BRITISH STANDARD

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Schedule for

Density-composition tables for aqueous solutions of hydrochloric acid

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Committees responsible for this British Standard

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British Laboratory Ware Association

Department of Trade and Industry (Laboratory of the Government Chemist)

Department of Trade and Industry (National Weights and Measures Laboratory)

Institute of Brewing

Institute of Petroleum

National Sulphuric Acid Association

Royal Society of Chemistry

Scientific Glassware Association

Scotch Whisky Association

Society of Glass Technology

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Contents

Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Committee.

This British Standard was first published in 1941 and was revised in 1957. This revision supersedes the 1957 edition which is withdrawn.

The United Kingdom participated in the preparation by Technical Committee TC 47, Chemistry, of the International Organization for Standardization (ISO), of the related ISO Recommendation ISO/R 905:1968, but disapproved it on technical grounds. The United Kingdom did not disapprove of the conversion of ISO/R 905:1968 into ISO 905:1976 "*Hydrochloric acid for industrial use — Evaluation of hydrochloric acid concentration by measurement of density*".

Together with hydrometers the tables provide a simple means of determining the strength of any given aqueous solution of hydrochloric acid, or making up solutions of known strength. The tables may, or course, be used with other methods of determining density (for example, see BS 733).

The previous edition of this British Standard made reference to density and specific gravity hydrometers complying with BS 718:1953. When BS 718 was revised in 1979 it was aligned as far as possible with the intentions of Technical Committee 48, Laboratory glassware and related apparatus, of the International Organization for Standardization (ISO). The term "specific gravity" was replaced by "relative density", scales of relative density were excluded, and scales marked in kilograms per cubic metre were introduced as an alternative to grams per millilitre. Users who had a continuing need for relative density hydrometers (d 60/60 °F) were referred to ISO 650.

The readings of a 60/60 °F relative density hydrometer can readily be corrected (see Appendix A) to yield density (in kg/m^3) of the liquid at the temperature at which the hydrometer is used.

Within 1 to 2 parts in 1 000 readings at a temperature t (in °C) of a 60/60 °F relative density hydrometer can be taken as the density (in kg/m^3) at t. To an accuracy which is very frequently adequate (within 1 part in 1 000) the reading at a temperature t between 10 °C and 40 °C on a 20 °C or 15 °C density hydrometer complying with BS 718 may be accepted as the density (in kg/m^3) of the liquid at t. Density and relative density hydrometers therefore may often be used without correction. Appendix A gives information on how the highest accuracy can be obtained. Recommendations as to the choice of suitable hydrometers for use in conjunction with these tables are given in Appendix B. Appendix C gives examples of the use of density-composition tables in conjunction with these hydrometers.

The principal differences between BS 976:1957 and this edition are:

a) density, in Table 1, is given in kilograms per cubic metre instead of grams per millilitre;

b) SI units have been used throughout and, where applicable, the tables have been recomputed;

c) recommendations as to the choice of suitable hydrometers for use in conjunction with Table 1 have been revised to accord with BS 718;

d) the temperature calculations given in Table 3 have been computed using the value of the thermal cubical expansion coefficient quoted in ISO 1768 for the use in preparation of measurement tables for liquids.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 24, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This British Standard gives tables that enable the composition of an aqueous solution of hydrochloric acid to be determined from its density at temperatures between 0 °C and 40 °C.

Appendix A gives information on the corrections that are necessary when density is determined by a hydrometer complying with BS 718[1)].

Appendix B gives information on the choice of BS hydrometers that are suitable for the determination of the density of hydrochloric acid solutions.

Appendix C gives examples of the use of a BS hydrometer in conjunction with Table 1.

NOTE The titles of the publications referred to in this standard are listed on inside back cover.

2 Basis of Table 1

Table 1 is based on data obtained from the International Critical Tables (1928) Vol. III, page 54, supplemented by density-composition determinations in solutions containing more than 30 % of hydrochloric acid by mass at 10 °C, 20 °C and 30 °C, which were carried out at the suggestion of the Technical Committee responsible for this standard. The results of the latter determinations support the data which appear in the International Critical Tables, though at a given density the concentrations given in certain other data, published since the International Critical Tables were compiled, are appreciably greater. In particular the percentages given by Akerlöf and Teare[2)] are about 0.5 greater at about 1.15 g/mL (i.e. about 30 % HCl).

It should be observed that the table relates to mass, not to apparent mass in air.

3 Application of Table 1

Table 1 is arranged primarily for ease in determining the strength of an aqueous solution of hydrochloric acid of known density. The density of a solution of known strength can, however, be obtained quite readily from the table. Moreover, by the application of small allowances (see Appendix A) Table 1 can be used to find the strength of solutions of known relative density or the relative density of solutions of known strength.

Consider, for example, a solution containing 10 g of HCl in 100 g of solution, i.e. one for which $g = 10$. By looking up the value of D_t corresponding to the value $g = 10$ under any particular temperature in Table 1, the density of the solution at that temperature can be obtained. Thus, for example, the density of the solution of 1 050 kg/m^3 at 10 °C, 1 047 kg/m^3 at 20 °C, etc. Due allowance, based on the density of water at the various temperatures concerned, can then be made to find the corresponding relative densities at the same temperature as the acid.

It should be observed that the percentage composition g of a solution is independent of its temperature, but G, the number of grams of hydrochloric acid in 1 L of solution, varies with the temperature of the solution owing to the change in volume of the solution with change in temperature. Hence, the concentration G should always be associated with a particular temperature. For a given value of G applicable at a particular temperature, Table 1 can be used to obtain the density of the solution at the specified temperature or at any other temperature within the range of the table. The value of G for the solution at temperatures other than the specified one can also be obtained. For example, consider a solution 1 L of which, at 20 °C, contains 199 g of HCl. Under 20 °C in Table 1 the value of D_t corresponding to $G = 199$ is 1 089 kg/m^3 and the corresponding value of g is 18.2 g. By tracing the value $g = 18.2$ g through the table, and interpolating where necessary, the density D_t at various temperatures of the solution containing 199 g of HCl in 1 L of solution at 20 °C can be obtained and also the number of grams of HCl in 1 L of the solution at various temperatures.

The following are examples of values which may thus be obtained.

t	HCl in 100 g of solution	Density of solution at t	HCl in 1 L of solution at t
°C	g	kg/m^3	g
0	18.2	1 097	200
10	18.2	1 093	199
20	18.2	1 089	199
30	18.2	1 084	198
40	18.2	1 080	197

[1)] From hereon referred to as a BS hydrometer.
[2)] *J. Amer. Chem. Soc.*, **60** (1938), 1226.

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 000	0.0	0	0.0	0	0.1	1	0.2	2
1 001	0.2	2	0.2	2	0.3	3	0.4	4
1 002	0.4	4	0.4	4	0.5	5	0.6	6
1 003	0.6	6	0.6	6	0.7	7	0.8	8
1 004	0.8	8	0.8	8	0.8	8	1.0	10
1 005	1.0	10	1.0	10	1.0	10	1.2	12
1 006	1.1	12	1.2	12	1.2	12	1.4	14
1 007	1.3	13	1.4	14	1.4	14	1.6	16
1 008	1.5	15	1.5	16	1.6	16	1.8	18
1 009	1.7	17	1.7	18	1.8	18	2.0	20
1 010	1.9	19	1.9	19	2.0	20	2.2	22
1 011	2.1	21	2.1	21	2.2	22	2.4	24
1 012	2.3	23	2.3	23	2.4	24	2.6	26
1 013	2.5	25	2.5	25	2.6	26	2.8	28
1 014	2.6	27	2.7	27	2.8	28	3.0	30
1 015	2.8	29	2.9	29	3.0	30	3.2	32
1 016	3.0	31	3.1	31	3.2	32	3.4	34
1 017	3.2	33	3.3	33	3.4	34	3.6	36
1 018	3.4	34	3.4	35	3.6	36	3.8	38
1 019	3.6	36	3.6	37	3.8	38	4.0	40
1 020	3.8	38	3.8	39	4.0	40	4.2	42
1 021	3.9	40	4.0	41	4.2	42	4.4	44
1 022	4.1	42	4.2	43	4.4	45	4.6	47
1 023	4.3	44	4.4	45	4.6	47	4.8	49
1 024	4.5	46	4.6	47	4.8	49	5.0	51
1 025	4.7	48	4.8	49	5.0	51	5.2	53
1 026	4.9	50	5.0	51	5.2	53	5.4	55

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
0.3	3	0.6	6	0.9	9	1.2	12	1.6	16	**1 000**
0.5	5	0.8	8	1.1	11	1.4	14	1.8	18	**1 001**
0.8	8	1.0	10	1.3	13	1.6	16	2.0	20	**1 002**
1.0	10	1.2	12	1.5	15	1.8	18	2.2	22	**1 003**
1.2	12	1.4	14	1.7	17	2.1	21	2.4	24	**1 004**
1.4	14	1.6	16	1.9	19	2.3	23	2.6	26	**1 005**
1.6	16	1.8	18	2.1	21	2.5	25	2.8	29	**1 006**
1.8	18	2.0	20	2.3	23	2.7	27	3.1	31	**1 007**
2.0	20	2.2	22	2.5	25	2.9	29	3.3	33	**1 008**
2.2	22	2.4	24	2.7	28	3.1	31	3.5	35	**1 009**
2.4	24	2.6	27	2.9	30	3.3	33	3.7	37	**1 010**
2.6	26	2.8	29	3.1	32	3.5	35	3.9	39	**1 011**
2.8	28	3.0	31	3.3	34	3.7	38	4.1	41	**1 012**
3.0	30	3.2	33	3.6	36	3.9	40	4.3	43	**1 013**
3.2	32	3.4	35	3.8	38	4.1	42	4.5	46	**1 014**
3.4	34	3.6	37	4.0	40	4.3	44	4.7	48	**1 015**
3.6	36	3.9	39	4.2	42	4.5	46	4.9	50	**1 016**
3.8	38	4.1	41	4.4	45	4.8	48	5.1	52	**1 017**
4.0	40	4.3	43	4.6	47	5.0	51	5.4	54	**1 018**
4.2	43	4.5	46	4.8	49	5.2	53	5.6	57	**1 019**
4.4	45	4.7	48	5.0	51	5.4	55	5.8	59	**1 020**
4.6	47	4.9	50	5.2	53	5.6	57	6.0	61	**1 021**
4.8	49	5.1	52	5.4	55	5.8	59	6.2	63	**1 022**
5.0	51	5.3	54	5.6	58	6.0	61	6.4	66	**1 023**
5.2	53	5.5	56	5.8	60	6.2	64	6.6	68	**1 024**
5.4	55	5.7	58	6.0	62	6.4	66	6.8	70	**1 025**
5.6	58	5.9	61	6.3	64	6.6	68	7.0	72	**1 026**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 027	5.1	52	5.2	53	5.4	55	5.6	57
1 028	5.3	54	5.4	55	5.5	57	5.8	59
1 029	5.5	56	5.6	57	5.7	59	6.0	61
1 030	5.6	58	5.8	59	5.9	61	6.2	63
1 031	5.8	60	6.0	61	6.1	63	6.4	66
1 032	6.0	62	6.2	64	6.3	65	6.6	68
1 033	6.2	64	6.4	66	6.5	68	6.8	70
1 034	6.4	66	6.6	68	6.7	70	7.0	72
1 035	6.6	68	6.8	70	6.9	72	7.2	74
1 036	6.8	70	7.0	72	7.1	74	7.4	77
1 037	7.0	72	7.1	74	7.3	76	7.6	79
1 038	7.2	74	7.3	76	7.5	78	7.8	81
1 039	7.4	77	7.5	78	7.7	80	8.0	83
1 040	7.6	79	7.7	80	7.9	83	8.2	85
1 041	7.8	81	7.9	82	8.1	85	8.4	87
1 042	7.9	83	8.1	85	8.3	87	8.6	90
1 043	8.1	85	8.3	87	8.5	89	8.8	92
1 044	8.3	87	8.5	89	8.7	91	9.0	94
1 045	8.5	89	8.7	91	8.9	93	9.2	96
1 046	8.7	91	8.9	93	9.1	95	9.4	98
1 047	8.9	93	9.1	95	9.3	98	9.6	101
1 048	9.1	95	9.3	97	9.5	100	9.8	103
1 049	9.3	97	9.5	99	9.7	102	10.0	105
1 050	9.5	99	9.7	102	9.9	104	10.2	107
1 051	9.7	101	9.9	104	10.1	106	10.4	109
1 052	9.8	104	10.1	106	10.3	108	10.6	112
1 053	10.0	106	10.3	108	10.5	111	10.8	114

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
5.8	60	6.1	63	6.5	66	6.9	70	7.3	75	**1 027**
6.0	62	6.3	65	6.7	69	7.1	73	7.5	77	**1 028**
6.2	64	6.5	67	6.9	71	7.3	75	7.7	79	**1 029**
6.4	66	6.7	69	7.1	73	7.5	77	7.9	81	**1 030**
6.6	68	7.0	72	7.3	75	7.7	79	8.1	84	**1 031**
6.9	71	7.2	74	7.5	78	7.9	82	8.3	86	**1 032**
7.1	73	7.4	76	7.7	80	8.1	84	8.5	88	**1 033**
7.3	75	7.6	78	7.9	82	8.3	86	8.7	90	**1 034**
7.5	77	7.8	81	8.1	84	8.5	88	9.0	93	**1 035**
7.7	79	8.0	83	8.4	87	8.8	91	9.2	95	**1 036**
7.9	82	8.2	85	8.6	89	9.0	93	9.4	97	**1 037**
8.1	84	8.4	87	8.8	91	9.2	95	9.6	99	**1 038**
8.3	86	8.6	89	9.0	93	9.4	97	9.8	102	**1 039**
8.5	88	8.8	92	9.2	95	9.6	100	10.0	104	**1 040**
8.7	90	9.0	94	9.4	98	9.8	102	10.2	106	**1 041**
8.9	93	9.2	96	9.6	100	10.0	104	10.4	108	**1 042**
9.1	95	9.4	98	9.8	102	10.2	107	10.6	111	**1 043**
9.3	97	9.6	101	10.0	105	10.4	109	10.8	113	**1 044**
9.5	99	9.9	103	10.2	107	10.6	111	11.0	115	**1 045**
9.7	102	10.1	105	10.4	109	10.8	113	11.2	118	**1 046**
9.9	104	10.3	107	10.6	111	11.0	116	11.4	120	**1 047**
10.1	106	10.5	110	10.8	114	11.2	118	11.7	122	**1 048**
10.3	108	10.7	112	11.0	116	11.5	120	11.9	124	**1 049**
10.5	111	10.9	114	11.2	118	11.7	122	12.1	127	**1 050**
10.7	113	11.1	116	11.5	120	11.9	125	12.3	129	**1 051**
10.9	115	11.3	119	11.7	123	12.1	127	12.5	131	**1 052**
11.1	117	11.5	121	11.9	125	12.3	129	12.7	134	**1 053**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

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t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 054	10.2	108	10.4	110	10.7	113	11.0	116
1 055	10.4	110	10.6	112	10.9	115	11.2	118
1 056	10.6	112	10.8	114	11.1	117	11.4	120
1 057	10.8	114	11.0	116	11.3	119	11.6	122
1 058	11.0	116	11.2	119	11.5	121	11.8	125
1 059	11.2	118	11.4	121	11.7	124	12.0	127
1 060	11.4	120	11.6	123	11.9	126	12.2	129
1 061	11.5	123	11.8	125	12.1	128	12.4	131
1 062	11.7	125	12.0	127	12.3	130	12.6	133
1 063	11.9	127	12.2	129	12.4	132	12.8	136
1 064	12.1	129	12.4	132	12.6	134	13.0	138
1 065	12.3	131	12.6	134	12.8	137	13.2	140
1 066	12.5	133	12.7	136	13.0	139	13.3	142
1 067	12.7	135	12.9	138	13.2	141	13.5	144
1 068	12.9	137	13.1	140	13.4	143	13.7	147
1 069	13.1	140	13.3	142	13.6	145	13.9	149
1 070	13.2	142	13.5	144	13.8	148	14.1	151
1 071	13.4	144	13.7	147	14.0	150	14.3	153
1 072	13.6	146	13.9	149	14.2	152	14.5	155
1 073	13.8	148	14.1	151	14.4	154	14.7	158
1 074	14.0	150	14.2	153	14.6	156	14.9	160
1 075	14.2	152	14.4	155	14.7	159	15.1	162
1 076	14.4	154	14.6	157	14.9	161	15.3	165
1 077	14.5	157	14.8	160	15.1	163	15.5	167
1 078	14.7	159	15.0	162	15.3	165	15.7	169
1 079	14.9	161	15.2	164	15.5	167	15.9	171
1 080	15.1	163	15.4	166	15.7	170	16.1	174

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
11.3	119	11.7	123	12.1	127	12.5	132	12.9	136	**1 054**
11.5	122	11.9	125	12.3	129	12.7	134	13.1	138	**1 055**
11.7	124	12.1	128	12.5	132	12.9	136	13.3	140	**1 056**
11.9	126	12.3	130	12.7	134	13.1	138	13.5	143	**1 057**
12.1	128	12.5	132	12.9	136	13.3	141	13.7	145	**1 058**
12.3	131	12.7	134	13.1	138	13.5	143	13.9	147	**1 059**
12.5	133	12.9	137	13.3	141	13.7	145	14.1	150	**1 060**
12.7	135	13.1	139	13.5	143	13.9	148	14.3	152	**1 061**
12.9	137	13.3	141	13.7	145	14.1	150	14.5	154	**1 062**
13.1	139	13.5	143	13.9	148	14.3	152	14.7	157	**1 063**
13.3	142	13.7	146	14.1	150	14.5	155	14.9	159	**1 064**
13.5	144	13.9	148	14.3	152	14.7	157	15.1	161	**1 065**
13.7	146	14.1	150	14.5	154	14.9	159	15.3	164	**1 066**
13.9	148	14.3	152	14.7	157	15.1	161	15.5	166	**1 067**
14.1	151	14.5	155	14.9	159	15.3	164	15.8	168	**1 068**
14.3	153	14.7	157	15.1	161	15.5	166	16.0	171	**1 069**
14.5	155	14.9	159	15.3	164	15.7	169	16.2	173	**1 070**
14.7	157	15.1	162	15.5	166	16.0	171	16.4	175	**1 071**
14.9	160	15.3	164	15.7	168	16.2	173	16.6	178	**1 072**
15.1	162	15.5	166	15.9	171	16.4	176	16.8	180	**1 073**
15.3	164	15.7	168	16.1	173	16.6	178	17.0	182	**1 074**
15.5	166	15.9	171	16.3	175	16.8	180	17.2	185	**1 075**
15.7	169	16.1	173	16.5	178	17.0	183	17.4	187	**1 076**
15.9	171	16.3	175	16.7	180	17.2	185	17.6	189	**1 077**
16.1	173	16.5	178	16.9	182	17.4	187	17.8	192	**1 078**
16.3	176	16.7	180	17.1	185	17.6	189	18.0	194	**1 079**
16.5	178	16.9	182	17.3	187	17.8	192	18.2	197	**1 080**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 081	15.3	165	15.6	168	15.9	172	16.3	176
1 082	15.5	167	15.8	170	16.1	174	16.5	178
1 083	15.7	169	15.9	173	16.3	176	16.7	180
1 084	15.8	172	16.1	175	16.5	179	16.9	183
1 085	16.0	174	16.3	177	16.7	181	17.1	185
1 086	16.2	176	16.5	179	16.9	183	17.2	187
1 087	16.4	178	16.7	181	17.1	185	17.4	190
1 088	16.6	180	16.9	184	17.2	188	17.6	192
1 089	16.8	183	17.1	186	17.4	190	17.8	194
1 090	16.9	185	17.3	188	17.6	192	18.0	196
1 091	17.1	187	17.4	190	17.8	194	18.2	199
1 092	17.3	189	17.6	193	18.0	197	18.4	201
1 093	17.5	191	17.8	195	18.2	199	18.6	203
1 094	17.7	193	18.0	197	18.4	201	18.8	206
1 095	17.9	196	18.2	199	18.6	203	19.0	208
1 096	18.0	198	18.4	201	18.8	206	19.2	210
1 097	18.2	200	18.6	204	19.0	208	19.4	213
1 098	18.4	202	18.8	206	19.1	210	19.6	215
1 099	18.6	204	18.9	208	19.3	212	19.8	217
1 100	18.8	206	19.1	210	19.5	215	20.0	219
1 101	19.0	209	19.3	213	19.7	217	20.1	222
1 102	19.1	211	19.5	215	19.9	219	20.3	224
1 103	19.3	213	19.7	217	20.1	222	20.5	226
1 104	19.5	215	19.9	219	20.3	224	20.7	229
1 105	19.7	217	20.1	222	20.5	226	20.9	231
1 106	19.9	220	20.2	224	20.7	228	21.1	233
1 107	20.1	222	20.4	226	20.8	231	21.3	236

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
16.7	180	17.1	185	17.5	189	18.0	194	18.4	199	**1 081**
16.9	182	17.3	187	17.7	192	18.2	197	18.6	201	**1 082**
17.1	185	17.5	189	17.9	194	18.4	199	18.8	204	**1 083**
17.3	187	17.7	192	18.1	196	18.6	201	19.0	206	**1 084**
17.5	189	17.9	194	18.3	199	18.8	204	19.2	209	**1 085**
17.6	192	18.1	196	18.5	201	19.0	206	19.4	211	**1 086**
17.8	194	18.3	199	18.7	203	19.2	208	19.6	213	**1 087**
18.0	196	18.5	201	18.9	206	19.4	211	19.8	216	**1 088**
18.2	199	18.7	203	19.1	208	19.6	213	20.0	218	**1 089**
18.4	201	18.9	206	19.3	211	19.8	216	20.2	221	**1 090**
18.6	203	19.1	208	19.5	213	20.0	218	20.4	223	**1 091**
18.8	206	19.3	210	19.7	215	20.2	220	20.7	226	**1 092**
19.0	208	19.5	213	19.9	218	20.4	223	20.9	228	**1 093**
19.2	210	19.7	215	20.1	220	20.6	225	21.1	230	**1 094**
19.4	213	19.9	218	20.3	222	20.8	228	21.3	233	**1 095**
19.6	215	20.1	220	20.5	225	21.0	230	21.5	235	**1 096**
19.8	217	20.3	222	20.7	227	21.2	232	21.7	238	**1 097**
20.0	220	20.5	225	20.9	230	21.4	235	21.9	240	**1 098**
20.2	222	20.7	227	21.1	232	21.6	237	22.1	243	**1 099**
20.4	224	20.8	229	21.3	234	21.8	240	22.3	245	**1 100**
20.6	227	21.0	232	21.5	237	22.0	242	22.5	248	**1 101**
20.8	229	21.2	234	21.7	239	22.2	245	22.7	250	**1 102**
21.0	231	21.4	236	21.9	242	22.4	247	22.9	252	**1 103**
21.2	234	21.6	239	22.1	244	22.6	249	23.1	255	**1 104**
21.4	236	21.8	241	22.3	246	22.8	252	23.3	257	**1 105**
21.6	238	22.0	244	22.5	249	23.0	254	23.5	260	**1 106**
21.7	241	22.2	246	22.7	251	23.2	257	23.7	262	**1 107**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 108	20.2	224	20.6	228	21.0	233	21.5	238
1 109	20.4	226	20.8	231	21.2	235	21.7	240
1 110	20.6	229	21.0	233	21.4	238	21.9	243
1 111	20.8	231	21.2	235	21.6	240	22.1	245
1 112	21.0	233	21.4	238	21.8	242	22.2	247
1 113	21.1	235	21.6	240	22.0	245	22.4	250
1 114	21.3	238	21.7	242	22.2	247	22.6	252
1 115	21.5	240	21.9	244	22.4	249	22.8	254
1 116	21.7	242	22.1	247	22.5	252	23.0	257
1 117	21.9	244	22.3	249	22.7	254	23.2	259
1 118	22.1	247	22.5	251	22.9	256	23.4	261
1 119	22.2	249	22.7	254	23.1	259	23.6	264
1 120	22.4	251	22.8	256	23.3	261	23.8	266
1 121	22.6	253	23.0	258	23.5	263	24.0	269
1 122	22.8	256	23.2	261	23.7	266	24.1	271
1 123	23.0	258	23.4	263	23.9	268	24.3	273
1 124	23.1	260	23.6	265	24.0	270	24.5	276
1 125	23.3	262	23.8	267	24.2	273	24.7	278
1 126	23.5	265	24.0	270	24.4	275	24.9	280
1 127	23.7	267	24.1	272	24.6	277	25.1	283
1 128	23.9	269	24.3	274	24.8	280	25.3	285
1 129	24.1	272	24.5	277	25.0	282	25.5	288
1 130	24.2	274	24.7	279	25.2	284	25.7	290
1 131	24.4	276	24.9	281	25.4	287	25.9	293
1 132	24.6	279	25.1	284	25.5	289	26.1	295
1 133	24.8	281	25.2	286	25.7	292	26.3	297
1 134	25.0	283	25.4	288	25.9	294	26.4	300

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
21.9	243	22.4	248	22.9	254	23.4	259	23.9	265	**1 108**
22.1	246	22.6	251	23.1	256	23.6	262	24.1	267	**1 109**
22.3	248	22.8	253	23.3	259	23.8	264	24.3	270	**1 110**
22.5	250	23.0	256	23.5	261	24.0	267	24.5	272	**1 111**
22.7	253	23.2	258	23.7	263	24.2	269	24.7	275	**1 112**
22.9	255	23.4	260	23.9	266	24.4	271	24.9	277	**1 113**
23.1	257	23.6	263	24.1	268	24.6	274	25.1	280	**1 114**
23.3	260	23.8	265	24.3	271	24.8	276	25.3	282	**1 115**
23.5	262	24.0	267	24.5	273	25.0	279	25.5	285	**1 116**
23.7	265	24.2	270	24.7	276	25.2	281	25.7	287	**1 117**
23.9	267	24.4	272	24.9	278	25.4	284	25.9	290	**1 118**
24.1	269	24.5	275	25.1	280	25.6	286	26.1	293	**1 119**
24.3	272	24.7	277	25.3	283	25.8	289	26.4	295	**1 120**
24.4	274	24.9	280	25.5	285	26.0	291	26.6	298	**1 121**
24.6	276	25.1	282	25.7	288	26.2	294	26.8	300	**1 122**
24.8	279	25.3	285	25.9	290	26.4	296	27.0	303	**1 123**
25.0	281	25.5	287	26.1	293	26.6	299	27.2	305	**1 124**
25.2	284	25.7	289	26.3	295	26.8	302	27.4	308	**1 125**
25.4	286	25.9	292	26.5	298	27.0	304	27.6	311	**1 126**
25.6	289	26.1	294	26.7	300	27.2	307	27.8	313	**1 127**
25.8	291	26.3	297	26.9	303	27.4	309	28.0	316	**1 128**
26.0	294	26.5	299	27.1	306	27.6	312	28.2	319	**1 129**
26.2	296	26.7	302	27.3	308	27.8	315	28.4	321	**1 130**
26.4	298	26.9	304	27.5	311	28.0	317	28.6	324	**1 131**
26.6	301	27.1	307	27.7	313	28.2	320	28.8	327	**1 132**
26.8	303	27.3	309	27.9	316	28.4	322	29.1	329	**1 133**
27.0	306	27.5	312	28.1	318	28.7	325	29.3	332	**1 134**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 135	25.2	286	25.6	291	26.1	296	26.6	302
1 136	25.3	288	25.8	293	26.3	299	26.8	305
1 137	25.5	290	26.0	295	26.5	301	27.0	307
1 138	25.7	293	26.2	298	26.7	304	27.2	310
1 139	25.9	295	26.4	300	26.9	306	27.4	312
1 140	26.1	297	26.6	303	27.1	309	27.6	315
1 141	26.3	300	26.8	305	27.3	311	27.8	317
1 142	26.4	302	26.9	308	27.5	313	28.0	320
1 143	26.6	304	27.1	310	27.6	316	28.2	322
1 144	26.8	307	27.3	313	27.8	318	28.4	325
1 145	27.0	309	27.5	315	28.0	321	28.6	327
1 146	27.2	311	27.7	317	28.2	324	28.8	330
1 147	27.4	314	27.9	320	28.4	326	29.0	332
1 148	27.5	316	28.1	322	28.6	329	29.2	335
1 149	27.7	319	28.3	325	28.8	331	29.4	337
1 150	27.9	321	28.4	327	29.0	334	29.6	340
1 151	28.1	323	28.6	330	29.2	336	29.8	343
1 152	28.3	326	28.8	332	29.4	339	30.0	345
1 153	28.5	328	29.0	334	29.6	341	30.2	348
1 154	28.7	331	29.2	337	29.8	344	30.4	350
1 155	28.8	333	29.4	339	30.0	347	30.6	353
1 156	29.0	335	29.6	342	30.2	349	30.8	356
1 157	29.2	338	29.8	344	30.4	352	31.0	358
1 158	29.4	340	29.9	347	30.6	354	31.2	361
1 159	29.6	343			30.8	357	31.4	363
1 160	29.8	345			31.0	360	31.6	366
1 161	29.9	348			31.2	362	31.8	369

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		**25 °C**		**30 °C**		**35 °C**		**40 °C**		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
27.2	308	27.7	315	28.3	321	28.9	328	29.5	334	**1 135**
27.4	311	27.9	317	28.5	324	29.1	330	29.7	337	**1 136**
27.6	313	28.1	320	28.7	326	29.3	333	29.9	340	**1 137**
27.8	316	28.3	322	28.9	329	29.5	335			**1 138**
28.0	318	28.5	325	29.1	331	29.7	338			**1 139**
28.2	321	28.7	327	29.3	334	29.9	341			**1 140**
28.4	324	28.9	330	29.5	337					**1 141**
28.6	326	29.1	332	29.7	339					**1 142**
28.8	329	29.3	335	29.9	342					**1 143**
29.0	331	29.5	338	30.1	344					**1 144**
29.2	334	29.7	340	30.3	347					**1 145**
29.4	336	29.9	343	30.5	350					**1 146**
29.6	339	30.1	345	30.7	352					**1 147**
29.7	342	30.3	348	30.9	355					**1 148**
29.9	344	30.5	351	31.1	358					**1 149**
30.1	347	30.7	353	31.3	360					**1 150**
30.3	349	30.9	356	31.5	363					**1 151**
30.5	352	31.1	359	31.7	366					**1 152**
30.7	354	31.3	361	31.9	368					**1 153**
30.9	357	31.5	364	32.1	371					**1 154**
31.1	360	31.7	366	32.4	374					**1 155**
31.3	362	31.9	369	32.6	376					**1 156**
31.5	365	32.1	372	32.8	379					**1 157**
31.7	368	32.3	375	33.0	382					**1 158**
31.9	370	32.6	377	33.2	384					**1 159**
32.1	373	32.8	380	33.4	387					**1 160**
32.3	375	33.0	383	33.6	390					**1 161**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t. and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C	
D_t	g	G	g	G	g	G	g	G
1 162					31.4	365	32.0	371
1 163					31.6	368	32.2	374
1 164					31.8	370	32.4	377
1 165					32.0	373	32.6	379
1 166					32.2	375	32.8	382
1 167					32.4	378	33.0	385
1 168					32.6	381	33.2	388
1 169					32.8	383	33.4	390
1 170					33.0	386	33.6	393
1 171					33.2	389	33.8	396
1 172					33.4	391	34.0	398
1 173					33.6	394	34.2	401
1 174					33.8	397	34.4	404
1 175					34.0	400	34.6	406
1 176					34.2	402	34.8	409
1 177					34.4	405	35.0	412
1 178					34.6	408	35.2	415
1 179					34.8	410	35.4	417
1 180					35.0	413	35.6	420
1 181					35.2	416	35.8	423
1 182					35.4	418	36.0	426
1 183					35.6	421	36.2	429
1 184					35.8	424	36.4	431
1 185					36.0	427	36.6	434
1 186					36.2	429	36.8	437
1 187					36.4	432	37.0	440
1 188					36.6	435	37.3	443

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		25 °C		30 °C		35 °C		40 °C		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
32.5	378	33.2	385	33.8	393					**1 162**
32.8	381	33.4	388	34.0	396					**1 163**
33.0	384	33.6	391	34.2	398					**1 164**
33.2	386	33.8	394	34.4	401					**1 165**
33.4	389	34.0	396	34.6	404					**1 166**
33.6	392	34.2	399	34.8	407					**1 167**
33.8	394	34.4	402	35.1	410					**1 168**
34.0	397	34.6	405	35.3	412					**1 169**
34.2	400	34.8	408	35.5	415					**1 170**
34.4	403	35.0	410	35.7	418					**1 171**
34.6	405	35.2	413	35.9	421					**1 172**
34.8	408	35.5	416	36.1	424					**1 173**
35.0	411	35.7	419	36.3	427					**1 174**
35.2	414	35.9	422	36.5	429					**1 175**
35.4	416	36.1	424	36.8	432					**1 176**
35.6	419	36.3	427	37.0	435					**1 177**
35.8	422	36.5	430	37.2	438					**1 178**
36.0	425	36.7	433	37.4	441					**1 179**
36.2	428	36.9	436	37.6	444					**1 180**
36.4	430	37.2	439	37.9	447					**1 181**
36.6	433	37.4	442	38.1	450					**1 182**
36.8	436	37.6	445							**1 183**
37.1	439	37.8	448							**1 184**
37.3	442	38.0	450							**1 185**
37.5	444	38.2	453							**1 186**
37.7	447	38.4	456							**1 187**
37.9	450	38.7	459							**1 188**

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

D_t is the density (mass per unit volume) of solution (in kg/m^3) at a temperature t (in °C) [for many purposes it can be assumed that irrespective of the value of t the reading of a BS density hydrometer at t gives the density D_t, and that the reading of a 60/60 °F relative density hydrometer at t is numerically 0.001 greater than $D_{t/1\,000}$ (see Appendix A)].

t	0 °C		5 °C		10 °C		15 °C		
D_t	g	G	g	G	g	G	g	G	
1 189					36.8	438	37.5	445	
1 190					37.0	440	37.7	448	
1 191					37.2	443	37.9	451	
1 192					37.4	446	38.1	454	
1 193					37.6	449	38.3	457	
1 194					37.8	452	38.5	460	
1 195					38.0	455	38.7	462	
1 196					38.2	457	38.9	465	
1 197					38.5	460	39.1	468	
1 198					38.7	463	39.3	471	
1 199					38.9	466	39.5	474	
1 200					39.1	469	39.8	477	
1 201					39.3	472			
1 202					39.5	475			
1 203					39.7	478			
1 204					40.0	481			
1 205					40.2	484			

Table 1 — Density-composition table for aqueous solutions of hydrochloric acid

g is the mass (in g) of HCl in 100 g mass of solution.
G is the mass (in g) of HCl in a quantity of solution occupying 1 L at the temperature stated at the head of the column.

20 °C		**25 °C**		**30 °C**		**35 °C**		**40 °C**		*t*
g	*G*	*g*	*G*	*g*	*G*	*g*	*G*	*g*	*G*	D_t
38.1	453									**1 189**
38.3	456									**1 190**
38.5	459									**1 191**
38.7	462									**1 192**
39.0	465									**1 193**
39.2	468									**1 194**
39.4	470									**1 195**
39.6	473									**1 196**
39.8	476									**1 197**
40.0	480									**1 198**
										1 199
										1 200
										1 201
										1 202
										1 203
										1 204
										1 205

Appendix A Correction of readings taken on BS hydrometers

For many purposes it may be assumed that a reading taken at a temperature t (in °C) on a BS density hydrometer gives the density of the liquid D_t (in kg/m^3) at t.

When a relative density hydrometer is used in a liquid at t the reading may be assumed to give the relative density of the liquid at t relative to water at 60 °F. Multiplying the reading thus obtained by 1 000 and applying the correction given in Table 2 will convert the reading to D_t (in kg/m^3) at t before entering Table 1.

Table 2 — Corrections to be applied to obtain density at t

Relative density t/60 °F × **1 000**	**Correction to give density at** t
	kg/m^3
1 000	– 1.0
1 100	– 1.1
1 200	– 1.2
NOTE The sign being negative the quantity noted is to be subtracted to obtain the density at t.	

Occasions may however arise when greater accuracy is necessary. Additional corrections can then be applied for:

a) the scale error of the hydrometer;

b) the difference between the temperature of the liquid and the standard temperature of the hydrometer;

c) the difference between the surface tension of the liquid and that for which the hydrometer is adjusted.

These corrections are considered in detail as follows.

1) *Corrections for scale errors.* The maximum permissible errors allowed on BS hydrometers are given in Table 7. When these errors are too large to be ignored hydrometers furnished with National Measurement Accreditation Service certificates of calibration should be obtained and the corrections given thereon should be applied.

2) *Temperature corrections.* When the hydrometer reading is taken at a temperature t other than the standard temperature t_s (20 °C or 15 °C) then the reading is in error due to the difference in the volume of the hydrometer between t_s and t.

Appropriate corrections for making allowance for this temperature effect are given in Table 3.

Table 3 — Temperature corrections for BS hydrometers

Standard temperature t_s **of hydrometer**		**Hydrometer reading at temperature** t	
20 °C	**15 °C**	**1 000**	**1 200**
Temperature t **of liquid**		**Correction (0.1 kg/m^3)**	
° C	° C		
0		+ 5	+ 6
5	0	+ 4	+ 5
10	5	+ 3	+ 3
15	10	+ 1	+ 2
20	15	0	0
25	20	– 1	– 2
30	25	– 3	– 3
35	30	– 4	– 5
40	35	– 5	– 6
	40	– 6	– 8

NOTE 1 When the sign is positive the correction is to be added to the hydrometer reading and when negative to be subtracted from it.
NOTE 2 Table 3 is based on the value 0.000 025 per degree Celsius for the coefficient of cubical expansion of the hydrometer.

3) *Surface tension corrections*

i) *For hydrometers that are used in an overflow vessel so as to ensure that the acid surface is truly clean.* Using this means the highest accuracy can be achieved.

Values of the surface tensions of clean surfaces of aqueous solutions of hydrochloric acid at 20 °C are given in Table 4. These are derived from data given in the International Critical Tables (1928) Vol. IV, page 464. It is unlikely that the values at other temperatures over the range 0 °C to 40 °C differ by more than 4 mN/m from the values at 20 °C.

Table 4 — Surface tensions of aqueous solutions of hydrochloric acid at 20 °C

Density of solution at 20 °C	Surface tension of solution at 20 °C
kg/m³	mN/m
1 000	73
1 050	72
1 100	71
1 150	69
1 200	65

When the highest accuracy is required hydrometers adjusted for the high surface tension value 75 mN/m should be used. An indication of possible errors, in the form of corrections which may be applied on account of the difference between the surface tension of the hydrochloric acid solution and the surface tension for which the hydrometer is graduated, is given in Table 8 of BS 718:1979.

It should be observed that it is of little advantage to apply these surface tension corrections unless corrections for scale errors and temperature are also applied.

ii) *For hydrometers used without special precautions for obtaining a clean acid surface.* In these circumstances the surface tensions of aqueous solutions are usually less than the surface tension values given in Table 4 for clean surfaces. Also, since the values depend to a great extent on the degree of contamination of the surface, the effective surface tension is erratic. Hence, when using ordinary hydrometer jars without overflow, it is not possible to assign a reliable value to the surface tension of the acid solution without measuring it. Under these conditions surface tension corrections are usually ignored. It may, however, be assumed that under ordinary conditions of cleanliness the values lie between 40 mN/m and 70 mN/m. It is therefore appropriate to use a BS hydrometer adjusted for 55 mN/m. The error then introduced by ignoring surface tension is unlikely to exceed the values given in Table 5.

Table 5 — Maximum errors introduced by ignoring surface tension when reading BS hydrometers, adjusted for 55 mN/m, in aqueous solutions of hydrochloric acid in an ordinary hydrometer jar

Density of acid solution (in kg/m³)	BS hydrometers adjusted for 55 mN/m				
	L20	L50	M50	M100	S50
	Maximum error (in kg/m³)				
1 000 to 1 200	± 0.2	± 0.4	± 0.7	± 1.1	± 0.9

It is of interest to examine the overall effect of ignoring corrections under a), b) and c) when using BS hydrometers adjusted for the medium surface tension value. In Table 6 the hydrometers are assumed to be floating in hydrochloric acid solution of density between 1 000 kg/m³ and 1 150 kg/m³ at a temperature differing by ± 10 degrees Celsius from the standard temperature of the hydrometer.

Table 6 — Maximum errors due to omission of all corrections to BS hydrometers adjusted for 55 mN/m

Series	L20	L50	M50	M100	S50
Value of one sub-division (kg/m³)	0.2	0.5	1.0	2.0	2.0
	kg/m³	kg/m³	kg/m³	kg/m³	kg/m³
a) Maximum permissible scale corrections	± 0.2	± 0.5	± 1.0	± 2.0	± 2.0
b) Temperature corrections for ± 10 °C	± 0.3	± 0.3	± 0.3	± 0.3	± 0.3
c) Maximum estimated surface tension corrections	± 0.2	± 0.4	± 0.7	± 1.1	± 0.9
Maximum value of total corrections	± 0.7	± 1.2	± 2.0	± 3.4	± 3.2

Error in grams in determined strength of solution of density 1 100 kg/m³ at 30 °C (21.3 g of HCl per 100 g of solution or 234 g of HCl per 1 L of solution) corresponding to total corrections above.

	g	g	g	g	g
HCl in 100 g of solution	± 0.2	± 0.2	± 0.4	± 0.7	± 0.6
HCl in 1 L of solution	± 2	± 3	± 5	± 8	± 8

NOTE It is assumed above that a BS density hydrometer was used. If a relative density hydrometer had been used without correction from Table 2, the errors in strength resulting from the neglect of *all corrections*, would be between the values, in grams, given below.

	g	g	g	g	g
HCl in 100 g of solution	+ 0.1 + 0.4	0 + 0.5	– 0.2 + 0.6	– 0.5 + 0.9	– 0.4 + 0.9
HCl in 1 L of solution	+ 1 + 5	0 + 6	– 2 + 8	– 5 + 11	– 5 + 10

Example of application of hydrometer corrections

Hydrometer used: density hydrometer L50 range 1 100 kg/m³ to 1 150 kg/m³ at 20 °C adjusted for 75 mN/m, ascertained scale error + 0.5 kg/m³ (i.e. maximum permissible positive error).

Temperature of acid solution	27 °C
Uncorrected hydrometer reading using overflow technique	1 106.5 kg/m³
Corrections	
For scale error	– 0.5 kg/m³
For temperature (from Table 3)	– 0.2 kg/m³
For surface tension (from Table 8 of BS 718:1979)	– 0.1 kg/m³
Then density of acid solution at 27 °C	1 105.7 kg/m³

By interpolation in Table 1 a solution of density 1 105.7 kg/m³ at 27 °C contains 22.1 g of HCl in 100 g of solution and 1 L of solution contains 245 g of HCl.

If the corrections for scale error, temperature and surface tension had been ignored, the values would have been 22.3 g and 247 g respectively.

Appendix B BS hydrometers available for use in conjunction with the tables

BS 718 affords a choice of hydrometers suitable for use in aqueous solutions of hydrochloric acid. They may have scales of density at 20 °C or 15 °C.

The choice of the hydrometer series will depend on the accuracy required and the amount of solution available. Table 7 gives the essential features of the various series of instruments with normal (N) tolerances suitable for aqueous solutions.

To use the hydrometers given in Table 7 to the best advantage (see Appendix A) it is recommended that instruments adjusted for the high surface tension category (75 mN/m) should be used in an overflow vessel as described in BS 718. If considered necessary, adjustments for the surface tension of the acid solution may also be made.

For work of lower accuracy hydrometers adjusted for the medium surface tension category (55 mN/m) may be used without adopting the overflow technique (see Table 5).

Table 7 — BS hydrometers available for use in aqueous solutions of hydrochloric acid

Series	Maximum total length	Nominal range of each hydrometer		Number of scale divisions and value of the scale interval		Minimum scale length (nominal range)	Bulb diameter		Volume below lowest graduation line of nominal range		Extension of scale at each end beyond upper and lower nominal limits	Maximum permitted error at any point on the scale
							min.	max.	min.	max.		
	mm	kg/m³	g/mL	kg/m³	g/mL	mm	mm	mm	mL	mL		kg/m³
L20	335	20	0.020	100 × 0.2	100 × 0.000 2	105	36	40	108	132	5 to 10	± 0.2
L50	335	50	0.050	100 × 0.5	100 × 0.000 5	125	23	27	50	65	2 to 5	± 0.5
M50	270	50	0.050	50 × 1	50 × 0.001	70	20	24	30	45	2 to 5	± 1.0
M100	250	100	0.100	50 × 2	50 × 0.002	85	18	20	18	26	2 to 5	± 2.0
S50	190	50	0.050	25 × 2	25 × 0.002	50	18	20	18	26	2 or 3	± 2.0

Appendix C Examples of the use of Table 1 in conjunction with BS hydrometers

NOTE In these examples it has been assumed that either:

a) the readings on BS density hydrometers (or relative density hydrometers corrected to read density) have been corrected as described in Appendix A; or

b) the corrections are not significant to the accuracy required.

The hydrometer readings are therefore assumed to indicate the density of the acid solution (in kg/m^3) at the temperature of determination.

C.1 To determine the strength of an aqueous solution of hydrochloric acid

Suppose that the temperature of the solution is 25 °C and the density at that temperature (see note) is 1 096 kg/m^3. Then in Table 1 under the temperature 25 °C and opposite D_t = 1 096 will be found g = 20.1 and G = 220, indicating that the solution contains 20.1 g of HCl in 100 g of solution and 220 g of HCl in 1 L of solution at 25 °C.

C.2 To make up a solution containing 17.5 g of HCl in 100 g of solution

In Table 1 under t = 20 °C the value of D_t corresponding to g = 17.5 g is 1 085 kg/m^3. Water should therefore be mixed with a more concentrated solution of hydrochloric acid, checking the density of the diluted acid with a BS hydrometer during the dilution, until the hydrometer indicates that the density is approaching 1 085 kg/m^3. At this stage and before making the final adjustment, the temperature of the solution is taken. Suppose it is 25 °C; then from Table 1 the value of D_t corresponding to g = 17.5 g in the column headed 25 °C is 1 083 kg/m^3. The solution at 25 °C should therefore be adjusted so that a BS hydrometer indicates that its density is 1 083 kg/m^3 (see note). The solution thus obtained will contain 17.5 g of HCl in 100 g of solution.

C.3 To make up a solution containing 234 g of HCl in 1 L of solution at 20 °C

From Table 1 under the heading 20 °C it is found that a solution containing 234 g of HCl per litre has 21.1 g of HCl per 100 g of solution. Therefore the required solution is made up as in **C.2** using g = 21.2.

blank

Publications referred to

BS 718, *Specification for density hydrometers.*

BS 733, *Pyknometers*[3)].

ISO 650, *Relative density 60/60 °F hydrometers for general purposes*[3)].

ISO 905, *Hydrochloric acid for industrial use — Evaluation of hydrochloric acid concentration by measurement of density*[3)].

ISO 1768, *Glass hydrometers — Conventional value for the thermal cubic expansion coefficient (for use in the preparation of measurement tables for liquids)*[3)].

[3)] Referred to in the foreword only.

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