tion 5 parts of dextrose produce the same degree of sweetness as 3 parts of cane sugar. Dextrose fuses at 146 C. and at 170 passes into glucosan, C6H10O5, an almost tasteless solid, which when boiled with dilute sulphuric acid is reconverted into dextrose. If a solu­tion of dextrose in absolute alcohol is saturated with hydrochloric acid gas at 0° C., di-glucose, C12H22O11, is produced, which, however, is only isomeric with cane sugar (Gautier).

*Lævulose.—*The liquid part of crystalline honey consists chiefly of lævulose ; but its purification is difficult. From invert sugar it can be extracted, according to Dubrunfaut, by cautious addition of slaked lime at a low temperature. The lævulose separates out as a difficultly soluble lime compound, which is separated from the mother-liquor containing the dextrose by pressure and by judicious washing with cold water. The lævulosate of lime is de­composed by the exact equivalent of oxalic acid solution ; then the oxalate of lime is filtered off, and the filtrate evaporated on a water- bath. The lævulose ultimately remains as a thick syrup, which formerly was supposed not to be susceptible of crystallization ; but Jungfleisch and Lefranc have succeeded lately in obtaining crystals from it by means of alcohol. Lævulose is very largely soluble in water, and fully as sweet as cane sugar. It fuses at 95° C. ; at 170° it passes into lævulosan, C6H10O5, analogous to glucosan.

The following reactions, though studied chiefly with dextrose, apply also to lævulose, and, substantially at least, to glucoses gener­ally. If a solution of glucose is mixed with excess of caustic potash or soda, a solution of alkaline glucosate is formed, which, however, has little stability. If the solution is heated, the glucosate is decomposed with formation of dark-coloured (soluble) alkali salts of acid products, which, whatever they may be, are not reconvertible into glucose. Cane sugar, in these circumstances, remains sub­stantially unchanged, and can be regenerated by elimination of the alkali. If a solution of glucose is mixed with (not too much) sul­phate of copper, and an excess of caustic potash or soda be then added, no precipitate of cupric hydrate is formed, but an intensely blue solution, which, on standing in the cold gradually, and on heating promptly,‘deposits a red precipitate of cuprous oxide, Cu2O, the glucose being oxidized at the expense of the dissolved CuO into soluble alkali salts of little known acids. By means of this (Trommer’s) test the least trace of glucose in a solution can be dis­covered. Cane sugar, in the circumstances, yields cuprous oxide only on long-continued boiling. Fehling has brought this test into the following more convenient form, which, besides, admits of quantitative application: 34·6δ grams (1·22 oz.)of sulphate of copper, CuSO4 + 5H2O, and 173 grams (6 oz.) of Rochelle salt (double tartrate of potash and soda) are dissolved in a solution of 70 grams (2·46 oz.) of solid caustic soda, and the intensely blue solution produced is diluted to 1000 c.c. Every c.c. of Fehling solution oxidizes about 5 milligrams (·077 grain) of dextrose (not of glucose generally). To de­termine an unknown weight of glucose, its solution is added to an excess of suitably diluted Fehling solution at a boiling heat, which is maintained for a sufficient time to oxidize the glucose as com­pletely as possible,—the requisite time depending on the nature of the glucose. The cuprous oxide precipitate is allowed to settle, is then collected on a filter, and weighed directly or indirectly. From its weight the weight of the glucose is calculated,—a standard experi­ment with a known weight of the respective kind of pure glucose furnishing the factor. A less exact but more expeditious method is to dissolve the sugar to be analysed in water, to dilute to a known volume (not less than 200 c.c. for every gram of glucose), and to drop this solution from a burette into a measured volume of dilute Fehling solution at a boiling heat until the blue colour is just destroyed, *i.e.*, the copper just precipitated completely as Cu2O. This method is largely used in sugar-houses in the assaying of crude cane or beetroot sugars.

*Saccharoses.*

Of these only cane sugar, milk sugar, and maltose can be noticed here. The highest qualities of commercial cane sugar are chemi­cally pure. Pure cane sugar crystallizes from its supersaturated syrup in colourless, transparent monoclinic prisms (exemplified in colourless candy sugar). The crystals are barely, if at all, hygro­scopic ; they are rather hard, and when broken up in the dark give off a peculiar kind of bluish light. Sp. gr. 1·593 at 4° C. The aqueous solution, saturated at *t*° C., contains *p* per cent. of dry sugar. For *t*= 0° 10° 20° 30° 40° 50°

*p* = 65∙0 65·6 67∙0 69·8 75∙8 82·7.

From 50° upwards the solubility increases at such a rate that a given quantum of water dissolves any quantity of sugar if the mix­ture is constantly kept boiling. Accordingly a sugar syrup when boiled down deposits nothing, but passes gradually into the condi­tion of fused sugar when the boiling-point merges into the fusing- point of sugar, which lies at 160-161° C. Even a cold-saturated solution of sugar has the consistence of a syrup. Absolute alcohol hardly dissolves sugar at all ; aqueous alcohol dissolves it the more largely the greater its proportion of water. Fused sugar freezes into a transparent glass, which is colourless if pure, but in practice gener­ally exhibits a yellowish hue, and, if really anhydrous, remains

glassy for an indefinite time. Barley-sugar and certain other confections are substantially fused sugar ; but from their mode of manufacture they retain a trace of enclosed water, which constantly dissolves particles of the surrounding sugar glass to redeposit them in the less soluble form of crystals, so that barley - sugar in the course of time loses its transparency through conversion into an aggregate of minute crystals. If fused sugar is kept at a few degrees above its fusing-point for some time, it passes iuto an alloy, C6H12O6 + C6H10O5, of dextrose and lævulosan (see above). At higher temperatures it loses water and passes into anhydrides not reconvertible into cane sugar, which are known in the aggregate as “caramel,”—a most intensely brown viscous solid, easily soluble in water and in aqueous alcohol, with formation of intensely coloured solutions. Caramel (often made of dextrose) is much used as an innocent colouring agent for sauces, liqueurs, &c. A pure solution of cane sugar is said to remain unchanged on boiling (it being understood, of course, that local overheating be carefully avoided); but continued contact with even so feeble an acid as carbonic induces at least partial inversion. The statement of the unchangeability of sugar solution on boiling seems hardly credible, because a syrup boiling at all considerably above 100° C. contains plenty of mole­cules at temperatures- above 160° C., which are bound to suffer irreversible conversion into dextrose and lævulosan (or lævulose), and even, if hot enough, caramelization. In ordinary practice, at any rate, sugar solutions on boiling do behave as indicated by this theory. Cane sugar, as already stated, unites with alkalis, alkaline earths, and other of the more strongly basic metallic oxides into saccharates. A soluble saccharate of lime, which is readily decomposible by carbonic acid and even by filtration through bone charcoal, plays a great part in the manufacture of sugar. The fol­lowing strontium salt must be named, because it at least promised some years ago to occupy a similar position industrially. Accord­ing to Scheibler, if strontia hydrate, SrOH2O + 8H2O, is added to a boiling 15 per cent. solution of cane sugar, then as soon as 2SrO is added for every C12H22O11 the salt C12H22Oπ + 2SrO separates out as a sandy powder, and after addition of 2·5 times SrO al­most all the sugar is precipitated. The precipitate is easily washed and decomposed by water and carbonic acid, with formation of insoluble carbonate of strontia (from which the hydrate can be reproduced) and a solution of cane sugar. The ultimate molasses produced in sugar making or refining, though they refuse to deposit crystals under any conditions, contain some 30 to 40 per cent. of real cane sugar ; Scheibler’s process applies to them,—to put the industrial bearings of the discovery in the proper light,—and it has led to quite a series of patents for the production of strontia ; but, as far as we know, it has failed to take root in the sugar industry.

*Milk Sugar* occurs in the milk of mammals, and it is doubtful whether it occurs anywhere else, although Bouchardat once proved its presence in a sample marked as sugar obtained from *Sapota, Achras* (the sapodilla of the West Indies). It is made industrially in Switzerland as a bye-product in the making of cheese. It passes into the whey, from which it is extracted by evaporation to a small volume, decolorization with animal charcoal, and crystallization. From the commercial product the pure substance can be obtained by repeated recrystallization from water, and ultimately by pre­cipitation from the aqueous solution by alcohol. Milk sugar as it crystallizes from water under the ordinary conditions forms hydrated crystals of the composition C12H22O11 + H2O ; under certain conditions anhydrous crystals separate out. The hydrated crystals have pretty much the aspect of candy sugar, but they are less transparent, far harder, quite free from every *soupçon* of hygroscopicity, and far less sweet. They dissolve in six parts of cold and in 2·5 parts of boiling water ; the solutions are not syrupy. Milk sugar is hardly soluble in alcohol. The ordinary crystals, as the formula shows, have the composition of a glucose ; indeed milk sugar solution behaves to caustic alkalis and to Fehling solution as if it were a glucose. But the hydrated crystals lose their water at 130°, with formation of a residue reconvertible into the original substance by the mere action of water ; besides, milk sugar is susceptible of inversion into dextrose and a specific galactose. The optical behaviour of a milk sugar solution varies according as it is derived from the ordinary crystals or the anhy­dride produced at 130°, and according to the time which has elapsed since its preparation ; but if it stands sufficiently long the specific rotatory power assumes ultimately the same (constant) value. Milk sugar solution when brought in contact with yeast does not suffer vinous fermentation ; but certain *Spaltpilze* induce a fermentation involving the formation of alcohol and of lactic acid. This process is utilized by the Kirghiz in the production of their native drink, “koumiss,” made from mare’s milk (see Milk, vol. xvi. p. 305). Milk sugar is used in medicine as a diluent for dry medicines. Homœopathists use it by preference. A solution of milk sugar in certain proportions of water and cow’s milk is used occasionally as a substitute for mother’s milk.

*Maltose* does not occur in nature ; it is largely produced along with dextrin when starch paste is acted upon by dilute sulphuric