NOTES.

Naphthalene-2 : 3-dialdehyde. By J. W. Cook, Leon Hunter, and (Miss) R. Schoental.

The finding that anthracene can be oxidised by osmium tetroxide to 1 : 2 : 3 : 4-tetrahydroxy-1 : 2 : 3 : 4-tetrahydroanthracene (Cook and Schoental, *Nature*, 1948, **161**, 237) has enabled us to prepare the hitherto unknown *naphthalene-2 : 3-dialdehyde.* A solution of periodic acid (600 mg.) in water (4 c.c.) was added to a hot solution of the tetrol (40 mg.) in water (25 c.c.). The dialdehyde crystallised (25 mg.), and after recrystallisation from light petroleum, formed colourless needles, m. p. 131—132° (Found: C, 77·9; H, 4·3. $C_{12}H_8O_2$ requires C, 78·2; H, 4·4%). Its 2 : 4-*dinitrophenylhydrazone* formed an orange microcrystalline powder, m. p. 300° (decomp.) (Found: C, 53·2; H, 2·9. $C_{24}H_{16}O_8N_8$ requires C, 52·9; H, 3·0%).

We are indebted to the British Empire Cancer Campaign for a maintenance grant (to R.S.).—University of Glasgow. [*Received, August 4th,* 1948.]

The Dipole Moments of Trinitromethane Derivatives. By A. Audsley and F. R. Goss.

Dipole moments of trinitromethane and four of its derivatives, prepared as described by Reich, Rose, and Wilson (*J.*, 1947, 1234), have been obtained from their polarisation (P_∞) at infinite dilution in benzene, and calculations made to estimate the direction taken up by the polar groups. Lewis and Smyth (*J. Amer. Chem. Soc.*, 1939, **61**, 3067) found a slightly higher value (2·71) for trinitromethane, but their measurements were made in carbon tetrachloride solution, and such a difference is to be expected.

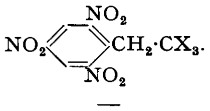
	μ.	P_∞.	$[R]_D$, calc.
Trinitromethane	2·61	168	23·1
1 : 1 : 1-Trinitroethane	3·33	262	27·7
p-Nitrobenzyltrinitromethane	3·45	311	57·4
2 : 4 : 6-Trinitro-1-(2′ : 2′ : 2′-trinitroethyl)benzene	3·35	309	68·4
5-Nitro-1 : 3-bis-2′ : 2′ : 2′-trinitroethylbenzene	3·77	387	83·1

These moments are not absolute values, but are comparable with other values for nitro-compounds obtained in benzene solution. The value of the elastic (electron plus atom) polarisation P_{E+A} has been estimated from the calculated molecular refraction as 1·05 $[R]_D$, and any error so introduced will probably be small for the large moments now under consideration. Lewis and Smyth (*loc. cit.*) suggest the probability of large values of the atom polarisation for compounds containing aliphatic nitro-groups. These large values for the atom polarisation can, however, be presumed to have comparable values, and may be expected in these compounds to compensate to some extent for the analogous lack of correction for the solvent effects.

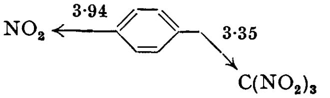
The effect of introducing a methyl group into trinitromethane is to increase the moment by about one-third as occurs with other trisubstituted methanes, chloroform, and hydrogen cyanide, owing to the induced moment in the Me–C bond.

X_3.	CHX_3.	$CMeX_3$.	Ratio $CMeX_3/CHX_3$.
$(NO_2)_3$	2·61	3·33	1·28
Cl_3	1·18	1·57	1·33
≡N	2·65	3·44	1·30

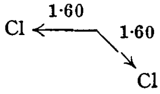
Coop and Sutton's measurements (*J.*, 1938, 1269) on *p*-dinitrobenzene, *s*.-trinitrobenzene, and *p*-nitrocyanobenzene suggest that the moments of the polar groups involved can be regarded as additive. If this is the case for 2 : 4 : 6-trinitro-(1-2′ : 2′ : 2′-trinitroethyl)benzene, the three nuclear nitro-groups will have a resultant moment which may be presumed to be zero, as in *s*.-trinitrobenzene, and the moment of the compound should then be practically the same as that of 2′ : 2′ : 2′-trinitroethylbenzene. Whereas the introduction of a benzene ring into the methyl halides results in an increased moment, its introduction into methyl cyanide has no appreciable effect on the moment. It may therefore be expected that 2′ : 2′ : 2′-trinitroethylbenzene, and hence its 2 : 4 : 6-trinitro-derivative, would have much the same value as 1 : 1 : 1-trinitroethane, in agreement with our experimental values.

X_3.	$CMeX_3$.	$CH_2Ph{\cdot}CX_3$.	
≡N	3·44	3·48	—
$(NO_2)_3$	3·33	(3·35)	3·35

The moment of *p*-nitrobenzyltrinitromethane should be the resultant of the group moments of 3·94 for the nitro- and 3·35 for the trinitroethyl group. The calculated value, 4·2, is higher than the experimental value in about the same proportion as the calculated value for methylene chloride is higher than the actual value, owing to the small induced moment arising from the trinitroethyl group, in the opposite direction to the moment of the nitro-group.

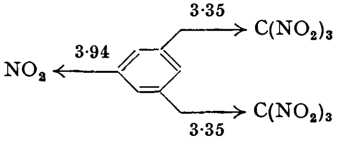


μ Calc., 4·2; found, 3·45

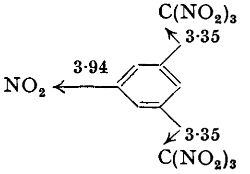


μ Calc., 1·83; found, 1·55

For meta-substituted benzene derivatives the group moments are usually found to be strictly additive. The two group moments due to trinitroethyl in 5-nitro-1 : 3-bis-2′ : 2′ : 2′-trinitroethylbenzene are free to rotate about the α-carbon atom, so a calculation has been made of the moments for the extreme positions, the experimental value falling between them.



μ Calc., 2·6.



μ Calc., 8·2.

μ Found, 3·77.

We are indebted to Dr. W. S. Reich for placing these compounds at our disposal, and our thanks are due to the Department of Scientific and Industrial Research for a grant in aid of this research.—THE UNIVERSITY, LEEDS, 2. [*Received, June 25th,* 1948.]

The Alkylation of Acetophenone and Phenyl Cyanide by the Friedel–Crafts Reaction.

By G. BADDELEY.

IN the course of the investigations on the isomerisation of acetophenone homologues by aluminium chloride (*J.*, 1944, 232), it was considered of interest to attempt the alkylation of acetophenone and phenyl cyanide by the Friedel–Crafts method. This paper describes the preliminary work carried out in 1944; the results of a more comprehensive investigation will be submitted later.

Acetophenone and phenyl cyanide form addition compounds with aluminium chloride and, in consequence, are even less amenable to electrophilic substitution in the presence of this reagent. This probably explains why the alkylation of these substances by the Friedel–Crafts method has not previously been observed. Konowalow and Finogejew (*Chem. Zentr.*, 1903, I, 521) attempted to ethylate acetophenone by the addition of ethyl bromide (1 mol.) and aluminium chloride (0·25 mol.). They obtained, as must be expected (Calloway and Green, *J. Amer. Chem. Soc.*, 1937, **59**, 809), dypnone (CPhMe:CH·COPh) and 1 : 3 : 5-triphenylbenzene which are the products of self-condensation of 2 and 3 molecules respectively of acetophenone. However, acetophenone and phenyl cyanide are both stable at 150—180° in the presence of excess of aluminium chloride (*loc. cit.*), and alkylation can, in consequence, be attempted under drastic conditions.

3-Methyl- (8%), 3 : 5-dimethyl- (5%), and 3 : 4 : 5-trimethyl-acetophenone (6%) were obtained together with unchanged acetophenone (66%) and 1 : 3 : 5-triphenylbenzene (12%) when a mixture of acetophenone, dimethyl ether (0·6 mol.), and aluminium chloride (3·5 mols.) was heated to 140—180°. Ethylation occurred much more readily than methylation, and 3-ethylacetophenone (25%) and a mixture of 3 : 4-diethyl- and 3 : 5-diethyl-acetophenone (55%) together with unchanged acetophenone (14%) were obtained when diethyl ether (1 mol.) was employed. 3-Ethylacetophenone was obtained in yields of 12% and 32% when ethyl bromide (1 mol.) and ethyl alcohol (1 mol.) respectively were employed.

3-Ethylphenyl cyanide (22%) and unchanged phenyl cyanide (70%) were obtained from a mixture of phenyl cyanide, diethyl ether (0·5 mol.), and aluminium chloride (2 mols.) which had been heated to 185°.

The isomerisation of acetophenone homologues occurs without any disproportionation into higher and lower homologues, and, in consequence, these results offer further proof that the isomerisation process is probably intramolecular and does not involve dealkylation and subsequent realkylation.

The ketones obtained in the following experiments were identified by the m. p.s of their semicarbazones and mixed m. p.s with authentic specimens (*loc. cit.*).

Methylation of Acetophenone.—Dimethyl ether (14 g., 0·6 mol.) was bubbled into a mixture of acetophenone (60 g.) and aluminium chloride (250 g., 3·5 mols.). Hydrogen chloride was slowly evolved at 140°, and the temperature was gradually raised to 180°. Gas evolution was complete after 30 minutes at 180°, and the mixture was decomposed with ice. The residue from the dried (K_2CO_3) ether extract was fractionally distilled repeatedly at 20 mm. Acetophenone, b. p. 85—88° (40·0 g.), 3-methyl-, b. p. 101—104° (5·4 g.), 3 : 5-dimethyl-, b. p. 117—120° (3·7 g.), and 3 : 4 : 5-trimethyl-acetophenone, b. p. 137—140° (5·0 g.), together with 1 : 3 : 5-triphenylbenzene (6 g., m. p. and mixed m. p. 165°) were obtained.

Ethylation of Acetophenone.—(*a*) Acetophenone (60 g.), diethyl ether (37 g., 1 mol.), and aluminium chloride (300 g., 4·3 mols.) were heated at 175° for an hour. Evolution of hydrogen chloride then ceased, and the subsequent procedure was similar to that in the previous experiment. Acetophenone, b. p. 85—87° (8·5 g.), 3-ethyl-, b. p. 115—117° (18·8 g.), and a mixture of 3 : 4-diethyl- and 3 : 5-diethyl-acetophenone, b. p. 142—144° (48·8 g.), were obtained.

(*b*) A mixture of acetophenone (30 g.), ethyl alcohol (11·5 g., 1 mol.), and aluminium chloride (140 g., 4 mols.) was heated at 100° for 12 hours and then at 175° for an hour. Acetophenone (11 g.), 3-ethylacetophenone (12 g.), and higher-boiling products (8 g.) were obtained.

(*c*) A mixture of acetophenone (24 g.), aluminium chloride (80 g., 3 mols.), and ethyl bromide (22 g., 1 mol.) was gradually heated to 100°. Gas evolution was complete after 3 hours. Acetophenone (21 g.) and its 3-ethyl derivative (3 g.) were obtained. The products were the same when the mixture was heated at 175° for an hour.

Ethylation of Phenyl Cyanide.—A mixture of phenyl cyanide (51·5 g.), diethyl ether (18·5 g., 0·5 mol.), and aluminium chloride (140 g., 2 mols.) was gradually heated to 185°. The reaction was complete in an hour, and the subsequent procedure was the same as in previous experiments. Phenyl cyanide, b. p. 80° (36 g.), the 3-ethyl derivative, b. p. 111—113° (14·5 g.) (Mayer and English, *Annalen*, 1918, **417**, 86, give b. p. 116—117°/25 mm.), and higher-boiling products (8 g.) were obtained. The 3-ethylphenyl cyanide was identified by (*a*) conversion into 3-ethylacetophenone by the action of methylmagnesium iodide, and (*b*) hydrolysis by sulphuric acid to the *acid amide*, m. p. 92° (Found: N, 9·45. $C_9H_{11}ON$ requires N, 9·40%), which was in turn hydrolysed by alkali to 3-ethylbenzoic acid, m. p. 47° (Voswinkel, *Ber.*, 1888, **21**, 2830).—College of Technology, Manchester. [*Received, July 6th*, 1948.]

The Preparation and Some Reactions of 2-Nitroanisaldehyde. By W. R. Boon.

During the course of some experiments involving the use of 6-methoxyindole, an attempt was made to reduce the potassium derivative of ethyl 2-nitro-4-methoxyphenylpyruvate directly to *ethyl 6-methoxyindole-2-carboxylate* by means of zinc and acetic acid, a procedure which had been employed successfully in the preparation of ethyl 5-methylindole-2-carboxylate (see preceding Note). Although in one early experiment a small yield of the desired indole was obtained, later attempts proved unsuccessful. Subsequently it appeared that this might have been due to the greater instability of the potassium derivative in this case, since only freshly prepared potassium derivative could be converted into the pyruvic acid. Meanwhile an attempt had been made to apply the elegant method of Gluud (*J.*, 1913, 1251) and Blaikie and Perkin (*J.*, 1924, 296) to the synthesis of 6-methoxyindole. For this purpose 2-*nitroanisaldehyde* was required, and it was found, rather surprisingly, that this compound could be obtained in good yield by the oxidation of 2-nitro-4-methoxytoluene with chromyl chloride. In addition to characterisation by the usual aldehyde reagents the compound was converted into 6 : 6′-dimethoxyindigo by the method of Baeyer and Drewson (*Ber.*, 1882, **15**, 2856). Reduction of the *oxime* with ammonium sulphide and condensation of the resulting *amino*-compound with chloroacetamide to give 2-*formyl*-5-*methoxyphenylglycineamide oxime* proceeded readily. Hydrolysis of this substance to 2-formyl-5-methoxyphenylglycine gave an ill-defined product which could not be satisfactorily purified for analysis. Hydrolysis with sodium hydroxide gave a poor yield of 2-*formyl*-5-*methoxyphenylglycine oxime*. Heating the crude 2-formyl-6-methoxyphenylglycine with acetic anhydride gave a brown amorphous product from which only traces of 6-methoxyindole could be obtained by hydrolysis with alcoholic potassium hydroxide.

Experimental.—*Ethyl* 6-*methoxyindole*-2-*carboxylate*. This was obtained in one experiment by reducing freshly prepared potassium derivative of ethyl 2-nitro-4-methoxyphenylpyruvate as in the previous Note. For analysis the product was crystallised from 5% aqueous ethanol (Found: N, 6·4. $C_{12}H_{13}O_3N$ requires N, 6·38%). The identity of the compound was confirmed by hydrolysis to 6-methoxyindole-2-carboxylic acid and decarboxylation of the ammonium salt of the latter to 6-methoxyindole identical with an authentic specimen.

2-*Nitroanisaldehyde*. 2-Nitro-4-methoxytoluene (14·3 g.) dissolved in carbon disulphide (30 c.c.) was added to a solution of chromyl chloride (25 g.) in carbon disulphide (86 c.c.) with shaking. After 96 hours the deep red precipitate was filtered off, washed with carbon disulphide, and suspended in water (250 c.c.). After 1 hour the product was separated and crystallised from 70% ethanol (yield 7·2 g.; 50%) (Found: C, 53·6; H, 3·9. $C_8H_7O_4N$ requires C, 53·5; H, 3·9%). The *phenylhydrazone* formed ruby red prisms from 50% ethanol, m. p. 148° (Found: C, 61·69; H, 4·88. $C_{14}H_{13}O_2N_3$ requires C, 61·98; H, 4·79%). The 2 : 4-*dinitrophenylhydrazone* formed orange needles from ethanol, m. p. 212° (decomp.) (Found: C, 46·5; H, 3·05. $C_{14}H_{13}O_7N_5$ requires C, 46·5; H, 3·05%). The *oxime* formed pale yellow needles from 20% ethanol, m. p. 123° (Found: C, 52·3; H, 4·4. $C_8H_8O_3N_2$ requires C, 52·7; H, 4·4%).

6 : 6′-*Dimethoxyindigo*. This was obtained in 90% yield by the method of Baeyer and Drewson (*loc. cit.*) (Found: C, 67·1; H, 4·5. Calc. for $C_{18}H_{14}O_4N_2$: C, 67·2; H, 4·7%).

2-*Aminoanisaldoxime*. Concentrated aqueous ammonia (*d* 0·88, 20 c.c.) was saturated with hydrogen sulphide and mixed with an equal volume of ammonia solution, and the whole added to a solution of 2-nitroanisaldoxime (2·5 g.) in ethanol (50 c.c.). After 1 hour's heating on the water bath, 2 vols. of water were added and the whole boiled until no more hydrogen sulphide was evolved. The product, contaminated with sulphur, separated on cooling, and was crystallised from ethanol; m. p. 145° (yield 1·8 g.; 80%) (Found: C, 57·5; H, 6·1. $C_8H_{10}O_2N_2$ requires C, 57·8; H, 6·0%).

2-*Formyl*-6-*methoxyphenylglycineamide oxime*. 2-Aminoanisaldoxime (3·2 g.), calcium carbonate (1·2 g.), chloroacetamide (1·9 g.), and water (60 c.c.) were heated under reflux for 3 hours. The product which separated on cooling was crystallised from ethanol; m. p. 189° (yield 4·0 g.; 89%) (Found: C, 53·8; H, 5·8. $C_{10}H_{13}O_3N_3$ requires C, 53·8; H, 5·8%).

2-*Formyl*-5-*methoxyphenylglycine oxime*. The amide (6 g.) was dissolved in 2N-sodium hydroxide (80 c.c.) and heated under reflux until the evolution of ammonia had ceased. After cooling in ice, the solution was neutralised to litmus with dilute sulphuric acid. The pale yellow precipitate was crystallised from a large volume of water; m. p. 148—149° (decomp.) (Found: C, 53·7; H, 5·4. $C_{10}H_{12}O_4N_2$ requires C, 53·6; H, 5·4%).

I wish to express my thanks to Dr. W. Robson for his interest and encouragement. This work was done during the tenure of a Berridge Studentship at King's College.—King's College, Strand, W.C.2. [*Received, September 1st*, 1948.]

5-*Methylindole and* 5-*Methyltryptophan*. By W. R. BOON.

THE recent papers by Anderson (*Science*, 1945, **101**, 565) and Fildes and Rydon (*Brit. J. Exper. Path.*, 1947, **28**, 211) in which it is shown that 5-methyltryptophan acts as an antagonist to tryptophan in the growth of *Esch. coli* and *B. typhosum* respectively and the further observation by the latter authors that 5-methylindole also exhibits this property render any method for the preparation of these compounds of interest. The preparation of 5-methyltryptophan given below was worked out several years ago. It includes a new synthesis of 5-methylindole together with some improvements in the procedure for the conversion of this compound into 5-methyltryptophan by the method of Robson (*J. Biol. Chem.*, 1924, **62**, 495) incorporating the improvements in the synthesis of tryptophan introduced by Boyd and Robson (*Biochem. J.*, 1935, **29**, 2256). 5-Methylindole was made from 4-nitro-*m*-xylene which was condensed with ethyl oxalate in the presence of potassium ethoxide to give the potassium derivative of ethyl 2-nitro-5-methylphenylpyruvate which was reduced directly by zinc dust in acetic aid to ethyl 5-methylindole-2-carboxylate. Of the several preparations of 4-nitro-*m*-xylene reported in the literature only that of Holleman (*Rec. Trav. chim.*, 1908, **27**, 267) is given in any detail. Only poor and erratic yields could be obtained by this method; the method given below, however, was found to work smoothly, giving material which was uncontaminated with higher nitrated products.

Experimental.—4-*Nitro*-m-*xylene*. *m*-Xylene (50 g.) was added slowly with stirring to a mixture of glacial acetic acid (250 c.c.) and fuming nitric acid (*d* 1·5; 250 c.c.) maintained at 0°. After 2 hours the mixture was poured on ice and extracted with ether. The extract was washed first with sodium hydroxide and then with water, the ether removed, and the residue distilled in steam. The distillate was then extracted with ether and the extract dried ($CaCl_2$) and distilled giving unchanged *m*-xylene (3 g.) and 4-nitro-*m*-xylene (53 g. = 79%), b. p. 125—126°/20 mm.

Ethyl 5-*methylindole*-2-*carboxylate*. Potassium (12 g.) was broken up under hot xylene and suspended in dry ether (500 c.c.); dry ethanol (22 c.c.) was then added. When all the metal had reacted the mixture was cooled in ice, and ethyl oxalate (50 g.) and 4-nitro-*m*-xylene (50 g.) added. After 3 days the dark red precipitate (82 g.) was collected and washed with dry ether. As a check on its identity a small sample was shaken with water, the solution acidified, and the precipitated solid crystallised from glacial acetic acid; it then had m. p. 193° in agreement with the value for 3-nitro-5-methylphenylpyruvic acid reported by Reissert and Scherk (*Ber.*, 1899, **31**, 391) who prepared it in poor yield using sodium ethoxide for the above condensation. For the reduction, nickel nitrate (2 g.) was dissolved in a mixture of water (154 c.c.) and glacial acetic acid (320 c.c.) cooled in a freezing mixture. The potassium derivative (29 g.) and zinc dust (112 g.) were then added alternately so that the temperature did not rise above 10°. One hour after the addition was completed the mixture was heated on the water-bath until it no longer gave a red colour with concentrated nitric acid. An excess of water was then added and the solid filtered off. On extraction with alcohol and crystallisation 16 g. (=64% on 4-nitro-*m*-xylene) of ethyl 5-methylindole-2-carboxylate were obtained, m. p. 163° undepressed on admixture with an authentic sample prepared from the *p*-tolylhydrazone of pyruvic acid.

5-*Methylindole*. The dry ammonium salt of 5-methylindole-2-carboxylic acid (20 g.), prepared by evaporation to dryness of an aqueous solution, was suspended in glycerol (120 c.c.) and heated under a wide-bore reflux condenser. The salt dissolved at 100° and decarboxylation occurred smoothly at 180—200°. After 45 minutes at this temperature the mixture was cooled, water was added, and the 5-methylindole isolated by distillation in steam; m. p. 58—59° (yield 10·5 g.; 62%).

5-(5-*Methyl*-3-*indolylidene*)*hydantoin*. 5-Methylindole-3-aldehyde (Boyd and Robson, *Biochem. J.*, 1935, **29**, 557) (6·4 g.) and hydantoin (4 g.) were dissolved in piperidine (20 c.c.) and boiled under reflux for one hour. Water was then added and the mixture acidified to litmus with acetic acid and filtered; m. p. 329° (yield 9·5 g.) (Robson, *loc. cit.*, gives m. p. 295—298°) (Found : N, 17·3. Calc. for $C_{13}H_{11}O_2N_3$: N, 17·4%).

5-*Methyltryptophan*. 5-(5-Methyl-3-indolylidene)hydantoin (5 g.), ethanol (50 c.c.), and 18% ammonium sulphide (300 c.c.) were heated in a pressure bottle at 110° for 300 hours. After evaporation of the solution to dryness under reduced pressure the residue was repeatedly extracted with dilute aqueous ammonia. The combined ammoniacal extracts were concentrated under reduced pressure and several volumes of ethanol were added. This yielded 1·2 g. of 5-methyltryptophan. A further 1 g. was obtained by evaporating the mother-liquor to dryness and extracting the residue with boiling ethanol to remove an impurity believed to be 5-(5-methyl-3-indolyl)hydantoin. 0·6 G. of unchanged 5-(5-methyl-3-indolylidene)hydantoin was recovered from the material insoluble in ammonia. The total yield of 5-methyltryptophan is 54% based on hydantoin used. The material resembled that prepared by Robson (*loc. cit.*) in all respects except that it was very sweet in taste while Robson's sample was bitter (Found : N, 12·89. Calc. for $C_{12}H_{14}O_2N_2$: N, 12·84%).

I am grateful to Dr. W. Robson for his interest and advice. This work was done during the tenure of a Berridge Studentship at King's College.—KING'S COLLEGE, STRAND, W.C.2. [*Received, September* 1*st*, 1948.]

The N-*Oxides of Nicotinic Acid and its Esters*. By G. R. CLEMO and H. KOENIG.

WHILE the *N*-oxides of pyridine (Meisenheimer, *Ber.*, 1926, **59**, 1848), picolinic acid (Diels and Alder, *Annalen*, 1933, **505**, 103; Diels and Meyer, *Annalen*, 1934, **513**, 129), *iso*nicotinic acid (Ghigi, *Ber.*, 1942, **75**, 1316), and 2-methylpyridine-6-carboxylic acid (Diels and Pistor, *Annalen*, 1937, **530**, 87) are well known, that of nicotinic acid has not been described. Since this was required for synthetic purposes and one of us (H. K.) will be unable to continue with the work we wish to record its preparation and properties and those of its methyl and ethyl esters.

Experimental.—(1) *Nicotinic acid* N-*oxide*. Nicotinic acid (1 part) in hot glacial acetic acid (3 parts) and perhydrol (3 parts) were heated on the water-bath with occasional shaking. After 3 hours gas evolution had decreased and the solution was evaporated to dryness and the yellow residue was recrystallised twice from methanol giving *nicotinic acid* N-*oxide* (70—80%) as faintly yellowish needles, m. p. 249° (decomp.) (Found : C, 51·9; H, 4·0; N, 10·6. $C_6H_5O_3N$ requires C, 51·8; H, 3·6; N, 10·1%).

Nicotinic acid *N*-oxide is slightly soluble in cold water, more soluble in hot water, hot glacial acetic acid, and hot methanol, less soluble in ethanol, and insoluble in light petroleum, benzene, and chloroform. It liberates iodine slowly from potassium iodide in hot solution. When heated in the impure state above 100° it decomposes spontaneously with gas evolution and darkening.

(2) *Methyl nicotinate* N-*oxide.* Nicotinic acid *N*-oxide (1 g.) was dissolved in absolute methanol (20 ml.), saturated with hydrogen chloride at 0°, and refluxed for 2 hours with exclusion of moisture. Excess methanol was removed and the resulting oil poured into water, basified with sodium carbonate, and extracted with ether. After being dried, the ether was removed and the remaining oil, which solidified, crystallised from light petroleum (b. p. 60—80°) in colourless *leaflets* (0·5 g., m. p. 97°) (Found : C, 55·2; H, 4·8; N, 8·8. $C_7H_7O_3N$ requires C, 54·9; H, 4·7; N, 9·1%).

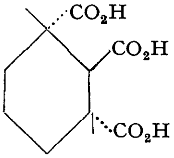
(3) *Ethyl nicotinate* N-*oxide.* (*a*) Nicotinic acid *N*-oxide (2 g.) in absolute ethanol (40 ml.) was treated as above and gave colourless needles (1·2 g., m. p. 99·5°) of the *ester* (Found : C, 58·1; H, 5·8; N, 8·4. $C_8H_9O_3N$ requires C, 57·5; H, 5·4; N, 8·4%).

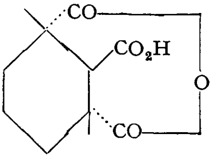
(*b*) Ethyl nicotinate (2 g.) in glacial acetic acid (10 ml.) was heated with perhydrol (30 ml.) for 3 hours on the water-bath. The reaction mixture was evaporated and the oily residue recrystallised from light petroleum (b. p. 60—80°), yielding colourless needles (1·1 g.), m. p. 99·5°, not depressed by material prepared by method (*a*).—UNIVERSITY OF DURHAM, KING'S COLLEGE, NEWCASTLE-UPON-TYNE, 1. [*Received, June* 17*th*, 1948.]

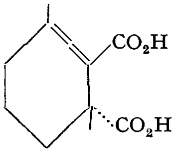
Stereochemistry of the $C_{11}H_{16}O_6$ *Tricarboxylic Acid from Abietic Acid.* By D. H. R. BARTON and G. A. SCHMEIDLER.

THE two principal chemical methods for determining the configuration of *cyclo*hexane-1 : 2-dicarboxylic acids are (*a*) conversion of *trans*-anhydrides into the *cis*-isomers by the action of heat alone, and (*b*) rearrangement of *cis*-acids to the *trans*-forms by heating with concentrated hydrochloric acid. A negative result in the application of either of these methods is, of course, also of diagnostic value. A recent utilisation of the hydrochloric acid method is that of Plattner, Fürst, and Hellerbach (*Helv. Chim. Acta*, 1947, **30**, 2158); this investigation shows further that *tertiary* carboxyl groups are not affected by such conditions.

We have previously (*J.*, 1948, 1197) given a proof that the 1 : 2-carboxyl groups in the $C_{11}H_{16}O_6$ tricarboxylic acid (I), obtained by oxidation of abietic acid, are in the *trans* relationship to each other (it was, of course, already recognised that the 1 : 3-carboxyl groups in this compound are related *cis* to one another). It was of interest to examine the effect of hot concentrated hydrochloric acid on this tricarboxylic acid for, according to our previous evidence, it should remain unchanged under these conditions.


(I.)


(II.)


(III.)

The action of concentrated hydrochloric acid at 190—200° for 8 hours on the $C_{11}H_{16}O_6$ tricarboxylic acid furnished a saturated acidic substance $C_{11}H_{14}O_5$, m. p. 177—178°, which was characterised by the beautifully crystalline *methyl* ester, which it gave with diazomethane. This acid, which is formed by the loss of one molecule of water, must be the 1 : 3-anhydride (II) of the tricarboxylic acid, previously described by Ruzicka, Goldberg, Huyser, and Seidel (*Helv. Chim. Acta*, 1931, **14**, 545) as of m. p. 170—172° and by Lombard (Thesis, Paris, 1943, p. 43) as of m. p. 175°. Ruzicka and his collaborators obtained it by the action of acetyl chloride, Lombard by the action of heat alone, on the tricarboxylic acid. It showed a marked depression in melting point on admixture with a synthetic specimen of Vocke's acid (Vocke, *Annalen*, 1932, **497**, 247) (III), m. p. 180° (Rydon, *J.*, 1937, 257), kindly supplied by Dr. H. N. Rydon. The methyl ester was hydrolysed back to the original tricarboxylic acid (I) on prolonged treatment with strong alcoholic potassium hydroxide. These experiments show that the secondary carboxyl group of the $C_{11}H_{16}O_6$ acid is not isomerised by concentrated hydrochloric acid, in agreement with expectation.

Experimental.—The $C_{11}H_{16}O_6$ tricarboxylic acid was prepared as described previously (Barton and Schmeidler, *loc. cit.*). 1-G. portions of the acid were suspended in 30-ml. quantities of concentrated hydrochloric acid and heated in a Carius tube for 8 hours at 190—200°. The product isolated by evaporation of the hydrochloric acid on the steam-bath, was a solid, which, on recrystallisation from alcohol–benzene gave the 1 : 3-anhydride, m. p. 177—178° (Found : C, 58·0, 58·9; H, 6·3, 6·3. Calc. for $C_{11}H_{14}O_5$: C, 58·4; H, 6·3%). The same result was obtained on heating at 180°, but at 150° there resulted a mixture of the 1 : 3-anhydride and unchanged tricarboxylic acid. No carbon dioxide was produced during these experiments.

Treatment of the 1 : 3-anhydride with an excess of diazomethane in ether furnished the *methyl* ester; recrystallised from benzene–light petroleum (b. p. 40—60°) it had m. p. 170° (Found: C, 60·2, 59·7; H, 6·6, 6·7. $C_{12}H_{16}O_5$ requires C, 60·1; H, 6·7%). By refluxing with strong methanolic potassium hydroxide for 16 hours this methyl ester was hydrolysed back to the $C_{11}H_{16}O_6$ tricarboxylic acid, m. p. 218° (decomp.) undepressed on admixture with the starting material.

This work was carried out during the tenure of an I.C.I. Fellowship by one of us (D. H. R. B.).—IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, S.W. 7. [*Received, July* 9*th*, 1948.]

The Reaction of Toluenesulphonic Esters of Carbohydrates with Sodium Iodide.

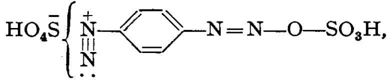
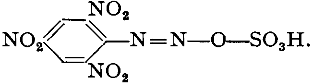
By G. R. BARKER and R. W. GOODRICH.

THE applicability of the rule regarding the reaction of toluene-*p*-sulphonyl (tosyl) derivatives of carbohydrates with sodium iodide in acetone solution, first suggested by Oldham and Rutherford (*J. Amer. Chem. Soc.*, 1932, **54**, 366), has been discussed by Hudson and his co-workers (*ibid.*, 1944, **66**, 1901) and by Tipson and Cretcher (*J. Org. Chem.*, 1943, **8**, 95). The latter workers found that tetratosyl erythritol reacted completely with sodium iodide with the formation of iodine and butadiene. The production of unsaturated linkages in this type of reaction had previously been noted by Bell, Friedmann, and Williamson (*J.*, 1937, 252) during the interaction of sodium iodide and 6-tosyl 1 : 2-*iso*propylidene D-glucose, in which there is an uncombined hydroxyl group adjacent to the tosyl radical. If, however, this hydroxyl group were substituted, as in 6-tosyl 3 : 5-benzylidene 1 : 2-*iso*propylidene D-glucose, the normal replacement of the tosyloxy-group by iodine resulted. We have now found that 6-tosyl 1 : 2-*iso*propylidene D-glucose reacts in the normal way with sodium iodide dissolved in acetic anhydride, the free hydroxyl groups being acetylated at the same time. The use of this solvent for the reaction has, as far as we are aware, been reported only by Hudson *et al.* (*J. Amer. Chem. Soc.*, 1942, **64**, 137; 1944, **66**, 1898), but, in these instances, no free hydroxyl groups were present in the molecule. We consider that the avoidance of the formation of unsaturated compounds by the use of acetic anhydride and the replacement, in the case now described, of the tosyloxy-group by iodine in one operation, extends the scope of this type of reaction.

*6-Iodo 3 : 5-Diacetyl 1 : 2-*iso*Propylidene* D-*Glucose*.—A mixture of 6-tosyl 1 : 2-*iso*propylidene D-glucose (Ohle and Dickhaüser, *Ber.*, 1925, **58**, 2593) (1 g.) and acetic anhydride (10 c.c.) was boiled under reflux for 2·5 hours, cooled to room temperature, and poured into ice–water. After the acetic anhydride had decomposed, the dark oil crystallised after scratching, and was collected. The material was obtained, after being crystallised thrice from ethyl alcohol by the gradual addition of water, as fine needles (0·4 g.), m. p. 75° (Found: C, 37·7; H, 4·6. Calc. for $C_{13}H_{19}O_7I$: C, 37·65; H, 4·6%). Helferich and Lang (*J. pr. Chem.*, 1932, **132**, 321) record m. p. 75—76°.—THE UNIVERSITY, MANCHESTER, 13, and UNIVERSITY COLLEGE, NOTTINGHAM. [*Received, June 16th*, 1948.]

The Influence of Water on the Coupling Power of Diazotised Amines and on Diazo-group Elimination in Aqueous Ethanol–Sulphuric Acid Media.

By HERBERT H. HODGSON and JOHN RATCLIFFE.

THE diazo-compounds of the 2 : 6-dihalogeno-4-nitroanilines in aqueous sulphuric acid of various concentrations have been coupled with β-naphthol dissolved in ethanol, and also decomposed by copper powder and by cuprous oxide, which appears to be equally efficient, in the same set of aqueous ethanolic media. The amount of coupled product decreased by *ca.* 10%, whereas the efficiency of diazo-group replacement increased by *ca.* 40% as the water content progressively increased. This result is in accord with Schoutissen's conclusions (*J. Amer. Chem. Soc.*, 1933, **55**, 4541) that strongly electrophilic groups promote covalent diazo-compound formation, *e.g.*,  in strong acid solution, and further support is afforded by the fact that diazotised picramide could be coupled but not deaminated under the same conditions by either copper or cuprous oxide, and so must be predominantly in the covalent form, 

2 : 4-Dinitro-1-naphthylamine and 1 : 6-dinitro-2-naphthylamine have been found to deaminate efficiently under conditions hitherto regarded as promoting diazo-oxide formation (cf. Hodgson and Birtwell, *J.*, 1943, 433). The yields of dihalogenonitrobenzenes obtained during the decompositions of the 2 : 6-dihalogeno-4-nitroanilines are higher than those hitherto recorded in the literature.

Diazotisation, Deamination, and Coupling Procedure.—(a) *The 2 : 6-dihalogeno-4-nitroanilines.* Five separate solutions of the amine (0·010 g.-mol.) in sulphuric acid (40 c.c., *d* 1·84) were diluted with water as follows: (i) none, (ii) 5 c.c., (iii) 10 c.c., (iv) 15 c.c., and (v) 20 c.c., and then treated gradually below 5° with a solution of sodium nitrite (0·75—1·0 g.) in sulphuric acid (10 c.c., *d* 1·84) so as to occasion the minimum rise of temperature. The 5 mixtures were kept at 0° in stoppered bottles for at least 2 hours to ensure complete diazotisation (as tested by complete dissolution of a small sample in water, since the amines are completely insoluble), and then were stirred gradually at room temperature into ethanol (50 c.c.) containing copper powder (98% purity) in suspension, the amount of copper being varied in duplicate experiments to ascertain its effect (catalytic) on yield. Nitrogen and acetaldehyde were evolved, the latter ceasing at about the half-way stage while the nitrogen continued to come off to the end of the reaction. The presence of urea had no appreciable effect on the final result; rise of temperature occurred in all cases. After being kept overnight, the mixtures were steam distilled until the more volatile matter had come over; the volumes of distillate collected were *ca.* 250 c.c. for the chloro-, 750—800 c.c. for the bromo-, and 2500—3000 c.c. for the iodo-compound, these volumes indicating approximately the relative steam volatilities. The steam distillates were filtered through sintered crucibles, and the solid matter dried in a vacuum over phosphoric oxide to constant weight; they were then recrystallised from ethanol and identified, the mother liquors from the ethanol being reduced to a third of their original volume and their deposits filtered off and determined as above.

For coupling purposes, the diazo-solutions were added slowly to ethanol (50 c.c.) containing the necessary amount of β-naphthol, temperature rise being avoided by external cooling to prevent the formation of naphthyl ethyl ether which had been detected when the temperature was uncontrolled. The precipitated azo-compounds were collected in sintered glass crucibles, washed free from acid with 50% aqueous ethanol and then with ethanol, and dried in a vacuum over phosphoric oxide to constant weight.

(b) 2 : 4-*Dinitro*-1-*naphthylamine and* 1 : 6-*dinitro*-2-*naphthylamine or their* p-*toluenesulphonates.* The compound (0·1 g.-mol.) was dissolved in sulphuric acid (200 c.c., *d* 1·84) and water (60 c.c.) at 20—30°, cooled, and treated with sodium nitrite (8 g.) in sulphuric acid (50 c.c., *d* 1·84) at 10°. During the period of stirring (30 minutes) with external cooling, powdered ice was added from time to time until a test sample gave a clear solution when diluted with water which persisted for a short time, after which the mixture was stirred into ethanol (250 c.c.) containing copper (10 g.) or cuprous oxide (20 g.), the temperature being kept below 40°. Evolution of nitrogen and aldehyde ceased in 30 minutes, and, after being kept overnight, the mixture was filtered, the precipitate washed free from acid, dried as above, and extracted with ethylene dichloride, the solvent freed from the extract, and the residue crystallised from aqueous pyridine. In this way almost pure 1 : 3-dinitronaphthalene was obtained in yields of 14·5—16·5 g. (66·5—75·5%), and almost pure 1 : 6-dinitronaphthalene in yields of 11—12 g. (50—55%).

(c) *Picramide.* Picramide was treated in like manner, at acid concentrations (ii) and (iv) above, for 48 hours with occasional stirring. When the mixtures were poured into an ethanol solution of β-naphthol, yields of 70—80% of 2 : 4 : 6-trinitrobenzeneazo-β-naphthol were obtained; this compound separated from *o*-dichlorobenzene in crystals which varied in colour in different preparations from orange-red to scarlet, m. p. 290° (decomp.) (Blangey, *Helv. Chim. Acta*, 1925, **8**, 780, gives m. p. 290—292°).

2 : 4-*Di-iodo*-4-*nitrobenzeneazo*-β-*naphthol* separated from *o*-dichlorobenzene in greenish metallic needles (red by transmitted light), m. p. 226—227° (Found : N, 8·0. $C_{16}H_9O_3N_3I_2$ requires N, 7·7%), which give an intense magenta colour with concentrated sulphuric acid, and a violet colour with ethanol containing a drop of sodium hydroxide; it is insoluble in cold ethanol.

Comparative yields of coupling and deamination products at five acid concentrations.

4-Nitroaniline.	Acid concn.	Azo-β-naphthol, %.	Pure deamination product, %.	4-Nitroaniline.	Acid concn.	Azo-β-naphthol, %.	Pure deamination product, %.
2 : 6-Dichloro-	i	94	32	2 : 6-Dibromo-	i	92·0	42·8
	ii	91	44		ii	91·7	51
	iii	87	57·1		iii	91·7	65
	iv	86	79·5		iv	87·0	83·5
	v	84·5	78·5		v	84·5	84

4-Nitroaniline.	Acid concn.	Azo-β-naphthol, %.	Pure deamination product, %.
2 : 6-Di-iodo-	i	88·6	15·7
	ii	95·2	17·3
	iii	94·7	49·3
	iv	78·5	80·5
	v	76·2	80·7

Comparative deamination in methanol, ethanol, and iso*propyl alcohol.*

4-Nitroaniline.	Acid concn.	Yield (%) of deamination product in : methanol.	ethanol.	*iso*propyl alcohol.
2 : 6-Dichloro-	iv	68·5	79·5	63—65
2 : 6-Dibromo-	iv	78·3	84·0	82·0
2 : 6-Di-iodo-	iv	69·3	78·5	43·3

All m. p.s are uncorrected.

The authors thank Mr. N. L. Thomas, B.Sc., for assistance in the preparation and identification of the azo-β-naphthol compounds.—HUDDERSFIELD TECHNICAL COLLEGE, and SOUTH EAST ESSEX TECHNICAL COLLEGE, DAGENHAM. [*Received, July 20th,* 1948.]