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SPECTRAL CHARACTERIZATION OF SOME DYESTUFFS USED IN THE EASTERN TOWNSHIPS OF QUEBEC

by

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ABSTRACT

A review is made of methods of determination of dyes in different media. Due to the widely varying chemical nature of dyes, there is no single method which would suffice for their chromatographic separation from each other and from natural co-extractives. The best current methods involve high performance liquid chromatography with a diode array spectrophotometric detector. This method naturally requires a library of dye spectra. Twenty-two dyestuffs which are commonly used in the Eastern Townships of Quebec are identified, and their ultraviolet-visible spectra are determined.

RÉSUMÉ

On passera en revue les méthodes de détermination de la présence de colorants dans différents milieux. Comme ils sont de natures chimiques très variées, il n'y a pas de méthode unique qui permette la séparation chromatographique des colorants entre eux, ni de leurs substances co-extractives naturelles. À l'heure actuelle, la meilleure méthode consiste en une chromatographie en phase liquide poussée avec un dispositif spectrophotométrique à diodes. Elle requiert évidemment un répertoire des spectres des colorants. On identifie vingt-deux colorants souvent utilisés dans la région des Cantons de l'Est, au Québec, et on détermine leurs spectres dans l'ultra-violet et dans le visible.

MANAGEMENT PERSPECTIVE

Dyestuffs are high volume chemicals which may enter aquatic environments in significant quantities. Interest in the environmental behaviour of dyestuffs arose largely from concerns about carcinogenicity. Very little is known of the environmental occurrence, persistence and fate of dyes, largely because of formidable analytical difficulties.

A review is made of methods of determination of dyes in different media. Due to the widely varying chemical nature of dyes, there is no single method which would suffice for their chromatographic separation from each other and from natural co-extractives. The best current method involves high performance liquid chromatography with a diode array spectrophotometric detector. This method naturally requires a library of dye spectra. Twenty-two dyestuffs which are commonly used in the Eastern Townships of Quebec are identified, and their ultraviolet-visible spectra are determined.

PERSPECTIVE DE GESTION

Les colorants sont des produits chimiques utilisés de façon massive, et peuvent donc se trouver en quantités notables dans le milieu aquatique. On s'est intéressé à leur comportement environnemental surtout parce qu'on craint qu'ils ne soient carcinogéniques. On a très peu de données sur leur présence dans l'environnmeent, leur persistance et leur sort final, en grande partie à cause d'énormes difficultés d'analyse.

On passera en revue les méthodes de détermination de la présence de colorants dans différents milieux. Comme ils sont de natures chimiques très variées, il n'y a pas de méthode unique qui permette la séparation chromatographique des colorants entre eux, ni de leurs substances co-extractives naturelles. À l'heure actuelle, la meilleure méthode consiste en une chromatographie en phase liquide poussée avec un dispositif spectrophotométrique à diodes. Elle requiert évidemment un répertoire des spectres des colorants. On identifie vingt-deux colorants souvent utilisés dans la région des Cantons de l'Est, au Québec, et on détermine leurs spectres dans l'ultra-violet et dans le visible.

INTRODUCTION

Man has used dyes for at least a few thousand years, and today the chemistry of dyes and dyeing processes has very great technical importance. Alizarin, extracted as the glycoside rubierythric acid from madder, was used by the ancient Egyptians and Persians (1). The use of indigo dates back to 3000 B.C., and Tyrian Purple, prepared from a sea snail, has been used since the Roman era. In 1856, Perkin prepared the first synthetic dyestuff, mauveine (1). Early important applications of synthetic organic chemistry were mainly in the field of dyestuffs.

The distinction between dyes and pigments is largely made on the basis of solubility. Pigments have extremely low solubililties in water, and are not very soluble in organic solvents either, generally being applied in the solid state. Dyes are generally more soluble either in water or organic solvents.

Dyes are classified according to both chemical structure and type of application. Chemical classes include azo, stilbene, di- and triphenylmethane, xanthene, acridine, quinoline, methine, azine, oxazine, thiazine, sulfur, anthraquinone, indigoid and phthalocyanine moieties. Application types include acidic, basic, direct, disperse, mordant, reactive, sulfur and vat dyes. Table 1 describes the applications of various dyes. Dyes are classified in the Colour Index (3), which lists 8000 different active ingredients and many more formulations. The classification includes the application type, the colour

and a five digit number (e.g., Disperse Blue 26, C.I. No. 63305). In addition, each dye, like any other chemical, has a Chemical Abstracts Service number. Dyestuffs are large volume industrial chemicals. Global production in 1978 was estimated to be 6.4 $x10^8$ kg of active ingredient (1). About 10^8 kg were produced in the United States in 1986 (2). It has been estimated that 90% of dyes applied end up in fabrics, with the remaining 10% discharged to waste streams (4). Table 2 shows data for 1982 on the importation of dyes and pigments to Canada. Most dyes are imported into Quebec and pigments into Ontario.

Interest in the environmental behaviour of dyes arose largely from concerns about carcinogenicity. Some dyes are carcinogens (6) and others after transformation yield compounds such as aromatic amines which may be carcinogenic or otherwise toxic (e.g., ref. 7). Very little is known of the environmental occurrence, persistence and fate of dyes, largely because of formidable analytical difficulties.

Methods of analysis of individual dyes and mixtures of dyes in different media are shown in Table 3. Determinations of known single dyes are straightforward, involving extraction with a suitable solvent and spectrophotometric detection.

Methods of analysis of mixtures of dyes in complex matrices are considerably more complex, involving extraction and determination by sophisticated spectrophotometric and mass spectrometric techniques. The following discussion will be divided into considerations of chromatographic separation and detection.

Due to the widely varying chemical nature of dyestuffs, there is no single method which would suffice for their chromatographic separation from each other and from natural co-extractives. Gas-liquid chromatography is in general unsuitable because of the low vapour pressures of dyes and their thermal lability at high temperatures. Methods of determination which currently show the most promise involve high performance liquid chromatography (HPLC). For two of the more common and large-volume classes of dyes, disperse and acid dyes, reverse-phase HPLC with an ion pair reagent appears to be suitable. Disperse dyes alone could be determined solely by reverse-phase HPLC, but the acid dyes require an ion-pair reagent. Ion pair methods may also suffice for other classes of dyes. Basic dyes have been determined by normal phase HPLC.

The most commonly used HPLC detector for the determination of dyestuffs has been the variable wavelength ultraviolet-visible detector. It has been most often used at a fairly non-specific wavelength such as 220 nm, and at that wavelength, it is probable that there will be interferences from other chemicals. A useful screening method has been to analyze the sample at wavelengths characteristic of certain colours, e.g., 420, 520 and 620 nm for yellow, red and blue dyes, respectively. This can be very time-consuming. A more suitable detector for HPLC determination of dyes is the diode array spectrophotometric detector. A diode array detector (DAD) can yield 190-800 nm spectral scans of HPLC effluent as often as every 20 ms. For this technique to be useful, a library of dye spectra must be

established. In addition, because of the large volumes of data acquired in full-wavelength scanning of a chromatographic determination lasting, e.g., 20 min., subsequent data manipulation can be slow and with some current instrumentation can not be accomplished in "background" mode while the DAD is acquiring data for the next chromatographic run in real time. This method, however, is the current method of choice. A newer technique which has not yet been used with dyes but which holds a great deal of promise is HPLC with a particle beam mass spectrometer. This technique yields electron impact mass spectra, which would allow an unambiguous assignment of structures.

Table 4 lists 22 dyes which are used in the Eastern Townships of Quebec. Although these are not by any means the only dyes which are used, they, or similar dyes, might be expected to be discharged by industries on, e.g., the Yamaska River. This report contains structural information on these dyes, and their ultraviolet-visible spectra which are necessary in the development of the spectral libraries for standards for the HPLC-DAD method.

EXPERIMENTAL SECTION

Ultraviolet-visible (UV-VIS) spectra were recorded in 1 cm cuvettes at room temperature in pH 2, 7 and 10.8 buffers with a Shimadzu UV-260 spectrophotometer (Tekscience, Oakville, Ontario). In some cases, methanol was used to solubilize the dyes. Spectra were not obtained for Direct Black 22 and Direct Black 91 since they were

not soluble in water, methanol, ethanol, n-amyl alcohol, ethyl acetate, acetonitrile, acetic acid, toluene or dichloromethane.

RESULTS AND DISCUSSION

The Chemical Abstracts Service numbers, Colour Index numbers, chemical formulae, molecular weights and structures of the 22 dyes listed in Table 4 are given in Tables 5-26. The UV-VIS spectra of those 20 dyes which were soluble in water or common solvents are given in Tables 27-46 in the form of extinction coefficients at 10 nm intervals. Table 47 lists the wavelength of maximal absorption in the visible region of the spectrum for each of these 20 dyes at pH 7. The dyes are listed in order of increasing λ_{max}. Although in several cases the wavelengths of maximal absorbance are very close to each other, full spectral analysis is capable of resolving them.

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Table 1. Classes of dyestuffs.*

ACID

Water-soluble, anionic dyes used primarily on nylon, wool, silk, and modified acrylic textiles. They consist of azo, anthraquinone and triarylmethane compounds with a few azine, xanthene, ketone, imine, nitro, nitroso and quinoline compounds. Acid dyes are applied in the presence of an organic or inorganic acid.

AZOIC

Azoic dyes are used as complementary dyes with pigments or mordant dyes on cellulosic fibers. All of these dyes contain chromophoric groups located between aromatic systems.

BASIC

Water-soluble, cationic dyes for application to modified acrylics, modified nylons, modified polyesters, leather, unbleached paper, and inks. Acrylic, nylon and polyester fibers are modified by incorporation of acidic groups as dye sites in the fiber to increase its ability to be dyed with basic dyes. Principal chemical classes of basic dyes are azo, anthraquinone, triarylmethane, methine, thiazine, oxazine, acridine, and quinoline. The dyes are applied in acidic dyebaths to fibers made of negatively charged polymer molecules.

DIRECT

Water-soluble, anionic dyes used for colouring cotton, rayon, other cellulosic fibers, leather and paper. Dyes of this class include azo and metallized azo compounds, as well as stilbenes, thiazoles, phthalocyanines and oxazines.

DISPERSE

Water-insoluble, non-ionic dyes used on polyester, nylon, cellulose diacetate, cellulose triacetate and acrylic fibers. Chemical types include azo, anthraquinone, nitro, methine, and quinoline compounds. Disperse dyes are applied as aqueous dispersions, either by high-temperature pressure methods, or low-temperature carrier methods.

FIBER-REACTIVE

Water-soluble, anionic dyes containing a reactive group (such as dichlorotriazine, monochlorotriazine or vinylsulfone) that can form a covalent bond with a compatible group on the substrate. Such covalent groups may be formed with the hydroxyl groups of cellulosic fibers such as cotton and rayon, or with the amino groups in nylon, silk and wool.

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Table 1. (cont'd)

FLUORESCENT BRIGHTENERS

Colourless compounds that absorb incident ultraviolet light and re-emit in the blue region of the spectrum. Although not strictly considered as dyes, fluorescent brighteners are used in textiles as well as in soaps and detergents and add light to a subtrate. The class includes stilbene, azole, coumarin, pyrazine and naphthalimide chemical types. Application is from solution, dispersion or suspension.

FOOD, DRUG AND COSMETIC

Synthetic organic colourants that are subject to health certification for use in foods, drugs and cosmetics. These dyes consist of azo, anthraquinone, carotenoid and triarylmethane compounds.

MORDANT

Mainly used to dye wool, but the class has secondary applications for dyeing silk, nylon, leather and anodized aluminum. A mordant helps fix dye to the fiber in the form of a complex. Mordants contain chemical groups capable of reacting with salts of aluminum, chromium, cobalt, copper, and iron to give differently coloured metal complexes.

SOLVENT

Dyes used principally in lacquers, varnishes, printing inks and plastics. Chemical types include azo, triphenylmethane, anthraquinone and phthalocyanine. Solvent dyes are soluble in organic solvents, which are used to disperse the dyes in the substrate.

SULFUR

Water-soluble dyes used on cotton, rayon and cellulosic blends with nylon, acrylic and polyester. These dyes contain sulfur both as a part of the chromophore and in polysulfide pendant chains.

VAT

Water-insoluble dyes applied in dispersions used principally for dyeing and printing cotton. Chemical classes of vat dyes include anthraquinones and indigoids.

*Ref. 2

Table 2. Importation of Formulated Dyes to Canada in 1982.*

Category	Imported to					
	Quebec		Ontario		Other Provinces	
	10^3 kg	% total	10^3 kg	% total	10^3 kg	% total
acid	468	76.8	141	23.1		0.1
azoic	20	100.0				
basic	512	62.1	233	28.3		1.0
chrome	20	36.0	35	64.0		
direct	401	92.0	35	8.0		
disperse	592	88.6	76	11.3		
sulfur	1048	98.6	15	1.4		
vat	245	45.2	295	54.5		
reactive	340	81.1	62	14.7		4.1
pigments (organic)	256	14.9	1457	84.6		
pigments (inorganic)	195	24.3	550	68.8		5.2
oil, spirit and wax dyes	141	37.1	225	59.4		3.0
cosmetic	25	61.4	15	36.5		
drug			13	96.9		
food	3	2.6	96	97.2		
food, drug and cosmetic	15	39.0	23	61.4		
non-specified	615	59.1	350	33.6		
textile	337	63.7	188	35.5		
TOTALS						
dyes	4785	70.6	1801	26.6		2.1
pigments	451	17.9	2007	79.6		

*Ref. 5

Table 3. Methods of determination of dyestuffs.

Individual dyes	Method	Ref.
disperse	organic solvent extraction, Florisil clean-up, TLC and sublimation, determination by IR and direct probe MS	8
various	determination of absorbance	9
various	determination of absorbance	4
various	determination of absorbance	10
Disperse Blue 295 in water and carp	(a) water: add acetone, extract with CCl_4, dry with Na_2SO_4, determine (A_{625} - A_{800}), which is a measure of dye concentration; (b) whole fish: homogenize with acetone, filter, dilute with water, determine as with water, with an acetone-water blank of similar composition	11
Acid Yellow 222 in fish	homogenize with hexane, discard hexane, reflux with NaOH, apply to anion exchange column, clean up by elution with acetic acid and propanol, elute dye with 2N HCl - isopropanol (1/1, v/v), determine A_{415}	12
disperse dyes in fish	homogenize whole fish, freeze-dry, extract with $CHCl_3$, apply to Sephadex LH-20 column, elute with $CHCl_3$, determine spectrophotometrically at wavelength suitable for the particular dye	13
Basic Yellow 49 in fish	homogenize fish, decompose with pepsin, elute from Sephadex G-10 column with 0.1% aqueous KBr, determine A_{435}	14
Reactive Red 158 in fish	homogeneize fish, decompose with subtilisin, apply to anion exchange column, elute impurities with acetic acid, elute dye with 4N HCl/n-propanol (1/1, v/v), determine A_{550}	15
Reactive Blue 121 in fish	decompose whole fish with sulfuric acid - nitric acid, determine Cr by diphenyl carbazide method	16
reactive dyes in water	extract with liquid ion exchange resin dissolved in $CHCl_3$, determine spectrophotometrically	17
Cr, Ni and Co-containing dyes in fish	homogenize fish, decompose in HNO_3/HCl (9/1, v/v), freeze-dry, redissolve in 1% HCl, analysis by GFAAS	18

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Table 3. (cont'd)

Individual dyes	Method	Ref.
dye standards	direct probe field desorption and electron impact mass spectrometry	19
reactive and acid dyes in fish	homogenize whole fish, decompose with urea, adsorb to DEAE-cellulose, elute impurities with water, isopropanol and acetic acid, elute dye with 3N HCl/isopropanol (1/1, v/v), determine spectrophotometrically	20
Acid Green 108 in fish	homogenize whole fish, disintegrate with urea, injection on LiChrosorb-NH_2 HPLC column, elution of interferents with CH_3CN/water/acetic acid, elution of dye with gradient of same solvent system plus similar eluent containing ammonia, determination of A_{644}	21
xanthene dyes	C_{18} reverse-phase HPLC with spectrophotometric determination XAD-2	22
Acid Blue 1 in water	(a) adsorption to XAD-2, elution with methanol; determination of A_{640}; (b) separation from other acid blue dyes by HPLC with C_{18} column and ion pair reagent (tetrabutylammonium hydroxide) dissolved in CH_3OH/H_2O (1/1, v/v)	23
dyes in food	extraction with a liquid anion-exchange resin dissolved in n-butanol (digested before with enzymes, if necessary), re-extraction from resin phase into water, clean-up and concentration by polyamide column chromatography, determination by reverse-phase HPLC with ion pair reagent and spectrophotometric determination	24
various	direct probe secondary ion (desorption) MS	25
Sulforhodamine B standard	reversed-phase Thermospray LCMS	26
various standards	surface-enhanced Raman scattering spectrometry	27
various standards	HPLC-Thermospray-MS/MS	28
various standards	^{252}Cf plasma desorption MS	29
petroleum dyes	direct probe high resolution MS, with or without prior TLC separation	30
various	direct probe fission fragment and liquid secondary ion mass spectrometry (SIMS)	31

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Table 3. (cont'd)

Individual dyes	Method	Ref.
erythrosine and contaminants	organic and inorganic ion-pair reverse-phase HPLC with spectrophotometric determination	32
Rhodamine-123 in rat tissues	extraction with ethyl acetate/n-butanol (1/1, v/v), analysis by reverse-phase HPLC with fluorometric detection	33
various	HPLC with Thermospray MS	34
various	direct probe fast atom bombardment MS	35
impurities in Direct Blues 6 and 15	ion-pair reverse-phase HPLC with UV-VIS detection	36
chrysoidine dyes	high performance thin-layer chromatography	37

Dye Mixtures	Method	Ref.
azo, anthraquinone and sulfonated	separation of mixtures of standards by silica column (for disperse dyes) and weak anion exchange column (for sulfonated dyes)	38
acid and disperse dyes in water	(a) addition of dimethylformamide to increase solubility of the disperse dyes, adsorption of the dyes to XAD-2 resin, elution of disperse dyes with benzene, acid dyes with methanol followed by pyridine/tetrahydrofuran/1% ammonium hydroxide (40/40/20, v/v/v) (b) disperse yellow dyes are determined by HPLC on Partisil-10 with THF/cyclohexane gradient and monitoring A_{420} (c) disperse red dyes are determined with a different gradient at 520 nm (d) disperse blue dyes are determined with a different gradient at 620 nm (e) for acid dyes, determination by HPLC with C_{18} reverse phase column, methanol-water gradient and paired ion reagent tetrabutylammonium phosphate. Yellow, red and blue dyes are determined at 420, 520 and 615 nm, respectively.	39
acid and disperse dyes in mud	dry mud extracted in Soxhlet extractor with benzene for disperse dyes, followed by methanol, then pyridine/THF/1% ammonium hydroxide as above for dyes in water, subsequent analyses as above for water	39

cont'd next page

Table 3. (cont'd)

Dye Mixtures	Method	Ref.
direct dyes in water	as above for acid dyes in water	39
food dye standards	reverse-phase HPLC with cetyltrimethylammonium bromide ion pair reagent and isopropanol-water-acetic acid isocratic eluent	40
food dyes	reversed-phase HPLC with isocratic elution by methanol-water containing tetrabutylammonium hydroxide ion pair reagent	41
acid fast dyes in liquor	acidify to pH 2, extract with wool yarn, elute with 10% NH_4OH, determine by TLC or (better) reverse-phase HPLC with inorganic ion pair reagent in water-methanol gradient	42
acid food dye standards	reverse-phase HPLC with tetrabutylammonium hydroxide ion pair reagent in water-methanol gradients	43
cosmetic dyes	ion pair reversed-phase HPLC with spectrophotometric determination	44
various dyes	TLC separation	45
azo, diazo and anthraquinone dyes in water, soil and gasoline	(a) gasoline passed through silica gel Sep-PAK which was eluted with hexane to remove hydrocarbons, then methanol to remove dyes, and concentrated; (b) wastewater passed through C_{18} Sep-PAK which was eluted with methanol to remove dyes; (c) soil was sonicated with water, and the aqueous phase treated like wastewater above; (d) azo dyes determined by Zorbax C_{18} reversed phase HPLC-Thermospray - MS; (e) diazo and anthraquinone dyes determined as above, but on Zorbax TMS	46
mixtures of azo, aniline and anthraquinone dyes	capillary column supercritical pentane chromatography with UV determination	47
mixtures of aryl sulfonate dyes, precursors and metabolites	reversed-phase C_{18} HPLC with K_3PO_4 - methanol gradient (superior to organic ion pair methods), determination of A_{220}	48

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Table 3. (cont'd)

Dye Mixtures	Method	Ref.
various dyes	reversed-phase C_{18} HPLC with Na_2SO_4 - methanol gradient, monitoring A_{254} for all dyes, A_{430} for yellow dyes, A_{520} for red dyes and A_{640} for blue/green dyes	49
dyes in cosmetic samples	extraction with DMF-phosphoric acid, analysis by ion-pair reverse-phase HPLC with a diode array spectrophotometric detector	50
azo dyes in water	extraction with C_{18} cartridges (pretreated with triethylamine (TEA) to prevent irreversible dye adsorption), elution with methanol/water/TEA, determination by ion-pair reverse-phase microbore HPLC with UV or atmospheric pressure ionization MS	51
xanthene dyes in cosmetics	extraction with DMF-phosphoric acid, analysis by ion-pair reverse-phase HPLC with UV-VIS detection	52
acid dyes in fibres	extraction with pyridine/water (4/3, v/v), determination by organic ion-pair reverse-phase HPLC with diode array spectrophotometric detection	53
basic dye standards	normal phase HPLC with diode array UV-VIS detection	54

Table 4. List of some representative dyes used in the Eastern Townships of Quebec.*

Name	Colour Index No.
Acid Black 52	15711
Acid Orange 60	18732
Acid Red 73	27290
Basic Green 4	42000
Basic Orange 2	11270
Basic Violet 1	42535
Basic Violet 3	42555
Direct Black 22	35435
Direct Black 91	30400
Direct Blue 86	74180
Direct Blue 218	24401
Direct Yellow 4	24890
Direct Yellow 11	40000
Disperse Blue 26	63305
Disperse Blue 27	60767
Disperse Blue 56	63285
Disperse Blue 79	11345
Disperse Red 60	60756
Mordant Black 11	14645
Reactive Black 5	20505
Reactive Blue 19	61200
Reactive Orange 13	18270

*Ref. 55

Table 5. Acid Black 52

C.A.S. No. 5610-64-0

C.I. No. 15711

Chemical formula: $C_{48}H_{22}N_6O_{14}S_2Cr$

Molecular weight: 1022.87

Structure:

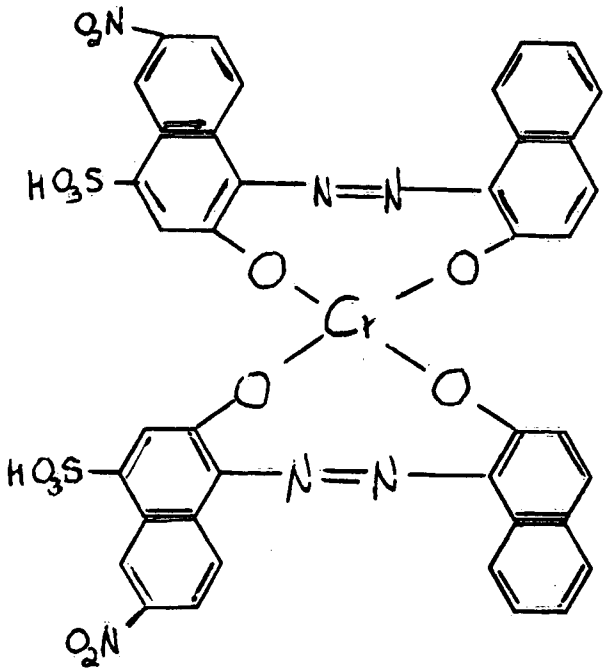

Table 6. Acid Orange 60

C.A.S. No. 30112-70-0

C.I. No. 18732

Chemical formula: $C_{32}H_{30}N_{10}O_6S_2Cu$

Molecular weight: 778.33

Structure:

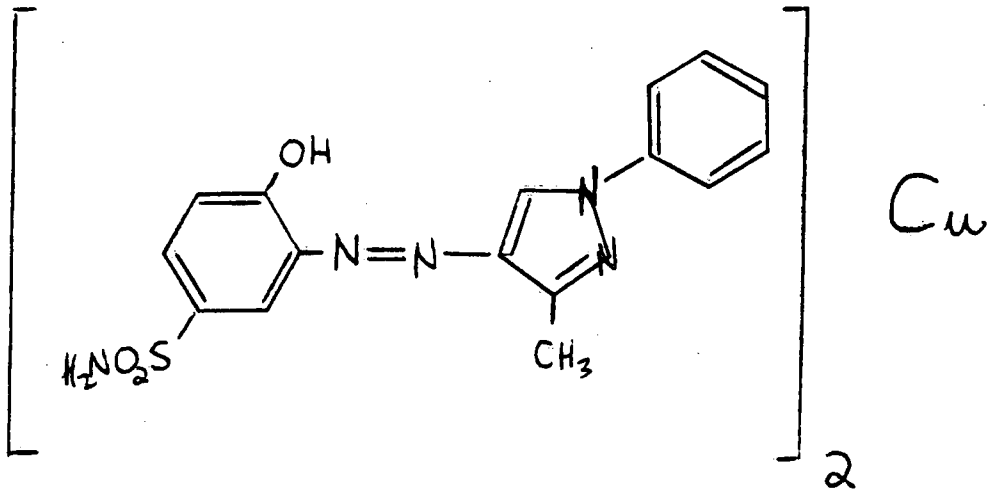

Table 7. Acid Red 73

C.A.S. No. 5413-75-2

C.I. No. 27290

Chemical formula: $C_{22}H_{14}N_4O_7S_2 \bullet 2Na$

Molecular weight: 556.49

Structure:

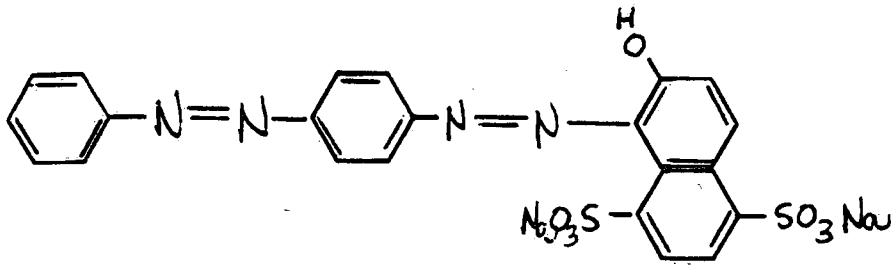

Table 8. Basic Green 4

C.A.S. No. 569-64-2

C.I. No. 42000

Chemical formula: $C_{23}H_{25}N_2Cl$

Molecular weight: 364.92

Structure:

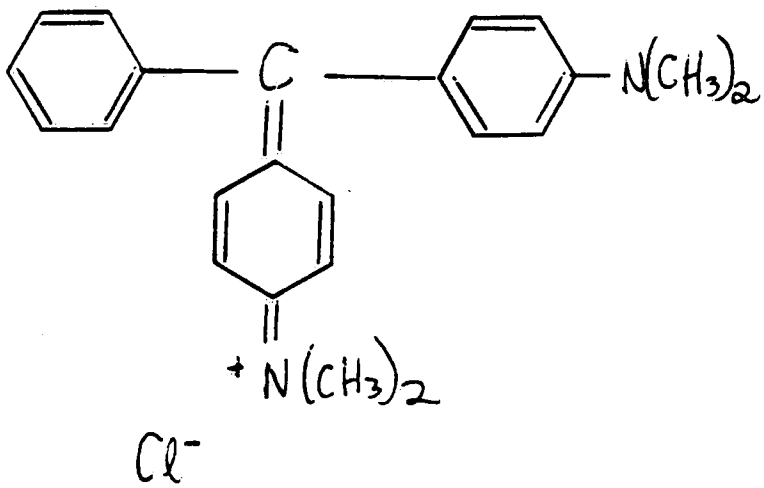

Table 9. Basic Orange 2

C.A.S. No. 532-82-1

C.I. No. 11270

Chemical formula: $C_{12}H_{13}N_4Cl$

Molecular weight: 248.72

Structure:

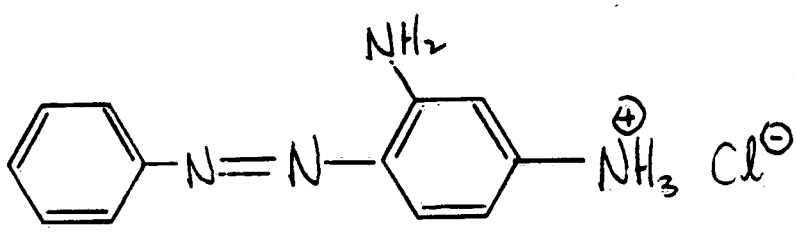

Table 10. Basic Violet 1

C.A.S. No. 8004-87-3

C.I. No. 42535

Chemical formula: $C_{24}H_{28}N_3Cl$

Molecular weight: 393.96

Structure:

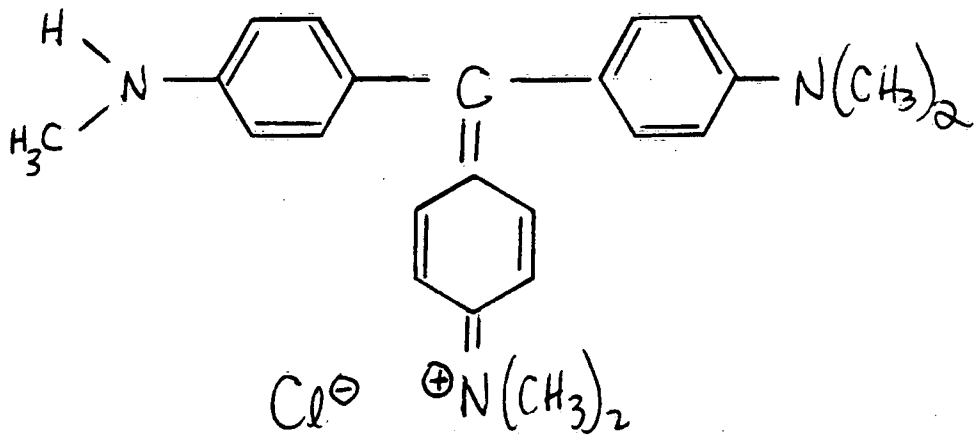

Table 11. Basic Violet 3

C.A.S. No. 548-62-9

C.I. No. 42555

Chemical formula: $C_{25}H_{30}N_3Cl$

Molecular weight: 407.99

Structure:

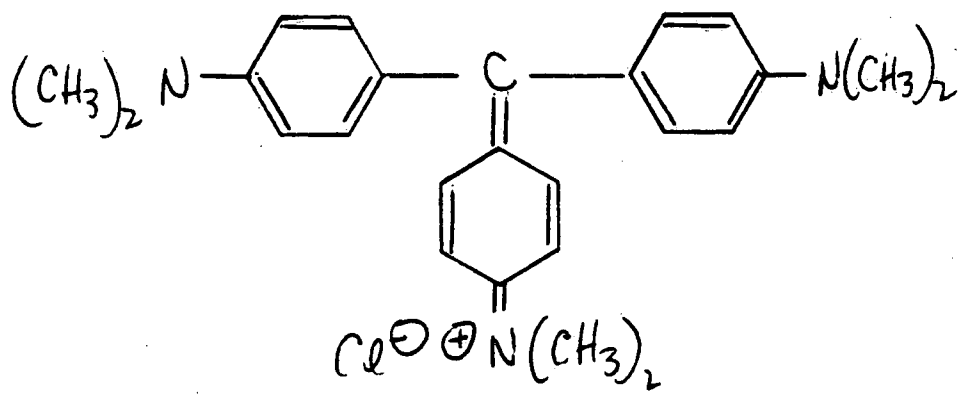

Table 12. Direct Black 22

C.A.S. No. 6473-13-8

C.I. No. 35435

Chemical formula: $C_{44}H_{32}N_{13}O_{11}S_3 \cdot 3Na$

Structure:

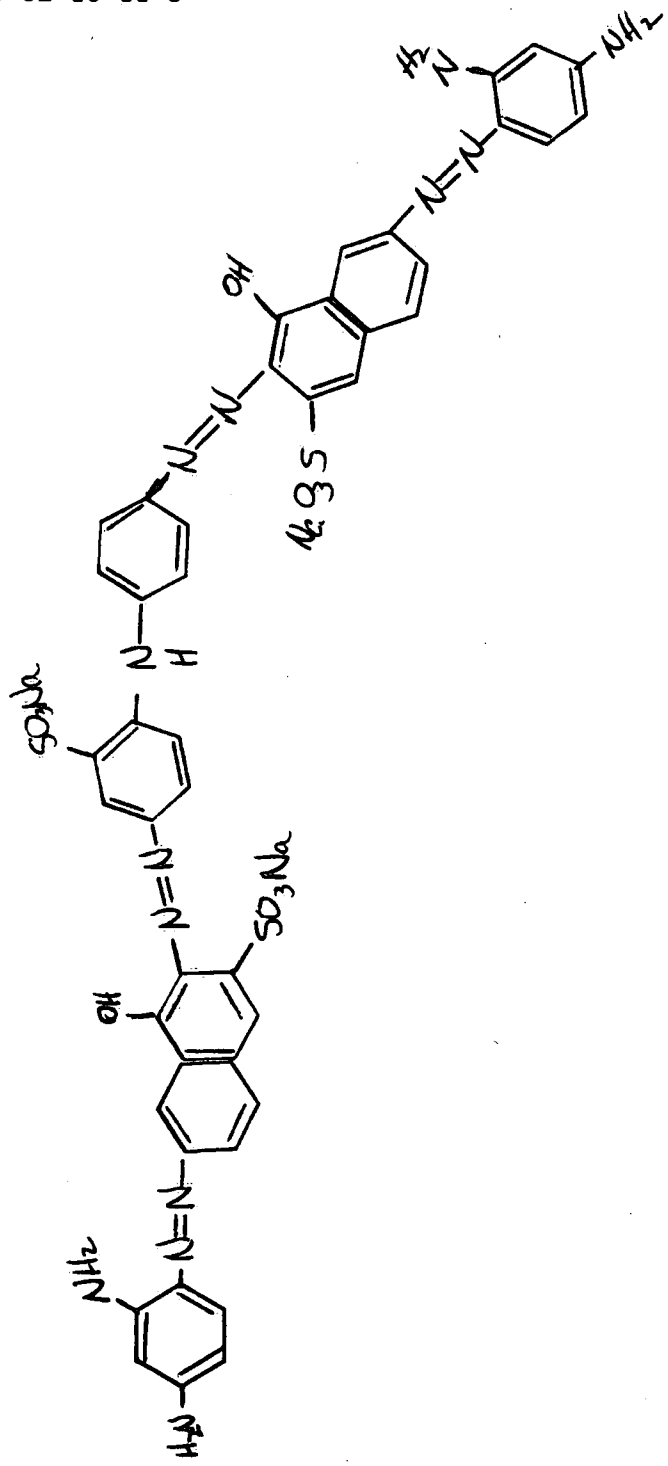

Table 13. Direct Black 91

C.A.S. No. 6739-62-4

C.I. No. 30400

Chemical formula: $C_{38}H_{25}N_8O_{13}S \bullet 3Na$

Molecular weight: 905.73

Structure:

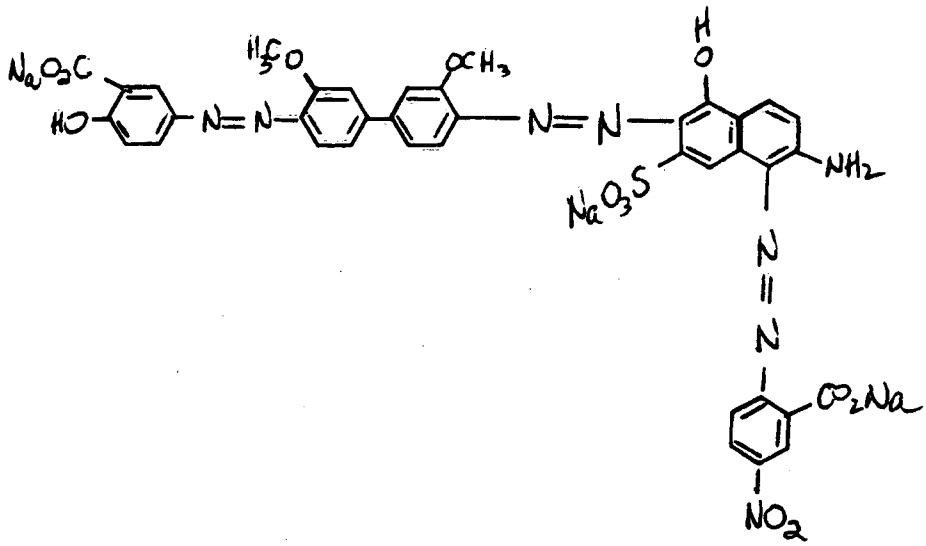

Table 14. Direct Blue 86

C.A.S. No. 1330-38-7

C.I. No. 74180

Chemical formula: $C_{32}H_{16}CuN_8O_6S_2$

Molecular weight: 736.20

Structure:

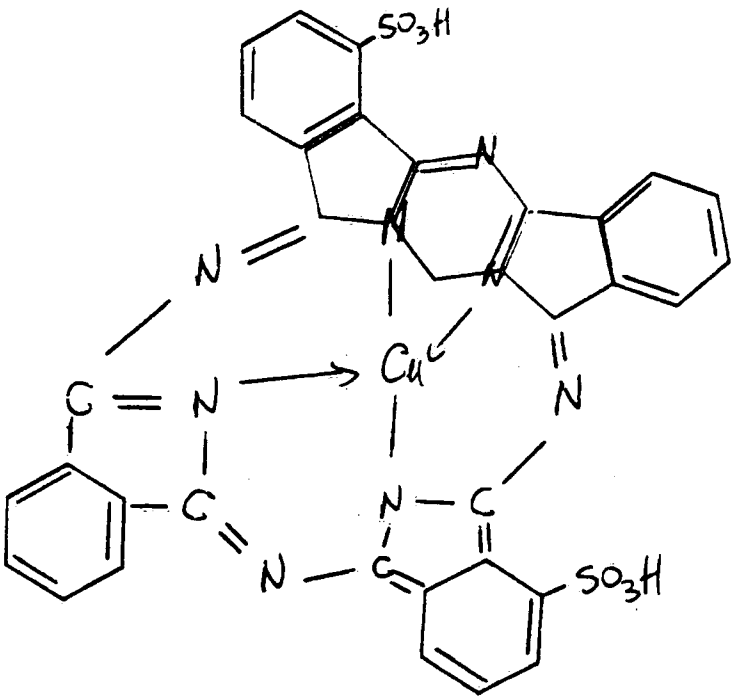

Table 15. Direct Blue 218

C.A.S. No. 10401-50-0

C.I. No. 24401

Chemical formula: $C_{36}H_{20}Cu_2N_6O_{10}S_2$

Molecular weight: 887.80

Structure:

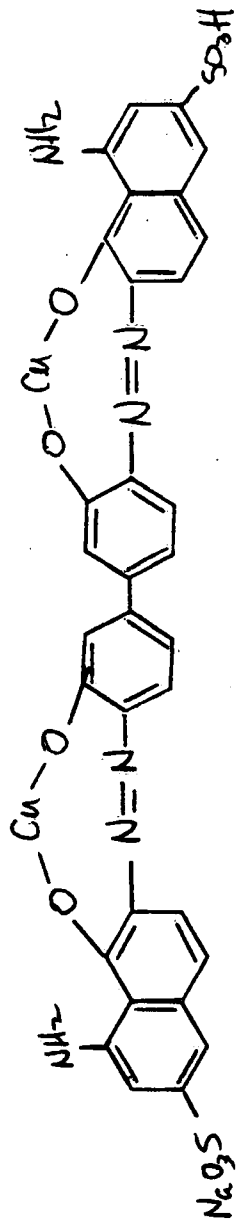

Table 16. Direct Yellow 4

C.A.S. No. 3051-11-4

C.I. No. 24890

Chemical formula: $C_{26}H_{20}N_4O_8S_2$

Molecular weight: 580.60

Structure:

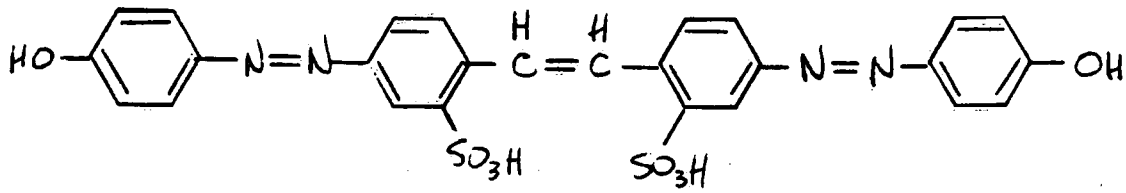

Table 17. Direct Yellow 11

C.A.S. No. 1325-37-7

C.I. No. 40000

Chemical formula: undefined

Molecular weight: undefined

Structure: a stilbene self-condensation product with 2-methyl-5-nitrobenzene sulfonic acid

Table 18. Disperse Blue 26

C.A.S. No. 3860-63-7

C.I. No. 63305

Chemical formula: $C_{16}H_{14}N_2O_4$

Molecular weight: 298.30

Structure:

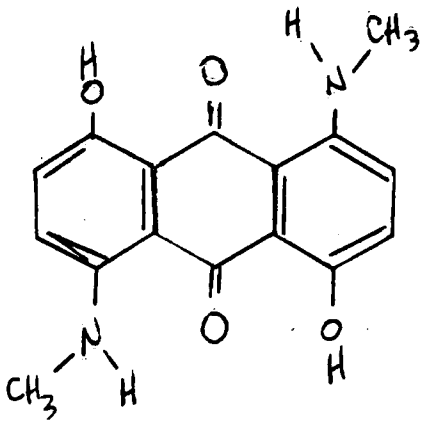

Table 19. Disperse Blue 27

C.A.S. No. 15791-78-3

C.I. No. 60767

Chemical formula: $C_{22}H_{16}N_2O_7$

Molecular weight: 420.38

Structure:

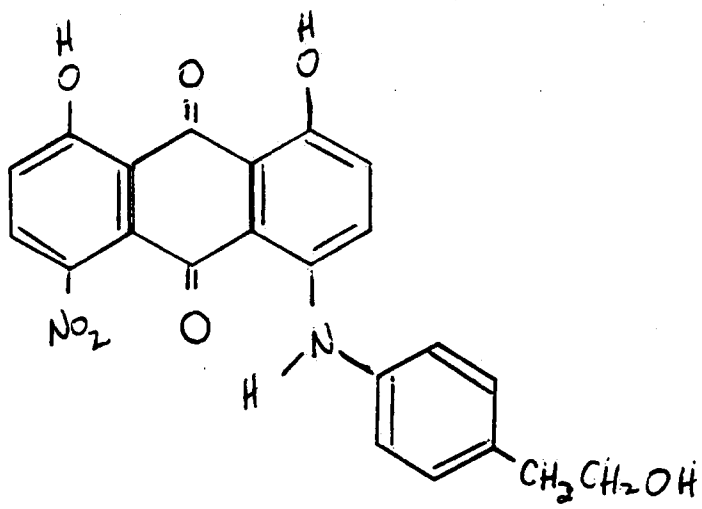

Table 20. Disperse Blue 56

C.A.S. No. 12217-79-7

C.I. No. 63285

Chemical formula: $C_{14}H_9ClN_2O_4$

Molecular weight: 304.69

Structure:

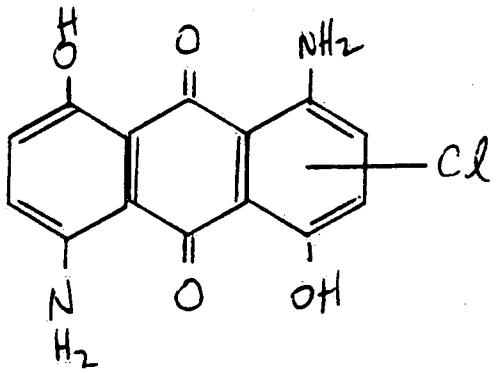

Table 21. Disperse Blue 79

C.A.S. No. 12239-34-8

C.I. No. 11345

Chemical formula: $C_{24}H_{27}BrN_6O_{10}$

Molecular weight: 639.43

Structure:

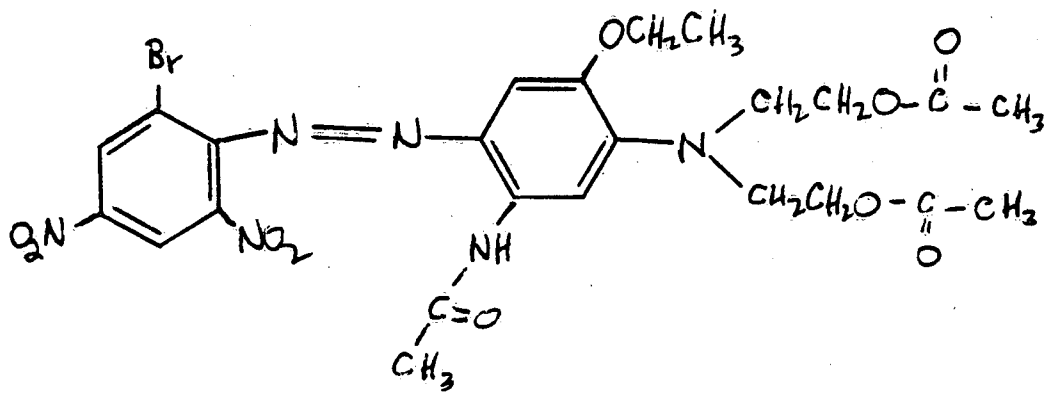

Table 22. Disperse Red 60

C.A.S. No. 17418-58-5

C.I. No. 60756

Chemical formula: $C_{20}H_{13}NO_4$

Molecular weight: 331.33

Structure:

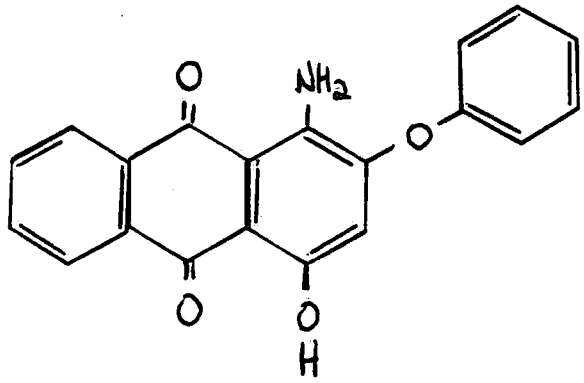

Table 23. Mordant Black 11

C.A.S. No. 25747-08-4

C.I. No. 14645

Chemical formula: $C_{20}H_{13}N_3O_7S$

Molecular weight: 439.41

Structure:

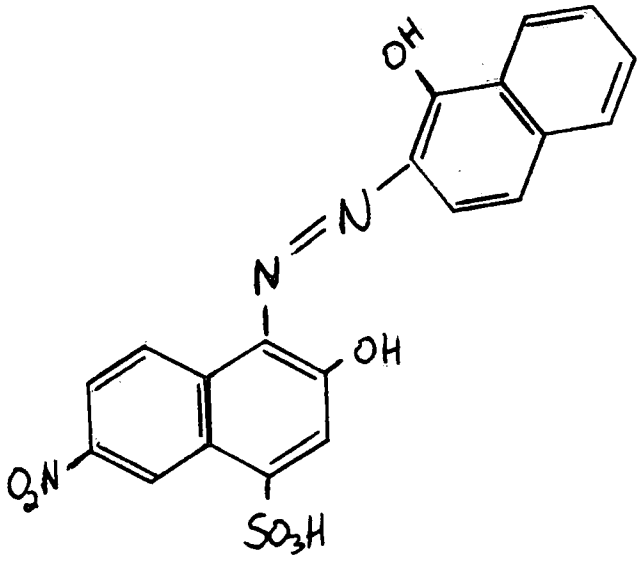

Table 24. Reactive Black 5

C.A.S. No. 17095-24-8

C.I. No. 20505

Chemical formula: $C_{26}H_{21}N_5O_{19}S_6 \bullet 4Na$

Molecular weight: 995.85

Structure:

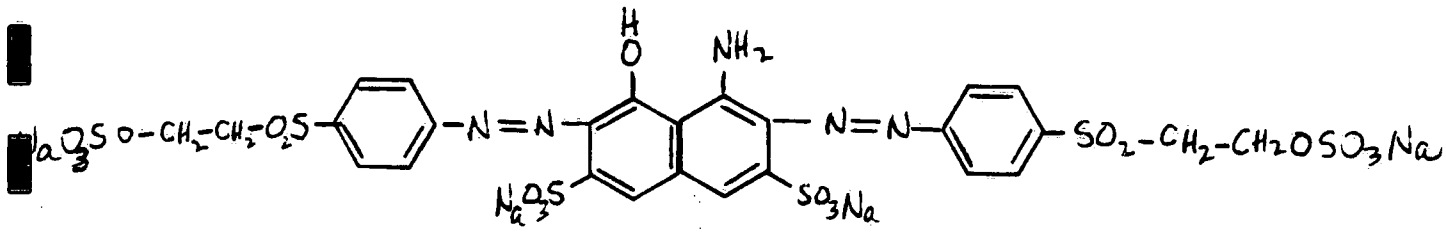

Table 25. Reactive Blue 19

C.A.S. No. 2580-78-1

C.I. No. 61200

Chemical formula: $C_{22}H_{18}N_2O_{11}S_3 \bullet 2Na$

Molecular weight: 628.57

Structure:

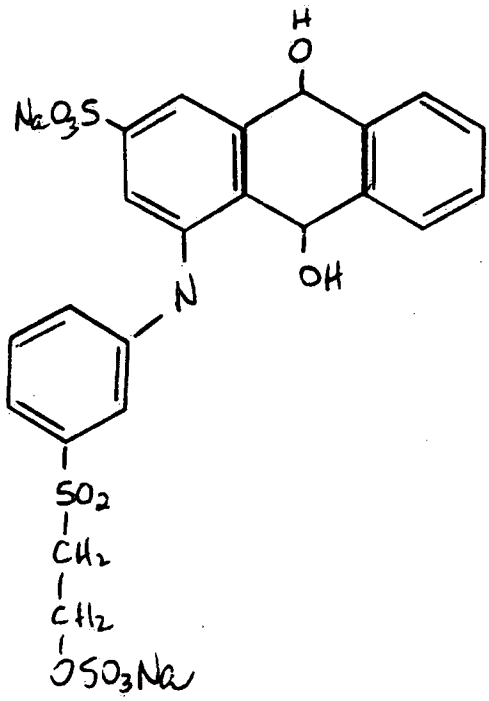

Table 26. Reactive Orange 13

C.A.S. No. 70616-89-6

C.I. No. 18270

Chemical formula: $C_{24}H_{18}ClN_7O_{10}S_3 \cdot 3Na$

Molecular weight: 667.02

Structure:

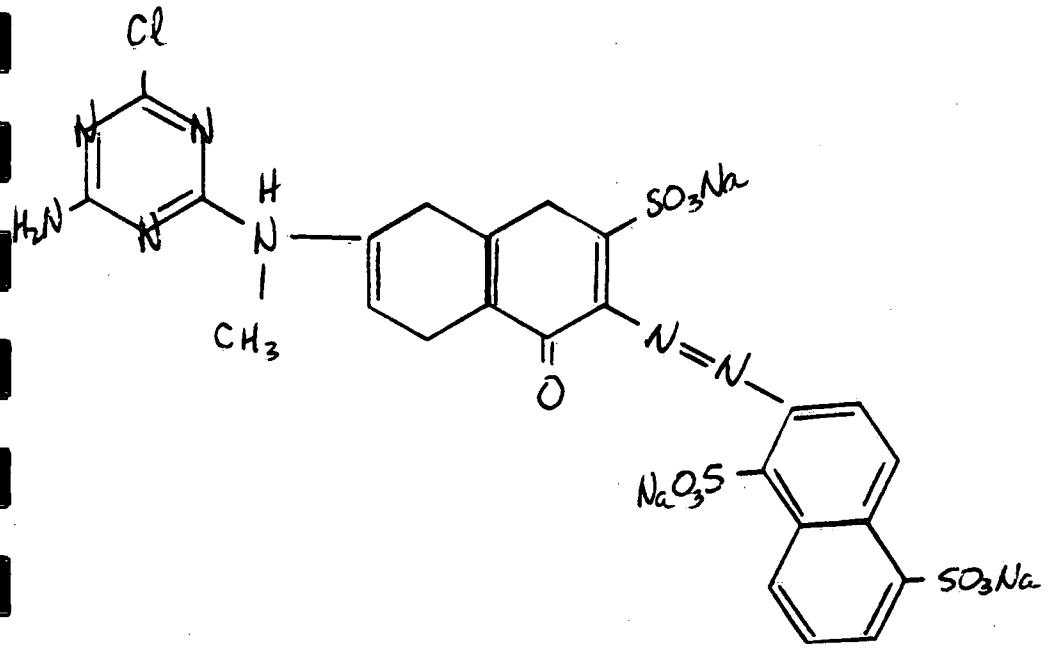

Table 27. Extinction coefficients of Acid Black 52.*

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
900	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
890	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
880	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
870	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
860	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
850	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
840	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
830	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
820	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
810	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
800	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
790	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
780	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
770	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
760	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
750	2.95×10^{2}	2.16×10^{2}	8.13×10^{1}
740	2.95×10^{2}	2.70×10^{2}	8.13×10^{1}
730	2.95×10^{2}	2.70×10^{2}	1.63×10^{2}
720	2.95×10^{2}	2.70×10^{2}	2.44×10^{2}
710	3.93×10^{2}	3.76×10^{2}	2.44×10^{2}
700	4.92×10^{2}	4.84×10^{2}	3.25×10^{2}
690	7.87×10^{2}	7.00×10^{2}	5.69×10^{2}
680	1.18×10^{3}	1.13×10^{3}	9.76×10^{2}
670	2.07×10^{3}	1.88×10^{3}	1.71×10^{3}
660	3.05×10^{3}	3.02×10^{3}	2.76×10^{3}
650	4.43×10^{3}	4.42×10^{3}	4.15×10^{3}
640	6.00×10^{3}	5.76×10^{3}	5.28×10^{3}
630	7.28×10^{3}	7.04×10^{3}	6.50×10^{3}
620	8.56×10^{3}	8.12×10^{3}	7.56×10^{3}
610	9.74×10^{3}	9.14×10^{3}	8.54×10^{3}
600	1.03×10^{4}	9.96×10^{3}	9.35×10^{3}
590	1.08×10^{4}	1.05×10^{4}	1.00×10^{4}
580	1.10×10^{4}	1.10×10^{4}	1.02×10^{4}
570	1.12×10^{4}	1.11×10^{4}	1.03×10^{4}
560	1.10×10^{4}	1.10×10^{4}	1.02×10^{4}
550	1.04×10^{4}	1.05×10^{4}	9.76×10^{3}
540	9.64×10^{3}	9.80×10^{3}	9.19×10^{3}
530	8.95×10^{3}	8.98×10^{3}	8.46×10^{3}
520	8.16×10^{3}	8.24×10^{3}	7.80×10^{3}
510	7.38×10^{3}	7.42×10^{3}	7.15×10^{3}
500	6.79×10^{3}	6.94×10^{3}	6.91×10^{3}

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Table 27. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	6.59×10^3	6.72×10^3	6.75×10^3
480	6.59×10^3	6.78×10^3	6.83×10^3
470	6.79×10^3	6.94×10^3	7.15×10^3
460	6.98×10^3	7.26×10^3	7.56×10^3
450	7.18×10^3	7.49×10^3	7.97×10^3
440	7.47×10^3	7.86×10^3	8.37×10^3
430	7.77×10^3	8.18×10^3	8.54×10^3
420	8.06×10^3	8.44×10^3	8.78×10^3
410	8.36×10^3	8.66×10^3	8.86×10^3
400	8.85×10^3	8.98×10^3	8.94×10^3
390	9.34×10^3	9.42×10^3	9.11×10^3
380	9.93×10^3	9.90×10^3	9.43×10^3
370	1.03×10^4	1.04×10^4	9.84×10^3
360	1.06×10^4	1.05×10^4	9.92×10^3
350	1.07×10^4	1.05×10^4	9.76×10^3
340	1.15×10^4	1.11×10^4	1.01×10^4
330	1.29×10^4	1.25×10^4	1.14×10^4
320	1.40×10^4	1.38×10^4	1.28×10^4
310	1.45×10^4	1.45×10^4	1.38×10^4
300	1.42×10^4	1.41×10^4	1.35×10^4
290	1.49×10^4	1.43×10^4	1.33×10^4
280	1.62×10^4	1.56×10^4	1.43×10^4
270	1.90×10^4	1.86×10^4	1.75×10^4
260	2.13×10^4	2.14×10^4	2.05×10^4
250	2.49×10^4	2.52×10^4	2.57×10^4
240	3.20×10^4	3.22×10^4	3.66×10^4
230	4.36×10^4	4.22×10^4	4.02×10^4
220	4.92×10^4	4.72×10^4	3.67×10^4
210	4.33×10^4	4.26×10^4	2.44×10^4
200	3.20×10^4	4.06×10^4	2.17×10^4
190	2.39×10^4	3.28×10^4	2.04×10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 570 nm (1.12×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 568 nm (1.11×10^4 L mol^{-1} cm^{-1}) at pH 7.0 and 570 nm (1.04×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 28. Extinction coefficients of Acid Orange 60.*

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
900	1.52×10^2	1.24×10^2	0
890	1.52×10^2	1.24×10^2	0
880	1.52×10^2	1.24×10^2	0
870	1.52×10^2	1.24×10^2	0
860	1.52×10^2	1.24×10^2	0
850	1.52×10^2	1.24×10^2	0
840	1.52×10^2	1.24×10^2	0
830	1.90×10^2	1.24×10^2	0
820	1.90×10^2	1.24×10^2	0
810	1.90×10^2	1.24×10^2	0
800	1.90×10^2	1.24×10^2	0
790	1.90×10^2	1.24×10^2	0
780	1.90×10^2	1.24×10^2	0
770	1.90×10^2	1.24×10^2	0
760	1.90×10^2	1.24×10^2	0
750	1.90×10^2	1.24×10^2	0
740	2.28×10^2	1.66×10^2	0
730	2.28×10^2	1.66×10^2	0
720	2.66×10^2	1.66×10^2	0
710	3.04×10^2	1.66×10^2	3.43×10^1
700	3.04×10^2	2.07×10^2	3.43×10^1
690	3.04×10^2	2.07×10^2	3.43×10^1
680	3.42×10^2	2.48×10^2	6.86×10^1
670	3.42×10^2	2.90×10^2	6.86×10^1
660	3.80×10^2	2.90×10^2	6.86×10^1
650	3.80×10^2	3.31×10^2	6.86×10^1
640	4.18×10^2	2.90×10^2	1.03×10^2
630	4.18×10^2	3.31×10^2	1.03×10^2
620	4.18×10^2	2.90×10^2	1.03×10^2
610	4.18×10^2	3.31×10^2	1.03×10^2
600	4.18×10^2	3.73×10^2	1.37×10^2
590	4.56×10^2	4.14×10^2	2.06×10^2
580	6.46×10^2	5.38×10^2	4.12×10^2
570	1.06×10^3	9.11×10^2	8.23×10^2
560	2.01×10^3	1.78×10^3	1.78×10^3
550	3.87×10^3	3.73×10^3	3.64×10^3
540	6.76×10^3	6.75×10^3	6.17×10^3
530	9.87×10^3	1.04×10^4	8.82×10^3
520	1.19×10^4	1.28×10^4	1.06×10^4
510	1.36×10^4	1.46×10^4	1.22×10^4
500	1.55×10^4	1.69×10^4	1.38×10^4

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Table 28. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	1.67×10^4	1.86×10^4	1.49×10^4
480	1.70×10^4	1.90×10^4	1.51×10^4
470	1.65×10^4	1.86×10^4	1.45×10^4
460	1.53×10^4	1.73×10^4	1.34×10^4
450	1.38×10^4	1.56×10^4	1.19×10^4
440	1.22×10^4	1.37×10^4	1.04×10^4
430	1.07×10^4	1.20×10^4	9.16×10^3
420	9.34×10^3	1.04×10^4	7.96×10^3
410	8.28×10^3	9.23×10^3	6.96×10^3
400	7.41×10^3	8.24×10^3	6.28×10^3
390	6.72×10^3	7.45×10^3	5.83×10^3
380	6.49×10^3	7.16×10^3	5.83×10^3
370	6.76×10^3	7.49×10^3	6.28×10^3
360	7.37×10^3	8.16×10^3	6.93×10^3
350	8.09×10^3	9.03×10^3	7.48×10^3
340	8.85×10^3	9.81×10^3	7.96×10^3
330	9.00×10^3	1.00×10^4	7.89×10^3
320	8.85×10^3	9.73×10^3	7.51×10^3
310	9.19×10^3	1.00×10^4	7.51×10^3
300	1.04×10^4	1.13×10^4	8.33×10^3
290	1.16×10^4	1.28×10^4	9.26×10^3
280	1.48×10^4	1.61×10^4	1.20×10^4
270	1.86×10^4	2.07×10^4	1.57×10^4
260	2.27×10^4	2.44×10^4	1.98×10^4
250	2.53×10^4	2.95×10^4	2.44×10^4
240	2.53×10^4	3.35×10^4	2.74×10^4
230	2.53×10^4	3.18×10^4	2.57×10^4
220	2.35×10^4	2.69×10^4	2.20×10^4
210	2.32×10^4	3.18×10^4	1.78×10^4
200	1.33×10^4	4.74×10^4	1.63×10^4
190	1.06×10^4	2.98×10^4	1.51×10^4

*Spectra were recorded at 25°C in 10% MeOH (v/v) - 90% pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 482 nm (1.70×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 480 nm (1.90×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 483 nm (1.51×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 29. Extinction coefficients of Acid Red 73.*

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	0
700	0	0	7.64×10^{1}
690	0	0	1.53×10^{2}
680	0	0	1.53×10^{2}
670	0	0	1.53×10^{2}
660	0	0	2.29×10^{2}
650	0	0	3.06×10^{2}
640	0	6.44×10^{1}	3.82×10^{2}
630	0	6.44×10^{1}	4.59×10^{2}
620	0	6.44×10^{1}	6.12×10^{2}
610	0	1.29×10^{2}	7.64×10^{2}
600	0	1.93×10^{2}	9.17×10^{2}
590	2.09×10^{2}	3.22×10^{2}	1.22×10^{3}
580	8.36×10^{2}	9.01×10^{2}	1.76×10^{3}
570	2.09×10^{3}	2.25×10^{3}	2.83×10^{3}
560	5.43×10^{3}	5.86×10^{3}	5.89×10^{3}
550	1.25×10^{4}	1.32×10^{4}	1.15×10^{4}
540	2.07×10^{4}	2.17×10^{4}	1.84×10^{4}
530	2.65×10^{4}	2.75×10^{4}	2.32×10^{4}
520	2.90×10^{4}	3.01×10^{4}	2.54×10^{4}
510	2.99×10^{4}	3.10×10^{4}	2.62×10^{4}
500	2.92×10^{4}	3.06×10^{4}	2.58×10^{4}

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Table 29. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	2.65×10^4	2.76×10^4	2.35×10^4
480	2.21×10^4	2.34×10^4	2.01×10^4
470	1.80×10^4	1.88×10^4	1.66×10^4
460	1.42×10^4	1.46×10^4	1.34×10^4
450	1.07×10^4	1.11×10^4	1.07×10^4
440	8.56×10^3	9.14×10^3	8.94×10^3
430	7.73×10^3	8.18×10^3	8.18×10^3
420	7.73×10^3	8.05×10^3	7.95×10^3
410	7.73×10^3	8.05×10^3	7.80×10^3
400	7.73×10^3	8.11×10^3	7.80×10^3
390	7.73×10^3	8.18×10^3	7.95×10^3
380	7.73×10^3	8.24×10^3	8.33×10^3
370	8.36×10^3	8.75×10^3	9.17×10^3
360	1.02×10^4	1.08×10^4	1.12×10^4
350	1.11×10^4	1.37×10^4	1.38×10^4
340	1.32×10^4	1.38×10^4	1.39×10^4
330	1.15×10^4	1.21×10^4	1.25×10^4
320	1.04×10^4	1.11×10^4	1.17×10^4
310	9.19×10^3	9.66×10^3	1.03×10^4
300	7.31×10^3	7.79×10^3	8.64×10^3
290	6.27×10^3	6.57×10^3	7.49×10^3
280	6.48×10^3	6.89×10^3	7.64×10^3
270	8.98×10^3	9.33×10^3	9.86×10^3
260	1.48×10^4	1.53×10^4	1.48×10^4
250	2.15×10^4	2.25×10^4	2.06×10^4
240	2.15×10^4	2.25×10^4	2.08×10^4
230	2.07×10^4	2.14×10^4	2.00×10^4
220	2.26×10^4	2.29×10^4	1.96×10^4
210	2.46×10^4	2.56×10^4	1.35×10^4
200	1.88×10^4	3.17×10^4	1.25×10^4
190	1.36×10^4	1.87×10^4	1.20×10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 510 nm (2.99×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 507 nm (3.11×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 506 nm (2.62×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 30. Extinction coefficients of Basic Green 4.*

	ε, L mol^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
900	0	0	6.44×10^{1}
890	0	0	6.44×10^{1}
880	0	0	6.44×10^{1}
870	0	0	6.44×10^{1}
860	0	0	6.44×10^{1}
850	0	0	6.44×10^{1}
840	0	0	6.44×10^{1}
830	0	0	6.44×10^{1}
820	0	0	8.05×10^{1}
810	0	0	8.05×10^{1}
800	0	0	8.05×10^{1}
790	0	0	8.05×10^{1}
780	0	0	8.05×10^{1}
770	0	0	8.05×10^{1}
760	0	0	8.05×10^{1}
750	0	0	9.66×10^{1}
740	0	0	1.13×10^{2}
730	0	0	1.13×10^{2}
720	0	0	1.29×10^{2}
710	0	0	1.29×10^{2}
700	0	1.37×10^{2}	1.45×10^{2}
690	2.98×10^{2}	2.74×10^{2}	1.61×10^{2}
680	4.96×10^{2}	9.59×10^{2}	1.77×10^{2}
670	1.59×10^{3}	2.60×10^{3}	2.09×10^{2}
660	3.77×10^{3}	6.03×10^{3}	3.22×10^{2}
650	8.13×10^{3}	1.32×10^{4}	4.99×10^{2}
640	1.56×10^{4}	2.49×10^{4}	7.73×10^{2}
630	2.46×10^{4}	4.05×10^{4}	1.13×10^{3}
620	3.04×10^{4}	5.08×10^{4}	1.34×10^{3}
610	2.89×10^{4}	4.90×10^{4}	1.29×10^{3}
600	2.28×10^{4}	3.89×10^{4}	1.08×10^{3}
590	1.74×10^{4}	2.96×10^{4}	8.69×10^{2}
580	1.40×10^{4}	2.37×10^{4}	7.57×10^{2}
570	1.13×10^{4}	1.95×10^{4}	6.92×10^{2}
560	8.73×10^{3}	1.47×10^{4}	5.96×10^{2}
550	6.15×10^{3}	1.05×10^{4}	5.15×10^{2}
540	4.27×10^{3}	7.12×10^{3}	4.67×10^{2}
530	3.17×10^{3}	4.93×10^{3}	4.51×10^{2}
520	2.28×10^{3}	3.42×10^{3}	4.51×10^{2}
510	1.79×10^{3}	2.33×10^{3}	4.35×10^{2}
500	1.49×10^{3}	1.51×10^{3}	4.35×10^{2}

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Table 30. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	1.39×10^{3}	9.59×10^{2}	4.51×10^{2}
480	1.39×10^{3}	6.85×10^{2}	4.83×10^{2}
470	1.59×10^{3}	6.85×10^{2}	5.15×10^{2}
460	1.98×10^{3}	1.10×10^{3}	5.47×10^{2}
450	3.27×10^{3}	3.01×10^{3}	6.44×10^{2}
440	5.36×10^{3}	6.58×10^{3}	7.73×10^{2}
430	7.24×10^{3}	9.86×10^{3}	7.25×10^{2}
420	7.14×10^{3}	1.01×10^{4}	9.66×10^{2}
410	5.85×10^{3}	8.36×10^{3}	9.82×10^{2}
400	4.36×10^{3}	6.30×10^{3}	1.03×10^{3}
390	2.78×10^{3}	4.11×10^{3}	1.08×10^{3}
380	1.69×10^{3}	2.47×10^{3}	1.16×10^{3}
370	9.92×10^{2}	1.51×10^{3}	1.29×10^{3}
360	4.96×10^{2}	8.22×10^{2}	1.45×10^{3}
350	3.97×10^{2}	6.85×10^{2}	1.66×10^{3}
340	4.96×10^{2}	8.22×10^{2}	1.96×10^{3}
330	1.59×10^{3}	2.47×10^{3}	2.45×10^{3}
320	5.36×10^{3}	9.18×10^{3}	3.03×10^{3}
310	5.46×10^{3}	9.18×10^{3}	3.38×10^{3}
300	4.46×10^{3}	7.95×10^{3}	3.91×10^{3}
290	3.67×10^{3}	7.12×10^{3}	4.83×10^{3}
280	2.98×10^{3}	6.44×10^{3}	6.23×10^{3}
270	2.48×10^{3}	6.44×10^{3}	8.26×10^{3}
260	2.88×10^{3}	8.22×10^{3}	9.74×10^{3}
250	3.37×10^{3}	9.32×10^{3}	9.16×10^{3}
240	3.97×10^{3}	8.22×10^{3}	7.42×10^{3}
230	7.04×10^{3}	7.40×10^{3}	6.71×10^{3}
220	1.98×10^{4}	1.15×10^{4}	8.06×10^{3}
210	4.15×10^{4}	3.10×10^{4}	5.94×10^{3}
200	1.96×10^{4}	3.49×10^{4}	5.58×10^{3}
190	5.16×10^{3}	1.77×10^{4}	5.39×10^{3}

*Spectra were recorded at 25°C in 2% MeOH (v/v) - 98% pH 2.0 glycine hydrochloride-glycine, 2% MeOH (v/v) - 98% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH (v/v) - 90% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 617 nm (3.07×10^{4} L mol^{-1} cm^{-1}) and 425 nm (7.34×10^{4} L mol^{-1} cm^{-1}) at pH 2.0, 615 nm (5.15×10^{4} L mol^{-1} cm^{-1}) and 425 nm (1.03×10^{4} L mol^{-1} cm^{-1}) at pH 7.0, and 616 nm (1.34×10^{3} L mol^{-1} cm^{-1}) at pH 10.8. At pH 10.8, the solution gradually became turbid.

Table 31. Extinction coefficients of Basic Orange 2.*

	ε, L mol^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	0
700	0	0	0
690	0	0	0
680	0	0	0
670	0	0	0
660	0	0	0
650	0	0	0
640	0	0	0
630	0	0	0
620	0	0	0
610	0	0	0
600	0	0	0
590	0	0	0
580	1.18×10^{2}	0	0
570	2.35×10^{2}	0	0
560	5.88×10^{2}	0	2.81×10^{1}
550	1.29×10^{3}	3.10×10^{1}	5.62×10^{1}
540	2.71×10^{3}	1.24×10^{2}	1.40×10^{2}
530	4.82×10^{3}	3.41×10^{2}	3.65×10^{2}
520	7.76×10^{3}	8.06×10^{2}	8.42×10^{2}
510	1.16×10^{4}	1.61×10^{3}	1.63×10^{3}
500	1.60×10^{4}	2.82×10^{3}	2.81×10^{3}

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Table 31. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	2.06x10^4	4.43x10^3	4.32x10^3
480	2.55x10^4	6.26x10^3	6.21x10^3
470	3.00x10^4	8.21x10^3	8.23x10^3
460	3.24x10^4	9.89x10^3	9.83x10^3
450	3.24x10^4	1.11x10^4	1.11x10^4
440	2.98x10^4	1.17x10^4	1.17x10^4
430	2.54x10^4	1.17x10^4	1.18x10^4
420	1.98x10^4	1.17x10^4	1.18x10^4
410	1.44x10^4	1.18x10^4	1.20x10^4
400	9.53x10^3	1.18x10^4	1.21x10^4
390	5.88x10^3	1.14x10^4	1.18x10^4
380	3.18x10^3	1.07x10^4	1.11x10^4
370	1.65x10^3	9.86x10^3	1.03x10^4
360	7.06x10^2	8.96x10^3	9.35x10^3
350	3.53x10^2	7.84x10^3	8.26x10^3
340	4.71x10^2	6.48x10^3	6.80x10^3
330	8.24x10^2	4.87x10^3	5.11x10^3
320	1.41x10^3	3.32x10^3	3.59x10^3
310	2.00x10^3	2.17x10^3	2.36x10^3
300	2.35x10^3	1.89x10^3	1.99x10^3
290	2.35x10^3	3.22x10^3	3.23x10^3
280	2.12x10^3	4.87x10^3	5.00x10^3
270	3.53x10^3	4.46x10^3	4.69x10^3
260	7.76x10^3	4.18x10^3	4.27x10^3
250	7.41x10^3	5.89x10^3	5.92x10^3
240	9.18x10^3	7.16x10^3	7.27x10^3
230	1.34x10^4	8.77x10^3	8.76x10^3
220	1.31x10^4	1.30x10^4	1.02x10^4
210	1.49x10^4	1.38x10^4	5.62x10^3
200	9.65x10^3	1.53x10^4	5.17x10^3
190	6.59x10^3	8.99x10^3	5.00x10^3

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, 10% MeOH - 90% (v/v) pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH - 90% (v/v) pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 455 nm (3.27x10^4 L mol^{-1} cm^{-1}) at pH 2.0, 433 nm (1.17x10^4 L mol^{-1} cm^{-1}) and 403 nm (1.18x10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 435 nm (1.18x10^4 L mol^{-1} cm^{-1}) and 400 nm (1.21x10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 32. Extinction coefficients of Basic Violet 1.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	2.79×10^2	0	1.17×10^2
890	2.79×10^2	0	1.17×10^2
880	2.79×10^2	0	1.17×10^2
870	2.79×10^2	0	1.17×10^2
860	2.79×10^2	0	1.17×10^2
850	2.79×10^2	0	1.17×10^2
840	2.79×10^2	0	1.56×10^2
830	2.79×10^2	0	1.56×10^2
820	2.79×10^2	0	1.56×10^2
810	2.79×10^2	0	1.95×10^2
800	2.79×10^2	0	1.95×10^2
790	2.79×10^2	0	1.95×10^2
780	2.79×10^2	0	1.95×10^2
770	2.79×10^2	0	1.95×10^2
760	2.79×10^2	0	1.95×10^2
750	2.79×10^2	0	1.95×10^2
740	2.79×10^2	0	1.95×10^2
730	2.79×10^2	0	1.95×10^2
720	3.72×10^2	0	2.72×10^2
710	4.65×10^2	0	3.11×10^2
700	7.43×10^2	0	3.11×10^2
690	1.11×10^3	0	3.50×10^2
680	2.14×10^3	0	3.50×10^2
670	4.00×10^3	2.19×10^2	3.89×10^2
660	7.25×10^3	6.57×10^2	5.45×10^2
650	1.23×10^4	1.53×10^3	8.17×10^2
640	1.83×10^4	3.28×10^3	1.32×10^3
630	2.40×10^4	7.66×10^3	2.41×10^3
620	2.75×10^4	1.58×10^4	4.63×10^3
610	3.06×10^4	2.95×10^4	8.36×10^3
600	3.43×10^4	4.49×10^4	1.26×10^4
590	3.61×10^4	5.47×10^4	1.54×10^4
580	3.40×10^4	5.41×10^4	1.53×10^4
570	2.93×10^4	4.79×10^4	1.36×10^4
560	2.53×10^4	4.27×10^4	1.23×10^4
550	2.23×10^4	4.01×10^4	1.15×10^4
540	2.01×10^4	3.72×10^4	1.07×10^4
530	1.74×10^4	3.28×10^4	9.41×10^3
520	1.41×10^4	2.69×10^4	7.74×10^3
510	1.08×10^4	2.04×10^4	5.91×10^3
500	7.99×10^3	1.51×10^4	4.47×10^3

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Table 32. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	6.04×10^3	1.09×10^4	3.38×10^3
480	4.46×10^3	7.66×10^3	2.57×10^3
470	3.34×10^3	5.25×10^3	1.95×10^3
460	2.79×10^3	3.28×10^3	1.56×10^3
450	2.69×10^3	2.19×10^3	1.28×10^3
440	3.34×10^3	1.31×10^3	1.17×10^3
430	4.37×10^3	1.09×10^3	1.13×10^3
420	4.83×10^3	8.75×10^2	1.13×10^3
410	4.65×10^3	6.57×10^2	1.21×10^3
400	4.09×10^3	4.38×10^2	1.28×10^3
390	3.34×10^3	6.57×10^2	1.44×10^3
380	2.79×10^3	1.09×10^3	1.67×10^3
370	2.60×10^3	1.53×10^3	1.95×10^3
360	2.32×10^3	1.53×10^3	2.14×10^3
350	1.95×10^3	1.75×10^3	2.33×10^3
340	1.86×10^3	1.53×10^3	2.45×10^3
330	2.88×10^3	2.19×10^3	2.68×10^3
320	6.32×10^3	3.72×10^3	4.24×10^3
310	9.48×10^3	9.41×10^3	5.87×10^3
300	1.10×10^4	1.34×10^4	7.35×10^3
290	7.62×10^3	1.01×10^4	7.27×10^3
280	5.30×10^3	7.00×10^3	7.59×10^3
270	4.74×10^3	6.13×10^3	8.60×10^3
260	5.39×10^3	7.66×10^3	9.92×10^3
250	7.43×10^3	1.16×10^4	1.04×10^4
240	6.88×10^3	9.63×10^3	8.09×10^3
230	7.15×10^3	6.78×10^3	7.04×10^3
220	1.49×10^4	1.25×10^4	9.61×10^3
210	3.01×10^4	3.02×10^4	7.55×10^3
200	1.77×10^4	2.80×10^4	7.31×10^3
190	7.25×10^3	1.71×10^4	7.08×10^3

*Spectra were recorded at 25°C in 2% MeOH (v/v) - 98% pH 2.0 glycine hydrochloride-glycine, 2% MeOH (v/v) - 98% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH (v/v) - 90% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 590 nm (3.61×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 586 nm (5.54×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 590 nm (1.54×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 33. Extinction coefficients of Basic Violet 3.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	2.49×10^{2}
700	3.21×10^{2}	0	2.49×10^{2}
690	7.49×10^{2}	0	2.49×10^{2}
680	1.93×10^{3}	0	4.98×10^{2}
670	4.28×10^{3}	0	4.98×10^{2}
660	8.03×10^{3}	4.74×10^{2}	9.95×10^{2}
650	1.38×10^{4}	1.90×10^{3}	1.99×10^{3}
640	2.01×10^{4}	4.27×10^{3}	4.48×10^{3}
630	2.48×10^{4}	1.09×10^{4}	1.04×10^{4}
620	2.68×10^{4}	2.35×10^{4}	2.09×10^{4}
610	2.87×10^{4}	4.27×10^{4}	3.86×10^{4}
600	3.17×10^{4}	6.31×10^{4}	5.65×10^{4}
590	3.23×10^{4}	7.23×10^{4}	6.37×10^{4}
580	2.89×10^{4}	6.71×10^{4}	5.87×10^{4}
570	2.40×10^{4}	5.79×10^{4}	5.07×10^{4}
560	2.05×10^{4}	5.27×10^{4}	4.60×10^{4}
550	1.82×10^{4}	4.93×10^{4}	4.35×10^{4}
540	1.62×10^{4}	4.58×10^{4}	4.01×10^{4}
530	1.32×10^{4}	3.89×10^{4}	3.41×10^{4}
520	1.04×10^{4}	3.04×10^{4}	2.66×10^{4}
510	7.49×10^{3}	2.23×10^{4}	1.97×10^{4}
500	5.35×10^{3}	1.59×10^{4}	1.42×10^{4}

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Table 33. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	3.85×10^3	1.09×10^4	1.04×10^4
480	2.68×10^3	7.59×10^3	6.97×10^3
470	1.93×10^3	4.98×10^3	4.98×10^3
460	1.61×10^3	2.85×10^3	3.48×10^3
450	1.71×10^3	1.66×10^3	2.49×10^3
440	2.57×10^3	9.49×10^2	1.74×10^3
430	3.75×10^3	4.74×10^2	1.24×10^3
420	4.07×10^3	2.37×10^2	9.95×10^2
410	3.53×10^3	0	7.46×10^2
400	2.89×10^3	0	7.46×10^2
390	1.93×10^3	0	7.46×10^2
380	1.39×10^3	0	9.95×10^2
370	1.07×10^3	2.37×10^2	1.24×10^3
360	7.49×10^2	4.74×10^2	1.74×10^3
350	6.42×10^2	4.74×10^2	1.74×10^3
340	5.35×10^2	4.74×10^2	1.74×10^3
330	1.82×10^3	1.42×10^3	2.74×10^3
320	5.24×10^3	3.56×10^3	5.22×10^3
310	8.88×10^3	1.14×10^4	1.24×10^4
300	8.99×10^3	1.49×10^4	1.59×10^4
290	5.56×10^3	9.01×10^3	1.27×10^4
280	3.64×10^3	5.46×10^3	1.04×10^4
270	2.89×10^3	4.74×10^3	1.49×10^4
260	3.64×10^3	6.64×10^3	2.02×10^4
250	5.56×10^3	1.16×10^4	2.29×10^4
240	4.60×10^3	7.83×10^3	1.57×10^4
230	5.35×10^3	5.22×10^3	1.17×10^4
220	1.17×10^4	1.33×10^4	1.72×10^4
210	2.55×10^4	3.32×10^4	1.37×10^4
200	1.51×10^4	2.68×10^4	1.42×10^4
190	5.89×10^3	1.83×10^4	1.42×10^4

*Spectra were recorded at 25°C in 2% MeOH (v/v) - 98% pH 2.0 glycine hydrochloride-glycine, 2% MeOH (v/v) - 98% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 2% MeOH - 98% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 594 nm (3.25×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 590 nm (7.23×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 590 nm (6.37×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 34. Extinction coefficients of Direct Blue 86.*

	ε, L mol^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
900	4.57×10^{2}	1.52×10^{2}	1.13×10^{2}
890	4.00×10^{2}	1.01×10^{2}	1.13×10^{2}
880	3.43×10^{2}	5.06×10^{1}	5.66×10^{1}
870	3.43×10^{2}	5.06×10^{1}	5.66×10^{1}
860	2.86×10^{2}	5.06×10^{1}	5.66×10^{1}
850	3.43×10^{2}	5.06×10^{1}	5.66×10^{1}
840	4.00×10^{2}	1.01×10^{2}	5.66×10^{1}
830	4.57×10^{2}	1.01×10^{2}	1.13×10^{2}
820	5.14×10^{2}	1.52×10^{2}	1.70×10^{2}
810	5.71×10^{2}	1.52×10^{2}	1.70×10^{2}
800	6.29×10^{2}	2.02×10^{2}	2.27×10^{2}
790	7.43×10^{2}	2.53×10^{2}	2.83×10^{2}
780	9.71×10^{2}	3.03×10^{2}	3.96×10^{2}
770	1.14×10^{3}	4.55×10^{2}	3.96×10^{2}
760	1.43×10^{3}	5.56×10^{2}	5.66×10^{2}
750	1.83×10^{3}	7.59×10^{2}	9.06×10^{2}
740	2.23×10^{3}	9.61×10^{2}	1.25×10^{3}
730	2.74×10^{3}	1.37×10^{3}	1.76×10^{3}
720	3.26×10^{3}	1.97×10^{3}	2.49×10^{3}
710	3.89×10^{3}	2.88×10^{3}	3.62×10^{3}
700	4.57×10^{3}	4.05×10^{3}	5.21×10^{3}
690	5.26×10^{3}	5.66×10^{3}	7.42×10^{3}
680	6.00×10^{3}	7.94×10^{3}	1.03×10^{4}
670	6.86×10^{3}	9.96×10^{3}	1.26×10^{4}
660	7.83×10^{3}	1.03×10^{4}	1.29×10^{4}
650	9.26×10^{3}	1.01×10^{4}	1.26×10^{4}
640	1.10×10^{4}	1.08×10^{4}	1.36×10^{4}
630	1.25×10^{4}	1.27×10^{4}	1.61×10^{4}
620	1.33×10^{4}	1.44×10^{4}	1.82×10^{4}
610	1.29×10^{4}	1.48×10^{4}	1.87×10^{4}
600	1.14×10^{4}	1.34×10^{4}	1.71×10^{4}
590	9.03×10^{3}	1.08×10^{4}	1.38×10^{4}
580	6.69×10^{3}	8.24×10^{3}	1.04×10^{4}
570	4.46×10^{3}	5.92×10^{3}	7.36×10^{3}
560	2.91×10^{3}	3.95×10^{3}	4.87×10^{3}
550	1.89×10^{3}	2.53×10^{3}	3.06×10^{3}
540	1.26×10^{3}	1.57×10^{3}	1.93×10^{3}
530	8.00×10^{2}	9.61×10^{2}	1.19×10^{3}
520	5.71×10^{2}	6.07×10^{2}	7.36×10^{2}
510	4.57×10^{2}	3.54×10^{2}	3.96×10^{2}
500	4.00×10^{2}	2.53×10^{2}	2.83×10^{2}

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Table 34. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	4.57×10^{2}	2.02×10^{2}	1.70×10^{2}
480	5.14×10^{2}	1.52×10^{2}	1.13×10^{2}
470	6.29×10^{2}	1.52×10^{2}	1.13×10^{2}
460	7.43×10^{2}	1.52×10^{2}	1.13×10^{2}
450	9.71×10^{2}	2.02×10^{2}	1.70×10^{2}
440	1.31×10^{3}	2.53×10^{2}	2.27×10^{2}
430	1.66×10^{3}	4.55×10^{2}	4.53×10^{2}
420	2.11×10^{3}	6.07×10^{2}	6.80×10^{2}
410	2.74×10^{3}	8.60×10^{2}	9.63×10^{2}
400	3.54×10^{3}	1.32×10^{3}	1.47×10^{3}
390	4.74×10^{3}	2.12×10^{3}	2.49×10^{3}
380	6.11×10^{3}	3.54×10^{3}	4.36×10^{3}
370	7.31×10^{3}	5.66×10^{3}	6.97×10^{3}
360	8.40×10^{3}	8.60×10^{3}	1.07×10^{4}
350	9.26×10^{3}	1.19×10^{4}	1.51×10^{4}
340	9.66×10^{3}	1.43×10^{4}	1.81×10^{4}
330	9.83×10^{3}	1.49×10^{4}	1.91×10^{4}
320	9.77×10^{3}	1.33×10^{4}	1.69×10^{4}
310	9.71×10^{3}	1.05×10^{4}	1.33×10^{4}
300	1.02×10^{4}	8.45×10^{4}	1.06×10^{4}
290	1.07×10^{4}	8.24×10^{3}	1.02×10^{4}
280	1.03×10^{4}	8.29×10^{3}	1.03×10^{4}
270	1.04×10^{4}	1.01×10^{3}	1.25×10^{4}
260	9.94×10^{3}	1.08×10^{3}	1.36×10^{4}
250	9.60×10^{3}	1.09×10^{4}	1.36×10^{4}
240	1.15×10^{4}	1.21×10^{4}	1.52×10^{4}
230	1.67×10^{4}	1.64×10^{4}	2.05×10^{4}
220	2.30×10^{4}	2.16×10^{4}	2.27×10^{4}
210	2.37×10^{4}	2.22×10^{4}	1.33×10^{4}
200	1.51×10^{4}	1.97×10^{4}	1.19×10^{4}
190	1.01×10^{4}	1.42×10^{4}	1.15×10^{4}

*Spectra were recorded at 25°C in 10% MeOH (v/v) - 90% pH 2.0 glycine hydrochloride-glycine, 10% MeOH - 90% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH - 90% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 617 nm (1.33×10^{4} L mol^{-1} cm^{-1}) at pH 2.0, 613 nm (1.48×10^{4} L mol^{-1} cm^{-1}) and 658 nm (1.03×10^{4} L mol^{-1} cm^{-1}) at pH 7.0, and 613 nm (1.88×10^{4} L mol^{-1} cm^{-1}) and 660 nm (1.29×10^{4} L mol^{-1} cm^{-1}) at pH 10.8.

Table 35. Extinction coefficients of Direct Blue 218.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	2.98×10^{2}	1.38×10^{2}	2.28×10^{2}
890	2.09×10^{2}	9.18×10^{1}	1.90×10^{2}
880	2.09×10^{2}	9.18×10^{1}	1.90×10^{2}
870	1.79×10^{2}	9.18×10^{1}	1.90×10^{2}
860	1.49×10^{2}	9.18×10^{1}	1.90×10^{2}
850	1.49×10^{2}	9.18×10^{1}	1.90×10^{2}
840	1.79×10^{2}	9.18×10^{1}	1.90×10^{2}
830	2.38×10^{2}	1.38×10^{2}	1.90×10^{2}
820	2.68×10^{2}	1.38×10^{2}	2.28×10^{2}
810	2.68×10^{2}	1.84×10^{2}	2.66×10^{2}
800	2.98×10^{2}	1.84×10^{2}	3.04×10^{2}
790	3.28×10^{2}	2.30×10^{2}	3.42×10^{2}
780	3.58×10^{2}	2.30×10^{2}	3.80×10^{2}
770	3.87×10^{2}	3.21×10^{2}	4.19×10^{2}
760	4.47×10^{2}	4.13×10^{2}	4.95×10^{2}
750	5.66×10^{2}	5.05×10^{2}	6.09×10^{2}
740	6.56×10^{2}	6.43×10^{2}	7.99×10^{2}
730	8.94×10^{2}	9.64×10^{2}	1.07×10^{3}
720	1.19×10^{3}	1.47×10^{3}	1.52×10^{3}
710	1.55×10^{3}	2.16×10^{3}	2.28×10^{3}
700	2.15×10^{3}	3.30×10^{3}	3.46×10^{3}
690	2.98×10^{3}	4.91×10^{3}	5.21×10^{3}
680	4.08×10^{3}	6.79×10^{3}	7.38×10^{3}
670	5.51×10^{3}	8.86×10^{3}	9.78×10^{3}
660	7.27×10^{3}	1.07×10^{4}	1.18×10^{4}
650	9.12×10^{3}	1.21×10^{4}	1.34×10^{4}
640	1.07×10^{4}	1.32×10^{4}	1.46×10^{4}
630	1.20×10^{4}	1.42×10^{4}	1.54×10^{4}
620	1.28×10^{4}	1.52×10^{4}	1.61×10^{4}
610	1.34×10^{4}	1.60×10^{4}	1.64×10^{4}
600	1.35×10^{4}	1.60×10^{4}	1.60×10^{4}
590	1.32×10^{4}	1.50×10^{4}	1.46×10^{4}
580	1.22×10^{4}	1.32×10^{4}	1.26×10^{4}
570	1.09×10^{4}	1.12×10^{4}	1.07×10^{4}
560	9.60×10^{3}	9.50×10^{3}	9.21×10^{3}
550	8.25×10^{3}	7.99×10^{3}	7.72×10^{3}
540	7.09×10^{3}	6.56×10^{3}	6.39×10^{3}
530	5.99×10^{3}	5.19×10^{3}	5.10×10^{3}
520	5.07×10^{3}	4.22×10^{3}	4.15×10^{3}
510	4.26×10^{3}	3.40×10^{3}	3.42×10^{3}
500	3.67×10^{3}	2.89×10^{3}	2.97×10^{3}

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Table 35. (cont'd)

	ε, L mol^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
490	3.49x10^3	2.43x10^3	2.47x10^3
480	2.83x10^3	2.07x10^3	2.09x10^3
470	2.56x10^3	1.84x10^3	1.86x10^3
460	2.32x10^3	1.79x10^3	1.86x10^3
450	2.21x10^3	1.84x10^3	1.90x10^3
440	2.09x10^3	1.84x10^3	1.98x10^3
430	2.06x10^3	1.84x10^3	1.98x10^3
420	2.09x10^3	1.84x10^3	2.02x10^3
410	2.12x10^3	1.84x10^3	2.05x10^3
400	2.12x10^3	1.97x10^3	2.24x10^3
390	2.15x10^3	2.30x10^3	2.59x10^3
380	2.26x10^3	2.71x10^3	3.08x10^3
370	2.47x10^3	3.21x10^3	3.61x10^3
360	2.98x10^3	3.76x10^3	4.30x10^3
350	3.64x10^3	4.50x10^3	4.98x10^3
340	4.50x10^3	5.14x10^3	5.59x10^3
330	5.13x10^3	5.51x10^3	6.01x10^3
320	5.27x10^3	5.42x10^3	5.86x10^3
310	4.98x10^3	4.77x10^3	5.25x10^3
300	4.44x10^3	4.36x10^3	4.83x10^3
290	4.23x10^3	4.68x10^3	5.17x10^3
280	4.56x10^3	5.83x10^3	6.35x10^3
270	5.45x10^3	7.67x10^3	8.07x10^3
260	6.82x10^3	8.66x10^3	9.25x10^3
250	8.67x10^3	9.23x10^3	1.06x10^4
240	1.04x10^4	1.15x10^4	1.32x10^4
230	1.13x10^4	1.37x10^4	1.56x10^4
220	1.28x10^4	1.37x10^4	1.45x10^4
210	1.48x10^4	1.18x10^4	9.74x10^3
200	1.02x10^4	1.14x10^4	8.83x10^3
190	7.24x10^3	1.06x10^4	8.60x10^3

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 602 nm (1.36x10^4 L mol^{-1} cm^{-1}) at pH 2.0, 615 nm (1.61x10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 609 nm (1.64x10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 36. Extinction coefficients of Direct Yellow 4.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	0
700	0	0	0
690	0	0	0
680	0	0	0
670	0	0	0
660	0	0	0
650	0	0	0
640	0	0	0
630	0	0	0
620	0	0	0
610	0	0	1.11×10^{2}
600	0	7.90×10^{1}	3.32×10^{2}
590	0	1.58×10^{2}	7.75×10^{2}
580	0	1.58×10^{2}	1.88×10^{3}
570	8.98×10^{1}	2.37×10^{2}	3.98×10^{3}
560	8.98×10^{1}	3.95×10^{2}	7.75×10^{3}
550	1.80×10^{2}	6.32×10^{2}	1.35×10^{4}
540	2.69×10^{2}	1.11×10^{3}	2.12×10^{4}
530	3.59×10^{2}	1.82×10^{3}	3.05×10^{4}
520	8.08×10^{2}	2.92×10^{3}	3.98×10^{4}
510	1.71×10^{3}	4.42×10^{3}	4.76×10^{4}
500	3.50×10^{3}	6.56×10^{3}	5.22×10^{4}

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Table 36. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	6.37×10^3	9.64×10^3	5.38×10^4
480	1.05×10^4	1.35×10^4	5.24×10^4
470	1.56×10^4	1.79×10^4	4.84×10^4
460	2.07×10^4	2.20×10^4	4.35×10^4
450	2.50×10^4	2.54×10^4	3.85×10^4
440	2.89×10^4	2.87×10^4	3.36×10^4
430	3.32×10^4	3.18×10^4	2.95×10^4
420	3.73×10^4	3.53×10^4	2.57×10^4
410	4.07×10^4	3.80×10^4	2.25×10^4
400	4.20×10^4	3.89×10^4	1.89×10^4
390	3.98×10^4	3.67×10^4	1.55×10^4
380	3.44×10^4	3.19×10^4	1.21×10^4
370	2.78×10^4	2.61×10^4	9.07×10^3
360	2.10×10^4	2.01×10^4	6.97×10^3
350	1.54×10^4	1.48×10^4	5.75×10^3
340	1.14×10^4	1.12×10^4	5.31×10^3
330	8.98×10^3	8.61×10^3	5.31×10^3
320	7.18×10^3	6.16×10^3	5.53×10^3
310	5.92×10^3	5.92×10^3	5.86×10^3
300	5.03×10^3	5.13×10^3	6.53×10^3
290	4.58×10^3	4.74×10^3	7.64×10^3
280	4.85×10^3	5.13×10^3	1.01×10^4
270	7.18×10^3	7.42×10^3	1.29×10^4
260	1.33×10^4	1.29×10^4	1.28×10^4
250	1.58×10^4	1.52×10^4	1.11×10^4
240	1.33×10^4	1.28×10^4	1.02×10^4
230	1.11×10^4	1.08×10^4	9.96×10^3
220	1.25×10^4	1.24×10^4	1.10×10^4
210	2.30×10^4	2.36×10^4	1.01×10^4
200	1.56×10^4	3.18×10^4	1.01×10^4
190	1.11×10^4	1.71×10^4	1.01×10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 402 nm (4.20×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 402 nm (3.89×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 490 nm (5.38×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 37. Extinction coefficients of Direct Yellow 11.*

	ϵ, L g^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	0
700	0	0	0
690	0	0	0
680	0	0	0
670	0	0	0
660	0	0	0
650	0	0	0
640	0	0	0
630	0	0	0
620	0	0	1.38×10^{-1}
610	0	0	2.75×10^{-1}
600	0	0	2.75×10^{-1}
590	0	1.72×10^{-1}	2.75×10^{-1}
580	0	3.44×10^{-1}	4.13×10^{-1}
570	0	3.44×10^{-1}	4.13×10^{-1}
560	0.17	3.44×10^{-1}	5.50×10^{-1}
550	0.33	5.16×10^{-1}	6.88×10^{-1}
540	0.50	6.89×10^{-1}	1.24
530	0.83	1.21	2.06
520	1.83	2.41	3.44
510	3.82	4.82	6.05
500	7.80	8.26	9.90

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Table 37. (cont'd)

λ, nm	ε, L g^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	1.39×10^1	1.34×10^1	1.55×10^1
480	2.11×10^1	2.01×10^1	2.28×10^1
470	2.95×10^1	2.79×10^1	3.07×10^1
460	3.80×10^1	3.62×10^1	3.95×10^1
450	4.61×10^1	4.44×10^1	4.79×10^1
440	5.31×10^1	5.13×10^1	5.43×10^1
430	5.71×10^1	5.61×10^1	5.87×10^1
420	5.83×10^1	5.78×10^1	5.98×10^1
410	5.59×10^1	5.63×10^1	5.81×10^1
400	5.15×10^1	5.27×10^1	5.37×10^1
390	4.60×10^1	4.73×10^1	4.77×10^1
380	4.02×10^1	4.17×10^1	4.15×10^1
370	3.49×10^1	3.60×10^1	3.58×10^1
360	3.02×10^1	3.12×10^1	3.05×10^1
350	2.62×10^1	2.70×10^1	2.64×10^1
340	2.32×10^1	2.36×10^1	2.34×10^1
330	2.07×10^1	2.10×10^1	2.09×10^1
320	1.89×10^1	1.86×10^1	1.88×10^1
310	1.76×10^1	1.74×10^1	1.76×10^1
300	1.69×10^1	1.62×10^1	1.65×10^1
290	1.64×10^1	1.58×10^1	1.61×10^1
280	1.69×10^1	1.60×10^1	1.64×10^1
270	1.88×10^1	1.77×10^1	1.83×10^1
260	2.17×10^1	2.10×10^1	2.16×10^1
250	2.39×10^1	2.36×10^1	2.49×10^1
240	2.41×10^1	2.44×10^1	2.48×10^1
230	2.44×10^1	2.44×10^1	2.45×10^1
220	3.34×10^1	3.34×10^1	2.83×10^1
210	5.81×10^1	6.28×10^1	2.20×10^1
200	3.40×10^1	7.40×10^1	2.17×10^1
190	2.27×10^1	3.70×10^1	2.15×10^1

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 423 nm (5.83×10^1 L g^{-1} cm^{-1}) at pH 2.0, 419 nm (5.80×10^1 L g^{-1} cm^{-1}) at pH 7.0, and 421 nm (5.98×10^1 L g^{-1} cm^{-1}) at pH 10.8.

Table 38. Extinction coefficients of Disperse Blue 26.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	3.17×10^2	4.05×10^2	3.26×10^2
890	3.17×10^2	4.05×10^2	3.14×10^2
880	3.30×10^2	4.05×10^2	3.10×10^2
870	3.36×10^2	4.21×10^2	3.14×10^2
860	3.49×10^2	4.36×10^2	3.18×10^2
850	3.62×10^2	4.59×10^2	3.34×10^2
840	3.74×10^2	4.74×10^2	3.53×10^2
830	3.94×10^2	4.97×10^2	3.69×10^2
820	4.13×10^2	5.28×10^2	4.00×10^2
810	4.38×10^2	5.51×10^2	4.20×10^2
800	4.57×10^2	5.89×10^2	4.44×10^2
790	4.89×10^2	6.27×10^2	4.75×10^2
780	5.20×10^2	6.66×10^2	5.10×10^2
770	5.59×10^2	7.11×10^2	5.50×10^2
760	5.97×10^2	7.73×10^2	5.93×10^2
750	6.47×10^2	8.26×10^2	6.44×10^2
740	6.98×10^2	8.95×10^2	7.03×10^2
730	7.49×10^2	9.79×10^2	7.65×10^2
720	8.19×10^2	1.06×10^3	8.40×10^2
710	8.82×10^2	1.16×10^3	9.15×10^2
700	9.58×10^2	1.25×10^3	9.93×10^2
690	1.03×10^2	1.35×10^3	1.08×10^3
680	1.10×10^3	1.46×10^3	1.16×10^3
670	1.17×10^3	1.56×10^3	1.23×10^3
660	1.25×10^3	1.66×10^3	1.31×10^3
650	1.34×10^3	1.76×10^3	1.41×10^3
640	1.44×10^3	1.88×10^3	1.51×10^3
630	1.54×10^3	2.01×10^3	1.62×10^3
620	1.64×10^3	2.14×10^3	1.72×10^3
610	1.73×10^3	2.25×10^3	1.81×10^3
600	1.80×10^3	2.32×10^3	1.88×10^3
590	1.85×10^3	2.36×10^3	1.92×10^3
580	1.85×10^3	2.36×10^3	1.92×10^3
570	1.83×10^3	2.31×10^3	1.88×10^3
560	1.75×10^3	2.22×10^3	1.81×10^3
550	1.63×10^3	2.07×10^3	1.68×10^3
540	1.48×10^3	1.86×10^3	1.51×10^3
530	1.29×10^3	1.62×10^3	1.32×10^3
520	1.11×10^3	1.40×10^3	1.13×10^3
510	9.52×10^2	1.19×10^3	9.54×10^2
500	8.00×10^2	1.03×10^3	7.97×10^2

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Table 38. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	6.92×10^2	8.95×10^2	6.87×10^2
480	6.16×10^2	7.96×10^2	6.04×10^2
470	5.65×10^2	7.34×10^2	5.57×10^2
460	5.39×10^2	7.04×10^2	5.38×10^2
450	5.39×10^2	6.96×10^2	5.30×10^2
440	5.39×10^2	7.11×10^2	5.38×10^2
430	5.71×10^2	7.34×10^2	5.61×10^2
420	5.97×10^2	7.73×10^2	5.97×10^2
410	6.47×10^2	8.26×10^2	6.40×10^2
400	6.98×10^2	8.95×10^2	6.95×10^2
390	7.81×10^2	9.79×10^2	7.65×10^2
380	8.57×10^2	1.07×10^3	8.40×10^2
370	9.46×10^2	1.19×10^3	9.30×10^2
360	1.04×10^3	1.32×10^3	1.03×10^3
350	1.17×10^3	1.48×10^3	1.17×10^3
340	1.40×10^3	1.77×10^3	1.41×10^3
330	2.07×10^3	2.62×10^3	2.03×10^3
320	2.52×10^3	3.15×10^3	2.45×10^3
310	3.17×10^3	3.98×10^3	3.30×10^3
300	3.94×10^3	5.12×10^3	4.29×10^3
290	4.63×10^3	5.97×10^3	4.95×10^3
280	4.76×10^3	6.42×10^3	5.18×10^3
270	4.57×10^3	6.58×10^3	5.79×10^3
260	4.83×10^3	6.96×10^3	5.75×10^3
250	7.49×10^3	9.71×10^3	8.20×10^3
240	1.62×10^4	2.04×10^4	1.65×10^4
230	2.43×10^4	3.04×10^4	2.34×10^4
220	2.26×10^4	2.88×10^4	1.30×10^4
210	1.77×10^4	2.33×10^4	5.93×10^3
200	9.59×10^3	2.03×10^4	5.18×10^3
190	6.67×10^3	1.43×10^4	4.85×10^3

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 581 nm (1.85×10^3 L mol^{-1} cm^{-1}) at pH 2.0, 584 nm (2.36×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 584 nm (1.93×10^3 L mol^{-1} cm^{-1}) at pH 10.8.

Table 39. Extinction coefficients of Disperse Blue 27.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	6.71×10^{2}	6.18×10^{2}	3.08×10^{1}
890	6.71×10^{2}	6.09×10^{2}	3.08×10^{1}
880	6.80×10^{2}	5.96×10^{2}	4.31×10^{1}
870	7.02×10^{2}	6.09×10^{2}	4.31×10^{1}
860	7.20×10^{2}	6.35×10^{2}	3.08×10^{1}
850	7.60×10^{2}	6.56×10^{2}	3.08×10^{1}
840	7.87×10^{2}	6.90×10^{2}	3.69×10^{1}
830	8.09×10^{2}	7.20×10^{2}	4.92×10^{1}
820	8.41×10^{2}	7.63×10^{2}	5.54×10^{1}
810	8.81×10^{2}	8.05×10^{2}	6.15×10^{1}
800	9.35×10^{2}	8.56×10^{2}	6.77×10^{1}
790	1.00×10^{3}	9.08×10^{2}	8.61×10^{1}
780	1.09×10^{3}	9.76×10^{2}	9.84×10^{1}
770	1.17×10^{3}	1.05×10^{3}	1.29×10^{2}
760	1.25×10^{3}	1.09×10^{3}	1.54×10^{2}
750	1.36×10^{3}	1.22×10^{3}	1.78×10^{2}
740	1.45×10^{3}	1.31×10^{3}	2.09×10^{2}
730	1.56×10^{3}	1.42×10^{3}	2.65×10^{2}
720	1.65×10^{3}	1.51×10^{3}	3.32×10^{2}
710	1.75×10^{3}	1.61×10^{3}	4.37×10^{2}
700	1.82×10^{3}	1.70×10^{3}	5.91×10^{2}
690	1.90×10^{3}	1.77×10^{3}	7.94×10^{2}
680	1.95×10^{3}	1.82×10^{3}	1.07×10^{3}
670	2.00×10^{3}	1.87×10^{3}	1.40×10^{3}
660	2.03×10^{3}	1.90×10^{3}	1.83×10^{3}
650	2.04×10^{3}	1.93×10^{3}	2.07×10^{3}
640	2.05×10^{3}	1.93×10^{3}	2.33×10^{3}
630	2.04×10^{3}	1.93×10^{3}	2.49×10^{3}
620	2.02×10^{3}	1.91×10^{3}	2.58×10^{3}
610	1.98×10^{3}	1.88×10^{3}	2.64×10^{3}
600	1.93×10^{3}	1.83×10^{3}	2.65×10^{3}
590	1.85×10^{3}	1.76×10^{3}	2.58×10^{3}
580	1.75×10^{3}	1.67×10^{3}	2.45×10^{3}
570	1.65×10^{3}	1.58×10^{3}	2.27×10^{3}
560	1.55×10^{3}	1.48×10^{3}	2.07×10^{3}
550	1.46×10^{3}	1.39×10^{3}	1.86×10^{3}
540	1.37×10^{3}	1.30×10^{3}	1.64×10^{3}
530	1.29×10^{3}	1.22×10^{3}	1.44×10^{3}
520	1.23×10^{3}	1.17×10^{3}	1.26×10^{3}
510	1.21×10^{3}	1.14×10^{3}	1.12×10^{3}
500	1.21×10^{3}	1.14×10^{3}	1.01×10^{3}

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Table 39. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	1.24×10^3	1.16×10^3	9.29×10^2
480	1.30×10^3	1.21×10^3	8.80×10^2
470	1.40×10^3	1.30×10^3	8.49×10^2
460	1.51×10^3	1.41×10^3	8.31×10^2
450	1.65×10^3	1.54×10^3	8.43×10^2
440	1.81×10^3	1.70×10^3	8.61×10^2
430	1.95×10^3	1.84×10^3	9.10×10^2
420	2.08×10^3	1.97×10^3	9.84×10^2
410	2.20×10^3	2.08×10^3	1.07×10^3
400	2.15×10^3	2.13×10^3	1.17×10^3
390	2.28×10^3	2.22×10^3	1.29×10^3
380	2.41×10^3	2.26×10^3	1.43×10^3
370	2.55×10^3	2.43×10^3	1.62×10^3
360	2.68×10^3	2.56×10^3	1.86×10^3
350	2.82×10^3	2.68×10^3	2.06×10^3
340	2.95×10^3	2.85×10^3	2.25×10^3
330	3.09×10^3	3.11×10^3	2.45×10^3
320	3.49×10^3	3.37×10^3	2.81×10^3
310	3.89×10^3	3.71×10^3	3.23×10^3
300	4.29×10^3	4.13×10^3	4.00×10^3
290	4.96×10^3	4.81×10^3	4.92×10^3
280	5.50×10^3	5.28×10^3	5.69×10^3
270	5.50×10^3	5.24×10^3	6.15×10^3
260	5.63×10^3	5.33×10^3	6.61×10^3
250	6.17×10^3	5.96×10^3	7.84×10^3
240	7.65×10^3	7.54×10^3	1.03×10^4
230	9.12×10^3	8.78×10^3	1.15×10^4
220	1.05×10^4	1.00×10^4	1.15×10^4
210	1.65×10^4	1.39×10^4	7.54×10^3
200	1.34×10^4	1.66×10^4	6.31×10^3
190	6.31×10^3	9.37×10^3	6.15×10^3

*Spectra were recorded at 25°C in 10% MeOH (v/v) - 90% pH 2.0 glycine hydrochloride-glycine, 10% MeOH - 90% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH - 90% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 639 nm (2.05×10^3 L mol^{-1} cm^{-1}) at pH 2.0, 632 nm (1.53×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 602 nm (2.35×10^3 L mol^{-1} cm^{-1}) at pH 10.8.

Table 40. Extinction coefficients of Disperse Blue 56.*

	ε, L mol^{-1} cm^{-1}		
λ, nm	pH 2.0	pH 7.0	pH 10.8
900	5.98×10^{2}	3.36×10^{2}	4.84×10^{2}
890	6.05×10^{2}	3.36×10^{2}	4.91×10^{2}
880	5.98×10^{2}	3.36×10^{2}	4.97×10^{2}
870	6.12×10^{2}	3.36×10^{2}	4.97×10^{2}
860	6.26×10^{2}	3.46×10^{2}	5.04×10^{2}
850	6.39×10^{2}	3.61×10^{2}	5.23×10^{2}
840	6.60×10^{2}	3.72×10^{2}	5.36×10^{2}
830	6.94×10^{2}	3.87×10^{2}	5.68×10^{2}
820	7.21×10^{2}	4.13×10^{2}	6.00×10^{2}
810	7.68×10^{2}	4.29×10^{2}	6.26×10^{2}
800	7.96×10^{2}	4.54×10^{2}	6.65×10^{2}
790	8.36×10^{2}	4.80×10^{2}	7.04×10^{2}
780	8.98×10^{2}	5.16×10^{2}	7.49×10^{2}
770	9.45×10^{2}	5.42×10^{2}	8.00×10^{2}
760	1.01×10^{3}	5.84×10^{2}	8.59×10^{2}
750	1.09×10^{3}	6.35×10^{2}	9.36×10^{2}
740	1.17×10^{3}	6.82×10^{2}	1.00×10^{3}
730	1.25×10^{3}	7.38×10^{2}	1.08×10^{3}
720	1.36×10^{3}	8.06×10^{2}	1.18×10^{3}
710	1.48×10^{3}	8.88×10^{2}	1.30×10^{3}
700	1.60×10^{3}	9.66×10^{2}	1.42×10^{3}
690	1.75×10^{3}	1.05×10^{3}	1.56×10^{3}
680	1.88×10^{3}	1.15×10^{3}	1.70×10^{3}
670	2.02×10^{3}	1.23×10^{3}	1.85×10^{3}
660	2.14×10^{3}	1.32×10^{3}	1.98×10^{3}
650	2.27×10^{3}	1.41×10^{3}	2.12×10^{3}
640	2.41×10^{3}	1.51×10^{3}	2.27×10^{3}
630	2.60×10^{3}	1.63×10^{3}	2.45×10^{3}
620	2.80×10^{3}	1.77×10^{3}	2.65×10^{3}
610	2.99×10^{3}	1.90×10^{3}	2.83×10^{3}
600	3.13×10^{3}	2.00×10^{3}	2.97×10^{3}
590	3.24×10^{3}	2.07×10^{3}	3.09×10^{3}
580	3.30×10^{3}	2.11×10^{3}	3.15×10^{3}
570	3.34×10^{3}	2.13×10^{3}	3.18×10^{3}
560	3.35×10^{3}	2.13×10^{3}	3.18×10^{3}
550	3.32×10^{3}	2.12×10^{3}	3.14×10^{3}
540	3.24×10^{3}	2.07×10^{3}	3.05×10^{3}
530	3.11×10^{3}	1.98×10^{3}	2.91×10^{3}
520	2.94×10^{3}	1.87×10^{3}	2.74×10^{3}
510	2.68×10^{3}	1.70×10^{3}	2.49×10^{3}
500	2.35×10^{3}	1.50×10^{3}	2.18×10^{3}

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Table 40. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	1.99×10^3	1.25×10^3	1.82×10^3
480	1.65×10^3	1.03×10^3	1.50×10^3
470	1.39×10^3	8.62×10^2	1.25×10^3
460	1.24×10^3	7.59×10^2	1.10×10^3
450	1.16×10^3	7.02×10^2	1.03×10^3
440	1.14×10^3	6.82×10^2	1.02×10^3
430	1.17×10^3	6.92×10^2	1.04×10^3
420	1.24×10^3	7.28×10^2	1.10×10^3
410	1.34×10^3	7.90×10^2	1.19×10^3
400	1.49×10^3	8.73×10^2	1.31×10^3
390	1.67×10^3	9.76×10^2	1.47×10^3
380	1.86×10^3	1.10×10^3	1.63×10^3
370	2.06×10^3	1.23×10^3	1.80×10^3
360	2.28×10^3	1.33×10^3	2.01×10^3
350	2.56×10^3	1.55×10^3	2.26×10^3
340	2.86×10^3	1.75×10^3	2.54×10^3
330	3.17×10^3	1.95×10^3	2.85×10^3
320	3.37×10^3	2.15×10^3	3.15×10^3
310	3.59×10^3	2.42×10^3	3.82×10^3
300	3.92×10^3	2.63×10^3	4.54×10^3
290	5.22×10^3	3.61×10^3	5.68×10^3
280	6.04×10^3	4.44×10^3	6.82×10^3
270	6.15×10^3	5.11×10^3	7.80×10^3
260	6.53×10^3	5.63×10^3	8.88×10^3
250	7.51×10^3	6.09×10^3	9.92×10^3
240	1.04×10^4	7.59×10^3	1.19×10^4
230	1.36×10^4	9.03×10^3	1.38×10^4
220	1.69×10^4	1.06×10^4	1.50×10^4
210	2.13×10^4	1.52×10^4	8.26×10^3
200	1.22×10^4	2.04×10^4	6.97×10^3
190	6.91×10^3	9.96×10^3	6.71×10^3

*Spectra were recorded in 10% MeOH (v/v) - 90% pH 2.0 glycine hydrochloride-glycine, 10% MeOH - 90% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and 10% MeOH - 90% pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 564 nm (3.35×10^3 L mol^{-1} cm^{-1}) at pH 2.0, 562 nm (2.14×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 564 nm (3.17×10^3 L mol^{-1} cm^{-1}) at pH 10.8.

Table 41. Extinction coefficients of Disperse Blue 79.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 3.0	pH 7.0	pH 10.0
900	1.60×10^{3}	2.75×10^{3}	2.22×10^{3}
890	1.60×10^{3}	2.69×10^{3}	2.19×10^{3}
880	1.52×10^{3}	2.67×10^{3}	2.22×10^{3}
870	1.57×10^{3}	2.69×10^{3}	2.25×10^{3}
860	1.60×10^{3}	2.76×10^{3}	2.28×10^{3}
850	1.63×10^{3}	2.82×10^{3}	2.38×10^{3}
840	1.65×10^{3}	2.90×10^{3}	2.44×10^{3}
830	1.73×10^{3}	2.97×10^{3}	2.47×10^{3}
820	1.81×10^{3}	3.05×10^{3}	2.56×10^{3}
810	1.84×10^{3}	3.14×10^{3}	2.62×10^{3}
800	1.87×10^{3}	3.22×10^{3}	2.71×10^{3}
790	1.92×10^{3}	3.31×10^{3}	2.80×10^{3}
780	2.00×10^{3}	3.42×10^{3}	2.86×10^{3}
770	2.08×10^{3}	3.52×10^{3}	2.98×10^{3}
760	2.18×10^{3}	3.65×10^{3}	3.08×10^{3}
750	2.26×10^{3}	3.72×10^{3}	3.17×10^{3}
740	2.37×10^{3}	3.84×10^{3}	3.29×10^{3}
730	2.48×10^{3}	3.95×10^{3}	3.41×10^{3}
720	2.58×10^{3}	4.08×10^{3}	3.56×10^{3}
710	2.72×10^{3}	4.19×10^{3}	3.68×10^{3}
700	2.88×10^{3}	4.29×10^{3}	3.90×10^{3}
690	3.06×10^{3}	4.44×10^{3}	4.17×10^{3}
680	3.36×10^{3}	4.55×10^{3}	4.51×10^{3}
670	3.76×10^{3}	4.70×10^{3}	4.99×10^{3}
660	4.29×10^{3}	4.85×10^{3}	5.63×10^{3}
650	5.06×10^{3}	5.04×10^{3}	6.46×10^{3}
640	5.97×10^{3}	5.27×10^{3}	7.40×10^{3}
630	7.17×10^{3}	5.59×10^{3}	8.43×10^{3}
620	8.34×10^{3}	5.91×10^{3}	9.44×10^{3}
610	9.54×10^{3}	6.21×10^{3}	1.02×10^{4}
600	1.06×10^{4}	6.45×10^{3}	1.08×10^{4}
590	1.13×10^{4}	6.68×10^{3}	1.12×10^{4}
580	1.18×10^{4}	6.81×10^{3}	1.13×10^{4}
570	1.21×10^{4}	6.92×10^{3}	1.13×10^{4}
560	1.22×10^{4}	7.00×10^{3}	1.11×10^{4}
550	1.20×10^{4}	7.01×10^{3}	1.07×10^{4}
540	1.15×10^{4}	7.00×10^{3}	1.02×10^{4}
530	1.10×10^{4}	6.94×10^{3}	9.62×10^{3}
520	1.02×10^{4}	6.81×10^{3}	9.01×10^{3}
510	9.48×10^{3}	6.58×10^{3}	8.46×10^{3}
500	8.61×10^{3}	6.17×10^{3}	7.73×10^{3}

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Table 41. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 3.0	pH 7.0	pH 10.0
490	7.59×10^3	5.57×10^3	6.91×10^3
480	6.79×10^3	5.12×10^3	6.36×10^3
470	6.21×10^3	4.91×10^2	6.00×10^3
460	5.78×10^3	4.70×10^2	5.75×10^3
450	5.41×10^3	4.53×10^2	5.51×10^3
440	5.14×10^3	4.42×10^2	5.48×10^3
430	4.90×10^3	4.33×10^2	5.45×10^3
420	4.66×10^3	4.21×10^2	5.48×10^3
410	4.53×10^3	4.19×10^2	5.63×10^3
400	4.48×10^3	4.23×10^2	5.97×10^3
390	4.45×10^3	4.31×10^2	6.39×10^3
380	4.48×10^3	4.46×10^3	6.91×10^3
370	4.58×10^3	4.65×10^3	7.43×10^3
360	4.80×10^3	4.85×10^3	7.83×10^3
350	5.12×10^3	5.17×10^3	8.10×10^3
340	5.57×10^3	5.57×10^3	8.34×10^3
330	6.13×10^3	6.15×10^3	8.65×10^3
320	6.82×10^3	6.92×10^3	9.17×10^3
310	7.83×10^3	7.56×10^3	1.00×10^4
300	8.98×10^3	8.12×10^3	1.11×10^4
290	1.06×10^4	9.22×10^3	1.27×10^4
280	1.12×10^4	9.72×10^3	1.34×10^4
270	1.09×10^4	9.84×10^3	1.39×10^4
260	1.14×10^4	1.05×10^4	1.46×10^4
250	1.31×10^4	1.19×10^4	1.72×10^4
240	1.85×10^4	1.50×10^4	2.27×10^4
230	2.24×10^4	1.82×10^4	2.69×10^4
220	2.59×10^4	2.10×10^4	3.09×10^4
210	3.52×10^4	2.89×10^4	2.10×10^4
200	3.48×10^4	3.14×10^4	1.61×10^4
190	1.53×10^4	2.26×10^4	1.52×10^4

*Spectra were recorded at 25°C in 50% MeOH (v/v) - 50% pH 2.0 glycine hydrochloride-glycine (final pH 3.0), 40% MeOH (v/v) - 60% pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate (final pH 7.0) and 50% MeOH (v/v) - 50% pH 10.8 glycine-sodium glycinate (final pH 10.0). The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 564 nm (1.22×10^4 L mol^{-1} cm^{-1}) at pH 3.0, 546 nm (7.01×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 576 nm (1.13×10^4 L mol^{-1} cm^{-1}) at pH 10.0.

Table 42. Extinction coefficients of Disperse Red 60.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	9.15×10^{2}	8.18×10^{2}	8.95×10^{2}
890	8.69×10^{2}	7.77×10^{2}	8.86×10^{2}
880	8.40×10^{2}	7.40×10^{2}	8.70×10^{2}
870	8.24×10^{2}	7.25×10^{2}	8.70×10^{2}
860	8.20×10^{2}	7.09×10^{2}	8.78×10^{2}
850	8.20×10^{2}	7.14×10^{2}	8.90×10^{2}
840	8.28×10^{2}	7.20×10^{2}	9.11×10^{2}
830	8.61×10^{2}	7.51×10^{2}	9.28×10^{2}
820	9.11×10^{2}	8.02×10^{2}	9.61×10^{2}
810	9.36×10^{2}	8.23×10^{2}	9.94×10^{2}
800	9.52×10^{2}	8.34×10^{2}	1.01×10^{3}
790	9.65×10^{2}	8.39×10^{2}	1.03×10^{3}
780	9.77×10^{2}	8.49×10^{2}	1.04×10^{3}
770	9.85×10^{2}	8.54×10^{2}	1.06×10^{3}
760	1.01×10^{3}	8.70×10^{2}	1.09×10^{3}
750	1.03×10^{3}	8.85×10^{2}	1.11×10^{3}
740	1.04×10^{3}	8.90×10^{2}	1.13×10^{3}
730	1.08×10^{3}	9.16×10^{2}	1.16×10^{3}
720	1.11×10^{3}	9.53×10^{2}	1.20×10^{3}
710	1.15×10^{3}	9.84×10^{2}	1.22×10^{3}
700	1.18×10^{3}	1.01×10^{3}	1.25×10^{3}
690	1.21×10^{3}	1.04×10^{3}	1.30×10^{3}
680	1.24×10^{3}	1.06×10^{3}	1.33×10^{3}
670	1.28×10^{3}	1.09×10^{3}	1.37×10^{3}
660	1.32×10^{3}	1.11×10^{3}	1.41×10^{3}
650	1.36×10^{3}	1.15×10^{3}	1.46×10^{3}
640	1.41×10^{3}	1.19×10^{3}	1.51×10^{3}
630	1.48×10^{3}	1.24×10^{3}	1.59×10^{3}
620	1.54×10^{3}	1.30×10^{3}	1.68×10^{3}
610	1.65×10^{3}	1.37×10^{3}	1.79×10^{4}
600	1.74×10^{3}	1.45×10^{3}	1.92×10^{4}
590	1.79×10^{3}	1.49×10^{3}	1.99×10^{4}
580	1.76×10^{3}	1.48×10^{3}	1.95×10^{4}
570	1.71×10^{3}	1.41×10^{3}	1.84×10^{4}
560	1.95×10^{3}	1.41×10^{3}	1.80×10^{4}
550	1.82×10^{3}	1.47×10^{3}	1.87×10^{4}
540	1.83×10^{3}	1.49×10^{3}	1.91×10^{4}
530	1.79×10^{3}	1.45×10^{3}	1.85×10^{3}
520	1.73×10^{3}	1.44×10^{3}	1.75×10^{3}
510	1.69×10^{3}	1.37×10^{3}	1.71×10^{3}
500	1.65×10^{3}	1.34×10^{3}	1.69×10^{3}

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Table 42. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	1.57×10^3	1.28×10^3	1.61×10^3
480	1.48×10^3	1.21×10^3	1.52×10^3
470	1.43×10^3	1.18×10^3	1.48×10^3
460	1.38×10^3	1.14×10^3	1.44×10^3
450	1.34×10^3	1.12×10^3	1.42×10^3
440	1.32×10^3	1.12×10^3	1.42×10^3
430	1.34×10^3	1.14×10^3	1.46×10^3
420	1.40×10^3	1.18×10^3	1.52×10^3
410	1.48×10^3	1.25×10^3	1.62×10^3
400	1.58×10^3	1.33×10^3	1.69×10^3
390	1.67×10^3	1.40×10^3	1.83×10^3
380	1.75×10^3	1.47×10^3	1.91×10^3
370	1.84×10^3	1.55×10^3	2.02×10^3
360	1.95×10^3	1.63×10^3	2.07×10^3
350	1.91×10^3	1.72×10^3	2.15×10^3
340	2.15×10^3	1.88×10^3	2.32×10^3
330	3.06×10^3	2.57×10^3	3.23×10^3
320	3.48×10^3	2.90×10^3	3.81×10^3
310	4.47×10^3	3.83×10^3	5.14×10^3
300	5.72×10^3	2.48×10^3	6.38×10^3
290	6.63×10^3	6.01×10^3	7.45×10^3
280	6.71×10^3	6.42×10^3	7.87×10^3
270	6.38×10^3	6.42×10^3	8.03×10^3
260	6.54×10^3	6.63×10^3	8.28×10^3
250	8.70×10^3	8.49×10^3	1.08×10^4
240	2.07×10^4	1.91×10^4	2.22×10^4
230	3.34×10^4	3.13×10^4	3.43×10^4
220	3.02×10^4	3.01×10^4	2.48×10^4
210	1.89×10^4	2.44×10^4	1.10×10^4
200	6.79×10^3	1.91×10^4	9.11×10^3
190	8.53×10^3	1.64×10^4	8.61×10^3

*Spectra were recorded at 25°C in 30% MeOH (v/v) - 70% pH 2.0 glycine hydrochloride-glycine, 20% MeOH - 80% potassium dihydrogen phosphate-disodium hydrogen phosphate and 30% MeOH - 70% glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) were 545 nm (1.84×10^3 L mol^{-1} cm^{-1}) and 589 nm (1.79×10^3 L mol^{-1} cm^{-1}) at pH 2.0, 541 nm (1.50×10^3 L mol^{-1} cm^{-1}) and 589 nm (1.50×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 540 nm (1.91×10^3 L mol^{-1} cm^{-1}) and 587 nm (2.00×10^3 L mol^{-1} cm^{-1}) at pH 10.8.

Table 43. Extinction coefficients of Mordant Black 11.*

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
900	1.57×10^{2}	1.95×10^{2}	0
890	1.57×10^{2}	1.71×10^{2}	0
880	1.73×10^{2}	1.46×10^{2}	0
870	1.73×10^{2}	1.22×10^{2}	0
860	1.73×10^{2}	1.22×10^{2}	0
850	1.73×10^{2}	9.76×10^{1}	0
840	1.73×10^{2}	1.22×10^{2}	0
830	1.73×10^{2}	1.22×10^{2}	0
820	1.88×10^{2}	1.22×10^{2}	0
810	2.04×10^{2}	1.46×10^{2}	2.77×10^{1}
800	2.04×10^{2}	1.71×10^{2}	5.53×10^{1}
790	2.04×10^{2}	1.95×10^{2}	5.53×10^{1}
780	2.20×10^{2}	2.44×10^{2}	8.30×10^{1}
770	2.36×10^{2}	3.17×10^{2}	1.11×10^{2}
760	2.36×10^{2}	4.15×10^{2}	2.49×10^{2}
750	2.51×10^{2}	6.10×10^{2}	4.43×10^{2}
740	2.67×10^{2}	9.28×10^{2}	7.47×10^{2}
730	2.83×10^{2}	1.51×10^{3}	1.36×10^{3}
720	2.98×10^{2}	2.37×10^{3}	2.35×10^{3}
710	3.45×10^{2}	3.66×10^{3}	3.84×10^{3}
700	4.08×10^{2}	5.30×10^{3}	5.92×10^{3}
690	5.18×10^{2}	7.08×10^{3}	8.24×10^{3}
680	6.59×10^{2}	8.47×10^{3}	1.02×10^{4}
670	8.32×10^{2}	9.35×10^{3}	1.15×10^{4}
660	1.10×10^{3}	9.72×10^{3}	1.21×10^{4}
650	1.44×10^{3}	9.94×10^{3}	1.23×10^{4}
640	1.84×10^{3}	1.03×10^{4}	1.26×10^{4}
630	2.29×10^{3}	1.07×10^{4}	1.31×10^{4}
620	2.78×10^{3}	1.09×10^{4}	1.32×10^{4}
610	3.28×10^{3}	1.07×10^{4}	1.30×10^{4}
600	3.83×10^{3}	1.03×10^{4}	1.26×10^{4}
590	4.36×10^{3}	9.94×10^{3}	1.22×10^{4}
580	4.95×10^{3}	9.62×10^{3}	1.19×10^{4}
570	5.53×10^{3}	9.08×10^{3}	1.15×10^{4}
560	6.11×10^{3}	8.37×10^{3}	1.10×10^{4}
550	6.70×10^{3}	7.57×10^{3}	1.02×10^{4}
540	7.33×10^{3}	6.91×10^{3}	9.54×10^{3}
530	7.52×10^{3}	6.27×10^{3}	8.93×10^{3}
520	7.74×10^{3}	5.66×10^{3}	8.30×10^{3}
510	7.71×10^{3}	5.05×10^{3}	7.69×10^{3}
500	7.46×10^{3}	4.32×10^{3}	7.22×10^{3}

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Table 43. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	6.94x10^3	4.37x10^3	6.92x10^3
480	6.33x10^3	3.78x10^3	6.69x10^3
470	5.71x10^3	3.64x10^3	6.67x10^3
460	5.37x10^3	3.64x10^3	6.78x10^3
450	5.24x10^3	3.69x10^3	6.86x10^3
440	5.23x10^3	3.69x10^3	6.72x10^3
430	5.26x10^3	3.66x10^3	6.28x10^3
420	5.32x10^3	3.61x10^3	5.89x10^3
410	5.34x10^3	3.59x10^3	5.48x10^3
400	5.35x10^3	3.73x10^3	5.37x10^3
390	5.39x10^3	4.17x10^3	5.62x10^3
380	5.56x10^3	4.88x10^3	6.28x10^3
370	5.92x10^3	5.79x10^3	7.27x10^3
360	6.42x10^3	6.66x10^3	8.38x10^3
350	7.16x10^3	7.25x10^3	9.29x10^3
340	7.83x10^3	7.47x10^3	9.74x10^3
330	8.00x10^3	7.62x10^3	9.74x10^3
320	8.64x10^3	7.76x10^3	9.71x10^3
310	8.95x10^3	7.79x10^3	9.68x10^3
300	9.42x10^3	7.79x10^3	9.63x10^3
290	9.73x10^3	7.64x10^3	9.49x10^3
280	9.57x10^3	7.76x10^3	9.87x10^3
270	9.42x10^3	8.23x10^3	1.11x10^4
260	9.89x10^3	9.47x10^3	1.25x10^4
250	1.21x10^4	1.21x10^4	1.71x10^4
240	1.68x10^4	1.63x10^4	2.44x10^4
230	2.32x10^4	2.06x10^4	2.49x10^4
220	2.71x10^4	2.28x10^4	2.25x10^4
210	2.76x10^4	2.31x10^4	1.54x10^4
200	1.96x10^4	2.17x10^4	1.42x10^4
190	1.22x10^4	1.44x10^4	1.35x10^4

*Spectra were recorded at 25°C in 10% MeOH (v/v) - 90% pH 2.0 glycine hydrochloride-glycine, 10% MeOH - 90% potassium dihydrogen phosphate-disodium hydrogen phosphate and 2% MeOH - 98% glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 517 nm (7.74x10^3 L mol^{-1} cm^{-1}) at pH 2.0, 620 nm (1.09x10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 622 nm (1.32x10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 44. Extinction coefficients of Reactive Black 5.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	0	4.92×10^{3}	2.07×10^{3}
890	0	4.92×10^{3}	2.07×10^{3}
880	0	4.92×10^{3}	2.07×10^{3}
870	0	4.92×10^{3}	2.07×10^{3}
860	0	4.92×10^{3}	2.07×10^{3}
850	0	4.92×10^{3}	2.07×10^{3}
840	0	4.92×10^{3}	2.07×10^{3}
830	0	4.92×10^{3}	2.07×10^{3}
820	0	4.92×10^{3}	2.07×10^{3}
810	0	4.92×10^{3}	2.07×10^{3}
800	0	4.92×10^{3}	2.07×10^{3}
790	1.21×10^{2}	4.92×10^{3}	2.21×10^{3}
780	1.21×10^{2}	4.92×10^{3}	2.21×10^{3}
770	2.42×10^{2}	5.10×10^{3}	2.34×10^{3}
760	2.42×10^{2}	5.10×10^{3}	2.34×10^{3}
750	2.42×10^{2}	5.25×10^{3}	2.48×10^{3}
740	3.63×10^{2}	5.25×10^{3}	2.76×10^{3}
730	3.63×10^{2}	5.40×10^{3}	3.03×10^{3}
720	4.83×10^{2}	5.40×10^{3}	3.72×10^{3}
710	6.05×10^{2}	5.55×10^{3}	4.83×10^{3}
700	1.21×10^{3}	6.40×10^{3}	6.62×10^{3}
690	2.18×10^{3}	7.05×10^{3}	8.83×10^{3}
680	3.87×10^{3}	8.70×10^{3}	1.34×10^{4}
670	7.00×10^{3}	1.18×10^{4}	1.79×10^{4}
660	1.21×10^{4}	1.67×10^{4}	2.76×10^{4}
650	1.89×10^{4}	2.45×10^{4}	3.45×10^{4}
640	3.03×10^{4}	3.43×10^{4}	4.91×10^{4}
630	4.11×10^{4}	4.48×10^{4}	5.83×10^{4}
620	5.05×10^{4}	5.40×10^{4}	6.52×10^{4}
610	5.60×10^{4}	5.95×10^{4}	6.66×10^{4}
600	5.75×10^{4}	6.15×10^{4}	6.59×10^{4}
590	5.75×10^{4}	6.20×10^{4}	6.48×10^{4}
580	5.55×10^{4}	6.05×10^{4}	6.21×10^{4}
570	5.20×10^{4}	5.70×10^{4}	5.97×10^{4}
560	4.70×10^{4}	5.25×10^{4}	5.42×10^{4}
550	4.18×10^{4}	4.69×10^{4}	4.97×10^{4}
540	3.71×10^{4}	4.17×10^{4}	4.33×10^{4}
530	3.28×10^{4}	3.69×10^{4}	3.93×10^{4}
520	2.83×10^{4}	3.26×10^{4}	3.31×10^{4}
510	2.47×10^{4}	2.85×10^{4}	2.95×10^{4}
500	2.21×10^{4}	2.58×10^{4}	2.50×10^{4}

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Table 44. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	2.14x10^4	2.49x10^4	2.25x10^4
480	2.09x10^4	2.41x10^4	2.03x10^4
470	1.92x10^4	2.28x10^4	1.83x10^4
460	1.80x10^4	2.15x10^4	1.70x10^4
450	1.73x10^4	2.08x10^4	1.63x10^4
440	1.65x10^4	2.02x10^4	1.59x10^4
430	1.57x10^4	1.97x10^4	1.56x10^4
420	1.51x10^4	1.94x10^4	1.53x10^4
410	1.49x10^4	1.95x10^4	1.52x10^4
400	1.62x10^4	2.12x10^4	1.52x10^4
390	1.78x10^4	2.30x10^4	1.72x10^4
380	1.60x10^4	2.17x10^4	1.67x10^4
370	1.34x10^4	1.97x10^4	1.70x10^4
360	1.14x10^4	1.81x10^4	1.68x10^4
350	1.28x10^4	1.94x10^4	2.07x10^4
340	1.71x10^4	2.33x10^4	2.88x10^4
330	2.67x10^4	3.28x10^4	4.28x10^4
320	3.67x10^4	4.23x10^4	5.06x10^4
310	4.04x10^4	4.49x10^4	5.03x10^4
300	3.82x10^4	4.17x10^4	4.07x10^4
290	3.19x10^4	3.56x10^4	3.26x10^4
280	2.56x10^4	2.90x10^4	2.65x10^4
270	2.32x10^4	2.66x10^4	2.54x10^4
260	2.64x10^4	2.99x10^4	2.77x10^4
250	2.78x10^4	3.17x10^4	3.10x10^4
240	2.88x10^4	3.28x10^4	3.63x10^4
230	3.50x10^4	3.90x10^4	4.22x10^4
220	3.54x10^4	3.90x10^4	4.00x10^4
210	3.87x10^4	4.26x10^4	3.35x10^4
200	3.69x10^4	6.00x10^4	3.08x10^4
190	2.78x10^4	4.26x10^4	3.03x10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 596 nm (5.77x10^4 L mol^{-1} cm^{-1}) at pH 2.0, 595 nm (6.15x10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 611 nm (6.69x10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 45. Extinction coefficients of Reactive Blue 19.*

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	2.31×10^{1}	0	0
750	4.61×10^{1}	0	0
740	4.69×10^{1}	1.98×10^{1}	0
730	6.92×10^{1}	3.96×10^{1}	4.76×10^{1}
720	1.15×10^{2}	7.91×10^{1}	8.33×10^{1}
710	2.77×10^{2}	1.98×10^{2}	1.90×10^{2}
700	5.30×10^{2}	4.15×10^{2}	4.04×10^{2}
690	9.91×10^{2}	7.91×10^{2}	8.33×10^{2}
680	1.80×10^{3}	1.48×10^{3}	1.52×10^{3}
670	3.03×10^{3}	2.61×10^{3}	2.74×10^{3}
660	4.71×10^{3}	4.18×10^{3}	4.38×10^{3}
650	6.57×10^{3}	6.02×10^{3}	6.33×10^{3}
640	8.09×10^{3}	7.66×10^{3}	8.04×10^{3}
630	9.01×10^{3}	8.56×10^{3}	9.09×10^{3}
620	9.30×10^{3}	8.87×10^{3}	9.52×10^{3}
610	9.53×10^{3}	9.27×10^{3}	9.78×10^{3}
600	9.87×10^{3}	9.38×10^{3}	1.01×10^{4}
590	1.00×10^{4}	9.58×10^{3}	1.03×10^{4}
580	9.60×10^{3}	9.21×10^{3}	9.92×10^{3}
570	8.74×10^{3}	8.36×10^{3}	9.02×10^{3}
560	7.72×10^{3}	7.46×10^{3}	7.97×10^{3}
550	6.88×10^{3}	6.61×10^{3}	7.02×10^{3}
540	5.99×10^{3}	5.74×10^{3}	6.04×10^{3}
530	5.07×10^{3}	4.83×10^{3}	5.09×10^{3}
520	4.19×10^{3}	3.98×10^{3}	4.14×10^{3}
510	3.48×10^{3}	3.28×10^{3}	3.40×10^{3}
500	2.88×10^{3}	2.67×10^{3}	2.76×10^{3}

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Table 45. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
490	2.30×10^3	2.14×10^3	2.21×10^3
480	1.87×10^3	1.70×10^3	1.76×10^3
470	1.48×10^3	1.36×10^3	1.38×10^3
460	1.15×10^3	1.05×10^3	1.09×10^3
450	9.22×10^2	8.31×10^2	8.57×10^2
440	8.07×10^2	7.12×10^2	7.61×10^2
430	9.22×10^2	7.91×10^2	8.33×10^2
420	1.22×10^3	1.07×10^3	1.19×10^3
410	1.73×10^3	1.52×10^3	1.67×10^3
400	2.34×10^3	2.12×10^3	2.26×10^3
390	3.00×10^3	2.73×10^3	2.90×10^3
380	3.55×10^3	3.22×10^3	3.50×10^3
370	3.88×10^3	3.62×10^3	3.88×10^3
360	4.26×10^3	3.98×10^3	4.28×10^3
350	5.09×10^3	4.72×10^3	5.04×10^3
340	6.32×10^3	5.88×10^3	6.33×10^3
330	8.22×10^3	7.69×10^3	8.30×10^3
320	9.26×10^3	8.70×10^3	9.40×10^3
310	1.15×10^4	1.04×10^4	1.17×10^4
300	1.57×10^4	1.45×10^4	1.58×10^4
290	2.00×10^4	1.88×10^4	1.99×10^4
280	2.30×10^4	2.17×10^4	2.28×10^4
270	2.54×10^4	2.40×10^4	2.53×10^4
260	3.84×10^4	3.70×10^4	3.89×10^4
250	4.30×10^4	4.07×10^4	4.35×10^4
240	4.88×10^4	4.66×10^4	4.98×10^4
230	6.57×10^4	6.39×10^4	6.72×10^4
220	6.22×10^4	6.33×10^4	4.89×10^4
210	4.99×10^4	5.85×10^4	2.56×10^4
200	2.30×10^4	4.92×10^4	2.28×10^4
190	1.78×10^4	3.16×10^4	2.18×10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 593 nm (1.01×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 592 nm (9.58×10^3 L mol^{-1} cm^{-1}) at pH 7.0, and 593 nm (1.03×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 46. Extinction coefficients of Reactive Orange 13.*

λ, nm	ε, L mol^{-1} cm^{-1} pH 2.0	pH 7.0	pH 10.8
900	0	0	0
890	0	0	0
880	0	0	0
870	0	0	0
860	0	0	0
850	0	0	0
840	0	0	0
830	0	0	0
820	0	0	0
810	0	0	0
800	0	0	0
790	0	0	0
780	0	0	0
770	0	0	0
760	0	0	0
750	0	0	0
740	0	0	0
730	0	0	0
720	0	0	0
710	0	0	0
700	0	0	0
690	0	0	0
680	0	0	0
670	0	0	0
660	0	0	0
650	0	0	0
640	0	0	0
630	0	0	0
620	0	0	0
610	0	0	0
600	0	0	0
590	0	0	0
580	5.18×10^{1}	5.05×10^{1}	6.30×10^{1}
570	1.55×10^{2}	1.52×10^{2}	1.89×10^{2}
560	4.65×10^{2}	4.55×10^{2}	4.41×10^{2}
550	1.55×10^{3}	1.36×10^{3}	1.32×10^{3}
540	3.98×10^{3}	3.85×10^{3}	3.72×10^{3}
530	8.65×10^{3}	8.28×10^{3}	8.25×10^{3}
520	1.34×10^{4}	1.33×10^{4}	1.34×10^{4}
510	1.63×10^{4}	1.64×10^{4}	1.64×10^{4}
500	1.76×10^{4}	1.73×10^{4}	1.74×10^{4}

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Table 46. (cont'd)

λ, nm	ε, L mol^{-1} cm^{-1}		
	pH 2.0	pH 7.0	pH 10.8
490	1.76×10^4	1.78×10^4	1.79×10^4
480	1.70×10^4	1.74×10^4	1.75×10^4
470	1.47×10^4	1.51×10^4	1.53×10^4
460	1.20×10^4	1.25×10^4	1.26×10^4
450	9.68×10^3	1.01×10^4	1.03×10^4
440	7.88×10^3	8.08×10^3	8.32×10^3
430	6.73×10^3	6.93×10^3	7.12×10^3
420	5.95×10^3	6.20×10^3	6.43×10^3
410	5.60×10^3	5.80×10^3	5.99×10^3
400	5.53×10^3	5.70×10^3	5.80×10^3
390	5.53×10^3	5.70×10^3	5.61×10^3
380	5.70×10^3	5.75×10^3	5.67×10^3
370	5.60×10^3	5.65×10^3	5.48×10^3
360	5.33×10^3	5.30×10^3	5.23×10^3
350	4.88×10^3	4.80×10^3	4.73×10^3
340	4.55×10^3	4.45×10^3	4.41×10^3
330	4.98×10^3	4.80×10^3	4.73×10^3
320	8.08×10^3	8.08×10^3	8.06×10^3
310	1.10×10^4	1.10×10^4	1.09×10^4
300	1.10×10^4	1.10×10^4	1.08×10^4
290	1.08×10^4	1.08×10^4	1.08×10^4
280	1.20×10^4	1.20×10^4	1.22×10^4
270	1.23×10^4	1.24×10^4	1.24×10^4
260	1.16×10^4	1.15×10^4	1.15×10^4
250	1.30×10^4	1.29×10^4	1.29×10^4
240	1.72×10^4	1.74×10^4	1.74×10^4
230	2.02×10^4	2.05×10^4	2.05×10^4
220	2.39×10^4	2.45×10^4	1.98×10^4
210	2.24×10^4	2.33×10^4	1.25×10^4
200	1.41×10^4	1.87×10^4	1.14×10^4
190	1.14×10^4	1.52×10^4	1.10×10^4

*Spectra were recorded at 25°C in pH 2.0 glycine hydrochloride-glycine, pH 7.0 potassium dihydrogen phosphate-disodium hydrogen phosphate and pH 10.8 glycine-sodium glycinate. The ionic strength of all buffers was 0.05M. The wavelength maximum in the visible region (and extinction coefficient) was 490 nm (1.77×10^4 L mol^{-1} cm^{-1}) at pH 2.0, 489 nm (1.79×10^4 L mol^{-1} cm^{-1}) at pH 7.0, and 490 nm (1.79×10^4 L mol^{-1} cm^{-1}) at pH 10.8.

Table 47. Wavelength maxima in the visible region for 20 dyes.

Dye	λ_{max}, nm
Direct Yellow 4	402
Direct Yellow 11	419
Basic Orange 2	433
Acid Orange 60	480
Reactive Orange 13	489
Acid Red 73	507
Disperse Red 60	541 and 589
Disperse Blue 79	546
Disperse Blue 56	562
Acid Black 52	568
Disperse Blue 26	584
Basic Violet 1	586
Basic Violet 3	590
Reactive Blue 19	592
Reactive Black 5	595
Direct Blue 86	613
Direct Blue 218	615
Basic Green 4	615
Mordant Black 11	620
Disperse Blue 27	632