NOTE ON SUGAR TITRATION.

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THE reaction between sugar and Fehling solution has, during the last few years, been the subject of a number of critical investigations, and it has been proved that it cannot be expressed by any equivalent relation, but that the reduction of Cu_2O is a function of concentration, alkalinity, time of heating, and other circumstances—and that, in fact, the method only gives correct results when similar conditions are as nearly as possible adhered to.

These investigations only applied to Fehling solution as ordinarily made, with copper sulphate, alkali, and tartrate. Having some years ago (*Chem. News*, xxxix. 197) tested, and obtained *under certain conditions*, very satisfactory results, with the ammoniacal Fehling solution, proposed by Dr. Pavy (*Chem. News*, xxxix. 77), and having proved that the amount of alkali present in it greatly influences the ratio of reduction, I was led to examine the influence of other substances upon the same.

The presence of ammonia in the copper solution renders that of tartrate unnecessary, the tartrate merely being used to keep the alkali from precipitating cupric hydrate. As glucose readily reduces copper sulphate in plain ammoniacal solution—although much less rapidly than in the presence of potash—it seemed most advantageous to start with such simple ammoniacal solution only, and thus to avoid possible complications due to the tartrate or alkali. Using the copper solution of the ordinary strength, 34·639 grammes of the sulphate per litre, and employing a glucose solution which had been obtained by inverting cane sugar by 10 per cent. HCl. and exactly neutralizing with soda, I assumed for the purpose of comparison only, that the ration of reduction of Cu_2O was the same under the circumstances of the following experiments as with ordinary Fehling solution. This, of course, is not the case, but the results, percentically expressed, give the measure of any fluctuation.

Sugar determined—

With $\text{CuSO}_4 + \text{NH}_3$	..	..	..	..	obtained	90·70 per cent. glucose.
"	"	..	..	..	"	90·00 " "
		+ 1·5 grm. iod. pot. tartrate			"	114·9 " "
		+ 6 grms. tartrate	..		"	146·6 " "

A new sugar solution exactly neutralized with NaHO gave—

With $\text{CuSO}_4 + \text{NH}_3$	..	..	..	..	..	100·3
"	"	..	..	..	..	99·8 per cent. of glucose taken.
		+ 1 grm. tartrate	..	..	..	123·9
		+ 2 grms. "	..	..	..	126·1
		+ 5 " "	..	..	..	135·8
		+ 10 " "	..	..	..	142·1
$\text{CuSO}_4 + \text{NH}_3$	+ 2 grms. sod. acetate	..	..	..	..	98·9 per cent. glucose.
	+ 5 " "	..	..	..	..	99·8 " "
	+ 10 " "	..	..	..	..	99·0 " "
$\text{CuSO}_4 + \text{NH}_3$	+ sod. carbonate, dry, 1 grm...	..	..	..	..	105·7
	2 " "	..	..	..	..	108·1
	5 " "	..	..	..	..	112·6
	10 " "	..	..	..	..	113·4
$\text{CuSO}_4 + \text{NH}_3$	+ 1 grm. NH_4Cl .	..	..	..	..	79·7
	+ 5 " "	..	..	..	..	79·9
	+ 10 " "	..	..	..	..	81·8

The figures speak for themselves—they show that the ratio of reduction is influenced to a very considerable extent by the substances experimented upon, the percentages being raised or depressed according to the nature of the addition, and that, therefore, sugar titration by ammoniacal copper solution can only give correct result by a concurrence of favourable circumstances, and only when certain conditions are scrupulously adhered to. Of course, in actual work, neither the quantity of tartrate nor of potassium carbonate would fluctuate so widely as the extremes in the test experiments quoted; but a fluctuation must necessarily follow any variation in the strength, dilution, or composition of the test fluid. While I, therefore, fully concede that correct results *may* be obtained by means of ammo-

niacal copper solution, yet it is evident that the method is devoid of the essential conditions of a trustworthy analytical method.

An ammoniacal solution of sulphate of copper cannot, without further addition, be utilised for determining sugar, on account of the slowness of the reaction, and because the end-point of the titration is not sufficiently distinct.