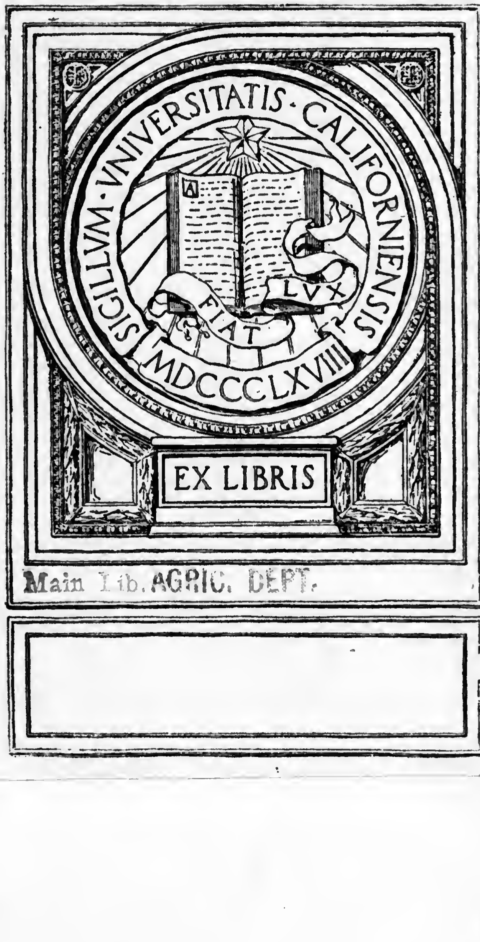
METHODS FOR SUGAR ANALYSIS

GIVEN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AND

ALLIED DETERMINATIONS

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Methods for Sugar Analysis

and

Allied Determinations

BY

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PREFACE.

This book was undertaken because, as the result of ten years' experience in sugar work and in breaking in inexperienced men both for food and technical sugar analysis, it has become increasingly evident that the present methods as given in many of the books on sugar analysis and in the A. O. A. C. methods are not sufficiently explicit as to the proper method for a particular case, thereby confusing the novice, and making it difficult to secure uniform results, since different men select different methods for the same material; nor even when the proper method is indicated does it go sufficiently into the details of the manipulation to enable one without previous experience to carry it through successfully without many repetitions. The methods here presented are not set forth as the only methods applicable, but as those which the author, from long practice on a very large variety of substances, considers to be best adapted for the purposes in hand. Where, for reasons stated, a second method seems desirable, it has been inserted, but this is not often. Because the methods of Allihn for dextrose, Wein for maltose, and Soxhlet-Wein for lactose have been so well known and widely used among chemists everywhere, they have been included, with their respective tables.

It is hoped that this book will be useful not only to food chemists, but to all who have occasion to make sugar determinations.

Hearty thanks are due Dr. G. L. Spencer for original instruction and for permission to use extracts from his books; and to Mr. A. Hugh Bryan and Mr. M. N. Straughn for assistance in preparing parts of the manuscript and in reading proof.

A. GIVEN.

WASHINGTON, D. C.

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AND

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SUGAR CANE.

1. It is impossible to get a sample of sugar cane sufficiently small for laboratory use which will represent with any close approximation the average composition of a field of cane or of the cane as delivered to the mill. Individual canes, however, or several stalks can be analyzed by shredding the stalks in the Warmouth-Hyatt shredder, which reduces the canes to a mass of fine saw-dust and fine fibers. The analytical work must be done quickly as the shredded mass loses water very rapidly.

2. **Sucrose.***—Digest 50 grams of the prepared cane in a suitable tared vessel with 500 cc. of water and 5 cc. of a 5% solution of sodium carbonate during one hour at boiling temperature. After digestion cool and weigh the vessel and contents. Drain off the liquid and determine its degree Brix. Clarify a portion with dry lead subacetate, filter and polarize, using a 400 mm. tube. Example and calculations:

Fiber in the cane	12	%
Fiber in the sample = 50 x 0.12 =	6	grams
Weight of vessel + cane + water	798.5	grams
Weight of vessel	243.5	grams
Weight of cane + water	555.0	grams
Weight of fiber in the cane	6.0	grams
Weight of thin juice	549.0	grams
Density of thin juice	4.0°	Brix

Polarization of thin juice (Horne's dry lead method) in 400 mm. tube = 6.8°; 6.8 ÷ 1.1 = 6.2; by Schmitz's table this corresponds to

* Spencer, Methods of Analysis and Control, page 11, (1911).

1.72% or, dividing by 2 to correct for tube length, to 0.86% sucrose in thin juice. The grams thin juice, 549.0, multiplied by 0.0086 = 4.72 grams sucrose in 50 grams cane, or 9.44% sucrose in the sample.

If it is desired to use the solution of lead acetate instead of the Horne's dry lead, 100 cc. of the solution is clarified with the lead solution, made up to 110 cc., filtered and polarized, and the Schmitz's table used without dividing the polarization by 1.1.

A tall copper beaker with a flanged lip ground to receive a metal cover is best adapted for digestion. The cover and flange should be ground to form a tight joint, using small clamps to hold the former in position. A reflux condenser consisting of a long straight glass tube, should be fitted in an opening in the cover. A piece of lead or copper, tared with the beaker, should be used to hold the cane under water. In the absence of the special copper beaker a flask with a large neck may be used. These are inconvenient on account of the breakage and the difficulty in introducing samples.

3. The usual method of calculating the sucrose in the cane is from the analysis of the normal juice, i.e., the juice from the crusher or from the first mill in a factory, or that obtained by a hand mill or by pressing the shredded cane in the laboratory; and the per cent. of fiber in the bagasse. The sucrose in the juice is determined as described in ¶ 8 and the fiber as in ¶ 4. Then per cent. sucrose in cane = per cent. sucrose in juice times (100 − per cent. fiber) ÷ 100. This assumes that the juice remaining in the bagasse is of the same composition as that expressed, which is not strictly true. A more exact method* is, per cent. sucrose in cane = 100 (weight sucrose in raw juice + weight sucrose in bagasse) ÷ weight of cane.

4. **Moisture.**—Place approximately 10 grams of the shredded cane in a previously weighed drying dish (e.g., a flat aluminum moisture dish or a 3 inch lead bottle cap), weigh quickly but accurately, and dry to constant weight, or until there is a slight gain, at the temperature of boiling water. Cool in a desiccator and weigh quickly. Calculate the loss as per cent. water.

5. **Fiber.**—Weigh 50 grams of the shredded cane in a tared cylinder of a very fine copper gauze fitted with a cap of the same material. Suspend the filled cylinder in a vessel containing distilled water at about 75° C. for 10 minutes. Then remove to another vessel of fresh water of like temperature for the same time. Digest in 5 successive portions of boiling water for 10 minutes each, allowing to drain after each digestion. After the last, drain thoroughly, dry at the temperature

* Spencer, Methods of Analysis and Control, page 10, (1911).

of boiling water, cool, and weigh quickly. The weight of the fiber multiplied by 2 is the per cent. fiber or marc in the cane.

SORGHUM CANE.

5*a*.—The analysis of sorghum cane and sorghum cane juice is carried out in the same manner as that of sugar cane and sugar cane juice, except that, on account of the large amounts of reducing sugars that are liable to be present, it is always necessary to determine the sucrose by the Clerget method, ¶ 29, or by the method of double reduction, ¶ 12.

SUGAR CANE JUICE.

6. **Density or Solids.**—Strain the expressed juice into a tall cylinder, allowing it to fill and overflow, and let stand 10 minutes to allow air bubbles to rise. Blow off the foam and insert the Brix hydrometer (spindle) quickly but with care not to wet the stem above the point at which it comes to rest. When the instrument comes to the temperature of the juice, read the density at the level of the surface of the liquid. The temperature of the juice should be noted, and if it differs from 17.5° C. the reading should be corrected by Gerlach's Table, page 71.

In as much as hydrometers as purchased are seldom correct they should be carefully tested and standardized by the method given on page 35.

7. The per cent. solids determined by the Brix spindle is known as the apparent density, as this method assumes that any solids other than sucrose present in the juice have the same specific gravity as sucrose, which is not strictly true. The true per cent. of solids is determined by the vacuum or absolute method. For this determination a moisture dish is half filled with fine quartz sand or finely broken pumice stone, dried at the temperature of boiling water for 2 hours, cooled and

FIG. 1.—THE SPENCER (CRAMPTON) SUCROSE PIPET.

This pipet was devised independently at about the same time by G. L. Spencer and C. A. Crampton. When filled to the mark A, it delivers the normal or double normal weight (26 or 52 grams) of water. The graduations are for degrees Brix, corrected for error of the spindle but not for temperature; and the pipet after filling to the mark corresponding to the degree Brix, will deliver 26 or 52 (26.048 or 52.096) grams of juice according to the standard for which calibrated.

weighed. Approximately 10 grams of juice are weighed accurately into the dish, and the whole dried to constant weight in the vacuum oven at 70° C. When the weight becomes constant, or a slight increase is noted, the lowest weight is taken as final, and the loss is calculated as water; and 100 − per cent. water = per cent. solids.

8. **Sucrose.**—Place 26 or 52 grams of the juice in a 100 cc. flask graduated in true cc. at 20° C., add 3 to 5 cc. of a saturated solution of neutral lead acetate and 5 cc. of alumina cream and mix. Fill to the mark with distilled water, shake thoroughly and filter through an 18.5 cm. folded filter. Polarize the solution in a 200 mm. tube, and if 52 grams have been used, divide the polariscope reading by 2. This result is the per cent. sucrose in the juice.

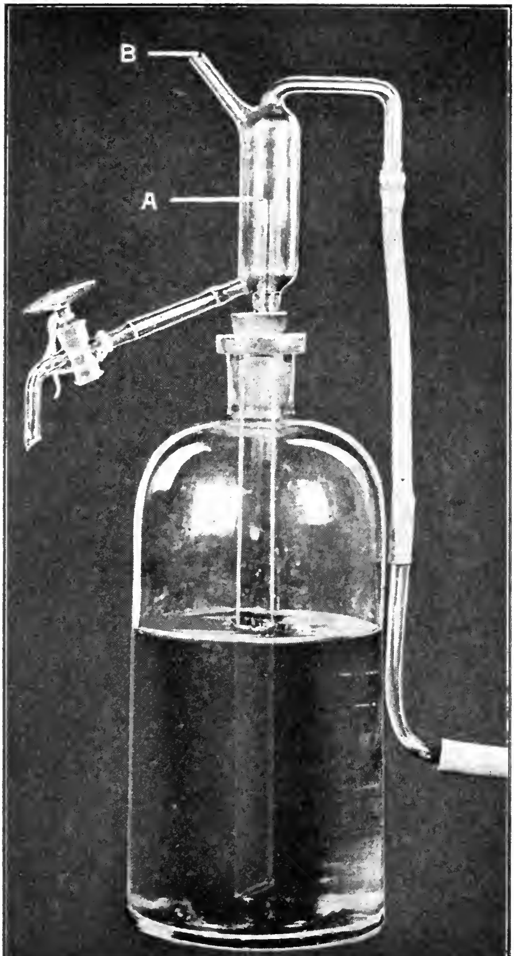
The most convenient and rapid method of weighing out juices and other liquids of not over 25° Brix is by means of the Spencer sucrose pipet. (Fig. 1.) This pipet is so graduated that one need simply note the degree Brix of the juice, corrected for error of spindle but not for temperature, then fill the pipet to the corresponding degree marked on its stem. The graduations indicate the volume of juice, of corresponding densities, which weighs 26 or 52 grams (26.048 or 52.096 grams for 100 Mohr's cc.).

9. Where the greatest accuracy is desired, the polarization should be made at the temperature for which the instrument is adjusted, either 17.5 or 20° C. For this purpose the solution, after adding the lead and alumina cream, should be brought to the standard temperature before making to volume, and if the polariscope is not located in a room at the standard temperature, the solution after filtering should be brought to the correct temperature and polarized quickly; or better still, after having filled the flask at the standard temperature and filtered, a jacketed polariscope tube is used, having water of the correct temperature flowing through the jacket.

10. **Purity.**—The apparent purity is the quotient of the polarization divided by the degree Brix. True purity = sucrose ÷ total solids. Example: The corrected degree Brix of a juice is 17.6 and the polarization is 16°. $16 \div 17.6 \times 100 = 90.9$ = coefficient of purity.

11. **Reducing Sugars.**—Reducing sugars in cane products are called glucose in sugar factories; which term should not be confused with commercial glucose, or with the sugar named glucose.

Reducing sugars are determined by either gravimetric or volumetric methods. Where the greatest accuracy is desired, the gravimetric method of Munsen and Walker, a modification of Soxhlet's application of Fehling's method, is to be preferred. (page 50.) Precipitate the



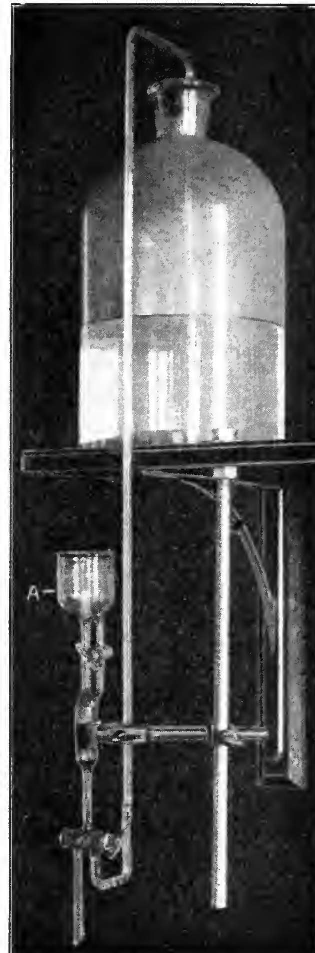


FIG. 2. FIG. 3.

FIG. 2.—AUTOMATIC PIPET FOR SOXHLET'S ALKALINE SOLUTION.

This pipet was devised in the Sugar Laboratory, U. S. D. A. with the idea of getting a pipet in which the solution did not remain always in contact with the stop-cock. The rubber tube is connected with the suction, which must be adjusted to be very light. The rubber stopper carrying the pipet has a second hole for the admission of air to the bottle. With the stop-cock closed the tube B is closed with the thumb. The suction fills the bulb to above the end of tube A, when the thumb is removed and the excess runs back into the bottle. Of course, in order to avoid getting the stop-cock stuck the stopper must be removed and the pipet washed out after use.

FIG. 3.—AUTOMATIC PIPET FOR COPPER SOLUTION.

This pipet is a modification of the usual overflow pipet, and was devised to avoid, first, the loss of solution and, second, the creeping of the copper salts which occurs wherever there is a joint. The pipet holds 25 cc. to the top of tube A. When filling, the excess runs over into the cup, which is kept covered with a watch-glass or beaker, and when 10 or 15 c.c. has accumulated it is run through the side stop-cock into the pipet and so saved. The side-cock is kept closed except when returning the overflow. This pipet is much more rapid than the suction pipet for the alkaline solution, Fig. 2, but the other can be used for any solution, while this cannot be used for alkalies.

excess of lead from the solution used for polarization with powdered anhydrous sodium carbonate. Powdered sodium oxalate can often be used to advantage if great care is used to avoid an excess. Filter through a 15 cm. ashless filter paper, returning the filtrate until it runs perfectly clear. Test with a small quantity of carbonate, and if any further precipitation occurs, add more of the anhydrous carbonate (or oxalate) and return through the filter. Dilute an aliquot to such a volume that 50 cc. of the diluted solution contains not exceeding 0.25 gram reducing sugar. This amount is best determined approximately by a preliminary test. Place 25 cc. of each of Soxhlet's alkaline and copper solutions in a 400 cc. beaker with 25 cc. distilled water and heat to boiling. Make successive small additions of the undiluted solution from a buret, letting come to a boil after each addition, until all the blue color disappears. The quantity of sugar solution added contains approximately 0.25 gram reducing sugars. Suppose the amount added to be 12 cc.; then 12 cc. contains approximately 0.25 gram reducing sugars. Then the original solution should be diluted so that 50 cc. contains this amount or a little less. The proper dilution in the above case would be 20 cc. to 100 cc. The reduction is made on this dilute solution by the Munson and Walker method, and the result calculated to reducing sugars as invert sugar.

12. When a polariscope is not available the sucrose may be determined by reduction before and after inversion. In this method the reducing sugars are determined as above by the method suitable under the conditions. Fifty cc. of the deleaded polarization solution are placed in a 400 cc. beaker, and neutralized with acetic acid. Five cc. concentrated hydrochloric acid are added and the whole allowed to stand over night. When ready to make the reduction the next day the solution is neutralized with sodium carbonate, washed into a 100 cc. flask, filled to the mark and thoroughly mixed. The total reducing sugars in this solution are determined as before, the only difference being that the weight of reducing sugars corresponding to the copper sub-oxid is found in the column headed "invert sugar." From the per cent. total reducing sugars as invert found by this second determination, subtract the per cent. reducing sugars first found, and multiply the difference by 0.95, which is the conversion factor from invert sugar to sucrose. The result is the per cent. sucrose by reduction. Example: Reducing sugars before inversion, 7.45%. Reducing sugars after inversion, 28.57%. $28.57 - 7.45 = 21.12$. $21.12 \times 0.95 = 20.06\%$ sucrose.

13. Volumetric Method.—The volumetric determination of reducing sugars is carried out with Violette's solution, exactly as described under the preparation and standardization of that reagent. The solution is prepared for reduction as described in the previous paragraph. A preliminary test is made on the deleaded solution, adding 1 cc. for the first boiling and boiling only 1 minute. Additions of

FIG. 4.—SUCTION FILTERING APPARATUS FOR REDUCING SUGAR DETERMINATIONS.
The rubber tube is connected with the vacuum pump. The three-way cock serves either to exhaust or admit the air. The filtrate is received in the beaker and is thrown out after each reduction. The rubber packing on the flat surface of the ground-glass plate makes a tight joint. The beaker is kept from being held to the rubber and broken by the vacuum by a section of the rubber, like a cross, 3 inches long being cut out. The side neck is not necessary, though useful in some cases.

1/2 cc. each are continued until the blue color disappears. The sugar solution is then diluted so that 15 to 20 cc. will be required for complete reduction. Thus, if the preliminary test uses 3 cc. of the original sugar solution, this solution should be diluted 6 times, i.e., 10 cc. to 60 cc. The determination is then made on this solution as described.

If we suppose 15.4 cc. of the dilute solution to be required for complete reduction, this 15.4 cc. contains 0.05 gram invert sugar or $\frac{0.05\times 60}{15.4\times 10}=$ 0.1937 gram in the 10 cc. of the original solution which was diluted to 60 cc. But this 10 cc. contains 2.6 grams of the juice; so the reducing sugars $=\frac{0.1937\times 100}{2.6}=7.45\%$.

14. Ash.—The ash in sugar house products is determined by the sulfated ash method. In this method the proper quantity of substance in a shallow platinum dish is saturated with concentrated sulfuric acid, burned to a white ash, cooled, weighed, and 1/10 deducted from the calculated per cent. Ten grams of juice and 1 cc. concentrated sulfuric acid are placed in a 50 cc. platinum dish, evaporated to sirup on steam bath or in water oven, and gently heated over an open flame until intumescence ceases. The dish is then placed in a muffle and the burning completed at low red heat to whiteness, care being taken not to fuse the ash. The dish is cooled and weighed, and the result calculated as above.

BAGASSE.

15. Moisture.—Weight 50 to 100 grams of finely broken pieces of bagasse in one of the tared gauze cylinders used for fiber determination on cane, and dry to constant weight. Calculate loss as moisture.

16. Fiber.—Determine as under fiber in cane, ¶ 4.

17. Sucrose.—Determine as under sucrose in sugar cane, ¶ 2.

FILTER PRESS CAKE.

18. Moisture.—Dry 5–10 grams to constant weight in water oven.

19. Sucrose.—Weigh out 50 grams, place in a small mortar and rub to smooth cream with hot water. Wash into a 200 cc. flask, preferably a Kohlraush flask, clarify with lead acetate solution and alumina cream, cool, make to volume and polarize. The polariscopic reading is the per cent. sucrose in the press cake. Fifty grams are taken instead of 52 to allow for the insoluble matter in the press cake. Press cake from cane factories using the carbonatation process, and from beet factories, after having been rubbed to cream and cooled, must be treated with carbon dioxid to break up lime-sucrose compounds, then boiled to expel excess of CO_2, then washed into a 200 cc. flask, cooled, clarified, made up and polarized as above.

SUGAR BEETS.

20. Sucrose.*—Pellet's Aqueous Method, Hot Digestion. Any good beet rasp or the Warmouth-Hyatt shredder may be used in the preparation of the sample. If the sample is small, i.e., 1 to 4 beets, especially if the beets are small, the whole sample should be pulped and a sub-sample taken for analysis. If the sample is large, one quarter of each beet should be pulped and a sub-sample taken. For sucrose determination 26 grams are weighed in a sugar dish and washed into a

FIG. 5.—SUGAR DISH.

This style of nickel dish, with its counterpoise, was designed and made in Germany, and is the best thing that has ever been devised for weighing out samples of sugar and sirup.

beet flask, 5 to 10 cc. lead sub-acetate solution of 54.3° Brix added, then a few drops of ether to break the foam and water to make about 190 cc. The flask is immersed in a kettle of hot water heated and held at 80° C. for 1/2 hour, adding water as necessary to keep the volume approximately constant. The flask should be shaken with a rotary motion occasionally to assist the escape of air from the pulp. After 30 minutes at 80° C. remove from bath, cool to temperature of polariscope room, acidify with a few drops of concentrated acetic acid, fill to mark, shake thoroughly and filter, rejecting the first drops of the filtrate. Polarize in a 400 mm. tube. The polariscope reading is the per cent. sucrose. A beet flask is a Kohlrausch flask graduated at 201.2 cc. to compensate for volume of marc or fiber and lead precipitate.

21. Fiber.—The fiber is determined exactly as is fiber in sugar cane, ¶ 4.

SUGAR BEET JUICE.

22.—The beets are pulped as under ¶ 20, and the juice expressed from the pulp for analysis.

Solids.—Determine as under solids in cane juice, ¶ 6.

23. Sucrose.—Determine as under sucrose in cane juice, ¶ 8.

* H. Pellet, Neue Zts. Rubenzuckerind., **19**, 375, (1887).

If the beets are immature or have been siloed or frozen, or if the filtered juice is allowed to stand for a considerable time before polarizing, it is very apt to darken so that it cannot be polarized. In this case, add a little powdered sodium chlorid and refilter. If there is not enough lead to cause a good precipitate with the sodium chlorid, add a little dry sub-acetate. Sub-acetate of lead of 54.3° Brix should be used for clarification in order to remove optically active non-sugars which may be present.

24. **Reducing Sugars.**—Beet juices seldom contain reducing sugars. If desired to test for their presence, 50 cc. of the deleaded solution for polarization may be boiled with 50 cc. of the mixed Soxhlet's solution, and if any reduction takes place, the quantity is determined as under reducing sugar in cane juice, ¶ 11.

25. **Ash.**—Determine as under ash in cane juice, ¶ 14.

26. **Purity.**—Determine as under cane juice, ¶ 10.

MASSECUITE.

27. **Solids.**—Apparent degree Brix. In factory practice it is customary to express the solids in massecuite and molasses in degree Brix. This gives only the apparent solids, as the inorganic substances present have a higher specific gravity in solution than the sugars, and thus make the solids appear higher than they really are. This error in some cases may amount to several per cent. For the determination of the apparent degree Brix a weighed quantity of the massecuite is dissolved in an equal weight of distilled water and the degree Brix determined and corrected as under juice, ¶ 6. This figure multiplied by 2 gives the apparent degree Brix.

The true per cent. solids is determined by drying on sand in vacuo at 70° C. The moisture dish is half filled with fine quartz sand or finely broken pumice stone and dried and weighed, including in the weight a small stirring rod just long enough not to fall inside the dish. Approximately 2 grams of the sample are weighed into the dish, 5 to 10 cc. water added, and the whole stirred until the massecuite is all dissolved and thoroughly distributed through the sand. The dish is then placed in a boiling water oven, remaining until most of the water has evaporated, leaving a pasty mass. This is stirred up with the rod, allowed to cool, and is then placed in the vacuum oven and dried to constant weight, or until there is a slight gain, at 70° C. The per cent. loss is calculated as moisture, the difference being the per cent. solids. See also Stanek's method, page 38.

28. Ash.—Approximately 5 grams of the sample are weighed into a platinum dish and the ash determined as under juice, ¶ 14. Use about 1/2 cc. sulfuric acid.

29. Sucrose.—Twenty-six grams of the sample are carefully weighed out in the sugar dish, washed into a 100 cc. flask with hot water, thoroughly dissolved by shaking, cooled, and clarified with a saturated solution of neutral lead acetate. The contents of the flask are then brought to the temperature of the polariscope, made to volume, filtered, and polarized. The reading is the apparent per cent. sucrose.

The true per cent. sucrose is determined by the Clerget method. The polarization solution is freed from lead by the use of anhydrous sodium carbonate as for reducing sugars, ¶ 11. Fifty cc. of the lead-free solution are placed in a 250 cc. beaker with a piece of neutral litmus paper and acetic acid added until the solution is acid. Five cc. concentrated hydrochloric acid are then added and the solution allowed to stand over night at room temperature. In the morning it is washed into a 100 cc. flask, made to volume and polarized. This reading, which is negative, is multipled by 2, the result being the invert polarization of the sample. From the direct and invert readings the sucrose is calculated by the formula $\frac{(a-b)\ 100}{142.66-\frac{t}{2}}$, a being the direct polarization, b the invert, negative, polarization; and t the observed temperature at which the readings were made, which should be the same for both. If a reduction is to be made on the invert solution, it should be neutralized before washing into the flask and making to volume; and in this case the formula becomes

$$\frac{(a-b)\ 100}{141.7-\frac{t}{2}}$$

MOLASSES.

30. Solids.—The apparent degree Brix can be determined approximately by the use of the Brix spindle, but on account of the density and viscosity of the molasses this method is unsatisfactory and the method of half dilution as under solids in massecuite, ¶ 27, is to be preferred. The true solids are determined as in massecuite in the same paragraph. A much more rapid method, which has been found to be very satisfactory in a long series of comparisons is that by the use of the Abbé refractometer.* The table, page 41, reads the per cent. solids

* Geerligs, Intern. Sugar J., **10**, 69.

directly from the index of refraction. As Geerligs' Table is for 28° C., the table of temperature corrections must be used, subtracting the correction if below 28° and adding if above. The table of Main* gives the per cent. solids without having to correct, but it is only for 20° C., so is not so generally applicable.

31. **Ash.**—Determine as under massecuite, ¶ 28.

32. **Sucrose.**—Determine as under massecuite, ¶ 29. Unfortunately many samples of molasses are too dark to polarize without considerable dilution, which of course multiplies the errors of reading. When the solution is too dark to polarize it is preferable to determine by reduction before and after inversion. Moreover, the large amount of non-saccharine matter present in molasses renders the Clerget determination of sucrose more or less inaccurate, being sometimes as much as 3% out of the way.

If there is reason to expect adulteration with commercial glucose or starch sirup, the invert solution should be polarized at 87° C. in a jacketed silver tube. A plus polarization exceeding 3° is indication of glucose, and if over 6° is positive proof of its presence. The per cent. glucose is calculated as follows: Multiply the observed reading by 1.0315 to correct for expansion by heating, and calculate to reading on original solution. Divide the result by 1.63, and express quotient as per cent. glucose. This result is only approximate, but is within 2% or 3% of the true amount.

33. **Reducing Sugars.**—Determine as under reducing sugars in cane juices, ¶ 11. On account of the many non-sugar impurities, especially in final molasses, the copper sub-oxid precipitate is often contaminated by the precipitation of other substances. When this is suspected to have occurred, as is readily observable by the appearance of yellowish and greenish colors during reduction, and a noticeable change in the color of the precipitate after drying, the amount of copper in the precipitate should be determined by Low's method,† page 50, and the amount of reducing sugars found in the table corresponding to this amount of copper instead of copper sub-oxid.

34. **Purity.**—As under cane juice, ¶ 10.

RAW SUGAR.

35. **Moisture.**—Dry 2 grams for 2 hours in boiling water oven. See also the method of Stanek, page 38, for method of moisture determination in sugars by means of immersion refractometer.

* Main, Intern Sugar J., **9**, 481.
† J. Amer. Chem. Soc., **24**, 1082, (1902).

36. Ash.—Ash 5 grams as under massecuite, ¶ 28.

37. Sucrose.—As under massecuite, ¶ 29. As the amount of precipitable matter is small in raw sugars of high purity, the addition of a few cc. of alumina cream before making to volume will assist in obtaining a bright filtrate. If the temperature of polarization varies from 20° C., the true polarization on sugars polarizing over 90° should be obtained by the use of Wiley's correction factor. This correction is 0.03° Ventzke (polariscope scale) for each degree centigrade on a pure sugar solution polarizing 100° V.; and is not applicable where the reducing sugars exceed 3%, as differences in temperature affect the reducing sugars more strongly than sucrose. The correction is applied by adding 0.03 to the polariscope reading for each degree centigrade above the standard temperature for the polarization proportionately to the amount of sucrose present. For example, a solution polarizes 95° at 30° C. If the standard temperature for the instrument is 20°, $30° - 20° = 10$ and $0.03 \times 10 = 0.3°$ V. correction for a reading of 100°; therefore for a reading of 95° the correction is $0.95 \times 0.3° = 0.285$ or approximately 0.3°, and the per cent. of sucrose is 95.3.

38. Reducing Sugars.—As under cane juice, ¶ 11.

39. Raffinose.—If in examining a beet sugar, the direct polarization is more than 1% higher than the sucrose by Clerget, raffinose is probably present, and the sucrose and raffinose should be calculated by the formula of Creydt, modified by Hertzfeldt:

$$S = \frac{0.5124\,P - I}{0.839}, \quad R = \frac{P - S}{1.85}$$

P = Direct reading.
I = Invert reading.
S = Per cent. sucrose.
R = Per cent. raffinose.

REFINED SUGAR.

40. Sucrose.—As under raw sugar, ¶ 37.

41. Ash.—As under massecuite, ¶ 28.

REFINERS SIRUP.

42. Refiners sirup in its crude state is the final product of the sugar refinery, from which all the sucrose possible has been crystalized. When it is to be put on the market for mixing purposes, it is passed through a partially exhausted char filter, and concentrated to the desired density. It has practically the same chemical characteristics as final sugar-house molasses, and the same determinations are made on it as on molasses. It is distinguished from molasses by three characteristics. (1) When viewed by reflected light it is fluorescent like mineral oils. (2) It has a flavor or taste entirely distinctive and unlike any other natural sirup or molasses. This is familiar to the public, as refiners sirup is much used to flavor commercial glucose sirups. (3) The Winton lead number (see maple sirup) is markedly less than that of cane sirup or molasses. Cane sirup and the various grades of cane molasses have a lead number of above 3.00, while refiners sirup has a lead number less than 2.00.

CANE SIRUP.

43.—Cane sirup is the clarified juice of the sugar cane which has been concentrated to a water content of not exceeding 30%, without the removal by crystalization of any of its sucrose. The same determinations are made on it as upon molasses. Cane sirup is divided into two primary classes according to its method of manufacture, open kettle sirup and vacuum sirup, which names are sufficiently indicative. Open kettle sirup is classified according to the method of clarification used. In those of the Southern States which do not produce sugar, but only sirup, the clarification is by heat alone, the scums formed during the heating and boiling being removed by hand skimming. In Louisiana the cane juice is limed and sometimes treated with sulfur dioxid fumes to produce a more complete clarification than heat alone will bring about under ordinary conditions; and a noticeable change in flavor takes place. Also less invert sugar is formed during the boiling.

SORGHUM SIRUP.

44.—Sorghum sirup is produced from the juice of the sorghum cane as cane sirup from sugar cane, and like cane sirup, is made by both open kettle and vacuum processes. The clarification in both is by heat alone or by lime and heat. Sulfur is rarely or never used. Sorghum sirup is distinguished from cane sirup (1) by its distinctive taste; (2) by its greatly increased reducing sugar content; (3) by its high ash. Also, sorghum sirup is rarely or never bright and transparent, while good cane sirup usually is; and sorghum sirup is usually darker in color than cane sirup. The same determinations are made on sorghum sirup as on molasses.

MAPLE SIRUP.

45.—Maple sirup is the sap of the suger maple tree concentrated to a water content of not more than 35% without the removal by crystallization of any of its sucrose. Its value lies in its exquisite flavor; and the great demand on this account together with the high cost of production, due to the extreme dilution of the sap, which rarely exceeds 3% of sugar, causes its high price in the market, and so incites to many attempts at adulteration. It is with the view of detecting this adulteration that maple sirup and sugar have been especially studied, and while much remains to be learned, the determinations here given are those which thus far have been most carefully worked out, and which give information in the grosser and more common forms of adulteration.

46. Solids.—As under molasses (a) by refractometer, (b) by drying. Should exceed 65%.

47. Total ash.—Approximately 5 grams are carefully weighed in a platinum dish, 2 to 3 drops of oil added to prevent excessive foaming, and the sirup is charred over a small open flame. The dish is then placed in a muffle, preferably electric, and all the carbon burned off at a low red heat. The muffle should not be tightly closed as a slight circulation of air aids in burning off the carbon, which, especially in adulterated sirups, is very resistant. Cool, weigh and calculate as total ash. It should exceed 0.5%. The ash of many maple sirups has a greenish tinge, sometimes extremely marked, due to traces of manganese. Where the color is very marked, upon adding water the color changes to purple.

48. Insoluble ash.—To the total ash in the platinum dish 10 to 20 cc. distilled water are added and brought to a boil. This water is then poured on a 9 cm. ashless filter and the dish and paper washed with hot water till the washings amount to 75–100 cc. The paper is then folded and burnt in the dish with great care until the last spark disappears, allowed to cool, covering with a watch glass meanwhile, moistened with a few drops of 5% solution Na_2Co_3, dried in water oven and again ignited over gas burner, cooled and weighed. Calculate the result as per cent. insoluble ash. It should exceed 0.15%. The moistening, drying, and reignition are for the purpose of binding the ash to the dish, as it is so extremely light that some of it is very likely to be lost unless this precaution is taken. *Save the washings.*

49. Soluble ash.—By difference. The soluble ash is nearly always greater than the insoluble, and in pure sirup is very apt to be about 2/3 the total ash.

50. **Alkalinity of the soluble ash.**—To the washings from the insoluble ash add 1–2 drops methyl orange, and titrate with n/10 HCl. Express the result as cc. n/10 HCl. Also calculate the result on 1 gram soluble ash, in order to compare alkalinity of ash of sirups having different content of ash, i.e., suppose a sirup to have a total ash of 0.6% and a soluble ash of 0.4%. The weight of the total ash from 5 grams sirup is then 0.0300 gram, and the weight of the soluble ash is 0.0200 gram. If this soluble ash requires 2 cc. n/10 HCl to neutralize it, the alkalinity of the soluble ash would be 2.00; and the alkalinity of 1 gram soluble ash 2.00 divided by 0.0200 = 100.0. This value is used in comparing sirups having different ash content, since the ash of adulterants is of different quality from maple sirup ash.

51. **Alkalinity of insoluble ash.**—After weighing the insoluble ash add 10 cc. n/10 HCl and heat just to boiling. Add 1–2 drops methyl orange, and titrate excess of acid with n/10 NaOH. The difference between the 10 cc. n/10 HCl and the number of cc. n/10 NaOH used is the alkalinity of the insoluble ash, and is so expressed. Also calculate this to alkalinity of 1 gram insoluble ash as under soluble ash. This should be above 200.

52. **Sucrose.**—Determine by the Clerget method, polarization before and after inversion, as in ¶ 29. The use of lead acetate solution for clarification is not necessary in light colored sirups, but 5 cc. alumina cream should be used to ensure a bright solution. If the sirup is dark use lead acetate solution, and if necessary dilute until a good reading can be obtained; but this last is only rarely required.

53. **Reducing sugars.**—Determine as under cane juice, ¶ 11, on a portion of the polarization solution or on a separate sample of 10 to 25 grams in 100 cc. Always clarify, filter and remove the excess of lead before testing and diluting for reduction.

54. **Winton's lead number.***—This determination and that of ash are the most valuable indications of the purity of a maple sirup. Weigh out 25 grams of the sample, wash into a 100 cc. flask, add 25 cc. Winton's lead sub-acetate, shake well, and let stand 1 to 3 hours. Make to volume, shake and filter, rejecting the first drops of filtrate. Place 10 cc. of the filtrate in a 250 cc. beaker, add 40 cc. distilled water and 10 drops concentrated sulfuric acid, mix thoroughly, add 100 cc. 95% alcohol and let stand over night. Prepare a blank with 25 cc. of the sub-acetate and distilled water, acidifying with acetic acid to prevent formation of carbonate, fill to mark and shake thoroughly. Take 10 cc. of this solution and add water, sulfuric acid and alcohol as

* J. Am. Chem. Soc., **28**, 1204.

to filtrate from sirup and let stand likewise. Prepare Gooch crucibles as for reducing sugar determinations, heat to low redness in muffle, cool and weigh. Filter the precipitated $PbSO_4$ in these crucibles, washing with 95% alcohol, being careful to remove adhering precipitate from beaker with a policeman. Dry in water oven, heat to low redness in muffle, cool and weigh. Subtract the weight of precipitate of the sirup from the weight of precipitate from the blank and multiply the difference by 27.32, the factor for lead precipitated per cent. sirup. The result is the Winton lead number. Example: A sample of sirup gives a $PbSO_4$ precipitate weighing 0.1125 grams. The precipitate from the blank weighed 0.1746 grams. $0.1746-0.1125=0.0621$. $0.0621 \times 27.32 = 2.17$ = lead number.

The lowest lead number for a pure sirup of 65% solid content is 1.20. The maximum is above 3.00, with an average of about 1.80.

55. Malic Acid Value.—This is a confirmatory test nearly equal in value to the preceding.

Modified A.O.A.C.* method.—Weigh 6.7 grams of the sample in a sugar dish and transfer to a 250 cc. breaker with 15 cc. water. Add 2 drops NH_4OH (sp. gr. 0.90); shake, add 1 cc. of a 10% solution of $CaCl_2$, then 60 cc. 95% alcohol; cover with a watch glass and heat on steam bath for 1/2 hour. Allow to stand on steam bath over night with steam turned off. Filter the material through good filter-paper and wash the precipitate with 75% alcohol until the filtrate measures 100 cc., dry and ignite. Add from 5 to 10 cc. n/10 HCl to the ignited residue, thoroughly dissolve the lime by heating carefully to just below the boiling point; cool, and titrate the excess of acid with n/10 NaOH, using methyl orange as an indicator. One-tenth of the number of cc. of acid neutralized by the ignited residue expresses the malic acid value. Run blanks with each set of determinations, using the same amount of reagents, NH_4OH, acid, etc., and subtract the result on the blank from the malic acid value obtained.

56. In order to compare samples of varying water content, it is best to calculate all results to the water free basis. The following are the results on 395 samples of sirup from the maple producing regions of the United States calculated to water free basis.

	Total ash.	Soluble ash.	Insoluble ash.	Lead no.	Malic acid value.
Maximum.......	1.68	1.23	1.01	4.41	1.60
Minimum.......	0.68	0.35	0.23	1.76	0.29
Average.........	1.02	0.64	0.38	2.72	0.85

* Association of Official Agricultural Chemists.

MAPLE SUGAR.

57. On account of the difficulty of getting uniform samples of maple sugar for the various determination, it is best to make a sirup by dissolving the sugar in boiling water and making the same determinations on this sirup as on maple sirup presented as such. About 200 grams of the sugar are placed in an 800 cc. beaker with sufficient water to cover it, placed over a gas burner and heated carefully to boiling. The sugar dissolves readily, and the solution is boiled until a thermometer placed in it just clear of the bottom reads 104° C. The resulting sirup is allowed to stand over night and is then strained through a heavy cotton cloth. The cold, strained sirup should contain about 35% water. The same determinations are made on it as on maple sirup bought as such, and the same constants apply. If it is desired to determine the water content of the sugar itself, the method of Stanek for raw sugars, page 38, gives excellent results.

HONEY.

58. The methods for the examination of honeys here given are those of the A.O.A.C. as developed by Dr. C. A. Browne, and published in Bulletin 110 of the Bureau of Chemistry, U. S. Department of Agriculture. The only differences are the substitution of the Munson and Walker method for reducing sugars for the Allihn method; and the addition of Fiehe's test for commercial invert sugar, which has been developed since the bulletin was written.

If the honey is solid it should be liquefied by heating on steam bath until the sugar are dissolved. Most honeys thus liquefied will remain in this state for some time, but occasionally one begins to crystallize again as soon as cold. Such a sample must be weighed out while still warm.

OPTICAL METHODS.

59. Direct Polarization.—For the direct polarization of honey, the normal weight, 26 grams, of the liquefied sample is dissolved to 100 metric cc. at 20° C. after the addition of 5 cc. alumina cream. The solution is filtered and immediately polarized in a 200 mm. tube at 20° C. The same solution is again polarized after 18 or 20 hours standing, the second reading being taken as the constant polarization of the honey. The difference between the two polarizations is taken as the bi-rotation. After taking the constant reading at 20° C. the solution is brought to a temperature of 87° C. and again polarized. The temperature in the jacketed silver tube is maintained by a regulated current of hot water and constant reading can usually be secured within 5 minutes. The field is never so clearly marked at 87° C. as at 20° C. on account of slight striations produced in the heated liquid, hence readings cannot be made with the same degree of accuracy as at the lower temperature. Nevertheless, consecutive readings can usually be obtained agreeing within 0.1° or 0.2°.

60. Invert polarization.—Fifty cc. of the solution for the direct polarization, with 5 cc. concentrated HCl, are placed in a 400 cc. beaker covered with a watch glass, and allowed to stand at room temperature over night. In the morning the solution is neutralized and washed into a 100 cc. flask, filled to mark at 20° C., and thoroughly shaken. It is then polarized in a jacketed silver tube at 20° and at 87° C. The readings are doubled to correct for dilution, and these values are entered as the invert polarizations at 20° and 87° C. respectively.

61. Calculation of Levulose.—Inasmuch as the variations in polarizations at different temperatures are due almost entirely to the change in the specific rotation of levulose, it is possible to calculate with a fair degree of approximation the levulose content of any saccharine solution. Wiley's* optical method for estimating levulose is based upon this principle. In the method as described by Wiley, it is shown that 1 gram levulose in 100 cc. shows a variation of 0.0357° V. for each degree centigrade; the variation for 67° C. would therefore be 2.3919. The difference in the direct polarization of the honey at 20° and 87° C. divided by 2.3919 will give, therefore, the grams of levulose in a normal weight of honey; from this the per cent. of levulose may be obtained easily. The above method of calculation, however, only holds for solutions which have been made up at 20° and 87° C. The polarization at 87° C. being made on solutions prepared at 20° C. must be corrected for the dilution due to the expansion of the liquid. One hundred cc. of water at 20° C. will expand to 103.15 cc. at 87° C.; the polarization at 87° C. must, therefore, be multiplied by 1.0315 to obtain the reading corrected for this expansion.

CHEMICAL METHODS.

62. Moisture.—For the determination of moisture in honeys 2 grams of the sample are weighed out in a flat-bottomed aluminum dish 2-1/2 inches in diameter, containing 10 to 15 grams fine quartz sand which has been thoroughly washed and ignited. A small glass stirring rod is weighed with the dish and sand, and after the addition of

* Wiley, Principles and Practice of Agricultural Analysis, iii, 267, (1897).

the honey the latter is dissolved in 5 to 10 cc. of distilled water and thoroughly incorporated with the sand by stirring with the rod. The dish is then placed in a vacuum oven and dried at 65° to 70°C., under 20 to 24 inches vacuum to constant weight. The average length of time required for drying samples of honey is about 18 hours; with honeys of high purity, such as those of the clover and alfalfa types, 12 hours drying or even less is sufficient, while with low grade honeys of the honey dew class, which are high in dextrins and gums, 36 hours or longer are required to secure constancy in weight.

63. Invert Sugar.—Ten cc. of the solution used for the direct polarization, 26 grams to 100 cc., are made up to 500 cc. and the reducing sugars as invert sugar determined by Munson and Walker's method. The reducing sugars as dextrose are also found from the proper column in the table, or they may be calculated by dividing the figure for invert sugar by factor 1.044.

64. Calculation of Dextrose.*—The per cent. of levulose subtracted from the total reducing sugars as invert will give very closely the per cent. of dextrose if these two sugars are present in nearly equal amounts. If the two sugars differ widely in per cent. an error† is introduced into the calculation of invert sugar and hence into the per cent. of dextrose. It is therefore most accurate to reduce the levulose to its dextrose equivalent in copper reducing power by multiplying by the factor 0.915. This subtracted from the total reducing sugar as dextrose will give the true per cent. of dextrose.

65. Sucrose.—On account of the various errors involved in the estimation of sucrose in honeys by the Clerget method of double polarization, such as the difference in specific rotation of levulose in neutral and acid solution, the sucrose is determined by the gravimetric method. Ten cc. of the solution used for invert polarization are made up to 250 cc. after neutralizing the free acid with Na_2CO_3, and the invert sugar determined as before. The difference between the per cent. of invert sugar as found before and after inversion multiplied by 0.95 gives the per cent. of sucrose.

66. Ash.—Five grams of honey, to which have been added a drop or two of vegetable oil, are carefully heated in a platinum dish until intumescence ceases, and then ignited at low redness until a white ash is obtained. With impure honeys of the honey-dew class, which are usually high in ash content, it is sometimes necessary first to carbonize the honey and wash out the soluble salts with hot water; this solution is

* Browne, Analysis of Sugar Mixtures, J. Amer. Chem. Soc., **28**, 446, (1906).
† von Lippmann, Chemie der Zuckerarten, i, 898.

added to the ash from the leached char and the whole evaporated and ignited at low redness as before.

67. Dextrin.—Eight grams of honey are transferred to a 100 cc. flask with 4 cc. of water and sufficient absolute alcohol to complete to the mark. A little care is required to affect the complete removal of the honey from the weighing dish without using more than 4 cc. of water. The transference is best made by decanting as much as possible of the liquefied honey into the flask, then adding 2 cc. of water to the dish to take up any adhering honey and again decanting. By using 1 cc. more of the water in two successive washings and adding a few cc. of the absolute alcohol each time before decanting, the honey can be completely transferred without the necessity of using more than the 4 cc. Absolute alcohol is used finally to rinse out the dish and is then added to the flask with continual agitation until the volume is completed to 100 cc. After shaking thoroughly the flask is allowed to stand until the dextrin has settled out on the sides and bottom of the flask and the supernatant liquid has become perfectly clear, usually in 24 hours. The clear solution is then decanted through a filter and the precipitated residue washed with 10 cc. of cold 95% alcohol to remove adhering liquid, the washings being also poured through the filter. The residue adhering to the flask and the particles which may have been caught on the filter are dissolved in a little boiling distilled water and washed into a weighed platinum dish. The contents of the latter are then evaporated and dried in a water oven to constant weight. Should the amount of precipitate be considerable, it is necessary to dry on sand in vacuo at 70° C. After determining the weight of the dried alcohol precipitate, the latter is redissolved in water and made to a definite volume. The following dilutions are employed in making up solutions:

Weight of precipitate, grams.	Volume, c.c.
0.00 to 0.5	100
0.5 to 1.0	200
1.0 to 1.5	300
1.5 to 2.5	500

The sugars are then determined in aliquots from the filtered solution of the alcohol precipitate both before and after inversion. The total precipitate less invert sugar and sucrose gives per cent. dextrin. With honey-dew honey giving a large amount of alcohol precipitate it is found best to take only 4 grams of honey for analysis; in other respects the method of procedure is the same.

While this method of estimating dextrin in honey gives much more accurate results than the direct weighing of the alcohol precipitate, it cannot be said to give the true dextrin content of the honey, although it is believed that the figures obtained are a close approximation. A small amount of dextrin always escapes precipitation with alcohol; furthermore, no account is taken of the other ingredients which may be occluded in the alcohol precipitate other than the sugars, and no correction is made for the copper reducing power of the honey dextrin itself. This latter factor, though apparently very small, might prove to be of some importance if much dextrin were present. Notwithstanding these limitations, however, the per cent. of dextrin as determined by the method described has been found to have a decided value, especially when it is wished to compare honeys of different origins.

68. Undetermined Matter.—The undetermined matter of honey (wax particles, pollen grains, higher alcohols, tannins, essential oils, combined acids, etc.) is estimated by difference.

69. Free Acid.—The free acid in honey, expressed as formic acid, is determined by titrating a weighed portion of the sample, after solution in distilled water, with n/10 NaOH, using phenol phthalein as indicator. It is customary to express the free acid in honey as formic, although other acids may, no doubt, be present. In soured or fermented honeys acetic acid is always formed.

70. Commercial Glucose.—Starch sirup resembles liquefied honey in color and consistency, so that the appearance of a sample does not indicate adulteration. It is largely used to improve the appearance of low grade dark colored honeys, and also to modify the taste of the more rank and strongly flavored natural honeys. It is also used for preventing granulation, the addition of only a small amount of glucose checking the crystallization of the honey permanently. One of the quickest and simplest methods of detecting commercial glucose on honey is the test for erythro or amylo-dextrin with iodin proposed by Beckmann.* A solution of the suspected honey in water (1:1) is prepared and treated with a few cc. of iodin solution. If glucose be present the solution turns red or violet. The depth and character of the color depending upon the quantity and nature of the glucose employed for adulteration. A blank test with a pure honey using the same quantity of iodin solution should be made at the same time for the purpose of securing an accurate comparison of color. Beckmann has made this test even more sensitive when only very small amounts are present by first precipitating the

* Zts. Anal. Chem., **35**, 267, (1896).

dextrin of the honey with alcohol and applying the iodin test to a solution of this precipitate in a small amount of water.

On account of the extreme variations in the composition of honeys the quantitative determination of commercial glucose is at best very unsatisfactory; and no method has as yet been devised which can be depended upon to give results within several per cent. of the truth, so far from it, in fact, that it is not thought desirable to attempt to give any method so apt to be misleading.

71. **Grape Sugar or Commercial Dextrose.**—There is no absolute method for the estimation of added grape sugar; yet the addition of this may often be inferred with a fair degree of certainty. If the difference in the invert polarization of a honey at 20° and 87° C. falls below 20, and the per cent. of reducing sugars is normal and no reaction for amylo- or erythro-dextrin is obtained with iodin, then commercial dextrose has, in all probability, been added.

72. **Invert Sugar.**—Commercial invert sugar is becoming a common adulterant of honey and as its sugars are identical with the principal sugars in honey, its detection is very difficult, and becomes possible only in so far as the non-sugars of the honey are modified by the addition of substances added to the invert sugar or produced in the processes of its manufacture. In the Hertzfeld and similar processes of making invert sugar, a small amount of furfural is produced, and a red or pink color is produced by the reaction of this substance with aniline acetate. The method employed in applying this test is as follows:—(*a*) Preparation of Reagent. This should be freshly prepared each time before using. Five cc. of chemically pure anilin are shaken up with 5 cc. water and sufficient glacial acetic acid added (2 cc.) to just clear the emulsion. (*b*) Execution of test:—Five cc. of a concentrated solution of honey (1:1) are treated in a test tube with one or two cc. of the aniline reagent. The latter is allowed to flow down the walls of the tube so as to form a layer upon the honey solution. If the tube is gently agitated a red ring forms beneath the anilin solution, this color becoming gradually imparted to the whole layer, artificial invert sugar is present.

73. **Fiehe's Test.**—Another, later, and in some respects better, test is that developed by Fiehe.* Ten cc. of 1:1 honey solution is well shaken in a test tube with 5 cc. of ether, and the solutions allowed to separate. The ether solution is poured off into another tube and a few drops of a solution of 1 gram resorcinol in 100 grams HCl, sp. gr. 1.19, added. In the presence of the decomposition products of the manu-

* Zts. Unter. Nahr. u. Genussm., **16**, 75.

facture of invert sugar by heat and inversion an orange color appears, which quickly changes to a dark red and then to a red-brown color.

74. Neither of the above tests develop the characteristic color with pure honey, even if it has been heated to a temperature below 100° C. for several hours; but if it has actually been heated to boiling, about 107° C., the color reactions appear. However, it is of rare occurrence to find a honey which has been boiled, and when such a thing happens it is readily distinguished, since a honey so treated loses all its characteristic honey odor and flavor.

COMMERCIAL GLUCOSE OR STARCH SIRUP.

75. Commercial glucose or starch sirup is made by the incomplete hydrolysis of starch by dilute mineral acids under pressure. The determinations usually made are:

Polarization.—Thirteen grams in 100 cc. polarized at 20° C. No clarification is necessary for higher grades; for low grade and dark colored glucose, clarify with 2 to 5 cc. of lead acetate and 5 cc. alumina cream. Polarization calculated to normal weight varies from 150° to 175°.

76. **Reducing Sugars as Dextrose.**—By Munson and Walker's method for reducing sugars. See also reducing sugars under cane juice, ¶ 11. Usually 25% to 35% dextrose is present.

77. **Ash.**—Ash 10 grams with a few drops of oil as under maple sirup, ¶ 47. Ash varies from 0.05% to 0.2%.

78. **Dextrin.**—The dextrin may be determined as under dextrin in honey, ¶ 67, using 4 grains material.

DEXTRIN (BRITISH GUM).

79. Dextrin is manufactured by heating starch to 212° or 275° C. In order to get a dextrin which shall always be uniform and work the same, the following determinations have been established by some of the largest users.

Moisture.—Dry approximately 5 grams, accurately weighed, for 5 hours at 105° C. (see page 25). Cool in dessicator, weigh and calculate loss as moisture.

80. **Ash.**—Char 5 grams of the sample, to which have been added 2 to 5 drops vegetable oil, in a platinum dish of 100 cc. capacity over an open gas flame, and when intumescence ceases remove to muffle and ash completely. Calculate residue as per cent. ash. If the sample is slow to burn down, remove the dish from muffle, cool, leach the char

with hot water and burn; add to the ash the leachings, evaporate to dryness, ignite and weigh as ash.

81. Hot Water Insoluble.—Weigh 10 grams in the sugar dish

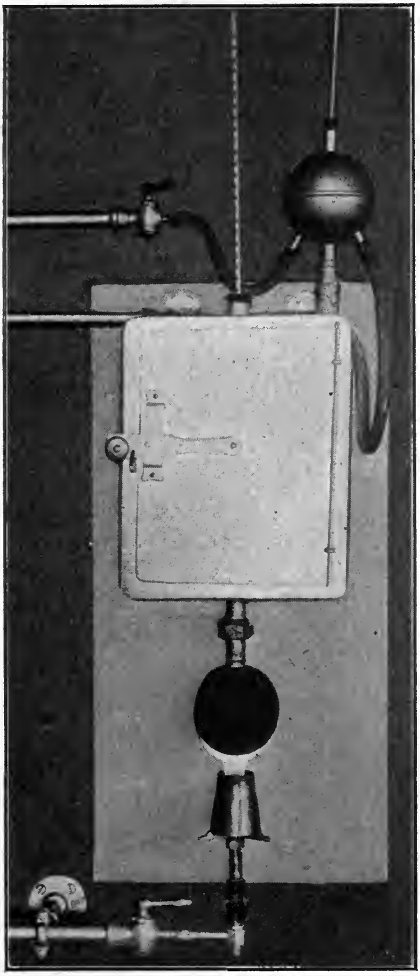


FIG. 6.—DOUBLE-WALLED DRYING OVEN FOR 105° C., OR ANY TEMPERATURE OTHER THAN THAT OF BOILING WATER.

The lower ball is two-thirds filled with toluene or any other liquid having the boiling point desired. The gas burner vaporizes the liquid, thus heating the oven. The vapor is condensed by the ball condenser above and returns to the lower ball to be used again.

and dissolve in water with the aid of a stirring rod. Wash into a 100 cc. flask and fill to mark. Filter through a tared Gooch crucible, wash with 100–200 cc. hot water, dry and weigh. Calculate increase as hot water insoluble.

82. Organic Insoluble.—Burn off all organic matter from the residue in the Gooch used for hot water insoluble, cool and weigh. Calculate loss in weight as organic insoluble.

83. Polarization.—Weigh 10 grams in the sugar dish, dissolve in cold water, wash into a 100 cc. flask, add 5 cc. alumina cream and make to volume at 20° C. Filter and polarize.

84. Dextrose.—Determine reducing sugar as dextrose in solution for polarization by the Munson and Walker method.

85. Specific Rotation.—Subtract from the polariscope reading the reading due to the dextrose in 10 grams to 100 cc. One per cent. dextrose in a solution of 26 grams to 100 cc. polarizes 0.8° V. Therefore in a 10 gram to 100 cc. solution, the polarization will be 10/26 of 0.8° = 0.30°. This is not absolutely true, as the specific rotation of dextrose decreases with the dilution, but it is true for the small amount of dextrose involved. Calculate the specific rotation of the dextrin by the formula $\frac{a \times 66.5}{100}$, in which $a = \frac{26 \times \text{pol. dextrin}}{10}$ and 66.5 = specific rotation of sucrose. *Example:*—The polarization of a sample of dextrin is 105° and the dextrose content of the sample is 3.50%. 3.5% dextrose in a 10 gram to 100 cc. solution polarizes 1.05°. 105° − 1.05° = 103.95°.

$$\frac{103.95 \times 26}{10} = 270.27 = a.$$

$$\frac{270.27 \times 66.5}{100} = 179.73 = \text{specific rotation.}$$

86. Viscosity of Cold Water Solution.—Fifty grams of the sample are weighed out in the sugar dish and placed in a porcelain mortar, 50 cc. cold distilled water added and the dextrin dissolved by working with the pestle. When most of the dextrin is dissolved, the solution is poured into a 250 cc. beaker and 25 cc. water added to the mortar and solution is completed. This is added to the solution in the beaker; and 25 cc. more water used to rinse mortar and wash pestle clean. This is also added to solution in beaker which is then thoroughly mixed and allowed to stand 1 hour. At the end of that time the viscosity is determined in a flow viscosimeter having an orifice 1/8″ in diameter. The viscosimeter shown (Fig. 8) is made by cementing a 100 cc. cylinder, from which the base has been cut, into a brass base turned inside to a cone of 60°. The instrument is standardized by filling to the top with distilled water, keeping the finger over the orifice. With a stop watch the time of out-flow is taken, beginning when the meniscus passes the 100 cc. mark, and ending when it passes the

50 cc. mark. This is usually about 5 seconds for a column of the height and diameter shown. The instrument is dried and the time taken in like manner on the dextrin solution. This varies between 15 and 21 seconds. The viscosity is expressed as the quotient of the time of outflow of the dextrin solution divided by the time of outflow of the distilled water, both at 20° C., multiplied by 100. *Example:* —The time of outflow for water is 5 seconds, and for a sample of dextrin 19.4 seconds.

$$\frac{19.4 \times 100}{5} = 388 = \text{viscosity.}$$

Of course any type of flow viscosimeter having a sufficiently large orifice can be used in like manner. The viscosity determination is repeated on the same solution at the end of 24 hours and 48 hours. It should not change markedly.

87. Viscosity of Hot Water Solution.—Fifty grams of the sample are weighed into a tared 250 cc. beaker provided with a short stirring rod, 100 cc. water added, the beaker covered with a watch glass and placed on the steam bath where it is heated until the dextrin is all dissolved. The beaker and contents are again weighed and water added to make up for the loss. The solution is thoroughly mixed and cooled, and the viscosity determined as on the cold water solution, immediately, after 24 hours, and after 48 hours. The viscosity should not vary much from that of the cold water solution, nor should it increase much in 24 and 48 hours.

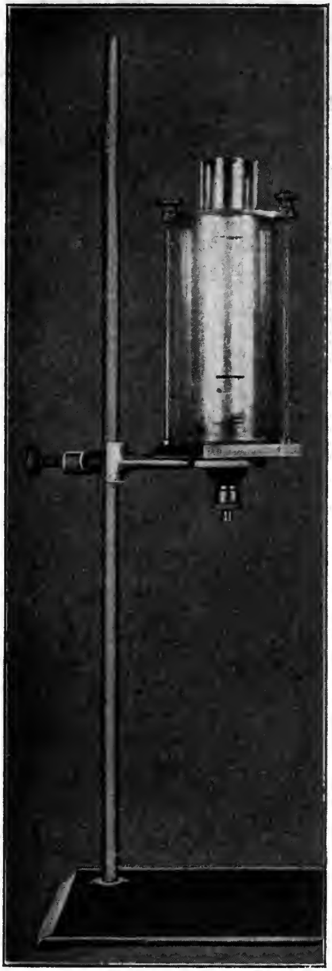


FIG 7.—FLOW VISCOSIMETER WITH WATER JACKET.

The bottom of the viscosimeter inside is a cone of an angle of 60°. The water jacket can be kept filled with water of any desired temperature at which samples are to be examined. Keeping a finger over the outlet, the inner cylinder is filled with the sample nearly to the top. With a stop watch in readiness, the finger is removed and when the meniscus passes the 100 mark, the watch is snapped. When it passes the 50 mark the watch is stopped. The time elapsed divided by the time for a standard solution, water, for example, is the measure of the viscosity of the sample.

STARCH.

88. Determination of starch in cattle feeds, roots and other starchy materials.

(a) **Preparation of malt extract, and correction for its use** in starch determinations. Digest 10 grams of fresh, finely ground malt 2 hours at room temperature with 200 cc. water and filter. In each of 2 flasks place 50 cc. water. To each add 20 cc. of the malt extract, heat 1 hour at 55° C. Heat to boiling and cool to 55° C. Add 20 cc. more of the malt extract and heat at this temperature for 1 hour. Bring to boiling, cool and make up to 500 cc. and filter. Place 200 cc. of the filtrate in a flask with 20 cc. of HCl of 1.125 sp. gr.; connect with an air condenser and heat in boiling water bath for 2-1/2 hours. Cool, neutralize with Na_2CO_3 and make up to 250 cc. Mix thoroughly, pour through a dry filter and determine dextrose in 50 cc. by the Munson and Walker method. The average of these 2 dextrose determinations is to be deducted from the total dextrose as found from the starch in the samples under examination. This treatment is to be carried on simultaneously with the determination on the samples themselves.

89. (b) **Determination.**—Extract from 1 to 6 grams of the very finely ground material on an asbestos felt with 5 successive portions of 10 cc. of ether. Wash with 150 cc. of 10% alcohol and then with a little strong alcohol. Place the residue in an 800 cc. flask with 50 cc. water. Immerse the flask in a boiling water bath and stir constantly for 15 minutes or until the starch is gelatinized. Cool to 55° C. and add 20 cc. of the malt extract and maintain at this temperature for 1 hour. Heat to boiling for 1 minute, cool to 55° C., add 20 cc. more of the malt extract and maintain at this temperature for 1 hour. Bring to a boil, cool and make up to 500 cc. and filter. Apply iodin test for starch to the residue and if starch is found reject the determination. Place 200 cc. of the filtrate in a flask with 20 cc. HCl sp. gr. 1.125. Connect with an air condenser and heat in a boiling water bath for 2-1/2 hours. Cool, neutralize with Na_2CO_3 and make up to 250 cc. Mix thoroughly and pour through a dry filter. Determine dextrose in 50 cc. by the Munson and Walker method. From the weight of dextrose from this quantity of solution subtract the correction found in (a). Calculate the difference as per cent. dextrose. This figure multiplied by 0.90 gives per cent. starch. The amount of copper sub-oxid obtained by the reduction should preferably be above 0.30 gram. Use such weights of sample as will give this quantity.

SUGARS IN GRAINS, CATTLE FEEDS AND LIKE MATERIAL.

90. On account of the action of enzymes in grains, cattle feeds, etc., the ordinary methods of water extraction of the sugars do not give correct results either in quantity or in composition. Extraction with boiling water can be used in some instances, but this sometimes removes reducing substances not sugars; and, if starch is present in any appreciable quantity, makes a gelatinous solution which cannot be filtered. The following method is the result of exhaustive work on this subject and has been found to give excellent results:—Weigh out 12 grams of the finely ground sample into a 300 cc. graduated flask, add 100 cc. 50% alcohol and boil on steam bath for 1 hour with frequent shaking. Use a small funnel in neck of flask to reflux vapor. Cool. (At this point it may safely stand over night.) Make to volume with 95% alcohol, mix thoroughly, let settle and draw off with a pipet 200 cc., which evaporate on steam in a beaker to 10 or 20 cc. (The presence of a trace of alcohol is not harmful. A jet of air playing on the surface of the liquid greatly hastens the evaporation.) The solution should *not* be evaporated to dryness. (If a short necked, balloon shaped distilling flask and small distilling apparatus is available the alcohol may be recovered for use at 75 to 80% strength by distilling until the residue foams badly. The short neck, about 1 inch, of the flask makes it possible to remove the residue easily. The 100 cc. containing the suspended solid matter may be strained through a cotton bag and the alcohol recovered from the liquid as above. It is very little trouble, and makes a considerable saving where large numbers of samples are run.) Transfer the contents of the beaker (or flask) to a 100 cc. graduated flask, removing all the residue carefully with a policeman. Add enough saturated solution of neutral lead acetate to produce a flocky precipitate and let stand 15 minutes. (May stand safely over night.) Make to mark with distilled water and filter through folded filter, carefully saving all the filtrate, except the first few drops. Add to the filtrate enough anhydrous Na_2CO_3 to precipitate all the lead. Let stand 15 minutes and filter through a 15 cm. ashless filter. Over 75 cc. filtrate should be obtained. Be sure to test filtrate for lead with a small quantity of Na_2CO_3 and if any is shown add more anhydrous Na_2CO_3 and filter again through the same filter. Use 25 cc. of the clear filtrate for determination of reducing sugars as invert by the method of Munson and Walker. Place 50 cc. of the filtrate in a 250 cc. beaker, add a small piece of litmus paper, make acid with acetic acid, add 5 cc. concentrated HCl and let stand over night. (Standing 48 hours apparently does not affect results.) Neutralize with Na_2CO_3, wash into a 100 cc. flask, make to mark with distilled water and mix thoroughly. Filter if necessary. Use 50 cc. for determination of total sugars as invert by method of Munson and Walker.

The amount of copper sub-oxid obtained in both reducing sugar and total sugar determinations represents the sugar contained in 2 grams of the material, so the weight of the sugar corresponding to the weights of the copper sub-oxid when divided by 2 and multiplied by 100 give the respective per cents. of sugar. The average of duplicates of reducing sugars calculated as invert, should be subtracted from the average of the total sugar determinations, calculated as invert, and the difference multiplied by 0.95, giving non-reducing sugars as sucrose. Since the insoluble material occupies space in the flask as originally made up, it is necessary to correct for this volume. It has been found as the result of a large number of determinations, that the average volume of the insoluble matter in 12 grams of feeds mentioned is 9 cc. making the correction factor 0.97 for 12 grams in 300 cc. Therefore, all results calculated as per cent. sugar should be multiplied by 0.97 to give true per cent. in material.

LACTOSE IN MILK.

91. Lactose in milk can be determined by the polariscope, but the method is complicated and unsatisfactory. The best method is the official A. O. A. C. method.*

(*a*) *Preparation of the milk solution.*

Dilute 25 cc. of milk with 400 cc. water in a 500 cc. graduated flask and add 10 cc. of a solution of $CuSO_4$ of the strength given for Soxhlet's modification of Fehling's solution; add 8.8 cc. n/2 NaOH. After the addition of the alkali solution the mixture must still be of acid reaction and contain copper in solution. Fill the flask to the mark, mix, and filter through a dry filter.

(*b*) *Determination.*

Determine the lactose in the solution as lactose + 1 molecule water by the Munson and Walker method and Straughn and Given table. Calculate the per cent. lactose from the sp. gr. of the milk as determined by a delicate spindle.

* Bul. 107, Bu. Chem., U. S. Dept. Agr., p. 119.

CONDENSED MILK.

92. **Lactose.**—Dilute 25 grams with 400 cc. water in a 500 cc. graduated flask, clarify as in (a) ¶ 91, and determine as under milk, using 1 lactose 4 sucrose table.

93. **Sucrose.**—Invert 50 cc. of the solution prepared for lactose determination with 5 cc. concentrated HCl in the cold; neutralize, make up to 100 cc. and determine reducing sugars as invert. From the result obtained subtract the reducing sugars as invert corresponding to the lactose previously found, and multiply the result by 0.95 for per cent. sucrose.

94. Sucrose in condensed milk is also determined optically by the method of Patein and Dufau.* To 200 grams yellow HgO, with 300 to 400 cc. water in an evaporating dish, add cautiously enough HNO_3 to just dissolve the HgO. Add enough NaOH to make a permanent precipitate, dilute to 1000 cc. and filter. As this solution tends to become more acid with age, by the deposition of basic mercuric salts, it should receive a little alkali from time to time.

To 50 cc. of a 20 gram to 100 cc. solution of condensed milk add 25 cc. water and 5 cc. of the Patein and Dufau reagent and shake well. Without delay run in, with constant shaking, sufficient NaOH to just bring the solution to neutrality but not to alkalinity, using litmus paper for indicator; between 12 and 13 cc. usually. Make up to 100 cc., shake well and polarize. Invert 50 cc. by HCl in the cold. Make up to 100 cc., polarize the invert solution, and calculate the sucrose by the Clerget formula, being careful to figure back to original weight of material. Correct for volume of precipitate by multiplying the grams protein present in the 50 cc. original solution used by 0.73; and the grams fat in the same solution by 1.075. Add these results and subtract from 100, the result being the true volume of the solution. The per cent. sucrose divided by 100 and multiplied by the above gives the true per cent. sucrose.

95. **Milk Chocolates.**—The determination of sugars is made on the residue from the fat determination, or upon another portion of about 10 grams carefully extracted with ether or petroleum ether. The extracted residue is macerated with a little distilled water in a mortar to a smooth cream and washed into a 200 cc. flask with about 150 cc. water. Clarify and make up the solution as in ¶ 91 (a), and make the determination as there described, using the 1 lactose 12 sucrose table for calculating the lactose. The sucrose is determined as in ¶ 93.

* Annales de Chim. **7**, 128, (1902); or Zts. Unters. Nahr. u. Genussm., **5**, 726, (1902).

REDUCING SUGARS AND SUCROSE IN MISCELLANEOUS PRODUCTS.

96. Where the nature of the material is such that there can be no enzymic action (jellies, jams, sirups, solid and liquid medicines, candies, mince meat, etc., etc.) weigh out 10 grams and wash into a 100 cc. flask. Dissolve as completely as possible, using heat if necessary, in which case cool to room temperature as soon as solution is complete; add a saturated solution of neutral lead acetate until no more precipitate forms, mix, make to mark, shake thoroughly and filter. Remove the excess of lead with anhydrous sodium carbonate or sodium oxalate, and determine reducing sugars before and after inversion by the method of Munson and Walker. The difference between the two results multiplied by 0.95 gives non-reducing sugars as sucrose.

Where enzymic action may take place or the solution prepared as above cannot be filtered or will not filter clear (food products containing malt preparations, infant foods, etc.) prepare the solution by alcoholic digestion as under sugars in grains, ¶ 90, and make the determination as there directed.

REAGENTS.

97. Acids.

Acetic, C. P. 99.5%.

10% solution.

Hydrochloric, C. P. concentrated, sp. gr. 1.20.

Dilute, sp. gr. 1.125.

n/10, carefully standardized.

n/2, carefully standardized.

Nitric, C. P. concentrated, sp. gr. 1.42.

Dilute, 1:1.

Dilute, HNO_3 500 cc., distilled water 1500 cc.

Sulfuric, C. P. concentrated, sp. gr. 1.84.

Alcohol, absolute.

Pure neutral spirits, 95%.

Dilute, 75%

Dilute, 50%.

Alumina cream.

Dilute a saturated solution of ammonia alum with 3 volumes distilled water and add strong ammonia till just alkaline. Let stand for 1 hour, decant supernatant liquid and wash by decantation for several days until nearly free from sulfates. Make to volume of original diluted solution. Shake thoroughly each time before using.

Ammonia, C. P., sp. gr. 0.90.

Aniline Acetate.

5 cc. c.p. aniline are shaken up with 5 cc. water and 2 cc. glacial acetic acid.

Asbestos.

Prepare asbestos by combing out with a spatula on a smooth piece of heavy wrapping paper. Cover with a saturated solution of NaOH and let stand for 24 hours. Wash free from alkali, cover with concentrated HCl and let stand for 46 hours. Wash free of acid and suspend in water, using about 100 grams of the moist asbestos in 1000 cc. water.

Bromin Water.

Saturated solution c.p. bromin in distilled water.

Calcium Chloride. C. P. granulated.

10% solution.

Ether. U. S. P.

Fiehe's Reagent.

1 gram resorcinol in 100 grams concentrated HCl.

Lead Acetate. C. P. neutral salt.

Saturated solution in distilled water.

Lead Sub-acetate. Horne's dry salt. Baker and Adamson's. Solution of 54.3° Brix, or prepare by boiling together 430 grams normal lead acetate, 130 grams litharge and 1000 cc. water for 1 hour. Allow to cool and settle, and dilute supernatant liquid to 1.25 sp. gr. with freshly boiled distilled water.

Winton's Lead Sub-acetate.—Dilute 1 volume of the 1.25 solution with 4 volumes freshly boiled distilled water. Winton lead number blank should be about 0.1700 gram.

Litmus Paper. Squibbs' neutral strips.

Malt. Fresh malt, to be ground just before using.

Methyl Orange. 0.1 gram in 100 cc. distilled water. Use 1–2 drops to 25 cc. solution to be titrated.

Patein and Dufau's Reagent.

To 200 grams yellow HgO, with 300 to 400 cc. water in an evaporating dish, add cautiously enough HNO_3 to just dissolve the HgO. Add enough NaOH to make a permanent precipitate and dilute to 1000 cc. and filter. As this solution tends to become more acid with age, by the deposition of basic mercuric salts, it should receive a little alkali from time to time.

Potassium Ferrocyanide. C. P.

20 grams in 1000 cc. distilled water.

Potassium Iodide. C. P. crystals.

Dissolve 300 grams and make up to 1000 cc. with distilled water.

Sodium Carbonate. C. P. anhydrous, powdered.

Sodium Carbonate. C. P. crystals, fine.

5% solution.

Sodium Hydrate. C. P. sticks by alcohol.

n/2 solution, carefully standardized.

n/10 solution, carefully standardized.

Sodium Oxalate. C. P. powdered.

Sodium Thiosulfate. C. P. crystals.

19 grams in 1000 cc. distilled water.

Soxhlet's Alkaline Solution. (*a*).

173 grams Rochelle salts and 50 grams NaOH dissolved and made to 500 cc. with distilled water. When preparing this solution in quantity, the Rochelle salts are dissolved to a nearly saturated solution, filtered, as the solution is almost always dirty, and diluted to 37.05° Brix (1.16435 sp. gr.). To each 4.5 liters of this solution 1 pound of NaOH is added and dissolved by stirring.

Soxhlet's Copper Solution. (*b*).

34.639 grams C. P. $CuSO_4 + 5H_2O$ are dissolved and made up to 500 cc. with distilled water. When preparing in quantity, $CuSO_4$ is dissolved to a strong solution and diluted to 11.3.° Brix (sp. gr. 1.04557).

Starch Paste.

Boil 2 grams starch with 200 cc. distilled water for 5 minutes.

Violette's Alkaline Solution.

187 grams Rochelle salts and 78 grams NaOH dissolved and made up to 1000 cc.

Violette's Copper Solution.

34.639 grams c.p., $CuSo_4$ dissolved and made up to 1000 cc. For use, 10 cc. of each of these reagents are placed in a 1.5″×9″ test tube with 10 cc. distilled water. The copper should be completely reduced by 20 cc. of invert sugar solution =0.05 gram invert sugar. This solution is prepared by dissolving 2.375 grams pure sucrose (pure white refined sugar will do) in water and diluting to 100 cc. Ten cc. concentrated HCl are added and the whole allowed to stand over night.

It is then exactly neutralized with NaOH and diluted to 1000° cc. The Violette's solution in the test tube is brought to a boil, 5 cc. of the sugar solution added and the whole boiled 2 minutes. Sugar solution is then added a little at a time, bringing to a boil after each addition, until the blue color just disappears. The solution is then tested by filtering a few drops on to a sugar test plate, adding a drop of acetic acid followed by a drop of potassium ferrocyanide. A brown coloration indicates the presence of copper; in which case the cautious addition of the sugar solution as above should be continued till no test for copper is obtained.

98. **Standardization of Brix Hydrometers.**—In as much as hydrometers as purchased are seldom correct, it is best to test each instrument and ascertain its error. This should be marked on the bulb with "diamond ink" or with ammonium fluoride made to a paste with starch and acetic acid. The true reading of the instrument is obtained by preparing a solution of pure sucrose (or pure refined sugar) of such a density that the instrument sinks in it till about one-half the stem is exposed. The reading and temperature correction are taken as usual. Twenty-six grams of the solution are carefully weighed out in the sugar dish, washed into a 100 cc. (true cc. as 20° C.) flask, 2 cc. alumina cream added; and after the solution is brought to 20° C. the flask is filled to the mark, the solution filtered, and polarized in a 200 mm. tube. The polariscope reading is the per cent. sucrose in the sugar solution, which is the true degree Brix. If the polariscope reading is the same as the corrected hydrometer reading, the instrument is correct. If, for example, the corrected hydrometer reading is 17.6° and the polariscope reading is 17.4°, the hydrometer reads 0.2° too high, and the bulb should be marked "Error+0.2." If the hydrometer reads 17.4° and the polariscope 17.6°, the hydrometer reads 0.2° too low, and the bulb should be marked "Error−0.2." When noting the correct Brix reading, the error of the spindle as well as the temperature correction should be taken into consideration.

99. **Polariscope.**—The polariscope referred to is in all cases the Schmidt and Haensch instrument, or the Fric or Peters having the same constants, adjusted for a normal weight of 26 grams in 100 true cc. at 20° C. or 26.048 grams in 100 Mohr's at 17.5° C. If it is desired to use the Laurent instrument, the normal weight is 16.29 grams in 100 true cc. The Mohr flasks are graduated to hold 100 grams of water at 17.5° C. The description, construction and the theory of the various kinds of polariscopes are very fully discussed in the works of Spencer,

Tucker, Rolfe, Wiechman and others in English; and in many standard German and French works on sugar.

99a. If it is at any time desired to test the purity of any other sugars than sucrose, the specific rotations of which are given in circular degrees, the angular reading corresponding to the reading of the sugar or Ventzke scale is found by multiplying the polariscope reading by 0.3468. From this reading the specific rotatory power of the sugar under examination is found by the formula* $[\alpha]_D = \frac{100a}{cl}$, in which

a = reading in angular degrees.
c = weight substance in 100 cc.
l = length of observation tube in decimeters.

A table giving the empirical formulæ and most important properties of the sugars most frequently encountered follows. For more detailed and extended information one should refer to the works of Tollens, von Lippmann and others.

100. A TABLE OF THE PROPERTIES OF THE MORE COMMON SUGARS.

D-glucose, $C_6H_{12}O_6$, aldo-hexose, $CHOH(CHOH)_4CHO$.
Dextrose, grape sugar, starch sugar.
Specific rotation 10 % solution at 20° C., 53°.
Reduces Fehling's solution, K = 100.
Fermentable with yeast.

D-mannose, $C_6H_{12}O_6$, aldo-hexose.
Specific rotation 13°.
Reduces Fehling's solution, K = 110.
Fermentable with yeast.

D-fructose, $C_6H_{12}O_6$, keto-aldose, $CH_2OH(CHOH)_3CO.CH_2OH$.
Fructose, levulose, fruit sugar, chylariose.
Specific rotation, 25 grams in 100 cc. at 20° C., −91.8°.
Rotation diminishes as temperature rises.
Reduces Fehling's solution, K = 90.
Fermentable with yeast.

Sucrose, $C_{12}H_{22}O_{11}$, disaccharide.
Saccharose, cane sugar.
Specific rotation, 17 grains in 100 cc., at 20° C., 66.5°.
Non-reducing.

* Wiley, Principles and Practice of Agricultural Analysis, iii, 116, (1897).

Fermentable with yeast.

Inverted in cold with 10% HCl, forming equal parts d-glucose and d-fructose.

Lactose, $C_{12}H_{22}O_{11}$, disaccharide.

Specific rotation at 20° C., 52.53° for $C_{12}H_{22}O_{11}+H_2O$.

Reduces Fehling's solution, K=70.

Not fermentable by yeast, but is fermented by special ferments.

Not inverted by 10 % HCl in cold; but on heating hydrolizes to d-glucose and d-galactose.

Maltose, $C_{12}H_{22}O_{11}$, disaccharide.

Specific rotation, 10% solution, at 20° C., 138.3°.

Reducing Fehling's solution, K=57.5.

Fermentable with yeast.

Not inverted by 10% HCl in cold; on heating hydrolizes to 2 molecules d-glucose.

Raffinose, $C_{18}H_{32}O_{16}$, trisaccharide.

Specific rotation 105°.

Non-reducing.

Fermentable with yeast.

Inverted by invertase and 10% HCl in cold, forming d-glucose and d-galactose.

Note.—K=ratio of reducing power to that of d-glucose, which is taken as 100.

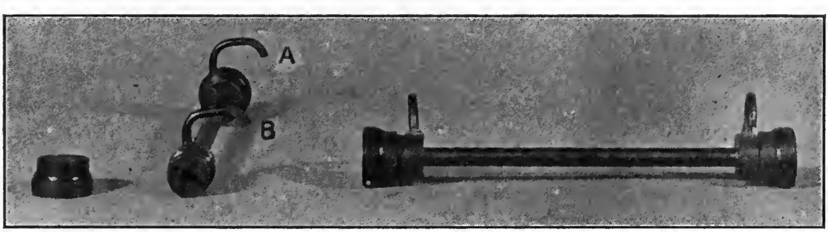


FIG. 8.—CONTINUOUS POLARISCOPE TUBE.

This tube for the rapid polarization of solutions of about the same density was devised by H. Pellet, but modified and made thoroughly satisfactory by Spencer and Ewell of the U. S. Dept. of Agriculture. A short rubber tube is attached to one of the curved tubes (A) and a long rubber tube with a pinch-cock to the other (B). After filling the tube with water by suction, to start it, the solutions are siphoned into the tube as required. The fresh solution entering through the bent tube issues from the four passages shown and sweeps the inner face of the cover-glass, flows the length of the tube, carrying the old solution before it, and escapes through the four passages and the bent tube at the other end. The striations where the old and new solutions meet make is impossible to see through the tube as long as any of the old solution remains in the tube, but as soon as that is gone, the tube is clear and the reading can be made.

101. Continuous Polariscope Tube.—If many samples are to be polarized, much time may be saved by using the continuous tube designed by Pellet, and modified by Spencer and Ewell, shown in Fig. 8. The tube is first filled with water by suction. The successive samples are drawn into the tube through tube *a* by the syphonic action of the rubber tube attached to *b*, which is provided with a pinch cock. The samples completely displace one another, entirely clearing the tube each time. Unless the difference in density is very great, not more than 50 cc. of solution should be required for complete displacement. As many as 500 polarizations per hour can be made with this tube, without sacrifice of accuracy.

102. The Estimation of Water in Raw Sugars by Means of the Immersion Refractometer.*—The necessary apparatus for this determination are an immersion refractometer; constant temperature tank; accurate thermometer, divided into tenths of degrees; and specially standardized 100 cc. flasks. The flasks are to be cleaned thoroughly and a mark placed on the neck where 100 grams of recently boiled distilled water at 17.5° C. would bring it. The tables are constructed for this volume, so this part of the work must be accurate. The operation consists in weighing out 20 grams of the sample and transferring it to one of the 100 cc. flasks with water. The flask is placed in the constant temperature bath and allowed to stand 20 to 30 minutes, shaking occasionally. After this time, the volume is completed with water, held in a flask also placed in this bath, shaken, and the reading of the solution taken. The temperature of the solution is taken by a thermometer divided into tenths of degrees, and should be the same at which the flask is filled. If the reading is made at any other temperature than 17.5°, a correction taken from Table 2 is added or subtracted from this reading, depending on whether the temperature of the test is above or below 17.5° C. Having made the correction, the per cent. of water in the sugar is found from Table 1. *For Example:* A sugar so treated read 90.15 in the immersion refractometer at 15.5° C. The correction for this temperature, Table 2, is 0.58. Then, 90.15—0.58 = 89.57. From Table 1, 89.5 = 3.025%, and 0.07 = 0.09%, so the moisture content is 2.935%.

Another case: A sugar read 88.40 at 21.3° C. The correction for this temperature is 1.15, so 88.40 + 1.15 = 89.55. From Table 1, 89.55 = 3.025 − 0.06 = 2.965%. The sugar has 2.96% moisture.

It is well to check the accuracy of the refractometer and of the flasks by dissolving 20.02 grams of pure dry sugar in a 100 cc. flask and making the reading at 17.5° C. The reading should be 92. If any other figure is obtained, the difference between this and 92 should be the correction for the instrument, to be applied before using the table.

* V. Stanek., Zts. für Zuckerind. in Böhmen., **35**, 57, (1910).

103. TABLE I.

Water Content of Raw Sugars.

Refractometer reading.	Per cent. water.	Refractometer reading.	Per cent. water.	Refractometer reading.	Per cent. water.	Refractometer reading.	Per cent. water.
88.0	4.900	89.0	3.650	90.0	2.400	91.0	1.150
88.1	4.775	89.1	3.525	90.1	2.275	91.1	1.025
88.2	4.650	89.2	3.400	90.2	2.150	91.2	0.900
88.3	4.525	89.3	3.275	90.3	2.025	91.3	0.775
88.4	4.400	89.4	3.150	90.4	1.900	91.4	0.650
88.5	4.275	89.5	3.025	90.5	1.775	91.5	0.525
88.6	4.150	89.6	2.900	90.6	1.650	91.6	0.400
88.7	4.025	89.7	2.775	90.7	1.525	91.7	0.275
88.8	3.900	89.8	2.650	90.8	1.400	91.8	0.150
88.9	3.775	89.9	2.525	90.9	1.275	91.9	0.025

Correction for Hundredths Estimated on Scale.

0.03° estimated on scale = −0.04% water.
0.05° estimated on scale = −0.06% water.
0.07° estimated on scale = −0.09% water.

TABLE II.

104. Table of Temperature Corrections for Determination of Water in Raw Sugars.

Temp. ° C.	Subtracted from refractometer reading.	Temp. ° C.	Added to refractometer reading.	Temp. ° C.	Added to refractometer reading.	Temp. ° C.	Added to refractometer reading.
15.0	0.72	17.6	0.03	20.2	0.82	22.8	1.62
15.1	0.70	17.7	0.06	20.3	0.85	22.9	1.65
15.2	0.67	17.8	0.09	20.4	0.88	23.0	1.69
15.3	0.64	17.9	0.12	20.5	0.91	23.1	1.72
15.4	0.61	18.0	0.15	20.6	0.94	23.2	1.75
15.5	0.58	18.1	0.18	20.7	0.97	23.3	1.78
15.6	0.55	18.2	0.21	20.8	1.00	23.4	1.81
15.7	0.52	18.3	0.24	20.9	1.03	23.5	1.85
15.8	0.49	18.4	0.27	21.0	1.06	23.6	1.88
15.9	0.46	18.5	0.30	21.1	1.09	23.7	1.91
16.0	0.44	18.6	0.33	21.2	1.12	23.8	1.96
16.1	0.41	18.7	0.36	21.3	1.15	23.9	1.99
16.2	0.38	18.8	0.39	21.4	1.18	24.0	2.03
16.3	0.35	18.9	0.42	21.5	1.22	24.1	2.06
16.4	0.32	19.0	0.45	21.6	1.25	24.2	2.09
16.5	0.29	19.1	0.48	21.7	1.28	24.3	2.12
16.6	0.26	19.2	0.51	21.8	1.31	24.4	2.15
16.7	0.23	19.3	0.54	21.9	1.34	24.5	2.19
16.8	0.20	19.4	0.57	22.0	1.37	24.6	2.22
16.9	0.17	19.5	0.61	22.1	1.41	24.7	2.25
17.0	0.15	19.6	0.64	22.2	1.44	24.8	2.29
17.1	0.12	19.7	0.67	22.3	1.47	24.9	2.32
17.2	0.09	19.8	0.70	22.4	1.50	25.0	2.35
17.3	0.06	19.9	0.73	22.5	1.53	25.1	2.38
17.4	0.03	20.0	0.76	22.6	1.56	25.2	2.42
17.5	0.00	20.1	0.79	22.7	1.59	25.3	2.45

105. Geerligs' Table for Dry Substance in Sugar-house Products by Abbe Refractometer, at 28° C. (*Intern. Sugar J.*, 10, 69.)

Index. Refraction.	Per cent dry. Substance.	Decimals.	
1.3335	1	0.0001=0.05	0.0010=0.75
1.3349	2	0.0002=0.1	0.0011=0.8
1.3364	3	0.0003=0.2	0.0012=0.8
1.3379	4	0.0004=0.25	0.0013=0.85
1.3394	5	0.0005=0.3	0.0014=0.9
1.3409	6	0.0006=0.4	0.0015=1.0
1.3424	7	0.0007=0.5	
1.3439	8	0.0008=0.6	
1.3454	9	0.0009=0.7	
1.3469	10		
1.3484	11	0.0001=0.05	
1.3500	12	0.0002=0.1	
1.3516	13	0.0003=0.2	
1.3530	14	0.0004=0.25	
1.3546	15	0.0005=0.3	
1.3562	16	0.0006=0.4	
1.3578	17	0.0007=0.45	
1.3594	18	0.0008=0.5	
1.3611	19	0.0009=0.6	
1.3627	20	0.0010=0.65	
1.3644	21	0.0011=0.7	
1.3661	22	0.0012=0.75	
1.3678	23	0.0013=0.8	
1.3695	24	0.0014=0.85	
1.3712	25	0.0015=0.9	
1.3729	26	0.0016=0.95.	
1.3746	27	0.0001=0.05	0.0012=0.6
1.3764	28	0.0002=0.1	0.0013=0.65
1.3782	29	0.0003=0.15	0.0014=0.7
1.3800	30	0.0004=0.2	0.0015=0.75
1.3818	31	0.0005=0.25	0.0016=0.8
1.3836	32	0.0006=0.3	0.0017=0.85
0.3854	33	0.0007=0.35	0.0018=0.9
1.3872	34	0.0008=0.4	0.0019=0.95
1.3890	35	0.0009=0.45	0.0020=1.0
1.3909	36	0.0010=0.5	0.0021=1.0
1.3928	37	0.0011=0.55	
1.3947	38		
1.3966	39		
1.3984	40		
1.4003	41		
1.4023	42	0.0001=0.05	0.0012=0.6
1.4043	43	0.0002=0.1	0.0013=0.65
1.4063	44	0.0003=0.15	0.0014=0.7
1.4083	45	0.0004=0.2	0.0015=0.75

Index. Refraction.	Per cent dry. Substance.	Decimals.	
1.4104	46	0.0005=0.25	0.0016=0.8
1.4124	47	0.0006=0.3	0.0017=0.85
1.4145	48	0.0007=0.35	0.0018=0.9
1.4166	49	0.0008=0.4	0.0019=0.95
1.4186	50	0.0009=0.45	0.0020=1.0
1.4207	51	0.0010=0.5	0.0021=1.0
1.4228	52	0.0011=0.55	
1.4249	53		
1.4270	54		
1.4292	55	0.0001=0.05	0.0013=0.55
1.4314	56	0.0002=0.1	0.0014=0.6
1.4337	57	0.0003=0.1	0.0015=0.65
1.4359	58	0.0004=0.15	0.0016=0.7
1.4382	59	0.0005=0.2	0.0017=0.75
1.4405	60	0.0006=0.25	0.0018=0.8
1.4428	61	0.0007=0.3	0.0019=0.85
1.4451	62	0.0008=0.35	0.0020=0.9
1.4474	63	0.0009=0.4	0.0021=0.9
1.4497	64	0.0010=0.45	0.0022=0.95
1.4520	65	0.0011=0.5	0.0023=1.0
1.4543	66	0.0012=0.5	0.0024=1.0
1.4567	67		
1.4591	68		
1.4615	69		
1.4639	70		
1.466	71		
1.4687	72		
1.4711	73	0.0001=0.0	0.0015=0.55
1.4736	74	0.0002=0.05	0.0016=0.6
1.4761	75	0.0003=0.1	0.0017=0.65
1.4786	76	0.0004=0.15	0.0018=0.65
1.4811	77	0.0005=0.2	0.0019=0.7
1.4836	78	0.0006=0.2	0.0020=0.75
1.4862	79	0.0007=0.25	0.0021=0.8
1.4888	80	0.0008=0.3	0.0022=0.8
1.4914	81	0.0009=0.35	0.0023=0.85
1.4940	82	0.0010=0.35	0.0024=0.9
1.4966	83	0.0011=0.4	0.0025=0.9
1.4992	84	0.0012=0.45	0.0026=0.95
1.5019	85	0.0013=0.5	0.0027=1.0
1.5046	86	0.0014=0.5	0.0028=1.0
1.5073	87		
1.5100	88		
1.5127	89		
1.5155	90		

106. **Table of Corrections for the Temperature.**

Temperature of the prisms in ° C.	Dry substance.												
	0	5	10	15	20	25	30	40	50	60	70	80	90
	Subtract.												
20	0.53	0.54	0.55	0.56	0.57	0.58	0.60	0.62	0.64	0.62	0.61	0.60	0.58
21	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.54	0.56	0.54	0.53	0.52	0.50
22	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.47	0.48	0.47	0.46	0.45	0.44
23	0.33	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.39	0.38	0.38	0.38
24	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.31	0.32	0.31	0.31	0.30	0.30
25	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.23	0.23	0.23	0.22
26	0.12	0.12	0.13	0.14	0.14	0.14	0.15	0.15	0. 6	0.16	0.16	0.15	0.14
27	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07
	Add.												
29	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07
30	0.12	0.12	.13	0.14	0.14	0.14	0.15	0.15	0.16	0.16	0.16	0.15	0.14
31	0 20	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.23	0.23	0.23	0.22
32	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.31	0.32	0.31	0.31	0.30	0.30
33	0.33	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.39	0.38	0.38	0.38
34	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.47	0.48	0.47	0.46	0.45	0.44
35	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.54	0.56	0.54	0.53	0.52	0.50

107. Schmitz' Table for the Calculation of Per Cents Sucrose; allowance being made for variations in the specific rotatory power of cane-sugar. Corrected for an increase in volume of 1/10.

Directions for using Schmitz' Table.—Note the degree Brix (not corrected for temperature) of the solution. Measure out 100 cc., add the lead, and dilute to 110 cc. Filter and polarize in 200 mm. tube. Take the number in the table opposite the integral part of the polariscopic reading and under the degree Brix nearest that observed, and add to it the number corresponding to the tenths as shown in the small table. The sum so obtained is the per cent sucrose in the solution.

Schmitz' Table for the Calculation of Per Cents Sucrose.

Polariscope reading.	Degree Brix.											
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
2		0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.56	0.56	0.56
3		0.85	0.85	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84	0.84
4			1.14	1.13	1.13	1.13	1.13	1.13	1.12	1.12	1.12	1.12
5			1.42	1.42	1.41	1.41	1.41	1.41	1.40	1.40	1.40	1.40
6				1.70	1.70	1.69	1.69	1.69	1.68	1.68	1.68	1.67
7				1.98	1.98	1.98	1.97	1.97	1.96	1.96	1.96	1.95
8					2.26	2.26	2.26	2.25	2.25	2.24	2.24	2.23
9						2.54	2.54	2.53	2.53	2.52	2.52	2.51
10						2.82	2.82	2.81	2.81	2.79	2.79	2.78
11							3.10	3.09	3.09	3.08	3.08	3.07
12							3.38	3.38	3.37	3.36	3.36	3.35
13								3.66	3.65	3.64	3.64	3.63
14								3.94	3.93	3.92	3.92	3.91
15									4.21	4.20	4.19	4.19
16									4.49	4.48	4.47	4.47
17										4.77	4.76	4.75
18											5.03	5.02
19											5.32	5.31
20												5.58
21												5.86

Degree Brix from 0.5 to 12.0.	
Tenths of the polariscope reading.	Per cent sucrose.
0.1	0.03
0.2	0.06
0.3	0.08
0.4	0.11
0.5	0.14
0.6	0.17
0.7	0.19
0.8	0.22
0.9	0.25

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree Brix.											
	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0
1	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27
2	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
3	0.84	0.83	0.83	0.83	0.83	0.83	0.83	0.82	0.82	0.82	0.82	0.82
4	1.11	1.11	1.11	1.11	1.11	1.10	1.10	1.10	1.10	1.10	1.09	1.09
5	1.39	1.39	1.39	1.38	1.38	1.38	1.38	1.37	1.37	1.37	1.36	1.36
6	1.67	1.67	1.66	1.66	1.66	1.66	1.65	1.65	1.64	1.64	1.64	1.64
7	1.95	1.95	1.94	1.94	1.93	1.93	1.93	1.92	1.92	1.91	1.91	1.91
8	2.23	2.22	2.22	2.22	2.21	2.21	2.20	2.20	2.19	2.19	2.18	2.18
9	2.51	2.50	2.50	2.49	2.49	2.48	2.48	2.47	2.47	2.46	2.46	2.45
10	2.79	2.78	2.78	2.77	2.76	2.76	2.75	2.75	2.74	2.74	2.73	2.73
11	3.06	3.06	3.05	3.05	3.04	3.03	3.03	3.02	3.02	3.01	3.00	3.00
12	3.34	3.34	3.33	3.32	3.32	3.31	3.30	3.30	3.29	3.28	3.28	3.27
13	3.62	3.61	3.61	3.60	3.59	3.59	3.58	3.57	3.56	3.56	3.55	3.54
14	3.90	3.89	3.88	3.88	3.87	3.86	3.85	3.85	3.84	3.83	3.82	3.82
15	4.18	4.17	4.16	4.15	4.15	4.14	4.13	4.12	4.11	4.11	4.10	4.09
16	4.46	4.45	4.44	4.43	4.42	4.41	4.40	4.40	4.39	4.38	4.37	4.36
17	4.74	4.73	4.72	4.71	4.70	4.69	4.68	4.67	4.66	4.65	4.64	4.63
18	5.01	5.00	4.99	4.99	4.97	4.97	4.96	4.95	4.93	4.93	4.91	4.91
19	5.29	5.28	5.27	5.26	5.25	5.24	5.23	5.22	5.21	5.20	5.19	5.18
20	5.57	5.56	5.55	5.54	5.53	5.52	5.51	5.50	5.49	5.47	5.46	5.45
21	5.85	5.84	5.83	5.82	5.81	5.79	5.78	5.77	5.76	5.75	5.74	5.73
22	6.13	6.12	6.11	6.09	6.08	6.07	6.06	6.05	6.03	6.02	6.01	6.00
23	6.41	6.40	6.38	6.37	6.36	6.35	6.33	6.32	6.31	6.30	6.28	6.27
24		6.67	6.66	6.65	6.64	6.62	6.61	6.60	6.58	6.57	6.56	6.54
25			6.94	6.93	6.91	6.90	6.89	6.87	6.86	6.84	6.83	6.82
26			7.22	7.20	7.19	7.17	7.16	7.15	7.13	6.12	7.10	7.09
27				7.48	7.46	7.45	7.44	7.42	7.41	7.39	7.38	7.36
28				7.76	7.74	7.73	7.71	7.70	7.68	7.65	7.65	7.63
29					8.02	8.00	7.99	7.97	7.96	7.94	7.92	7.91
30						8.28	8.26	8.25	8.23	8.21	8.20	8.18
31						8.55	8.54	8.52	8.50	8.49	8.47	8.45
32						8.83	8.81	8.80	8.78	8.76	8.74	8.73
33							9.09	9.07	9.05	9.03	9.02	9.00
34								9.35	9.33	9.31	9.28	9.27
35								9.62	9.60	9.58	9.56	9.54
36									9.88	9.86	9.84	9.82
37									10.15	10.13	10.11	10.09
38										10.40	10.38	10.36
39										10.68	10.66	10.64

*For addition for tenths of polariscopic reading, see p. 43

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree Brix.											
	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0
1	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
2	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.53	0.53	0.53
3	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80
4	1.09	1.09	1.08	1.08	1.08	1.08	1.08	1.07	1.07	1.07	1.07	1.06
5	1.36	1.36	1.35	1.35	1.35	1.35	1.34	1.34	1.34	1.34	1.33	1.33
6	1.63	1.63	1.62	1.62	1.62	1.62	1.61	1.61	1.61	1.60	1.60	1.60
7	1.90	1.90	1.89	1.89	1.89	1.88	1.88	1.88	1.87	1.87	1.86	1.86
8	2.18	2.17	2.17	2.16	2.16	2.15	2.15	2.15	2.14	2.14	2.13	2.13
9	2.45	2.44	2.44	2.43	2.43	2.42	2.42	2.41	2.41	2.40	2.40	2.39
10	2.72	2.71	2.71	2.70	2.70	2.69	2.69	2.68	2.68	2.67	2.67	2.66
11	2.99	2.99	2.98	2.97	2.97	2.96	2.95	2.95	2.94	2.94	2.93	2.92
12	3.26	3.26	3.25	3.24	3.24	3.23	3.22	3.22	3.21	3.20	3.20	3.19
13	3.54	3.53	3.52	3.51	3.51	3.50	3.49	3.49	3.48	3.47	3.46	3.46
14	3.81	3.80	3.79	3.78	3.78	3.77	3.77	3.77	3.75	3.74	3.73	3.72
15	4.08	4.07	4.06	4.06	4.05	4.04	4.03	4.02	4.02	4.01	4.00	3.99
16	4.35	4.34	4.33	4.33	4.32	4.31	4.30	4.29	4.28	4.27	4.26	4.26
17	4.62	4.62	4.61	4.60	4.59	4.58	4.57	4.56	4.55	4.54	4.53	4.52
18	4.90	4.89	4.88	4.87	4.86	4.85	4.84	4.83	4.82	4.81	4.80	4.79
19	5.17	5.16	5.15	5.14	5.13	5.12	5.11	5.10	5.09	5.08	5.06	5.05
20	5.44	5.43	5.42	5.41	5.40	5.39	5.38	5.36	5.35	5.34	5.33	5.32
21	5.71	5.70	5.69	5.68	5.67	5.66	5.65	5.63	5.62	5.61	5.60	5.59
22	5.99	5.97	5.96	5.95	5.94	5.93	5.91	5.90	5.89	5.88	5.87	5.85
23	6.26	6.24	6.23	6.22	6.21	6.20	6.18	6.17	6.16	6.14	6.13	6.12
24	6.53	6.52	6.50	6.49	6.48	6.46	6.45	6.44	6.43	6.41	6.40	6.39
25	6.80	6.79	6.78	6.76	6.75	6.73	6.72	6.71	6.69	6.68	6.67	6.65
26	7.07	7.06	7.05	7.03	7.02	7.00	6.99	6.97	6.96	6.95	6.93	6.92
27	7.35	7.33	7.32	7.30	7.29	7.27	7.26	7.24	7.23	7.21	7.20	7.18
28	7.62	7.60	7.59	7.57	7.56	7.54	7.53	7.51	7.50	7.48	7.47	7.45
29	7.89	7.87	7.86	7.84	7.83	7.81	7.80	7.78	7.77	7.75	7.73	7.72
30	8.16	8.15	8.13	8.11	8.10	8.08	8.06	8.05	8.03	8.02	8.00	7.98
31	8.44	8.42	8.40	8.39	8.37	8.35	8.33	8.32	8.30	8.28	8.27	8.25
32	8.71	8.69	8.67	8.66	8.64	8.62	8.60	8.58	8.57	8.55	8.53	8.51
33	8.98	8.96	8.94	8.93	8.91	8.89	8.87	8.85	8.84	8.82	8.80	8.78
34	9.25	9.23	9.22	9.20	9.18	9.16	9.14	9.12	9.10	9.09	9.07	9.05
35	9.53	9.51	9.49	9.47	9.45	9.43	9.41	9.39	9.37	9.35	9.34	9.31
36	9.80	9.78	9.76	9.74	9.72	9.70	9.68	9.66	9.64	9.62	9.60	9.58
37	10.07	10.05	10.03	10.01	9.99	9.97	9.95	9.93	9.91	9.89	9.87	9.85
38	10.34	10.32	10.30	10.28	10.26	10.24	10.22	10.20	10.18	10.15	10.13	10.11
39	10.61	10.59	10.57	10.55	10.53	10.51	10.49	10.46	10.44	10.42	10.40	10.38

*For addition for tenths of polariscopic reading, see p. 46.

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree Brix.			
	18.5	19.0	19.5	20.0
1	0.27	0.27	0.27	0.26
2	0.53	0.53	0.53	0.53
3	0.80	0.79	0.79	0.79
4	1.06	1.06	1.06	1.06
5	1.33	1.32	1.32	1.32
6	1.59	1.59	1.59	1.58
7	1.86	1.85	1.85	1.85
8	2.12	2.12	2.12	2.11
9	2.39	2.38	2.38	2.37
10	2.65	2.65	2.64	2.64
11	2.92	2.91	2.91	2.90
12	3.18	3.18	3.17	3.17
13	3.45	3.44	3.44	3.43
14	3.72	3.71	3.70	3.69
15	3.98	3.97	3.97	3.96
16	4.25	4.24	4.23	4.22
17	4.51	4.50	4.49	4.48
18	4.78	4.77	4.76	4.75
19	5.04	5.03	5.02	5.01
20	5.31	5.30	5.29	5.28
21	5.58	5.56	5.55	5.54
22	5.84	5.83	5.82	5.80
23	6.11	6.09	6.08	6.07
24	6.37	6.36	6.35	6.33
25	6.64	6.63	6.61	6.60
26	6.90	6.89	6.88	6.86
27	7.17	7.15	7.14	7.13
28	7.44	7.42	7.40	7.39
29	7.70	7.68	7.67	7.65
30	7.97	7.95	7.93	7.92
31	8.23	8.21	8.20	8.18
32	8.50	8.48	8.46	8.45
33	8.76	8.75	8.73	8.71
34	9.03	9.01	8.99	8.97
35	9.30	9.28	9.26	9.24
36	9.56	9.54	9.52	9.50
37	9.83	9.81	9.79	9.77
38	10.09	10.07	10.05	10.03
39	10.36	10.34	10.32	10.29

Degree Brix from 12.5 to 22.5.	
Tenths of the polariscope reading.	Per cent sucrose
0.1	0.03
0.2	0.05
0.3	0.08
0.4	0.11
0.5	0.13
0.6	0.16
0.7	0.19
0.8	0.21
0.9	0.24

Degree Brix from 23 to 24.	
Tenths of the polariscope reading.	Per cent sucrose.
0.1	0.03
0.2	0.05
0.3	0.08
0.4	0.10
0.5	0.13
0.6	0.16
0.7	0.18
0.8	0.21
0.9	0.23

*For addition for tenths of polariscopic reading, see p. 46.

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree Brix.									
	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0
40	10.93	10.91	10.89	10.84	10.82	10.80	10.78	10.76	10.73	10.71
41		11.18	11.16	11.14	11.12	11.09	11.07	11.05	11.03	11.00
42		11.46	11.43	11.41	11.39	11.36	11.34	11.32	11.29	11.27
43			11.71	11.68	11.66	11.64	11.61	11.59	11.56	11.54
44			11.98	11.95	11.93	11.91	11.88	11.86	11.83	11.81
45			12.25	12.23	12.20	12.18	12.15	12.13	12.10	12.08
46				12.50	12.47	12.45	12.42	12.40	12.37	12.35
47					12.74	12.72	12.69	12.67	12.64	12.61
48					13.02	12.99	12.97	12.94	12.91	12.88
49						13.26	13.23	13.21	13.18	13.15
50							13.50	13.48	13.45	13.42
51							13.78	13.75	13.72	13.69
52								14.02	13.99	13.96
53								14.29	14.26	14.23
54									14.53	14.50
55									14.80	14.77
56										15.03
57										15.30
58										15.57

*For addition for tenths of polariscopic reading, see p. 46.

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree brix.						
	16.5	17.0	17.5	18.0	18.5	19.0	19.5
40	10.71	10.69	10.67	10.64	10.62	10.60	10.58
41	10.98	10.96	10.94	10.91	10.89	10.87	10.85
42	11.25	11.23	11.20	11.18	11.16	11.13	11.11
43	11.52	11.49	11.47	11.45	11.42	11.40	11.38
44	11.79	11.76	11.74	11.71	11.69	11.66	11.64
45	12.05	12.03	12.01	11.98	11.96	11.93	11.91
46	12.32	12.30	12.27	12.25	12.22	12.20	12.17
47	12.59	12.56	12.54	12.51	12.49	12.46	12.44
48	12.86	12.83	12.81	12.78	12.75	12.73	12.70
49	13.13	13.10	13.07	13.05	13.02	12.99	12.97
50	13.40	13.37	13.34	13.31	13.29	13.26	13.23
51	13.66	13.64	13.61	13.58	13.55	13.52	13.50
52	13.93	13.90	13.88	13.85	13.82	13.79	13.76
53	14.20	14.17	14.14	14.11	14.08	14.05	14.03
54	14.47	14.44	14.41	14.38	14.35	14.32	14.29
55	14.74	14.71	14.68	14.65	14.62	14.59	14.56
56	15.00	14.97	14.94	14.91	14.88	14.85	14.82
57	15.27	15.24	15.21	15.18	15.15	15.12	15.09
58	15.54	15.51	15.48	15.45	15.42	15.38	15.35
59	15.81	15.78	15.75	15.71	15.68	15.65	15.62
60		16.05	16.01	15.98	15.95	15.92	15.88
61		16.31	16.28	16.25	16.21	16.18	16.15
62			16.55	16.52	16.48	16.45	16.41
63			16.82	16.78	16.75	16.71	16.68
64				17.03	17.01	16.98	16.94
65				17.32	17.28	17.24	17.21
66					17.55	17.51	17.47
67					17.81	17.78	17.74
68						18.04	18.00
69						18.31	18.27
70							18.63

*For addition for tenths of polariscopic reading, see p. 46.

Schmitz' Table for the Calculation of Per Cents Sucrose.* (Continued.)

Polariscope reading.	Degree brix.								
	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0
40	10.56	10.54	10.52	10.49	10.47	10.45	10.43	10.41	10.38
41	10.82	10.80	10.78	10.76	10.74	10.71	10.69	10.67	10.65
42	11.09	11.07	11.04	11.02	11.00	10.97	10.95	10.93	10.90
43	11.35	11.33	11.31	11.28	11.26	11.24	11.21	11.19	11.17
44	11.62	11.59	11.57	11.55	11.52	11.50	11.47	11.45	11.42
45	11.88	11.86	11.83	11.81	11.78	11.76	11.73	11.71	11.69
46	12.15	12.12	12.09	12.07	12.05	12.02	12.00	11.97	11.94
47	12.41	12.39	12.36	12.33	12.31	12.28	12.26	12.23	12.21
48	12.67	12.65	12.62	12.60	12.57	12.54	12.52	12.49	12.47
49	12.94	12.91	12.88	12.86	12.83	12.81	12.77	12.75	12.73
50	13.20	13.18	13.15	13.12	13.09	13.07	13.04	13.01	12.99
51	13.47	13.44	13.41	13.39	13.36	13.33	13.30	13.27	13.25
52	13.73	13.70	13.68	13.65	13.62	13.59	13.56	13.53	13.51
53	14.00	13.97	13.94	13.91	13.88	13.85	13.82	13.79	13.77
54	14.26	14.23	14.20	14.17	14.14	14.11	14.08	14.06	14.02
55	14.53	14.50	14.47	14.44	14.41	14.38	14.35	14.32	14.29
56	14.79	14.76	14.73	14.70	14.67	14.64	14.61	14.58	14.55
57	15.06	15.02	14.99	14.96	14.93	14.90	14.87	14.84	14.81
58	15.32	15.29	15.26	15.23	15.19	15.16	15.13	15.10	15.07
59	15.58	15.55	15.52	15.49	15.46	15.42	15.39	15.36	15.33
60	15.85	15.82	15.78	15.75	15.72	15.69	15.65	15.62	15.59
61	16.11	16.08	16.05	16.01	15.98	15.95	15.91	15.88	15.85
62	16.38	16.35	16.31	16.28	16.24	16.21	16.18	16.14	16.11
63	16.64	16.61	16.57	16.54	16.51	16.47	16.44	16.40	16.37
64	16.91	16.87	16.84	16.80	16.77	16.73	16.70	16.66	16.63
65	17.17	17.14	17.10	17.07	17.03	17.00	16.96	16.92	16.89
66	17.44	17.40	17.37	17.33	17.29	17.26	17.22	17.19	17.15
67	17.70	17.67	17.63	17.59	17.56	17.52	17.48	17.45	17.41
68	17.97	17.93	17.89	17.86	17.83	17.78	17.74	17.71	17.67
69	18.23	18.19	18.16	18.12	18.08	18.04	18.00	17.97	17.93
70	18.50	18.46	18.42	18.38	18.35	18.31	18.27	18.23	18.19
71	18.76	18.72	18.68	18.65	18.61	18.57	18.53	18.49	18.45
72	19.03	18.99	18.95	18.91	18.87	18.83	18.79	18.75	18.71
73		19.25	19.21	19.17	19.13	19.09	19.05	19.01	18.97
74		19.52	19.48	19.44	19.40	19.35	19.31	19.27	19.23
75		19.78	19.74	19.70	19.66	19.62	19.57	19.53	19.49
76			20.00	19.96	19.92	19.88	19.84	19.80	19.75
77			20.27	20.22	20.18	20.14	20.10	20.06	20.01
78				20.49	20.45	20.40	20.36	20.32	20.27
79				20.75	20.71	20.66	20.62	20.58	20.54
80					20.97	20.93	20.88	20.84	20.80

*For addition for tenths of polariscopic reading, see p. 46.

108. Low's Volumetric Method for Estimation of Reduced Copper, Modified.*

(a) Standardization of the Thiosulphate Solution.

Prepare a solution of sodium thiosulphate containing 19 grams of pure crystals to 1,000 cc. Weigh accurately about 0.2 gram of pure copper foil and place in a flask of 250 cc. capacity. Dissolve by warming with 5 cc. of a mixture of equal volumes of strong nitric acid and water. Dilute to 50 cc. boil to expel the red fumes, add 5 cc. strong bromin water, and boil until the bromin is thoroughly expelled. Remove from the heat and add a slight excess of strong ammonium hydroxid—7 cc. is about the right amount. Again boil until the excess of ammonia is expelled, as shown by a change of color of the liquid, and a partial precipitation. Now add a slight excess of strong acetic acid (3 or 4 cc. of 80 per cent. acid) and boil for a minute. Cool to room temperature and add 10 cc. of a solution of pure potassium iodid containing 300 grams of potassium iodid to 1000 cc. Titrate at once with the thiosulphate solution until the brown tinge has become weak, then add sufficient starch liquor to produce a marked blue coloration. Continue the titration cautiously until the color due to free iodin has entirely vanished. The blue color changes toward the end to a faint lilac. If at this point the thiosulphate be added drop by drop and a little time be allowed for complete reaction after each addition there is no difficulty in determining the end point within a single drop. One cubic centimeter of the thiosulphate solution will be found to correspond to about 0.005 gram of copper.

(b) Determination of Copper.

After washing the precipitated cuprous oxid, cover the Gooch with a watch-glass and dissolve the oxid by means of 5 cc. of warm nitric acid (1:1) poured under the watch-glass with a pipette. Catch the filtrate in a flask of 250 cc. capacity and wash watch-glass and Gooch free of copper; 50 cc. of water will be sufficient. Boil to expel red fumes, add 5 cc. of bromin water, boil off the bromin, and proceed exactly as in standardizing the thiosulphate.

109. Uniform Method for Determining Reducing Sugars in General (Munson and Walker).†

(1) *Preparation of Solutions and Asbestos.*

(*a*) *Solutions.*—Use solutions (*a*), and (*b*), as given on page 34, under Soxhlet's modification of Fehling's solution.

* J. Amer. Chem. Soc., **24,** 1082, (1902).
† J. Amer. Chem. Soc., **28,** 663 (1906); **29,** 541, (1907).

(*b*) *Asbestos.*—Prepare the asbestos, which should be the amphibole variety, by first digesting with 1:3 hydrochloric acid for two or three days. Wash free from acid and digest for a similar period with soda solution, after which treat for a few hours with hot alkaline copper tartrate solution of the strength employed in sugar determinations. Then wash the asbestos free from alkali, finally digest with nitric acid for several hours, and after washing free from acid shake with water for use. In preparing the Gooch crucible load it with a film of asbestos one-fourth inch thick, wash this thoroughly with water to remove fine particles of asbestos; finally wash with alcohol and ether, dry for thirty minutes at 100° C., cool in a desiccator and weigh. It is best to dissolve the cuprous oxid with nitric acid each time after weighing and use the same felts over and over again, as they improve with use.

(2) *Determination.*

Transfer 25 cc. each of the copper and alkaline tartrate solutions to a 400 cc. Jena or Non-sol beaker and add 50 cc. of reducing sugar solution, or, if a smaller volume of sugar solution be used, add water to make the final volume 100 cc. Heat the beaker upon an asbestos gauze over a Bunsen burner, so regulate the flame that boiling begins in four minutes, and continue the boiling for exactly two minutes. Keep the beaker covered with a watch-glass throughout the entire time of heating. Without diluting, filter the cuprous oxid at once on an asbestos felt in a porcelain Gooch crucible, using suction. Wash the cuprous oxid thoroughly with water at a temperature of about 60°C., then with 10 cc. of alcohol and finally with 10 cc. of ether. Dry for thirty minutes in a water oven at 100° C., cool in a desiccator and weigh as cuprous oxid.

N. B. The number of milligrams of copper reduced by a given amount of reducing sugar differs when sucrose is present and when it is absent. In the tables following the absence of sucrose is assumed except in the two columns under invert sugar, where one for mixtures of invert sugar and sucrose (0.4 gram of total sugar in 50 cc. of solution) and one for invert sugar and sucrose when the 50 cc. of solution contains 2 grams of total sugar are given and in the two columns under lactose for the mixtures of 1 part lactose with 4 parts sucrose and 1 part lactose with 12 parts sucrose.

Explanatory Note:

Since this manuscript was first prepared, the lactose table included in the Munson and Walker tables has been found to be incorrect. Mr. P. H. Walker has published this fact* and his corrected table; but as some

* Circular 82, Bureau of Chem., U. S. Dept. Agr.

question has arisen as to the composition of the lactose used by him, Mr. M. N. Straughn of the Sugar Laboratory, Bureau of Chemistry, U. S. Dept. of Agr., has prepared a pure sugar and made the determinations for a new table for lactose, and with the assistance of the author has made the calculations for that table, and in addition the determinations and calculations for a table for a mixture of 1 part lactose and 4 parts sucrose for use on condensed milks, and for 1 part lactose and 12 parts sucrose for use on milk chocolates. In all cases the work was done on lactose of the formula $5(C_{12}H_{22}O_{11})+2(H_2O)$, and calculated to the hydrated form, $C_{12}H_{22}O_{11}+H_2O$, as the only one occurring in nature. These have been substituted for the original Walker tables.

Only one maltose column is left, since the sugar as found commercially is only in the hydrated form.

110.—Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose. (Crystallized.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
10	8.9	4.0	4.5	1.6	....	6.3	6.1	....	6.2	10
11	9.8	4.5	5.0	2.1	....	6.9	6.7	....	7.0	11
12	10.7	4.9	5.4	2.5	....	7.5	7.3	....	7.9	12
13	11.5	5.3	5.8	3.0	....	8.2	7.9	....	8.7	13
14	12.4	5.7	6.3	3.4	....	8.8	8.5	....	9.5	14
15	13.3	6.2	6.7	3.9	....	9.4	9.1	....	10.4	15
16	14.2	6.6	7.2	4.3	....	10.0	9.7	....	11.2	16
17	15.1	7.0	7.6	4.8	....	10.7	10.3	....	12.0	17
18	16.0	7.5	8.1	5.2	....	11.3	10.9	....	12.9	18
19	16.9	7.9	8.5	5.7	....	11.9	11.5	....	13.7	19
20	17.8	8.3	8.9	6.1	....	12.5	12.1	....	14.6	20
21	18.7	8.7	9.4	6.6	....	13.2	12.7	....	15.4	21
22	19.5	9.2	9.8	7.0	....	13.8	13.3	....	16.2	22
23	20.4	9.6	10.3	7.5	....	14.4	13.9	....	17.1	23
24	21.3	10.0	10.7	7.9	....	15.0	14.5	....	17.9	24
25	22.2	10.5	11.2	8.4	....	15.7	15.2	....	18.7	25
26	23.1	10.9	11.6	8.8	....	16.3	15.8	....	19.6	26
27	24.0	11.3	12.0	9.3	....	16.9	16.4	....	20.4	27
28	24.9	11.8	12.5	9.7	....	17.6	17.0	....	21.2	28
29	25.8	12.2	12.9	10.2	....	18.2	17.6	....	22.1	29
30	26.6	12.6	13.4	10.7	4.3	18.8	18.2	....	22.9	30
31	27.5	13.1	13.8	11.1	4.7	19.4	18.8	....	23.7	31
32	28.4	13.5	14.3	11.6	5.2	20.1	19.4	....	24.6	32
33	29.3	13.9	14.7	12.0	5.6	20.7	20.0	....	25.4	33
34	30.2	14.3	15.2	12.5	6.1	21.4	20.7	....	26.2	34
35	31.1	14.8	15.6	12.9	6.5	22.1	21.3	....	27.1	35
36	32.0	15.2	16.1	13.4	7.0	22.8	22.0	....	27.9	36
37	32.9	15.6	16.5	13.8	7.4	23.5	22.7	....	28.7	37
38	33.8	16.1	16.9	14.3	7.9	24.2	23.3	....	29.6	38
39	34.6	16.5	17.4	14.7	8.4	24.8	24.0	....	30.4	39
40	35.5	16.9	17.8	15.2	8.8	25.5	24.7	....	31.3	40
41	36.4	17.4	18.3	15.6	9.3	26.2	25.3	....	32.1	41
42	37.3	17.8	18.7	16.1	9.7	26.9	26.0	....	32.9	42
43	38.2	18.2	19.2	16.6	10.2	27.6	26.6	....	33.8	43
44	39.1	18.7	19.6	17.0	10.7	28.3	27.3	....	34.6	44
45	40.0	19.1	20.1	17.5	11.1	28.9	28.0	....	35.4	45
46	40.9	19.6	20.5	17.9	11.6	29.6	28.6	....	36.3	46
47	41.7	20.0	21.0	18.4	12.0	30.3	29.3	....	37.1	47
48	42.6	20.4	21.4	18.8	12.5	31.0	30.0	....	37.9	48
49	43.5	20.9	21.9	19.3	12.9	31.7	30.6	....	38.8	49
50	44.4	21.3	22.3	19.7	13.4	32.3	31.3	....	39.6	50
51	45.3	21.7	22.8	20.2	13.9	33.0	32.0	....	40.4	51
52	46.2	22.2	23.2	20.7	14.3	33.7	32.6	....	41.3	52
53	47.1	22.6	23.7	21.1	14.8	34.4	33.3	....	42.1	53
54	48.0	23.0	24.1	21.6	15.2	35.1	34.0	....	42.9	54
55	48.9	23.5	24.6	22.0	15.7	35.8	34.6	....	43.8	55
56	49.7	23.9	25.0	22.5	16.2	36.4	35.3	....	44.6	56
57	50.6	24.3	25.5	22.9	16.6	37.1	35.9	....	45.4	57
58	51.5	24.8	25.9	23.4	17.1	37.8	36.6	....	46.3	58
59	52.4	25.2	26.4	23.9	17.5	38.5	37.3	....	47.1	59
60	53.3	25.6	26.8	24.3	18.0	39.2	37.9	....	48.0	60
61	54.2	26.1	27.3	24.8	18.5	39.9	38.6	....	48.8	61
62	55.1	26.5	27.7	25.2	18.9	40.5	39.3	....	49.6	62
63	56.0	27.0	28.2	25.7	19.4	41.2	39.9	....	50.5	63
64	56.8	27.4	28.6	26.2	19.8	41.9	40.6	....	51.3	64

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
65	57.7	27.8	29.1	26.6	20.3	42.6	41.3	......	52.1	65
66	58.6	28.3	29.5	27.1	20.8	43.3	41.9	......	53.0	66
67	59.5	28.7	30.0	27.5	21.2	44.0	42.6	40.1	53.8	67
68	60.4	29.2	30.4	28.0	21.7	44.7	43.3	40.7	54.6	68
69	61.3	29.6	30.9	28.5	22.2	45.3	43.9	41.3	55.5	69
70	62.2	30.0	31.3	28.9	22.6	46.0	44.6	41.9	56.3	70
71	63.1	30.5	31.8	29.4	23.1	46.7	45.3	42.5	57.1	71
72	64.0	30.9	32.3	29.8	23.5	47.4	45.9	43.1	58.0	72
73	64.8	31.4	32.7	30.3	24.0	48.1	46.6	43.7	58.8	73
74	65.7	31.8	33.2	30.8	24.5	48.8	47.3	44.2	59.6	74
75	66.6	32.2	33.6	31.2	24.9	49.4	47.9	44.8	60.5	75
76	67.5	32.7	34.1	31.7	25.4	50.1	48.6	45.4	61.3	76
77	68.4	33.1	34.5	32.1	25.9	50.8	49.3	46.0	62.1	77
78	69.3	33.6	35.0	32.6	26.3	51.5	49.9	46.6	63.0	78
79	70.2	34.0	35.4	33.1	26.8	52.2	50.6	47.2	63.8	79
80	71.1	34.4	35.9	33.5	27.3	52.9	51.3	47.8	64.6	80
81	71.9	34.9	36.3	34.0	27.7	53.6	51.9	48.4	65.5	81
82	72.8	35.3	36.8	34.5	28.2	54.2	52.6	49.0	66.3	82
83	73.7	35.8	37.3	34.9	28.6	54.9	53.3	49.6	67.1	83
84	74.6	36.2	37.7	35.4	29.1	55.6	53.9	50.1	68.0	84
85	75.5	36.7	38.2	35.8	29.6	56.3	54.6	50.7	68.8	85
86	76.4	37.1	38.6	36.3	30.0	57.0	55.3	51.3	69.7	86
87	77.3	37.5	39.1	36.8	30.5	57.7	55.9	51.9	70.5	87
88	78.2	38.0	39.5	37.2	31.0	58.4	56.6	52.5	71.3	88
89	79.1	38.4	40.0	37.7	31.4	59.0	57.3	53.1	72.2	89
90	79.9	38.9	40.4	38.2	31.9	59.7	57.9	53.7	73.0	90
91	80.8	39.3	40.9	38.6	32.4	60.4	58.6	54.3	73.8	91
92	81.7	39.8	41.4	39.1	32.8	61.1	59.3	54.9	74.7	92
93	82.6	40.2	41.8	39.6	33.3	61.8	59.9	55.5	75.5	93
94	83.5	40.6	42.3	40.0	33.8	62.5	60.6	56.0	76.3	94
95	84.4	41.1	42.7	40.5	34.2	63.2	61.3	56.6	77.2	95
96	85.3	41.5	43.2	41.0	34.7	63.8	61.9	57.2	78.0	96
97	86.2	42.0	43.7	41.4	35.2	64.5	62.6	57.8	78.8	97
98	87.1	42.4	44.1	41.9	35.6	65.2	63.3	58.4	79.7	98
99	87.9	42.9	44.6	42.4	36.1	65.9	63.9	59.0	80.5	99
100	88.8	43.3	45.0	42.8	36.6	66.6	64.6	59.6	81.3	100
101	89.7	43.8	45.5	43.3	37.0	67.3	65.3	60.2	82.2	101
102	90.6	44.2	46.0	43.8	37.5	68.0	66.0	60.8	83.0	102
103	91.5	44.7	46.4	44.2	38.0	68.7	66.6	61.4	83.8	103
104	92.4	45.1	46.9	44.7	38.5	69.3	67.3	62.0	84.7	104
105	93.3	45.5	47.3	45.2	38.9	70.0	68.0	62.6	85.5	105
106	94.2	46.0	47.8	45.6	39.4	70.7	68.6	63.2	86.3	106
107	95.0	46.4	48.3	46.1	39.9	71.4	69.3	63.8	87.2	107
108	95.9	46.9	48.7	46.6	40.3	72.1	70.0	64.4	88.0	108
109	96.8	47.3	49.2	47.0	40.8	72.8	70.6	65.0	88.8	109
110	97.7	47.8	49.6	47.5	41.3	73.5	71.3	65.6	89.7	110
111	98.6	48.2	50.1	48.0	41.7	74.2	72.0	66.1	90.5	111
112	99.5	48.7	50.6	48.4	42.2	74.8	72.6	66.7	91.3	112
113	100.4	49.1	51.0	48.9	42.7	75.5	73.3	67.3	92.2	113
114	101.3	49.6	51.5	49.4	43.2	76.2	74.0	67.9	93.0	114
115	102.2	50.0	51.9	49.8	43.6	76.9	74.6	68.5	93.9	115
116	103.0	50.5	52.4	50.3	44.1	77.6	75.3	69.1	94.7	116
117	103.9	50.9	52.9	50.8	44.6	78.3	76.0	69.7	95.5	117
118	104.8	51.4	53.3	51.2	45.0	79.0	76.7	70.3	96.4	118
119	105.7	51.8	53.8	51.7	45.5	79.6	77.3	70.9	97.2	119

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams total Sugar), Lactose, Lactose and Sucrose (2 mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sucrose.	Invert sugar and surcose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
120	106.6	52.3	54.3	52.2	46.0	80.3	78.0	71.5	98.0	120
121	107.5	52.7	54.7	52.7	46.5	81.0	78.7	72.1	98.9	121
122	108.4	53.2	55.2	53.1	46.9	81.7	79.3	72.7	99.7	122
123	109.3	53.6	55.7	53.6	47.4	82.4	80.0	73.3	100.5	123
124	110.1	54.1	56.1	54.1	47.9	83.1	80.7	73.9	101.4	124
125	111.0	54.5	56.6	54.5	48.3	83.8	81.3	74.5	102.2	125
126	111.9	55.0	57.0	55.0	48.8	84.5	82.0	75.1	103.0	126
127	112.8	55.4	57.5	55.5	49.3	85.1	82.7	75.7	103.9	127
128	113.7	55.9	58.0	55.9	49.8	85.8	83.4	76.3	104.7	128
129	114.6	56.3	58.4	56.4	50.2	86.5	84.0	76.9	105.5	129
130	115.5	56.8	58.9	56.9	50.7	87.2	84.7	77.5	106.4	130
131	116.4	57.2	59.4	57.4	51.2	87.9	85.4	78.1	107.2	131
132	117.3	57.7	59.8	57.8	51.7	88.6	86.0	78.7	108.0	132
133	118.1	58.1	60.3	58.3	52.1	89.3	86.7	79.3	108.9	133
134	119.0	58.6	60.8	58.8	52.6	90.0	87.4	79.7	109.7	134
135	119.9	59.0	61.2	59.3	53.1	90.6	88.1	80.5	110.5	135
136	120.8	59.5	61.7	59.7	53.6	91.3	88.7	81.1	111.4	136
137	121.7	60.0	62.2	60.2	54.0	92.0	89.4	81.7	112.2	137
138	122.6	60.4	62.6	60.7	54.5	92.7	90.1	82.3	113.0	138
139	123.5	60.9	63.1	61.2	55.0	93.4	90.7	82.9	113.9	139
140	124.4	61.3	63.6	61.6	55.5	94.1	91.4	83.5	114.7	140
141	125.2	61.8	64.0	62.1	55.9	94.8	92.1	84.1	115.5	141
142	126.1	62.2	64.5	62.6	56.4	95.5	92.8	84.7	116.4	142
143	127.0	62.7	65.0	63.1	56.9	96.1	93.4	85.3	117.2	143
144	127.9	63.1	65.4	63.5	57.4	96.8	94.1	85.9	118.0	144
145	128.8	63.6	65.9	64.0	57.8	97.5	94.8	86.5	118.9	145
146	129.7	64.0	66.4	64.5	58.3	98.2	95.4	87.1	119.7	146
149	130.6	64.5	66.9	65.9	58.8	98.9	96.1	87.7	120.5	147
148	131.5	65.0	67.3	65.4	59.3	99.6	96.8	88.3	121.4	148
149	132.4	65.4	67.8	65.9	59.7	100.3	97.5	88.9	122.2	149
150	133.2	65.9	68.3	66.4	60.2	101.0	98.1	89.5	123.0	150
151	134.1	66.3	68.7	66.9	60.7	101.6	98.8	90.2	123.9	151
152	135.0	66.8	69.2	67.3	61.2	102.3	99.5	90.8	124.7	152
153	135.9	67.2	69.7	67.8	61.7	103.0	100.1	91.4	125.5	153
154	136.8	67.7	70.1	68.3	62.1	103.7	100.8	92.0	126.4	154
155	137.7	68.2	70.6	68.8	62.6	104.4	101.5	92.6	127.2	155
156	138.6	68.6	71.1	69.2	63.1	105.1	102.2	93.2	128.0	156
157	139.5	69.1	71.6	69.7	63.6	105.8	102.8	93.8	128.9	157
158	140.3	69.5	72.0	70.2	64.1	106.5	103.5	94.4	129.7	158
159	141.2	70.0	72.5	70.7	64.5	107.2	104.2	95.0	130.5	159
160	142.1	70.4	73.0	71.2	65.0	107.9	104.8	95.6	131.4	160
161	143.0	70.9	73.4	71.6	65.5	108.5	105.5	96.2	132.2	161
162	143.9	71.4	73.9	72.1	66.0	109.2	106.2	96.8	133.0	162
163	144.8	71.8	74.4	72.6	65.5	109.9	106.9	97 4	133.9	163
164	145.7	72.3	74.9	73.1	66.9	110.6	107.5	98.0	134.7	164
165	146.6	72.8	75.3	73.6	67.4	111.3	108.2	98.6	135.5	165
166	147.5	73.2	75.8	74.0	67.9	112.0	108.9	99.2	136.4	166
167	148.3	73.7	76.3	74.5	68.4	112.7	109.6	99.8	137.2	167
168	149.2	74.1	76.8	75.0	68.9	113.4	110.2	100.4	138.0	168
169	150.1	74.6	77.2	75.5	69.3	114.1	110.9	101.0	138.9	169
170	151.0	75.1	77.7	76.0	69.8	114.8	111.6	101.6	139.7	170
171	151.9	75.5	78.2	76.4	70.3	115.4	112.3	102.2	140.5	171
172	152.8	76.0	78.7	76.9	70.8	116.1	112.9	102.8	141.4	172
173	153.7	76.4	79.1	77.4	71.3	116.8	113.6	103.5	142.2	173
174	154.6	76.9	79.6	77.9	71.7	117.5	114.3	104.1	143.0	174

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
175	155.5	77.4	80.1	78.4	72.2	118.2	114.9	104.7	143.9	175
176	156.3	77.8	80.6	78.8	72.7	118.9	115.6	105.3	144.7	176
177	157.2	78.3	81.0	79.3	73.2	119.6	116.3	105.9	145.5	177
178	158.1	78.8	81.5	79.8	73.7	120.3	117.0	106.5	146.4	178
179	159.0	79.2	82.0	80.3	74.2	121.0	117.6	107.1	147.2	179
180	159.9	79.7	82.5	80.8	74.6	121.6	118.3	107.7	148.0	180
181	160.8	80.1	82.9	81.3	75.1	122.3	119.0	108.3	148.9	181
182	161.7	80.6	83.4	81.7	75.6	123.1	119.7	108.9	149.7	182
183	162.6	81.1	83.9	82.2	76.1	123.7	120.3	109.5	150.5	183
184	163.4	81.5	84.4	82.7	76.6	124.3	121.0	110.1	151.4	184
185	164.3	82.0	84.9	83.2	77.1	125.1	121.7	110.7	152.2	185
186	165.2	82.5	85.3	83.7	77.6	125.8	122.4	111.3	153.0	186
187	166.1	82.9	85.8	84.2	78.0	126.5	123.1	111.9	153.9	187
188	167.0	83.4	86.3	84.6	78.5	127.2	123.7	112.5	154.7	188
189	167.9	83.9	86.8	85.1	79.0	127.9	124.4	113.1	155.5	189
190	168.8	84.3	87.2	85.6	79.5	128.5	125.1	113.8	156.4	190
191	169.7	84.8	87.7	86.1	80.0	129.2	125.8	114.4	157.2	191
192	170.5	85.3	88.2	86.6	80.5	129.9	126.4	115.0	158.0	192
193	171.4	85.7	88.7	87.1	81.0	130.6	127.1	115.6	158.9	193
194	172.3	86.2	89.2	87.6	81.4	131.3	127.8	116.2	159.7	194
195	173.2	86.7	89.6	88.0	81.9	132.0	128.5	116.8	160.5	195
196	174.1	87.1	90.1	88.5	82.4	132.7	129.2	117.4	161.4	196
197	175.0	87.6	90.6	89.0	82.9	133.4	129.8	118.0	162.2	197
198	175.9	88.1	91.1	89.5	83.4	134.1	130.5	118.6	163.0	198
199	176.8	88.5	91.6	90.0	83.9	134.8	131.2	119.2	163.9	199
200	177.7	89.0	92.0	90.5	84.4	135.4	131.9	119.8	164.7	200
201	178.5	89.5	92.5	91.0	84.8	136.1	132.5	120.4	165.5	201
202	179.4	89.9	93.0	91.4	85.3	136.8	133.2	121.0	166.4	202
203	180.3	90.4	93.5	91.9	85.8	137.5	133.9	121.7	167.2	203
204	181.2	90.9	94.0	92.4	86.3	138.2	134.6	122.3	168.0	204
205	182.1	91.4	94.5	92.9	86.8	138.9	135.3	122.9	168.9	205
206	183.0	91.8	94.9	93.4	87.3	139.6	135.9	123.5	169.7	206
207	183.9	92.3	95.4	93.9	87.8	140.3	136.6	124.1	170.5	207
208	184.8	92.8	95.9	94.4	88.3	141.0	137.3	124.7	171.4	208
209	185.6	93.2	96.4	94.9	88.8	141.7	138.0	125.3	172.2	209
210	186.5	93.7	96.9	95.4	89.2	142.3	138.6	126.0	173.0	210
211	187.4	94.2	97.4	95.8	89.7	143.0	139.3	126.6	173.8	211
212	188.3	94.6	97.8	96.3	90.2	143.7	140.0	127.2	174.7	212
213	189.2	95.1	98.3	96.8	90.7	144.4	140.7	127.8	175.5	213
214	190.1	95.6	98.8	97.3	91.2	145.1	141.4	128.4	176.4	214
215	191.0	96.1	99.3	97.8	91.7	145.8	142.0	129.0	177.2	215
216	191.9	96.5	99.8	98.3	92.2	146.5	142.7	129.6	178.0	216
217	192.8	97.0	100.3	98.8	92.7	147.2	143.4	130.2	178.9	217
218	193.6	97.5	100.8	99.3	93.2	147.9	144.1	130.9	179.7	215
219	194.5	98.0	101.2	99.8	93.7	148.6	144.7	131.5	180.5	219
220	195.4	98.4	101.7	100.3	94.2	149.3	145.4	132.1	181.4	220
221	196.3	98.9	102.2	100.8	94.7	150.0	146.1	132.7	182.2	221
222	197.2	99.4	102.7	101.2	95.1	150.7	146.8	133.3	183.0	222
223	198.1	99.9	103.2	101.7	95.6	151.3	147.5	133.9	183.9	223
224	199.0	100.3	103.7	102.2	96.1	152.0	148.1	134.5	184.7	224
225	199.9	100.8	104.2	102.7	96.6	152.7	148.8	135.2	185.5	225
226	200.7	101.3	104.6	103.2	97.1	153.4	149.5	135.8	186.4	226
227	201.6	101.8	105.1	103.7	97.6	154.1	150.2	136.4	187.2	227
228	202.5	102.2	105.6	104.2	98.1	154.8	150.8	137.0	188.0	228
229	203.4	102.7	106.1	104.7	98.6	155.5	151.5	137.6	188.8	229

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures), and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 grams total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
230	204.3	103.2	106.6	105.2	99.1	156.2	152.2	138.2	189.7	230
231	205.2	103.7	107.1	105.7	99.6	156.9	152.9	138.8	190.5	231
232	206.1	104.1	107.6	106.2	100.1	157.6	153.6	139.4	191.3	232
233	207.0	104.6	108.1	106.7	100.6	158.3	154.2	140.1	192.2	233
234	207.9	105.1	108.6	107.2	101.1	159.0	154.9	140.7	193.0	234
235	208.7	105.6	109.1	107.7	101.6	159.6	155.6	141.3	193.8	235
236	209.6	106.0	109.5	108.2	102.1	160.3	156.3	141.9	194.7	236
237	210.5	106.5	110.0	108.7	102.6	161.0	156.9	142.5	195.5	237
238	211.4	107.0	110.5	109.2	103.1	161.7	157.6	143.2	196.3	238
239	212.3	107.5	111.0	109.6	103.5	162.4	158.3	143.8	197.2	239
240	213.2	108.0	111.5	110.1	104.0	163.1	159.0	144.4	198.0	240
241	214.1	108.4	112.0	110.6	104.5	163.8	159.7	145.0	198.8	241
242	215.0	108.9	112.5	111.1	105.0	164.5	160.3	145.6	199.7	242
243	215.8	109.4	113.0	111.6	105.5	165.2	161.0	146.3	200.5	243
244	216.7	109.9	113.5	112.1	106.0	165.9	161.7	146.9	201.3	244
245	217.6	110.4	114.0	112.6	106.5	166.6	162.4	147.5	202.2	245
246	218.5	110.8	114.5	113.1	107.0	167.3	163.1	148.1	203.0	246
247	219.4	111.3	115.0	113.6	107.5	168.0	163.7	148.7	203.8	247
248	220.3	111.8	115.4	114.1	108.0	168.7	164.4	149.3	204.7	248
249	221.2	112.3	115.9	114.6	108.5	169.4	165.1	150.0	205.5	249
250	222.1	112.8	116.4	115.1	109.0	170.1	165.8	150.6	206.3	250
251	223.0	113.2	116.9	115.6	109.5	170.8	166.5	151.2	207.2	251
252	223.8	113.7	117.4	116.1	110.0	171.5	167.2	151.8	208.0	254
253	224.7	114.2	117.9	116.6	110.5	172.1	167.8	152.4	208.8	253
254	225.6	114.7	118.4	117.1	111.0	172.8	168.5	153.1	209.7	254
255	226.5	115.2	118.9	117.6	111.5	173.5	169.2	153.7	210.5	255
256	227.4	115.7	119.4	118.1	112.0	174.2	169.9	154.3	211.3	256
257	228.3	116.1	119.9	118.6	112.5	174.9	170.6	154.9	212.2	257
258	229.2	116.6	120.4	119.1	113.0	175.6	171.3	155.5	213.0	258
259	230.1	117.1	120.9	119.6	113.5	176.3	171.9	156.2	213.8	259
260	231.0	117.6	121.4	120.1	114.0	177.0	172.6	156.8	214.7	260
261	231.8	118.1	121.9	120.6	114.5	177.7	173.3	157.4	215.5	261
262	232.7	118.6	122.4	121.1	115.0	178.4	174.0	158.0	216.3	262
263	233.6	119.0	122.9	121.6	115.5	179.1	174.7	158.6	217.2	263
264	234.5	119.5	123.4	122.1	116.0	179.8	175.3	159.3	218.0	264
265	235.4	120.0	123.9	122.6	116.5	180.5	176.0	159.9	218.8	265
266	236.3	120.5	124.4	123.1	117.0	181.2	176.7	160.5	219.7	266
267	237.2	121.0	124.9	123.6	117.5	181.9	177.4	161.1	220.5	267
268	238.1	121.5	125.4	124.1	118.0	182.6	178.1	161.8	221.3	268
269	238.9	122.0	125.9	124.6	118.5	183.3	178.8	162.4	222.1	269
270	239.8	122.5	126.4	125.1	119.0	184.0	179.4	163.0	223.0	270
271	240.7	122.9	126.9	125.6	119.5	184.6	180.1	163.6	223.8	271
272	241.6	123.4	127.4	126.2	120.0	185.3	180.8	164.3	224.6	272
273	242.5	123.9	127.9	126.7	120.6	186.0	181.5	164.9	225.5	273
274	243.4	124.4	128.4	127.2	121.1	186.7	182.2	165.5	226.3	274
275	244.3	124.9	128.9	127.7	121.6	187.4	182.9	166.1	227.1	275
276	245.2	125.4	129.4	128.2	122.1	188.1	183.5	166.8	228.0	276
277	246.1	125.9	129.9	128.7	122.6	188.8	184.2	167.4	228.8	277
278	246.9	126.4	130.4	129.2	123.1	189.5	184.9	168.0	229.6	278
279	247.8	126.9	130.9	129.7	123.6	190.2	185.6	168.7	230.5	279
280	248.7	127.3	131.4	130.2	124.1	190.9	186.3	169.3	231.3	280
281	249.6	127.8	131.9	130.7	124.6	191.6	187.0	169.9	232.1	281
282	250.5	128.3	132.4	131.2	125.1	192.3	187.6	170.5	233.0	282
283	251.4	128.8	132.9	131.7	125.6	193.0	188.3	171.2	233.8	283
284	252.3	129.3	133.4	132.2	126.1	193.7	189.0	171.8	234.6	284

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
285	253.2	129.8	133.9	132.7	126.6	194.4	189.7	172.4	235.5	285
286	254.0	130.3	134.4	133.2	127.1	195.1	190.4	173.0	236.3	286
287	254.9	130.8	134.9	133.7	127.6	195.8	191.0	173.7	237.1	287
288	255.8	131.3	135.4	134.3	128.1	196.5	191.7	174.3	238.0	288
289	256.7	131.8	135.9	134.8	128.6	197.1	192.4	174.9	238.8	289
290	257.6	132.3	136.4	135.3	129.2	197.8	193.1	175.5	239.6	290
291	258.5	132.7	136.9	135.8	129.7	198.5	193.8	176.2	240.5	291
292	259.4	133.2	137.4	136.3	130.2	199.2	194.4	176.8	241.3	292
293	260.3	133.7	137.9	136.8	130.7	199.9	195.1	177.4	242.1	293
294	261.2	134.2	138.4	137.3	131.2	200.6	195.8	178.1	242.9	294
295	262.0	134.7	138.9	137.8	131.7	201.3	196.5	178.7	243.8	295
296	262.9	135.2	139.4	138.3	132.2	202.0	197.2	179.3	244.6	296
297	263.8	135.7	140.0	138.8	132.7	202.7	197.9	179.9	245.4	297
298	264.7	136.2	140.5	139.4	133.2	203.4	198.6	180.6	246.3	298
299	265.6	136.7	141.0	139.9	133.7	204.1	199.2	181.2	247.1	299
300	266.5	137.2	141.5	140.4	134.2	204.8	199.9	181.8	247.9	300
301	267.4	137.7	142.0	140.9	134.8	205.5	200.6	182.5	248.8	301
302	268.3	138.2	142.5	141.4	135.3	206.2	201.3	183.1	249.6	302
303	269.1	138.7	143.0	141.9	135.8	206.9	202.0	183.7	250.4	303
304	270.0	139.2	143.5	142.4	136.3	207.6	202.7	184.4	251.3	304
305	270.9	139.7	144.0	142.9	136.8	208.3	203.3	185.0	252.1	305
306	271.8	140.2	144.5	143.4	137.3	209.0	204.0	185.6	252.9	306
307	272.7	140.7	145.0	144.0	137.8	209.7	204.7	186.2	253.8	307
308	273.6	141.2	145.5	144.5	138.3	210.4	205.4	186.9	254.6	308
309	274.5	141.7	146.1	145.0	138.8	211.1	206.1	187.5	255.4	309
310	275.4	142.2	146.6	145.5	139.4	211.8	206.8	188.1	256.3	310
311	276.3	142.7	147.1	146.0	139.9	212.5	207.5	188.8	257.1	311
312	277.1	143.2	147.6	146.5	140.4	213.2	208.1	189.4	257.9	312
313	278.0	143.7	148.1	147.0	140.9	213.9	208.8	190.0	258.8	313
314	278.9	144.2	148.6	147.6	141.4	214.6	209.5	190.7	259.6	314
315	279.8	144.7	149.1	148.1	141.9	215.3	210.2	191.3	260.4	315
316	280.7	145.2	149.6	148.6	142.4	216.0	210.9	191.9	261.2	316
317	281.6	145.7	150.1	149.1	143.0	216.6	211.6	192.6	262.1	317
318	282.5	146.2	150.7	149.6	143.5	217.3	212.2	193.2	262.9	318
319	283.4	146.7	151.2	150.1	144.0	218.0	212.9	193.8	263.7	319
320	284.2	147.2	151.7	150.7	144.5	218.7	213.6	194.4	264.6	320
321	285.1	147.7	152.2	151.2	145.0	219.4	214.3	195.1	265.4	321
322	286.0	148.2	152.7	151.7	145.5	220.1	215.5	195.7	266.2	322
323	286.9	148.7	153.2	152.2	146.0	220.8	215.7	196.3	267.1	323
324	287.8	149.2	153.7	152.7	146.6	221.5	216.4	197.0	267.9	324
325	288.7	149.7	154.3	153.2	147.1	222.2	217.0	197.6	268.7	325
326	289.6	150.2	154.8	153.8	147.6	222.9	217.7	198.2	269.6	326
327	290.5	150.7	155.3	154.3	148.1	223.6	218.4	198.9	270.4	327
328	291.4	151.2	155.8	154.8	148.6	224.3	219.1	199.5	271.2	328
329	292.2	151.7	156.3	155.3	149.1	225.0	219.8	200.1	272.1	329
330	293.1	152.2	156.8	155.8	149.7	225.7	220.5	200.8	272.9	330
331	294.0	152.7	157.3	156.4	150.2	226.4	221.2	201.4	273.7	331
332	294.9	153.2	157.9	156.9	150.7	227.1	221.8	202.0	274.6	332
333	295.8	153.7	158.4	157.4	151.2	227.8	222.5	202.7	275.4	333
334	296.7	154.2	158.9	157.9	151.7	228.5	223.2	203.3	276.2	334
335	297.6	154.7	159.4	158.4	152.3	229.2	223.9	204.0	277.0	335
336	298.5	155.2	159.9	159.0	152.8	229.9	224.6	204.6	277.9	336
337	299.3	155.8	160.5	159.5	153.3	230.6	225.3	205.2	278.7	337
338	300.2	156.3	161.0	160.0	153.8	231.3	226.0	205.9	279.5	338
339	301.1	156.8	161.5	160.5	154.3	232.0	226.7	206.5	280.4	339

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures), and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
340	302.0	157.3	162.0	161.0	154.8	232.7	227.4	207.1	281.2	340
341	302.9	157.8	162.5	161.6	155.4	233.4	228.1	207.8	282.0	341
342	303.8	158.3	163.1	162.1	155.9	234.1	228.7	208.4	282.9	342
343	304.7	158.8	163.6	162.6	156.4	234.8	229.4	209.0	283.7	343
344	305.6	159.3	164.1	163.1	156.9	235.5	230.1	209.7	284.5	344
345	306.5	159.8	164.6	163.7	157.5	236.2	230.8	210.3	285.4	345
346	307.3	160.3	165.1	164.2	158.0	236.9	231.5	211.0	286.2	346
347	308.2	160.8	165.7	164.7	158.5	237.6	232.2	211.6	287.0	347
348	309.1	161.4	166.2	165.2	159.0	238.3	232.9	212.2	287.9	348
349	310.0	161.9	166.7	165.7	159.5	239.0	233.6	212.9	288.7	349
350	310.9	162.4	167.2	166.3	160.1	239.7	234.3	213.5	289.5	350
351	311.8	162.9	167.7	166.8	160.6	240.4	235.0	214.1	290.4	351
352	312.7	163.4	168.3	167.3	161.1	241.1	235.6	214.8	291.2	352
353	313.6	163.9	168.8	167.8	161.6	241.8	236.3	215.4	292.0	353
354	314.4	164.4	169.3	168.4	162.2	242.5	237.0	216.1	292.8	354
355	315.3	164.9	169.8	168.9	162.7	243.2	237.7	216.7	293.7	355
356	316.2	165.4	170.4	169.4	163.2	243.9	238.4	217.3	294.5	356
357	317.1	166.0	170.9	170.0	163.7	244.6	239.1	218.0	295.3	357
358	318.0	166.5	171.4	170.5	164.3	245.3	239.8	218.6	296.2	358
359	318.9	167.0	171.9	171.0	164.8	246.0	240.5	219.2	297.0	359
360	319.8	167.5	172.5	171.5	165.3	246.7	241.2	219.9	297.8	360
361	320.7	168.0	173.0	172.1	165.8	247.4	241.9	220.5	298.7	361
362	321.6	168.5	173.5	172.6	166.4	248.1	242.5	221.2	299.5	362
363	322.4	169.0	174.0	173.1	166.9	248.8	243.2	221.8	300.3	363
364	323.3	169.6	174.6	173.7	167.4	249.5	243.9	222.5	301.2	364
365	324.2	170.1	175.1	174.2	167.9	250.2	244.6	223.1	302.0	365
366	325.1	170.6	175.6	174.7	168.5	250.9	245.3	223.7	302.8	366
367	326.0	171.1	176.1	175.2	169.0	251.6	246.0	224.4	303.6	367
368	326.9	171.6	176.7	175.8	169.5	252.3	246.7	225.0	304.5	368
369	327.8	172.1	177.2	176.3	170.0	253.0	247.4	225.7	305.3	309
370	328.7	172.7	177.7	176.8	170.6	253.7	248.1	226.3	306.1	370
371	329.5	173.2	178.3	177.4	171.1	254.4	248.8	227.0	307.0	371
372	330.4	173.7	178.8	177.9	171.6	255.1	249.5	227.6	307.8	372
373	331.3	174.2	179.3	178.4	172.2	255.8	250.3	228.3	308.6	373
374	332.2	174.7	179.8	179.0	172.7	256.5	250.9	228.9	309.5	374
375	333.1	175.3	180.4	179.5	173.2	257.2	251.5	229.6	310.3	375
376	334.0	175.8	180.9	180.0	173.7	257.9	252.2	230.2	311.1	376
377	334.9	176.3	181.4	180.6	174.3	258.6	252.9	230.8	312.0	377
378	335.8	176.8	182.0	181.1	174.8	259.3	253.6	231.5	312.8	378
379	336.7	177.3	182.5	181.6	175.3	260.0	254.3	232.1	313.6	379
380	337.5	177.9	183.0	182.1	175.9	260.7	255.0	232.8	314.5	380
381	338.4	178.4	183.6	182.7	176.4	261.4	255.7	233.4	315.3	381
382	339.3	178.9	184.1	183.2	176.9	262.1	256.4	234.1	316.1	382
383	340.2	179.4	184.6	183.6	177.5	262.8	257.1	234.7	316.9	383
384	341.1	180.0	185.2	184.3	178.0	263.5	257.8	235.4	317.8	384
385	342.0	180.5	185.7	184.8	178.5	264.2	258.5	236.0	318.6	385
386	342.9	181.0	186.2	185.4	179.1	264.9	259.2	236.6	319.4	386
387	343.8	181.5	186.8	185.9	179.6	265.6	259.8	237.3	320.3	387
388	344.6	182.0	187.3	186.4	180.1	266.3	260.5	237.9	321.1	388
389	345.5	182.6	187.8	187.0	180.6	267.0	261.2	238.6	321.9	389
390	346.4	183.1	188.4	187.5	181.2	267.7	261.9	239.2	322.8	390
391	347.3	183.6	188.9	188.0	181.7	268.4	262.6	239.9	323.6	391
392	348.2	184.1	189.4	188.6	182.3	269.1	263.3	240.5	324.4	392
393	349.1	184.7	190.0	189.1	182.8	269.8	264.0	241.2	325.2	393
394	350.0	185.2	190.5	189.7	183.3	270.5	264.7	241.8	326.1	394

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O)
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
395	350.9	185.7	191.0	190.2	183.9	271.2	265.4	242.5	326.9	395
396	351.8	186.2	191.6	190.7	184.4	271.9	266.1	243.1	327.7	396
397	352.6	186.8	192.1	191.3	184.9	272.6	266.8	243.8	328.6	397
398	353.5	187.3	192.7	191.8	185.5	273.3	267.5	244.4	329.4	398
309	354.4	187.8	193.2	192.3	186.0	274.0	268.2	245.1	330.2	399
400	355.3	188.4	193.7	192.9	186.5	274.7	268.9	245.7	331.1	400
401	356.2	188.9	194.3	193.4	187.1	275.4	269.6	246.4	331.9	401
402	357.1	189.4	194.8	194.0	187.6	276.1	270.3	247.0	332.7	402
403	358.0	189.9	195.4	194.5	188.1	276.8	271.0	247.7	333.6	403
404	358.9	190.5	195.9	195.0	188.7	277.5	271.7	248.3	334.4	404
405	359.7	191.0	196.4	195.6	189.2	278.2	272.3	249.0	355.2	405
406	360.6	191.5	197.0	196.1	189.8	278.9	273.0	249.6	336.0	406
407	361.5	192.1	197.5	196.7	190.3	279.6	273.7	250.3	336.9	407
408	362.4	192.6	198.1	197.2	190.8	280.3	274.4	251.0	337.7	408
409	363.3	193.1	198.6	197.7	191.4	281.0	275.1	251.6	338.5	409
410	364.2	193.7	199.1	198.3	191.9	281.7	275.8	252.3	339.4	410
411	365.1	194.2	199.7	198.8	192.5	282.4	276.5	252.9	340.2	411
412	366.0	194.7	200.2	199.4	193.0	283.2	277.2	253.6	341.0	412
413	366.9	195.2	200.8	199.9	193.5	283.9	277.9	254.2	341.9	413
414	367.7	195.8	201.3	200.5	194.1	284.6	278.6	254.9	342.7	414
415	368.6	196.3	201.8	201.0	194.6	285.3	279.3	255.5	343.5	415
416	369.5	196.8	202.4	201.6	195.2	286.0	280.0	256.2	344.4	416
417	370.4	197.4	202.9	202.1	195.7	286.7	280.7	256.8	345.2	417
418	371.3	197.9	203.5	202.6	196.2	287.4	281.4	257.5	346.0	418
419	372.2	198.4	204.0	203.2	196.8	288.1	282.1	258.1	346.8	419
420	373.1	199.0	204.6	203.7	197.3	288.8	282.8	258.8	347.7	420
421	374.0	199.5	205.1	204.3	197.9	289.5	283.5	259.4	348.5	421
422	374.8	200.1	205.7	204.8	198.4	290.2	284.2	260.1	349.3	422
423	375.7	200.6	206.2	205.4	198.9	290.9	284.9	260.7	350.2	423
424	376.6	201.1	206.7	205.9	199.5	291.6	285.6	261.4	351.0	424
425	377.5	201.7	207.3	206.5	200.0	292.3	286.3	262.1	351.8	425
426	378.4	202.2	207.8	207.0	200.6	293.0	287.0	262.7	352.7	426
427	379.3	202.8	208.4	207.6	201.1	293.7	287.7	263.4	353.5	427
428	380.2	203.3	208.9	208.1	201.7	294.4	288.4	264.0	354.3	428
429	381.1	203.8	209.5	208.7	202.2	295.1	289.1	264.7	355.1	429
430	382.0	204.4	210.0	209.2	202.7	295.8	289.8	265.4	356.0	430
431	382.8	204.9	210.6	209.8	203.3	296.5	290.5	266.0	356.8	431
432	383.7	205.5	211.1	210.3	203.8	297.2	291.2	266.7	357.6	432
433	384.6	206.0	211.7	210.9	204.4	297.9	291.9	267.3	358.5	433
434	385.5	206.5	212.2	211.4	204.9	298.6	292.6	268.0	359.3	434
435	386.4	207.1	212.8	212.0	205.5	299.3	293.3	268.7	360.1	435
436	387.3	207.6	213.3	212.5	206.0	300.0	294.0	269.3	361.0	436
437	388.2	208.2	213.9	213.1	206.6	300.7	294.7	270.0	361.8	437
438	389.1	208.7	214.4	213.6	207.1	301.4	295.4	270.6	362.6	438
439	390.0	209.2	215.0	214.2	207.7	302.1	296.1	271.3	363.4	439
440	390.8	209.8	215.5	214.7	208.2	302.8	296.8	272.0	364.3	440
441	391.7	210.3	216.1	215.3	208.8	303.5	297.5	272.6	365.1	441
442	392.6	210.9	216.6	215.8	209.3	304.2	298.2	273.3	365.9	442
443	393.5	211.4	217.2	216.4	209.9	304.9	298.9	273.9	366.8	443
444	394.4	212.0	217.8	216.9	210.4	305.6	299.6	274.6	367.6	444
445	395.3	212.5	218.3	217.5	211.0	306.3	300.3	275.3	368.4	445
446	396.2	213.1	218.9	218.0	211.5	307.0	301.0	275.9	369.3	446
447	397.1	213.6	219.4	218.6	212.1	307.7	301.7	276.6	370.1	447
448	397.9	214.1	220.0	219.1	212.6	308.4	302.4	277.2	370.9	448
449	398.8	214.7	220.5	219.7	213.2	309.1	303.1	277.9	371.7	449

Table for Calculating Dextrose, Invert Sugar Alone, Invert Sugar in the Presence of Sucrose (0.4 gram and 2 grams Total Sugar), Lactose, Lactose and Sucrose (2 Mixtures) and Maltose (Crystallized). (Continued.)

[Expressed in milligrams.]

Cuprous oxid (Cu_2O).	Copper (Cu).	Dextrose (*d*-glucose).	Invert sugar.	Invert sugar and sucrose.		Lactose.	Lactose and sucrose.		Maltose.	Cuprous oxid (Cu_2O).
				0.4 gram total sugar.	2 grams total sugar.	$C_{12}H_{22}O_{11} + H_2O$.	1 lactose, 4 sucrose.	1 lactose 12 sucrose.	$C_{12}H_{22}O_{11} + H_2O$.	
450	399.7	215.2	221.1	220.2	213.7	309.9	303.8	278.6	372.6	450
451	400.6	215.8	221.6	220.8	214.3	310.6	304.5	279.2	373.4	451
452	401.5	216.3	222.2	221.4	214.8	311.3	305.2	279.9	374.2	452
453	402.4	216.9	222.8	221.9	215.4	312.0	305.9	280.5	375.1	453
454	403.3	217.4	223.3	222.5	215.9	312.7	206.6	281.2	375.9	454
455	404.2	218.0	223.9	223.0	216.5	313.4	307.3	281.9	376.7	455
456	405.1	218.5	224.4	223.6	217.0	314.1	308.0	282.5	377.6	456
457	405.9	219.1	225.0	224.1	217.6	314.8	308.7	283.2	378.4	457
458	406.8	219.6	225.5	224.7	218.1	315.5	309.4	283.9	379.2	458
459	407.7	220.2	226.1	225.3	218.7	316.2	310.1	284.5	380.0	459
460	408.6	220.7	226.7	225.8	219.2	316.9	310.8	285.2	380.9	460
461	409.5	221.3	227.3	226.4	219.8	317.6	311.5	285.9	381.7	461
462	410.4	221.8	227.8	226.9	220.3	318.3	312.2	286.5	382.5	462
463	411.3	222.4	228.3	227.5	220.9	319.0	312.9	287.2	383.4	463
464	412.2	222.9	228.9	228.1	221.4	319.7	313.6	287.8	384.2	464
465	413.0	223.5	229.5	228.6	222.0	320.4	314.3	288.5	385.0	465
466	413.9	224.0	230.0	229.2	222.5	321.1	215.0	289.2	385.9	466
467	414.8	224.6	230.6	229.7	223.1	321.8	315.7	289.8	386.7	467
468	415.7	225.1	231.2	230.3	223.7	322.5	316.4	290.5	387.5	468
469	416.6	225.7	231.7	230.9	224.2	323.2	317.0	291.2	388.3	469
470	417.5	226.2	232.3	231.4	224.8	323.9	317.7	291.8	389.2	470
471	418.4	226.8	232.8	232.0	225.3	324.6	318.4	292.5	390.0	471
472	419.3	227.4	233.4	232.5	225.9	325.3	319.1	293.2	390.8	472
473	420.2	227.9	234.0	233.1	226.4	326.0	319.8	293.8	391.7	473
474	421.0	228.5	234.5	233.7	227.0	326.8	320.5	294.5	392.5	474
475	421.9	229.0	235.1	234.2	227.6	327.5	321.2	295.2	393.3	475
476	422.8	229.6	235.7	234.8	228.1	328.2	321.9	295.8	394.2	476
477	423.7	230.1	236.2	235.4	228.7	328.9	322.6	296.5	395.0	477
478	424.6	230.7	236.8	235.9	229.2	329.6	323.3	297.1	395.8	478
479	425.5	231.3	237.4	236.5	229.8	330.3	324.0	297.8	396.6	479
480	426.4	231.8	237.9	237.1	230.3	331.0	324.7	298.5	397.5	480
481	427.3	232.4	238.5	237.6	230.9	331.7	325.4	299.1	398.3	481
482	428.1	432.9	239.1	238.2	131.5	332.4	326.1	299.8	399.1	482
483	429.0	233.5	239.6	238.8	232.0	333.1	326.8	300.5	400.0	483
484	429.9	234.1	240.2	239.3	232.6	333.8	327.5	301.1	400.8	484
485	430.8	234.6	240.8	239.9	233.2	334.5	328.2	301.8	401.6	485
486	431.7	235.2	241.4	240.5	233.7	335.2	328.9	302.5	402.4	486
487	432.6	235.7	241.9	241.0	234.3	335.9	329.6	303.1	403.3	487
488	433.5	236.3	242.5	241.6	234.8	336.6	330.3	303.8	404.1	488
489	434.4	236.9	243.1	242.2	235.4	337.3	331.0	304.5	404.9	489
490	435.3	237.4	243.6	242.7	236.0	338.0	331.7	305.1	405.8	490

III. MALTOSE.

Place 50 cc. of the mixed copper reagent in a beaker and heat to the boiling point. While boiling briskly add 25 cc. of the maltose solution containing not more than 0.250 gram of maltose and boil for four minutes. Filter immediately through asbestos and determine the amount of copper reduced from the weight of the Cu_2O. Obtain the weight of maltose equivalent to the weight of copper found from the following table:

112. **Table for the Determination of Maltose.**

[*According to Wein.*]

Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of maltose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of maltose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of maltose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of maltose.
31	34.9	26.1	86	96.8	74.1	141	158.7	123.3	196	220.7	172.5
32	36.0	27.0	87	97.9	75.0	142	159.9	124.2	197	221.8	173.4
33	37.2	27.9	88	99.1	75.9	143	161.0	125.1	198	222.9	174.3
34	38.3	28.7	89	100.2	76.8	144	162.1	126.0	199	224.0	175.2
35	39.4	29.6	90	101.3	77.7	145	163.2	126.9	200	225.2	176.1
36	40.5	30.5	91	102.4	78.6	146	164.4	127.8	201	226.3	177.0
37	41.7	31.3	92	103.6	79.5	147	165.5	128.7	202	227.4	177.9
38	42.8	32.2	93	104.7	80.3	148	166.6	129.6	203	228.5	178.7
39	43.9	33.1	94	105.8	81.2	149	167.7	130.5	204	229.7	179.6
40	45.0	33.9	95	107.0	82.1	150	168.9	131.4	205	230.8	180.5
41	46.2	34.8	96	108.1	83.0	151	170.0	132.3	206	231.9	181.4
42	47.3	35.7	97	109.2	83.9	152	171.1	133.2	207	233.0	182.3
43	48.4	36.5	98	110.3	84.8	153	172.3	134.1	208	234.2	183.2
44	49.5	37.4	99	111.5	85.7	154	173.4	135.0	209	235.3	184.1
45	50.7	38.3	100	112.6	86.6	155	174.5	135.9	210	236.4	185.0
46	51.8	39.1	101	113.7	87.5	156	175.6	136.8	211	237.6	185.9
47	52.9	40.0	102	114.8	88.4	157	176.8	137.7	212	238.7	186.8
48	54.0	40.9	103	116.0	89.2	158	177.9	138.6	213	239.8	187.7
49	55.2	41.8	104	117.1	90.1	159	179.0	139.5	214	240.9	188.6
50	56.3	42.6	105	118.2	91.0	160	180.1	140.4	215	242.1	189.5
51	57.4	43.5	106	119.3	91.9	161	181.3	141.3	216	243.2	190.4
52	58.5	44.4	107	120.5	92.8	162	182.4	142.2	217	244.3	191.2
53	59.7	45.2	108	121.6	93.7	163	183.5	143.1	218	245.4	192.1
54	60.8	46.1	109	122.7	94.6	164	184.6	144.0	219	246.6	193.0
55	61.9	47.0	110	123.8	95.5	165	185.8	144.9	220	247.7	193.9
56	63.0	47.8	111	125.0	96.4	166	186.9	145.8	221	248.7	194.8
57	64.2	48.7	112	126.1	97.3	167	188.0	146.7	222	249.9	195.7
58	65.3	49.6	113	127.2	98.1	168	189.1	147.6	223	251.0	196.6
59	66.4	50.4	114	128.3	99.0	169	190.3	148.5	224	252.4	197.5
60	67.6	51.3	115	129.6	99.9	170	191.4	149.4	225	253.3	198.4
61	68.7	52.2	116	130.6	100.8	171	192.5	150.3	226	254.4	199.3
62	69.8	53.1	117	131.7	101.7	172	193.6	151.2	227	255.6	200.2
63	70.9	53.9	118	132.8	102.6	173	194.8	152.0	228	256.7	201.1
64	72.1	54.8	119	134.0	103.5	174	195.9	152.9	229	257.8	202.0
65	73.2	55.7	120	135.1	104.4	175	197.0	153.8	230	258.9	202.9
66	74.3	56.6	121	136.2	105.3	176	198.1	154.7	231	260.1	203.8
67	75.4	57.4	122	137.4	106.2	177	199.3	155.6	232	261.2	204.7
68	76.6	58.3	123	138.5	107.1	178	200.4	156.5	233	262.3	205.6
69	77.7	59.2	124	139.6	108.0	179	201.5	157.4	234	263.4	206.5
70	78.8	60.1	125	140.7	108.9	180	202.6	158.3	235	264.6	207.4
71	79.9	61.0	126	141.9	109.8	181	203.8	159.2	236	265.7	208.3
72	81.1	61.8	127	143.0	110.7	182	204.9	160.1	237	266.8	209.1
73	82.2	62.7	128	144.1	111.6	183	206.0	160.9	238	268.0	210.0
74	83.3	63.6	129	145.2	112.5	184	207.1	161.8	239	269.1	210.9
75	84.4	64.5	130	146.4	113.4	185	208.3	162.7	240	270.2	211.8
76	85.6	65.4	131	147.5	114.3	186	209.4	163.6	241	271.3	212.7
77	86.7	66.2	132	148.6	115.2	187	210.5	164.5	242	272.5	213.6
78	87.8	67.1	133	149.7	116.1	188	211.7	165.4	243	273.6	214.5
79	88.9	68.0	134	150.9	117.0	189	212.8	166.3	244	274.7	215.4
80	90.1	68.9	135	152.0	117.9	190	213.9	167.2	245	275.8	216.3
81	91.2	69.7	136	153.1	118.8	191	215.0	168.1	246	277.0	217.2
82	92.3	70.6	137	154.2	119.7	192	216.2	169.0	247	278.1	218.1
83	93.4	71.5	138	155.4	120.6	193	217.3	169.8	248	279.2	219.0
84	94.6	72.4	139	156.5	121.5	194	218.4	170.7	249	280.3	219.9
85	95.7	73.2	140	157.6	122.4	195	219.5	171.6	250	281.5	220.8

Table for the Determination of Maltose. (Continued.)

Milli-grams of copper.	Milli-grams of cuprous oxid.	Milli-grams of maltose.	Milli-grams of copper.	Milli-grams of cuprous oxid.	Milli-grams of maltose.	Milli-grams of copper.	Milli-grams of cuprous oxid.	Milli-grams of maltose.	Milli-grams of copper.	Milli-grams of cuprous oxid.	Milli-grams of maltose.
251	282.6	221.7	264	297.2	233.4	277	311.9	245.1	290	326.5	256.6
252	283.7	222.6	265	298.3	234.3	278	313.0	246.0	291	327.4	257.5
253	284.8	223.5	266	299.5	235.2	279	314.1	246.9	292	328.7	258.4
254	286.0	224.4	267	300.6	236.1	280	315.2	247.8	293	329.9	259.3
255	287.1	225.3	268	301.7	237.0	281	316.4	248.7	294	331.0	260.2
256	288.2	226.2	269	302.8	237.9	282	317.5	249.6	295	332.1	261.1
257	289.3	227.1	270	304.0	238.8	283	318.6	250.4	296	333.2	262.0
258	290.5	228.0	271	305.1	239.7	284	319.7	251.3	297	334.4	262.8
259	291.6	228.9	272	306.2	240.6	285	320.9	252.2	298	335.5	263.7
260	292.7	229.8	273	307.3	241.5	286	322.0	253.1	299	336.6	264.6
261	293.8	230.7	274	308.5	242.4	287	323.1	254.0	300	337.8	265.5
262	295.0	231.6	275	309.6	243.3	288	324.2	254.9			
263	296.1	232.5	276	310.7	244.2	289	325.4	255.8			

113. LACTOSE.

Place 50 cc. of the mixed copper reagent in a beaker and heat to the boiling point. While boiling briskly add 100 cc. of the lactose solution containing not more than 0.300 gram of lactose and boil for six minutes. Filter immediately through asbestos and determine the amount of copper reduced from the weight of Cu_2O, by factor 0.888. Obtain the weight of lactose equivalent to the weight of copper found from the following table:

114. **Table for the Determination of Lactose (Soxhlet-Wein).**

Milli-grams of copper.	Milli-grams of lactose.	Milli-grams of copper.	Milli-grams of lactose.	Milli-grams of copper.	Milli-grams of lactose.	Milli-grams of copper.	Milli-grams of lactose.	Milli-grams of copper.	Milli-grams of lactose.
100	71.6	125	90.1	150	108.8	175	127.8	200	146.9
101	72.4	126	90.9	151	109.6	176	128.5	201	147.7
102	73.1	127	91.6	152	110.3	177	129.3	202	148.5
103	73.8	128	92.4	153	111.1	178	130.1	203	149.2
104	74.6	129	93.1	154	111.9	179	130.8	204	150.0
105	75.3	130	93.8	155	112.6	180	131.6	205	150.7
106	76.1	131	94.6	156	113.4	181	132.4	206	151.5
107	76.8	132	95.3	157	114.1	182	133.1	207	152.2
108	77.6	133	96.1	158	114.9	183	133.9	208	153.0
109	78.3	134	96.9	159	115.6	184	134.7	209	153.7
110	79.0	135	97.6	160	116.4	185	135.4	210	154.5
111	79.8	136	98.3	161	117.1	186	136.2	211	155.2
112	80.5	137	99.1	162	117.9	187	137.0	212	156.0
113	81.3	138	99.8	163	118.6	188	137.7	213	156.7
114	82.0	139	100.5	164	119.4	189	138.5	214	157.5
115	82.7	140	101.3	165	120.2	190	139.3	215	158.2
116	83.5	141	102.0	166	120.9	191	140.0	216	159.0
117	84.2	142	102.8	167	121.7	192	140.8	217	159.7
118	85.0	143	103.5	168	122.4	193	141.6	218	160.4
119	85.7	144	104.3	169	123.2	194	142.3	219	161.2
120	86.4	145	105.1	170	123.9	195	143.1	220	161.9
121	87.2	146	105.8	171	124.7	196	143.9	221	162.7
122	87.9	147	106.6	172	125.5	197	144.6	222	163.4
123	88.7	148	107.3	173	126.2	198	145.4	223	164.2
124	89.4	149	108.1	174	127.0	199	146.2	224	164.9

Table for the Determination of Lactose (Soxhlet-Wein). (Continued.)

Milligrams of copper.	Milligrams of lactose.	Milligrams of copper.	Milligrams of lactose.	Milligrams of copper.	Milligrams of lactose.	Milligrams of copper.	Milligrams of lactose.	Milligrams of copper.	Milligrams of lactose.
225	165.7	261	193.3	297	221.9	333	250.0	369	279.6
226	166.4	262	194.1	298	222.7	334	250.8	370	280.5
227	167.2	263	194.9	299	223.5	335	251.6	371	281.4
228	167.9	264	195.7	300	224.4	336	252.5	372	282.2
229	168.6	265	196.4	301	225.2	337	253.3	373	283.1
230	169.4	266	197.2	302	225.9	338	254.1	374	283.9
231	170.1	267	198.0	303	226.7	339	254.9	375	284.8
232	170.9	268	198.8	304	227.5	340	255.7	376	285.7
233	171.6	269	199.5	305	228.3	341	256.5	377	286.5
234	172.4	270	200.3	306	229.1	342	257.4	378	287.4
235	173.1	271	201.1	307	229.8	343	258.2	379	288.2
236	173.9	272	201.9	308	230.6	344	259.0	380	289.1
237	174.6	273	202.7	309	231.4	345	259.8	381	289.9
238	175.4	274	203.5	310	232.2	346	260.6	382	290.8
239	176.2	275	204.3	311	232.9	347	261.4	383	291.7
240	176.9	276	205.1	312	233.7	348	262.3	384	292.5
241	177.7	277	205.9	313	234.5	349	263.1	385	293.4
242	178.5	278	206.7	314	235.3	350	263.9	386	294.2
243	179.3	279	207.5	315	236.1	351	264.7	387	295.1
244	180.1	280	208.3	316	236.8	352	265.5	388	296.0
245	180.8	281	209.1	317	237.6	353	266.3	389	296.8
246	181.6	282	209.9	318	238.4	354	267.2	390	297.7
247	182.4	283	210.7	319	239.2	355	268.0	391	298.5
248	183.2	284	211.5	320	240.0	356	268.8	392	299.4
249	184.0	285	212.3	321	240.7	357	269.6	393	300.3
250	184.8	286	213.1	322	241.5	358	270.4	394	301.1
251	185.5	287	213.9	323	242.3	359	271.2	395	302.0
252	186.3	288	214.7	324	243.1	360	272.1	396	302.8
253	187.1	289	215.5	325	243.9	361	272.9	397	303.7
254	187.9	290	216.3	326	244.6	362	273.7	398	304.6
255	188.7	291	217.1	327	245.4	363	274.5	399	305.4
256	189.4	292	217.9	328	246.2	364	275.3	400	306.3
257	190.2	293	218.7	329	247.0	365	276.2		
258	191.0	294	219.5	330	247.7	366	277.1		
259	191.8	295	220.3	331	248.5	367	277.9		
260	192.5	296	221.1	332	249.2	368	278.8		

115. Determination Requiring the use of Allihn's Modification of Fehling's Solution.

(1) *Preparation of Reagents.*

(*a*) *Copper sulphate solution.*—Dissolve 34.639 grams of $CuSO_4, 5H_2O$ in water and dilute to 500 cc.

(*b*) *Alkaline tartrate solution.*—Dissolve 173 grams of Rochelle salts and 125 grams of potassium hydroxid in water and dilute to 500 cc.

(2) *Gravimetric Method for the Determination of Dextrose.*

Place 30 cc. of the copper solution, 30 cc. of the alkaline tartrate solution, and 60 cc. of water in a beaker and heat to boiling. Add 25 cc. of the solution of the material to be examined, which must be so prepared as not to contain more than 0.250 gram of dextrose, and boil for two minutes. Filter immediately through asbestos without diluting, and obtain the weight of copper from the Cu_2O. The corresponding weight of dextrose is found from the following table:

116. Allihn's Table for the Determination of Dextrose.

Milli-grams of cop-per.	Milli-grams of cu-prous oxid.	Milli-grams of dex-trose.	Milli-grams of cop-per.	Milli-grams of cu-prous. oxid.	Milli-grams of dex-trose.	Milli-grams of cop-per.	Milli-grams of cu-prous oxid.	Milli-grams of dex-trose.	Milli-grams of cop-per.	Milli-grams of cu-prous oxid.	Milli-grams of dex-trose.
11	12.4	6.6	71	79.9	36.3	131	147.5	66.7	191	215.0	97.8
12	13.5	7.1	72	81.1	36.8	132	148.6	67.2	192	216.2	98.4
13	14.6	7.6	73	82.2	37.3	133	149.7	67.7	193	217.3	98.9
14	15.8	8.1	74	83.3	37.8	134	150.9	68.2	194	218.4	99.4
15	16.9	8.6	75	84.4	38.3	135	152.0	68.8	195	219.5	100.0
16	18.0	9.0	76	85.6	38.8	136	153.1	69.3	196	220.7	100.5
17	19.1	9.5	77	86.7	39.3	137	154.2	69.8	197	221.8	101.0
18	20.3	10.0	78	87.8	39.8	138	155.4	70.3	198	222.9	101.5
19	21.4	10.5	79	88.9	40.3	139	156.5	70.8	199	224.0	102.0
20	22.5	11.0	80	90.1	40.8	140	157.6	71.3	200	225.2	102.6
21	23.6	11.5	81	91.2	41.3	141	158.7	71.8	201	226.3	103.1
22	24.8	12.0	82	92.3	41.8	142	159.9	72.3	202	227.4	103.7
23	25.9	12.5	83	93.4	42.3	143	161.0	72.9	203	228.5	104.2
24	27.0	13.0	84	94.6	42.8	144	162.1	73.4	204	229.7	104.7
25	28.1	13.5	85	95.7	43.4	145	163.2	73.9	205	230.8	105.3
26	29.3	14.0	86	96.8	43.9	146	164.4	74.4	206	231.9	105.8
27	30.4	14.5	87	97.9	44.4	147	165.5	74.9	207	233.0	106.3
28	31.5	15.0	88	99.1	44.9	148	166.6	75.5	208	234.2	106.8
29	32.7	15.5	89	100.2	45.4	149	167.7	76.0	209	235.3	107.4
30	33.8	16.0	90	101.3	45.9	150	168.9	76.5	210	236.4	107.9
31	34.9	16.5	91	102.4	46.4	151	170.0	77.0	211	237.6	108.4
32	36.0	17.0	92	103.6	46.9	152	171.1	77.5	212	238.7	109.0
33	37.2	17.5	93	104.7	47.4	153	172.3	78.1	213	239.8	109.5
34	38.3	18.0	94	105.8	47.9	154	173.4	78.6	214	240.9	110.0
35	39.4	18.5	95	107.0	48.4	155	174.5	79.1	215	242.1	110.6
36	40.5	18.9	96	108.1	48.9	156	175.6	79.6	216	243.2	111.1
37	41.7	19.4	97	109.2	49.4	157	176.8	80.1	217	244.3	111.6
38	42.8	19.9	98	110.3	49.9	158	177.9	80.7	218	245.4	112.1
39	43.9	20.4	99	111.5	50.4	159	179.0	81.2	219	246.6	112.7
40	45.0	20.9	100	112.6	50.9	160	180.1	81.7	220	247.7	113.2
41	46.2	21.4	101	113.7	51.4	161	181.3	82.2	221	248.8	113.7
42	47.3	21.9	102	114.8	51.9	162	182.4	82.7	222	249.9	114.3
43	48.4	22.4	103	116.0	52.4	163	183.5	83.3	223	251.0	114.8
44	49.5	22.9	104	117.1	52.9	164	184.6	83.8	224	252.4	115.3
45	50.7	23.4	105	118.2	53.5	165	185.8	84.3	225	253.3	115.9
46	51.8	23.9	106	119.3	54.0	166	186.9	84.8	226	254.4	116.4
47	52.9	24.4	107	120.5	54.5	167	188.0	85.3	227	255.6	116.9
48	54.0	24.9	108	121.6	55.0	168	189.1	85.9	228	256.7	117.4
49	55.2	25.4	109	122.7	55.5	169	190.3	86.4	229	257.8	118.0
50	56.3	25.9	110	123.8	56.0	170	191.4	86.9	230	258.9	118.5
51	57.4	26.4	111	125.0	56.5	171	192.5	87.4	231	260.1	119.0
52	58.5	26.9	112	126.1	57.0	172	193.6	87.9	232	261.2	119.6
53	59.7	27.4	113	127.2	57.5	173	194.8	88.5	233	262.3	120.1
54	60.8	27.9	114	128.3	58.0	174	195.9	89.0	234	263.4	120.7
55	61.9	28.4	115	129.6	58.6	175	197.0	89.5	235	264.6	121.2
56	63.0	28.8	116	130.6	59.1	176	198.1	90.0	236	265.7	121.7
57	64.2	29.3	117	131.7	59.6	177	199.3	90.5	237	266.8	122.3
58	65.3	29.8	118	132.8	60.1	178	200.4	91.1	238	268.0	122.8
59	66.4	30.3	119	134.0	60.6	179	201.5	91.6	239	269.1	123.4
60	67.6	30.8	120	135.1	61.1	180	202.6	92.1	240	270.2	123.9
61	68.7	31.3	121	136.2	61.6	181	203.8	92.6	241	271.3	124.4
62	69.8	31.8	122	137.4	62.1	182	204.9	93.1	242	272.5	125.0
63	70.9	32.3	123	138.5	62.6	183	206.0	93.7	243	273.6	125.5
64	72.1	32.8	124	139.6	63.1	184	207.1	94.2	244	274.7	126.0
65	73.2	33.3	125	140.7	63.7	185	208.3	94.7	245	275.8	126.6
66	74.3	33.8	126	141.9	64.2	186	209.4	95.2	246	277.0	127.1
67	75.4	34.3	127	143.0	64.7	187	210.5	95.7	247	278.1	127.6
68	76.6	34.8	128	144.1	65.2	188	211.7	96.3	248	279.2	128.1
69	77.7	35.3	129	145.2	65.7	189	212.8	96.8	249	280.3	128.7
70	78.8	35.8	130	146.4	66.2	190	213.9	97.3	250	281.5	129.2

Allihn's Table for the Determination of Dextrose. (Continued.)

Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of dextrose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of dextrose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of dextrose.	Milligrams of copper.	Milligrams of cuprous oxid.	Milligrams of dextrose.
251	282.6	129.7	305	343.4	159.3	359	404.2	189.4	413	465.0	220.4
252	283.7	130.3	306	344.5	159.8	360	405.3	190.0	414	466.1	221.0
253	284.8	130.8	307	345.6	160.4	361	406.4	190.6	415	467.2	221.6
254	286.0	131.4	308	346.8	160.9	362	407.6	191.1	416	468.4	222.2
255	287.1	131.9	309	347.9	161.5	363	408.7	191.7	417	469.5	222.8
256	288.2	132.4	310	349.0	162.0	364	409.8	192.3	418	470.6	223.3
257	289.3	133.0	311	350.1	162.6	365	410.9	192.9	419	471.8	223.9
258	290.5	133.5	312	351.3	163.1	366	412.1	193.4	420	472.9	224.5
259	291.6	134.1	313	352.4	163.7	367	413.2	194.0	421	474.0	225.1
260	292.7	134.6	314	353.5	164.2	368	414.3	194.6	422	475.6	225.7
261	293.8	135.1	315	354.6	164.8	369	415.4	195.1	423	476.2	226.3
262	295.0	135.7	316	355.8	165.3	370	416.6	195.7	424	477.4	226.9
263	296.1	136.2	317	356.9	165.9	371	417.7	196.3	425	478.5	227.5
264	297.2	136.8	318	358.0	166.4	372	418.8	196.8	426	479.6	228.0
265	298.3	137.3	319	359.1	167.0	373	420.0	197.4	427	480.7	228.6
266	299.5	137.8	320	360.3	167.5	374	421.1	198.0	428	481.9	229.2
267	300.6	138.4	321	361.4	168.1	375	422.2	198.6	429	483.0	229.8
268	301.7	138.9	322	362.5	168.6	376	423.3	199.1	430	484.1	230.4
269	302.8	139.5	323	363.7	169.2	377	424.5	199.7	431	485.3	231.0
270	304.0	140.0	324	364.8	169.7	378	425.6	200.3	432	486.4	231.6
271	305.1	140.6	325	365.9	170.3	379	426.7	200.8	433	487.5	232.2
272	306.2	141.1	326	367.0	170.9	380	427.8	201.4	434	488.6	232.8
273	307.3	141.7	327	368.2	171.4	381	429.0	202.0	435	489.7	233.4
274	308.5	142.2	328	369.3	172.0	382	430.1	202.5	436	490.9	233.9
275	309.6	142.8	329	370.4	172.5	383	431.2	203.1	437	492.0	234.5
276	310.7	143.3	330	371.5	173.1	384	432.3	203.7	438	493.1	235.1
277	311.9	143.9	331	372.7	173.7	385	433.5	204.3	439	494.3	235.7
278	313.0	144.4	332	373.8	174.2	386	434.6	204.8	440	495.4	236.3
279	314.1	145.0	333	374.9	174.8	387	435.7	205.4	441	496.5	236.9
280	315.2	145.5	334	376.0	175.3	388	436.8	206.0	442	497.6	237.5
281	316.4	146.1	335	377.2	175.9	389	438.0	206.5	443	498.8	238.1
282	317.5	146.6	336	378.3	176.5	390	439.1	207.1	444	499.9	238.7
283	318.6	147.2	337	379.4	177.0	391	440.2	207.7	445	501.0	239.3
284	319.7	147.7	338	380.5	177.6	392	441.3	208.3	446	502.1	239.8
285	320.9	148.3	339	381.7	178.1	393	442.4	208.8	447	503.2	240.4
286	322.0	148.8	340	382.8	178.7	394	443.6	209.4	448	504.4	241.0
287	323.1	149.4	341	383.9	179.3	395	444.7	210.0	449	505.5	241.6
288	324.2	149.9	342	385.0	179.8	396	445.9	210.6	450	506.6	242.2
289	325.4	150.5	343	386.2	180.4	397	447.0	211.2	451	507.8	242.8
290	326.5	151.0	344	387.3	180.9	398	448.1	211.7	452	508.9	243.4
291	327.4	151.6	345	388.4	181.5	399	449.2	212.3	453	510.0	244.0
292	328.7	152.1	346	389.6	182.1	400	450.3	212.9	454	511.1	244.6
293	329.9	152.7	347	390.7	182.6	401	451.5	213.5	455	512.3	245.2
294	331.0	153.2	348	391.8	183.2	402	452.6	214.1	456	513.4	245.7
295	332.1	153.8	349	392.9	183.7	403	453.7	214.6	457	514.5	246.3
296	333.3	154.3	350	394.0	184.3	404	454.8	215.2	458	515.6	246.9
297	334.4	154.9	351	395.2	184.9	405	456.0	215.8	459	516.8	247.5
298	335.5	155.4	352	396.3	185.4	406	457.1	216.4	460	517.9	248.1
299	336.6	156.0	353	397.4	186.0	407	458.2	217.0	461	519.0	248.7
300	337.8	156.5	354	398.6	186.6	408	459.4	217.5	462	520.1	249.3
301	338.9	157.1	355	399.7	187.2	409	460.5	218.1	463	521.3	249.9
302	340.0	157.6	356	400.8	187.7	410	461.6	218.7			
303	341.1	158.2	357	401.9	188.3	411	462.7	219.3			
304	342.3	158.7	358	403.1	188.9	412	463.8	219.9			

117. Relation of Brix, Specific Gravity, Baumé. $\frac{17.5^\circ}{17.5^\circ}$C.

(Stammer.)

°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.
0.1	1.00038	0.06	6.6	1.02616	3.7	13.1	1.05318	7.3	19.6	1.08151	10.85
0.2	1.00077	0.11	6.7	1.02657	3.7	13.2	1.05361	7.3	19.7	1.08196	10.9
0.3	1.00116	0.17	6.8	1.02694	3.8	13.3	1.05404	7.4	19.8	1.08240	11.0
0.4	1.00155	0.22	6.9	1.02738	3.8	13.4	1.05446	7.4	19.9	1.08285	11.0
0.5	1.00193	0.28	7.0	1.02779	3.9	13.5	1.05489	7.5	20.0	1.08329	11.1
0.6	1.00232	0.33	7.1	1.02819	3.9	13.6	1.05532	7.5	20.1	1.08374	11.1
0.7	1.00271	0.39	7.2	1.02860	4.0	13.7	1.05574	7.6	20.2	1.08419	11.2
0.8	1.00310	0.44	7.3	1.02901	4.1	13.8	1.05617	7.65	20.3	1.08464	11.2
0.9	1.00349	0.5	7.4	1.02942	4.1	13.9	1.05660	7.7	20.4	1.08509	11.3
1.0	1.00388	0.55	7.5	1.02983	4.2	14.0	1.05703	7.8	20.5	1.08553	11.3
1.1	1.00427	0.6	7.6	1.03024	4.2	14.1	1.05746	7.8	20.6	1.08599	11.4
1.2	1.00466	0.7	7.7	1.03064	4.3	14.2	1.05789	7.9	20.7	1.08643	11.45
1.3	1.00505	0.7	7.8	1.03105	4.3	14.3	1.05831	7.9	20.8	1.08688	11.5
1.4	1.00544	0.8	7.9	1.03146	4.4	14.4	1.05874	8.0	20.9	1.08733	11.6
1.5	1.00583	0.8	8.0	1.03187	4.4	14.5	1.05917	8.0	21.0	1.08778	11.6
1.6	1.00622	0.9	8.1	1.03228	4.5	14.6	1.05960	8.1	21.1	1.08824	11.7
1.7	1.00662	0.9	8.2	1.03270	4.55	14.7	1.06003	8.15	21.2	1.08869	11.7
1.8	1.00701	1.0	8.3	1.03311	4.6	14.8	1.06047	8.2	21.3	1.08914	11.8
1.9	1.00740	1.05	8.4	1.03352	4.7	14.9	1.06090	8.3	21.4	1.08959	11.8
2.0	1.00779	1.1	8.5	1.03393	4.7	15.0	1.06133	8.3	21.5	1.09004	11.9
2.1	1.00818	1.2	8.6	1.03434	4.8	15.1	1.06176	8.4	21.6	1.09049	11.95
2.2	1.00858	1.2	8.7	1.03475	4.8	15.2	1.06219	8.4	21.7	1.09095	12.0
2.3	1.00897	1.3	8.8	1.03517	4.9	15.3	1.06262	8.5	21.8	1.09140	12.05
2.4	1.00936	1.3	8.9	1.03558	4.9	15.4	1.06306	8.5	21.9	1.09185	12.1
2.5	1.00976	1.4	9.0	1.03599	5.0	15.5	1.06349	8.6	22.0	1.09231	12.2
2.6	1.01015	1.4	9.1	1.03640	5.05	15.6	1.06392	8.65	22.1	1.09276	12.2
2.7	1.01055	1.5	9.2	1.03682	5.1	15.7	1.06436	8.7	22.2	1.09321	12.3
2.8	1.01094	1.55	9.3	1.03723	5.2	15.8	1.06479	8.8	22.3	1.09367	12.3
2.9	1.01134	1.6	9.4	1.03765	5.2	15.9	1.06522	8.8	22.4	1.09412	12.4
3.0	1.01173	1.7	9.5	1.03806	5.3	16.0	1.06566	8.9	22.5	1.09458	12.4
3.1	1.01213	1.7	9.6	1.03848	5.3	16.1	1.06609	8.9	22.6	1.09503	12.5
3.2	1.01252	1.8	9.7	1.03889	5.4	16.2	1.06653	9.0	22.7	1.09549	12.55
3.3	1.01292	1.8	9.8	1.03931	5.4	16.3	1.06696	9.0	22.8	1.09595	12.6
3.4	1.01332	1.9	9.9	1.03972	5.5	16.4	1.06740	9.1	22.9	1.09640	12.7
3.5	1.01371	1.9	10.0	1.04014	5.55	16.5	1.06783	9.1	23.0	1.09686	12.7
3.6	1.01411	2.0	10.1	1.04055	5.6	16.6	1.06827	9.2	23.1	1.09732	12.8
3.7	1.01451	2.0	10.2	1.04097	5.7	16.7	1.06871	9.25	23.2	1.09777	12.8
3.8	1.01491	2.1	10.3	1.04139	5.7	16.8	1.06914	9.3	23.3	1.09823	12.9
3.9	1.01531	2.2	10.4	1.04180	5.8	16.9	1.06958	9.4	23.4	1.09869	12.9
4.0	1.01570	2.2	10.5	1.04222	5.8	17.0	1.07002	9.4	23.5	1.09915	13.0
4.1	1.01610	2.3	10.6	1.04264	5.9	17.1	1.07046	9.5	23.6	1.09961	13.0
4.2	1.01650	2.3	10.7	1.04306	5.9	17.2	1.07090	9.5	23.7	1.10007	13.1
4.3	1.01690	2.4	10.8	1.04348	6.0	17.3	1.07133	9.6	23.8	1.10053	13.15
4.4	1.01730	2.4	10.9	1.04390	6.05	17.4	1.07177	9.6	23.9	1.10099	13.2
4.5	1.01770	2.5	11.0	1.04431	6.1	17.5	1.07221	9.7	24.0	1.10145	13.3
4.6	1.01810	2.6	11.1	1.04473	6.2	17.6	1.07265	9.75	24.1	1.10191	13.3
4.7	1.01850	2.6	11.2	1.04515	6.2	17.7	1.07309	9.8	24.2	1.10237	13.4
4.8	1.01890	2.7	11.3	1.04557	6.3	17.8	1.07353	9.9	24.3	1.10283	13.4
4.9	1.01930	2.7	11.4	1.04599	6.3	17.9	1.07397	9.9	24.4	1.10329	13.5
5.0	1.01970	2.8	11.5	4.04641	6.4	18.0	1.07441	10.0	24.5	1.10375	13.5
5.1	1.02010	2.8	11.6	1.04683	6.4	18.1	1.07485	10.0	24.6	1.10421	13.6
5.2	1.02051	2.9	11.7	1.04726	6.5	18.2	1.07530	10.1	24.7	1.10468	13.6
5.3	1.02091	2.9	11.8	1.04768	6.55	18.3	1.07574	10.1	24.8	1.10514	13.7
5.4	1.02131	3.0	11.9	1.04810	6.6	18.4	1.07618	10.2	24.9	1.10560	13.75
5.5	1.02171	3.0	12.0	1.04852	6.7	18.5	1.07662	10.2	25.0	1.10607	13.8
5.6	1.02211	3.1	12.1	1.04894	6.7	18.6	1.07706	10.3	25.1	1.10653	13.9
5.7	1.02252	3.2	12.2	1.04937	6.8	18.7	1.07751	10.35	25.2	1.10700	13.9
5.8	1.02292	3.2	12.3	1.04979	6.8	18.8	1.07795	10.4	25.3	1.10746	14.0
5.9	1.02333	3.3	12.4	1.05021	6.9	18.9	1.07839	10.5	25.4	1.10793	14.0
6.0	1.02373	3.3	12.5	1.05064	6.9	19.0	1.07884	10.5	25.5	1.10839	14.1
6.1	1.02413	3.4	12.6	1.05106	7.0	19.1	1.07928	10.6	25.6	1.10886	14.1
6.2	1.02454	3.4	12.7	1.05149	7.05	19.2	1.07973	10.6	25.7	1.10932	14.2
6.3	1.02494	3.5	12.8	1.05191	7.1	19.3	1.08017	10.7	25.8	1.10979	14.2
6.4	1.02535	3.6	12.9	1.05233	7.2	19.4	1.08062	10.7	25.9	1.11026	14.3
6.5	1.02575	3.6	13.0	1.05276	7.2	19.5	1.08106	10.8	26.0	1.11072	14.35

Relation of Brix, Specific Gravity, and Baumé. (Continued.)

°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Pei cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.
26.1	1.11119	14.4	32.6	1.14227	17.9	39.1	1.17481	21.4	45.6	1.20886	24.9
26.2	1.11166	14.5	32.7	1.14276	18.0	39.2	1.17532	21.5	45.7	1.20939	24.9
26.3	1.11213	14.5	32.8	1.14325	18.0	39.3	1.17583	21.5	45.8	1.20993	25.0
26.4	1.11259	14.6	32.9	1.14374	18.1	39.4	1.17635	21.6	45.9	1.21046	25.0
26.5	1.11306	14.6	33.0	1.14423	18.15	39.5	1.17686	21.6	46.0	1.21100	25.1
26.6	1.11353	14.7	33.1	1.14472	18.2	39.6	1.17737	21.7	46.1	1.21154	25.1
26.7	1.11400	14.7	33.2	1.14521	18.25	39.7	1.17789	21.7	46.2	1.21208	25.2
26.8	1.11447	14.8	33.3	1.14570	18.3	39.8	1.17840	21.8	46.3	1.21261	25.2
26.9	1.11494	14.8	33.4	1.14620	18.4	39.9	1.17892	21.85	46.4	1.21315	25.3
27.0	1.11541	14.9	33.5	1.14669	18.4	40.0	1.17943	21.9	46.5	1.21369	25.35
27.1	1.11588	14.9	33.6	1.14718	18.5	40.1	1.17995	22.0	46.6	1.21423	25.4
27.2	1.11635	15.0	33.7	1.14767	18.5	40.2	1.18046	22.0	46.7	1.21477	25.45
27.3	1.11682	15.1	33.8	1.14816	18.6	40.3	1.18090	22.1	46.8	1.21531	25.5
27.4	1.11729	15.1	33.9	1.14866	18.6	40.4	1.18150	22.1	46.9	1.21585	25.6
27.5	1.11776	15.2	34.0	1.14915	18.7	40.5	1.18201	22.2	47.0	1.21639	25.6
27.6	1.11824	15.2	34.1	1.14965	18.7	40.6	1.18253	22.2	47.1	1.21693	25.7
27.7	1.11871	15.3	34.2	1.15014	18.8	40.7	1.18305	22.3	47.2	1.21747	25.7
27.8	1.11918	15.3	34.3	1.15064	18.85	40.8	1.18357	22.3	47.5	1.21802	25.8
27.9	1.11965	15.4	34.4	1.15113	18.9	40.9	1.18408	22.4	47.4	1.21856	25.8
28.0	1.12013	15.4	34.5	1.15163	18.95	41.0	1.18460	22.4	47.5	1.21910	25.9
28.1	1.12060	15.5	34.6	1.15213	19.0	41.1	1.18512	22.5	47.6	1.21964	25.9
28.2	1.12107	15.55	34.7	1.15262	19.1	41.2	1.18564	22.5	47.7	1.22019	26.0
28.3	1.12155	15.6	34.8	1.15312	19.1	41.3	1.18616	22.6	47.8	1.22073	26.0
28.4	1.12202	15.7	34.9	1.15362	19.2	41.4	1.18668	22.65	47.9	1.22127	26.1
28.5	1.12250	15.7	35.0	1.15411	19.2	41.5	1.18720	22.7	48.0	1.22182	26.1
28.6	1.12297	15.8	35.1	1.15461	19.3	41.6	1.18772	22.75	48.1	1.22236	26.2
28.7	1.12345	15.8	35.2	1.15511	19.3	41.7	1.18824	22.8	48.2	1.22291	26.2
28.8	1.12393	15.9	35.3	1.15561	19.4	41.8	1.18877	22.9	48.3	1.22345	26.3
28.9	1.12440	15.9	35.4	1.15611	19.4	41.9	1.18929	22.9	48.4	1.22400	26.35
29.0	1.12488	16.0	35.5	1.15661	19.5	42.0	1.18981	23.0	48.5	1.22455	26.4
29.1	1.12536	16.0	35.6	1.15710	19.55	42.1	1.19033	23.0	48.6	1.22509	26.45
29.2	1.12583	16.1	35.7	1.15760	19.6	42.2	1.19086	23.1	48.7	1.22564	26.5
29.3	1.12631	16.1	35.8	1.15810	19.65	42.3	1.19138	23.1	48.8	1.22619	26.6
29.4	1.12679	16.2	35.9	1.15861	19.7	42.4	1.19190	23.2	48.9	1.22673	26.6
29.5	1.12727	16.25	36.0	1.15911	19.8	42.5	1.19243	23.2	49.0	1.22728	26.7
29.6	1.12775	16.3	36.1	1.15961	19.8	42.6	1.19295	23.3	49.1	1.22783	26.7
29.7	1.12823	16.4	36.2	1.16011	19.9	42.7	1.19348	23.3	49.2	1.22838	26.8
29.8	1.12871	16.4	36.3	1.16061	19.9	42.8	1.19400	23.4	49.3	1.22893	26.8
29.9	1.12919	16.5	36.4	1.16111	20.0	42.9	1.19453	23.45	49.4	1.22948	26.9
30.0	1.12967	16.5	36.5	1.16162	20.0	43.0	1.19505	23.5	49.5	1.23003	26.9
30.1	1.13015	16.6	36.6	1.16212	20.1	43.1	1.19558	23.55	49.6	1.23058	27.0
30.2	1.13063	16.6	36.7	1.16262	20.1	43.2	1.19611	23.6	49.7	1.23113	27.0
30.3	1.13111	16.7	36.8	1.16313	20.2	43.3	1.19663	23.7	49.8	1.23168	27.1
30.4	1.13159	16.7	36.9	1.16363	20.2	43.4	1.19716	23.7	49.9	1.23223	27.1
30.5	1.13207	16.8	37.0	1.16413	20.3	43.5	1.19769	23.8	50.0	1.23278	27.2
30.6	1.13255	16.85	37.1	1.16464	20.35	43.6	1.19822	23.8	50.1	1.23334	27.2
30.7	1.13304	16.9	37.2	1.16514	20.4	43.7	1.19875	23.9	50.2	1.23389	27.3
30.8	1.13352	17.0	37.3	1.16565	20.5	43.8	1.19927	23.9	50.3	1.23444	27.3
30.9	1.13400	17.0	37.4	1.16616	20.5	43.9	1.19980	24.0	50.4	1.23499	27.4
31.0	1.13449	17.1	37.5	1.16666	20.6	44.0	1.20033	24.0	50.5	1.23555	27.45
31.1	1.13497	17.1	37.6	1.16717	20.6	44.1	1.20086	24.1	50.6	1.23610	27.5
31.2	1.13545	17.2	37.7	1.16768	20.7	44.2	1.20139	24.1	50.7	1.23666	27.55
31.3	1.13594	17.2	37.8	1.16818	20.7	44.3	1.20192	24.2	50.8	1.23721	27.6
31.4	1.13642	17.3	37.9	1.16869	20.8	44.4	1.20245	24.2	50.9	1.23777	27.7
31.5	1.13691	17.3	38.0	1.16920	20.8	44.5	1.20299	24.3	51.0	1.23832	27.7
31.6	1.13740	17.4	38.1	1.16971	20.9	44.6	1.20352	24.35	51.1	1.23888	27.8
31.7	1.13788	17.4	38.2	1.17022	20.9	44.7	1.20405	24.4	51.2	1.23943	27.8
31.8	1.13837	17.5	38.3	1.17072	21.0	44.8	1.20458	24.45	51.3	1.23999	27.9
31.9	1.13885	17.55	38.4	1.17123	21.05	44.9	1.20512	24.5	51.4	1.24055	27.9
32.0	1.13934	17.6	38.5	1.17174	21.1	45.0	1.20565	24.6	51.5	1.24111	28.0
32.1	1.13983	17.7	38.6	1.17225	21.15	45.1	1.20618	24.6	51.6	1.24166	28.0
32.2	1.14032	17.7	38.7	1.17276	21.2	45.2	1.20672	24.7	51.7	1.24222	28.1
32.3	1.14081	17.8	38.8	1.17327	21.3	45.3	1.20725	24.7	51.8	1.24278	28.1
32.4	1.14129	17.8	38.9	1.17379	21.3	45.4	1.20779	24.8	51.9	1.24334	28.2
32.5	1.14178	17.9	39.0	1.17430	21.4	45.5	1.20832	42.8	52.0	1.24390	28.2

Relation of Brix, Specific Gravity, and Baumé. (Continued.)

°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent. of sugar.)	Specific gravity.	Degree Baumé.
52.1	1.24446	28.3	58.6	1.28166	31.6	65.1	1.32050	34.95	71.6	1.36101	38.2
52.2	1.24502	28.3	58.7	1.28224	31.7	65.2	1.32111	35.0	71.7	1.36164	38.2
52.3	1.24558	28.4	58.8	1.28283	31.7	65.3	1.32172	35.05	71.8	1.36238	38.2
52.4	1.24614	28.4	58.9	1.28342	31.8	65.4	1.32233	35.1	71.9	1.36292	38.3
52.5	1.24670	28.5	59.0	1.28400	31.85	65.5	1.32294	35.15	72.0	1.36355	38.3
52.6	1.24726	28.5	59.1	1.28459	31.9	65.6	1.32355	35.2	72.1	1.36429	38.4
52.7	1.24782	28.6	59.2	1.28518	31.95	65.7	1.32417	35.25	72.2	1.36483	38.4
52.8	1.24839	28.65	59.3	1.28576	32.0	65.8	1.32478	35.3	72.3	1.36557	38.5
52.9	1.24895	28.7	59.4	1.28635	32.05	65.9	1.32539	35.35	72.4	1.36611	38.5
53.0	1.24951	28.75	59.5	1.28694	32.1	66.0	1.32601	35.4	72.5	1.36675	38.6
53.1	1.25008	28.8	59.6	1.28753	32.15	66.1	1.32662	35.4	72.6	1.36749	38.6
53.2	1.25064	28.85	59.7	1.28812	32.2	66.2	1.32724	35.5	72.7	1.36803	38.7
53.3	1.25120	28.9	59.8	1.28871	32.3	66.3	1.32785	35.5	72.8	1.36877	38.7
53.4	1.25177	28.9	59.9	1.28930	32.3	66.4	1.32857	35.6	72.9	1.36931	38.8
53.5	1.25233	29.0	60.0	1.28989	32.4	66.5	1.32918	35.6	73.0	1.36995	38.8
53.6	1.25290	29.1	60.1	1.29048	32.4	66.6	1.32970	35.7	73.1	1.37059	38.9
53.7	1.25347	29.1	60.2	1.29107	32.5	66.7	1.33031	35.7	73.2	1.37124	38.9
53.8	1.25403	29.2	60.3	1.29166	32.5	66.8	1.33093	35.8	73.3	1.37198	39.0
53.9	1.25460	29.2	60.4	1.29225	32.6	66.9	1.33155	35.8	73.4	1.37252	39.0
54.0	1.25517	29.3	60.5	1.29284	32.6	67.0	1.33227	35.9	73.5	1.37327	39.1
54.1	1.25573	29.3	60.6	1.29343	32.7	67.1	1.33278	35.9	73.6	1.37381	39.1
54.2	1.25630	29.4	60.7	1.29403	32.7	67.2	1.33340	36.0	73.7	1.37456	39.2
54.3	1.25687	29.4	60.8	1.29462	32.8	67.3	1.33402	36.0	73.8	1.37510	39.2
54.4	1.25747	29.5	60.9	1.29521	32.8	67.4	1.33464	36.1	73.9	1.37575	39.3
54.5	1.25801	29.5	61.0	1.29581	32.9	67.5	1.33526	36.1	74.0	1.37649	39.3
54.6	1.25857	29.6	61.1	1.29640	32.9	67.6	1.33598	36.2	74.1	1.37704	39.4
54.7	1.25914	29.6	61.2	1.29700	33.0	67.7	1.33650	36.2	74.2	1.37778	39.4
54.8	1.25971	29.7	61.3	1.29759	33.0	67.8	1.33712	36.3	74.3	1.37833	39.5
54.9	1.26028	29.7	61.4	1.29819	33.1	67.9	1.33774	36.3	74.4	1.37908	39.5
55.0	1.26086	29.8	61.5	1.29878	33.1	68.0	1.33846	36.4	74.5	1.37962	39.6
55.1	1.26143	29.8	61.6	1.29938	33.2	68.1	1.33909	36.4	74.6	1.38037	39.6
55.2	1.26200	29.9	61.7	1.29998	33.2	68.2	1.33961	36.5	74.7	1.38092	39.7
55.3	1.26257	29.9	61.8	1.30057	33.3	68.3	1.34023	36.5	74.8	1.38167	39.7
55.4	1.26314	30.0	61.9	1.30117	33.3	68.4	1.34085	36.6	74.9	1.38222	39.8
55.5	1.26372	30.05	62.0	1.30177	33.4	68.5	1.34158	36.6	75.0	1.38287	39.8
55.6	1.26429	30.1	62.1	1.30237	33.4	68.6	1.34210	36.7	75.1	1.38352	39.9
55.7	1.26486	30.15	62.2	1.30297	33.5	68.7	1.34273	36.7	75.2	1.38427	39.9
55.8	1.26544	30.2	62.3	1.30356	33.5	68.8	1.34335	36.8	75.3	1.38482	40.0
55.9	1.26601	30.25	62.4	1.30416	33.6	68.9	1.34408	36.8	75.4	1.38557	40.0
56.0	1.26658	30.3	62.5	1.30476	33.6	69.0	1.34460	36.9	75.5	1.38612	40.1
56.1	1.26716	30.4	62.6	1.30536	33.7	69.1	1.34523	36.9	75.6	1.38687	40.1
56.2	1.26773	30.4	62.7	1.30596	33.7	69.2	1.34585	37.0	75.7	1.38743	40.2
56.3	1.26831	30.5	62.8	1.30657	33.8	69.3	1.34658	37.0	75.8	1.38808	40.2
56.4	1.26889	30.5	62.9	1.30717	33.8	69.4	1.34711	37.1	75.9	1.38873	40.3
56.5	1.26946	30.6	63.0	1.30777	33.9	69.5	1.34774	37.1	76.0	1.38949	40.3
56.6	1.27004	30.6	63.1	1.30837	33.9	69.8	1.34846	37.2	76.1	1.39004	40.4
56.7	1.27062	30.7	63.2	1.30897	34.0	69.7	1.34909	37.2	76.2	1.39070	40.4
56.8	1.27120	30.7	63.3	1.30958	34.0	69.8	1.34962	37.3	76.3	1.39135	40.5
56.9	1.27177	30.8	63.4	1.31018	34.1	69.9	1.35025	37.3	76.4	1.39201	40.5
57.0	1.27235	30.8	63.5	1.31078	34.1	70.0	1.35098	37.4	76.5	1.39266	40.6
57.1	1.27293	30.9	63.6	1.31139	34.2	70.1	1.35151	37.4	76.6	1.39332	40.6
57.2	1.27351	30.9	63.7	1.31199	34.2	70.2	1.35214	37.5	76.7	1.39407	40.7
57.3	1.27400	31.0	63.8	1.31260	34.3	70.3	1.35287	37.5	76.8	1.39463	40.7
57.4	1.27464	31.0	63.9	1.31320	34.3	70.4	1.35340	37.6	76.9	1.39539	40.8
57.5	1.27525	31.1	64.0	1.31381	34.4	70.5	1.35403	37.6	77.0	1.39595	40.8
57.6	1.27583	31.1	64.1	1.31442	34.4	70.6	1.35466	37.7	77.1	1.39660	40.8
57.7	1.27641	31.2	64.2	1.31502	34.5	70.7	1.35530	37.7	77.2	1.39726	40.9
57.8	1.27699	31.2	64.3	1.31563	34.5	70.8	1.35593	37.8	77.3	1.39792	41.0
57.9	1.27758	31.3	64.4	1.31624	34.6	70.9	1.35656	37.8	77.4	1.39868	41.0
58.0	1.27816	31.3	64.5	1.31684	34.6	71.0	1.35720	37.9	77.5	1.39924	41.0
58.1	1.27874	31.4	64.6	1.31745	34.7	71.1	1.35783	37.9	77.6	1.39992	41.1
58.1	1.27932	31.4	64.7	1.31806	34.7	71.2	1.35857	38.0	77.7	1.40056	41.1
58.3	1.27991	31.5	64.8	1.31867	34.8	71.3	1.35910	38.0	77.8	1.40122	41.2
58.4	1.28049	31.5	64.9	1.31928	34.8	71.4	1.35974	38.1	77.9	1.40198	41.2
58.5	1.28107	31.6	65.0	1.31989	34.9	71.5	1.36047	38.1	78.0	1.40254	41.3

Relation of Brix, Specific Gravity, and Baumé. (Continued.)

°Brix, (Per cent of sugar)	Specific gravity.	Degree Baumé.	°Brix, (Per cent of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent of sugar.)	Specific gravity.	Degree Baumé.	°Brix, (Per cent of sugar.)	Specific gravity.	Degree Baumé.
78.1	1.40321	41.3	80.1	1.41653	42.3	82.1	1.43002	43.3	84.1	1.44377	44.2
78.2	1.40397	41.4	80.2	1.41720	42.3	82.2	1.43070	43.3	84.2	1.44435	44.3
78.3	1.40453	41.4	80.3	1.41797	42.4	82.3	1.43147	43.4	84.3	1.44504	44.3
78.4	1.40520	41.5	80.4	1.41854	42.4	82.4	1.43205	43.4	84.4	1.44573	44.3
78.5	1.40586	41.5	80.5	1.41921	42.5	82.5	1.43273	43.5	84.5	1.44641	44.4
78.6	1.40652	41.6	80.6	1.41999	42.5	82.6	1.43341	43.5	84.6	1.44710	44.4
78.7	1.40729	41.6	80.7	1.42056	42.6	82.7	1.43419	43.5	84.7	1.44789	44.5
78.8	1.40785	41.7	80.8	1.42123	42.6	82.8	1.43488	43.6	84.8	1.44858	44.5
78.9	1.40852	41.7	80.9	1.42190	42.7	82.9	1.43546	43.6	84.9	1.44927	44.6
79.0	1.40928	41.8	81.0	1.42268	42.7	83.0	1.43614	43.7	85.0	1.44986	44.6
79.1	1.40985	41.8	81.1	1.42325	42.8	83.1	1.43682	43.7	85.1	1.45055	44.7
79.2	1.41052	41.9	81.2	1.42393	42.8	83.2	1.43750	43.8	85.2	1.45124	44.7
79.3	1.41128	41.9	81.3	1.42460	42.9	83.3	1.43829	43.8	85.3	1.45193	44.8
79.4	1.41195	42.0	81.4	1.42538	42.9	83.4	1.43887	43.9	85.4	1.45262	44.8
79.5	1.41252	42.0	81.5	1.42595	43.0	83.5	1.43955	43.9	85.5	1.45331	44.9
79.6	1.41328	42.1	81.6	1.42663	43.0	83.6	1.44024	44.0	85.6	1.45401	44.9
79.7	1.41385	42.1	81.7	1.42731	43.1	83.7	1.44092	44.0	85.7	1.45470	45.0
79.8	1.41452	42.2	81.8	1.42808	43.1	83.8	1.44161	44.1	85.8	1.45549	45.0
79.9	1.41529	42.2	81.9	1.42876	43.2	83.9	1.44239	44.1	85.9	1.45619	45.1
80.0	1.41586	42.2	82.0	1.42934	43.2	84.0	1.44308	44.2	86.0	1.45688	45.1

118. Table for Correction of the Readings of the Brix Spindle when the Reading is made at other than the Standard Temperature, 17.5°.
(Gerlach.)

[For temperatures below 17.5° the correction is to be subtracted.]

Temperature.	Degree Brix of the solution.												
	0	5	10	15	20	25	30	35	40	50	60	70	75
° C. 0	0.17	0.30	0.41	0.52	0.62	0.72	0.82	0.92	0.98	1.11	1.22	1.25	1.29
5	0.23	0.30	0.37	0.44	0.52	0.59	0.65	0.72	0.75	0.80	0.88	0.91	0.94
10	0.20	0.26	0.29	0.33	0.36	0.39	0.42	0.45	0.48	0.50	0.54	0.58	0.61
11	0.18	0.23	0.26	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.47	0.50	0.53
12	0.16	0.20	0.22	0.24	0.26	0.29	0.31	0.33	0.34	0.36	0.40	0.42	0.46
13	0.14	0.18	0.19	0.21	0.22	0.24	0.26	0.27	0.28	0.29	0.33	0.35	0.39
14	0.12	0.15	0.16	0.17	0.18	0.19	0.21	0.22	0.22	0.23	0.26	0.28	0.32
15	0.09	0.11	0.12	0.14	0.14	0.15	0.16	0.17	0.16	0.17	0.19	0.21	0.25
16	0.06	0.07	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.12	0.14	0.16	0.18
17	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06
For temperatures above 17.5° the correction is to be added.													
18	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
19	0.06	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.06
20	0.11	0.14	0.15	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.18	0.15	0.11
21	0.16	0.20	0.22	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.25	0.22	0.18
22	0.21	0.26	0.29	0.31	0.31	0.32	0.32	0.32	0.33	0.34	0.32	0.29	0.25
23	0.27	0.32	0.35	0.37	0.38	0.39	0.39	0.39	0.40	0.42	0.39	0.36	0.33
24	0.32	0.38	0.41	0.43	0.44	0.46	0.46	0.47	0.47	0.50	0.46	0.43	0.40
25	0.37	0.44	0.47	0.49	0.51	0.53	0.54	0.55	0.55	0.58	0.54	0.51	0.48
26	0.43	0.50	0.54	0.56	0.58	0.60	0.61	0.62	0.62	0.66	0.62	0.58	0.55
27	0.49	0.57	0.61	0.63	0.65	0.68	0.68	0.69	0.70	0.74	0.70	0.65	0.62
28	0.56	0.64	0.68	0.70	0.72	0.76	0.76	0.78	0.78	0.82	0.78	0.72	0.70
29	0.63	0.71	0.75	0.78	0.79	0.84	0.84	0.86	0.86	0.90	0.86	0.80	0.78
30	0.70	0.78	0.82	0.87	0.87	0.92	0.92	0.94	0.94	0.98	0.94	0.88	0.86
35	1.10	1.17	1.22	1.24	1.30	1.32	1.33	1.35	1.36	1.39	1.34	1.27	1.25
40	1.50	1.61	1.67	1.71	1.73	1.79	1.79	1.80	1.82	1.83	1.78	1.69	1.65
50	....	2.65	2.71	2.74	2.78	2.80	2.80	2.80	2.80	2.79	2.70	2.56	2.51
60	....	3.87	3.88	3.88	3.88	3.88	3.88	3.88	3.90	3.82	3.70	3.43	3.41
70	....	5.17	5.18	5.20	5.14	5.13	5.10	5.08	5.06	4.90	4.72	4.47	4.35
80	....	.....	6.62	6.59	6.54	6.46	6.38	6.30	6.26	6.06	5.82	5.50	5.33
90	....	.....	8.26	8.16	8.06	7.97	7.83	7.71	7.58	7.30	6.96	6.58	6.37
100	....	.....	10.01	9.87	9.72	9.56	9.39	9.21	9.03	8.64	8.22	7.76	7.42

Example—A sugar solution shows a reading of 30.2° Brix at 30° C. To find the necessary correction for the conversion of this reading to the reading which would have been obtained if the observation had been made at 17.5° C., find the vertical column in the table headed 30° Brix, which is the nearest to the observed reading. Follow down this column until the number is reached which is opposite to the temperature of observation—in this case 30°. The number found, 0.92, is to be added to the observed reading.

INDEX.

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