INFRARED BAND HANDBOOK

Edited by

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INTRODUCTION

Recent rapid advances in the techniques and instrumentation of infrared spectroscopy have made the determination of absorption spectra an increasingly more important and accurate method of analysis. However, the very refinements that have served to enhance the attractiveness of the method have also created the need for a greatly expanded information program. The Infrared Band Handbook is designed to play a many-sided role in this program. Perhaps its primary use will be in the identification of unknown compounds, but it will also be of value as a guide in assigning group frequencies, as a key to most advantageous sample conditions, as a tool in comparing series of related compounds for similar vibrations, and finally as an index to the literature.

The particular arrangement of the data that has been evolved is based on a number of premises:

1. That band position is the primary parameter for identifying unknown compounds from their infrared spectra. The identification of a compound from group frequencies alone is often difficult since many bands are not group frequencies.
2. That modern instrumentation and techniques make possible very accurate reporting of band position, and that, if the sample conditions are stated, this accuracy is reproducible.
3. That much of the literature does not report complete spectra, but concerns itself with the influences of physical and chemical changes on band position. This information is frequently lost to the spectroscopist.

The Handbook therefore presents data arranged by wavenumber, in steps of 1 cm^{-1}, and does not limit itself to complete spectra.

Sources

While the most accurate data are found in the current journals, it seemed desirable to include the widest selection of compounds in this initial volume. For this it was necessary to use data from older sources as well as from the current literature. This is especially true for many common organic compounds whose spectra have not been determined recently, but which form a necessary background, for instance, for the assignment of group frequencies.

The primary source of data for these common compounds was the American Petroleum Institute Project 44 series. This series represents accurate spectra of highly purified compounds, and therefore even early spectra of this group can be considered satisfactory. The Project 44 series, which shall be referred to as the API file, began issuing spectra in 1943. The file has been updated, and much of the early work has been redetermined quite accurately. However, some compounds have not been redetermined, and a few of these older entries have been included in the Handbook for completeness. It has been our experience in comparing these early data with those of later work that they are quite similar, except that the accuracy of the earlier work, especially in the 3600-2500 cm^{-1} region, is much lower. But all incorrect spectra have been replaced with other

data by the API workers. The only other source of older data has been several textbooks.

The remaining Handbook data have been taken from the literature published since 1957, although secondary references to earlier work will be found in the reference list. While the API file of course gives only complete spectra, data from the current literature may cover either single bands or the complete spectrum of a compound. In either case, only tabular data were used and in the interest of accuracy no attempt was made to measure band position in printed spectra. It should be noted that the ASTM indexing method utilized only printed spectra, so that in this respect the Handbook forms a complement to the ASTM index.

Accuracy of Band Position

As stated above, data have been entered in the Handbook in 1 cm^{-1} steps. While this arrangement is warranted by the accuracy of much of the information now being reported in the literature, we do not mean to imply this accuracy for all the data in the Handbook. A reasonable estimate of the accuracy of each entry can be made on basis of the date of the reference, the nature of the monochromator used, and the region of the spectrum involved. The following considerations will serve as a guide.

If the reference is of recent origin and only a NaCl prism spectrophotometer was used in the 3600-600 cm^{-1} region, the accuracy of band position from 3600 to 2500 cm^{-1} can be assumed to range from ± 5 cm^{-1} to ± 10 cm^{-1}. From 2500 cm^{-1} to 600 cm^{-1} the accuracy can be assumed to range from ± 5 cm^{-1} to ± 1 cm^{-1}, with the higher accuracy corresponding to the lower wavenumbers. If the reference is to API data prior to 1950, the accuracy should be assumed to be even lower. For example, in the 3600-2500 cm^{-1} region it probably is ± 10 cm^{-1} unless a grating was used, in which case it would be closer to ± 5 cm^{-1}.

In general, where CaF_2, LiF, or grating monochromators are used, the accuracy in the 3600-2500 cm^{-1} region can be assumed to range from ± 5 cm^{-1} to ± 1 cm^{-1}, i.e., to fall within the same limits assumed for the 2500-600 cm^{-1} region. Some literature sources list the accuracy of their data, and this information is entered in the Handbook whenever it appeared pertinent.

Measured with a NaCl monochromator, many hydrocarbons have a series of common bands, particularly in the 3500-2000 cm^{-1} region, where the band position cannot be measured as accurately as in the 2000-600 cm^{-1} region. Obviously, these bands are not particularly useful for identification, and to conserve space in the Handbook, only some typical examples of such bands have been entered. The reader may assume that all compounds of the following types entered in the Handbook have the following bands in common:

Band	Intensity	Path Length or Concentration	Physical State or Solvent
	CH_3 and CH_2 Vibrations		
3370 $\pm$ 10 cm^{-1}	MWSh	0.169	liquid
3215 $\pm$ 10 cm^{-1}	SSh	0.169	liquid
3180 $\pm$ 10 cm^{-1}	SSh	0.169	liquid
2970 $\pm$ 10 cm^{-1}	S	0.0088	liquid
2920 $\pm$ 10 cm^{-1}	S	0.0088	liquid
2880 $\pm$ 10 cm^{-1}	S	0.0088	liquid

Band	Intensity	Path Length or Concentration	Physical State or Solvent
2850 ± 10 cm^{-1}	S	0.0088	liquid
2660 ± 10 cm^{-1}	MSSh	0.169	liquid
2415 ± 10 cm^{-1}	M	0.728	liquid
2320 ± 10 cm^{-1}	M	0.728	liquid
2295 ± 10 cm^{-1}	S	0.728	liquid
	OH of Alcohols		
3350 ± 10 cm^{-1}	S	5%	CCl_4

Intensity Data

It is important for the reader to understand how intensity data were entered into the Handbook. Of all the information in the Handbook, intensity is the one most difficult to give in a generally meaningful way.

It is not intended for intensities of one compound to be compared to those of another, but only for intensities of all bands of a single compound to be compared to each other. Of course, in some instances different compounds can be compared to each other, but the reader should do this only after he has assured himself that the sample conditions were sufficiently similar to make the comparison meaningful.

The intensity data were prepared in the following manner. Where the source listed relative intensity for each band of a compound and only a single sample condition was used, the relative intensity data and physical conditions under which the sample was determined are listed. In general, no cell path length or concentrations are given unless such data are pertinent to band position. Where several path lengths or concentrations were used to complete the spectrum but the author has converted intensities to a relative scale, the relative intensity scale is used and concentrations and/or path lengths are not stated. API data presented a special problem since in many instances the sample had been determined using several path lengths and/or concentrations but no relative intensity data were given. For these spectra the intensity reported is that corresponding to the single concentration and/or path length which, in a given region of the spectrum, brings the greatest number of bands to an intensity from 5% to 95%. To indicate which bands are comparable in this situation, either the concentration or the path length is entered after the physical state code as an identifying mark. Since in this case either the path length or concentration is listed, but not both, the reader must consult the original reference for complete sample data.

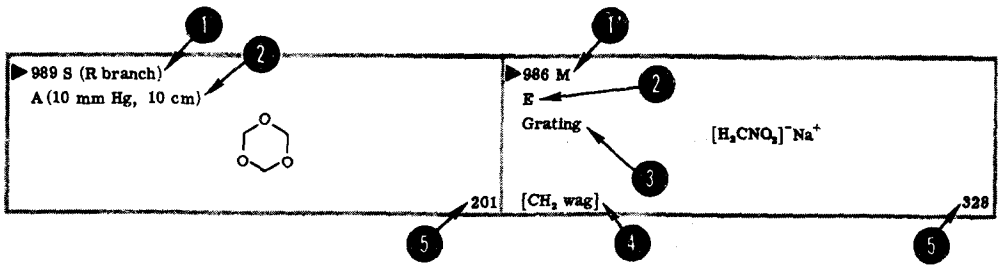
Buffalo, N.Y. H.A. Szymanski

EXPLANATION

The information listed to the left of the STRUCTURAL FORMULA of each compound has the following significance:

1 **The first line** gives the WAVE NUMBER in cm^{-1} and a code designation indicating the INTENSITY of the band (see Intensity Code below). For gases the band center or branch is identified whenever possible.

2 **The second entry** gives either a code letter indicating the PHYSICAL STATE in which the spectrum was measured (see Physical State Code below) or the solvent used for the sample (followed by the concentration, in brackets, and cell thickness, where pertinent).



3 **The next line** is reserved for SPECIAL INFORMATION, such as the dispersive element used, the material of the prism, etc. In the absence of an entry the reader may assume that an NaCl prism was used.

4 **The bracketed entry** on the last line indicates the STRUCTURAL GROUP to which the vibration was assigned in the original reference, which may belong to either the original or the isomerized form of the compound, and the mode of vibration, where pertinent.

5 ***The number in the lower right-hand corner*** is the REFERENCE NUMBER and pertains to the list of source material on pages 429-434.

Intensity Code

(Intensity is described relative to all other bands in a given spectrum, except where it is necessary to use different path lengths and/or concentrations to record all bands. In such cases the path length and/or concentration is stated on the second line.)

S = Strong, **M** = Medium, **W** = Weak, **V** = Very, **B** = Broad, **Sh** = Shoulder, **Sp** = Sharp

Physical State Code

(The temperature is given after the code letter if it is other than 25°C.)

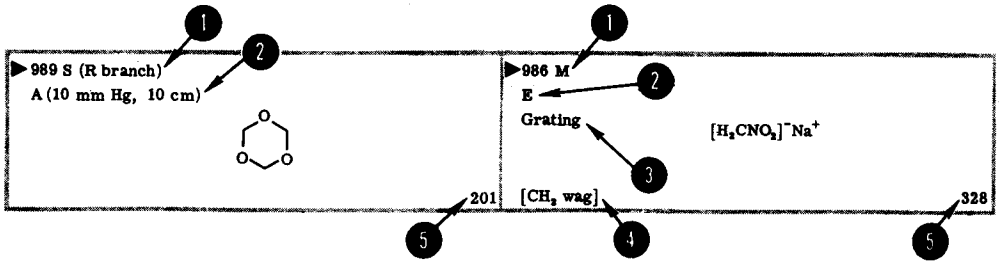
A = Vapor or gaseous state (followed by the pressure and path length, where pertinent)
B = Sample run as a liquid (followed by the cell thickness, in millimeters, where pertinent)
C = Solid, powder
D = Solid, film
E = Nujol oil
F = Fluorocarbon oil
G = KBr disk
H = Solution – solvent not specified
I = Solid state – method not specified
K = Polyethylene bagging
M = Hexachlorobutadiene mull
N = Sample above room temperature and run as a liquid
O = Single crystal
P = KCl disk
Q = KI disk

EXPLICATION

Les renseignements situés à gauche de la FORMULE DE CONSTITUTION de chaque composé ont la signification suivante:

1 **La première ligne** donne l'INDICE DE L'ONDE en cm^{-1} et une désignation-code indiquant l'INTENSITE de la bande (voir Code-Intensité ci-dessous). Pour les gaz, le milieu de la bande ou l'embranchement est identifié quand c'est possible.

2 **La seconde inscription** donne soit une lettre-code indiquant l'ETAT PHYSIQUE dans lequel le spectre fut mesuré (voir Code-Etat Physique ci-dessous) ou le solvant utilisé comme échantillon, entre parenthèses, et la cellule épaisse, là où c'est à propos.



3 **La ligne suivante** est réservée pour des RENSEIGNEMENTS SPECIAUX, tels que l'élément du composé utilisé, la nature du prisme, etc. En l'absence d'une inscription, le lecteur peut assumer qu'on a employé un prisme NaCl.

4 **L'inscription entre** crochets de la dernière ligne indique le GROUPE DE CONSTITUTION auquel la vibration fut assignée dans la référence originale, laquelle peut appartenir ou à l'originale ou à la forme isomérisée du composé, et du genre du vibration, là où c'est à propos.

5 **Le nombre qui se trouve à l'extrémité droite**, en bas, est le NUMERO DE REFERENCE et se rattache à la liste de matériel source aux pages 429-434.

Code-Intensité

(L'intensité est décrite relative à toutes les autres bandes d'un spectre donné, sauf là où il faut s'en servir des differentes longueurs de traces et/ou des concentrations differentes pour enregistrer toutes les bandes. Dans de tels cas, la longueur de trace et/ou la concentration est donnée dans la seconde ligne.)

S = fort, **M** = moyen, **W** = faible, **V** = très, **B** = large, **Sh** = epaulement, **Sp** = aigu

Code-Etat Physique

(Si la température est ature que 25°C, elle est donnée après la lettre-code.)

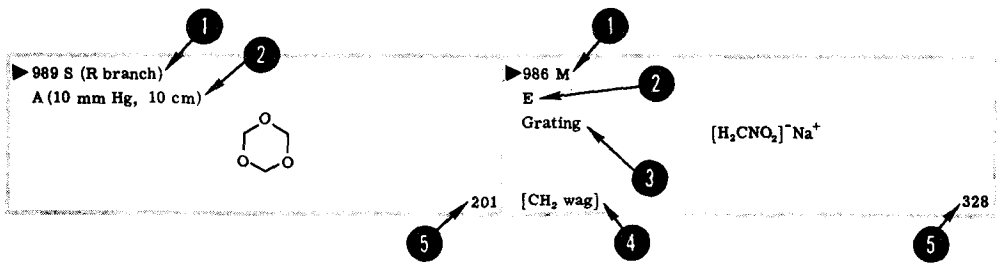
A = Vapeur ou état gazeux (suivi de la pression et la longueur du trace, là où c'est à propos)
B = Echantillon éprouvé en tant que liquide (suivi de l'épaisseur de la cellule, en millimètres, là où c'est à propos)
C = Solid, en poudre
D = Solide, pellicule
E = Huile de Nujol
F = Huile de fluorocarbone
G = Disque KBr
H = Solution—solvant non specifié
I = Etat solide—méthode non specifié
K = Ensachement polyéthylène
M = Mélange hexachlorobutadiene
N = Echantillon au-dessus de la température normale d'intérieur et utilisé en tant que liquide
O = Cristal simple
P = Disque KCl
Q = Disque KI

ПОЯСНЕНИЯ

Слева СТРУКТУРНОЙ ФОРМУЛЫ каждого соединения приводятся данные, имеющие следующее значение:

1 **На первой строке** указываются НОМЕР ВОЛНЫ в $см^{-1}$ и код, обозначающий ИНТЕНСИВНОСТЬ полосы. (См. ниже код интенсивности.) Для газов там, где это представляется возможным, обозначается центр или ветвь полосы.

2 **На второй строке** приводится буква кода, указывающая на ФИЗИЧЕСКОЕ СОСТОЯНИЕ, в котором измерялся спектр (см. ниже код физического состояния), или растворитель, применявшийся для пробы. Затем, в скобках, указывается концентрация, а там, где это существенно, толщина ячейки.



3 **На следующей строке** приводятся ОСОБЫЕ ДАННЫЕ, как-то: применявшийся элемент дисперсии, материал призмы и т. д. Если третья строка отсутствует, следует считать, что применялась призма NaCl.

4 **На последней строке, в скобках,** указывается СТРУКТУРНАЯ ГРУППА, к которой вибрация была отнесена в первоначальной ссылке. Эта группа может относиться к первоначальной или к изомеризованной форме соединения, а также там, где это существенно, к типу вибрации.

5 **Номер, напечатанный справа внизу,** является НОМЕРОМ ССЫЛКИ. Он относится к списку источников, упоминающихся на стр. 429-434.

Код интенсивности

(Интенсивность указывается в отношении всех прочих полос данного спектра, за исключением тех случаев, когда следует применять иные длины пробега и/или концентраций для записи всех полос. В таких случаях длина пробега и/или концентрации приводятся на второй строке.)

S = сильная, **M** = средняя, **W** = слабая, **V** = очень, **B** = широкая, **Sh** = плечо, **Sp** = острая

Код физического состояния

(Температура следует за буквой кода в том случае, если она не равняется 25°.)

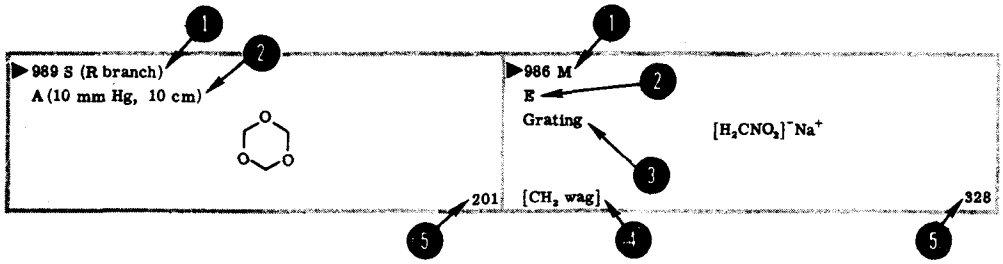
A = Паро- или газообразное состояние (с указанием давления и длины пробега там, где это существенно)
B = Проба в жидком состоянии (с указанием толщины ячейки в миллиметрах там, где это существенно)
C = Твердое тело, порошок
D = Твердое тело, пленка
E = Масло Нюжоль
F = Фтороуглеводородное масло
G = Диск KBr
H = Раствор—без указания растворителя
I = Твердое состояние—без указания метода
K = Полиэтиленовая упаковка
M = Шестихлоробутадиеновая смесь
N = Температура пробы выше комнатной; проба в жидком состоянии
O = Монокристалл
P = Диск KCl
Q = Диск KI

ERKLÄRUNG

Die links von der STRUKTURFORMEL einer jeden Verbindung stehenden Angaben haben die folgende Bedeutung:

1 **Auf der ersten Zeile** steht die WELLENZAHL in cm^{-1} sowie ein oder zwei Kennbuchstaben, die die INTENSITÄT des Bandes angeben (siehe Intensitäts-Kennbuchstaben unten). Nach Möglichkeit ist für Gase die Bandmitte oder jeweilige Bandseite mitgeteilt.

2 **Die zweite Eintragung** enthält entweder einen Kennbuchstaben, der den PHYSIKALISCHEN ZUSTAND bezeichnet, in dem das Spektrum ermittelt wurde (siehe Zustands-Kennbuchstaben unten), oder das für die Probe benutzte Lösungsmittel (sowie nachstehend die Konzentration in eckigen Klammern und die Zellendicke, falls zutreffend).



3 **Die nächste Zeile** ist für BESONDERE ANGABEN vorbehalten, wie z.B. das benutzte Dispersionselement, das Prismenmaterial usw. Sofern keine Angaben gemacht sind, kann der Leser annehmen, dass ein NaCl-Prisma benutzt wurde.

4 **Die Eintragung in eckigen Klammern** auf der letzten Zeile gibt die STRUKTURGRUPPE an, der die Schwingung im Originalbericht zugeteilt worden war—diese kann entweder der ursprünglichen oder der isomerischen Form der Verbindung angehören —, sowie die Schwingungsart, falls zutreffend.

5 **Die Zahl in der rechten unteren Ecke** stellt die BEZUGSZAHL dar und bezieht sich auf die Quellenliste auf S. 429-434.

Intensitäts-Kennbuchstaben

(Die Einstufung der Intensität bezieht sich auf alle anderen Bänder eines gegebenen Spektrums, ausser in Fällen, wo verschiedene Bahnlängen und/oder Konzentrationen erforderlich waren, um alle Bänder zu erfassen. In diesen Fällen sind Bahnlänge und/oder Konzentration auf der zweiten Zeile angegeben.)

S = Stark, **M** = Mittel, **W** = Schwach, **V** = Sehr, **B** = Breit, **Sh** = Schulter, **Sp** = Scharf

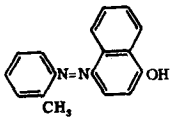
Zustands-Kennbuchstaben

(Die Temperatur ist nach dem Kennbuchstaben angeführt, falls sie nicht 25°C betrug.)

A = Dampf- oder Gaszustand (dahinter Druck und Bahnlänge, falls zutreffend)
B = Prüfung erfolgte im flüssigen Zustand (dahinter die Zellendicke, falls zutreffend)
C = Festzustand, pulverförmig
D = Festzustand, Filmform
E = Nujol-Öl
F = Fluorkohlenstoff-Öl
G = KBr-Scheibe
H = Lösung—Lösungsmittel nicht angegeben
I = Festzustand—Methode nicht angegeben
K = Polyäthylen-Beutel
M = Hexachlorbutadien-Mull
N = Prüfung oberhalb Zimmertemperatur im flüssigen Zustand
O = Einkristall
P = KCl-Scheibe
Q = KI-Scheibe

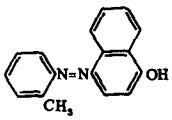
CONTENTS

▶3610 S
C_6H_{12}, C_2Cl_4



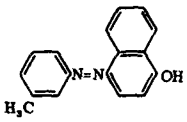
[OH] 35

▶3600 S
CCl_4



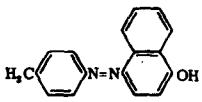
[OH] 35

▶3580 S
CH_2Cl_2



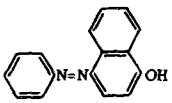
[OH] 35

▶3580 S
CH_2Cl_2



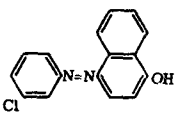
[OH] 35

▶3580 S
CH_2Cl_2



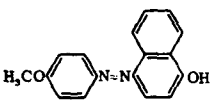
[OH] 35

▶3580 M
CH_2Cl_2



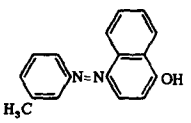
[OH] 35

▶3575 S
CH_2Cl_2



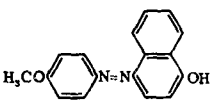
[OH] 35

▶3575 MS
$CHCl_3$



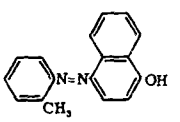
[OH] 35

▶3570 S
$CHCl_3$



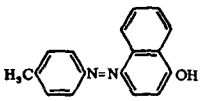
[OH] 35

▶3570 MS
CH_2Cl_2, $CHCl_3$



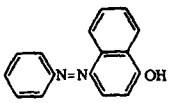
[OH] 35

▶3570 MS
$CHCl_3$



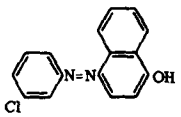
[OH] 35

▶3570 MS
$CHCl_3$



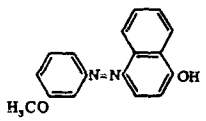
[OH] 35

▶3570 VW
$CHCl_3$



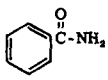
[OH] 35

▶3560 M
CH_2Cl_2, $CHCl_3$



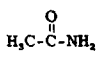
[OH] 35

▶3540 MW
CCl_4



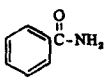
29

▶3538
$CHCl_3$



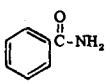
474

▶3525 MW
$CHCl_3$



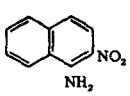
29

▶3520 MW
CCl_4



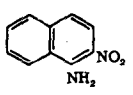
29

▶3520 MW
CCl_4
CaF_2

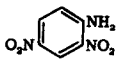


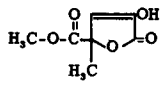
[NH_2] 19

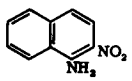
▶3519
$CHCl_3$
CaF_2



[NH_2] 19

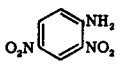
▶3517
CCl_4
CaF_2

[NH_2] 19

▶3516 M
CCl_4

[OH] 475

▶3516 Sh
$CHCl_3$
CaF_2

[NH_2] 19

▶3511 M
CCl_4, $CHCl_3$
CaF_2

[NH_2] 19

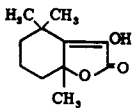
▶3511
$CHCl_3$
CaF_2

[NH_2] 19

▶3510
$CHCl_3$, CCl_4

327

▶3510
$CHCl_3$

327

▶3507 M
CCl_4

[OH] 475

▶3504

477

▶3504 MW
$(C_2H_5)_2O$
CaF_2

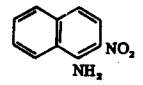
[NH_2] 19

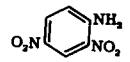
▶3504 Sh
$(C_2H_5)_2O$
CaF_2

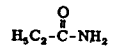
[NH_2] 19

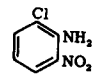
▶3501 MW
C_6H_6
CaF_2

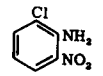
[NH_2] 19

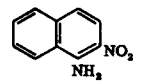
▶3501 MW
C_6H_6
CaF_2

[NH_2] 19

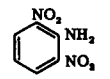
▶3500
C_6H_6
CaF_2

[NH_2] 19

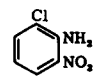
▶3500

465

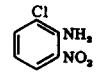
▶3497 MW
$C_6H_5NO_2$
CaF_2

[NH_2] 19

▶3495
C_5H_5N
CaF_2

[NH_2] 19

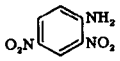
▶3490
$C_6H_5NO_2$
CaF_2

[NH_2] 19

▶3488 W
C_5H_5N
CaF_2

[NH_2] 19

▶3487 MW
CH_3CN
CaF_2

[NH_2] 19

▶3487 Sh
$CHCl_3$
CaF_2

[NH_2] 19

▶3484 M
$C_5H_5NO_2$
CaF_2

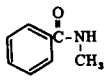


[NH_2] 19

▶3481

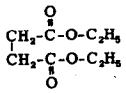
479

▶3480 W
CCl_4 [0.3 g/ml]



2

▶3480



[C=O overtone] 478

▶3480
$CHCl_3$, CCl_4
CaF_2

[NH_2] 470

▶3479 MW
$(C_2H_5)_2O$
CaF_2

[NH_2] 19

▶3478 S
$CHCl_3$
CaF_2

[NH_2] 19

▶3478 M
CH_3CN
CaF_2

[NH_2] 19

▶3477 M
$(C_2H_5)_2O$
CaF_2

[NH_2] 19

▶3476 S
C_2Cl_4
CaF_2

[NH_2] 19

▶3475 S
CCl_4
CaF_2

[NH_2] 19

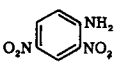
▶3475 M
C_6H_6
CaF_2

[NH_2] 19

▶3474 M
C_5H_5N
CaF_2

[NH_2] 19

▶3474 MW
CH_3CN
CaF_2



[NH_2] 19

▶3473 M
$C_6H_5NO_2$
CaF_2

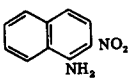
[NH_2] 19

▶3470

CH_3NH_2

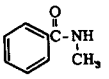
480

▶3464 MW
CH_3CN
CaF_2



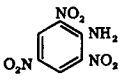
[NH_2] 19

▶3460 W
CCl_4 [0.007 g/ml]



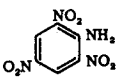
[NH] 2

▶3457 MS
C_2Cl_4, $CHCl_3$
CaF_2



[NH_2] 19

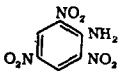
▶3457 M
CH_3CN
CaF_2



[NH_2] 19

3456

▶3456 S
C_6H_6
CaF_2



[NH_2] 19

▶3420 M
$CHCl_3$

327

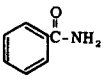
▶3420
CCl_4

327

▶3455 MW
C_5H_5N
CaF_2

[NH_2] 19

▶3420 MW
CCl_4

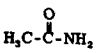


29

▶3454
$CHCl_3$
CaF_2

[NH_2] 470

▶3420
$CHCl_3$

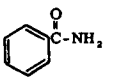


474

▶3450 M
E

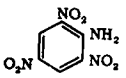
327

▶3410 M
$CHCl_3$



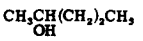
29

▶3450 Sh
C_5H_5N
CaF_2
CaF_2



[NH_2] 19

▶3401 MS
CCl_4 [5%]

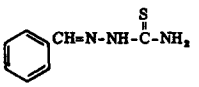


318

▶3450

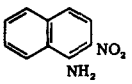
483, see also 36, 44, 482

▶3400 S



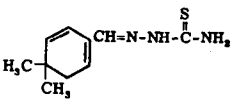
380

▶3443 M
$(C_2H_5)_2O$
CaF_2



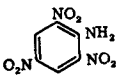
[NH_2] 19

▶3400 S



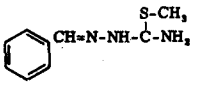
380

▶3437
P
CaF_2



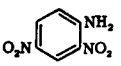
[NH_2] 19

▶3400 S



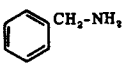
380

▶3435 M
C_5H_5N
CaF_2



[NH_2] 19

▶3400



383

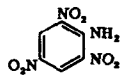
▶3435 M
E

327

▶3400
$CHCl_3$

327

▶3395 MW
C_5H_6N

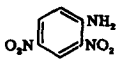


19

▶3394
CCl_4
CaF_2

$[NH_2]$ 470

▶3393
CCl_4
CaF_2

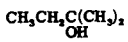


$[NH_2]$ 19

▶3392 M
$(C_2H_5)_2O$, CCl_4, $CHCl_3$
CaF_2

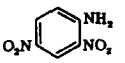
$[NH_2]$ 19

▶3391 MS
CCl_4 [5%]



194

▶3391
$CHCl_3$
CaF_2

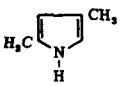


$[NH_2]$ 19

▶3388 M
C_6H_6
CaF_2

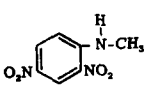
$[NH_2]$ 19

▶3385 VVS
B (0.055)
CaF_2



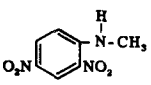
344

▶3384 S
C_6H_6
CaF_2



[NH] 19

▶3383 S
CCl_4
CaF_2

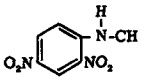


[NH] 19

▶3383 MW
C_5H_5N
CaF_2

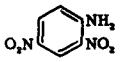
$[NH_2]$ 19

▶3382 M
CH_3CN
CaF_2



19

▶3381
C_6H_6
CaF_2

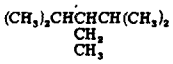


$[NH_2]$ 19

▶3381 M
$C_6H_5NO_2$
CaF_2

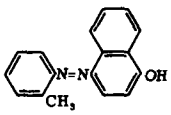
$[NH_2]$ 19

▶3380 MWSh
B (0.169)



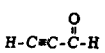
301, see also 472

▶3380 MW
CCl_4



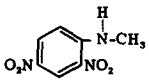
[NH] 35

▶3380 MSh
A



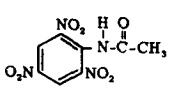
18

▶3380 VS
$CHCl_3$
CaF_2



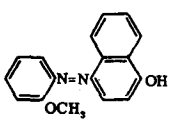
[NH] 19

▶3380 M
CCl_4, C_6H_6, $CHCl_3$
CaF_2



[NH] 19

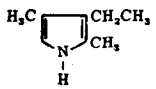
▶3380 M
C_6H_{12}



[NH] 35

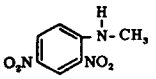
3379

▶3379 VVS
B (0.055)
CaF_2



343

▶3378 M
$C_6H_5NO_2$
CaF_2



[NH] 19

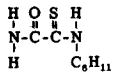
▶3376
$CHCl_3$
CaF_2

$[NH_2]$ 470

▶3373 MW
CH_3CN

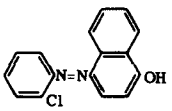
19

▶3372 MS
G



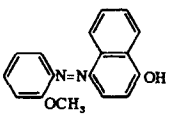
$[NH_2]$ 31

▶3370 M
C_6H_{12}, CCl_4, C_2Cl_4



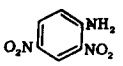
[NH] 35

▶3370 M
C_2Cl_4, CCl_4



[NH] 35

▶3368 S
$C_6H_5NO_2$
CaF_2



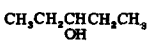
$[NH_2]$ 19

▶3367 VS
V

$(CH_3)_2CHOH$

460

▶3367 VS
CCl_4 [5%]



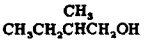
196

▶3367 S
CCl_4 [5%]

$(CH_3)_2CHCH_2CH_2OH$

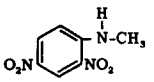
195

▶3367 MS
CCl_4 [25%]



321

▶3365 M
$(CH_3)_2CO$
CaF_2

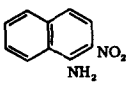


[NH] 19

▶3364 M
$CHCl_3$
CaF_2

$[NH_2]$ 19

▶3363 MW
$CHCl_3$
CaF_2

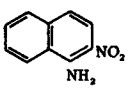


$[NH_2]$ 19

▶3362 M
C_6H_6, $C_6H_5NO_2$, $(C_2H_5)_2O$
CaF_2

19

▶3362 M
CCl_4, C_6H_6
CaF_2

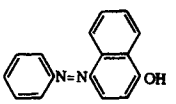


$[NH_2]$ 19

▶3361 M
C_2Cl_4
CaF_2

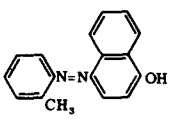
$[NH_2]$ 19

▶3360 W
CH_2Cl_2, $CHCl_3$



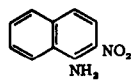
[NH] 35

▶3360 W
CH_2Cl_2, $CHCl_3$



[NH] 35

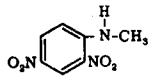
▶3360 M
$C_6H_5NO_2$
CaF_2



[NH_3] 19

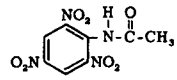
▶3360
CH_3NH_2
480

▶3360 MW
C_5H_5N
CaF_2



[NH] 19

▶3359 MW
$C_8H_8N_2O_3$
CaF_2



[NH] 19

▶3358 M
C_6H_5N
CaF_2

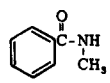
[NH_3] 19

▶3358 M
CCl_4
CaF_2

[NH_2] 19

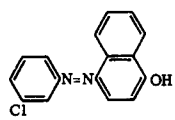
▶3356 VS
CCl_4 [5%]
$CH_3CH_2CH_2OH$
314

▶3350 W
CCl_4 [0.007 g/ml]



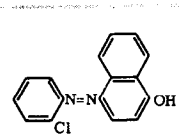
[NH] 2

▶3350 M
CH_2Cl_2



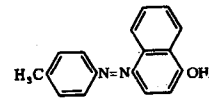
[NH] 35

▶3350 M
CH_2Cl_2



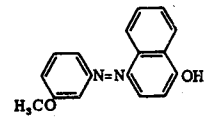
[NH] 35

▶3350 M
CH_2Cl_2, $CHCl_3$



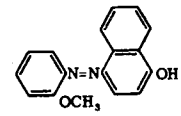
[NH] 35

▶3350 M
CH_2Cl_2, $CHCl_3$



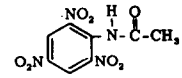
[NH] 35

▶3350 MS
CH_2Cl_2



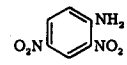
[NH] 35

▶3349 MW
CH_3CN
CaF_2



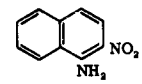
[NH] 19

▶3348 MS
CH_3CN
CaF_2



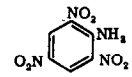
[NH_2] 19

▶3348 M
CH_3CN
CaF_2



[NH_2] 19

▶3344 MS
$CHCl_3$, C_2Cl_4, C_6H_6
CaF_2

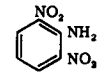


[NH_2] 19

▶3343 MW
$(C_2H_5)_2O$
CaF_2

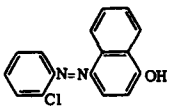
[NH_2] 19

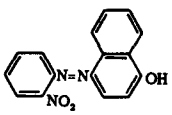
▶3342 Sh
$(C_2H_5)_2O$
CaF_2

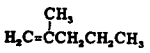


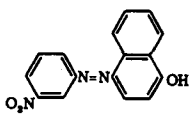
[NH_2] 19

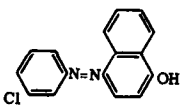
▶3340 MSh
B (0.169)
$(CH_3)_2CHCH_2CH_2CH(CH_3)_2$
137, see also 339

▶3340 M
E, G, $CHCl_3$

[NH] 35

▶3330 MS
C_2Cl_4

[NH] 35

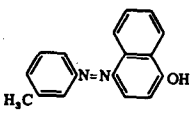
▶3340 VS
B (0.169)

206

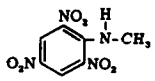
▶3330 M
$CHCl_3$

[NH] 35

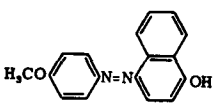
▶3340 M
$CHCl_3$

[NH] 35

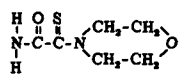
▶3330 M
E

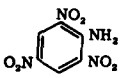
327

▶3340 W
CH_2Cl_2, $CHCl_3$

[NH] 35

▶3329 M
P, CH_3CN, C_5H_5N
CaF_2

19

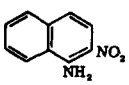
▶3340 W
CH_2Cl_2, $CHCl_3$

[NH] 35

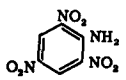
▶3325 S
G

[NH] 31

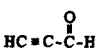
▶3339 M
CH_3CN
CaF_2

$[NH_2]$ 19

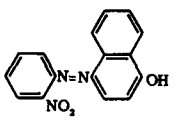
▶3325
A

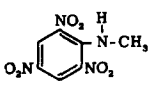
485

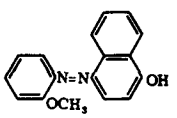
▶3336 M
$(C_2H_5)_2O$
CaF_2

$[NH_2]$ 19

▶3321 M
P
CaF_2

$[NH_2]$ 19

▶3335 VS
A

[≡CH] 18

▶3320 MS
E, G, CH_2Cl_2

[NH] 35

▶3334 M
$CHCl_3$, C_6H_6
CaF_2

[NH] 19

▶3320 M
E, G

[NH] 35

▶3334
E, $CHCl_3$

$[NH_2]$ 327

▶3334
CCl_4

327

▶3320
E, $CHCl_3$

327