cm}^{-1}$

Regions of the Infrared spectrum

Most of the bands that indicate what functional group is present are found in the region from 4000 cm^{-1} to 1300 cm^{-1} .

Their bands can be identified and used to determine the functional group of an unknown compound.

Bands that are unique to each molecule, similar to a fingerprint, are found in the fingerprint region, from 1300 cm^{-1} to 400 cm^{-1} .

These bands are only used to compare the spectra of one compound to another.

Infrared radiation

$$\lambda = 2.5 \text{ to } 17 \mu\text{m}$$

$$\nu = 4000 \text{ to } 600 \text{ cm}^{-1}$$

These frequencies match the frequencies of covalent bond stretching and bending vibrations.

Infrared spectroscopy can be used to find out about **covalent bonds** in molecules.

IR is used to tell:

- 1. what type of bonds are present**
- 2. some structural information (function group OH, CO, NH₂, COOH, SH)**

Principle Of Infrared Spectroscopy

The IR spectroscopy theory utilizes the concept that molecules tend to absorb specific frequencies of light that are characteristic of the corresponding structure of the molecules.

The molecule can absorb the energy contained in the incident light and the result is a faster **rotation** or a more pronounced **vibration**.

Modes of Vibration

The interaction of infrared radiations with matter can be understood in terms of changes in molecular dipoles associated with vibrations.

Vibrations can involve either changes in bond length (stretching) or bond angle (bending).

Some bonds can **stretch in-plane** (symmetric stretching) or **out-of-plane** (asymmetric stretching).

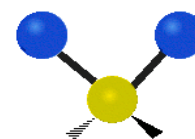
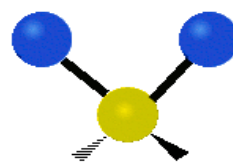
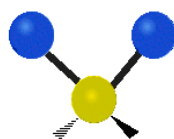
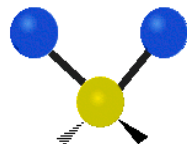
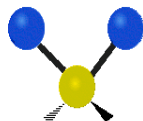
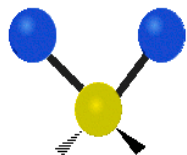
Bending vibrations can be either **in-plane** (as; scissoring, rocking) or **out-of-plane** (as; wagging, twisting) bending vibrations. STRETCHING

Modes of Vi

Number of vibrational modes

- In order for a vibrational mode in a sample to be "IR active", it must be associated with changes in the molecular dipole moment. A permanent dipole is not necessary, as the rule requires only a *change* in dipole moment.
- A molecule can vibrate in many ways, and each way is called a **vibrational mode**. For molecules with N number of atoms, geometrically linear molecules have $3N - 5$ degrees of vibrational modes, whereas nonlinear molecules have $3N - 6$ degrees of vibrational modes (also called vibrational degrees of freedom). As examples linear carbon dioxide (CO_2) has $3 \times 3 - 5 = 4$, while nonlinear water (H_2O), has only $3 \times 3 - 6 = 3$.

Symmetry		Symmetric	Antisymmetric
Direction			
	Radial	Symmetric stretching (ν_s)	Antisymmetric stretching (ν_{as})
	Latitudinal	Scissoring (δ)	Rocking (ρ)
	Longitudinal	Wagging (ω)	Twisting (τ)



- **Uses and applications**

- Infrared spectroscopy is a simple and reliable technique widely used in both organic and inorganic chemistry, in research and industry..
- It is used in quality control, used to analyze the insect repellent, Food and Drug Administration.
- Scientist uses portable near infrared spectroscopy device to detect potentially illegal substances.
- It is also used in forensic analysis in both criminal and civil cases, for example in identifying the blood alcohol content of a suspected drunk driver.
-

• **Practical IR Spectroscopy**

- The infrared spectrum of a sample is recorded by passing a beam of infrared light through the sample. When the frequency of the IR is the same as the vibrational frequency of a bond or collection of bonds, absorption occurs.
- Examination of the transmitted light reveals how much energy was absorbed at each frequency (or wavelength). This measurement can be achieved by scanning the wavelength range using a monochromator.
- Alternatively, the entire wavelength range is measured using a Fourier transform instrument and then a transmittance or absorbance spectrum is generated using a dedicated procedure.

Sample preparation

Gas samples

- Gaseous samples require a sample cell with long pathlength . The pathlength of the sample cell depends on the concentration of the compound of interest. A simple glass tube with length of 5 to 10 cm equipped with infrared-transparent windows at both ends of the tube can be used .

Liquid samples

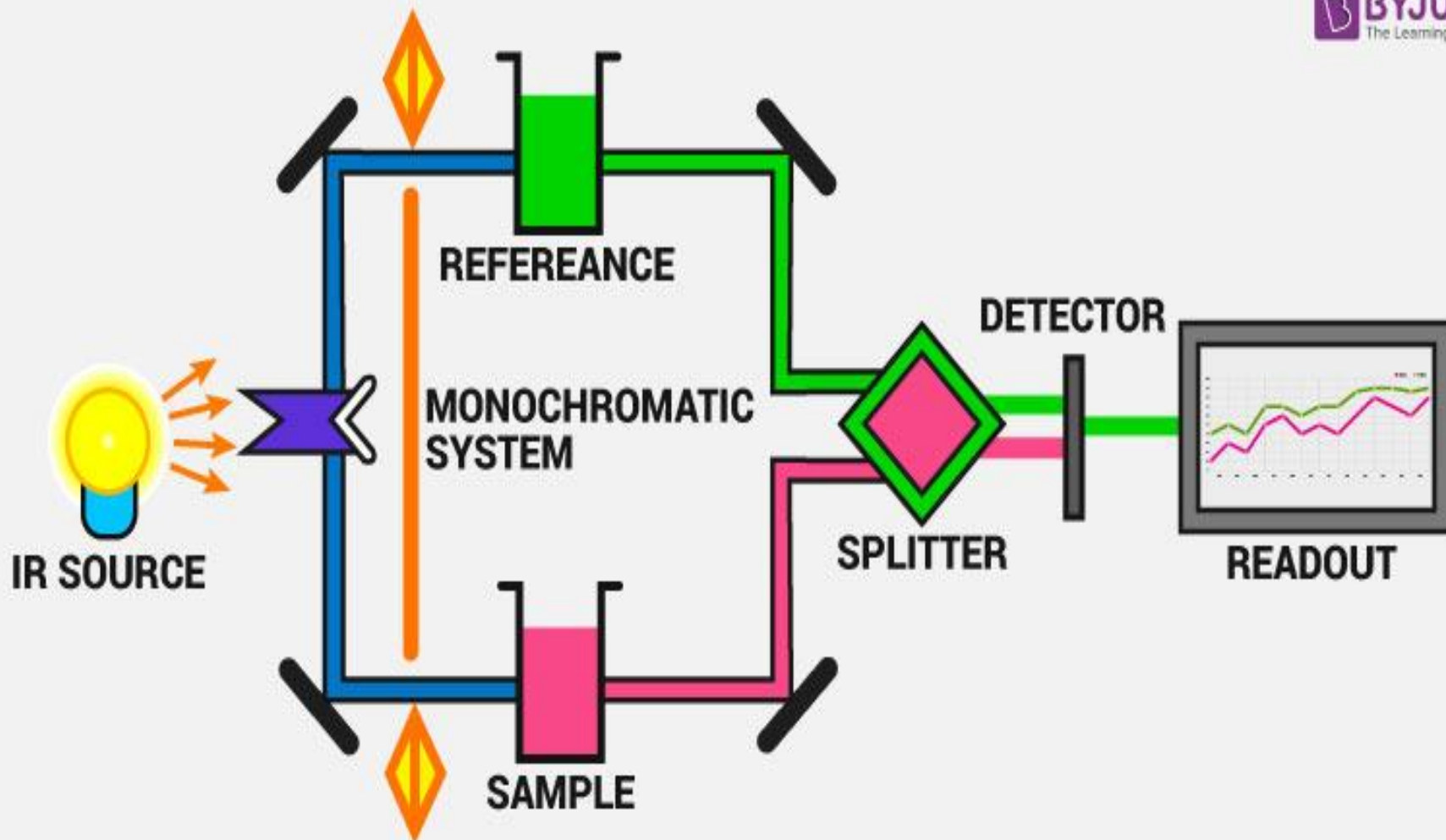
- Liquid samples can be sandwiched between two plates of a salt (commonly sodium chloride, or common salt, although a number of other salts such as potassium bromide or calcium fluoride are also used). The plates are transparent to the infrared light and do not introduce any lines onto the spectra.

Solid samples

- Solid samples can be prepared in a variety of ways. One common method is to crush the sample with an oily mulling agent (usually mineral oil Nujol). A thin film of the mull is applied onto salt plates and measured.
- The second method is to grind a quantity of the sample with a specially purified salt (usually potassium bromide) finely (to remove scattering effects from large crystals). This powder mixture is then pressed in a mechanical press to form a translucent pellet through which the beam of the spectrometer can pass.

• IR Spectroscopy Instrumentation

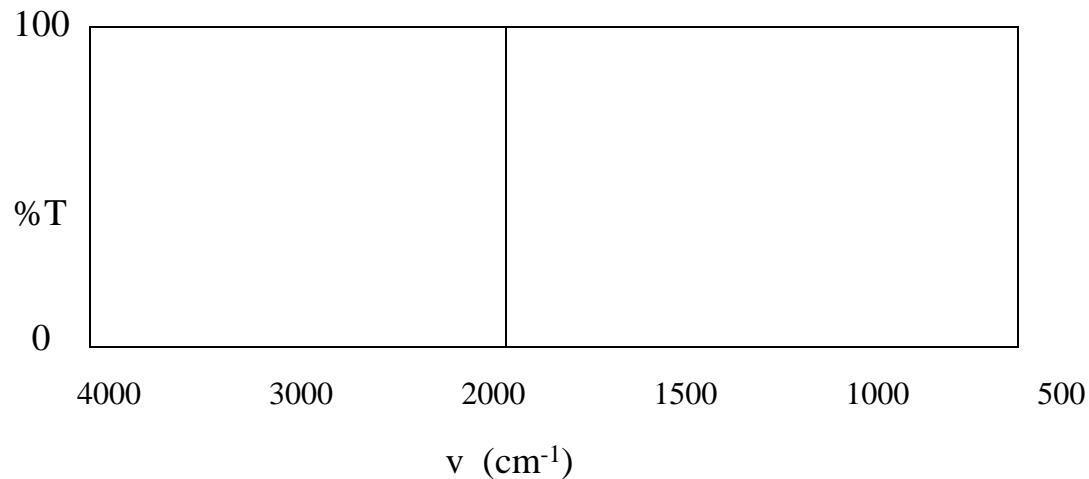
- The instrumentation of infrared spectroscopy is illustrated below.
- First, a beam of IR light from the source is split into two and passed through the reference and the sample respectively.
- Now, both of these beams are reflected to pass through a splitter and then through a detector.
- Finally, the required reading is printed out after the processor deciphers the data passed through the detector.



IR source → sample → prism → detector

graph of % transmission vs. frequency

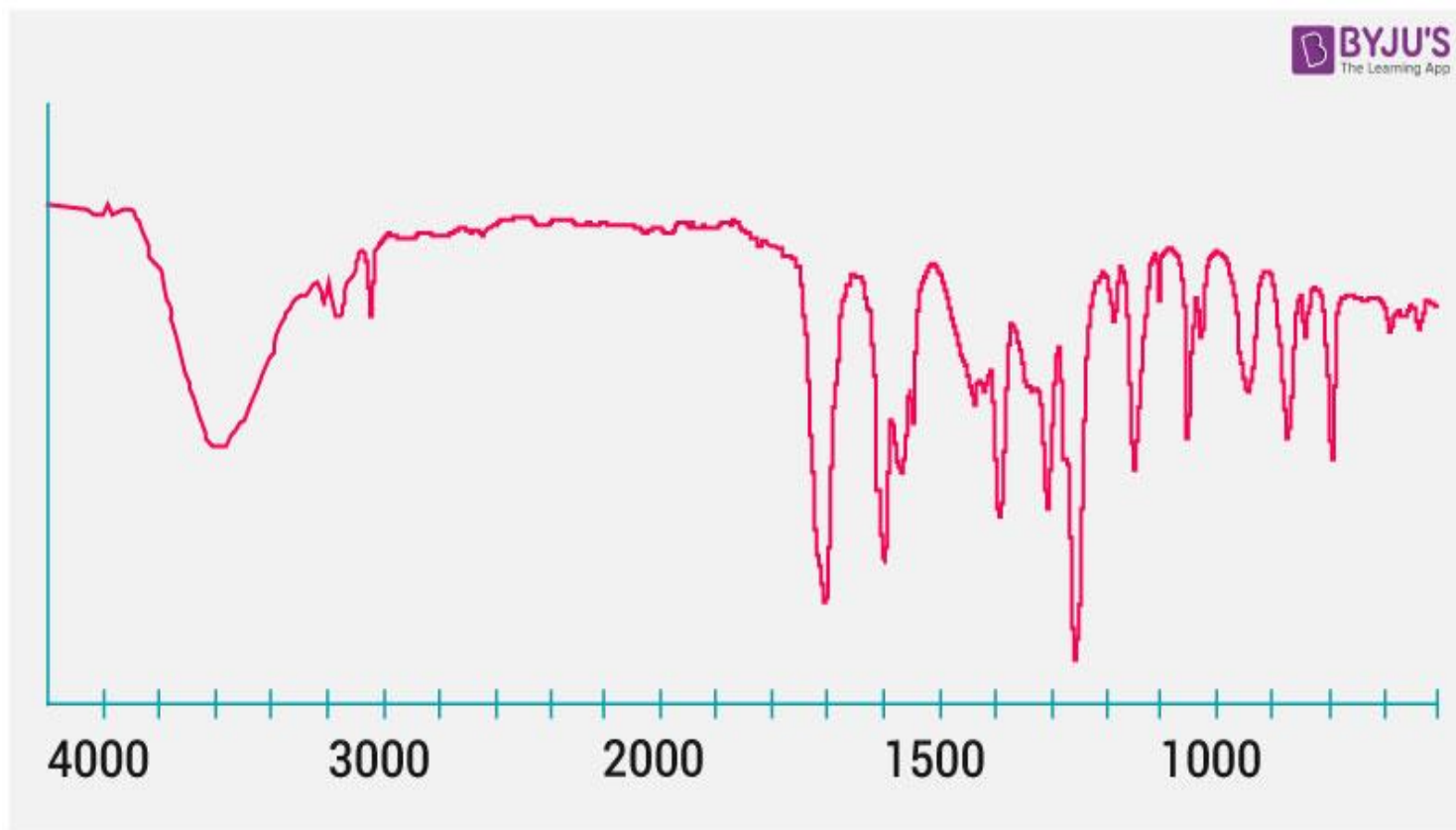
⇒ IR spectrum



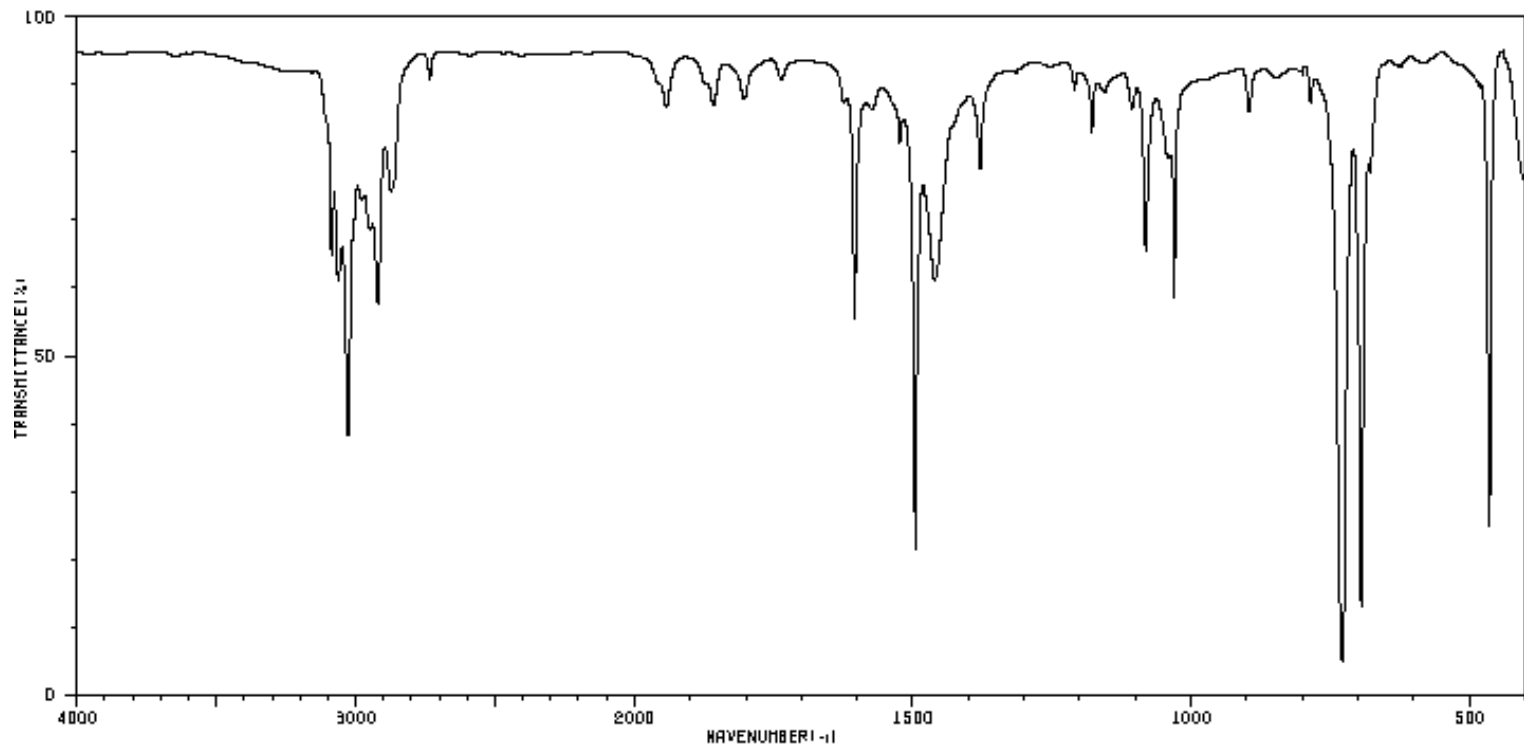
Graph of the IR spectrum

Given below is a sample of typical Infrared Absorption Frequencies.

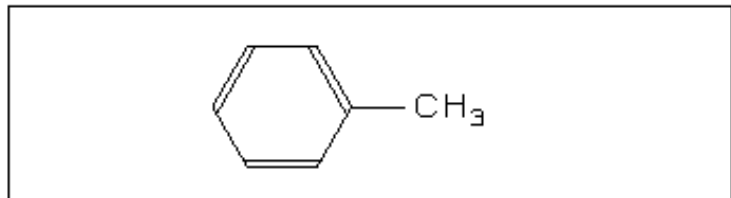
Thus, IR spectroscopy involves the collection of absorption information and its analysis in the form of a spectrum.



HIT-NO=857	SCORE= ()	SDBS-NO=97	IR-NIDA-63542 : LIQUID FILM
TOLUENE toluene			
C ₇ H ₈			



3087	62	1868	84	1210	86	896	81
3062	58	1803	84	1179	79	786	84
3026	37	1605	55	1156	86	729	4
2948	66	1524	79	1107	84	696	12
2920	55	1496	20	1082	82	678	74
2873	70	1461	58	1042	77	465	29
1942	84	1379	74	1030	67		



Some characteristic infrared absorption frequencies

<u>BOND</u>	<u>COMPOUND TYPE</u>	<u>FREQUENCY RANGE, cm⁻¹</u>
C-H	alkanes	2850-2960 and 1350-1470
	alkenes	3020-3080 (m) and
	RCH=CH ₂	910-920 and 990-1000
	R ₂ C=CH ₂	880-900
	<i>cis</i> -RCH=CHR	675-730 (v)
	<i>trans</i> -RCH=CHR	965-975
	aromatic rings	3000-3100 (m) and
	monosubst.	690-710 and 730-770
	<i>ortho</i> -disubst.	735-770
	<i>meta</i> -disubst.	690-710 and 750-810 (m)
	<i>para</i> -disubst.	810-840 (m)
	alkynes	3300
O-H	alcohols or phenols	3200-3640 (b)
C=C	alkenes	1640-1680 (v)
	aromatic rings	1500 and 1600 (v)
C≡C	alkynes	2100-2260 (v)
C-O	primary alcohols	1050 (b)
	secondary alcohols	1100 (b)
	tertiary alcohols	1150 (b)
	phenols	1230 (b)
	alkyl ethers	1060-1150
	aryl ethers	1200-1275(b) and 1020-1075 (m)

all abs. strong unless marked: m, moderate; v, variable; b, broad

IR spectra of **ALKANES**

C—H bond “saturated”

(sp³) **2850-2960 cm⁻¹**

+ 1350-1470 cm⁻¹

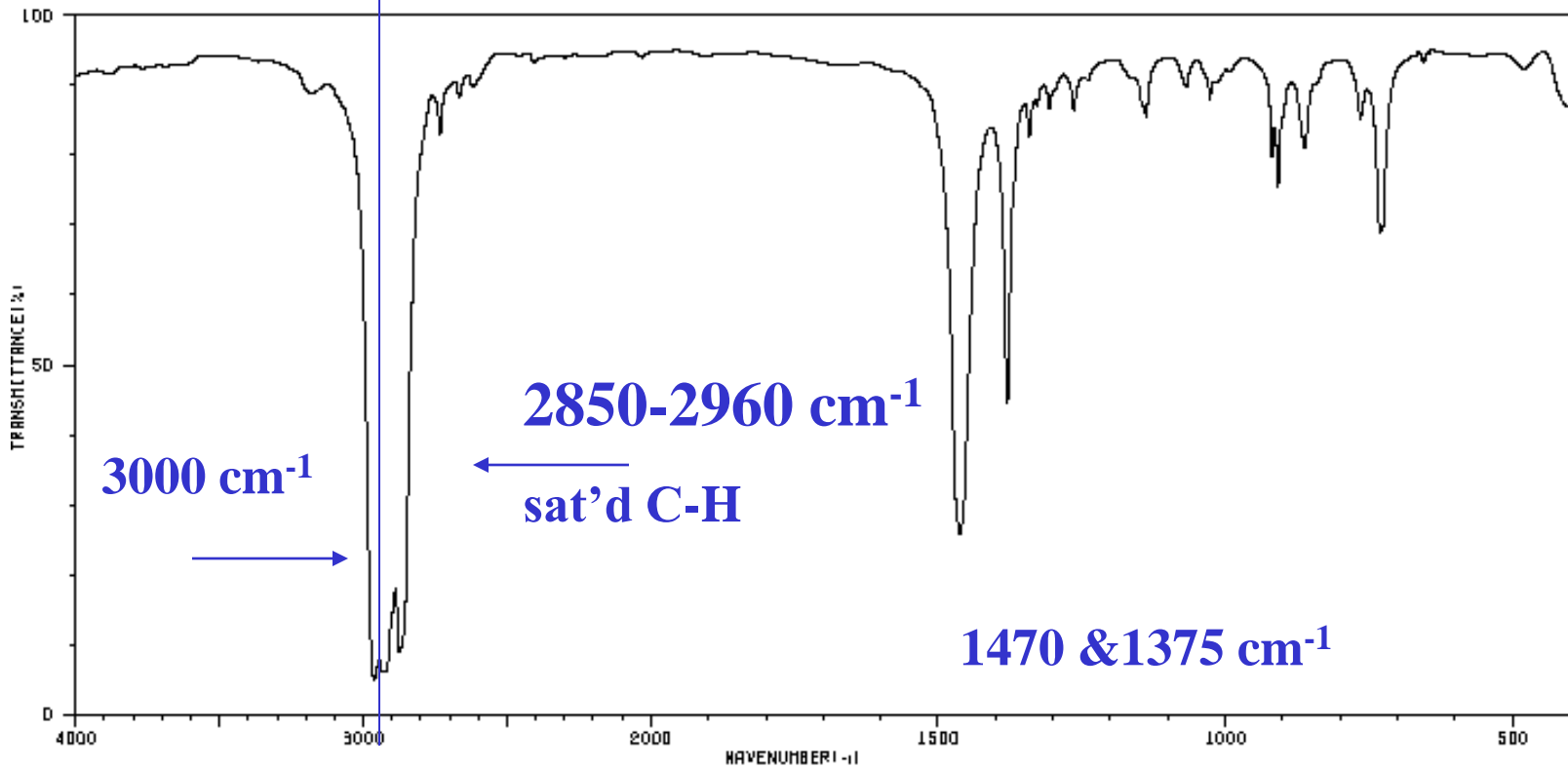
-CH₂- + 1430-1470

-CH₃ + “ and 1375

-CH(CH₃)₂ + “ and 1370, 1385

-C(CH₃)₃ + “ and 1370(s), 1395 (m)

HIT-NO=1929	SCORE= ()	SDBS-NO=2475	IR-NIDA-68185 : LIQUID FILM
PENTANE <i>n</i> -pentane			
C ₅ H ₁₂			



3182	86	2619	86	1138	81	732	66
3172	86	1462	24	1068	86		
2961	4	1380	45	1027	84		
2928	5	1342	79	919	77		
2875	8	1307	84	908	72		
2733	79	1264	84	862	79		
2666	84	1144	84	765	81		



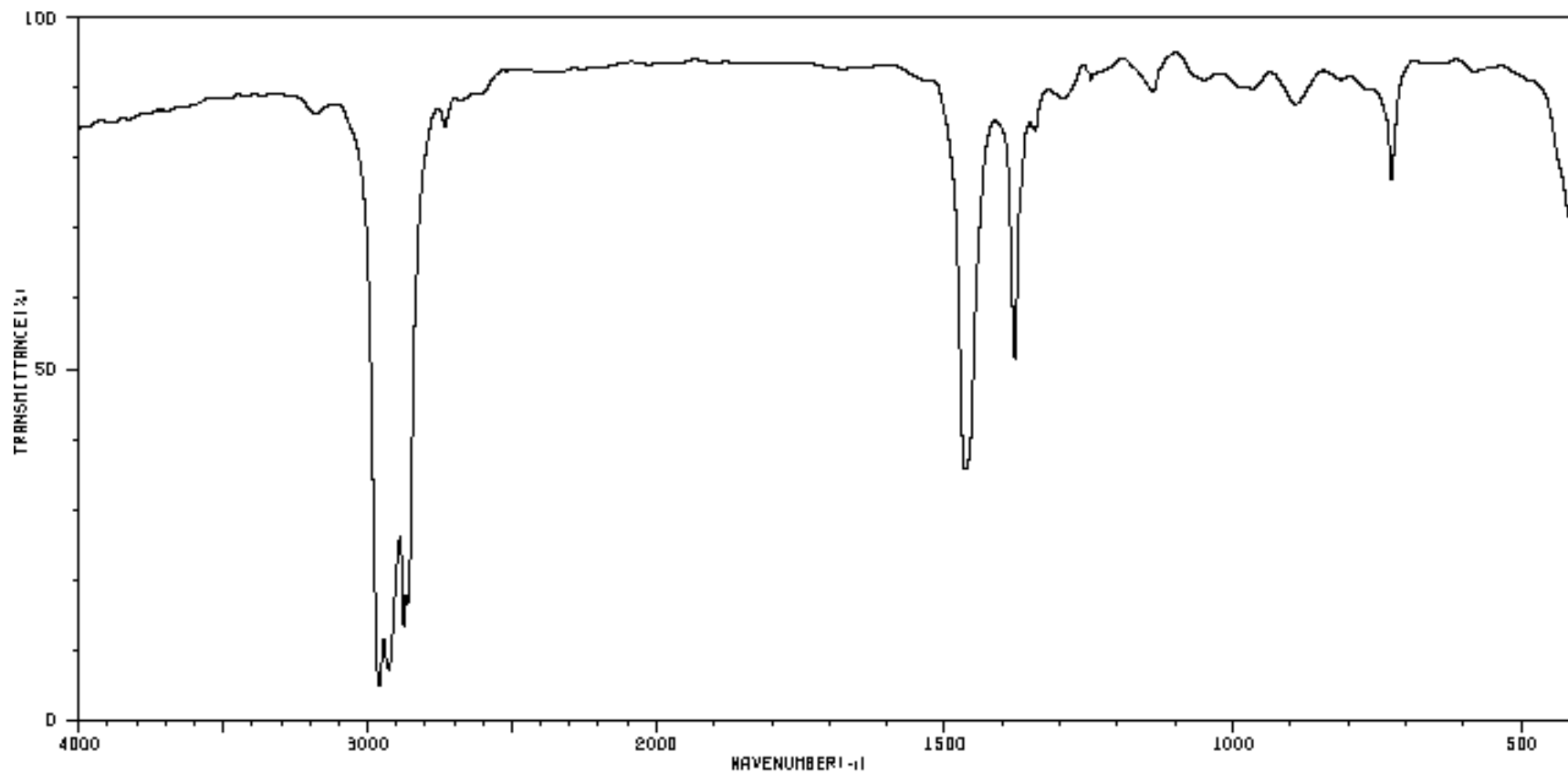
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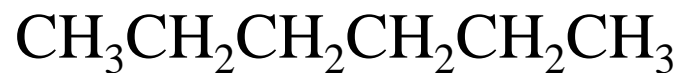
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IR-NIDA-14110 : LIQUID FILM

HEXANE

n-hexane C_6H_{14} 

3187	84	1466	34	726	74
3176	84	1379	49		
2959	4	1300	84		
2928	7	1294	84		
2875	13	1138	86		
2862	15	891	84		
2734	81	884	84		

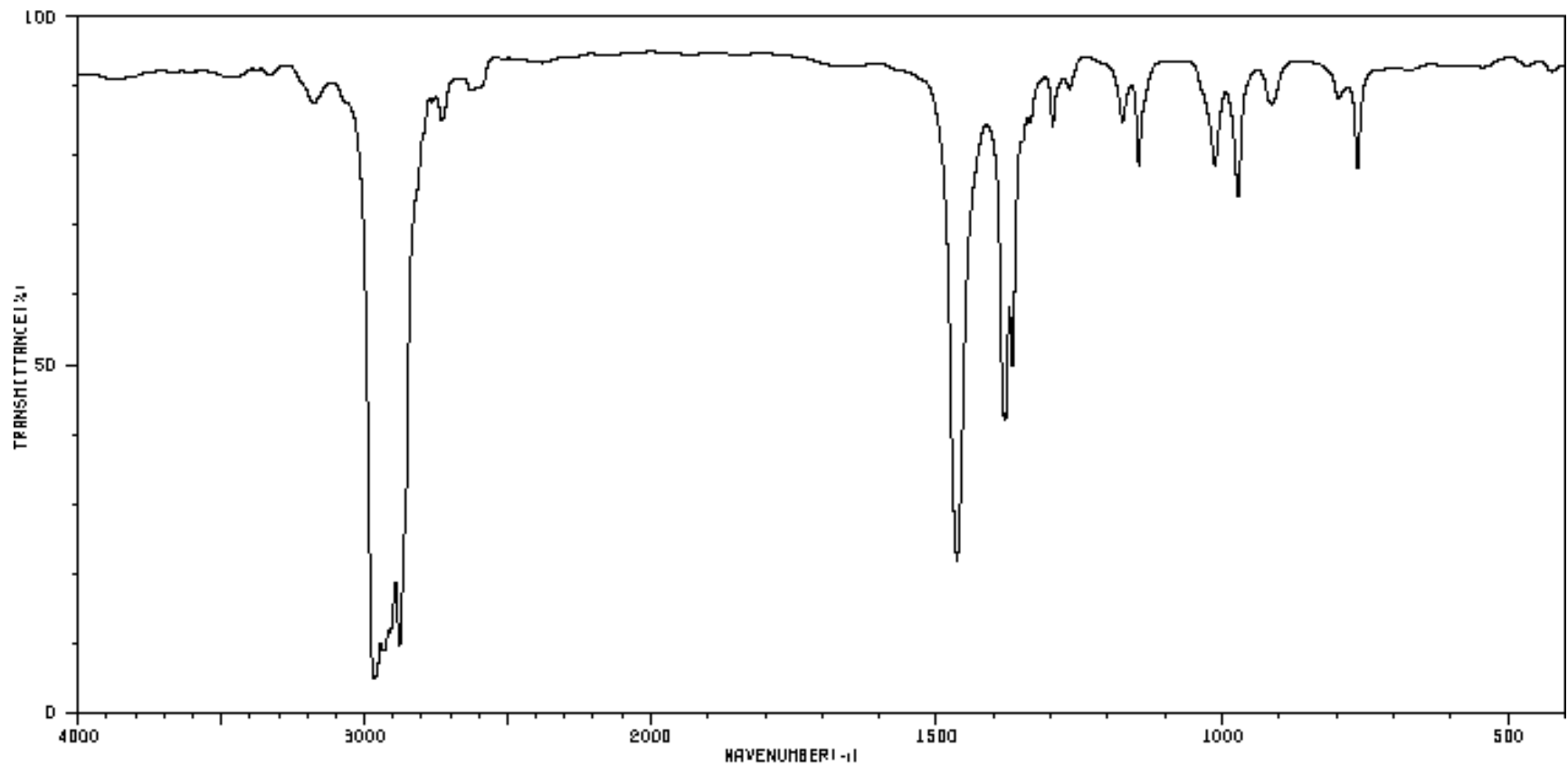


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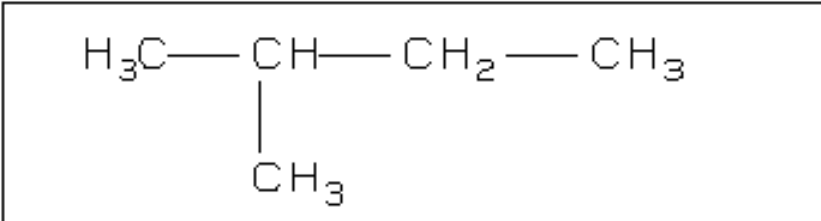
ISOPENTANE

2-methylbutane (isopentane)

C₅H₁₂



3176	84	1464	21	1013	77
2964	4	1380	41	972	70
2933	6	1368	47	913	84
2878	9	1297	81	797	84
2733	81	1268	86	764	74
2627	86	1175	81		
2604	86	1147	77		

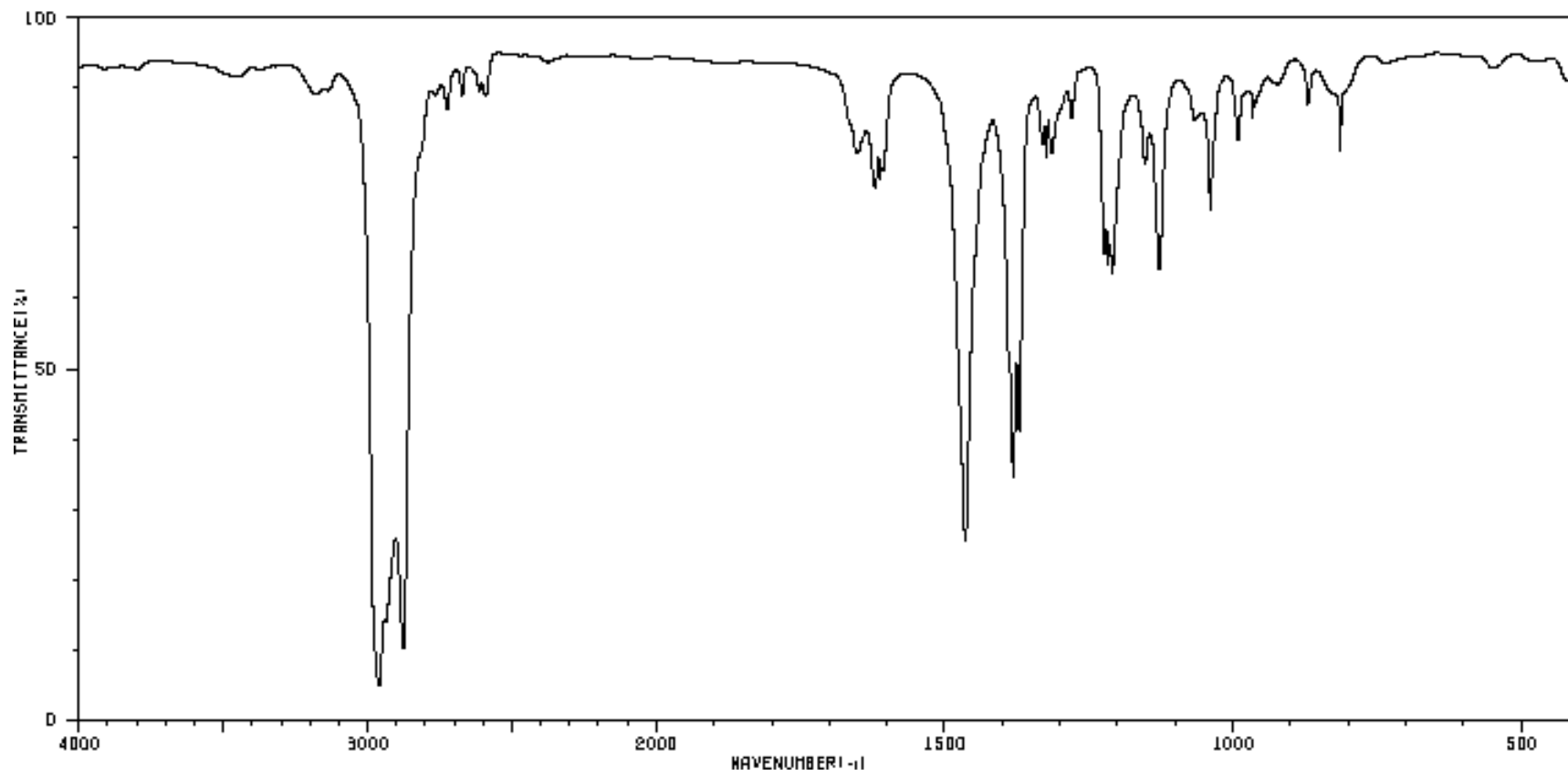


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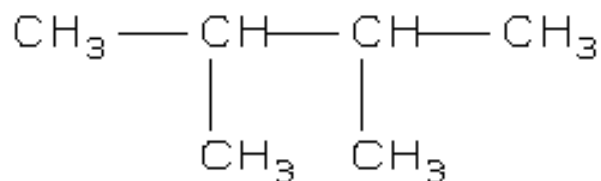
2,3-DIMETHYLBUTANE

2,3-dimethylbutane

C₆H₁₄



3176	86	2691	86	1381	33	1218	62	960	84
2959	4	1651	77	1371	39	1209	60	870	84
2938	13	1621	72	1330	79	1153	77	823	86
2876	9	1613	74	1323	77	1128	62	814	79
2722	84	1607	74	1315	77	1039	70		
2673	86	1454	24	1280	81	991	79		
2614	86	1389	48	1223	64	966	81		



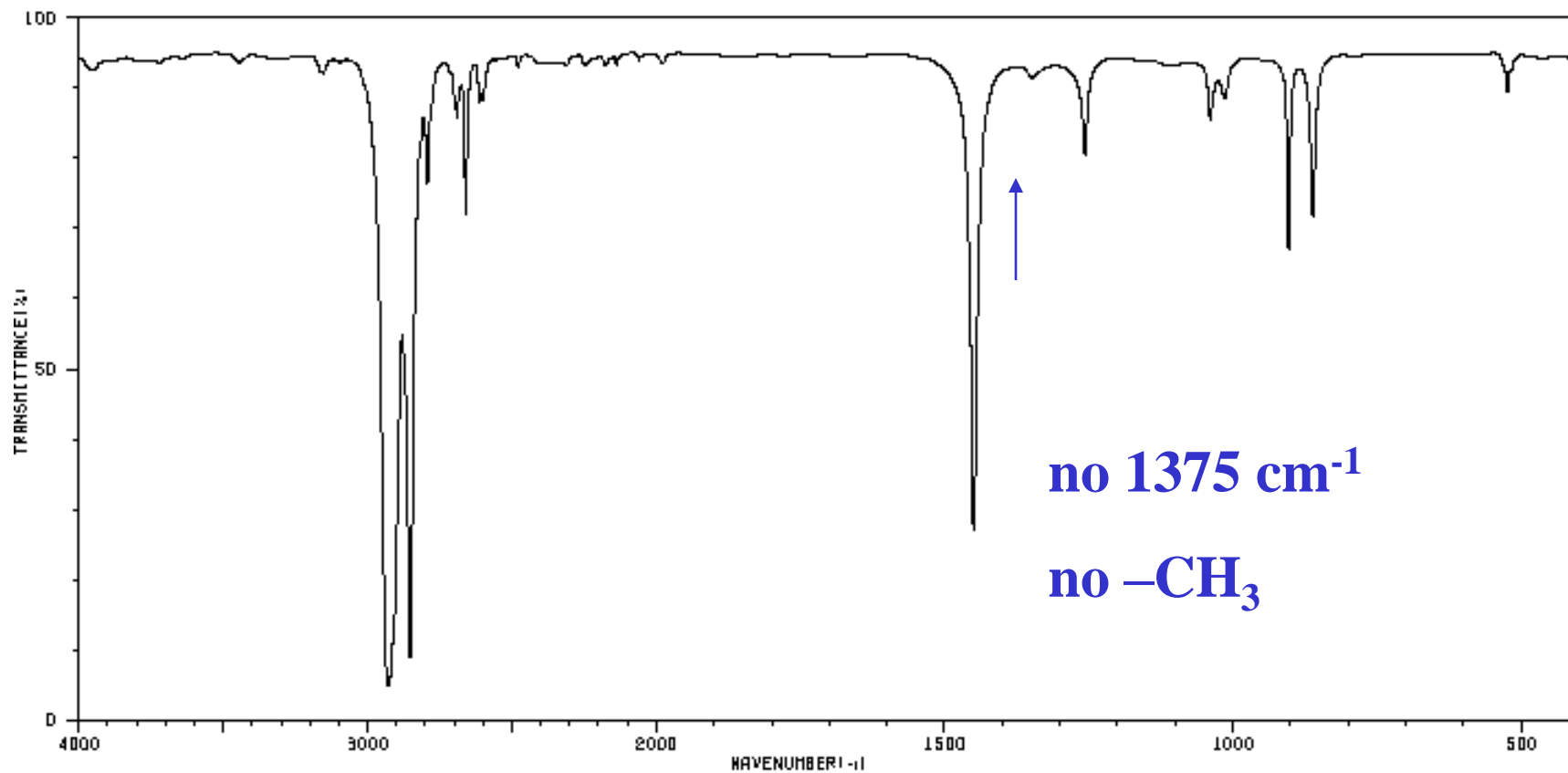
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SCORE= ()

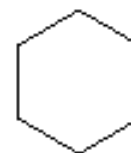
SDBS-NO=897

IR-NIDA-05221 : LIQUID FILM

CYCLOHEXANE

cyclohexane C_6H_{12} 

2928	4	1460	26
2853	8	1257	77
2794	72	1039	81
2690	81	1016	84
2661	70	904	64
2613	84	862	68
2599	84	624	86



IR of **ALKENES**

=C—H bond, “unsaturated” vinyl

(sp²) **3020-3080 cm⁻¹**

+ **675-1000**

RCH=CH₂ + 910-920 & 990-1000

R₂C=CH₂ + 880-900

cis-RCH=CHR + 675-730 (v)

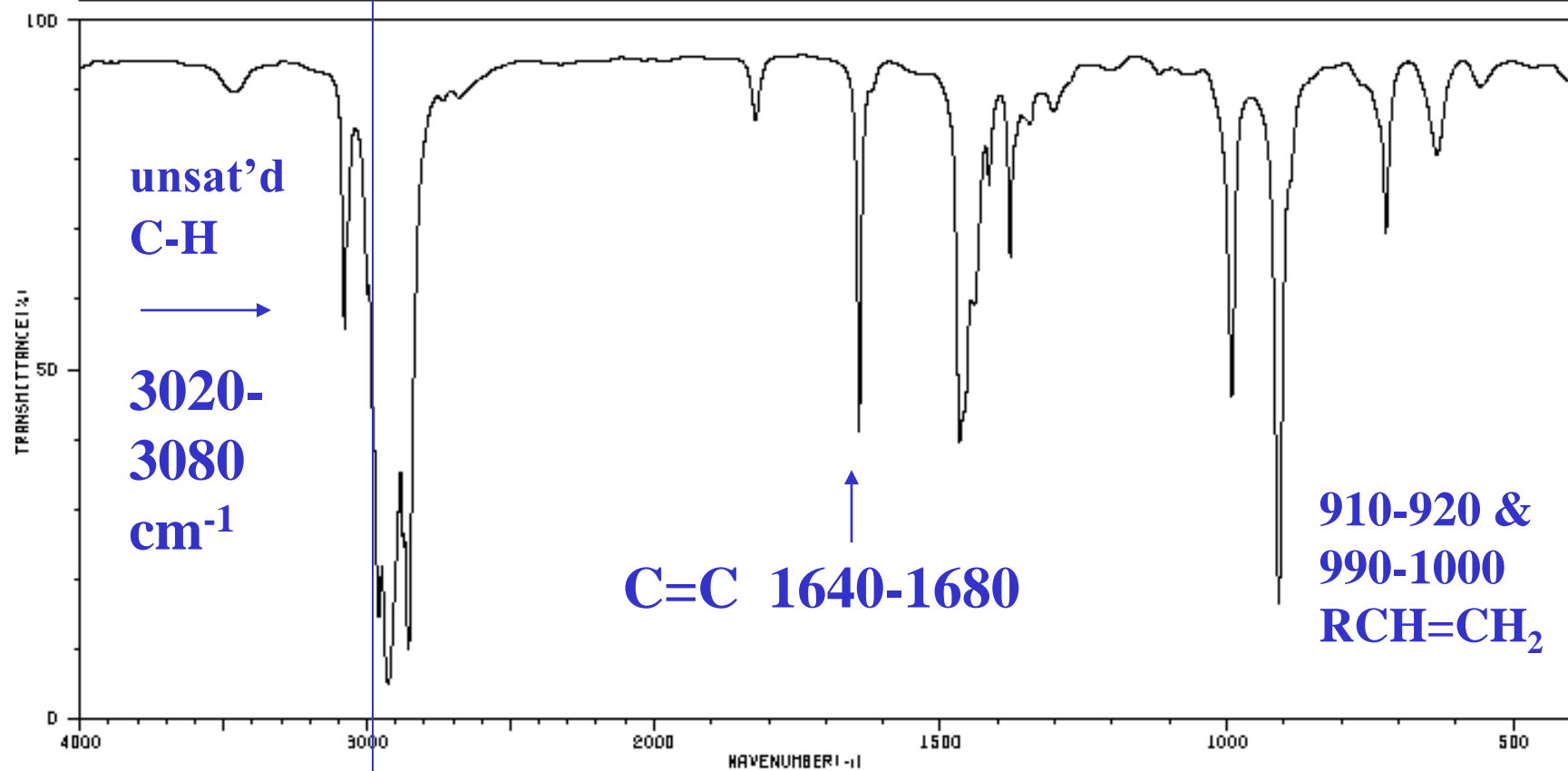
trans-RCH=CHR + 965-975

C=C bond **1640-1680 cm⁻¹ (v)**

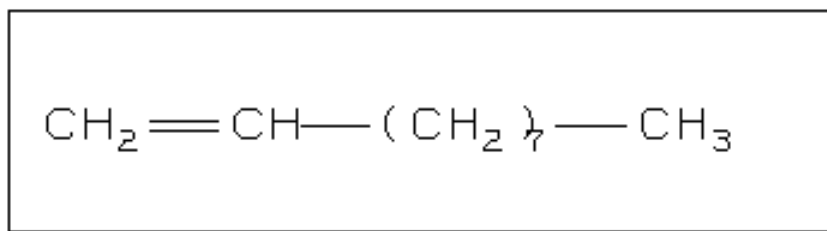
1-DECENE

1-decene

C₁₀H₂₀



3467	86	2874	29	1379	64
3457	86	2858	9	1343	81
3079	53	2678	86	1303	84
3068	68	1822	81	991	44
2998	58	1642	39	910	15
2958	13	1467	38	723	86
2926	4	1416	72	633	77



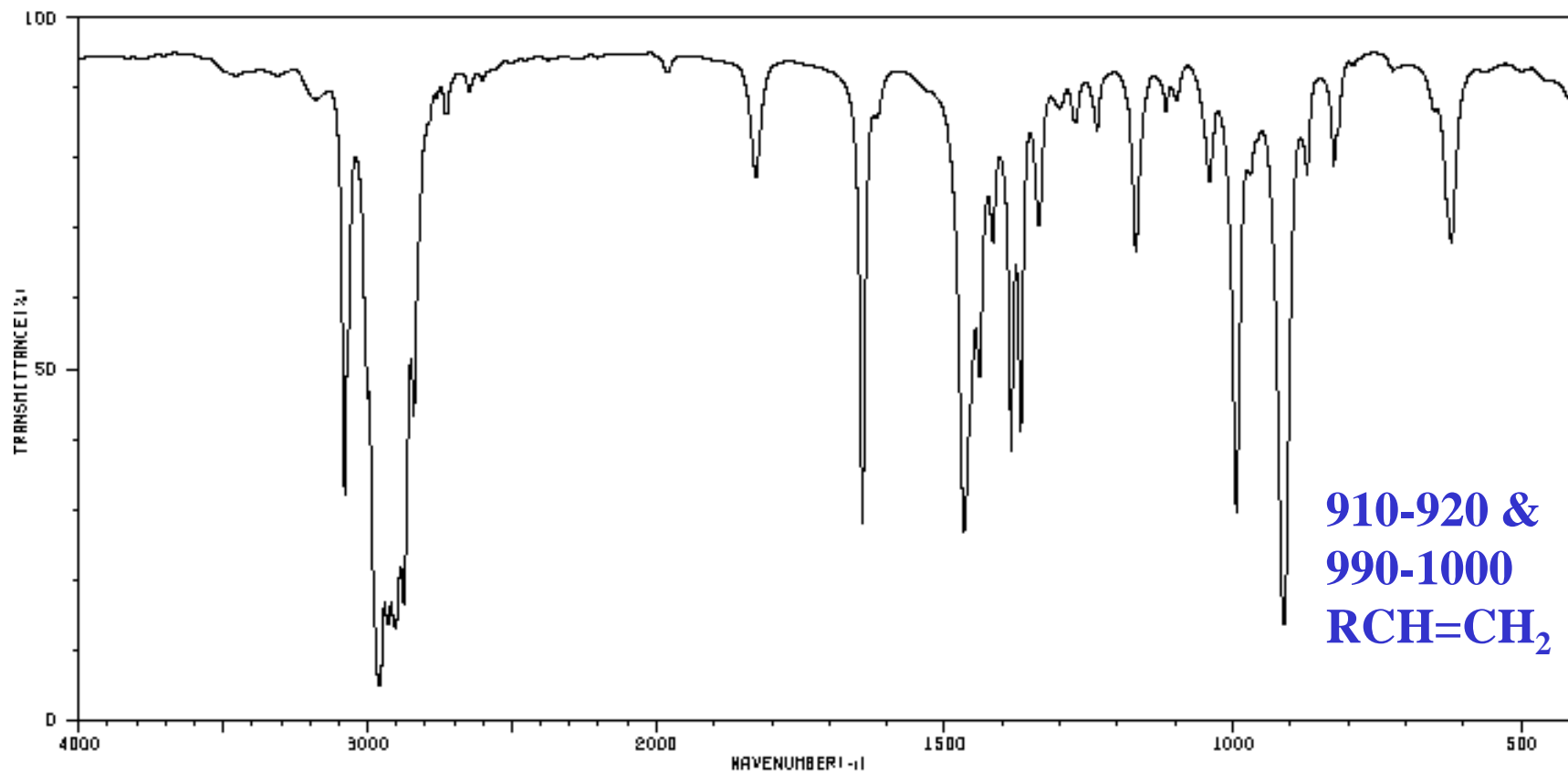
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SCORE= ()

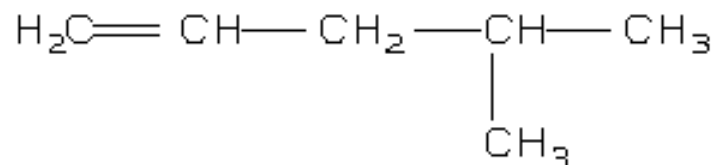
SDBS-NO=212

IR-NIDA-03077 : LIQUID FILM

4-METHYL-1-PENTENE

4-methyl-1-pentene C_6H_{12} 

3178	84	2727	84	1385	37	1116	84	622	56
3079	31	2648	86	1368	39	1098	84		
2960	4	1828	74	1337	86	1041	74		
2929	13	1643	26	1300	84	994	28		
2904	12	1467	26	1274	81	911	13		
2874	15	1440	47	1236	81	871	74		
2839	42	1417	66	1169	64	826	77		

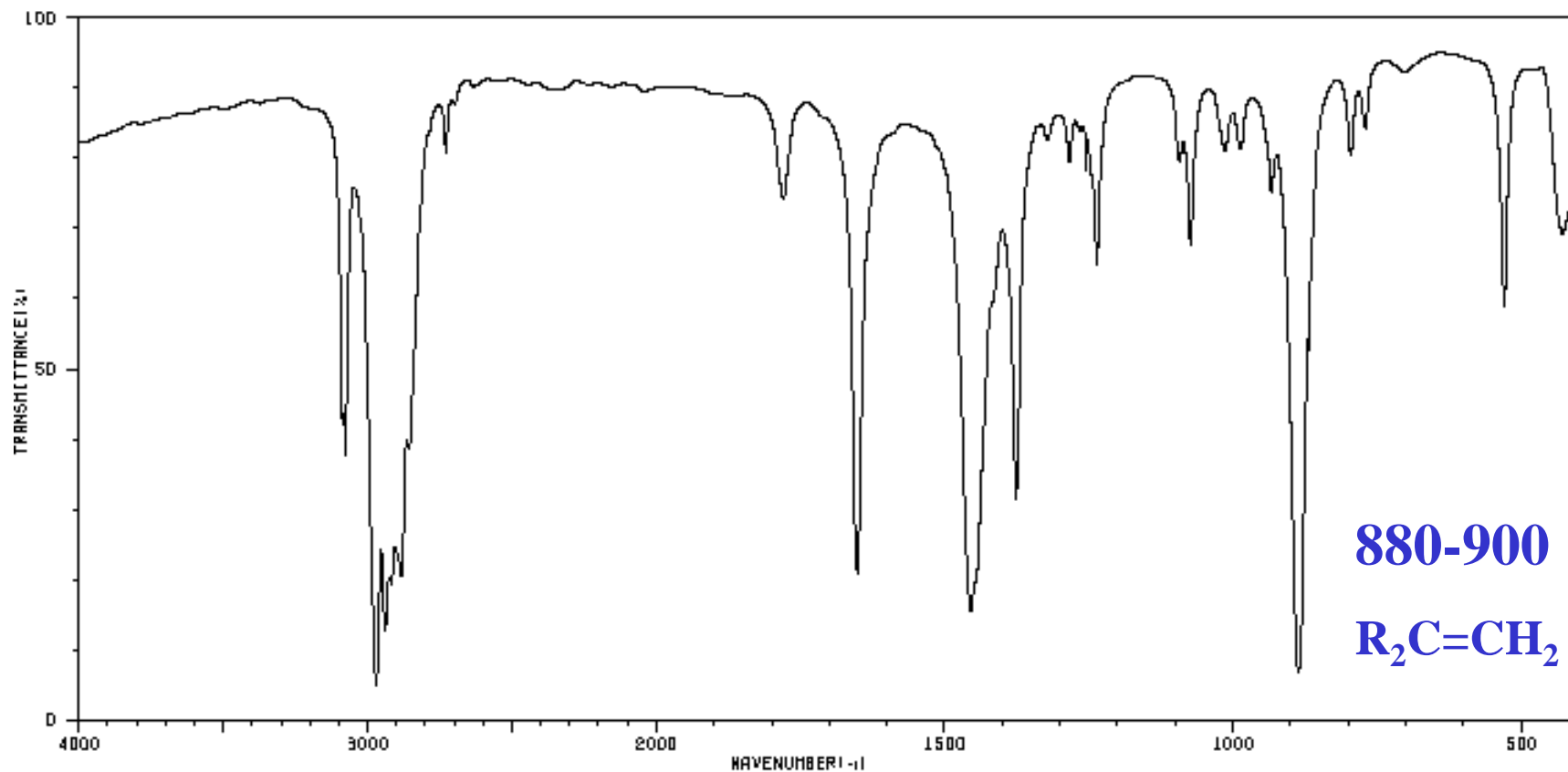


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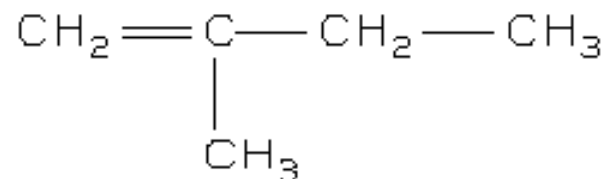
2-METHYL-1-BUTENE

2-methyl-1-butene

C₅H₁₀



3087	41	2728	77	1266	74	887	6
3077	36	1780	72	1237	62	869	50
2970	4	1651	20	1093	77	796	77
2939	12	1466	14	1074	64	770	81
2919	18	1377	30	1014	79	530	57
2883	20	1322	79	987	79	429	66
2866	37	1284	77	933	72		

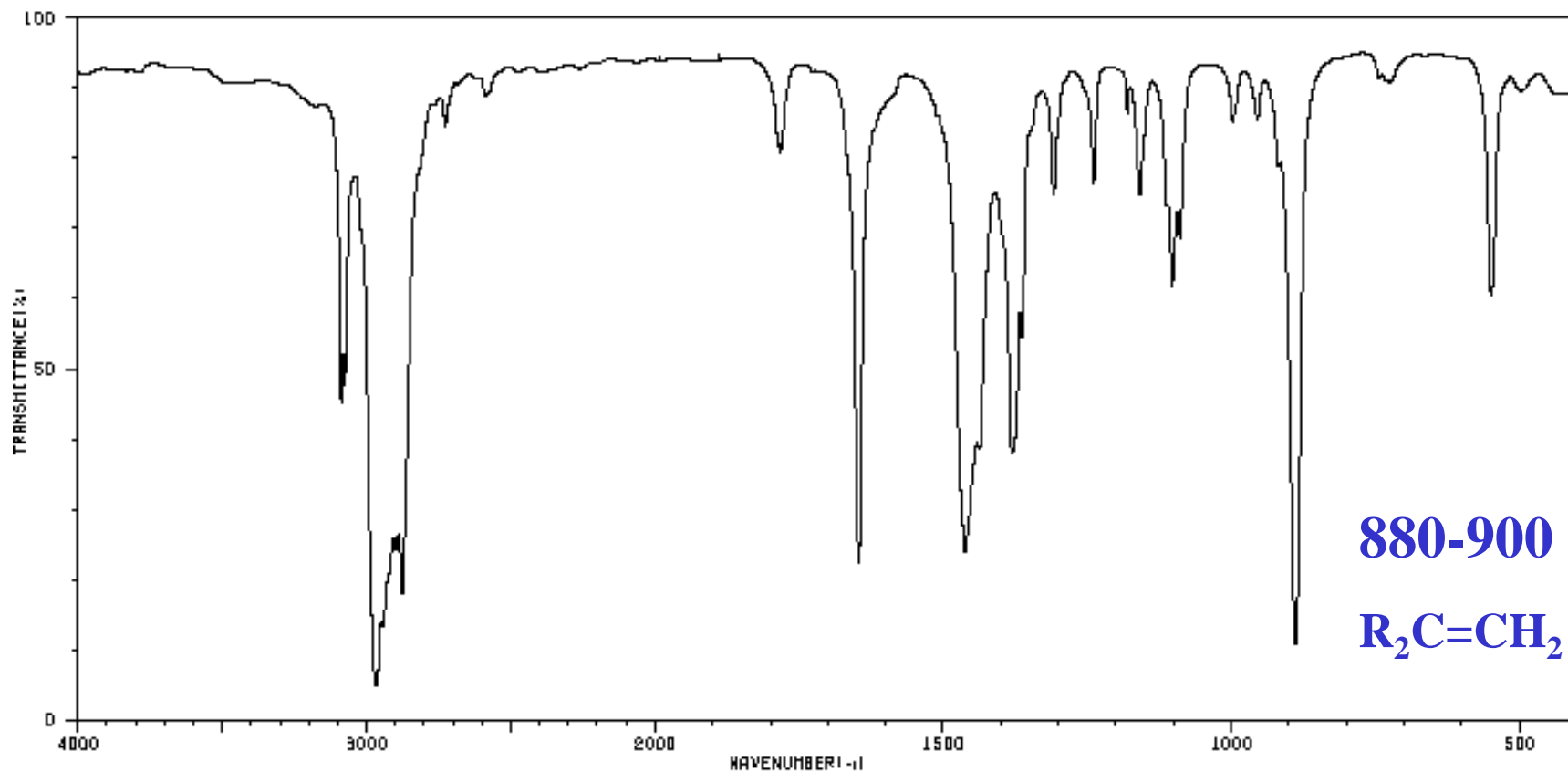


HIT-NO=2801 SCORE= () SDBS-NO=4815 IR-NIDA-03377 : LIQUID FILM

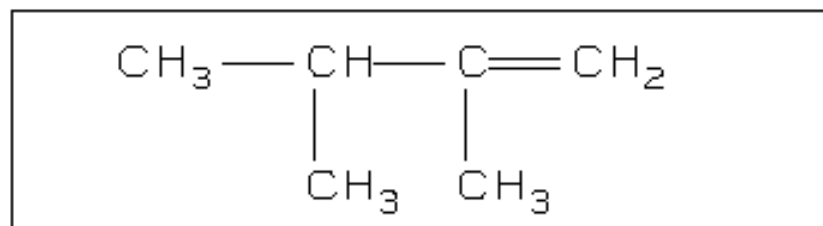
2,3-DIMETHYL-1-BUTENE

2,3-dimethyl-1-butene

C₆H₁₂



3087	43	2588	86	1308	72	966	81
3075	46	1794	84	1239	74	868	10
2966	4	1783	77	1181	84	550	58
2944	13	1646	21	1169	72	497	86
2898	23	1462	29	1102	58		
2875	17	1380	36	1089	86		
2727	81	1363	62	998	81		



IR spectra **BENZENE**s

=C—H bond, “unsaturated” “aryl”

(sp²) **3000-3100 cm⁻¹**

+ 690-840

mono-substituted + 690-710, 730-770

ortho-disubstituted + 735-770

meta-disubstituted + 690-710, 750-810(m)

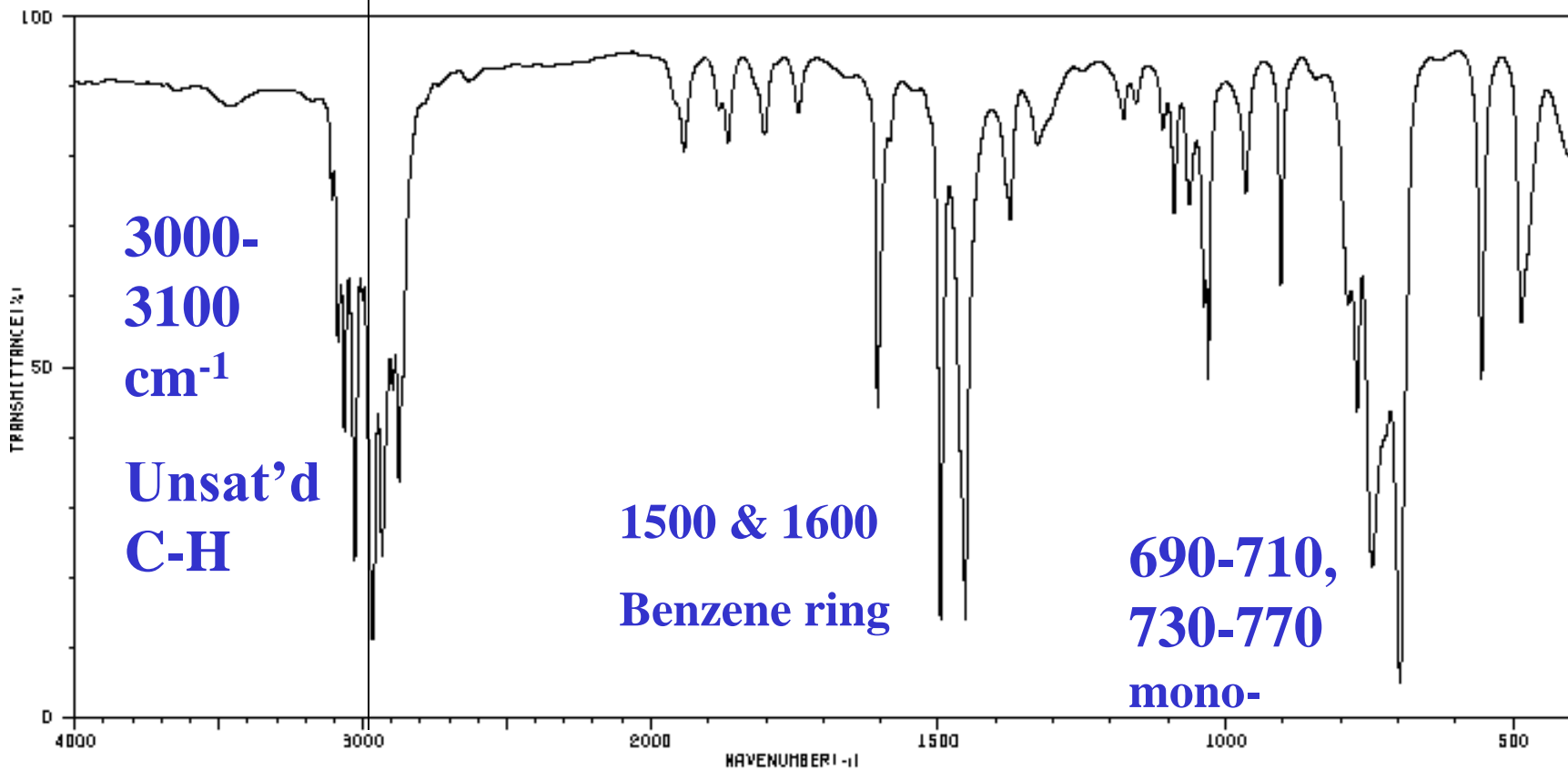
para-disubstituted + 810-840(m)

C=C bond **1500, 1600 cm⁻¹**

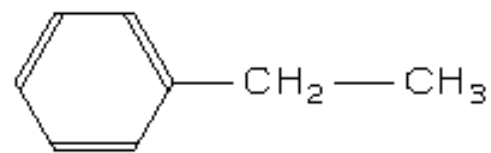
HIT-NO=1402 SCORE= () SDBS-NO=1332 IR-NIDA-05258 : LIQUID FILM

ETHYLBENZENE
ethylbenzene

C_8H_{10}



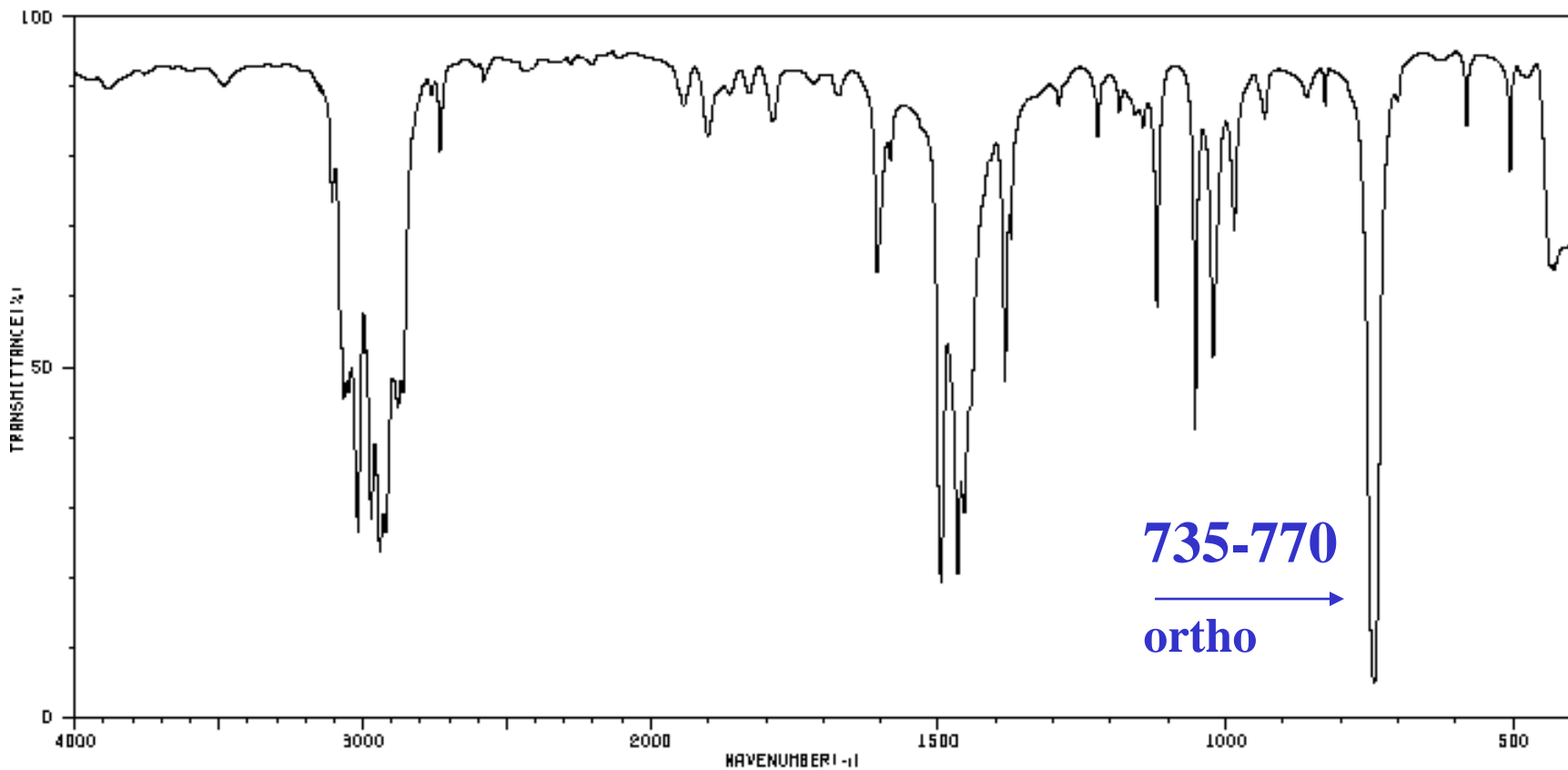
3468	84	2933	21	1802	79	1178	81	904	58
3108	70	2896	44	1744	84	1110	81	788	57
3087	52	2875	32	1806	42	1090	70	772	42
3066	39	1966	84	1496	13	1064	70	746	20
3028	21	1942	77	1453	13	1037	57	697	4
3003	57	1881	84	1376	88	1030	46	556	46
2967	10	1866	78	1329	79	966	72	486	63



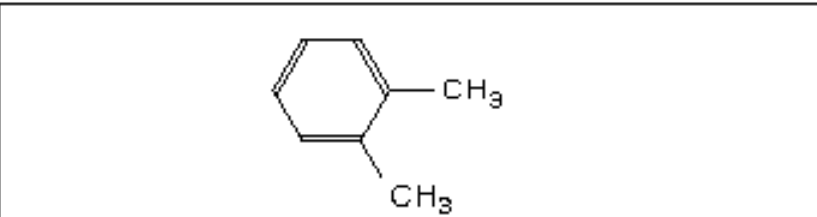
HIT-NO=1272 | SCORE= () | SDBS-NO=1028 | IR-NIDA-21942 : LIQUID FILM

O-XYLENE
***o*-xylene**

C_8H_{10}



3108	70	2878	42	1683	77	1223	79	986	66
3066	43	2860	44	1495	18	1186	84	932	81
3050	44	2732	77	1467	20	1157	81	742	4
3018	25	1942	84	1456	27	1146	81	682	81
2971	26	1901	79	1384	46	1120	57	506	74
2940	22	1787	81	1374	86	1053	38	436	62
2921	25	1606	60	1291	84	1022	48	431	62

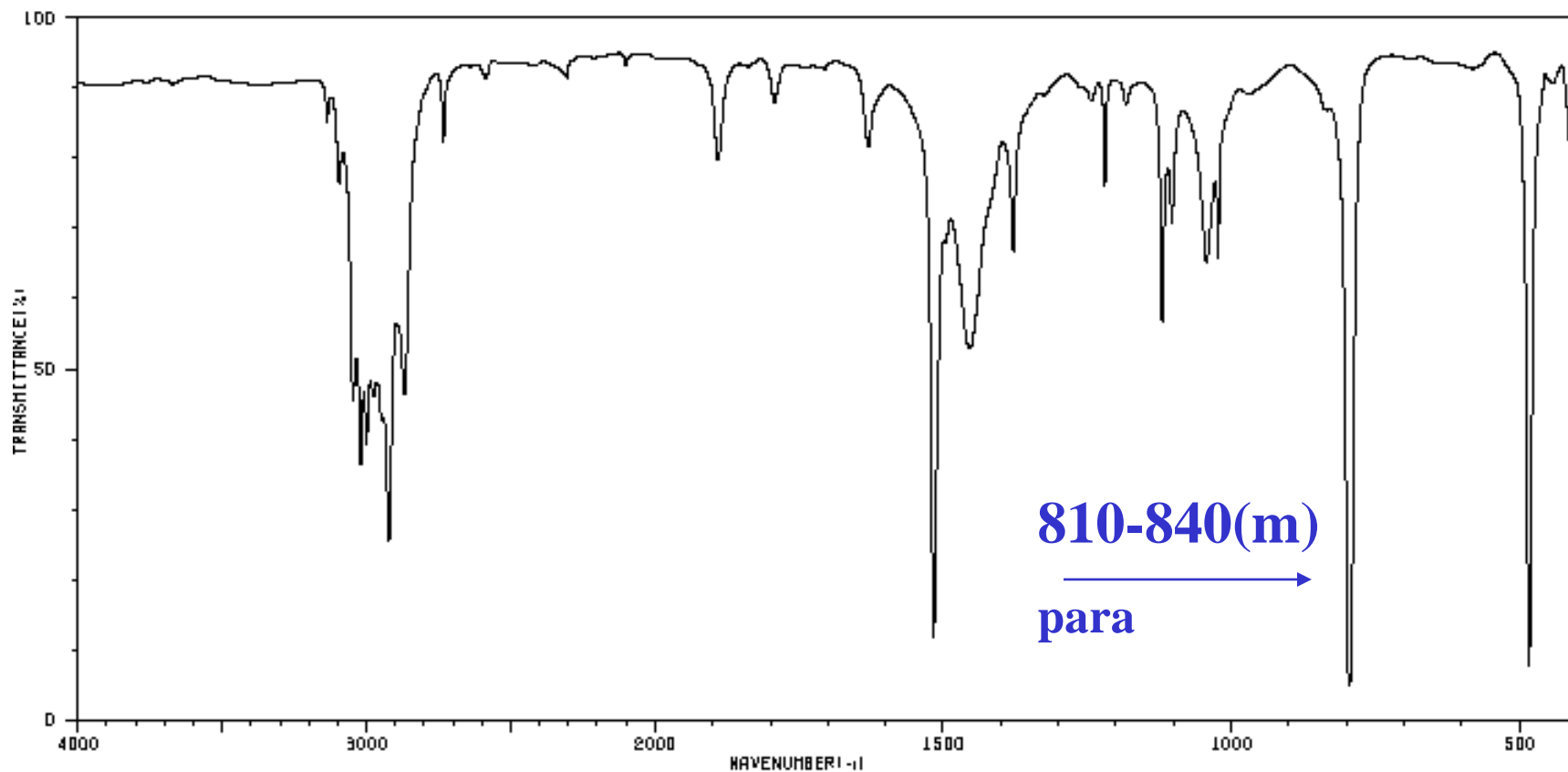


HIT-NO=1238 SCORE= () SDBS-NO=899 IR-NIDA-63598 : LIQUID FILM

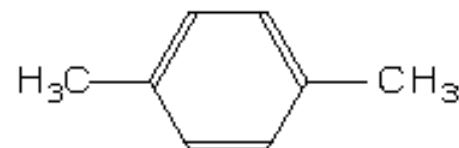
P-XYLENE

p-xylene

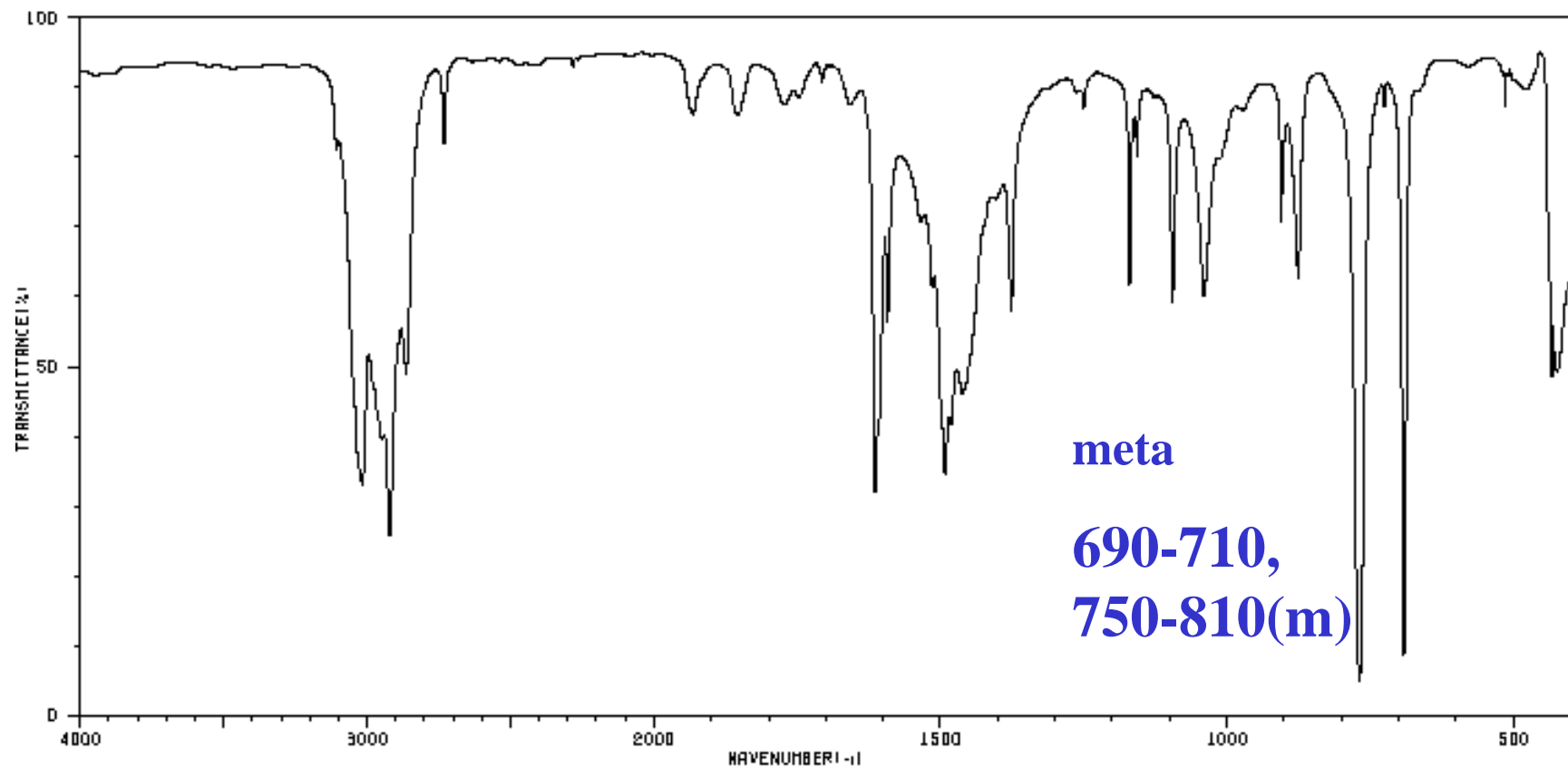
C₈H₁₀



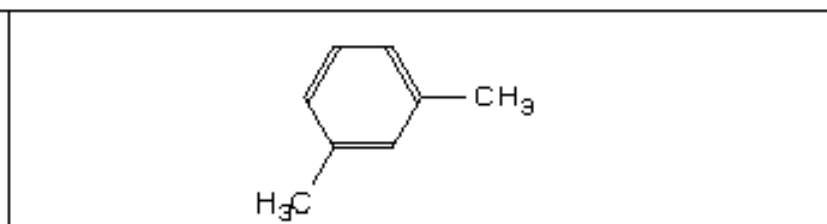
3136	81	2923	24	1454	60	1043	62
3095	74	2868	44	1378	64	1023	64
3047	43	2733	79	1243	84	795	4
3020	36	1890	77	1220	72	484	7
3000	37	1793	84	1183	84		
2976	44	1630	79	1120	55		
2945	41	1516	11	1103	68		



HIT-NO=1275	SCORE= ()	SDBS-NO=1032	IR-NIDA-63601 : LIQUID FILM
M-XYLENE			
<i>m-xylene</i>			
C ₈ H ₁₀			



3106	79	1864	84	1492	33	1170	58	726	84
3016	32	1772	84	1482	39	1157	77	691	8
2948	37	1764	84	1462	44	1095	57	515	64
2921	24	1668	84	1376	55	1040	57	483	86
2864	47	1614	31	1263	86	905	68	478	86
2732	79	1592	59	1256	86	876	60	434	46
1932	84	1616	58	1250	84	769	4		

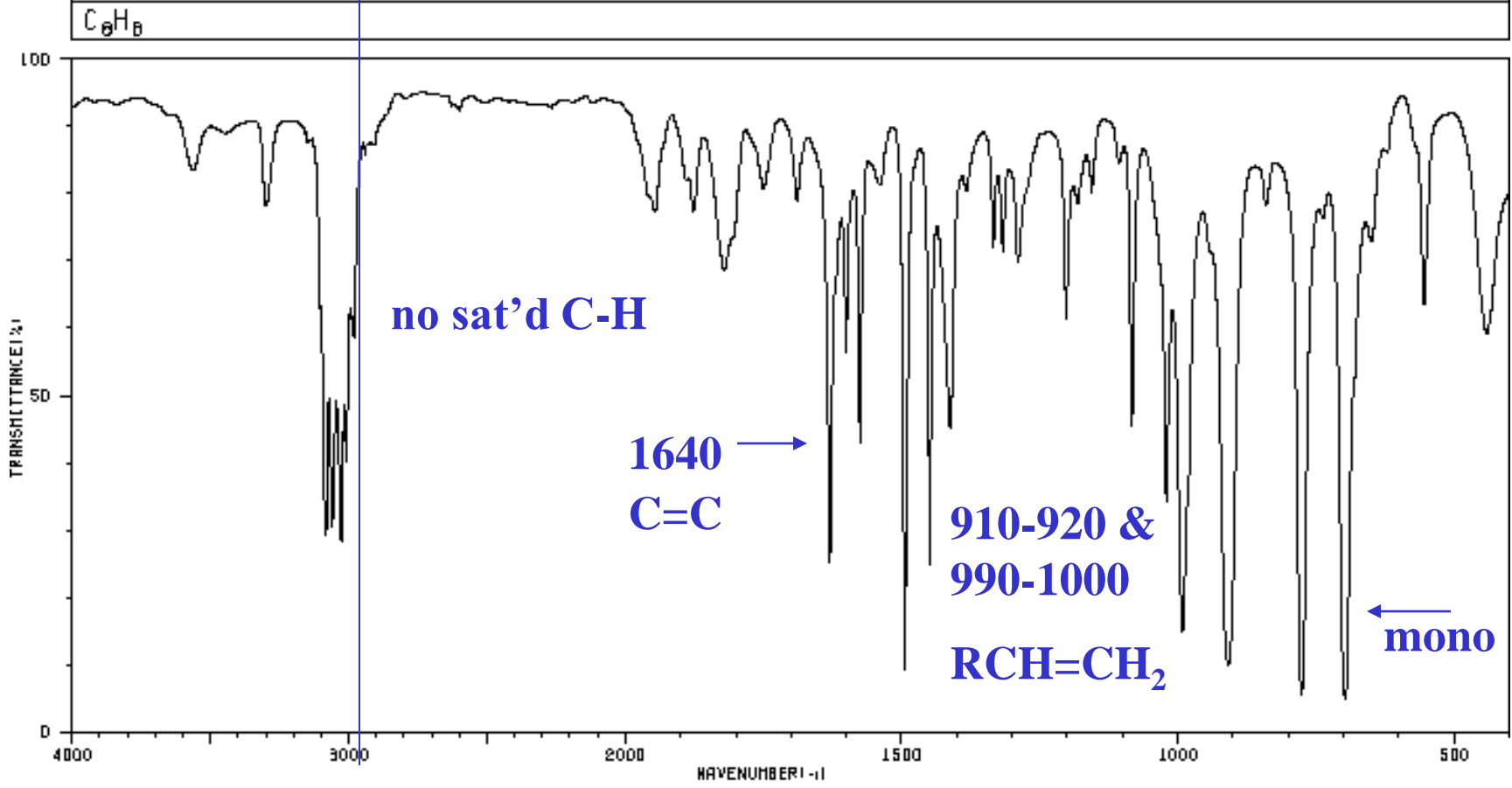


HIT-NO=2170 SCORE= () SDBS-NO=3044 IR-NIDA-10290 : LIQUID FILM

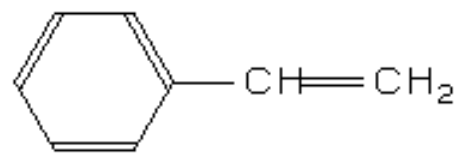
STYRENE

styrene

C_6H_8



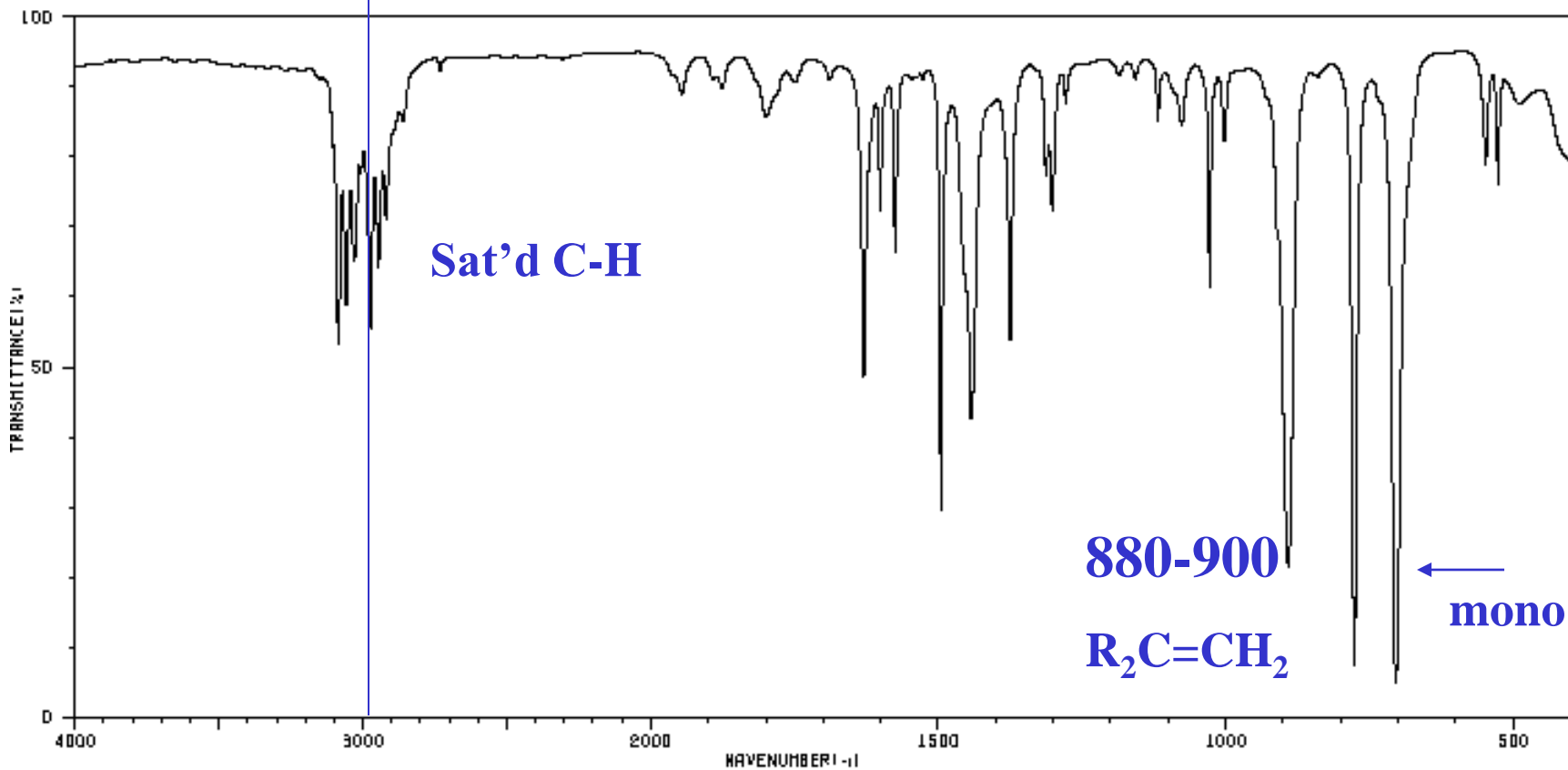
3299	74	1946	74	1496	9	1202	68	841	74
3082	28	1876	74	1449	23	1182	74	777	5
3060	29	1821	66	1412	43	1156	77	738	72
3027	27	1689	77	1383	77	1083	43	698	4
3009	38	1630	24	1334	70	1021	33	650	70
2980	57	1601	59	1317	88	992	14	555	60
1955	77	1576	41	1290	66	909	9	442	67



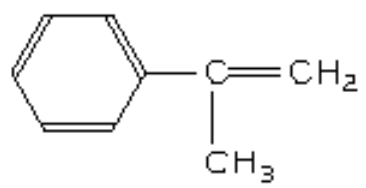
HIT-NO=1854 | SCORE= () | SDBS-NO=2368 | IR-NIDA-00385 : LIQUID FILM

ISOPROPENYLBENZENE
2-phenylpropene

C₉H₁₀



3085	60	2861	81	1496	28	1077	81	627	72
3058	57	1946	86	1443	41	1028	58	488	84
3033	82	1878	86	1375	52	1003	79		
3008	74	1800	81	1313	74	892	20		
2974	53	1630	46	1302	70	777	7		
2946	82	1601	70	1279	84	704	4		
2920	68	1576	64	1118	81	648	77		

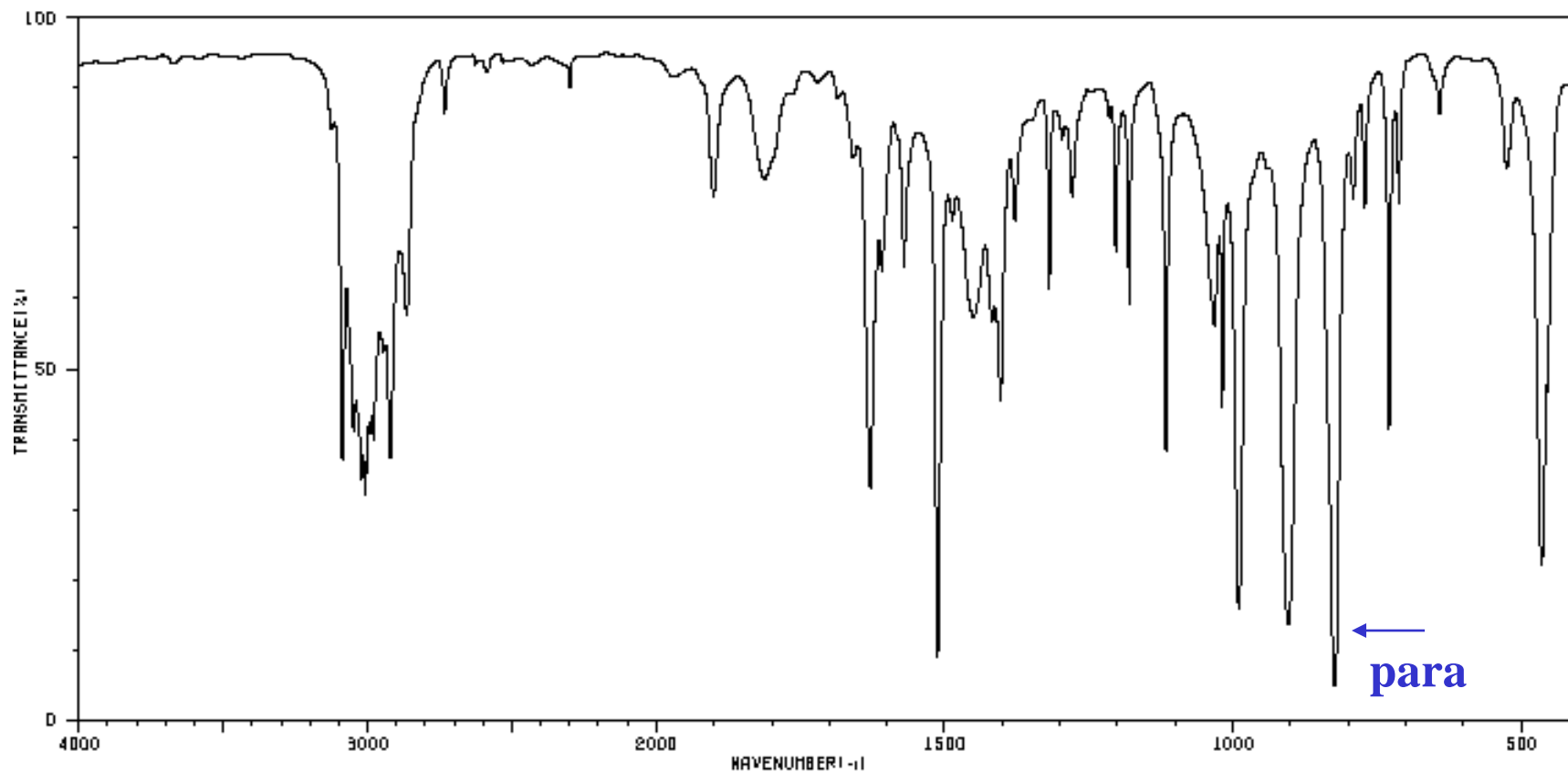


HIT-NO=3320 SCORE= () SDBS-NO=6328 IR-NIDA-09901 : LIQUID FILM

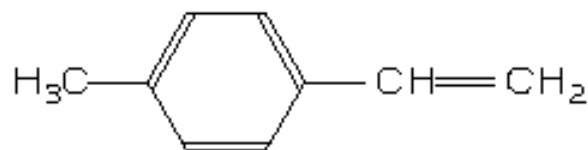
P-METHYLSTYRENE

p-methylstyrene

C₉H₁₀



3087	36	2922	36	1487	68	1204	64	824	4
3048	39	2864	55	1450	55	1181	57	792	72
3020	33	1901	72	1418	55	1116	36	772	70
3007	31	1829	32	1403	43	1032	59	730	39
2993	38	1609	60	1378	68	1018	43	712	70
2980	36	1571	62	1319	58	990	15	466	21
2946	60	1513	8	1279	72	904	19	457	43



IR spectra **ALCOHOLS & ETHERS**

C—O bond **1050-1275 (b) cm⁻¹**

1° ROH 1050

2° ROH 1100

3° ROH 1150

ethers 1060-1150

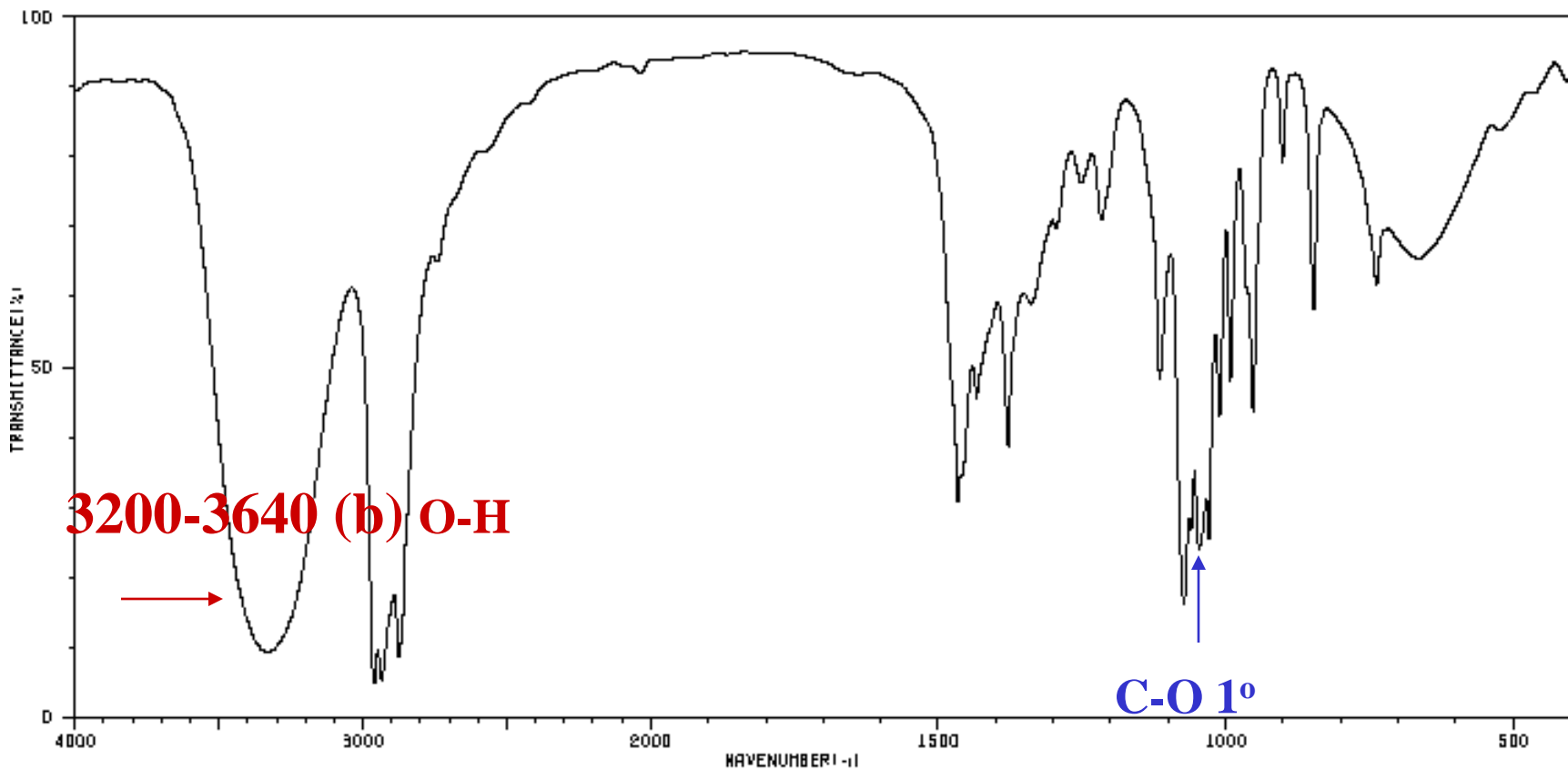
O—H bond **3200-3640 (b)**



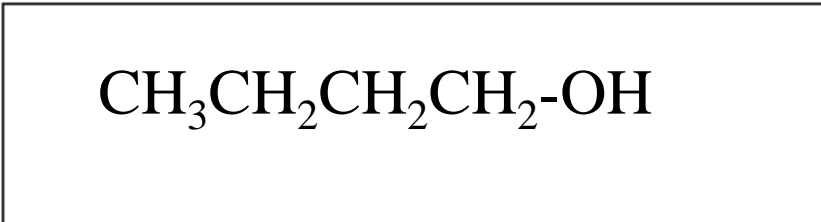
HIT-NO=1418 SCORE= () SDBS-NO=1374 IR-NIDA-05408 : LIQUID FILM

1-BUTANOL
1-butanol

C₄H₁₀O



3333	9	1434	49	1073	16	901	77
3323	9	1379	37	1060	26	847	57
2960	4	1338	57	1047	23	738	58
2934	6	1296	68	1029	24	670	62
2875	8	1252	74	1011	42	665	62
1466	30	1217	68	992	46		
1461	33	1116	46	963	42		



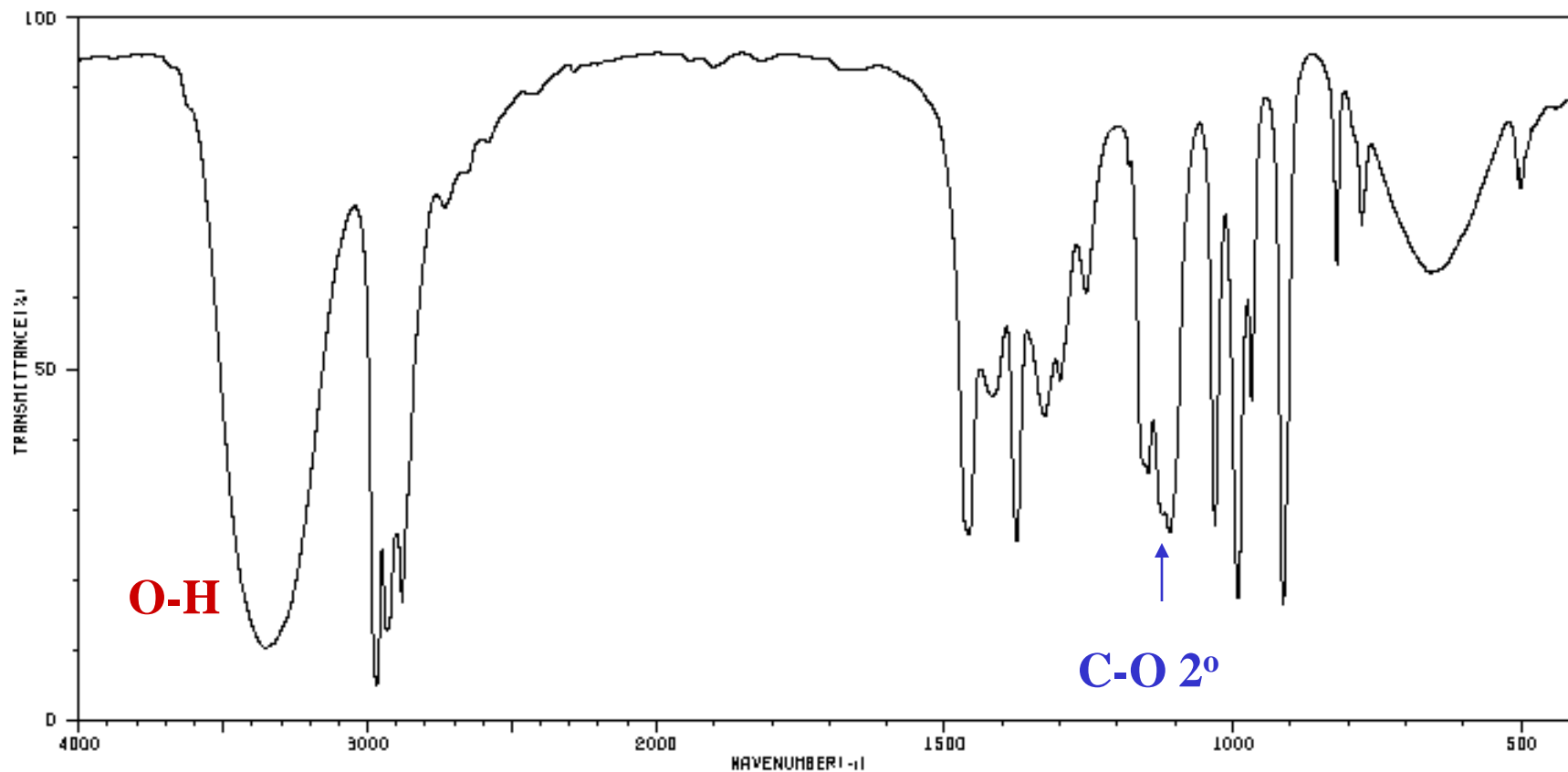
HIT-NO=1035

SCORE= ()

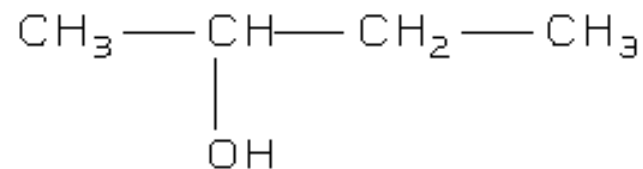
SDBS-NO=507

IR-NIDA-04700 : LIQUID FILM

2-BUTANOL

2-butanol $C_4H_{10}O$ 

3363	10	1376	24	1110	26	666	60
2968	4	1327	42	1031	26	651	60
2932	12	1300	46	991	16	501	72
2880	16	1266	68	968	43		
2734	70	1154	35	913	15		
1457	25	1148	34	820	82		
1416	44	1122	28	777	68		



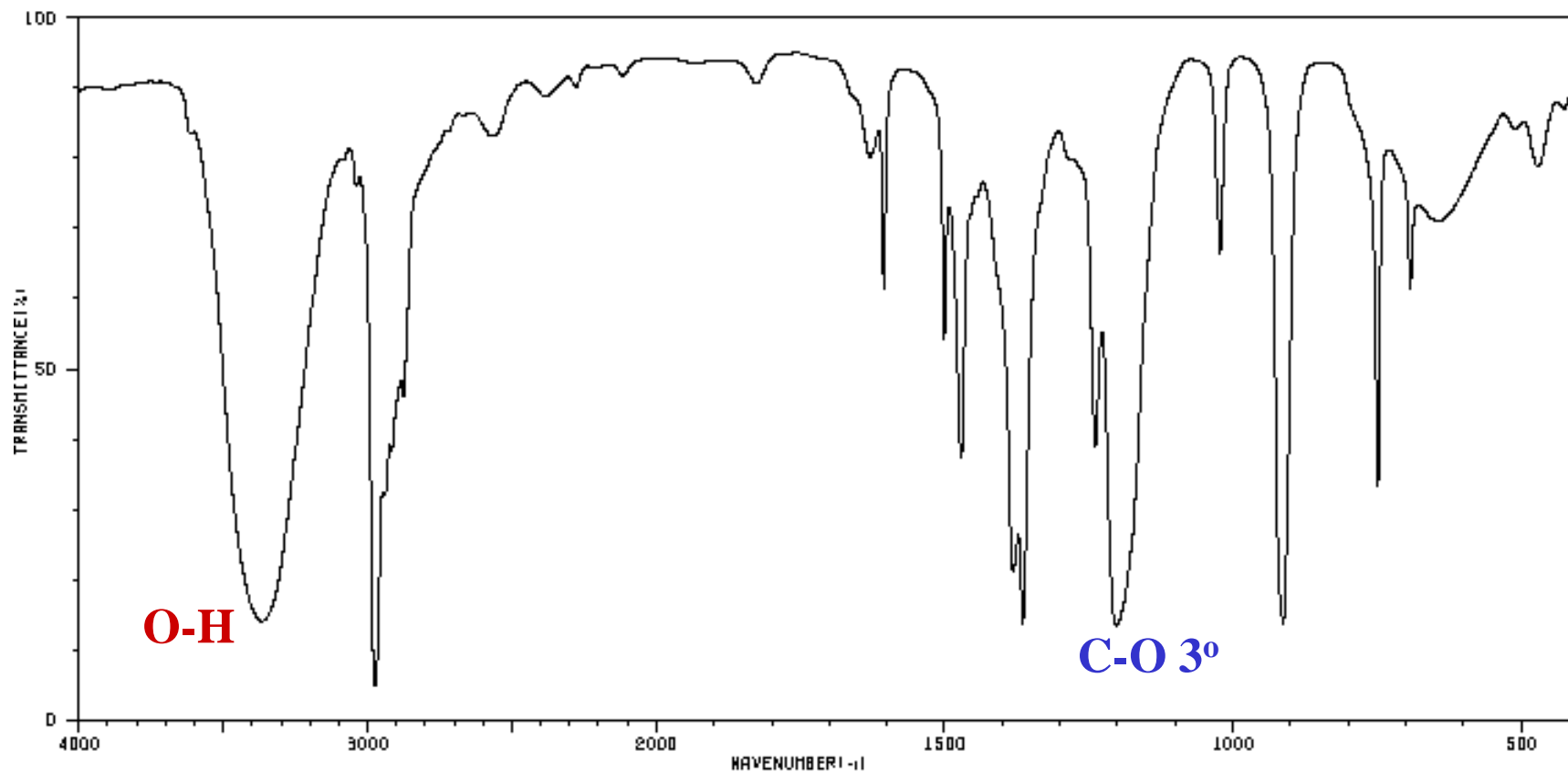
HIT-NO=1034

SCORE= ()

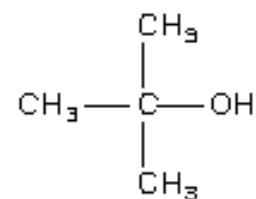
SDBS-NO=506

IR-NIDA-05409 : LIQUID FILM

2-METHYL-2-PROPANOL

tert-butyl alcohol $C_4H_{10}O$ 

3366	13	1630	77	1202	12	611	81
3038	72	1606	58	1022	64	471	77
2974	4	1501	52	913	13		
2940	31	1471	36	749	32		
2875	44	1381	20	693	58		
2564	79	1365	19	646	66		
2385	86	1239	37	643	68		

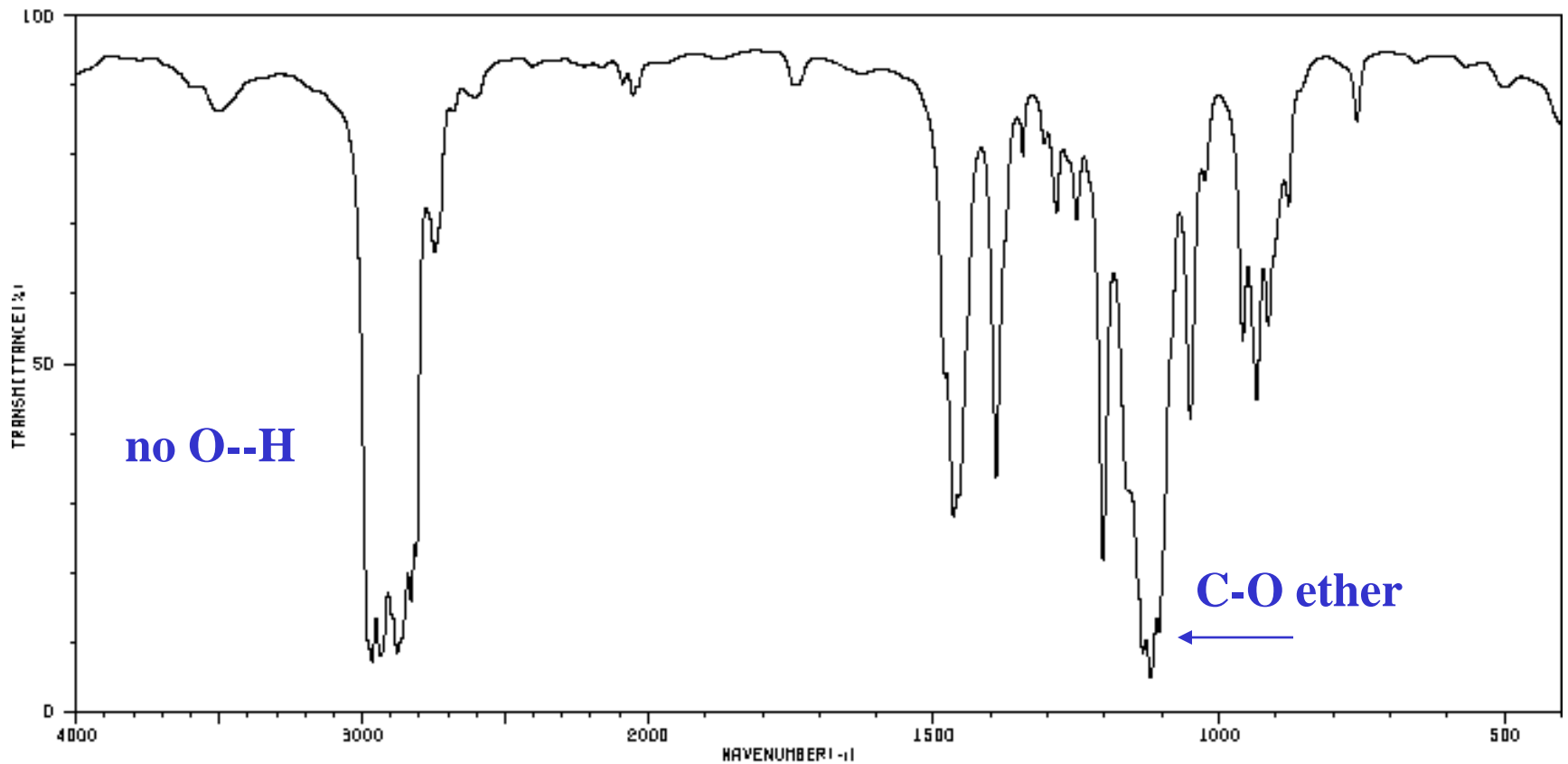


HIT-NO=2077 | SCORE= () | SDBS-NO=2841 | IR-NIDA-03073 : LIQUID FILM

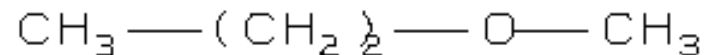
METHYL PROPYL ETHER

methyl *n*-propyl ether

C₄H₁₀O



3600	84	2616	84	1344	77	1106	10	769	81
2965	7	2605	84	1307	79	1050	41	501	86
2935	7	2053	84	1285	88	1024	72		
2879	7	2039	86	1260	88	969	50		
2830	15	1465	26	1204	21	934	43		
2810	21	1458	29	1134	7	914	59		
2745	64	1391	32	1120	4	879	70		



HIT-NO=1228

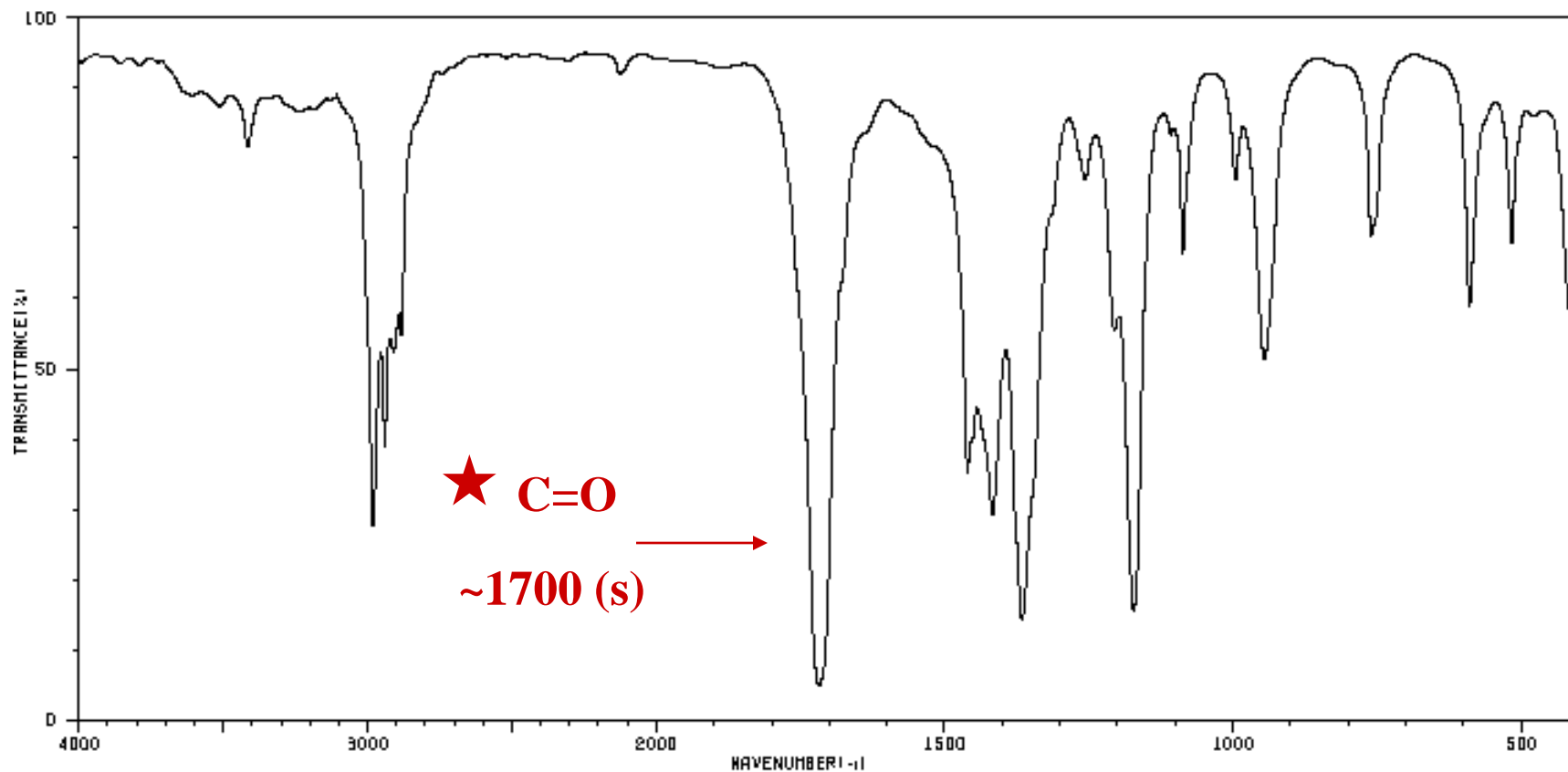
SCORE= ()

SDBS-NO=888

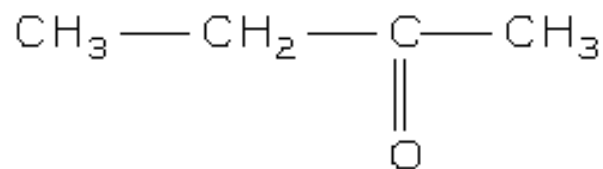
IR-NIDA-33689 : LIQUID FILM

2-BUTANONE

2-butanone

 C_4H_8O 

3611	84	1718	4	1173	14
3416	79	1461	34	1087	64
2981	26	1454	38	996	74
2964	44	1417	27	946	49
2940	37	1366	13	761	66
2909	50	1257	74	590	57
2883	62	1206	69	617	66

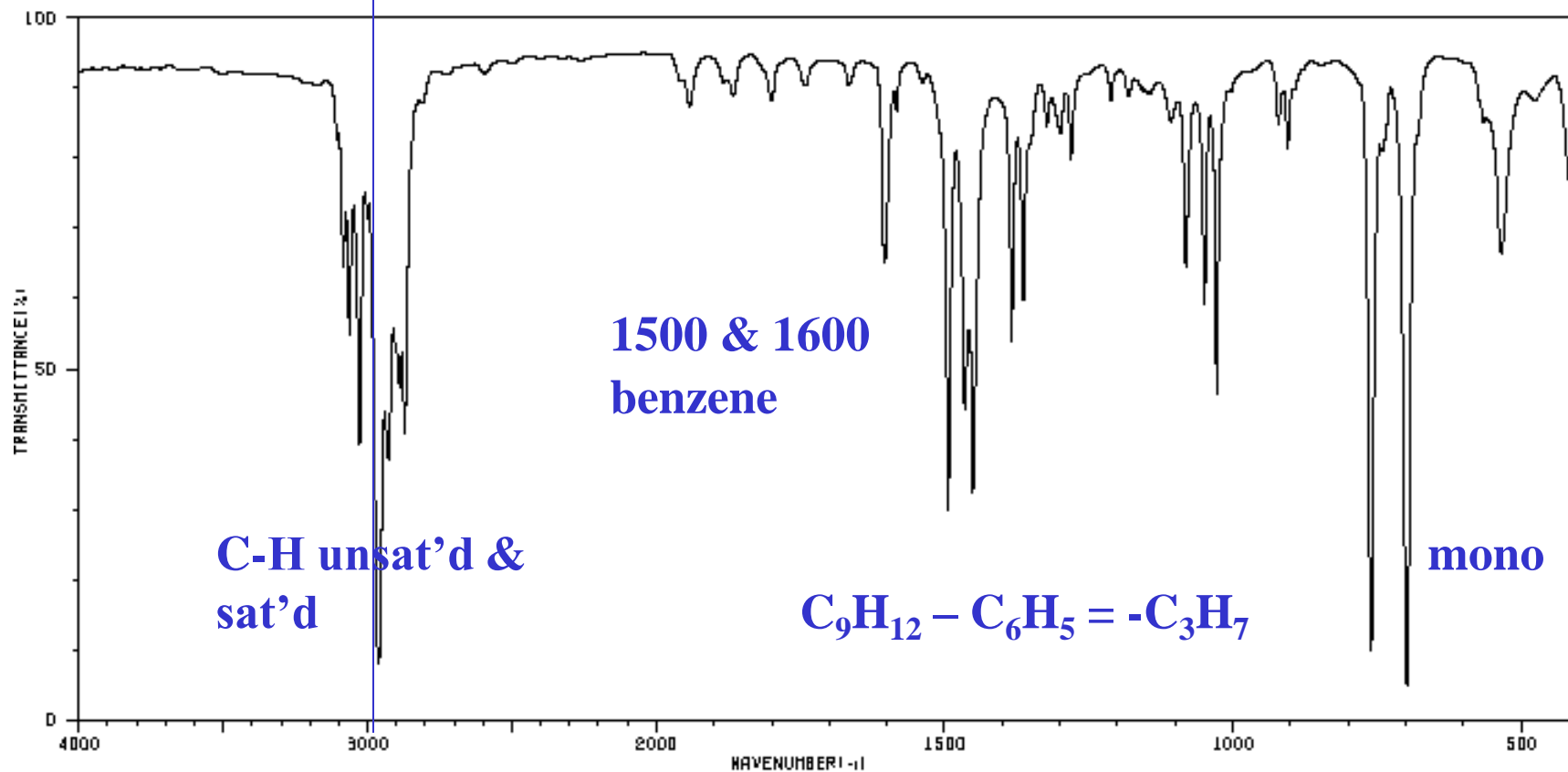


HIT-NO=1576

SCORE= ()

SDBS-NO=1816

IR-NIDA-63602 : LIQUID FILM

C₉H₁₂

3084	62	2871	38	1466	42	1281	77	1028	44
3064	53	1942	84	1458	53	1213	84	922	81
3028	37	1868	86	1452	31	1150	86	905	79
3002	68	1800	84	1384	52	1144	86	761	9
2961	7	1604	62	1364	57	1108	81	699	4
2927	35	1583	84	1323	81	1082	62	535	64
2890	46	1494	28	1300	81	1060	57	478	84

isopropylbenzene

n-propylbenzene?

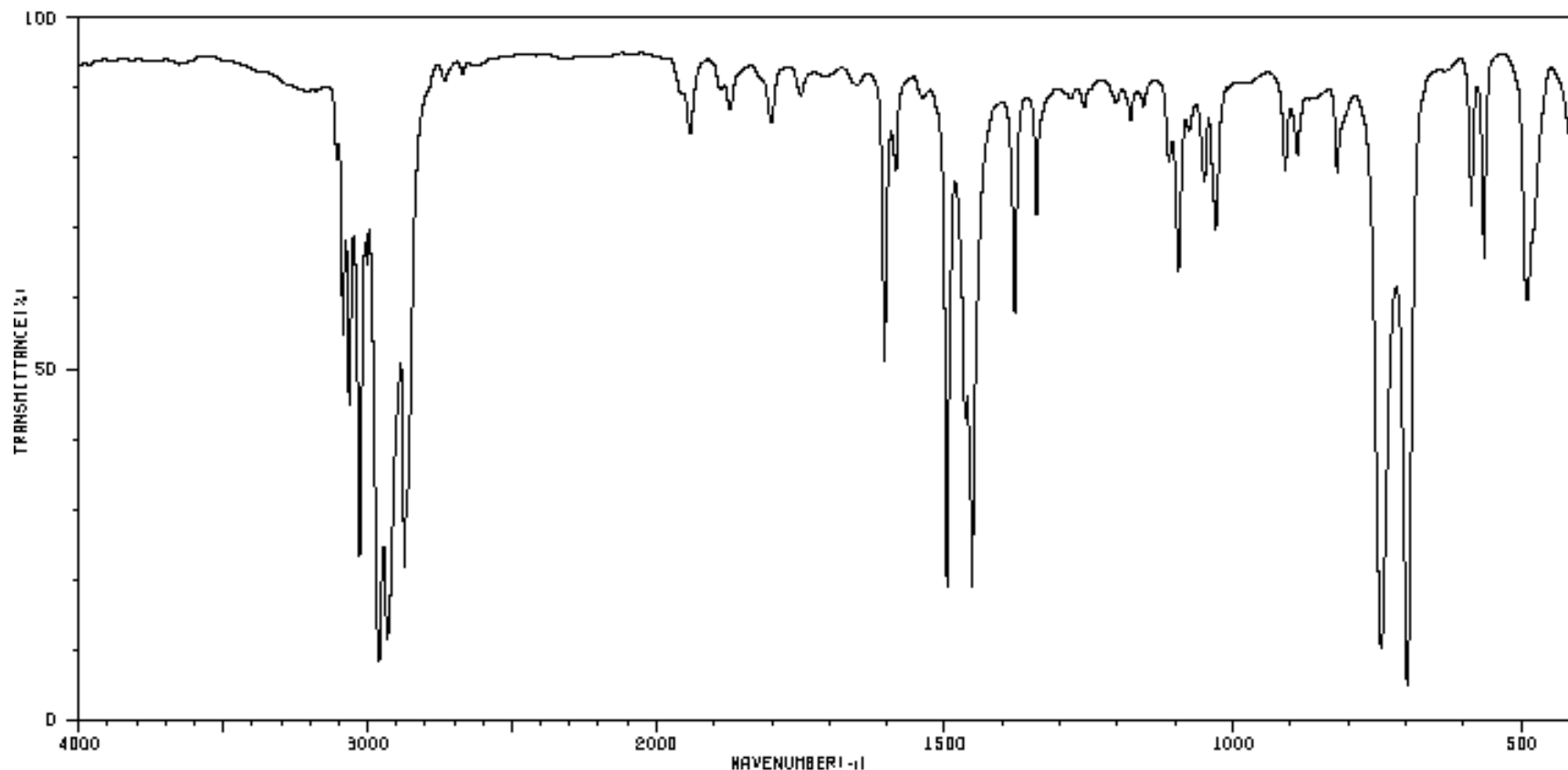
HIT-NO=1235

SCORE= ()

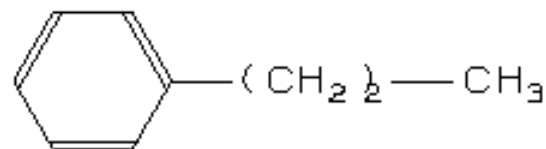
SDBS-NO=896

IR-NIDA-64858 : LIQUID FILM

PROPYLBENZENE

n-propylbenzene C_9H_{12} 

3108	77	2873	20	1466	41	1111	77	619	74
3085	52	1941	79	1453	18	1095	62	743	9
3064	43	1801	81	1379	55	1076	81	698	4
3028	22	1604	49	1341	70	1060	74	687	70
3002	62	1584	74	1258	84	1031	66	665	62
2960	8	1538	84	1203	84	909	74	490	57
2931	10	1496	18	1178	81	888	77	481	66



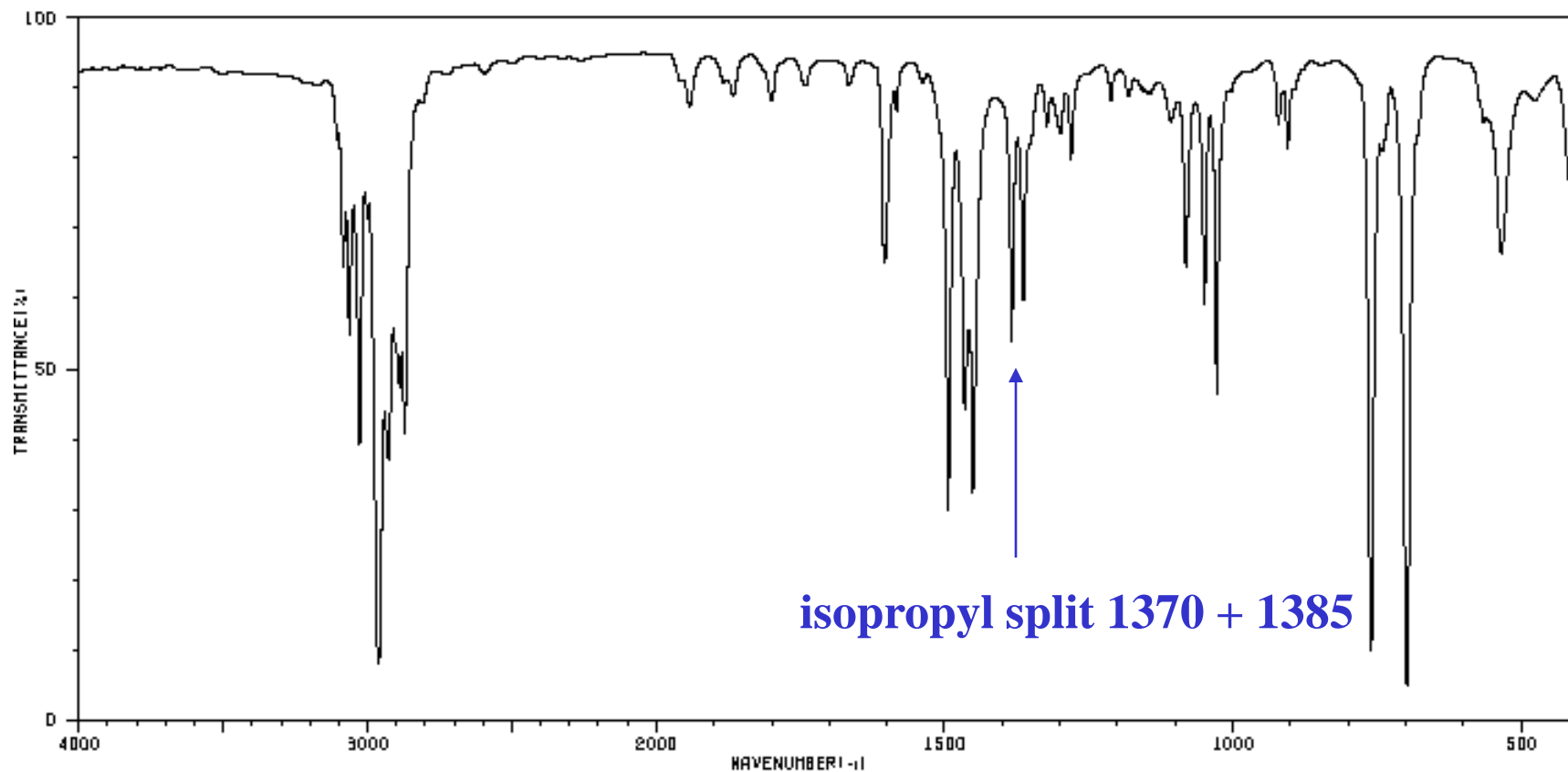
HIT-NO=1576

SCORE= ()

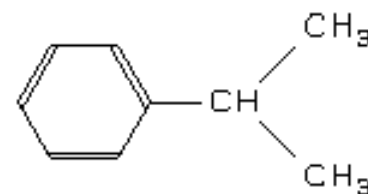
SDBS-NO=1816

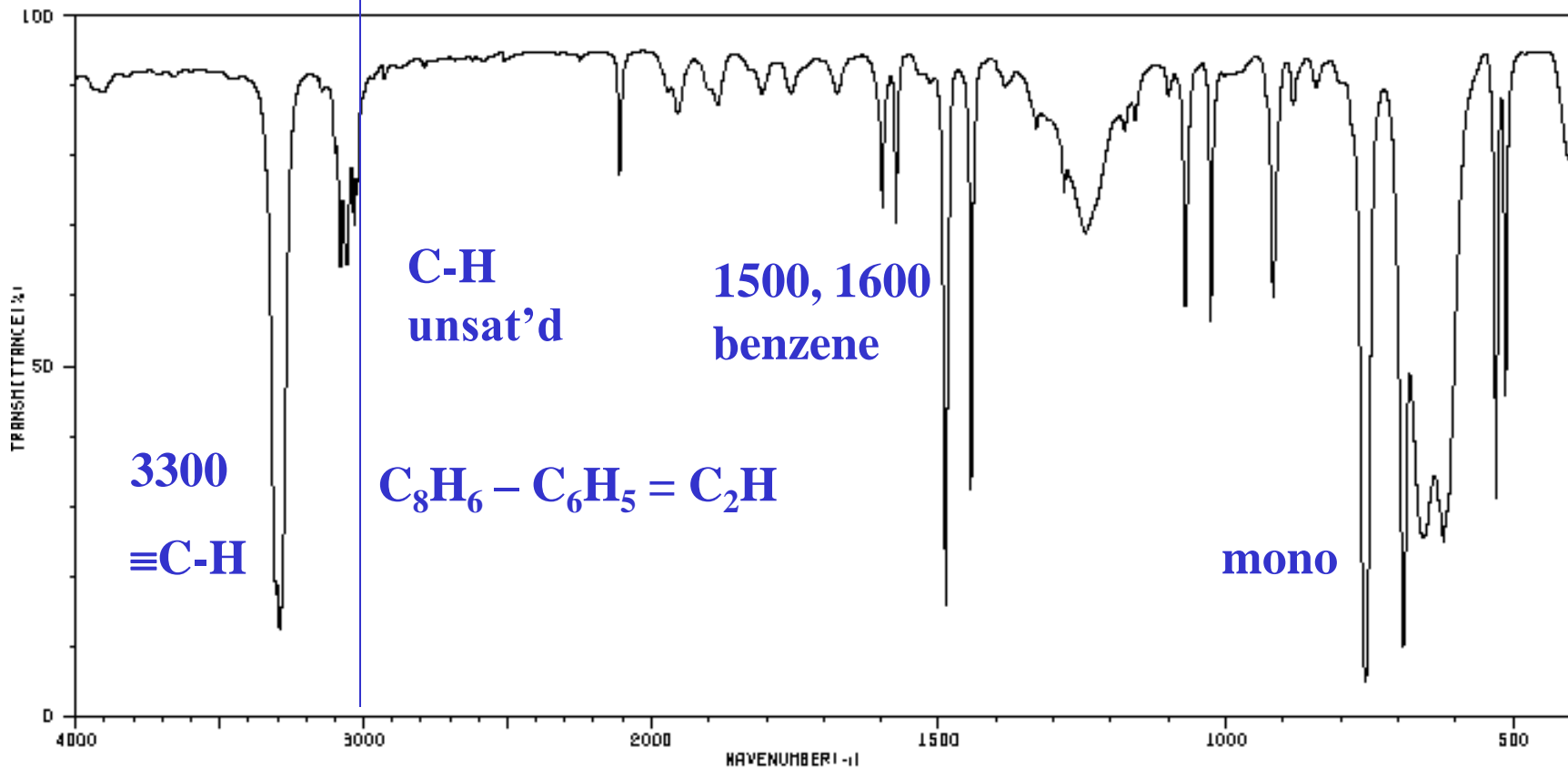
IR-NIDA-63602 : LIQUID FILM

CUMENE

isopropylbenzene C_9H_{12} 

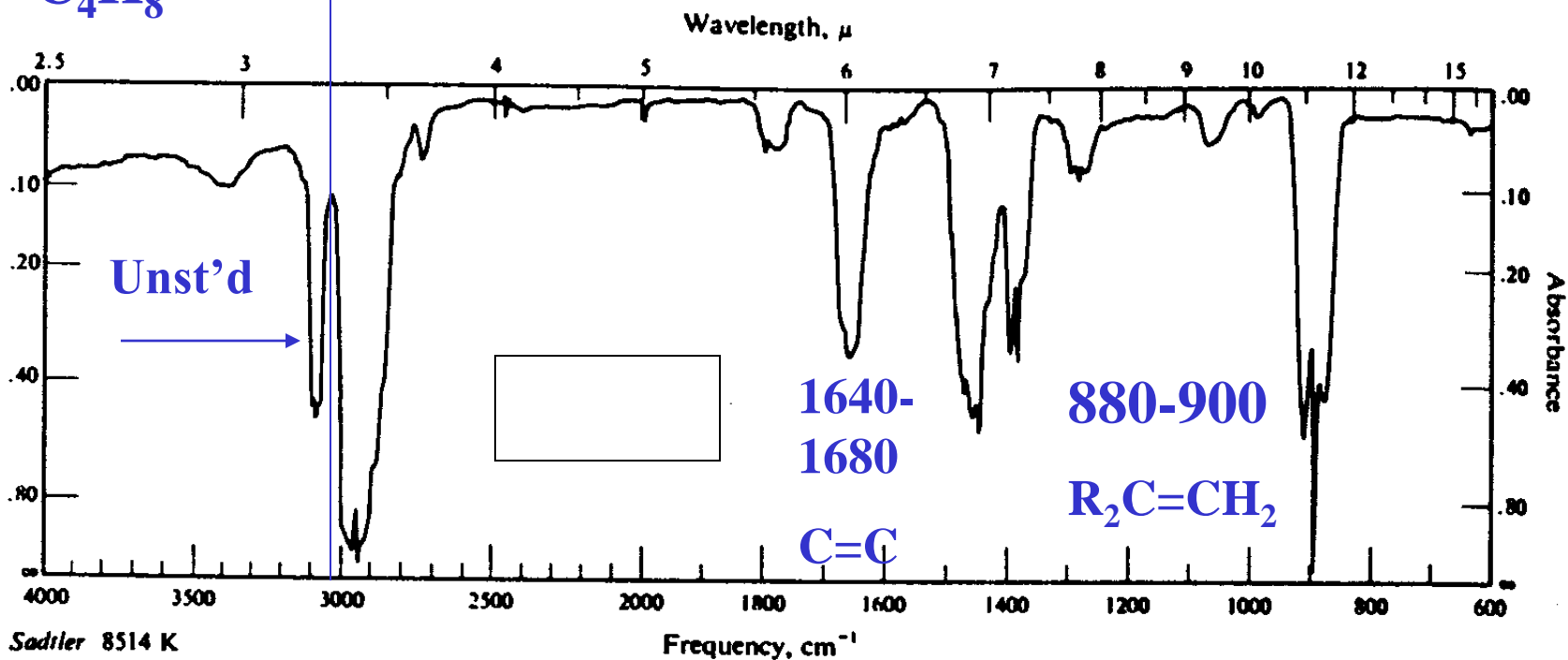
3084	62	2871	38	1466	42	1281	77	1028	44
3064	53	1942	84	1458	53	1219	84	922	81
3028	37	1858	85	1452	31	1150	85	905	79
3002	68	1800	84	1384	52	1144	86	761	9
2961	7	1604	62	1364	57	1108	81	699	4
2927	35	1583	84	1323	81	1082	62	535	64
2890	46	1494	28	1300	81	1060	57	478	84



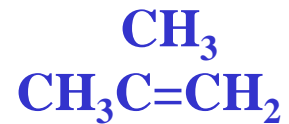


3906	86	2110	74	1674	68	1176	81	843	86
3306	16	1954	84	1488	15	1159	81	757	4
3291	12	1900	86	1444	31	1100	84	692	9
3081	62	1886	84	1386	86	1071	67	666	24
3058	62	1808	86	1331	81	1026	53	621	23
3034	86	1757	86	1282	72	918	57	530	30
3022	72	1698	70	1245	66	883	84	514	43

phenylacetylene



isobutylene

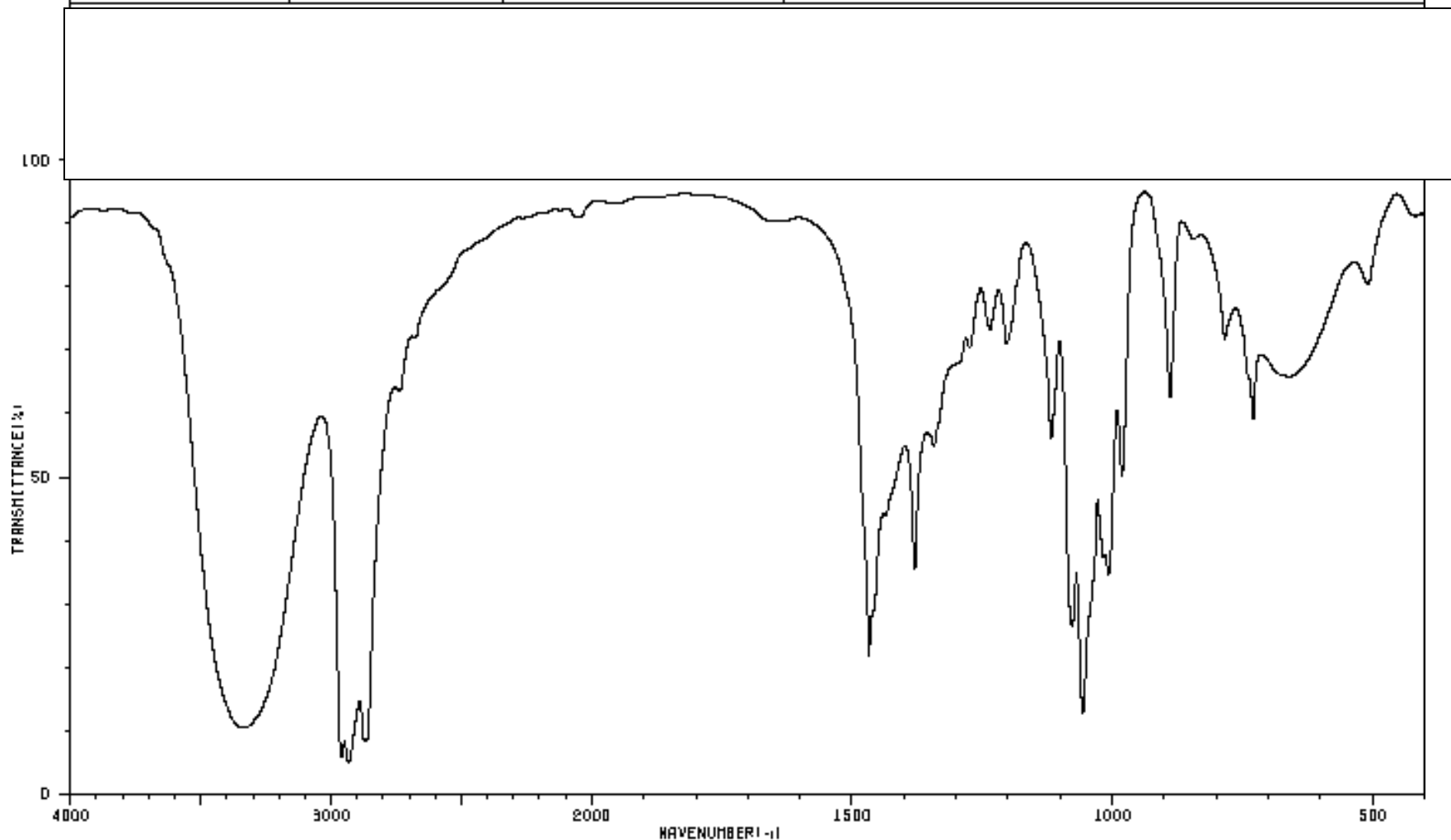


HIT-NO=2622

SCORE= ()

SDBS-NO=4321

IR-NIDA-02204 : LIQUID FILM



Which compound is this?

- a) 2-pentanone
- b) 1-pentanol
- c) 1-bromopentane
- d) 2-methylpentane

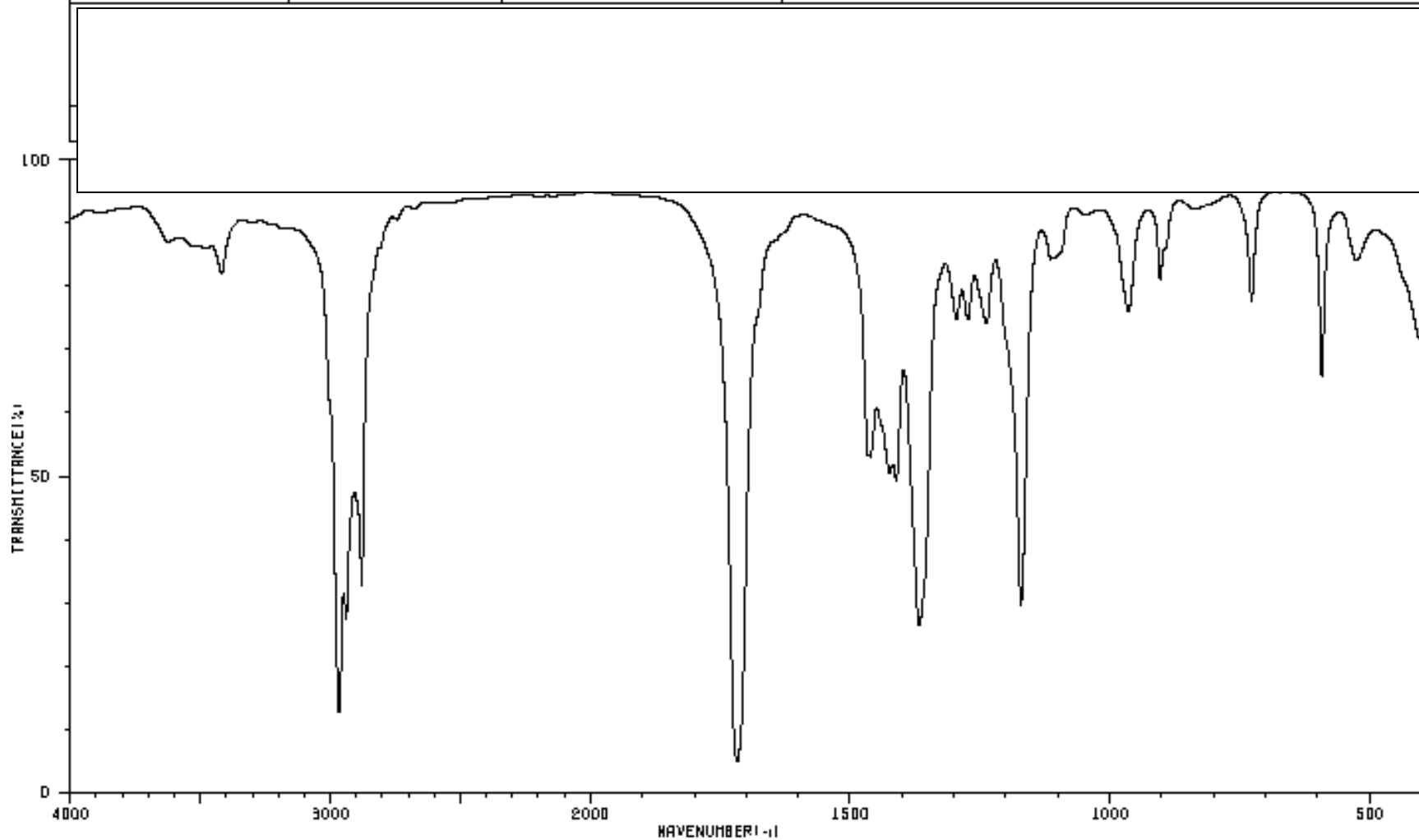
1-pentanol

HIT-NO=1985

SCORE= ()

SDBS-NO=2673

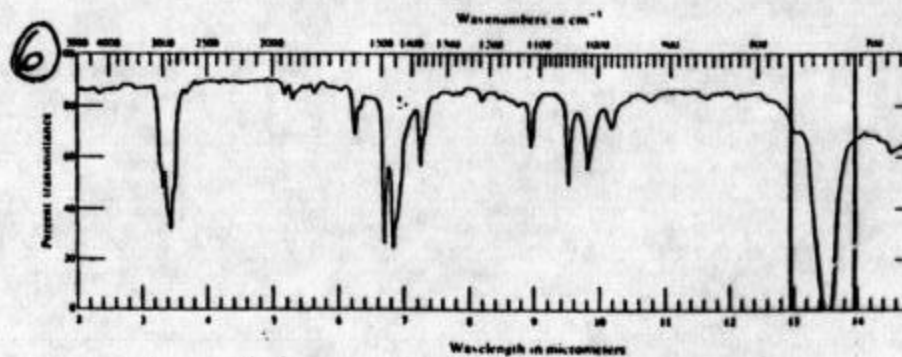
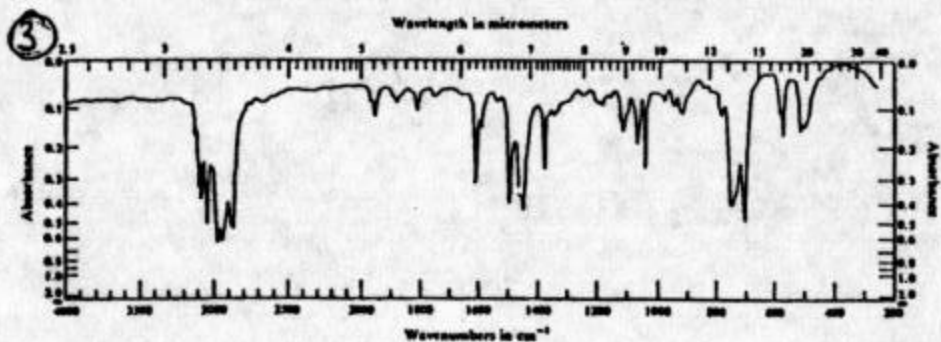
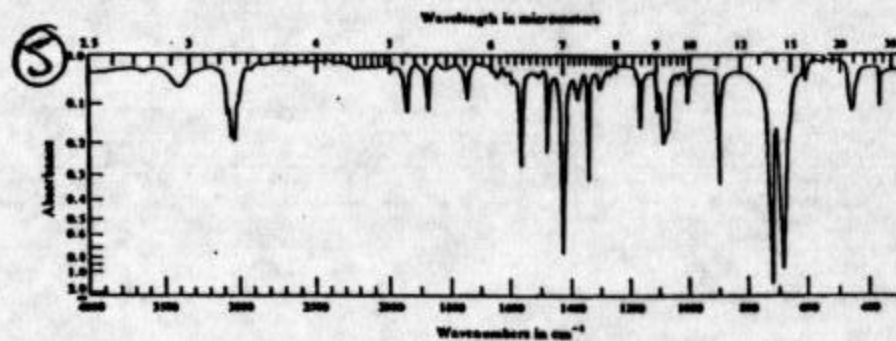
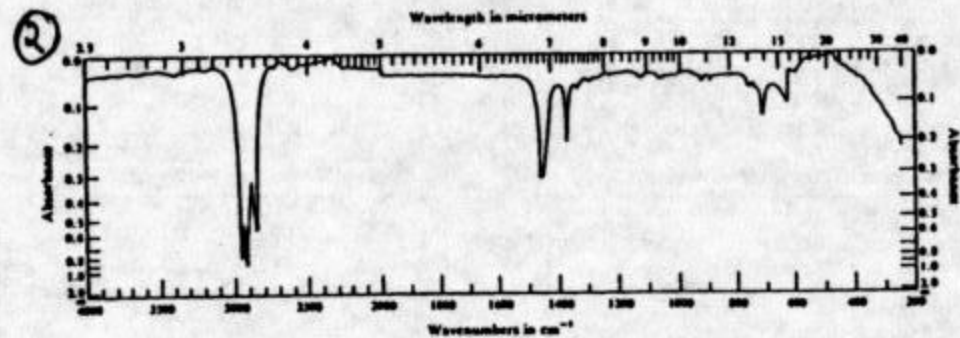
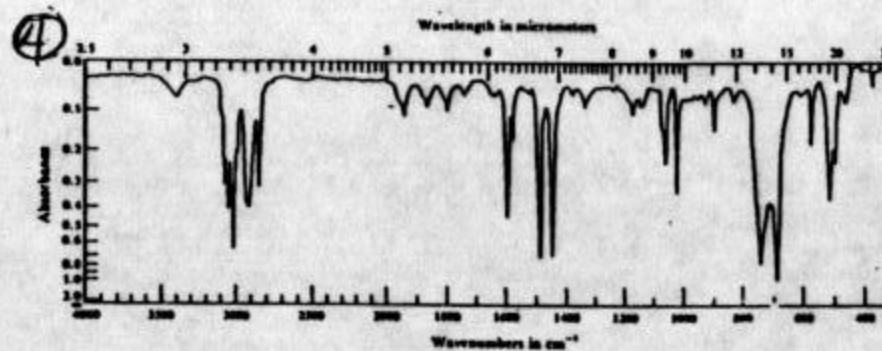
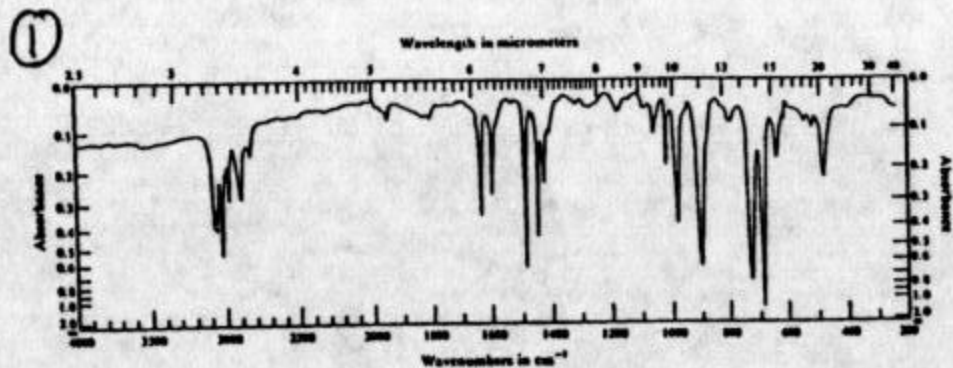
IR-NIDA-00433 : LIQUID FILM



What is the compound?

- a) 1-bromopentane
- b) 1-pentanol
- c) 2-pentanone
- d) 2-methylpentane

2-pentanone



A. triphenyl

B. *o*-xylene

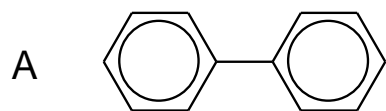
C. allylbenzene

D. *n*-pentane

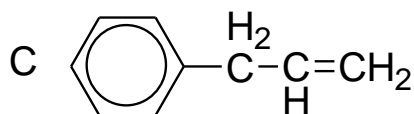
E. 1,2-diphenylethane

F. *n*-butylbenzene

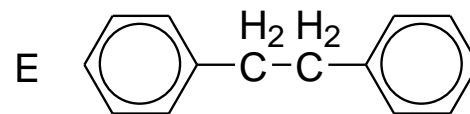
In a “matching” problem, do **not** try to fully analyze each spectrum. Look for differences in the possible compounds that will show up in an infrared spectrum.



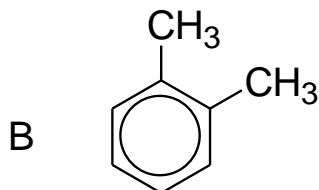
biphenyl



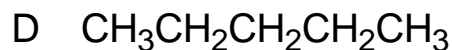
allylbenzene



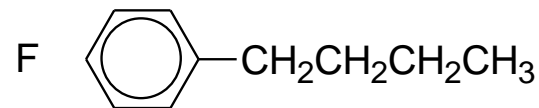
1,2-diphenylethane



o-xylene



n-pentane



n-butylbenzene

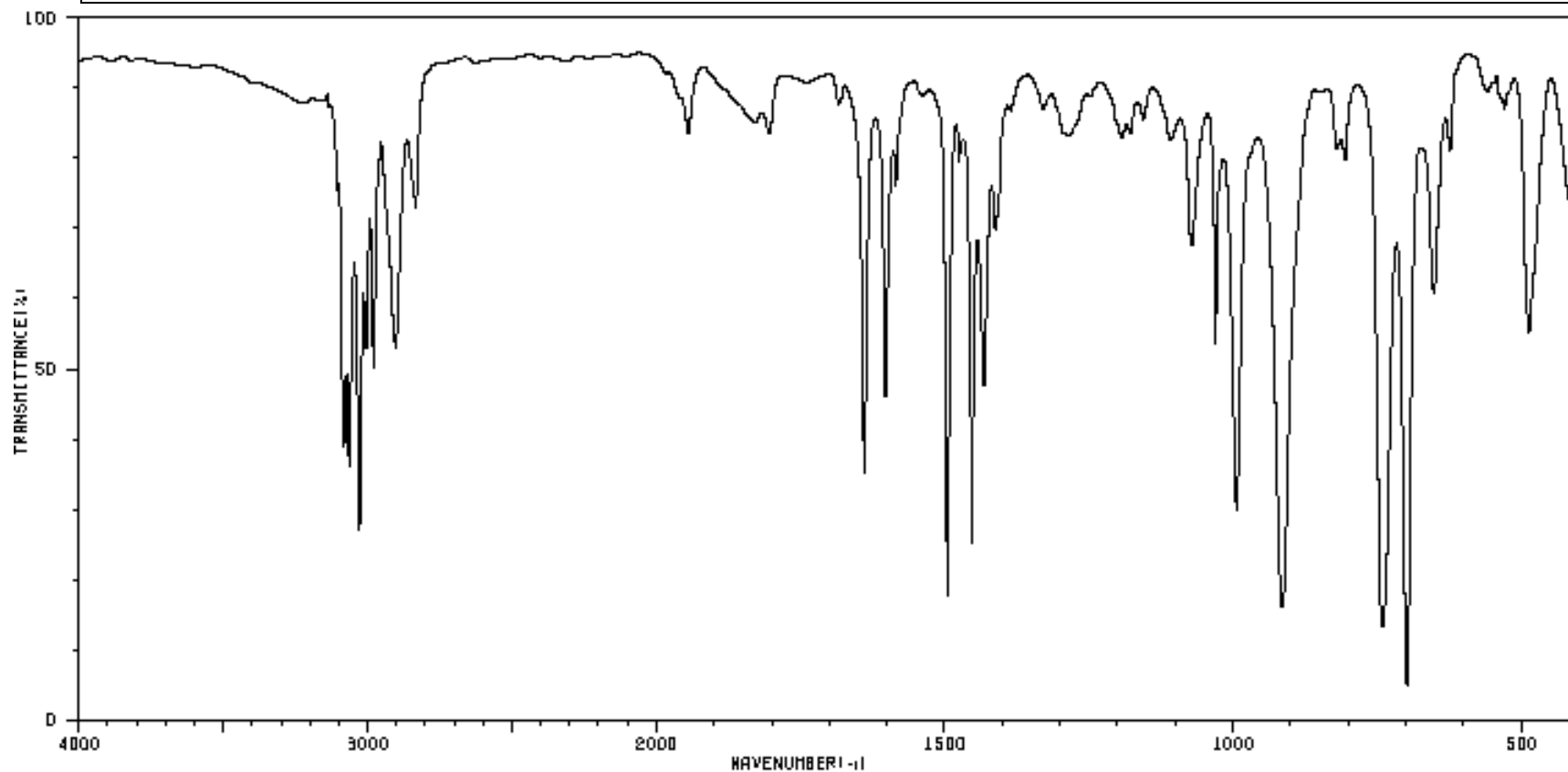
HIT-NO=3317

SCORE= ()

SDBS-NO=6325

IR-NIDA-64189 : LIQUID FILM

1



3082	37	1946	81	1463	24	1107	79	806	77
3064	34	1804	79	1432	46	1071	64	741	13
3029	26	1639	34	1412	86	1030	52	699	4
3006	50	1603	44	1286	79	994	28	662	58
2979	49	1585	72	1194	79	914	15	625	79
2904	50	1495	17	1186	81	821	79	487	53
2833	70	1476	77	1178	81	816	78	481	58

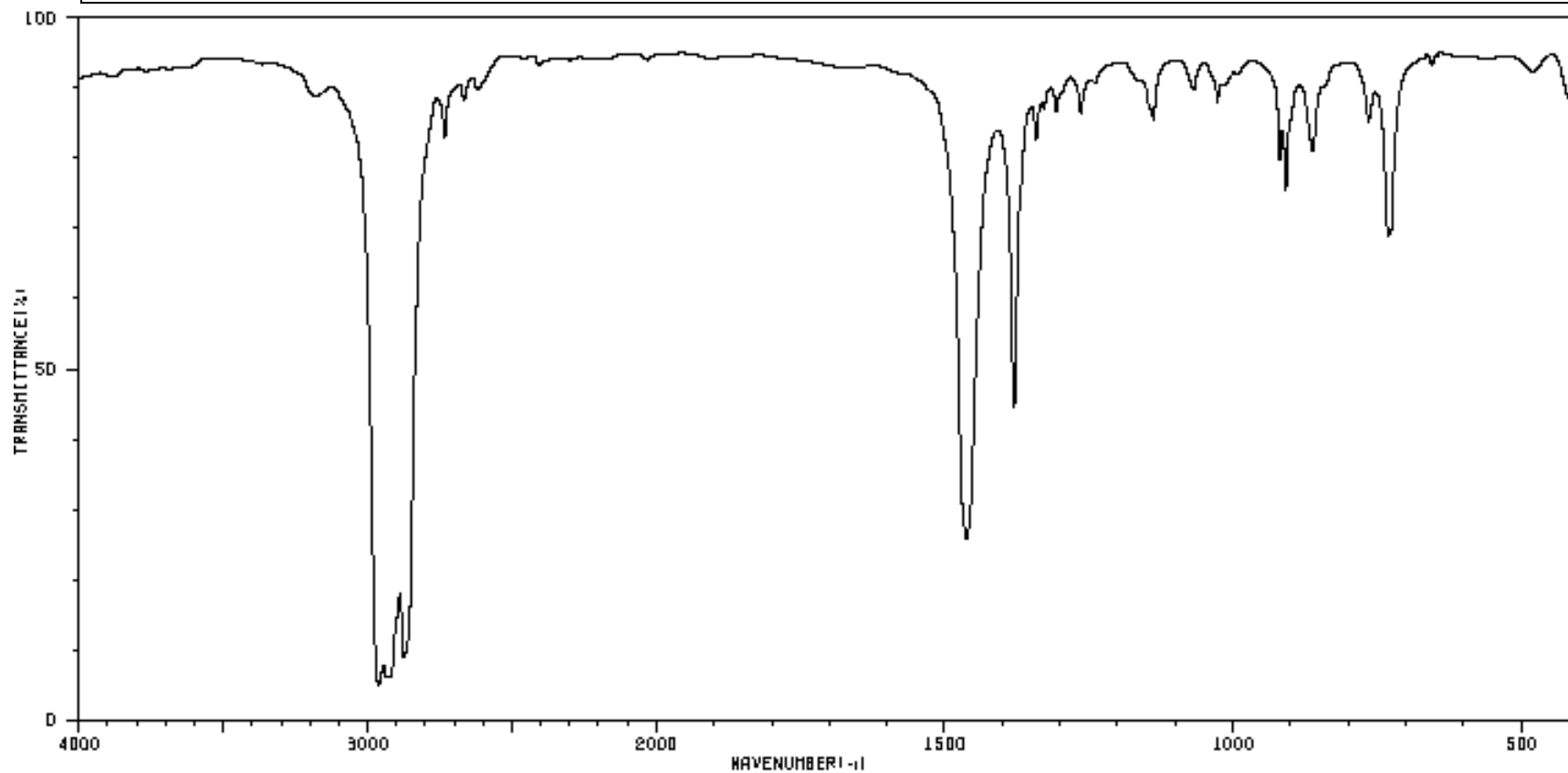
HIT-NO=1929

SCORE= ()

SDBS-NO=2475

IR-NIDA-68185 : LIQUID FILM

2



3182	86	2619	86	1138	81	732	66
3172	86	1462	24	1068	86		
2961	4	1380	45	1027	84		
2928	6	1342	78	919	77		
2875	8	1307	84	908	72		
2733	79	1264	84	862	79		
2666	84	1144	84	766	81		



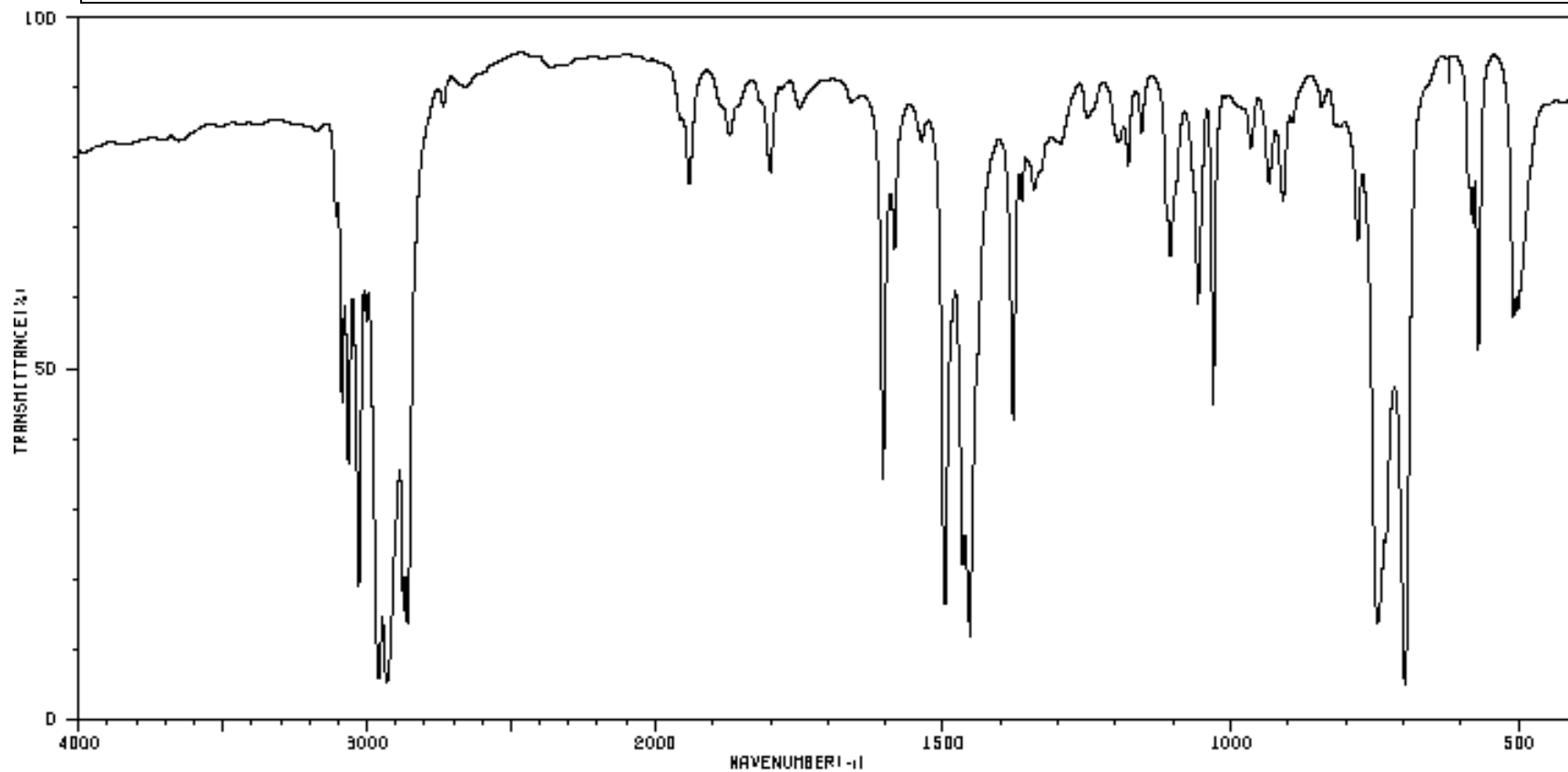
HIT-NO=1575

SCORE= ()

SDBS-NO=1815

IR-NIDA-02821 : LIQUID FILM

3



3108	68	2873	14	1467	21	1067	67	731	23
3087	43	2860	13	1454	11	1030	43	698	4
3064	35	1941	74	1379	41	965	79	588	72
3028	18	1800	74	1363	70	934	74	581	68
3002	55	1604	33	1342	72	909	70	570	50
2958	5	1584	64	1179	77	779	66	510	55
2931	4	1497	16	1106	64	746	19	503	67

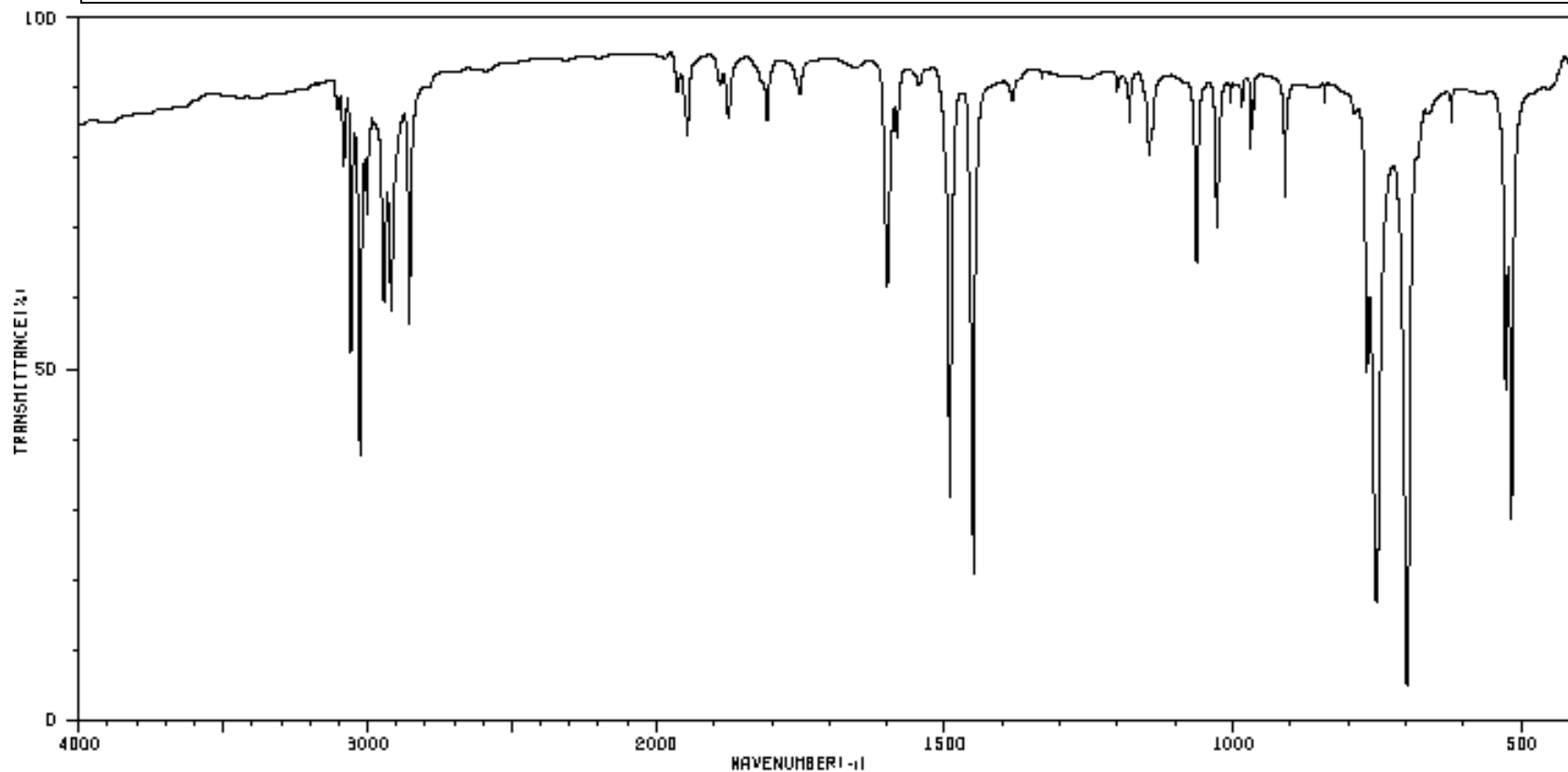
HIT-NO=1384

SCORE= ()

SDBS-NO=1264

IR-NIDA-62151 : KBR DISC

4



3102	84	2919	66	1600	68	1146	77	841	84
3083	77	2856	55	1583	79	1064	62	768	47
3058	50	1963	86	1492	30	1028	68	752	16
3040	79	1946	79	1460	20	1003	84	699	4
3027	36	1874	81	1383	84	985	84	622	81
3002	66	1808	81	1202	86	969	79	528	44
2943	67	1761	86	1180	81	910	72	518	27

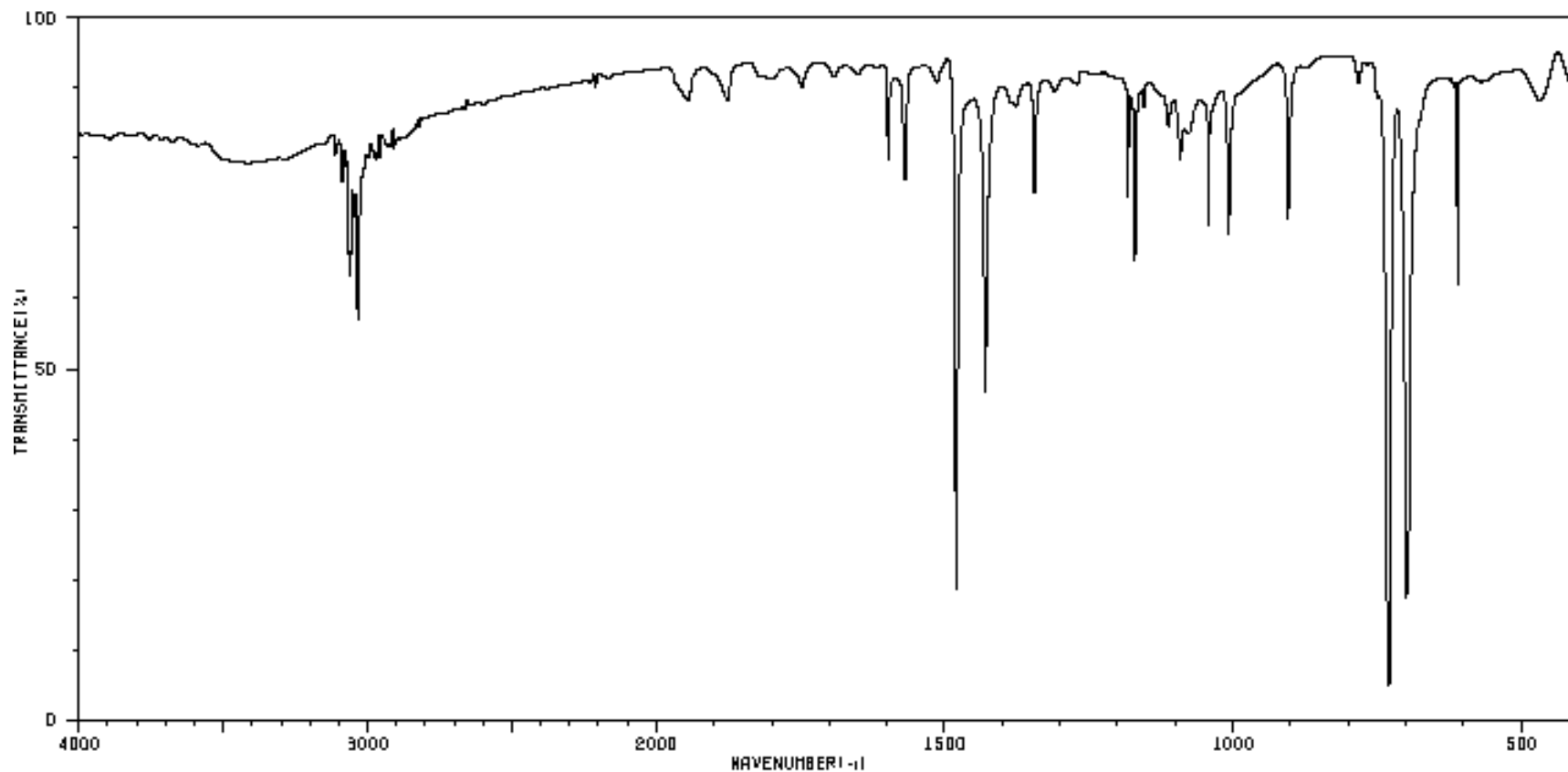
HIT-NO=1355

SCORE= ()

SDBS-NO=1182

IR-NIDA-60114 : KBR DISC

5



3111	77	2934	79	1669	74	1183	72	1007	66
3088	74	2921	79	1481	18	1170	62	904	68
3064	80	2908	79	1430	44	1155	64	730	4
3046	68	2876	79	1386	84	1112	81	700	16
3035	55	1944	84	1377	84	1092	77	611	60
2970	77	1877	84	1345	72	1077	79	468	64
2959	77	1699	77	1309	86	1043	68		

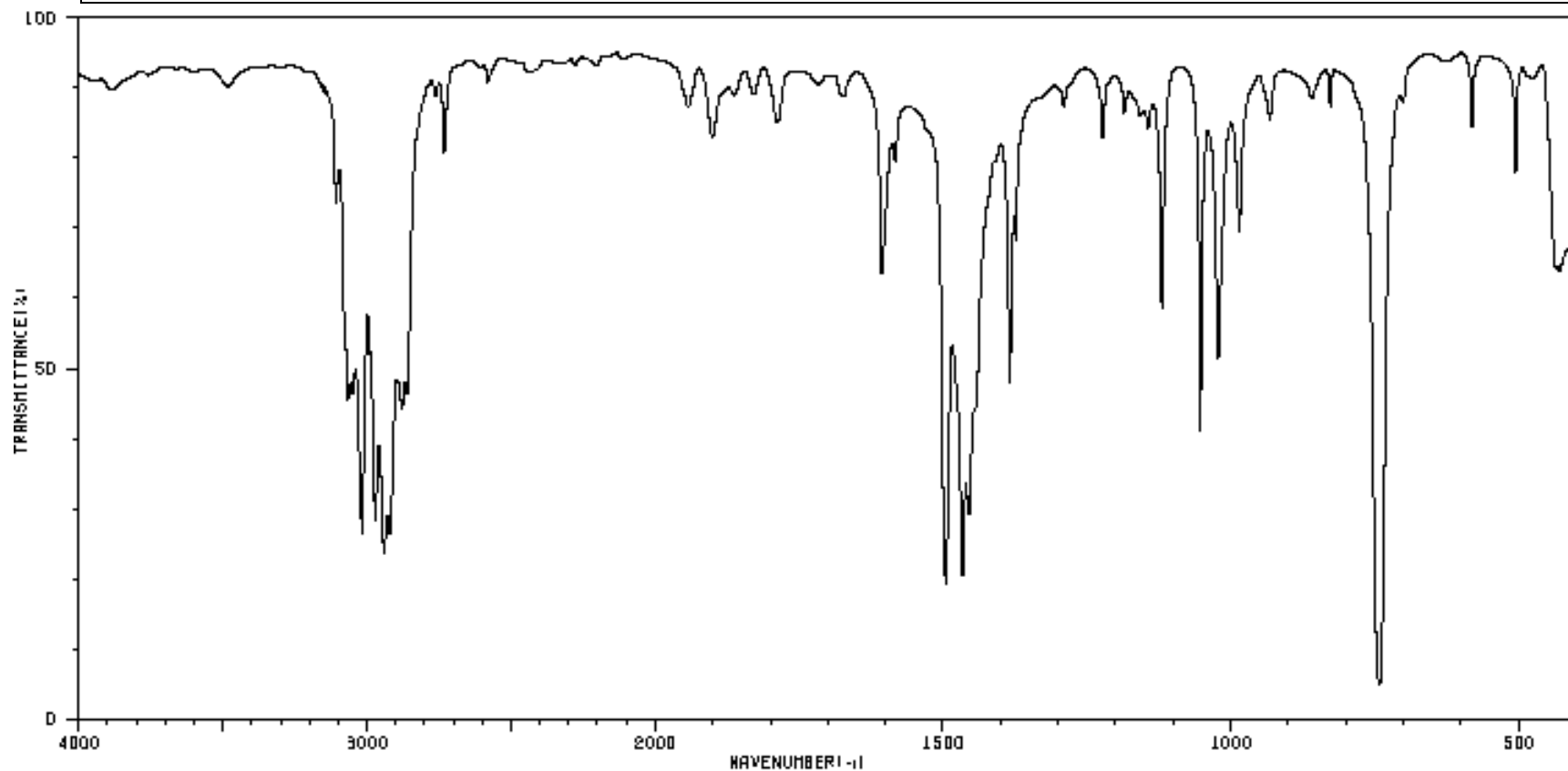
HIT-NO=1272

SCORE= ()

SDBS-NO=1028

IR-NIDA-21942 : LIQUID FILM

6



3108	70	2878	42	1683	77	1223	79	986	66
3066	43	2860	44	1495	18	1186	84	932	81
3050	44	2732	77	1467	20	1157	81	742	4
3018	25	1942	84	1466	27	1146	81	682	81
2971	26	1901	79	1384	46	1120	57	506	74
2940	22	1787	81	1374	86	1053	38	436	62
2921	25	1606	60	1291	84	1022	48	431	62