First Commission Directive of 26 July 1979 laying down Community methods of analysis for testing certain sugars intended for human consumption (79/796/EEC)

[[X1]FIRST COMMISSION DIRECTIVE

of 26 July 1979

laying down Community methods of analysis for testing certain sugars intended for human consumption

(79/796/EEC)**]**

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community,

Having regard to Council Directive 73/437/EEC of 11 December 1973 on the approximation of the laws of the Member States concerning certain sugars intended for human consumption[(1)], and in particular Article 11 thereof,

Whereas Article 11 of that Directive lays down that the composition of certain sugars shall be verified by Community methods of analysis;

Whereas it is desirable to adopt an initial series of methods in respect of which studies have been completed;

Whereas the method of determining the colour type for sugar or white sugar and for extra-white sugar, the method of measuring the conductivity ash in extra-white sugar, in sugar solution, in invert sugar solution and in invert sugar syrup, and the method of determining the colour in solution of extra-white sugar and sugar solution are laid down in the Annex to Directive 73/437/EEC;

Whereas, on the other hand, pending the formulation of further Community methods for the determination of reducing sugars, it would be advisable to allow the Member States the option of continuing to authorize the use of the Lane and Eynon method (methods 7 and 8 in Annex II, III.3 and III.4) instead of the Luff-Schoorl method (method 6 in Annex 11, III.3 and III.4);

Whereas the methods of analysis provided for in this Directive are in accordance with the opinion of the Standing Committee on Foodstuffs,

HAS ADOPTED THIS DIRECTIVE:

Editorial Information

X1 Substituted by Corrigendum to First Commission Directive 79/796/EEC of 26 July 1979 laying down Community methods of analysis for testing certain sugars intended for human consumption (Official Journal of the European Communities L 239 of 22 September 1979).

Article 1

1 Member States shall require that the analyses necessary for verification of the criteria set out in Annex I be performed according to the methods described in Annex II to this Directive.

2 Without prejudice to the second subparagraph, the Luff-Schoorl method (Annex II, method 6) shall be used to determine the reducing sugars in the following sugars:

— sugar solution,
— white sugar solution,
— invert sugar solution,
— white invert sugar solution,
— invert sugar syrup,
— glucose syrup,
— dried glucose syrup,
— dextrose monohydrate,
— dextrose anhydrous.

Member States may, however, require the use in their territory of the Lane and Eynon method (Annex II, methods 7 and/or 8 as appropriate) to determine the reducing sugars in one or more of the sugars listed above.

3 If a Member State makes use of the option provided for in the second subparagraph of paragraph 2, it shall forthwith inform the Commission and the other Member States thereof.

Article 2

Member States shall bring into force the laws, regulations or administrative provisions necessary to comply with this Directive not later than 18 months following its notification. They shall forthwith inform the Commission thereof.

Article 3

This Directive is addressed to the Member States.

ANNEX I

SCOPE OF TOE COMMUNITY METHODS OF ANALYSIS FOR CERTAIN SUGARS INTENDED FOR HUMAN CONSUMPTION

I. **Determination of the loss of mass on drying in:**

— semi-white sugar — sugar or white sugar — extra-white sugar	(using method 1, Annex II)

II. **Dry matter determination in:**

II. 1.	— glucose syrup — dried glucose syrup — dextrose monohydrate — dextrose anhydrous	(using method 2, Annex II)
II.2.	— sugar solution or white sugar solution — invert sugar solution or white invert sugar solution — invert sugar syrup or white invert sugar syrup	(using method 3, Annex II)

III. **Measurement of reducing sugars in:**

III. 1.	— semi-white sugar	(using method 4, Annex II)
III.2.	— sugar or white sugar — extra-white sugar	(using method 5, Annex II)
III.3.	— sugar solution — white sugar solution — invert sugar solution — white invert sugar solution — invert sugar syrup — white invert sugar syrup	(using method 6 or 7, Annex II)

III.4.	—	glucose syrup	(using method 6 or 8, Annex II)
	—	dried glucose syrup	
	—	dextrose monohydrate	
	—	dextrose anhydrous	

IV. **Sulphated ash determination in:**

—	glucose syrup	(using method 9, Annex II)
—	dried glucose syrup	
—	dextrose monohydrate	
—	dextrose anhydrous	

V. **Determination of polarization in:**

—	semi-white sugar	(using method 10, Annex II)
—	sugar or white sugar	
—	extra-white sugar	

ANNEX II

METHODS OF ANALYSIS TO VERIFY THE COMPOSITION OF CERTAIN SUGARS INTENDED FOR HUMAN CONSUMPTION

INTRODUCTION

1. **Preparation of the sample for analysis**

Thoroughly mix the sample received at the laboratory.

Remove a sub-sample of at least 200 g and transfer immediately to a clean, dry, moisture-tight vessel fitted with an airtight closure.

2. **Reagents and apparatus**

In the description of the apparatus, reference is made only to special instruments and apparatus or to those calling for special standards.

Wherever mention is made of water, this means distilled water or demineralized water of at least equivalent purity.

All reagents shall be of analytical reagent quality unless otherwise specified.

Wherever reference is made to a reagent solution without further qualification, an aqueous solution is meant.

3. **Expression of results**

The result referred to in the official analysis report shall be the mean value of at least two satisfactory replicate determinations.

Unless otherwise stated the results shall be expressed as a percentage by mass of the original sample as received at the laboratory.

The number of significant figures in the result so expressed shall be governed by the precision of the method.

METHOD 1 **DETERMINATION OF THE LOSS OF MASS ON DRYING**

1. **Scope and field of application**

The method determines the loss of mass on drying in:

— semi-white sugar,

— sugar or white sugar,

— extra-white sugar.

2. **Definition**

‘Loss of mass on drying’: the value of the loss of mass on drying as determined by the method specified.

3. **Principle**

The loss of mass on drying is determined by drying at a temperature of 103 ± 2 °C.

4. **Apparatus**

4.1. *Analytical balance,* accurate to within 0.1 mg.

4.2. Oven, suitably ventilated, thermostatically controlled, and capable of being maintained at 103 ± 2 °C.

4.3. *Metal weighing dish,* flat-bottomed, resistant to attack by the samples and the conditions of test, diameter at least 100 mm, depth at least 30 mm.

4.4. *Desiccator,* containing freshly activated silica gel or an equivalent desiccant, with a water content indicator.

5. **Procedure**

N.B.: The operations described in sections 5.3 to 5.7 must be performed immediately after opening the sample container.

5.1. Dry the dish (4.3) to constant weight in the oven (4.2) at 103 ± 2 °C.

5.2. Allow the dish to cool in the desiccator (4.4) for at least 30 to 35 minutes and then weigh to the nearest 0.l mg.

5.3. Weigh accurately, to the nearest 0.1 mg, approximately 20 to 30 g of the sample into the dish.

5.4. Place the dish in the oven (4.2) at 103 ± 2 °C for three hours.

5.5. Allow the dish to cool in a desiccator (4.4) and weigh to the nearest 0.1 mg.

5.6. Replace the dish in the oven at 103 ± 2 °C for 30 minutes.

Allow to cool in the desiccator (4.4) and weigh to the nearest 01 mg. Repeat this operation if the difference between two weighings is more than 1 mg. Should an increase in mass occur, the lowest recorded reading will be used in the calculation.

5.7. Do not exceed four hours total drying time.

6. Expression of results

6.1. *Formula and method of calculation*

The loss of mass on drying, as a percentage by mass of the sample, is given by the following formula:

$$\frac{(m_0 - m_1)}{m_0} \times 100$$

where:

m_0 is the initial mass, in grams, of the test portion,
m_1 is the mass, in grams, of the test portion after drying.

6.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 0·02 g per 100 g of sample.

METHOD 2**DETERMINATION OF DRY MATTER**Vacuum oven method

1. Scope and field of application

The method determines the dry matter content in:

— glucose syrup,
— dried glucose syrup,
— dextrose monohydrate,
— dextrose anhydrous.

2. Definition

'The dry matter content': the content of dry matter as determined by the method specified.

3. Principle

The dry matter is determined at a temperature of 70 ± 1 °C using a vacuum oven at a pressure not exceeding 3·3 kPa (34 mbar). The test portions in the case of glucose syrup or dried glucose syrups, are prepared by mixing with water and kieselguhr before drying.

4. Reagents

4.1. *Kieselguhr:* place in a Buchner funnel and purify by repeated washings with dilute hydrochloric acid (1 ml of concentrated acid, density at 20 °C = 1·19 g/ml per litre of water). The treatment is complete when the washings remain definitely acid. Wash with water until the pH value of the filtered water is greater than 4. Dry in an oven at 103 ± 2 °C and store in an airtight container.

5. Apparatus

5.1. *Vacuum drying oven,* leak tight, thermostatically controlled and equipped with a thermometer and a vacuum manometer. The oven design must be such that the heat is rapidly transferred to the weighing dishes placed on the shelves.

5.2. *Air-drying train* consisting of a glass tower filled with freshly activated dry silica gel or an equivalent desiccant containing a water content indicator. This tower is mounted in series with a gas scrubber containing concentrated sulphuric acid connected to the air intake of the oven.

5.3. *Vaccum pump* capable of maintaining the presure in the oven at 3·3 kPa (34 mbar) or less.

5.4. *Metal weighing dish,* flat-bottomed, resistant to attack by the samples and the conditions of test, diameter at least 100 mm, depth at least 300 mm.

5.5. *Glass rod* of a length such that it cannot completely fall into the container.

5.6. *Desiccator* containing freshly activated dry silica gel, or an equivalent desiccant, with a water content indicator.

5.7. *Analytical balance* accurate to within 0.1 mg.

6. **Procedure**

6.1. Pour approximately 30 g of kieselguhr (4.1) into the weighing dish (5.4) equipped with a glass rod (5.5). Place the whole in the oven (5.1) at 70 ± 1 ^{o}C and reduce the pressure to 3·3 kPa (34 mbar) or less.

Dry for at least five hours, drawing a slow stream of air into the oven through the drying train. Check the pressure from time to time and correct it if necessary.

6.2. Restore atmospheric pressure in the oven by cautiously increasing the intake of dry air. Immediately place the dish together with the glass rod in the desiccator (5.6). Allow to cool and then weigh.

63. Accurately weigh to the nearest 1 mg approximately 10 g of the sample to be analyzed into a 100 ml beaker.

6.4. Dilute the test portion with 10 ml of warm water and transfer the solution quantitatively into the weighing dish, using the glass rod (5.5).

6.5. Place the dish containing the test portion and the glass rod in the oven and reduce the pressure to 3.3 kPa (34 mbar) or less. Dry at 70 ± 1 ^{o}C, allowing a slow stream of dry air to pass through the oven.

The drying operation should proceed for 20 hours; the bulk of the loss should occur towards the end of the first day. It will be necessary to keep the vacuum pump working at a preset pressure and allow a slow stream of dry air to enter the oven so as to maintain a pressure of approximately 3·3 kPa (34 mbar) or less during the night.

6.6. Restore atmospheric pressure in the oven by cautiously increasing the intake of dry air. Immediately place the weighing dish and contents in the desiccator. Allow to cool and then weigh to the nearest 1 mg.

6.7. Continue operation (6.5) for a further four hours. Restore atmospheric pressure in the oven and immediately place the dish in the desiccator. Allow to cool and then weigh. Ascertain whether constant mass has been reached. It is considered that constant mass has been satisfactorily attained if the difference between the two weighings of the same dish does not exceed 2 mg. If the difference is greater, repeat operation 6.7.

6.8. For the determination of the dry matter in dextrose anhydrous or dextrose monohydrate samples the use of kieselguhr and water is not required.

7. **Expression of results**

7.1. *Formula and method of calculation*

The dry matter content, expressed as a percentage by mass of the sample is given by:
$(m_1 - m_2) \times \frac{100}{m_0}$

where:

m_0 = the initial mass, in grams, of the test portion,
m_1 = the mass, in grams, of the weighing dish plus the kieselguhr, the glass rod and the residue of the test portion after drying,
m_2 = the mass, in grams, of the weighing dish plus the kieselguhr and the glass rod.

7.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 0·12 g per 100 g of sample.

METHOD 3**DETERMINATION OF TOTAL DRY MATTER**(Refractometric method)

1. **Scope and field of application**

The method determines the dry-matter content in:
— sugar solution,
— white sugar solution,
— invert sugar solution,
— white invert sugar solution,
— invert sugar syrup,
— white invert sugar syrup.

2. **Definition**

'Dry matter content': the content of dry matter as determined by the method specified.

3. **Principle**

The refractive index of a test portion is determined at 20 °C and converted into dry matter content by reference to tables showing the concentration as a function of the refractive index.

4. **Apparatus**

4.1. *Refractometer,* accurate to four decimal places, provided with a thermometer and a water-circulation pump connected to a water-bath thermostatically controlled at 20 ± 0·5 °C.

4.2. *Light source* consisting of a sodium vapour lamp.

5. **Procedure**

5.1. If any crystals are present in the sample, redissolve them by diluting the sample in the ratio 1 : 1 (m/m).

5.2. Measure the refractive index of the sample at 20 °C in the refractometer (4.1).

6. **Expression and calculation of results**

6.1. Calculate the dry matter content from the refractive indices for sucrose solutions at 20 °C in the table given and correct for the presence of invert sugars by adding to

the result obtained from the tables, 0.022 for every 1 % of invert sugar present in the sample as analyzed.

6.2. If the sample was diluted to 1: 1 (m/m) with water, the calculated dry matter content must be multiplied by two.

6.3. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 0·2 g dry matter per 100 g of sample.

REFERENCE TABLES

Refractive indices *(n)* of sucrose solutions at 20 °C[0]

***n*(20 °C)**	**Sucrose(%)**
1·3330	0·009
1·3331	0·078
1·3332	0·149
1·3333	0·218
1·3334	0·288
1·3335	0·358
1·3336	0·428
1·3337	0·498
1·3338	0·567
1·3339	0·637
1·3340	0·707
1·3341	0·776
1·3342	0·846
1·3343	0·915
1·3344	0·985
1·3345	1·054
1·3346	1·124
1·3347	1·193
1·3348	1·263
1·3349	1·332
1·3350	1·401

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 °C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 °C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3351	1·470
1·3352	1·540
1·3353	1·609
1·3354	1·678
1·3355	1·747
1·3356	1·816
1·3357	1·885
1·3358	1·954
1·3359	2·023
1·3360	2·092
1·3361	2·161
1·3362	2·230
1·3363	2·299
1·3364	2·367
1·3365	2·436
1·3366	2·505
1·3367	2·574
1·3368	2·642
1·3369	2·711
1·3370	2·779
1·3371	2·848
1·3372	2·917
1·3373	2·985
1·3374	3·053
1·3375	3·122
1·3376	3·190
1·3377	3·259
1·3378	3·327
1·3379	3·395
1·3380	3·463
1·3381	3·532

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1·3382	3·600
1·3383	3·668
1·3384	3·736
1·3385	3·804
1·3386	3·872
1·3387	3·940
1·3388	4·008
1·3389	4·076
1·3390	4·144
1·3391	4·212
1·3392	4·279
1·3393	4·347
1·3394	4·415
1·3395	4·483
1·3396	4·550
1·3397	4·618
1·3398	4·686
1·3399	4·753
1·3400	4·821
1·3401	4·888
1·3402	4·956
1·3403	5·023
1·3404	5·091
1·3405	5·158
1·3406	5·225
1·3407	5·293
1·3408	5·360
1·3409	5·427
1·3410	5·494
1·3411	5·562
1·3412	5·629

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1·3413	5·696
1·3414	5·763
1·3415	5·830
1·3416	5·897
1·3417	5·964
1·3418	6·031
1·3419	6·098
1·3420	6·165
1·3421	6·231
1·3422	6·298
1·3423	6·365
1·3424	6·432
1·3425	6·498
1·3426	6·565
1·3427	6·632
1·3428	6·698
1·3429	6·765
1·3430	6·831
1·3431	6·898
1·3432	6·964
1·3433	7·031
1·3434	7·097
1·3435	7·164[2]
1·3436	7·230
1·3437	7·296
1·3438	7·362
1·3439	7·429
1·3440	7·495
1·3441	7·561
1·3442	7·627
1·3443	7·693

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1·3444	7·759
1·3445	7·825
1·3446	7·891
1·3447	7·957
1·3448	8·023
1·3449	8·089
1·3450	8·155
1·3451	8·221
1·3452	8·287
1·3453	8·352
1·3454	8·418
1·3455	8·484
1·3456	8·550
1·3457	8·615
1·3458	8·681
1·3459	8·746
1·3460	8·812
1·3461	8·878
1·3462	8·943
1·3463	9·008
1·3464	9·074
1·3465	9·139
1·3466	9·205
1·3467	9·270
1·3468	9·335
1·3469	9·400
1·3470	9·466
1·3471	9·531
1·3472	9·596
1·3473	9·661
1·3474	9·726

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1·3475	9·791
1·3476	9·856
1·3477	9·921
1·3478	9·986
1·3479	10·051
1·3480	10·116
1·3481	10·181
1·3482	10·246
1·3483	10·311
1·3484	10·375
1·3485	10·440
1·3486	10·505
1·3487	10·570
1·3488	10·634
1·3489	10·699
1·3490	10·763
1·3491	10·828
1·3492	10·892
1·3493	10·957
1·3494	11·021
1·3495	11·086
1·3496	11·150
1·3497	11·215
1·3498	11·279
1·3499	11·343
1·3500	11·407
1·3501	11·472
1·3502	11·536
1·3503	11·600
1·3504	11·664
1·3505	11·728

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1·3506	11·792
1·3507	11·856
1·3508	11·920
1·3509	11·984
1·3510	12·048
1·3511	12·112
1·3512	12·176
1·3513	12·240
1·3514	12·304
1·3515	12·368
1·3516	12·431
1·3517	12·495
1·3518	12·559
1·3519	12·623
1·3520	12·686
1·3521	12·750
1·3522	12·813
1·3523	12·877
1·3524	12·940
1·3525	13·004
1·3526	13·067
1·3527	13·131
1·3528	13·194
1·3529	13·258
1·3530	13·321
1·3531	13·384
1·3532	13·448
1·3533	13·511
1·3534	13·574
1·3535	13·637
1·3536	13·700

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3537	13·763
1·3538	13·826
1·3539	13·890
1·3540	13·953
1·3541	14·016
1·3542	14·079
1·3543	14·141
1·3544	14·204
1·3545	14·267
1·3546	14·330
1·3547	14·393
1·3548	14·456
1·3549	14·518
1·3550	14·581
1·3551	14·644
1·3552	14·707
1·3553	14·769
1·3554	14·832
1·3555	14·894
1·3556	14·957
1·3557	15·019
1·3558	15·082
1·3559	15·144
1·3560	15·207
1·3561	15·269
1·3562	15·332
1·3563	15·394
1·3564	15·456
1·3565	15·518
1·3566	15·581
1·3567	15·643

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1·3568	15·705
1·3569	15·767
1·3570	15·829
1·3571	15·891
1·3572	15·953
1·3573	16016
1·3574	16·078
1·3575	16·140
1·3576	16·201
1·3577	16·263
1·3578	16·325
1·3579	16·387
1·3580	16·449
1·3581	16·511
1·3582	16·573
1·3583	16·634
1·3584	16·696
1·3585	16·758
1·3586	16·819
1·3587	16·881
1·3588	16·943
1·3589	17·004
1·3590	17·066
1·3591	17·127
1·3592	17·189
1·3593	17·250
1·3594	17·311
1·3595	17·373
1·3596	17·434
1·3597	17·496
1·3598	17·557

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1·3599	17·618
1·3600	17·679
1·3601	17·741
1·3602	17·802
1·3603	17·863
1·3604	17·924
1·3605	17·985
1·3606	18·046
1·3607	18·107
1·3608	18·168
1·3609	18·229
1·3610	18·290
1·3611	18·351
1·3612	18·412
1·3613	18·473
1·3614	18·534
1·3615	18·595
1·3616	18·655
1·3617	18·716
1·3618	18·777
1·3619	18·837
1·3620	18·898
1·3621	18·959
1·3622	19·019
1·3623	19·080
1·3624	19·141
1·3625	19·201
1·3626	19·262
1·3627	19·322
1·3628	19·382
1·3629	19·443

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3630	19·503
1·3631	19·564
1·3632	19·624
1·3633	19·684
1·3634	19·745
1·3635	19·805
1·3636	19·865
1·3637	19·925
1·3638	19·985
1·3639	20·045
1·3640	20·106
1·3641	20·166
1·3642	20·226
1·3643	20·286
1·3644	20·346
1·3645	20·406
1·3646	20·466
1·3647	20·525
1·3648	20·585
1·3649	20·645
1·3650	20·705
1·3651	20·765
1·3652	20·825
1·3653	20·884
1·3654	20·944
1·3655	21·004
1·3656	21·063
1·3657	21·123
1·3658	21·183
1·3659	21·242
1·3660	21·302

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3661	21·361
1·3662	21·421
1·3663	21·480
1·3664	21·540
1·3665	21·599
1·3666	21·658
1·3667	21·718
1·3668	21·777
1·3669	21·836
1·3670	21·896
1·3671	21·955
1·3672	22·014
1·3673	22·073
1·3674	22·132
1·3675	22·192
1·3676	22·251
1·3677	22·310
1·3678	22·369
1·3679	22·428
1·3680	22·487
1·3681	22·546
1·3682	22·605
1·3683	22·664
1·3684	22·723
1·3685	22·781
1·3686	22·840
1·3687	22·899
1·3688	22·958
1·3689	23·017
1·3690	23·075
1·3691	23·134

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3692	23·193
1·3693	23·251
1·3694	23·310
1·3695	23·369
1·3696	23·427
1·3697	23·486
1·3698	23·544
1·3699	23·603
1·3700	23·661
1·3701	23·720
1·3702	23·778
1·3703	23·836
1·3704	23·895
1·3705	23·953
1·3706	24·011
1·3707	24·070
1·3708	24·128
1·3709	24·186
1·3710	24·244
1·3711	24·302
1·3712	24·361
1·3713	24·419
1·3714	24·477
1·3715	24·535
1·3716	24·593
1·3717	24·651
1·3718	24·709
1·3719	24·767
1·3720	24·825
1·3721	24·883
1·3722	24·941

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3723	24·998
1·3724	25·056
1·3725	25·114
1·3726	25·172
1·3727	25·230
1·3728	25·287
1·3729	25·345
1·3730	25·403
1·3731	25·460
1·3732	25·518
1·3733	25·576
1·3734	25·633
1·3735	25·691
1·3736	25·748
1·3737	25·806
1·3738	25·863
1·3739	25·921
1·3740	25·978
1·3741	26·035
1·3742	26·093
1·3743	26·150
1·3744	26·207
1·3745	26·265
1·3746	26·322
1·3747	26·379
1·3748	26·436
1·3749	26·493
1·3750	26·551
1·3751	26·608
1·3752	26·665
1·3753	26·722

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3754	26·779
1·3755	26·836
1·3756	26·893
1·3757	26·950
1·3758	27·007
1·3759	27·064
1·3760	27·121
1·3761	27·178
1·3762	27·234
1·3763	27·291
1·3764	27·348
1·3765	27·405
1·3766	27·462
1·3767	27·518
1·3768	27·575
1·3769	27·632
1·3770	27·688
1·3771	27·745
1·3772	27·802
1·3773	27·858
1·3774	27·915
1·3775	27·971
1·3776	28·028
1·3777	28·084
1·3778	28·141
1·3779	28·197
1·3780	28·253
1·3781	28·310
1·3782	28·366
1·3783	28·422
1·3784	28·479

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3785	28·535
1·3786	28·591
1·3787	28·648
1·3788	28·704
1·3789	28·760
1·3790	28·816
1·3791	28·872
1·3792	28·928
1·3793	28·984
1·3794	29·040
1·3795	29·096
1·3796	29·152
1·3797	29·208
1·3798	29·264
1·3799	29·320
1·3800	29·376
1·3801	29·432
1·3802	29·488
1·3803	29·544
1·3804	29·600
1·3805	29·655
1·3806	29·711
1·3807	29·767
1·3808	29·823
1·3809	29·878
1·3810	29·934
1·3811	29·989
1·3812	30·045
1·3813	30·101
1·3814	30·156
1·3815	30·212

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3816	30·267
1·3817	30·323
1·3818	30·378
1·3819	30·434
1·3820	30·489
1·3821	30·544
1·3822	30·600
1·3823	30·655
1·3824	30·711
1·3825	30·766
1·3826	30·821
1·3827	30·876
1·3828	30·932
1·3829	30·987
1·3830	31·042
1·3831	31·097
1·3832	31·152
1·3833	31·207
1·3834	31·262
1·3835	31·317
1·3836	31·372
1·3837	31·428
1·3838	31·482
1·3839	31·537
1·3840	31·592
1·3841	31·647
1·3842	31·702
1·3843	31·757
1·3844	31·812
1·3845	31·867
1·3846	31·922

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3847	31·976
1·3848	32·031
1·3849	32·086
1·3850	32·140
1·3851	32·195
1·3852	32·250
1·3853	32·304
1·3854	32·359
1·3855	32·414
1·3856	32·468
1·3857	32·523
1·3858	32·577
1·3859	32·632
1·3860	32·686
1·3861	32·741
1·3862	32·795
1·3863	32·849
1·3864	32·904
1·3865	32·958
1·3866	33·013
1·3867	33·067
1·3868	33·121
1·3869	33·175
1·3870	33·230
1·3871	33·284
1·3872	33·338
1·3873	33·392
1·3874	33·446
1·3875	33·500
1·3876	33·555
1·3877	33·609

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3878	33·663
1·3879	33·717
1·3880	33·771
1·3881	33·825
1·3882	33·879
1·3883	33·933
1·3884	33·987
1·3885	34·040
1·3886	34·094
1·3887	34·148
1·3888	34·202
1·3889	34·256
1·3890	34·310
1·3891	34·363
1·3892	34·417
1·3893	34·471
1·3894	34·524
1·3895	34·578
1·3896	34·632
1·3897	34·685
1·3898	34·739
1·3899	34·793
1·3900	34·846
1·3901	34·900
1·3902	34·953
1·3903	35·007
1·3904	35·060
1·3905	35·114
1·3906	35·167
1·3907	35·220
1·3908	35·274

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3909	35·327
1·3910	35·380
1·3911	35·434
1·3912	35·487
1·3913	35·540
1·3914	35·593
1·3915	35·647
1·3916	35·700
1·3917	35·753
1·3918	35·806
1·3919	35·859
1·3920	35·912
1·3921	35·966
1·3922	36·019
1·3923	36·072
1·3924	36·125
1·3925	36·178
1·3926	36·231
1·3927	36·284
1·3928	36·337
1·3929	36·389
1·3930	36·442
1·3931	36·495
1·3932	36·548
1·3933	36·601
1·3934	36·654
1·3935	36·706
1·3936	36·759
1·3937	36·812
1·3938	36·865
1·3939	36·917

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3940	36·970
1·3941	37·023
1·3942	37·075
1·3943	37·128
1·3944	37·180
1·3945	37·233
1·3946	37·286
1·3947	37·338
1·3948	37·391
1·3949	37·443
1·3950	37·495
1·3951	37·548
1·3952	37·600
1·3953	37·653
1·3954	37·705
1·3955	37·757
1·3956	37·810
1·3957	37·862
1·3958	37·914
1·3959	37·967
1·3960	38·019
1·3961	38·071
1·3962	38·123
1·3963	38·175
1·3964	38·228
1·3965	38·280
1·3966	38·332
1·3967	38·384
1·3968	38·436
1·3969	38·488
1·3970	38·540

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·3971	38·592
1·3972	38·644
1·3973	38·696
1·3974	38·748
1·3975	38·800
1·3976	38·852
1·3977	38·904
1·3978	38·955
1·3979	39·007
1·3980	39·059
1·3981	39·111
1·3982	39·163
1·3983	39·214
1·3984	39·266
1·3985	39·318
1·3986	39·370
1·3987	39·421
1·3988	39·473
1·3989	39·525
1·3990	39·576
1·3991	39·628
1·3992	39·679
1·3993	39·731
1·3994	39·782
1·3995	39·834
1·3996	39·885
1·3997	39·937
1·3998	39·988
1·3999	40·040
1·4000	40·091
1·4001	40·142

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4002	40·194
1·4003	40·245
1·4004	40·296
1·4005	40·348
1·4006	40·399
1·4007	40·450
1·4008	40·501
1·4009	40·553
1·4010	40·604
1·4011	40·655
1·4012	40·706
1·4013	40·757
1·4014	40·808
1·4015	40·860
1·4016	40·911
1·4017	40·962
1·4018	41·013
1·4019	41·064
1·4020	41·115
1·4021	41·166
1·4022	41·217
1·4023	41·268
1·4024	41·318
1·4025	41·369
1·4026	41·420
1·4027	41·471
1·4028	41·522
1·4029	41·573
1·4030	41·623
1·4031	41·674
1·4032	41·725

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4033	41·776
1·4034	41·826
1·4035	41·877
1·4036	41·928
1·4037	41·978
1·4038	42·029
1·4039	42·080
1·4040	42·130
1·4041	42·181
1·4042	42·231
1·4043	42·282
1·4044	42·332
1·4045	42·383
1·4046	42·433
1·4047	42·484
1·4048	42·534
1·4049	42·585
1·4050	42·635
1·4051	42·685
1·4052	42·736
1·4053	42·786
1·4054	42·836
1·4055	42·887
1·4056	42·937
1·4057	42·987
1·4058	43·037
1·4059	43·088
1·4060	43·138
1·4061	43·188
1·4062	43·238
1·4063	43·288

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4064	43·338
1·4065	43·388
1·4066	43·439
1·4067	43·489
1·4068	43·539
1·4069	43·589
1·4070	43·639
1·4071	43·689
1·4072	43·739
1·4073	43·789
1·4074	43·838
1·4075	43·888
1·4076	43·938
1·4077	43·988
1·4078	44·038
1·4079	44·088
1·4080	44·138
1·4081	44·187
1·4082	44·237
1·4083	44·287
1·4084	44·337
1·4085	44·386
1·4086	44·436
1·4087	44·486
1·4088	44·535
1·4089	44·585
1·4090	44·635
1·4091	44·684
1·4092	44·734
1·4093	44·783
1·4094	44·833

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4095	44·882
1·4096	44·932
1·4097	44·981
1·4098	45·031
1·4099	45·080
1·4100	45·130
1·4101	45·179
1·4102	45·228
1·4103	45·278
1·4104	45·327
1·4105	45·376
1·4106	45·426
1·4107	45·475
1·4108	45·524
1·4109	45·574
1·4110	45·623
1·4111	45·672
1·4112	45·721
1·4113	45·770
1·4114	45·820
1·4115	45·869
1·4116	45·918
1·4117	46·967
1·4118	46·016
1·4119	46·065
1·4120	46·114
1·4121	46·163
1·4122	46·212
1·4123	46·261
1·4124	46·310
1·4125	46·359

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4126	46·408
1·4127	46·457
1·4128	46·506
1·4129	46·555
1·4130	46·604
1·4131	46·652
1·4132	46·701
1·4133	46·750
1·4134	46·799
1·4135	46·848
1·4136	46·896
1·4137	46·945
1·4138	46·994
1·4139	47·043
1·4140	47·091
1·4141	47·140
1·4142	47·188
1·4143	47·237
1·4144	47·286
1·4145	47·334
1·4146	47·383
1·4147	47·431
1·4148	47·480
1·4149	47·528
1·4150	47·577
1·4151	47·625
1·4152	47·674
1·4153	47·722
1·4154	47·771
1·4155	47·819
1·4156	47·868

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4157	47·916
1·4158	47·964
1·4159	48·013
1·4160	48·061
1·4161	48·109
1·4162	48·158
1·4163	48·206
1·4164	48·254
1·4165	48·302
1·4166	48·350
1·4167	48·399
1·4168	48·447
1·4169	48·495
1·4170	48·543
1·4171	48·591
1·4172	48·639
1·4173	48·687
1·4174	48·735
1·4175	48·784
1·4176	48·832
1·4177	48·880
1·4178	48·928
1·4179	48·976
1·4180	49·023
1·4181	49·071
1·4182	49·119
1·4183	49·167
1·4184	49·215
1·4185	49·263
1·4186	49·311
1·4187	49·359

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4188	49·407
1·4189	49·454
1·4190	49·502
1·4191	49·550
1·4192	49·598
1·4193	49·645
1·4194	49·693
1·4195	49·741
1·4196	49·788
1·4197	49·836
1·4198	49·884
1·4199	49·931
1·4200	49·979
1·4201	50·027
1·4202	50·074
1·4203	50·122
1·4204	50·169
1·4205	50·217
1·4206	50·264
1·4207	50·312
1·4208	50·359
1·4209	50·407
1·4210	50·454
1·4211	50·502
1·4212	50·549
1·4213	50·596
1·4214	50·644
1·4215	50·691
1·4216	50·738
1·4217	50·786
1·4218	50·833

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4219	50·880
1·4220	50·928
1·4221	50·975
1·4222	51·022
1·4223	51·069
1·4224	51·116
1·4225	51·164
1·4226	51·211
1·4227	51·258
1·4228	51·305
1·4229	51·352
1·4230	51·399
1·4231	51·446
1·4232	51·493
1·4233	51·540
1·4234	51·587
1·4235	51·634
1·4236	51·681
1·4237	51·728
1·4238	51·775
1·4239	51·822
1·4240	51·869
1·4241	51·916
1·4242	51·963
1·4243	52·010
1·4244	52·057
1·4245	52·104
1·4246	52·150
1·4247	52·197
1·4248	52·244
1·4249	52·291

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4250	52·338
1·4251	52·384
1·4252	52·431
1·4253	52·478
1·4254	52·524
1·4255	52·571
1·4256	52·618
1·4257	52·664
1·4258	52·711
1·4259	52·758
1·4260	52·804
1·4261	52·851
1·4262	52·897
1·4263	52·944
1·4264	52·990
1·4265	53·037
1·4266	53·083
1·4267	53·130
1·4268	53·176
1·4269	53·223
1·4270	53·269
1·4271	53·316
1·4272	53·362
1·4273	53·408
1·4274	53·455
1·4275	53·501
1·4276	53·548
1·4277	53·594
1·4278	53·640
1·4279	53·686
1·4280	53·733

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4281	53·779
1·4282	53·825
1·4283	53·871
1·4284	53·918
1·4285	53·964
1·4286	54·010
1·4287	54·056
1·4288	54·102
1·4289	54·148
1·4290	54·194
1·4291	54·241
1·4292	54·287
1·4293	54·333
1·4294	54·379
1·4295	54·425
1·4296	54·471
1·4297	54·517
1·4298	54·563
1·4299	54·609
1·4300	54·655
1·4301	54·701
1·4302	54·746
1·4303	54·792
1·4304	54·838
1·4305	54·884
1·4306	54·930
1·4307	54·976
1·4308	55·022
1·4309	55·067
1·4310	55·113
1·4311	55·159

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4312	55·205
1·4313	55·250
1·4314	55·296
1·4315	55·342
1·4316	55·388
1·4317	55·433
1·4318	55·479
1·4319	55·524
1·4320	55·570
1·4321	55·616
1·4322	55·661
1·4323	55·707
1·4324	55·752
1·4325	55·798
1·4326	55·844
1·4327	55·889
1·4328	55·935
1·4329	55·980
1·4330	56·026
1·4331	56·071
1·4332	56·116
1·4333	56·162
1·4334	56·207
1·4335	56·253
1·4336	56·298
1·4337	56·343
1·4338	56·389
1·4339	56·434
1·4340	56·479
1·4341	56·525
1·4342	56·570

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4343	56·615
1·4344	56·660
1·4345	56·706
1·4346	56·751
1·4347	56·796
1·4348	56·841
1·4349	56·887
1·4350	56·932
1·4351	56·977
1·4352	57·022
1·4353	57·067
1·4354	57·112
1·4355	57·157
1·4356	57·202
1·4357	57·247
1·4358	57·292
1·4359	57·337
1·4360	57·382
1·4361	57·427
1·4362	57·472
1·4363	57·517
1·4364	57·562
1·4365	57·607
1·4366	57·652
1·4367	57·697
1·4368	57·742
1·4369	57·787
1·4370	57·832
1·4371	57·877
1·4372	57·921
1·4373	57·966

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4374	58·011
1·4375	58·056
1·4376	58·101
1·4377	58·145
1·4378	58·190
1·4379	58·235
1·4380	58·279
1·4381	58·324
1·4382	58·369
1·4383	58·413
1·4384	58·458
1·4385	58·503
1·4386	58·547
1·4387	58·592
1·4388	58·637
1·4389	58·681
1·4390	58·726
1·4391	58·770
1·4392	58·815
1·4393	58·859
1·4394	58·904
1·4395	58·948
1·4396	58·993
1·4397	59·037
1·4398	59·082
1·4399	59·126
1·4400	59·170
1·4401	59·215
1·4402	59·259
1·4403	59·304
1·4404	59·348

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4405	59·392
1·4406	59·437
1·4407	59·481
1·4408	59·525
1·4409	59·569
1·4410	59·614
1·4411	59·658
1·4412	59·702
1·4413	59·746
1·4414	59·791
1·4415	59·835
1·4416	59·879
1·4417	59·923
1·4418	59·967
1·4419	60·011
1·4420	60·056
1·4421	60·100
1·4422	60·144
1·4423	60·188
1·4424	60·232
1·4425	60·276
1·4426	60·320
1·4427	60·364
1·4428	60·408
1·4429	60·452
1·4430	60·496
1·4431	60·540
1·4432	60·584
1·4433	60·628
1·4434	60·672
1·4435	60·716

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4436	60·759
1·4437	60·803
1·4438	60·847
1·4439	60·891
1·4440	60·935
1·4441	60·979
1·4442	61·023
1·4443	61·066
1·4444	61·110
1·4445	61·154
1·4446	61·198
1·4447	61·241
1·4448	61·285
1·4449	61·329
1·4450	61·372
1·4451	61·416
1·4452	61·460
1·4453	61·503
1·4454	61·547
1·4455	61·591
1·4456	61·634
1·4457	61·678
1·4458	61·721
1·4459	61·765
1·4460	61·809
1·4461	61·852
1·4462	61·896
1·4463	61·939
1·4464	61·983
1·4465	62·026
1·4466	62·070

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4467	62·113
1·4468	62·156
1·4469	62·200
1·4470	62·243
1·4471	62·287
1·4472	62·330
1·4473	62·373
1·4474	62·417
1·4475	62·460
1·4476	62·503
1·4477	62·547
1·4478	62·590
1·4479	62·633
1·4480	62·677
1·4481	62·720
1·4482	62·763
1·4483	62·806
1·4484	62·849
1·4485	62·893
1·4486	62·936
1·4487	62·979
1·4488	63·022
1·4489	63·065
1·4490	63·108
1·4491	63·152
1·4492	63·195
1·4493	63·238
1·4494	63·281
1·4495	63·324
1·4496	63·367
1·4497	63·410

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4498	63·453
1·4499	63·496
1·4500	63·539
1·4501	63·582
1·4502	63·625
1·4503	63·668
1·4504	63·711
1·4505	63·754
1·4506	63·797
1·4507	63·840
1·4508	63·882
1·4509	63·925
1·4510	63·968
1·4511	64·011
1·4512	64·054
1·4513	64·097
1·4514	64·139
1·4515	64·182
1·4516	64·225
1·4517	64·268
1·4518	64·311
1·4519	64·353
1·4520	64·396
1·4521	64·439
1·4522	64·481
1·4523	64·524
1·4524	64·567
1·4525	64·609
1·4526	64·652
1·4527	64·695
1·4528	64·737

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4529	64·780
1·4530	64·823
1·4531	64·865
1·4532	64·908
1·4533	64·950
1·4534	64·993
1·4535	65·035
1·4536	65·078
1·4537	65·120
1·4538	65·163
1·4539	65·205
1·4540	65·248
1·4541	65·290
1·4542	65·333
1·4543	65·375
1·4544	65·417
1·4545	65·460
1·4546	65·502
1·4547	65·544
1·4548	65·587
1·4549	65·629
1·4550	65·672
1·4551	65·714
1·4552	65·756
1·4553	65·798
1·4554	65·841
1·4555	65·883
1·4556	65·925
1·4557	65·967
1·4558	66·010
1·4559	66·052

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4560	66·094
1·4561	66·136
1·4562	66·178
1·4563	66·221
1·4564	66·263
1·4565	66·305
1·4566	66·347
1·4567	66·389
1·4568	66·431
1·4569	66·473
1·4570	66·515
1·4571	66·557
1·4572	66·599
1·4573	66·641
1·4574	66·683
1·4575	66·725
1·4576	66·767
1·4577	66·809
1·4578	66·851
1·4579	66·893
1·4580	66·935
1·4581	66·977
1·4582	67·019
1·4583	67·061
1·4584	67·103
1·4585	67·145
1·4586	67·186
1·4587	67·228
1·4588	67·270
1·4589	67·312
1·4590	67·354

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4591	67·396
1·4592	67·437
1·4593	67·479
1·4594	67·521
1·4595	67·563
1·4596	67·604
1·4597	67·646
1·4598	67·688
1·4599	67·729
1·4600	67·771
1·4601	67·813
1·4602	67·854
1·4603	67·896
1·4604	67·938
1·4605	67·979
1·4606	68·021
1·4607	68·063
1·4608	68·104
1·4609	68·146
1·4610	68·187
1·4611	68·229
1·4612	68·270
1·4613	68·312
1·4614	68·353
1·4615	68·395
1·4616	68·436
1·4617	68·478
1·4618	68·519
1·4619	68·561
1·4620	68·602
1·4621	68·643

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4622	68·685
1·4623	68·726
1·4624	68·768
1·4625	68·809
1·4626	68·850
1·4627	68·892
1·4628	68·933
1·4629	68·974
1·4630	69·016
1·4631	69·057
1·4632	69·098
1·4633	69·139
1·4634	69·181
1·4635	69·222
1·4636	69·263
1·4637	69·304
1·4638	69·346
1·4639	69·387
1·4640	69·428
1·4641	69·469
1·4642	69·510
1·4643	69·551
1·4644	69·593
1·4645	69·634
1·4646	69·675
1·4647	69·716
1·4648	69·757
1·4649	69·798
1·4650	69·839
1·4651	69·880
1·4652	69·921

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4653	69·962
1·4654	70·003
1·4655	70·044
1·4656	70·085
1·4657	70·126
1·4658	70·167
1·4659	70·208
1·4660	70·249
1·4661	70·290
1·4662	70·331
1·4663	70·372
1·4664	70·413
1·4665	70·453
1·4666	70·494
1·4667	70·535
1·4668	70·576
1·4669	70·617
1·4670	70·658
1·4671	70·698
1·4672	70·739
1·4673	70·780
1·4674	70·821
1·4675	70·861
1·4676	70·902
1·4677	70·943
1·4678	70·984
1·4679	71·024
1·4680	71·065
1·4681	71·106
1·4682	71·146
1·4683	71·187

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4684	71·228
1·4685	71·268
1·4686	71·309
1·4687	71·349
1·4688	71·390
1·4689	71·431
1·4690	71·471
1·4691	71·512
1·4692	71·552
1·4693	71·593
1·4694	71·633
1·4695	71·674
1·4696	71·714
1·4697	71·755
1·4698	71·795
1·4699	71·836
1·4700	71·876
1·4701	71·917
1·4702	71·957
1·4703	71·998
1·4704	72·038
1·4705	72·078
1·4706	72·119
1·4707	72·159
1·4708	72·199
1·4709	72·240
1·4710	72·280
1·4711	72·320
1·4712	72·361
1·4713	72·401
1·4714	72·441

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4715	72·482
1·4716	72·522
1·4717	72·562
1·4718	72·602
1·4719	72·643
1·4720	72·683
1·4721	72·723
1·4722	72·763
1·4723	72·803
1·4724	72·843
1·4725	72·884
1·4726	72·924
1·4727	72·964
1·4728	73·004
1·4729	73·044
1·4730	73·084
1·4731	73·124
1·4732	73·164
1·4733	73·204
1·4734	73·244
1·4735	73·285
1·4736	73·325
1·4737	73·365
1·4738	73·405
1·4739	73·445
1·4740	73·485
1·4741	73·524
1·4742	73·564
1·4743	73·604
1·4744	73·644
1·4745	73·684

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4746	73·724
1·4747	73·764
1·4748	73·804
1·4749	73·844
1·4750	73·884
1·4751	73·924
1·4752	73·963
1·4753	74·003
1·4754	74·043
1·4755	74·083
1·4756	74·123
1·4757	74·162
1·4758	74·202
1·4759	74·242
1·4760	74·282
1·4761	74·321
1·4762	74·361
1·4763	74·401
1·4764	74·441
1·4765	74·480
1·4766	74·520
1·4767	74·560
1·4768	74·599
1·4769	74·639
1·4770	74·678
1·4771	74·718
1·4772	74·758
1·4773	74·797
1·4774	74·837
1·4775	74·876
1·4776	74·916

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4777	74·956
1·4778	74·995
1·4779	75·035
1·4780	75·074
1·4781	75·114
1·4782	75·153
1·4783	75·193
1·4784	75·232
1·4785	75·272
1·4786	75·311
1·4787	75·350
1·4788	75·390
1·4789	75429
1·4790	75469
1·4791	75·508
1·4792	75·547
1·4793	75·587
1·4794	75·626
1·4795	75·666
1·4796	75·705
1·4797	75·744
1·4798	75·784
1·4799	75·823
1·4800	75·862
1·4801	75·901
1·4802	75·941
1·4803	75·980
1·4804	76·019
1·4805	76·058
1·4806	76·098
1·4807	76·137

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4808	76·176
1·4809	76·215
1·4810	76·254
1·4811	76·294
1·4812	76·333
1·4813	76·372
1·4814	76·411
1·4815	76·450
1·4816	76·489
1·4817	76·528
1·4818	76·567
1·4819	76·607
1·4820	76·646
1·4821	76·685
1·4822	76·724
1·4823	76·763
1·4824	76·802
1·4825	76·841
1·4826	76·880
1·4827	76·919
1·4828	76·958
1·4829	76·997
1·4830	77·036
1·4831	77·075
1·4832	77·113
1·4833	77·152
1·4834	77·191
1·4835	77·230
1·4836	77·269
1·4837	77·308
1·4838	77·347

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4839	77·386
1·4840	77·425
1·4841	77·463
1·4842	77·502
1·4843	77·541
1·4844	77·580
1·4845	77·619
1·4846	77·657
1·4847	77·696
1·4848	77·735
1·4849	77·774
1·4850	77·812
1·4851	77·851
1·4852	77·890
1·4853	77·928
1·4854	77·967
1·4855	78·006
1·4856	78·045
1·4857	78·083
1·4858	78·122
1·4859	78·160
1·4860	78·199
1·4861	78·238
1·4862	78·276
1·4863	78·315
1·4864	78·353
1·4865	78·392
1·4866	78·431
1·4867	78·469
1·4868	78·508
1·4869	78·546

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4870	78·585
1·4871	78·623
1·4872	78·662
1·4873	78·700
1·4874	78·739
1·4875	78·777
1·4876	78·816
1·4877	78·854
1·4878	78·892
1·4879	78·931
1·4880	78·969
1·4881	79·008
1·4882	79·046
1·4883	79·084
1·4884	79·123
1·4885	79·161
1·4886	79·199
1·4887	79·238
1·4888	79·276
1·4889	79·314
1·4890	79·353
1·4891	79·391
1·4892	79·429
1·4893	79·468
1·4894	79·506
1·4895	79·544
1·4896	79·582
1·4897	79·620
1·4898	79·659
1·4899	79·697
1·4900	79·735

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4901	79·773
1·4902	79·811
1·4903	79·850
1·4904	79·888
1·4905	79·926
1·4906	79·964
1·4907	80·002
1·4908	80·040
1·4909	80·078
1·4910	80·116
1·4911	80·154
1·4912	80·192
1·4913	80·231
1·4914	80·269
1·4915	80·307
1·4916	80·345
1·4917	80·383
1·4918	80·421
1·4919	80·459
1·4920	80·497
1·4921	80·534
1·4922	80·572
1·4923	80·610
1·4924	80·648
1·4925	80·686
1·4926	80·724
1·4927	80·762
1·4928	80·800
1·4929	80·838
1·4930	80·876
1·4931	80·913

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4932	80·951
1·4933	80·989
1·4934	81·027
1·4935	81·065
1·4936	81·103
1·4937	81·140
1·4938	81·178
1·4939	81·216
1·4940	81·254
1·4941	81·291
1·4942	81·329
1·4943	81·367
1·4944	81·405
1·4945	81·442
1·4946	81·480
1·4947	81·518
1·4948	81·555
1·4949	81·593
1·4950	81·631
1·4951	81·668
1·4952	81·706
1·5953	81·744
1·4954	81·781
1·4955	81·819
1·4956	81·856
1·4957	81·894
1·4958	81·932
1·4959	81·969
1·4960	82·007
1·4961	82·044
1·4962	82·082

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4963	82·119
1·4964	82·157
1·4965	82·194
1·4966	82·232
1·4967	82·269
1·4968	82·307
1·4969	82·344
1·4970	82·381
1·4971	82·419
1·4972	82·456
1·4973	82·494
1·4974	82·531
1·4975	82·569
1·4976	82·606
1·4977	82·643
1·4978	82·681
1·4979	82·718
1·4980	82·755
1·4981	82·793
1·4982	82·830
1·4983	82·867
1·4984	82·905
1·4985	82·942
1·4986	82·979
1·4987	83·016
1·4988	83·054
1·4989	83·091
1·4990	83·128
1·4991	83·165
1·4992	83·202
1·4993	83·240

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·4994	83·277
1·4995	83·314
1·4996	83·351
1·4997	83·388
1·4998	83·425
1·4999	83·463
1·5000	83·500
1·5001	83·537
1·5002	83·574
1·5003	83·611
1·5004	83·648
1·5005	83·685
1·5006	83·722
1·5007	83·759
1·5008	83·796
1·5009	83·833
1·5010	83·870
1·5011	83·907
1·5012	83·944
1·5013	83·981
1·5014	84·018
1·5015	84·055
1·5016	84·092
1·5017	84·129
1·5018	84·166
1·5019	84·203
1·5020	84·240
1·5021	84·277
1·5022	84·314
1·5023	84·351
1·5024	84·388

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·5025	84·424
1·5026	84·461
1·5027	84·498
1·5028	84·535
1·5029	84·572
1·5030	84·609
1·5031	84·645
1·5032	84·682
1·5033	84·719
1·5034	84·756
1·5035	84·792
1·5036	84·829
1·5037	84·866
1·5038	84·903
1·5039	84·939
1·5040	84·976
1·5041	85·013
1·5042	85·049
1·5043	85·086
1·5044	85·123
1·5045	85·159
1·5046	85·196
1·5047	85·233
1·5048	85·269
1·5049	85·306
1·5050	85·343
1·5051	85·379
1·5052	85·416
1·5053	85·452
1·5054	85·489
1·5055	85·525

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 ^{o}C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 ^{o}C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

1·5056	85·562
1·5057	85·598
1·5058	85·635
1·5059	85·672
1·5060	85·708
1·5061	85·744
1·5062	85·781
1·5063	85·817
1·5064	85·854
1·5065	85·890
1·5066	85·927
1·5067	85·963
1·5068	86·000
1·5069	86·036
1·5070	86·072
1·5071	86·109
1·5072	86·145
1·5073	86·182
1·5074	86·218
1·5075	86·254
1·5076	86·291
1·5077	86·327
1·5078	86·363
1·5079	86·399

a *n* values in these tables are calculated from the equation developed by K. Rosenhauer for ICUMSA, programed and computed by Frank G. Carpenter of UDSA, and published in *Sugar J.* 33, 15-22 (June 1970). Refractive index was measured at 20 °C with 0 line of Na. Brix (% sucrose by weight) was obtained by weighing at 20 °C in air at 760 Torr (mm Hg) pressure and 50 % relative humidity. It replaces the previous table, 47.012, 11th edition, taken from *Intern. Sugar J.* 39, 22s (1937).

METHOD 4**MEASUREMENT OF REDUCING SUGARS EXPRESSED AS INVERT SUGARS**(Berlin Institute method)

Scope and field of application

1. The method determines the reducing sugar content expressed as invert sugar in semi-white sugar.

2. **Definitions**

‘Reducing sugars expressed as invert sugar’: the content of reducing sugars as determined by the method specified.

3. **Principle**

The sample solution containing reducing sugars is used to reduce a solution of copper II complex. The copper I oxide formed is then oxidized with standard iodine solution, the excess of which is determined by back-titration with standardized sodium thiosulphate solution.

4. **Reagents**

4.1. *Copper II solution* (Muller's solution)

4.1.1. Dissolve 35 g of copper II sulphate, pentahydrate ($CuSO_4.5H_2O$) in 400 ml of boiling water. Allow to cool.

4.1.2. Dissolve 173 g of sodium potassium tartrate tetrahydrate (Rochelle salt or Seignette salt; $KNaC_4H_4O_64H_2O$) and 68 g of anhydrous sodium carbonate in 500 ml of boiling water. Allow to cool.

4.1.3. Transfer both solutions (4.1.1 and 4.1.2) to a one litre volumetric flask and make up to one litre with water. Add 2 g of activated carbon, shake, allow to stand for several hours and filter through thick filter paper or a membrane filter.

If small amounts of copper I oxide appear during storage, the solution should be re-filtered.

4.2. *Acetic acid solution* 5 mol/litre.

4.3. *Iodine solution* 0·01665 mol/litre (i.e. 0·0333 N, 4·2258 g/litre).

4.4. *Sodium thiosulphate solution* 0·0333 mol/litre.

4.5. *Starch solution:* to one litre of boiling water add a mixture of 5 g of soluble starch slurried in 30 ml of water. Boil for three minutes, allow to cool and add, if required, 10 mg of mercury II iodide as a preservative.

5. **Apparatus**

5.1. *Conical flask,* 300 ml; precision burettes and pipettes.

5.2. *Water-bath,* boiling.

6. **Procedure**

6.1. Weigh a portion of the sample (10 g or less) containing not more than 30 mg of invert sugar in a 300 ml conical flask and dissolve in about 100 ml of water.

Pipette 10 ml of the copper II solution (4.1), into the flask containing the sample solution. Mix the contents of the flask by swirling and place it in the boiling water-bath (5.2) for exactly 10 minutes.

The level of the solution in the conical flask should be at least 20 mm below the level of the water in the water-bath. Cool the flask rapidly in a stream of cold running water. During this operation the solution should not be stirred otherwise atmospheric oxygen will reoxidize some precipitated copper I oxide.

Add 5 ml of 5 mol/litre acetic acid (4.2) by pipette without shaking and immediately add an excess (between 20 and 40 ml) of the iodine solution 0.01665 mol/litre (4.3) from a burette.

Stir to dissolve the copper precipitate. Titrate the excess iodine against the sodium thiosulphate solution 0·0333 mol/litre (4.4) using the starch solution (4.5) as indicator. The indicator is added towards the end of the titration.

6.2. Carry out a blank test with water. This is to be carried out with each new copper II solution (4.4). The titration shall not exceed 0·1 ml.

6.3. Carry out a control test under cold conditions with the sugar solution. Allow to stand at room temperature for 10 minutes to permit any reducing agents such as sulphur dioxide which may by present to react.

7. **Expression of results.**

7.1. *Formula and method of calculation*

Volume of iodine consumed = ml 0·01665 mol/litre iodine added in excess minus ml 0·0333 mol/litre sodium thiosulphate used in titration.

The volume (in ml) of 0·01665 ml/litre iodine consumed is corrected by subtracting:

7.1.1. The number of ml consumed in the blank test carried out with water (6.2).

7.1.2. The number of ml consumed in the cold test with the sugar solution (6.3).

7.1.3. A value of 2·0 ml for every 10 g of sucrose present in the aliquot used, or a proportionate quantity where the sample contains less than 10 g sucrose (correction for sucrose).

After these corrections are made each ml of iodine solution (4.3) which has reacted corresponds to 1 mg of of invert sugar.

The invert sugar contents, as a percentage of the sample, is given by the formula:

$$\frac{V_1}{10 \times m_o}$$

where:

V_1 = the number of ml of iodine solution (4.3) after correction,
m_o = the mass, in grams, of the sample used.

7.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 0·02 g per 100 g of sample.

METHOD 5**MEASUREMENT OF REDUCING SUGARS EXPRESSED AS INVERT SUGAR**(Knight and Allen method)

1. **Scope and field of application**

The method determines the reducing sugar content expressed as invert sugar in:

— sugar or white sugar,
— extra white sugar.

2. **Definition**

‘Reducing sugars expressed as invert sugar’: the content of reducing sugars as determined by the method specified.

3. **Principle**

Copper II reagent is added in excess to the sample solution, reduced and the unreduced portion is back-titrated with EDTA solution.

4. **Reagents**

4.1. *Ethylene diamine tetra-acetic acid solution* (disodium salt) (EDTA) 0·0025 mol/litre: dissolve 0·930 g of EDTA in water and make up to one litre with water.

4.2. *Murexide indicator solution:* add 0·25 g of murexide to 50 ml of water and mix with 20 ml of a 0·2 g /100 ml aqueous solution of methylene blue.

4.3. *Alkaline copper reagent:* dissolve 25 g of anhydrous sodium carbonate and 25 g of potassium sodium tartrate tetrahydrate in about 600 ml of water containing 40 ml of 1.0 mol/litre sodium hydroxide. Dissolve 6·0 g of copper II sulphate pentahydrate ($CuSO_4.5H_2O$) in about 100 ml of water, and add to the tartrate solution. Dilute to one litre with water.

N.B.: the solution has a limited life (one week).

4.4. *Standard invert sugar solution:* dissolve 23·750 g of pure sucrose (4.5) in about 120 ml of water in a 250 ml graduated flask, add 9 ml of hydrochloric acid ($\zeta = 1{\cdot}16$) and allow to stand for eight days at room temperature. Make the solution up to 250 ml and check for completion of hydrolysis by a polarimeter or saccharimeter reading in a 200 mm tube. This should be - $11{\cdot}80^{o} \pm 0{\cdot}05$ ^{o}S (see Note 8). Pipette 200 ml of this solution into a 2 000 ml graduated flask. Dilute with water and while shaking (to avoid excessive local alkalinity) add 71·4 ml of sodium hydroxide solution (1 mol/litre) in which 4 g of benzoic acid has been dissolved. Make up to 2 000 ml to give a 1 g/100 ml solution of invert sugar. This solution should be approximately pH 3.

This stable stock solution should only be diluted immediately before use.

4.5. *Pure sucrose:* sample of pure sucrose with an invert sugar content not greater than 0·001 g/100 g.

5. **Apparatus**

5.1. *Test tubes,* 150 x 20 mm.

5.2. *White porcelain dish.*

5.3. *Analytical balance,* accurate to within 0·1 mg.

6. **Procedure**

6.1. Dissolve 5 g of sugar sample in 5 ml of cold water in the test tube (5.1). Add 2·0 ml of the copper reagent (4.3) and mix. Immerse the tube in a boiling water bath for five minutes and then cool in cold water.

6.2. Transfer quantitatively the solution in the test tube to the white porcelain dish (5.2) using as little water as possible, add three drops of indicator (4.2) and titrate with EDTA solution (4.1). V_o is the number of ml of EDTA used in the titration.

Just before the end-point the colour of the solution changes from green through grey to purple at the end-point. The purple colour will disappear slowly because of oxidation of copper I oxide to copper II oxide at a rate dependent on the concentration of reduced copper present. The end-point of the titration shall therefore be approached fairly rapidly.

6.3. Construct a calibration graph by adding known amounts of invert sugar (as solution 4.4 appropriately diluted) to 5 g of pure sucrose (4.5) and add sufficient cold water so that a total of 5 ml of solution is added. Plot the titration volumes (in ml) against the percentage of invert sugar added to the 5 g of sucrose: the resultant graph is a straight line over the range 0·001 to 0·019 g/100 g invert sugar/100 g sample.

7. **Expression of results**

7.1. *Method of calculation*

Read on the calibration curve the percentage of invert sugar corresponding to the value V_o ml of EDTA determined when analyzing the sample.

7.2. When a concentration greater than 0·017 g invert sugar/100 g sample is expected in the sample to be analyzed, the sample size taken in Procedure (6.1) must be appropriately reduced but the analysis sample made up to 5 g with pure sucrose (4.5).

7.3. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same, analyst, under the same conditions, shall not exceed 0·005 g per 100 g of sample.

8. **Note**

Divide by 2·889 to convert ^{o}S to polarmetric degrees of arc (precision tubes of 200 mm; light source consisting of a sodium vapour lamp; the instrument must be installed in a room where the temperature may be maintained close to 20 ^{o}C).

METHOD 6**DETERMINATION OF REDUCING SUGARS EXPRESSED AS INVERT SUGAR OR DEXTROSE EQUIVALENT**(Luff-Schoorl method)

1. **Scope and field of application**

The method determines:

1.1. The reducing sugars content expressed as invert sugar in:
— sugar solution,
— white sugar solution,
— invert sugar solution,
— white invert sugar solution,
— invert sugar syrup,
— white invert sugar syrup.

1.2. The reducing sugar content, expressed and calculated (on the dry matter) as the dextrose equivalent in:
— glucose syrup,
— dried glucose syrup

1.3. The reducing sugar content expressed as D-glucose in:
— dextrose monohydrate,
— dextrose anhydrous

2. **Definition**

'Reducing sugars expressed as invert sugars, D-glucose or dextrose equivalent': the content of reducing sugars expressed or calculated as invert sugar, D-glucose or dextrose equivalent as determined by the method specified.

3. **Principle**

The reducing sugars in the sample (clarified if necessary) are heated to boiling point under standardized conditions with a copper II solution, which is partially reduced to copper I. The excess copper II is subsequently determined iodometrically.

4. **Reagents**

4.1. *Carrez solution I:* dissolve 21·95 g of zinc acetate dihydrate ($Zn(CH_3COO)_2.2H_2O$) (or 24 g of zinc acetate trihydrate ($Zn(CH_3COO)_2.3H_2O$) and 3 ml of glacial acetic acid in water and make up to 100 ml with water.

4.2. *Carrez solution II:* dissolve 10·6 g of potassium hexacyanoferrate IT trihydrate $K_4[Fe(CN)_6].3H_2O$ in water and make up to 100 ml with water.

4.3. *Luff-Schoorl reagent:* prepare the following solutions:

4.3.1. Copper II sulphate solution: dissolve 25 g of iron-free copper II sulphate pentahydrate ($CuSO_4.5H_2O$) in 100 ml water.

4.3.2. Citric acid solution: dissolve 50 g of citric acid monohydrate ($C_6H_8O_7.H_2O$) in 50 ml of water.

4.3.3. Sodium carbonate solution: dissolve 143.8 g of anhydrous sodium carbonate in about 300 ml of warm water and allow to cool.

4.3.4. Add the citric acid solution (4.3.2) to the sodium carbonate solution (4.3.3) in a one litre volumetric flask with gentle swirling. Swirl until effervescence ceases and then add the copper II sulphate solution (4.3.1) and make up to 1 000 ml with water. Allow the solution to stand overnight and then filter if necessary. Check the molarity of the reagent thus obtained by the method described in 6.1 (Cu 0·1 mol/litre; Na_2CO_3 1 mol/litre).

4.4. *Sodium thiosulphate solution,* 0·1 mol/litre.

4.5. *Starch solution:* to one litre of boiling water add a mixture of 5 g of soluble starch slurried in 30 ml of water. Boil for three minutes, allow to cool and add, if required, 10 mg of mercury II iodide as a preservative.

4.6. *Sulphuric acid,* 3 mol/litre.

4.7. *Potassium iodide solution,* 30% (m/v).

4.8. *Pumice chips,* boiled in hydrochloric acid, washed free of acid with water and then dried.

4.9. *Isopentanol*

4.10. *Sodium hydroxide,* 0·1 mol/litre.

4.11. *Hydrochlorie acid,* 0·1 mol/litre.

4.12. *Phenolphthalein solution,* 1% (m/v) in ethanol.

5. **Apparatus**

5.1. *Conical flask,* 300 ml, fitted with a reflux condenser.

5.2. *Stop-watch.*

6. **Procedure**

6.1. *Standardization of the Luff-Schoorl reagent* (4.3)

6.1.1. To 25 ml of Luff-Schoorl reagent (4.3) add 3 g of potassium iodide and 25 ml of 3 mol/litre sulphuric acid (4.6).

Titrate with 0·1 mol/litre sodium thiosulphate (4.4) using starch solution (4.5) as indicator added towards the end of the titration. If the volume of 0·1 mol/litre sodium thiosulphate used is not 25 ml the reagent must be made up afresh.

6.1.2. Pipette 10 ml of the reagent into a 100 ml volumetric flask and dilute to volume with water.

Pipette 10 ml of the diluted reagent into 25 ml of 0·1 mol/litre hydrochloric acid (4.11) in a conical flask and heat for one hour in a boiling water-bath. Cool, make up to the original volume with freshly boiled water and titrate with 0·1 mol/litre sodium hydroxide (4.10) using phenolphthalein (4.12) as indicator.

The volume of 0·1 mol/litre sodium hydroxide (4.10) used must be between 5·5 and 6·5 ml.

6.1.3. Titrate 10 ml of the diluted reagent (6.1.2) with 0·1 mol/litre hydrochloric acid (4.11) using phenolphthalein (4.12) as indicator. The end-point is characterized by the disappearance of the violet colour.

The volume of 0·1 mol/litre hydrochloric acid (4.11) used must be between 6·0 and 7·5 ml.

6.1.4. The pH of the Luff-Schoorl reagent must be between 9·3 and 9·4 at 20 ^{o}C.

6.2. *Preparation of the solution*

6.2.1. Accurately weigh, to the nearest 1 mg, 5 g of the sample and transfer quantitatively to a 250 ml volumetric flask, with 200 ml water. Clarify, if necessary, by adding 5 ml of Carrez solution I (4.1) followed by 5 ml of Carrez solution II (4.2). Mix after each addition. Make up to 250 ml with water. Mix well. Filter if necessary.

6.2.2. Dilute the solution (6.2.1) so that 25 ml of the solution contains not less than 15 mg and not more than 60 mg of reducing sugars expressed as glucose.

6.3. *Titration by the Luff-Schoorl method*

Pipette 25 ml of Luff-Schoorl reagent (4.3) into a 300 ml conical flask (5.1). Pipette 25 ml of the sugar solution (6.2.2) into the conical flask and introduce two pumice chips (4.8). Fit a reflux condenser to the conical flask (5.1) and immediately place the apparatus on an asbestos wire gauze over a Bunsen flame. The gauze shall have a hole cut in the asbestos part of the same diameter as the base of the flask. Heat the liquid to boiling point over a period of about two minutes and simmer gently for exactly 10 minutes. Cool immediately in cold water and after five minutes titrate as follows:

Add 10 ml of potassium iodide solution (4.7) then immediately add with caution (because of effervescence) 25 ml of 3 mol/litre sulphuric acid (4.6). Titrate with 01 mol/litre sodium

thiosulphate solution (4.4) until the solution is almost colourless, then add a few ml of starch solution (4.5) as indicator and continue titrating until the blue colour disappears.

Carry out a control test, using 25 ml of water in place of the 25 ml of sugar solution (6.2.2).

7. Expression of results

7.1. *Formula and method of calculation*

From the table below, find (interpolating if necessary) the weight of glucose or of invert sugar in mg corresponding to the difference between the two titration readings, expressed in ml of 0·1 mol/litre sodium thiosulphate.

Express the result in terms of invert sugar or D-glucose as percentage (m/m) of the dry matter.

7.2. *Repeatability*

The difference between the results of two titrations when carried out simultaneously or in rapid succession on the same sample by the same analyst, under the same conditions, shall not exceed 0·2 ml.

8. Note

A small volume of isopentanol (4·9) may be added before acidifying with sulphuric acid to reduce foaming.

TABLE OF VALUES ACCORDING TO LUFF-SCHOORL REAGENT

0·1 mol/litre $Na_2S_2O_3$	**Glucose, fructose, invert sugars $C_6H_{12}O_6$**	
ml	**mg**	**difference**
1	2·4	
2	4·8	2·4
3	7·2	2·4
4	9·7	2·5
5	12·2	2·5
6	14·7	2·5
7	17·2	2·5
8	19·8	2·6
9	22·4	2·6
10	25·0	2·6
11	27·6	2·6
12	30·3	2·7
13	33·0	2·7
14	35·7	2·7
15	38·5	2·8
16	41·3	2·8

17	44·2	2·9
18	47·1	2·9
19	50·0	2·9
20	53·0	3·0
21	56·0	3·0
22	59·1	3·1
23	62·2	3·1

METHOD 7**MEASUREMENT OF REDUCING SUGARS EXPRESSED AS INVERT SUGAR**(Lane and Eynon constant volume modification)

1. **Scope and field of application**

The method determines the reducing sugars, expressed as invert sugar, in:
— sugar solution,
— white sugar solution,
— invert sugar solution,
— white invert sugar solution,
— invert sugar syrup,
— white invert sugar syrup.

2. **Definition**

‘Reducing sugars expressed as invert sugar’: the content of reducing sugars as determined by the method specified.

3. **Principle**

The sample solution is titrated at the boiling point against a specified volume of Fehling's solution, using methylene blue as internal indicator.

4. **Reagents**

4.1. *Fehling's solution:*

4.1.1. Solution A:

Dissolve 69·3 g of copper II sulphate pentahydrate ($CuSO_4.5H_{2O)}$ in water and make up to 1 000 ml.

4.1.2. Solution B:

Dissolve 346·0 g of double sodium potassium tartrate tetrahydrate ($KNaC_4H_4O_6.4H_2O$) with 100·0 g of sodium hydroxide in water and make up to 1 000 ml. The clear solution should be decanted from a sediment that may form from time to time.
Note:

These two solutions should be stored in brown or amber bottles.

4.2. *Sodium hydroxide solution,* 1 mol/litre.

4.3. *Standard invert sugar solution:* dissolve 23·750 g of pure sucrose in about 120 ml of water in a 250 ml graduated flask, add 9 ml of hydrochloric acid ($\zeta = 1{\cdot}16$) and allow to stand for eight days at room temperature. Make the solution up to 250 ml and check for completion of hydrolysis by a polarimeter or saccharimeter reading in a 200 mm tube. This should be - $11{\cdot}80^{o} \pm 0{\cdot}05$ ^{o}S (see note 8). Pipette 200 ml of this solution into a 2 000 ml graduated flask. Dilute with water and while shaking (to avoid excessive local alkalinity) add 71·4 ml of sodium hydroxide solution (1 mol/litre) (4.2) in which 4 g of benzoic acid has been dissolved. Make up to 2 000 ml to give a 1 g/100 ml solution of invert sugar. This solution should be a pH of approximately 3.

This stable stock solution should only be diluted immediately before use.

To make up the 0·25 g/100 ml invert sugar solution, fill a 250 ml graduated flask to the mark with the stock 1 g/100 ml invert solution at 20 ^{o}C. Wash the contents of this flask into a 1 000 ml graduated flask and dilute to the mark with water again at 20 ^{o}C.

4.4. *Methylene blue solution,* 1 g/100 ml.

5. **Apparatus**

5.1. *Narrow-necked laboratory boiling flasks,* 500 ml.

5.2. *Burette,* 50 ml, with tap and offset tip, graduated to 0·05 ml.

5.3. *Pipettes* graduated at 20, 25 and 50 ml.

5.4. *One mark volumetric flasks,* 250, 1 000 and 2 000 ml.

5.5. *A heating device,* suitable for maintaining boiling according to the conditions described in 6.1, permitting the observation of the end-point colour change without the necessity of removing the boiling flask (5.1) from the source of heat.

5.6. *Stop-watch,* indicating to within at least one second.

6. **Procedure**

6.1. *Standardization of Fehling's solution*

6.1.1. Pipette 50 ml of solution B (4.1.2) and then 50 ml of solution A (4.1.1) into a clean dry beaker and mix well.

6.1.2. Rinse and fill the burette with 0·25 % (0·25 g/100 ml) standard invert sugar solution (4.3).

6.1.3. Pipette a 20 ml aliquot of the mixed solutions A and B (6.1.1) into a 500 ml boiling flask (5.1). Add 15 ml of water to the flask. Run in, from the burette, 39 ml of the invert sugar solution, add a small quantity of anti-bumping granules and mix the contents of the flask by gentle swirling.

6.1.4. Heat the flask and contents till boiling and allow to boil for exactly two minutes; the flask must not be removed from the heat source during the course of the rest of the procedure, or allowed to cease boiling.

Add three or four drops of methylene blue solution (4.4) at the end of the two-minute boiling period: the solution should be a definite blue colour.

6.1.5. Continue the standardization by adding, from the burette, the standard invert sugar solution in small increments, initially of 0·2 ml; then 0·1 ml and finally in single drops until the end-point is reached. This is indicated by the disappearance of the blue colour imparted by the methylene blue. The solution has then assumed the reddish colour associated with a suspension of copper I oxide.

6.1.6. The end-point should be reached at the end of three minutes from when the solution started to boil. The final titre, V_o, shall be between 39·0 and 41·0 ml. If V_o lies outside these limits, adjust the copper concentration of Fehling's solution A (4.1.1) and repeat the standardization process.

6.2. *Preparation of sample solutions*

The concentration of the sample test solution should be such that it contains between 250 and 400 mg invert sugar per 100 ml.

6.3. *Preliminary test*

6.3.1. A preliminary test must be carried out to ensure that the quantity of water to be added to the 20 ml of mixed solutions A and B is sufficient to ensure that a final volume after titration of 75 ml is obtained.

The same procedure as described in 6.1.4 is carried out except that the sample solution is used instead of the standard invert sugar solution, i.e. 25 ml of the sample solution is run into the flask from the burette. 15 ml of water is added, and the solution is allowed to boil for two minutes and then titrated until the end-point is reached as described in 6.1.5.

6.3.2. If, after the addition of the methylene blue solution, the reddish colour persists, the sample solution used is too concentrated. In this case, the test is discarded but repeated using a less concentrated sample solution.

If more than 50 ml of sample solution are required to obtain the reddish colour, a more concentrated solution of the sample must be used.

Calculate the quantity of water to be added by subtracting the volumes of mixed Fehling's solution (20 ml) and of the sample solution from 75 ml.

6.4. *Final analysis of sample solution*

6.4.1. Pipette into the boiling flask 20 ml of mixed Fehling's solution and the quantity of water determined as in 6.3.

6.4.2. Add, from the burette, the observed titre of the sample solution (as determined in 63) less 1 ml. Add some anti-bumping granules, mix the contents of the flask by swirling, boil the flask and contents and titrate as previously (6.3). The end-point should be reached one minute from the time of addition of the methylene blue solution. Final titre = V_1.

7. Expression of results

7.1. *Formula and method of calculation*

The reducing sugars content of the sample calculation as invert sugar, is given by:

% reducing sugars (as invert sugar =

$$\frac{V_o \times 25 \times f}{C_o \times V_1}$$

where:

C = the concentration of the sample test solution in g per 100 ml.
V_o = the volume in ml of the standard invert solution used in the standardization titration,
V_1 = the volume in ml of the sample test solution used in the accurate analysis in 6.4.2,
f = the correction factor to take account of the sucrose concentration in the sample test solution. Values are shown in the table below:

Sucrose (g in boiling mixture)	Correction factor f
0	1·000
0·5	0·982
1·0	0·971
1·5	0·962
2·0	0·954
2·5	0·946
3·0	0·939
3·5	0·932
4·0	0·926
4·5	0·920
5·0	0·915
5·5	0·910
6·0	0·904
6·5	0·898
7·0	0·893
7·5	0·888
8·0	0·883
8·5	0·878
9·0	0·874
9·5	0·869
10·0	0· 64

Corrections for varying sucrose contents of the sample test solution may be calculated from the table by interpolation.
Note:

The approximate sucrose concentration may be found by subtraction of the dissolved solids concentration due to the invert sugar (estimated for the purposes of this calculation f as 1.0), from the total dissolved solids concentration, expressed as sucrose, obtained from the refractive index of the solution using method three of this document.

7.2. *Repeatability*

The difference between the results of two determinations, carried out simultaneously or in rapid succession on the same sample by the same analyst under the same conditions, shall not exceed 1·0 % of their arithmetic mean.

8. **Note**

Divide by 2·889 to convert ^{o}S to polarmetric degrees of arc (precision tubes of 200 mm; light source consisting of a sodium vapour lamp; the instrument must be installed in a room where the temperature may be maintained close to 20 ^{o}C).

METHOD 8**DETERMINATION OF DEXTROSE EQUIVALENT**(Lane and Eynon constant)

1. **Scope and field of application**

This method determines the dextrose equivalent of:

— glucose syrup,
— dried glucose syrup,
— dextrose monohydrate,
— dextrose anhydrous.

2. **Definition**

2.1. ‘Reducing power’: the reducing sugar content, determined by the method specified, expressed in terms of anhydrous dextrose (D-glucose) and calculated as a percentage by mass of the sample.

2.2. ‘Dextrose equivalent’: the reducing power, calculated as a percentage by mass of the dry matter in the sample.

3. **Principle**

The test solution is titrated at the boiling point against a specified volume of mixed Fehling's solution, under strictly specified conditions, using methylene blue as an internal indicator.

4. **Reagents**

4.1. *Fehling's solution:*

4.1.1. Solution A:

Dissolve 69·3 g of copper II sulphate pentahydrate ($CuSO_4.5H_2O$) in water and make up to volume in a 1 000 ml volumetric f ask.

4.1.2. Solution B:

Dissolve 346·0 g of sodium potassium tartrate tetrahydrate ($KNaC_4H_4O_6.4H_2O$) and 100 g of sodium hydroxide in water. Make up to volume in a 1 000 ml volumetric flask. Decant the clear solution from any sediment that may from time to time form.

Note:

These two solutions (4.1.1 and 4.1.2) should be stored in brown or amber bottles.

4.1.3. Preparation of the mixed Fehling's solution

Pipette 50 ml of solution B (4.1.2) and then 50 ml of solution A (4.1.1) into a clean dry beaker and mix well.

Note:

Mixed Fehling's solution shall not be stored but made up afresh every day and standardized (6.1).

4.2. *Anhydrous dextrose* (D-glucose) ($C_6H_{12}O_6$)

This material shall be dried before use for four hours in a vacuum oven at 100 ± 1 °C or less, and an internal pressure of approximately 10 kPa (103 mbar).

4.3. *Standard dextrose solution,* 0·600 g/100 ml

Weigh, to the nearest 0·1 mg, 0·6 g of anhydrous dextrose (4.2), dissolve it in water, transfer the solution quantitatively into a 100 ml volumetric flask (5.4), dilute to the mark and mix.

This solution shall be freshly prepared on each day of use.

4.4. *Methylene blue solution,* 0·1 g/100 ml

Dissolve 0·1 g of methylene blue in 100 ml water.

5. **Apparatus**

5.1. *Narrow necked laboratory boiling flasks,* 250 ml.

5.2. *Burette,* 50 ml, with tap and offset tip, graduated to 0·05 ml.

5.3. *One mark pipettes,* 25 ml and 50 ml.

5.4. *One mark volumetric flasks,* 100 and 500 ml.

5.5. *A heating device,* suitable for maintaining boiling according to the conditions described in 6·1, permitting the observation of the end-point colour change without the necessity of removing the boiling flask (5.1) from the source of heat (see 6.1, note 3).

5.6. *A stop-watch,* indicating to at least the nearest second.

6. **Procedure**

6.1. *Standardization of the Fehling's solution*

6.1.1. Pipette 25 ml of Fehling's solution (4.1.3) into a clean, dry boiling flask (5.1).

6.1.2. Fill the burette (5.2) with standard dextrose solution (4.3) and adjust the meniscus to the zero mark.

6.1.3. Run into the boiling flask (5.1) from the burette 18 ml of standard dextrose solution (4.3). Swirl the flask to mix contents.

6.1.4. Place the boiling flask on the heating device (5.5), previously adjusted so that boiling commences in 120 ± 15 seconds.

The heating device shall not be further adjusted during the whole of the titration (see note 1).

6.1.5. When boiling commences, start the stop-watch from zero.

6.1.6. Boil the contents of the flask for 120 seconds, as timed by the stop-watch.

Add 1 ml of methylene blue solution (4.4) towards the end of this period.

6.1.7. After boiling has continued for 120 seconds (by the stop-watch) start adding standard dextrose solution to the boiling flask (5.1) from the burette (6.1.2) in 0·5 ml increments until the colour of the methylene blue is discharged (see notes 2 and 3).

Note the total volume of standard dextrose solution added up to and including the penultimate 0·5 ml increment (X ml).

6.1.8. Repeat 6.1.1 and 6.1.2.

6.1.9. Run into the boiling flask (5.1) from the burette a volume of standard dextrose solution equal to (X-0·3) ml.

6.1.10 Repeat 6.1.4, 6.1.5 and 6.1.6.

6.1.11. After boiling has continued for 120 seconds (by the stop-watch), start adding standard dextrose solution to the boiling flask (5.1) from the burette, initially in 0·2 ml increments and finally dropwise, until the colour of the methylene blue is just discharged.

Towards the end of this action the time between successive additions of standard dextrose solution shall be 10 to 15 seconds.

These additions shall be completed within 60 seconds, making the total time to boiling no longer than 180 seconds.

A third titration with a slightly larger, appropriately adjusted, initial addition of standard dextrose solution (6.1.9) may be necessary to achieve this.

6.1.12. Note the volume (V_o ml) of standard dextrose solution used up to the end-point of the final titration (see note 4).

6.1.13. V_o shall be between 19·0 and 21·0 ml standard dextrose solution (4.3).

If V_o lies outside these limits, adjust the concentration of the Fehling's solution A (4.1.1) appropriately and repeat the standardization process.

6.1.14. For the day-to-day standardization of the mixed Fehling's solution, as V_o is known with accuracy, a single titration only is necessary, using an initial addition of (V_o — 0·5) ml standard dextrose solution.

Note 1:

This ensures that once boiling has commenced the evolution of steam is brisk and continuous throughout the whole of the titration process, thus preventing to the maximum possible extent the entrance of air into the titration flask with consquent re-oxidation of its contents.

Note 2:

The disappearance of the colour of the methylene blue is best seen by looking at the upper layers and the meniscus of the contents of the titration flask, as these will be relatively free from the precipiated, red copper I oxide. The colour disappearance is more easily seen when indirect lighting is used. A white screen behind the titration flask is helpful.

Note 3:

The burette should be isolated as much as possible from the source of heat during the determination.

Note 4:

As there is always a personal factor involved, each operator shall carry out his own standardization titration and use his own value of V_o in the calculation (7.1).

6.2. *Preliminary examination of the prepared sample*

6.2.1. Unless the reducing power (2.1) of the prepared sample is known approximately, it is necessary to carry out a preliminary examination in order to obtain an approximate figure for it so that the mass of the test portion (6.3) can be calculated.

This examination is carried out as follows:

6.2.2. Prepare a 2% m/v solution of the sample 'Z', having an estimated value.

6.2.3. As 6.1.2, using the sample solution (6.2.2) in place of the standard dextrose solution.

6.2.4. As 6.1.1.

6.2.5. As 6.1.3, using 10·0 ml sample solution instead of 18·0 ml standard dextrose solution.

6.2.6. As 6.1.4.

6.2.7. Heat the contents of the flask to boiling. Add 1 ml methylene blue solution (4.4).

6.2.8. Immediately boiling has started, start the stop-watch (5.6) from zero and commence adding sample solution to the flask from the burette in 1·0 ml increments at intervals of approximately 10 seconds until the blue colour of the methylene blue is discharged.

Note the total volume of sample solution added up to and including the penultimate increment (Y ml).

6.2.9. 'Y' must not exceed 50 ml. If it does, increase the concentration of the sample solution and repeat the titration.

6.2.10. The approximate reducing power of the prepared sample in percent by mass is given by:

$$\frac{60 \times V_0}{Y \times Z}$$

6.3. *Test portion*

Weigh out, to the nearest 0·1 mg, a mass of the prepared sample (mg) which contains between 2·85 and 3·15 g reducing sugars, expressed as anhydrous dextrose (D-glucose) using in the calculation either known approximate figure for the reducing power (2.1) or the approximate figure obtained in 6.2.10.

6.4. *Test solution*

Dissolve the test portion in water and make up to 500 ml in a volumetric flask.

6.5. *Determination*

6.5.1. As 6.1.1.

6.5.2. Fill the burette (5.2) with test solution (6.4) and adjust the meniscus to the zero mark.

6.5.3. Run into the boiling flask from the burette 18·5 ml test solution. Swirl the flask to mix the contents.

6.5.4. As 6.1.4.

6.5.5. As 6.1.5.

6.5.6. As 6.1.6.

6.5.7. As 6.1.7, using test solution in place of standard dextrose solution.

6.5.8. As 6.1.8.

6.5.9. As 6.1.9, using test solution in place of standard dextrose solution.

6.5.10. As 6.1.10.

6.5.11. As 6.1.11, using test solution in place of standard dextrose solution.

6.5.12. Note the volume (V_1) of test solution used up to the end-point of the final titration.

6.5.13. V_1 shall be between 19·0 and 21·0 ml test solution.

If V_1 lies outside these limits, adjust the concentration of the test solution appropriately and repeat 6.5.1 to 6.5.12.

6.5.14. Carry out two determinations on the same test solution.

6.6. *Dry matter content*

Determine the dry matter content of the prepared sample by method 2.

7. Expression of results

7.1. *Formulae and method of calculation*

7.1.1. Reducing power

The reducing power, calculated as a percentage by mass of the prepared sample, is given by:

$$\frac{300 \times V_0}{V_1 \times M}$$

where:

V_0 = the volume, in ml, of the standard dextrose solution (4.3) used in the standardization titration (6.1),

V_1 = the volume, in ml, of the test solution (6.4) used in the determination titration (6.5),

M = the mass, in grams, of the test portion (6.3) used to make 500 ml test solution.

7.1.2. Dextrose equivalent

The dextrose equivalent, calculated as a percentage by mass of the dry matter in the prepared sample, is given by:

$$\frac{RP \times 100}{D}$$

where:

RP = the reducing power, calculated as a percent by mass of the prepared sample (7.1.1),

D = the dry matter content of the prepared sample in percent by mass.

7.1.3. Take as the result the arithmetic mean of the two determinations provided that the requirement concerning repeatability (7.2) is satisfied.

7.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 10 % of their arithmetic mean.

METHOD 9 **DETERMINATION OF SULPHATED ASH**

1. **Scope and field of application**

The method determines the sulphated ash content in:

— glucose syrup,
— dried glucose syrup,
— dextrose monohydrate,
— dextrose anhydrous.

2. **Definition**

'Sulphated ash content': the content of sulphated ash as determined by the method specified.

3. **Principle**

The residual mass of a test portion is determined after incineration in an oxidizing atmosphere at 525 ^{o}C in the presence of sulphuric acid and calculated as a percentage by mass of the sample.

4. **Reagents**

4.1. *Sulphuric acid,* dilute solution: slowly and cautiously add 100 ml of concentrated sulphuric acid (density at 20 ^{o}C = 1·84 g/ml; 96 % m/m) to 300 ml water with stirring and cooling.

5. **Apparatus**

5.1. *Electric muffle furnace,* equipped with a pyrometer and capable of operating at a temperature of 525 ± 25 ^{o}C.

5.2. *Analytical balance,* accurate to 0·1 mg.

5.3. *Ashing crucibles,* platinum or quartz, of suitable capacity.

5.4. *Desiccator,* containing freshly activated silica gel or an equivalent desiccant with a water content indicator.

6. **Procedure**

Heat a crucible (5.3) to the ashing temperature, cool in a desiccator and weigh. Accurately weigh, to the nearest 01 mg, 5 g of glucose syrup or dried glucose syrup, or about 10 g of dextrose monohydrate or dextrose anhydrous into the crucible.

Add 5 ml of sulphuric acid solution (4.1) (see note 8.1) and carefully heat the sample in the crucible over a flame or on a hotplate until it is completely carbonized. This carbonization process, during which vapours are burnt off from the sample (see note 8.2), should be carried out in a fume cupboard.

Place the crucible (5.3) in the muffle furnace (5.1) heated to 525 ± 25^{o} C until a white ash is obtained. This normally takes two hours (see note 8.3).

Allow the sample to cool for about 30 minutes in a desiccator (5.4) and then weigh.

7. **Expression**

7.1. *Formula and method of calculation*

The sulphated ash content expressed as a percentage by mass of the sample to be analyzed is given by:

$$S = \frac{m_1}{m_0} \times 100$$

where:

m_1 = the mass, in grams, of the ash,
m_0 = the mass, in grams, of the test portion.

7.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, shall not exceed 2% of their arithmetic mean.

8. **Notes**

8.1. The sulphuric acid is added in small quantities to prevent excessive foaming.

8.2. Every relevant precaution must be taken during the first carbonization to prevent losses of sample or of ash through excessive swelling of the sample.

8.3. If the sample is difficult to ash completely (i.e. black particles remain) the crucible should be removed from the muffle furnace and the residue moistened, after cooling, with a few drops of water before being returned to the furnace.

METHOD 10 **DETERMINATION OF POLARIZATION**

1. **Scope and field of application**

The method determines the polarization in:

— semi-white sugar,
— sugar or white sugar,
— extra-white sugar.

2. **Definition**

The polarization is the rotation of the polarized light plane by a sugar solution with 26 g of sugar per 100 ml contained in a tube of 200 mm in length.

3. **Principle**

The polarization is determined by using a saccharimeter or a polarimeter according to the conditions described in the following method.

4. **Reagents**

4.1. *Clarification agent:* basic lead acetate solution.

Add 560 g of dry basic lead acetate to about 1 000 ml of freshly boiled water. Boil the mixture for 30 minutes and then leave it to stand overnight.

Decant the supernatant liquid and dilute with freshly boiled water to obtain a solution of density of 1·25 g/ml, at 20 °C.

Protect this solution from contact with air.

4.2. *Diethyl ether*

5. **Apparatus**

5.1. *Saccharimeter graduated for the normal weight of 26 g of sucrose, or polarimeter*

This instrument must be installed in a room where the temperature may be maintained close to 20 °C. Calibrate the instrument against standard quartz plates.

5.2. *Light source,* consisting of a sodium vapour lamp.

5.3. *Precision polarimeter tubes,* length 200 mm, error not exceeding ± 0·02 mm.

5.4. *Analytical balance,* accurate to within 0·1 mg,

5.5. *Individually calibrated 100 ml volumetric flasks stoppered.* Flasks with a real capacity in the range 100·00 ± 0·01 ml may be used without correction. Flasks with a capacity outside those limits must be used with an appropriate correction to adjust the capacity to 100 ml.

5.6. *Water-bath,* controlled thermostatically at 20 ± 0·1 °C.

6. **Procedure**

6.1. *Preparation of the solution*

Weigh as quickly as possible 26 ± 0·002 g of the sample and transfer it quantitatively into a 100 ml volumetric flask (5.5) with approximately 60 ml of water.

Dissolve by swirling but without heating.

Where clarification is necessary, add 0·5 ml of lead acetate reagent (4.1).

Mix the solution by rotating the flask and wash the flask walls, until the volume is such that the meniscus is about 10 mm below the calibration mark.

Place the flask in the water-bath controlled (5.6) at 20 ± 0·1 °C until the temperature of the sugar solution is constant.

Eliminate any bubbles formed at the surface of the liquid with a drop of diethyl ether (4.2).

Make up to volume with water.

Stopper and mix thoroughly by inverting the flask at least three times.

Allow to stand for five minutes.

6.2. *Polarization*

Maintain the temperature at 20 ± 1 °C for all subsequent operations.

6.2.1. Obtain the zero correction of the apparatus.

6.2.2. Filter the sample through a filter paper. Discard the first 10 ml of the filtrate. Collect the next 50 ml of the filtrate.

6.2.3. Wash the polarimeter tube by rinsing twice with the sample solution to be examined (6.2.2).

6.2.4. Fill the tube carefully at 20 ± 0·1 °C with the sample solution to be examined.

Remove all air bubbles when sliding the end-plate into position. Place the filled tube in the cradle of the instrument.

6.2.5. Read the rotation to within 0·05 ^{o}S or 0·02 angular degrees. Repeat a further four times. Take the mean of the five readings.

7. Expression of results

7.1. *Formula and method of calculation*

The results are expressed in degrees S to the nearest 0·1 ^{o}S. To convert the angular degrees into degrees S, the following formula is used:

$$^{o}S = \text{degree of arc} \times 2{\cdot}889$$

7.2. *Repeatability*

The difference between the results of two determinations when carried out simultaneously or in rapid succession on the same sample, by the same analyst, under the same conditions, and each representing the mean of five readings, must not exceed 0·1 ^{o}S.

(**1**) OJ No L 356, 27. 12. 1973, p. 71.