

and even numbers as exterior differences, combined with every possible and available middle difference; for negative differences may be rejected, inasmuch as, if the roots be put according to their algebraic value, all the differences must be even; thus the roots and differences of 15 above were

$$\begin{array}{c} 2, -3, 5 \\ -1, 1, -2, 3; \end{array}$$

if the roots be placed according to their algebraic value, they would be  $-2, -1, 1, 3$ , and with the differences above

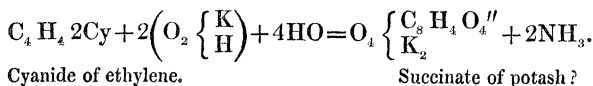
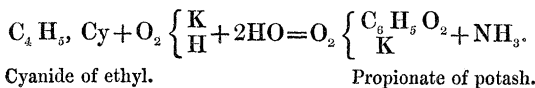
$$\begin{array}{c} 1, 2, 2 \\ -2, -1, 1, 3; \end{array}$$

15 will therefore be found in the column above 5, and in the fourth place. The Table (extended indefinitely) would therefore contain every possible odd number the sum of whose roots may equal 1.

It is possible that this connexion between the roots of the squares into which  $4n+1$  may be divided, with the exterior differences of the roots of the four square numbers into which  $2n+1$  may be divided, formed part of the mysterious properties of numbers to which Fermat alluded when he announced the theorems of the polygonal numbers.

### III. "On Cyanide of Ethylene and Succinic Acid."—Preliminary Notice. By MAXWELL SIMPSON, Ph.D. Communicated by Dr. FRANKLAND, F.R.S. Received August 1, 1860.

Succinic acid bears the same relation to the diatomic alcohol (glycol) that propionic acid bears to ordinary alcohol. Propionic acid can be obtained by treating the cyanide of the alcohol radical with potash. Can succinic acid be obtained by treating the cyanide of the glycol radical with the same reagent, or is it an isomeric acid that is formed under these circumstances?



The following experiments were performed with the view of determining this point:—

*Preparation of Cyanide of Ethylene.*—As a preliminary step to the formation of succinic acid in this way, it became of course necessary to prepare the cyanide of ethylene. This body I obtained by submitting bromide of ethylene to the action of cyanide of potassium.

The process was thus conducted:—A mixture of two equivalents of the cyanide and one of the bromide was introduced into a large balloon, together with a considerable quantity of alcohol, sp. gr. .840, and exposed to the temperature of a water-bath, a Liebig's condenser having been previously attached to the balloon in such a manner as to prevent the alcohol from distilling off the reacting ingredients. As soon as all the cyanide of potassium had been converted into bromide, the alcohol was separated and distilled. A semifluid residue was thus obtained, which was filtered at the temperature of 100° Cent. On treating the filtrate with a saturated solution of chloride of calcium, a reddish oil rose to the surface, which was well washed with ether, and exposed for some time to the temperature of 140°, in order to remove any bromide of ethylene that might have escaped the solvent action of the ether. This body proved, on analysis, to be cyanide of ethylene. It was not, however, quite pure. There are difficulties attending its complete purification which I have not yet overcome.

At the temperature of the air, cyanide of ethylene is a semisolid crystalline mass of a brownish colour. It melts under 50° Cent. It is very soluble in water and alcohol, and sparingly soluble in ether. It cannot be distilled. Nevertheless it bears a tolerably high temperature without suffering much decomposition. Heated with an alcoholic solution of potash, it gives off ammonia. Treated with nitric acid, it forms a body which crystallizes from alcohol in long needles. This and some other reactions I am at present engaged in studying.

*Preparation of Succinic Acid.*—Bromide of ethylene and cyanide of potassium were made to react upon each other in the same manner as in the preparation of the cyanide of ethylene. As soon as the reaction was complete, the alcohol was separated from the bromide of potassium, some sticks of caustic potash were added to it, and the whole heated for several days by means of a water-bath. Torrents of

ammonia were given off on applying the heat. As soon as the evolution of this gas had ceased, the alcohol was distilled off and the residue treated with a considerable excess of hydrochloric acid. This was then heated gently as long as acid vapours continued to be evolved, digested with absolute alcohol, and filtered, and then the filtrate was evaporated to dryness. The dry mass thus obtained was treated several times with alcohol in a similar manner. The result of these repeated digestions was then dissolved in water, and a few drops of a solution of nitrate of silver were added to it, which occasioned a slight precipitate of chloride of silver. This was separated by filtration, and the filtrate was exactly neutralized with ammonia. On adding excess of nitrate of silver to this, an abundant white precipitate was obtained, very soluble in nitric acid and ammonia. This gave, on analysis, numbers agreeing very well with the composition of succinate of silver. The acid itself possessed also all the properties of succinic acid. It sublimed on the application of heat, was soluble in water, alcohol, and ether, and gave, when neutralized, a reddish-brown precipitate with perchloride of iron. Moreover, on digesting this precipitate with ammonia, an acid could be detected in the filtered liquor, which gave white precipitates with nitrate of silver, and with a mixture of chloride of barium and alcohol.

Succinic acid *can* then be obtained from glycol in the same manner as propionic acid from ordinary alcohol; the bromide of ethylene, the point from which I started, being capable of derivation from the diatomic alcohol.

I propose extending this investigation to some other hydrocarbons of the series  $C_n H_n$ , with the view of ascertaining whether or not the homologues of succinic acid can be obtained from these bodies by a similar process.

IV. "Results of Researches on the Electric Function of the Torpedo." By PROFESSOR CARLO MATTEUCCI of Pisa. In a Letter to Dr. SHARPEY, Sec. R.S. Received August 3, 1860.

(Extract.)

"It has hitherto been believed that the action of the electric organ of the Torpedo was momentary only;—that it becomes charged