

salts studied by Bunsen was redetermined and the following additional salts were examined for the first time: Borax, sodium fluoride, potassium fluoride, and barium chloride. The results of all determinations are tabulated below. Bunsen's published figures are given in a separate column. Slight variations from his results are to be noticed in most cases. The material employed was the purest obtainable. Duplicate determinations always gave concordant results:

Salt.	Seconds.	Time of volatilization of 0.01 gram.	
		Sodium chloride as unity. N. and R.	Bunsen.
Sodium chloride.....	13	1.00	1.00
Sodium sulphate.....	130	10.00	15.04
Lithium carbonate.....	130	10.00	8.74
Potassium sulphate	87.5	6.73	7.89
Sodium carbonate.....	95.5	7.38	7.50
Potassium carbonate ...	47	3.61	3.23
“ chloride.....	12	0.923	0.776
“ bromide.....	7	0.538	0.487
“ iodide	5.5	0.423	0.352
Sodium borate	215.5	16.54
“ fluoride	104.5	8.04
Potassium fluoride	39.5	3.04
Barium chloride.....	1560.0	120.00

Tests were also made with calcium chloride, strontium chloride, and magnesium chloride. All three underwent decomposition, leaving a non-volatile, alkaline residue. Calcium sulphate and calcium fluoride were likewise tested. In both cases, although a slight coloration was imparted to the flame, there was no loss of material capable of detection by the balance.

COLOR REACTIONS OF NITRIC AND CHLORIC ACIDS WITH CERTAIN AROMATIC BODIES.¹

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THE object of this research was to find some new practical tests for nitric and chloric acids, more especially tests that would differentiate the two both in mixtures and separately. The latter object has been attained several times over. The former is more difficult for several reasons. In general, chloric

¹ A thesis presented for the degree of Master of Science to the Council of the Graduate School of the University of Michigan, June, 1896. Communicated by O. C. Johnson.

acid produces a darker color reaction than nitric, in some few cases sufficiently so as to indicate chlorates in the presence of nitrates, in almost all cases enough darker to completely mask the nitrate effect. In some cases the effects are indistinguishable. Still two methods will be given later whereby the nitrate effect can be made to predominate, and best of all, one test has been found that, properly manipulated, accomplishes the desired result very well.

THE DIMETHYL ANILIN TEST.

The general method of procedure was as follows : About one cc. of the test solution, generally a solution of two grams of the aromatic substance in 100 cc. of concentrated sulphuric acid, was placed in a dry and clean test-tube and one drop of the nitrate, chlorate, or other inorganic salt solution was added. The whole was agitated and set aside until cold and the color fully developed. Thereupon a slight excess of a strong solution of potassium hydroxide or ammonium hydroxide was very slowly added, and, after standing a little while, enough water was added to redissolve any precipitate that might have formed, if it proved to be soluble. The color was noted at three stages, before and after neutralization, and after dilution. Generally the dilution did not weaken the color, as in most cases the precipitate was coloring matter in contact with a saturated solution of the same.

The organic substances selected for the tests are fairly typical of the main groups of the aromatic series. At least of those groups that present color reactions, *i. e.*, those bodies containing hydroxyl groups, or amido groups, or both. The following is a classified list :

PHENOLS :

Monoxybenzene : Phenol, $C_6H_5.OH$.

Dioxybenzene : $C_6H_4.(OH)_2$.

Pyrocatechol, (1 : 2) ; Resorcinol, (1 : 3) ;

Hydroquinone, (1 : 4).

Trioxybenzene : $C_6H_3.(OH)_3$.

Pyrogallol, (1 : 2 : 3).

CRESOLS :

Monoxytoluene : $C_6H_4.CH_3.OH.$

Dioxytoluene : $C_6H_3.CH_3.(OH)_2.$

m-Cresol, (1 : 3). Orcinol, (1 : 3 : 5).

OXYACIDS :

Monoxybenzoic acid : $C_6H_4.OH.CO_2H.$

Trioxybenzoic acid : $C_6H_2.(OH)_3.CO_2H.$

Salicylic acid, (1 : 2). Gallic acid, (1 : 3 : 4 : 5— CO_2H in 1).

α -NAPHTHOL, $C_{10}H_7.OH.$

ALIZARIN, Dioxyanthroquinone, (1 : 2). $C_6H_4.(CO)_2.C_6H_2.$
(OH)₂.

AMINES :

Amidobenzenes :

Anilin, $C_6H_5.NH_2.$ Dimethylanilin, $C_6H_5.N(CH_3)_2.$

Acetanilid, $C_6H_5.NH.CO.CH_3.$

Diphenylamin, $(C_6H_5)_2NH.$

Amidotoluenes : $C_6H_4.CH_3.NH_2.$

Orthotoluidin, (1 : 2). Paratoluidin, (1 : 4)

Amidophenols :

Diamidophenol, $C_6H_3.(NH_2)_2.OH.$

Paramidometacresol, or "metol" $C_6H_3.CH_3.OH.NH_2.$

α -NAPHTHYLAMIN, $C_{10}H_7.NH_2.$

Table No. 1 gives in condensed tabulated form the reactions of these test solutions potassium nitrate, potassium chlorate, potassium bromate, potassium iodate, potassium bromide, potassium iodide, and a mixture of potassium chloride and nitrate. The colors are indicated thus :

V-violet ; I-indigo ; Bl-blue ; Gr-green ; Y-yellow ; O-orange ; R-red ; W-white ; Gra-gray ; Br-brown ; Pur-purple ; Car-carmin ; Cri-crimson ; Pk-pink ; Ch-cherry ; Blo-blood red ; YBr-yellowish brown ; etc.

The modifying adjectives are indicated thus :

s-strong ; l-light ; d-dark ; v-very ; m-muddy.

This gives a means of expressing nearly 300 reactions on one page.

In making out this table the general method of experimentation as given on page 157 was followed. The phenol solution was of thirty per cent. strength. It was made from crystals that had somewhat reddened. Still it gave a perfectly white solution

that at the end of one month showed not the slightest discoloration. It is one of the strongly recommended tests for nitrates, not being interfered with by bromides nor iodides nor any of the metals if the proper alkali be chosen for neutralization. The same can be said of the salicylic acid test. The solution consisted of one gram of sodium salicylate dissolved in forty cc. of concentrated sulphuric acid. These two tests depend on the formation of ammonium or potassium picrate, giving a solution of a strong yellow or greenish yellow color. Another method of performing the phenol test deserves mention. It is probably more delicate though not so quick-acting as the one first given. The final result is the same. Into a dry test-tube is put one cc. of concentrated sulphuric acid. On this is very carefully floated a layer of a saturated water solution of phenol, not more than one-half cc. Now a drop of the unknown is allowed to fall gently on the upper layer, generally immediately producing a strong brown ring. After standing for some time the whole is shaken and neutralized, when a strongly picrate-colored solution indicates a nitrate. Chlorates give a brownish yellow instead of a greenish yellow. This serves as a distinguishing test in solutions where only one of the two is present.

The di- and trioxybenzenes furnish still more delicate tests for both nitrates and chlorates, but unfortunately give the same result with both as far as color is concerned, though perhaps a somewhat stronger effect with chlorates. Hydroquinone is the best of the four by far, giving a clear white solution possessing comparatively remarkable keeping qualities. A three per cent. solution was used. The resorcinol keeps well but gives a light brown solution, making it unsuitable for delicate tests unless freshly prepared. The pyrocatechol and the pyrogallol solutions do not keep at all if allowed access to the air. In these cases the test was performed by adding a minute crystal of the pyrogallol or the pyrocatechol to one cc. of sulphuric acid already in the test-tube, and going through the operations somewhat rapidly. The resorcinol used was two per cent. strong. All four under the proper conditions give the same result, a yellow solution with either a brown or a green tinge.

The monoxytoluenes give practically the same result as the phenols, both as regards delicacy and certainty of result, and,

although the test solution itself is somewhat brownish, still the effect of this on the final color is absolutely nothing at all, which cannot be said concerning any color in the test solutions where mere oxidation and not nitration is concerned.

The strength of the orcinol solution was two per cent. It was light brown in color but kept well and gave good results. Its special value was in the different results it gave while still acid with nitrates and chlorates, strong yellow red with the former and strong green with the latter.

The gallic acid solution, one per cent., was a disappointment. Although it gave a clear white test solution, and strong color reactions, with the nitrates especially, still it would give some color with bromides and iodides, and sometimes on neutralization without having any other salt added to it.

Naphthol and naphthylamin. both one per cent., gave strong clear tests. The naphthylamin distinguishes nitrates and chlorates as per table.

The alizarin was a bleaching test. Alizarin was added to sulphuric acid until a pink or light crimson solution was obtained. This, plus water, would give a bright yellow, plus potassium hydroxide, would give a strong purple. but nitrates, chlorates, bromates, iodates, and iodides so affect the sulphuric acid solution that addition of potassium hydroxide gives a colorless, or at the most, a very light purple result.

Acetanilid, one per cent, is sufficiently explained by the table.

Diphenylamin, four per cent., gave a light green solution which gradually darkened. This makes a fairly delicate test for nitrates, but there are several serious faults in its workings. First, it gives a rather poorly keeping solution. Second, it will not bear dilution or neutralization, so as to eliminate the effects of bromides and iodides, and so as to distinguish between nitrates and chlorates, even when only one of the two is present, nitrates, chlorates, bromates, and iodates all giving practically the same color. Third, it must be kept cool; heat alone, even the heat generated by adding a drop of distilled water to two or three of the solution may give the color supposedly due to a nitrate. Heating changes it first to green, then to a blue, and finally to dense black flakes in a colorless liquid in which water no longer produces a muddy brown precipitate as before.

The anilins and the toluidins will be treated later, after the comparative indices.

“Amidol,” or diamidophenol hydrochloride, one per cent., makes a very delicate quick-acting test in acid solution, the test solution keeping very well considering its susceptibility to atmospheric oxidation. This latter sensitiveness somewhat spoils the effect of neutralization unless the test is performed rapidly.

“Metol,” or paramidometacresol, one per cent., makes a test solution that resembles hydroquinone in its keeping properties and reactions.

Table No. 2 gives a comparative index for nitrates, and Table No. 3 a similar index for chlorates. These indices are arranged as follows: The first column contains the list of test solutions with its own colors marked. Of the remaining columns those to the left of the central double line contain the reactions on neutralization with potassium hydroxide, and those to the right on neutralizing with ammonium hydroxide. Fifteen drops of the test solution and one drop of a five per cent. solution of the nitrate or chlorate gave reaction (1); six drops of water gave reaction (2); an insufficient quantity of the neutralizing agent, reaction (3); an excess of the same, reaction (4); lastly, equal dilution with water, reaction (5). The remaining columns indicate the comparative strength of the color produced after the reaction whose number occurs at the top. A indicates the strongest color, B the next strongest, and so on. In each case the comparison is made only with the other colors in the same column. The fact that any one reaction is marked A means only that it gave the darkest color, not that it gave the clearest, most distinctive, or even most delicate test. The addition of water in the second reaction was for the purpose of preventing the intense heating effect produced by dropping strong potassium hydroxide solution into concentrated sulphuric acid. In some cases this modified to a considerable extent the reaction as given in the General Table. Further important details will appear on examining the indices. Especially significant is the fact that the strongest tests for nitrates were not always the strongest for chlorates even when they gave the same color, and vice versa.

By far the most interesting and most valuable results came from the study of the anilins and the toluidins. Table No. 4 shows the reactions of ten combinations of these substances, both as to the actual color produced and the comparative strength of the colors at different stages. A great many peculiar features came out in this series. The green and blue effects in the chlorate series gradually faded away leaving brown. A little water might restore the color which would soon again fade away. Again addition of water might reproduce the color which would more slowly disappear. Finally, considerable dilution would restore the color so that it would fade quite slowly but permanently. The green and blue effects to which reference are made are the ones in the column headed $\text{H}_2\text{O}^{(4)}$. Effects of the same nature, but during the process of neutralization, were noticed in the experiments with mixtures of potassium nitrate, with potassium chloride or potassium chlorate, as per table. In all cases where orthotoluidin was used a strong green appeared while adding potassium hydroxide. Sometimes it persisted for quite a while after complete neutralization. All traces of green eventually disappearing, addition of water reproduced the color which faded and was again reproduced as above.

The tests to which particular attention is called are those in horizontal lines (8) and (9). Notice the difference in the first effect in all four cases. Test No. (9), it will be noticed, gives the much desired means of detecting a nitrate in the presence of chlorates, bromates, and iodates. The first operation is the important one. If the chlorate be not in too great excess the blood red color produced by the nitrate is sure to show. Below are given some data on the sensitiveness of this test. It will be noticed that though chlorides alone have no color effect, they very much intensify the nitrate effect. The best formula appeared to be:

Dimethyl anilin	2 drops.
Paratoluidine	0.2 grams.
Sulphuric acid	10 cc.

It gives a colorless solution that keeps well.

On the same page are given data on the sensitiveness of the phenol, salicylic acid, and hydroquinone tests for nitrates, and

the anilin test for chlorates. A remarkable feature about the last is the radical change in color on standing.

Two methods of removing or reducing the strength of chlorates in a solution containing nitrates have been experimented with.

(1). Acidify with sulphuric, add hydrochloric, and boil until on adding another drop of hydrochloric and boiling no yellow color appears. Now the phenol test can show the nitrate without the slightest trace of the brown color due to chlorates.

(2). Carefully evaporate just to dryness, add cold water not sufficient to redissolve all the chlorate, dilute, and use the dimethylanilin test. All the nitrate dissolves before an equal quantity of chlorate, and as the test is good for nitrates in the presence of the same bulk of chlorates, it will work even more surely with a less amount.

An actual experiment of this sort ran as follows: Twenty cc. of water was saturated with potassium chlorate at about 50° C. and one gram of potassium nitrate added. When the solution had cooled to the temperature of the room, some of the potassium chlorate had crystallized out. Still more potassium chlorate than nitrate remained in solution. One drop of this gave a dark brown test with traces of crimson. The chlorate masked the nitrate. But when some of the solution was diluted with four volumes of water, in spite of the fact that the chlorate exceeded the nitrate in the same ratio as before, one drop gave a strong crimson reaction, the chlorate effect being overlooked. Then the original solution was evaporated to dryness, the residue cooled, and agitated with ten cc. of cold water. Now a test showed strong crimson but with a brownish tint. On adding four volumes of water to some of this solution the brown tint did not appear, only the crimson nitrate effect.

The dimethylanilin test has proved to be practically an absolute test for nitrates. The test has been successfully worked in the presence of each of the inorganic salts commonly met with, even the most powerful oxidizing and reducing agents. Of the metals, Sn'' , Sb''' , Fe'' are the only ones that tend to spoil the test by reducing the nitrate. Oxalic, acetic, hydrosulphuric, iodic, and arsenious acids seemed to exert a similar influence on the test. However, the only one of these two lists that was

always deleterious was Fe'' . $\text{K}_3\text{Fe}(\text{CN})_6$, $\text{K}_4\text{Fe}(\text{CN})_6$, and KNO_3 seemed to give a pink to crimson color that might have been due to impurities in the reagents. Addition of nitrate, however, immediately strengthened the color to such an extent as to obviate any difficulty on that score. The color produced by potassium ferrocyanide was very feeble, which result seemed to uphold the suspicion of impurity in the other cases. Potassium chloride, potassium bromide, potassium iodide, chlorine, bromine, iodine, and potassium thiocyanate seemed to have no effect whatever, excepting that potassium chloride strengthened the nitrate reaction. Similarly potassium chromate, potassium dichromate, potassium arsenate, and potassium permanganate presented no color reaction of their own, but seemed to help the nitrate in its reaction. Potassium permanganate lost its own color when added separately to the test solution. As mentioned above, potassium chlorate, bromate, and iodate do not interfere with the test under ordinary circumstances.

In view of these various results, to get the maximum efficiency out of the test, would require the following method of procedure :

To the unknown add potassium chlorate, if not already present, then some hydrochloric acid, and boil. This will oxidize all the reducing agents that might otherwise be harmful, without introducing enough excess of potassium chlorate to injure the result.

TABLE NO. 1. GENERAL INDEX OF REACTIONS.

Test solution of	KNO ₃ .	KOH.	KClO ₃ .	KOH.	KBrO ₃ .	KOH.	KIO ₃ .	KOH.	KBr.	KOH.	KI.	KOH.	KCl and KNO ₃ .	KOH.
Phenol.....	Y	sGrY	RY	dGrBr	RY	lYBr	sRY	lYBr	lY	W	Md	W	Y	GrY
Pyrocatechol.....														
Resorcinol.....	Y	Y	BrY	lBr	BrY	lBr	MdBr	lBr	lY	W	Md	W	Y	Y
Hydroquinone... ..	sYR	YR	YBr	YBr	YBr	YBr	MdBr	YBr	W	W	MdGra	W	YBr	YBr
Pyrogallol.....	sYR	sYBr	vdBr	vlBr	YBr	lBr	sBr	lBr	lY	W	Md	W	sYR	YR
Cresol.....	Y	sY	BrY	dGrBr	BrY	vsRBr	MdBrY	vsRBr	Y	vv1	Md	vv1	Y	sY
Orcinol.....	sYR	sYR	sGr	YBr	sGr	Br	dMd	sBr	W	W	Md	W	sYR	sY
Salicylic acid.....	lY	sY	dYBr	sBr	RY	sBr	RY	sBr	lY	W	Md	W	lY	sY
Gallic acid.....	sYR	sYBr	Y	lY	Y	W	MdGr	lY	W	lPkBr	Md	lPkBr	RY	Y
<i>α</i> -Naphthol.....	sBrY	sY	sBrY	Br	sRY	Br	MdGr	Y	W	W	Md	W	sBrY	Y
Alizarin.....	Y	W	Y	W	BrY	W	Y	W	Y	Pur	Md	W	Y	W
Anilin oil.....	dRBr	Y	vsBl	sPur	dBl	lBr	sRBr	lBr	RY	W	Md	W	sPurBr	Br
Dimethylanilin... ..	RY	sY	Y	vlBr	Y	vlBr	sRY	vlBr	Y	W	Md	W	sRY	sY
Acetanilid.....	lY	sY	dRBr	dGrBr	YBr	Br	YBr	lBr	RY	W	Md	W	lY	Y
Diphenylamin... ..	sBl		sBl		sBl		sBl		sGr		Md		sBl	
Orthotoluidin....	sYBr	Y	sBl	PurBl	sBl	lBr	MdsBl	lBr	YBr	W	Md	W	sBrPur	GrY
Paratoluidin....	vdBr	Br	vsBr	Br										
"Amidol".....	vsYR	YBr	sPurR	YGr	sR	YGr	vsPurR	YBr	Y	lBr	Md	lBr	RY	YBr
"Metol".....	YR	YBr	Y	YBr	YR	Y	sYR	sYBr	vlY	W	Md	W	Y	YBr
<i>α</i> -Naphthylamin. .	dPurGr	Y	dYR	dBr	dYR	dBr	MdBr	YBr	W	W	Md	W	dPurR	RY

TABLE NO. 2. COMPARATIVE INDEX FOR NITRIC ACID.

Test solution of	(1) KNO ₃ .	(2) H ₂ O.	(3) KOH.	(4) KOH.	(5) H ₂ O.	(4)	(5)	(1) KNO ₃ .	(2) H ₂ O.	(3) NH ₄ OH.	(4) NH ₄ OH.	(5) H ₂ O.	(1)	(2)	(4)	(5)
Phenol, W.....	Y	1Y	v1Y	sY	sY	E	E	Y	1Y	v1Y	sY	sY	C	E	D	C
Pyrocatechol																
Resorcinol, 1Br	Y	Y	O	sY	sY	E	E	Y	Y	sY	sY	sY	C	E	D	C
Hydroquinone, W	vdRBr	RY	dBrR	vdBr	vsYBr	C	C	vdBr	sRBr	dRBr	vsRBr	sYBr	A	C	B	C
Pyrogallol.....	BrY	v1Y	dBr	vdBr	sBr	C	C	vdBr	vdBr	vdBr	vsBr	sYBr	A	B	A	C
Cresol																
Orcinol, 1Br	dRY	O	dYR	dRY	sBrY	D	D	sBrY	YBr	O	sRB	sYBr	B	D	B	C
Salicylic acid, W.....	1Y	v1Y	v1Y	sY	sY	E	E	1Y	W	sY	sY	sY	D	G	D	C
Gallic acid, v1Y.....	vsBr	dYBr	Br	vdBrR	sBrY	C	D	vdBr	vdBr	dBr	sYBr	sYBr	A	B	C	C
<i>α</i> -Naphthol, 1Br	sGrBr	O	1Y	dRY	sO	D	C	sGrY	YBr	Y	sRBr	sYBr	A	B	C	C
Alizarin, sPk.....	1Y	1Y	v1Y	v1Pur	v1Pur	H	H	1O	1Y	1Y	v1Y	W	C	F	F	F
Anilin oil, v1Y.....	vdBrR	Gra	1YBr	MdBr	Y	D	E	vsBr	sBlGra	MdY	MdY	GrY	A	B	C	D
Dimethylanilin																
Acetanilid, W.....	Y	Y	Y	sY	sY	F	E	Y	Y	Y	Y	GrY	C	E	E	D
Diphenylamin, Gr....	vsBl					(1) A		vsBl					A			
Orthotoluidin, Br....	vdRBr	vdBr	MdBr	MdBr	Y	D	E	vdR	sYBr	GrY	GrY	GrY	A	C	D	D
Paratoluidin																
"Amidol," v1.....	vdBrR	dBlo	vdBrR	vdBrR	vvsR	A	A	vdR	vsBlo	vvdBr	vvsBr	vvsBr	A	B	A	A
"Metol," W.....	Y	BrY	O	sYR	sYBr	D	D	Y	1O	RBr	vvsBlo	vsR	C	E	A	B
<i>α</i> -Naphthylamin, 1Br..	vdBr	dYBr	vdBr	vdYBr	vsRBr	B	B	vdBr	vsYBr	vvdBr	vsRBr	vsYBr	A	B	B	C

TABLE NO. 3. COMPARATIVE INDEX FOR CHLORIC ACID.

Test solution of	(1) KClO ₃ .	(2) H ₂ O.	(3) KOH.	(4) KOH.	(5) H ₂ O.	(1)	(2)	(4)	(5)	(1) KClO ₃ .	(2) H ₂ O.	(3) NH ₄ OH.	(4) NH ₄ OH.	(5) H ₂ O.	(1)	(2)	(4)	(5)
Phenol.....	Y	Y		dGrBr	v1Br	D	D	B	D	Y	Y	sBr	YBr	1Br	D	D	C	D
Pyrocatechol.....																		
Resorcinol.....	sY	Y		1Br	W	D	D	E	F	vsBr	vsBr	vsBr	vsBr	sBr	A	A	A	B
Hydroquinone...	sBrY	Br		YBr	sY	C	C	C	C	sBr	sBr	vsBloBr	vvvsBr	vdBr	B	B	A	B
Pyrogallol.....	vdBr	vdRBr		dYBr	vsBr	B	B	B	E	vsBr	vsBr	vsBr	vsBr	sBr	A	A	A	B
Cresol.....																		
Orcinol.....	MdsGr	MdGr		vdGrBr	dBr	C	C	A	B	vsBrGr	MdBr	BrY	sO	sB	A	C	C	C
Salicylic acid....	Y	Y		YBr	v1Br	D	D	C	D	Y	Y	BrY	Br	1Br	D	D	C	C
Gallic acid.....	sGrBr	Br		YBr	Br	B	C	C	C	vsBrY	sBrY	sO	sO	sGrBr	A	B	C	B
<i>α</i> -Naphthol.....	sYBr	Br		dYBr	Br	B	C	B	C	vsBrY	sBrY	BrY	vsBr	sGrBr	A	B	B	B
Alizarin.....	1Y	v1Y		W	W	E	E	F	F	1Y	1Y	1Y	W	W	F	E	E	E
Anilin oil.....	vdBl	vdBl		MdBr	RPur	A	A	B	B	vdBl	vdBl	MdBr	MdBr	sGra	A	A	A	C
Dimethylanilin ..																		
Acetanilid.....	1Y	O		1Br	v1Y	E	D	D	E	BrY	sBrY	YBr	YBr	1Br	D	C	C	D
Diphenylamin...	vsBl					A				vsBl				A				
Orthotoluidin ..	vdBl	vdBl		MdPur	sBlPur	A	A	A	A	vsBl	vsBl	MdPurGra	sBl	vsBl	A	A	B	A
Paratoluidin.....																		
"Amidol".....	1Br	sCh		dYGr	sGrBr	E	B	B	B	1Y	vsBlo	vsBr	vsBr	vdGrBr	F	A	A	A
"Metol".....	1O	1Y		YBr	v1Br	E	D	C	D	Y	1Y	vsBloBr	vsRBr	dBr	F	E	A	B
<i>α</i> -Naphthylamin..	sR	sYR		vdYBr	dBr	B	C	A	B	sRY	sBrY	vsBr	MdvvsBr	vdBr	B	B	A	B

TABLE NO. 4. INDEX FOR THE ANILINS AND TOLUIDINS.

Fifteen drops of test solution of	1 drop 5 per cent. KNO ₃ .		6 drops H ₂ O.				1 drop 5 per cent. HClO ₃ .				6 drops H ₂ O.				1 drop each KCl KNO ₂ .		4 cc. H ₂ O.		KOH and H ₂ O.		KNO ₃ and H ₂ O.		KOH and H ₂ O.							
	vdBr	Br	MdBr	Y	A	B	vvsBl	vdBr	MdBr	PkBr	A	A	vsBr	Br	Y	A	vsBl	dBr	BrY	A	vsBl	dBr	Gr	Y	A	vsBl	dBr	Gr	Y	A
(1) Anilin.....	vdBr	Br	MdBr	Y	A	B	vvsBl	vdBr	MdBr	PkBr	A	A	vsBr	Br	Y	A	vsBl	dBr	BrY	A	vsBl	dBr	Gr	Y	A	vsBl	dBr	Gr	Y	A
(2) Orthotoluidin.	vvdBr	vsRBr	MdBr	Br	A	A	vvsBl	sCri	MdBr	GrBl	A	Bl	vsPurBr	sBr	Gr	A	vsBl	dBr	Gr	A	vsBr	YBr	Y	A	vsBr	YBr	Y	A	A	
(3) Paratoluidin.	vdBr	Br	MdBr	Y	A	B	vsBr	Br	MdBr	Br	B	C	vsRBr	Y	Y	A	vs	Br			vs	Br			vs	Br				
(4) Anilin and orthotoluidin	vdBr	sBr	MdBr	Y	A	B	vvsBl	sCri	MdBr	GraBl	A	B	vsPurBr	Br	Gr	A	PurBl	dR	Gr	A	vsCri				vs	PurBl	dR	Gr	A	
(5) Anilin and paratoluidin.....	vsCri	lBr	MdY	Y	C	B	Pur	sBr	MdBr	lBr	B	C	vsCri	Y	Y	A	Pur	R	BrY	A	vsPur				vsPur	R	BrY	A		
(6) Anilin and both toluidins.....	Blo	sBr	MdBr	Y	A	B	vvsBl	vsCri	MdBr	GraBl	A	B	vsCri	RY	YGr	A	Cri	dBr	YGr	A										
(7) Dimethylanilin	sYO	O	MdY	Y	C	B	Y	YGr	MdBr	lBr	C	C	sYCri	O	Y	B	sYCri	O	Y	B										
(8) Dimethylanilin and orthotoluidin	vsBr	Br	MdY	Y	B	B	BlGr	RBr	MdBr	Br	B	B	vsRB	R	Gr	A	vsBr	R	Br	A										
* (9) Dimethylanilin and paratoluidin	vsBlo	lBr	MdY	Y	C	B	vsBr	sRBr	MdBr	lBr	B	C	vsBlo	Y	YBr	*A	vsBlo	YBr	BrY	A										
(10) Dimethylanilin and both toluidins	vsBlo	lBr	MdY	Y	A	B	BlPur	sRBr	MdBr	lBr	A	C	vsBlo	R	YBr	*A	vsBlo	R	BrY	A										

FORMULAS USED IN PREPARING THE TABLE.

- | | | | | | |
|-------------------------|----------|--------------------------|----------|-------------------------|----------|
| (1) Anilin..... | 4 drops | (6) Anilin..... | 2 drops | (9) Dimethylanilin.... | 2 drops |
| (2) Orthotoluidin | 4 " | Orthotoluidin | 2 " | Paratoluidin..... | 0.2 gram |
| (3) Paratoluidin | 0.4 gram | Paratoluidin | 0.2 gram | (10) Dimethylanilin.... | 2 drops |
| (4) Anilin..... | 2 drops | (7) Dimethylanilin | 4 drops | Paratoluidin | 0.2 gram |
| Orthotoluidin | 2 " | (8) Dimethylanilin | 3 " | Orthotoluidin | 2 drops |
| (5) Anilin..... | 2 " | Orthotoluidin | 2 " | | |
| Paratoluidin..... | 0.2 gram | | | | |

In all cases ten cc. of concentrated sulphuric acid were used.

TABLE NO. 5. SENSITIVENESS OF VARIOUS TESTS.

Dimethylanilin, (9) Table 4.			Phenolsulphonic Acid.				Salicylic Acid.			
Ten drops of test solution and one drop of KNO ₃ of	In a few seconds.	In ten minutes.	Ten drops of test solution and one drop 5 per cent. KCl and KNO ₃ as before.	In ten minutes	15 drops of test solution and 1 drop KNO ₃ as before, two minutes.	Three hours.	+KOH.	Two minutes.	Three hours.	+KOH.
5 per cent.	sCri	vsCri	sCri	vvsBlo						
I " "	Pk	sPk	Cri	vsBlo	IY	Y	sY	IY	Y	sY
0.1 " "	vIPk	IPk	Pk	sBlo	vvIY	vIY	IY	W	IY	IY
0.01 " "	vvIY	vvIY	vIPk	IPk	W	W	W	W	W	W
0.001 " "	vvIY	vvIY	vvIPk	IPk						
Hydroquinone.										
15 drops of a one per cent. solution and 1 drop KNO ₃ of	After five minutes.	After one half hour + KOH.	Fresh solution { 0.1 gram Diphenylamin. 10 cc. H ₂ SO ₄ .		15 mm. No. 6. Table 4. + 1 mm. of		Anilin test for chlorates.			
			15 mm. + 7 mm.	2 seconds.				2 min.	15 min.	
			1 per cent. KNO ₃ .	vvsBl		1 per cent. KClO ₃ .	vvdB1	dBrR		
0.1 per cent.	Br	BrY	0.1 per cent. KNO ₃ .	6 seconds. sBl		0.1 per cent. KClO ₃ .	Bl	lBr		
0.01 per cent.	lBr	vIY	0.01 per cent. KNO ₃ .	0.5 minute. lGrBl		0.01 per cent. KClO ₃ .	W	vvvlBr		
0.001 per cent.	vlBr	W	0.001 per cent. KNO ₃ .	1 minute. No change.						