



Water
& Process
Solutions

MEMENTO

Tables and data for use with ion exchange resins

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PERIODIC CLASSIFICATION OF THE ELEMENTS (Mendeleev's periodic table)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Group	I	II	IIIb	IVb	Vb	VIb	VIIb	VIIIb			Ib	IIb	III	IV	V	VI	VII	VIII
Period																		
1	1 H 1.008																	2 He 4.002
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.17
3	11 Na 22.99	12 Mg 24.3											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.9	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	48 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.7	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 a) La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209	85 At 210	86 Rn 222
7	87 Fr 223	88 Ra 226	89 b) Ac 227	104 Rf 261	105 Db 262	106 Sg 266	107 Bh 264	108 Hs 269	109 Mt 268	110 Ds 271	111 Rg 272							

a) Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
b) Actinides	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 254	100 Fm 257	101 Md 258	102 No 259	103 Lr 260

Keys to the table	1 H 1.008	Atomic number Symbol of element Atomic mass	Metals (black)	Semi-metals (blue)	Non-metals (grey)
	00 AA 00.00	Alkaline metals			
	00 EE 00.00	Earth-alkalis			
	00 TT 00.00	Transition metals			
	00 MM 00.00	Other metals			
	00 XX 00.00	Halogens			
	00 OO 00.00	Noble gases			

ABBREVIATIONS USED IN WATER ANALYSIS

ENGLISH		FRANÇAIS	
Abbrev.	Name	Abrév.	Appellation
T.H.	Total Hardness	T.H. (Ca ⁺⁺ + Mg ⁺⁺)	Dureté totale
—	Temporary Hardness	—	Dureté temporaire
—	Permanent Hardness	—	Dureté permanente
P. Alk.	Caustic + 1/2 carbonate alkalinity	T.A.	Titre alcalimétrique
M. Alk.	Total Alkalinity	T.A.C.	Titre alcalimétrique complet
F.M.A.	Free Mineral Acidity	T.A.F.	Titre acides forts
S.S.A.	Salts of Strong Anions or	TACI	Titre acidimétrique
E.M.A.	Equivalent Mineral Acidity	S.A.F.	Sels d'acides forts
T.D.S.	Total Dissolved Solids	S.T.	Salinité totale
D.M.	Dry Matter	M.S.	Matières sèches
O.M.	Organic Matter	M.O.	Matières organiques

DEUTSCH		ESPAÑOL	
Abkürzung	Benennung	Abreviación	Nombre
GH	Gesamthärte	T.H. (Ca ⁺⁺ + Mg ⁺⁺)	Dureza total
KH	Karbonathärte	—	Dureza temporal
NKH	Nichtkarbonathärte	—	Dureza permanente
p-Wert		T.A.	Título alcalimétrico
m-Wert	Alkalität	T.A.C.	Título alcalimétrico completo
–m-Wert	Freie Mineralsäuren (nach Kationenaustauscher)	T.A.F.	Título en ácidos fuertes (tras intercambiador de cationes)
–m-Wert	Salze der Mineralsäuren (im Rohwasser)	S.A.F.	Sales de ácidos fuertes (en el agua bruta)
G . S .	Gesamtsalzgehalt	S.T.	Salinidad Total
T . S .	Gesamtrockensubstanz	M.S.	Materias Secas
O.S.	Organische Substanz	M.O.	Materias Orgánicas

METRIC UNITS USED IN ION EXCHANGE

Units	Abbreviation	Name
Length	Å = 10 ⁻¹⁰ m	Ångström
	nm = 10 ⁻⁹ m	Nanometre
	µm = 10 ⁻⁶ m	Micron or micrometre
	mm = 10 ⁻³ m	Millimetre
Surface	m ²	Square metre
Volume	m ³	Cubic metre
	L = dm ³ = 10 ⁻³ m ³	Litre
	ml = cm ³ = 10 ⁻⁶ m ³	Millilitre
	BV = m ³ water/m ³ resin	Bed volume
Mass	ng = 10 ⁻⁹ g	Nanogram
	µg = 10 ⁻⁶ g	Microgram
	mg = 10 ⁻³ g	Milligram
	g	Gram
	kg = 10 ³ g	Kilogram
Flow rate	m ³ /h = 1000 L/h = 0.278 L/s	Cubic metre per hour
Linear flow rate or velocity	m/h = (m ³ /h)/m ²	Metre per hour
Specific flow rate	BV/h = (m ³ /h)/m ³ = h ⁻¹	Bed volume per hour
Resistance	Ω	Ohm
Conductance = Resistance ⁻¹	S	Siemens (mho)
Resistivity	Ω·cm	Ohm-centimetre
	MΩ·cm	Megohm-centimetre
	S/cm = Resistivity ⁻¹	Siemens per centimetre
	S/m = 100 S/cm	Siemens per metre
	µS/cm = 10⁻⁴ S/m	Microsiemens per centimetre
Conductivity	µS/cm = 10 ⁻⁶ S/cm	Microsiemens per centimetre
	mS/m = 10 µS/cm	Millisiemens per metre

ABBREVIATIONS OF VARIOUS UNITS

atm	atmosphere	kWh	kilowatt-hour
BV	bed-volume	L	litre
Btu	British thermal unit	lb	pound
cal	calorie	m	meter
cm	centimetre	min	minute
cuft = ft ³	cubic foot	oz	ounce
fps	foot-pound-second	Pa	pascal
ft	foot	ppb	part per billion
ft-lb	foot-pound	ppm	part per million
g	gram	ppt	part per trillion
gal	gallon	psf	pound per square foot
gpm	gallon per minute	psi	pound per square inch
h	hour	s	second
hp	horsepower	sq ft = ft ²	square foot
in	inch	sq in = in ²	square inch
J	joule	W	watt

TABLES OF CONVERSION

	1 unit	multiplied by	=
LENGTH	m	3.2808	ft
	m	39.37	in.
	in.	0.0833	ft
	in.	0.0254	m
	ft	12	in.
	ft	0.3048	m
	J	$9.486 \cdot 10^{-4}$	Btu
ENERGY	J	0.239	cal
	J	0.7377	ft-lb
	J	$2.778 \cdot 10^{-7}$	kWh
	Btu	777.65	ft-lb
	Btu	1054.35	J
	Btu	$2.93 \cdot 10^{-4}$	kWh
	ft-lb	0.324	cal
MASS	ft-lb	1.3558	J
	ft-lb	$3.766 \cdot 10^{-7}$	kWh
	g	0.035	oz
	g	15.43	grain
	g	0.0022	lb (avdp)
	lb (avdp)	7000	grain
	lb (avdp)	453.6	g
SURFACE	lb (avdp)	16	oz
	grain	0.065	g
	grain	0.0023	oz
	m ²	10.764	sq ft
	m ²	1550	sq in.
	sq ft or ft ²	0.093	m ²
	sq in	0.069	sq ft
RELATIVE DENSITY & CONCENTRATION	g/L	58.42	grain/gal (U.S.)
	g/L	0.0624	lb/ft
	g/L	1000	ppm
	g/L		lb/gal (US)
	grain/gal (U.S.)	17.12	ppm
	grain/gal (U.K.)	14.25	g/cm ³
	lb/ft ³	0.016	g/cm ³
	lb/ft ³	$5 \cdot 10^{-4}$	lb/in ³
	lb/in ³	27.68	g/cm ³
	lb/in ³	1728	lb/ft ³

VOLUME	m ³	35.31	ft ³
	m ³	61024	in ³
	m ³	219.97	gal (U.K.)
	m ³	264.17	gal (U.S.)
	m ³	1000	L
	m ³	61.024	in ³
	m ³	0.03531	ft ³
	m ³	0.21997	gal (U.K.)
	m ³	0.26417	gal (U.S.)
	L	10 ⁻³	m ³
	gal (U.K.)	4.546	L
	gal (U.K.)	1.201	gal (U.S.)
	gal (U.S.)	0.13368	ft ³
	gal (U.S.)	231	in ³
	gal (U.S.)	0.83267	gal.(U.K.)
	gal (U.S.)	3.7854 · 10 ⁻³	m ³
	gal (U.S.)	3.7854	L
	ft ³ or cuft	1728	in ³
	ft ³	7.4805	gal.(U.S.)
	ft ³	6.2288	gal . (U . K.)
	ft ³	28.317	L
	ft ³	2.8317 · 10 ⁻²	m ³
	in ³	16.387	cm ³
	in ³	5.787 · 10 ⁻⁴	ft ³
	in ³	4.329 · 10 ⁻³	gal (U.S.)
	in ³	1.639 · 10 ⁻²	
	in ³	1.639 · 10 ⁻⁵	m ³
BED VOLUME	BV	7.481	gal (U.S.)/ft ³
	BV	6.22	gal (U.K.)/ft ³
	gal (U.S.)/ft ³	0.134	BV
	gal (U.K.)/ft ³	0.16	BV
	gal (U.S.)/ft ³	0.134	L/L
	gal (U.K.)/ft ³	0.16	L/L
SPEED & LINEAR VELOCITY	m/s	196.85	ft/min
	ft/min	5.08 · 10 ⁻³	m/s
	ft/min	18.29	m/h
	ft/s	0.3048	m/s
	m/h	0.41	gal (U.S.)/ft ² min
	m/h	0.35	gal (U.K.)/ft ² min
	gal (U.S.)/ft ² min	2.44	m/h
	gal (U.K.)/ft ² min	2.93	m/h
FLOW RATE	m ³ /h	0.589	ft ³ /mn
	m ³ /h	4.403	gal (U.S.)/min
	m ³ /h	0.278	I/s
	ft ³ /mn	0.472	I/s
	ft ³ /mn	1.7	m ³ /h
	ft ³ /mn	0.125	gal (U.S.)/s
	BV/h	0.125	gal (U.S.)/ft ³ min
	gal (U.S.)/ft ³ min	8.02	BV/h
	gal (U.K.)/ft ³ min	9.62	BV/h

PRESSURE	atm	1.0133	bar
	atm	76	cm Hg
	atm	33.9	ft H ₂ O
	atm	10.333	m H ₂ O
	atm	$1.013 \cdot 10^5$	Pa
	atm	14.696	psi
	bar	0.987	atm
	bar	75.006	cm Hg
	bar	10.197	m H ₂ O
	bar	10^5	Pa
	bar	14.504	psi
	Pa	$9.867 \cdot 10^{-6}$	atm
	Pa	10^{-5}	bar
	kPa	0.01	bar
	kPa	0.33	ft H ₂ O
	kPa	0.10197	m H ₂ O
	kPa	0.15	psi
	MPa	10	bar
	MPa	145.04	psi
	psf	$6.944 \cdot 10^{-3}$	psi
	psf	47.880	Pa
	psi	0.068	atm
	psi	0.069	bar
	psi	0.703	m H ₂ O
	psi	$6.9 \cdot 10^3$	Pa
psi	144	psf	
VISCOSITY	poise	$2.089 \cdot 10^{-3}$	lbF · s/ft ²
	poise	$3.6 \cdot 10^2$	kg/mh
	poise	$5.6 \cdot 10^{-3}$	lb/in.s
	lb/ft s	14.88	poise
	kg/m h	0.672	lb/ft h
EXCHANGE CAPACITY	eq/L	50	g/L as CaCO ₃
	eq/L	28	g/L as CaO
	eq/L	21.85	kgr (CaCO ₃)/ft ³
	g/L as CaCO ₃	0.02	eq/L
	g/L as CaCO ₃	0.56	g/L as CaO
	g/L as CaCO ₃	0.437	kgr (CaCO ₃)/ft ³
	g/L as CaO	0.0357	eq/L
	g/L as CaO	0.780	kgr (CaCO ₃)/ft ³
	kgr (CaCO ₃)/ft ³	0.0458	eq/L
	PRESSURE DROP (per unit of bed depth)	psi/ft	22.6
psi/ft		2.307	m H ₂ O/m
psi/ft		0.231	kg/cm ² /m
psi/ft		0.226	bar/m

UNITS OF CONCENTRATION

10 meq/l = 50°f =500 ppm CaCO₃ =29.21 grain CaCO₃/US gal =28 dH°

UNITS OF CAPACITY

1 eq/l = 5000°f = 50 g CaCO₃/l = 21.83 kgrains/cuft = 2800 dH°

VALUE IN mg/L OF THE MAIN CONCENTRATION UNITS

	Formula	Mol. weight	1 meq/L =	1 degré français (°f) =	1 deutscher Härtegrad (°dH) =	1 grain as CaCO ₃ per US gal =	1 ppm as CaCO ₃ =
CATIONS							
Sodium	Na ⁺	23	23	4.6	8.2	7.9	0.46
Potassium	K ⁺	39.1	39.1	7.8	13.9	13.4	0.78
Ammonium	NH ₄ ⁺	18	18	3.6	6.4	6.2	0.36
Iron	Fe ⁺⁺	55.8	27.9	5.6	10	9.6	0.56
Calcium	Ca ⁺⁺	40	20	4	7.1	6.8	0.4
Magnesium	Mg ⁺⁺	24.3	12.1	2.43	4.3	4.2	0.24
Aluminium	Al ⁺⁺⁺	27	9	1.8	3.2	3.1	0.18
ANIONS							
Chloride	Cl ⁻	35.5	35.5	7.1	12.7	12.2	0.71
Nitrate	NO ₃ ⁻	62	62	12.4	22.1	21.2	1.24
Bicarbonate	HCO ₃ ⁻	61	61	12.2	21.8	20.9	1.22
Bisulphate	HSO ₄ ⁻	97	97	19.4	34.6	33.2	1.94
Bisilicate	HSiO ₃ ⁻	77	77	15.4	27.5	26.3	1.54
Carbonate	CO ₃ ²⁻	60	30	6	10.7	10.3	0.6
Sulphate	SO ₄ ²⁻	96	48	9.6	17.1	16.4	0.96
Sulphite	SO ₃ ²⁻	80	40	8	14.3	13.7	0.8
Silicate	SiO ₃ ²⁻	76	38	7.6	13.5	13	0.76
Phosphate	PO ₄ ³⁻	95	31.7	6.3	11.3	10.8	0.63
REGENERANTS & SALTS							
Hydrochloric acid	HCl	36.5	36.5	7.3	13	12.5	0.73
Nitric acid	HNO ₃	63	63	12.6	22.5	21.5	1.26
Sulphuric acid	H ₂ SO ₄	98	49	9.8	17.5	16.6	0.98
Caustic soda	NaOH	40	40	8	14.3	13.7	0.8
Caustic potash	KOH	56	56	11.2	20	19.1	1.12
Ammonia	NH ₃	17	17	3.4	6.1	5.8	0.34
Ammonia	NH ₄ OH	35	35	7.0	12.5	12.0	0.7
Sodium carbonate	Na ₂ CO ₃	106	53	10.6	18.9	18.1	1.06
Sodium bicarbonate	NaHCO ₃	84	84	16.8	30	28.7	1.68
Sodium sulphate	Na ₂ SO ₄	142	71	14.2	25.3	24.3	1.42
Sodium chloride	NaCl	58.5	58.5	11.7	20.9	20	1.17
Calcium carbonate	CaCO ₃	100	50	10	17.8	17.1	1.00
Calcium sulphate	CaSO ₄	136	68	13.6	24.3	23.3	1.36
Calcium oxide	CaO	56	28	5.6	10	9.6	0.56
Calcium hydroxide	Ca(OH) ₂	74	37	7.4	13.2	12.7	0.74
Ferric chloride	FeCl ₃	162.3	54.1	10.8	19.3	18.5	1.08
Ferrous sulphate	FeSO ₄	152	76	15.2	27.1	26	1.52
Aluminium sulphate	Al ₂ (SO ₄) ₃	347	57	11.4	20.3	19.5	1.14

CONCENTRATION OF REGENERANTS***SULPHURIC ACID***

% H₂SO₄	g H₂SO₄/L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	10.05	0.205	1.0051	0.7	0.08388
2	20.24	0.413	1.0118	1.7	0.1689
3	30.55	0.625	1.0184	2.6	0.2550
4	41.00	0.836	1.0250	3.5	0.3422
5	51.59	1.05	1.0317	4.5	0.4305
6	62.31	1.27	1.0385	5.4	0.5200
8	84.18	1.72	1.0522	7.2	0.7025
10	106.6	2.17	1.0661	9.0	0.8897
12	129.6	2.64	1.0802	10.8	1.082
15	165.3	3.37	1.1020	13.4	1.379
20	227.9	4.65	1.1394	17.7	1.902
30	365.4	7.46	1.2180	25.9	3.051
50	697.6	14.2	1.3951	41.1	5.821
90	1634	33.3	1.815	64.9	13.64
92	1678	34.2	1.824	65.3	14.01
94	1720	35.1	1.830	65.6	14.36
96	1762	35.9	1.836	66.0	14.71
98	1799	36.7	1.836	66.0	15.02
100	1831	37.3	1.831	65.8	15.28

HYDROCHLORIC ACID

% HCl	g HCl/L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	10.03	0.275	1.003	0.5	0.08372
2	20.16	0.553	1.008	1.2	0.1683
4	40.72	1.12	1.018	2.6	0.3399
5	51.70	1.42	1.023	3.3	0.4315
6	61.67	1.69	1.027	3.9	0.5147
8	83.01	2.28	1.038	5.3	0.6927
10	104.7	2.87	1.047	6.6	0.8741
12	126.9	3.48	1.057	7.9	1.059
16	172.4	4.73	1.078	10.4	1.439
20	219.6	6.02	1.098	12.9	1.833
30	344.8	9.46	1.149	18.8	2.879
32	370.9	10.16	1.159	19.9	3.097
34	397.6	10.90	1.169	21.0	3.318
36	424.4	11.63	1.179	22.0	3.544
40	479.2	13.10	1.198	24.0	3.999

SODIUM CHLORIDE

% NaCl	g NaCl/L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	10.05	0.172	1.0053	0.8	0.08390
2	20.25	0.346	1.0125	1.8	0.1690
4	41.07	0.703	1.0268	3.8	0.3428
6	62.48	1.069	1.0413	5.8	0.5214
8	84.47	1.445	1.0559	7.7	0.7050
10	107.1	1.832	1.0707	9.6	0.8935
12	130.3	2.229	1.0857	11.5	1.087
16	178.6	3.056	1.1162	15.1	1.490
20	229.6	3.928	1.1478	18.7	1.916
26	311.3	5.326	1.1972	23.9	2.598

CAUSTIC SODA

% NaOH	g NaOH /L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	10.10	0.262	1.0095	1.4	0.08425
2	20.41	0.511	1.0207	2.9	0.1704
3	30.95	0.774	1.032	4.5	0.2583
4	41.71	1.04	1.043	6.0	0.3481
5	52.69	1.32	1.054	7.4	0.4397
6	63.89	1.60	1.065	8.8	0.5332
8	86.95	2.17	1.087	11.6	0.7256
10	110.9	2.77	1.109	14.2	0.9254
12	135.7	3.39	1.131	16.8	1.333
16	188.0	4.70	1.175	21.6	1.569
20	243.8	6.10	1.219	26.1	2.035
30	411.0	10.27	1.341	36.9	3.432
36	500.4	12.51	1.390	40.7	4.178
40	571.9	14.29	1.430	43.6	4.773
42	608.7	14.49	1.449	45.0	5.082
45	665.5	16.63	1.479	47.0	5.557
48	723.1	18.08	1.507	48.8	6.038
50	762.7	19.06	1.525	49.9	6.365

AMMONIA

% NH₃	g NH₃/L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	9.939	0.583	0.9939	10.9	0.08294
2	19.79	1.16	0.9895	11.5	0.1652
4	39.24	2.31	0.9811	12.7	0.3275
6	58.38	3.43	0.9730	13.9	0.4872
8	77.21	4.53	0.9651	15.1	0.6443
10	95.75	5.62	0.9575	16.2	0.7991
12	114.0	6.70	0.9501	17.3	0.9515
16	149.8	8.79	0.9362	19.5	1.250
20	184.6	10.8	0.9229	21.7	1.540
30	267.6	17.0	0.8920	27.0	2.233

NITRIC ACID

% HNO₃	g HNO₃/L	Normality	Specific gravity	° Baumé	Pounds per US gallon
1	10.0	0.159	1.0037	0.5	0.0834
2	20.2	0.320	1.0091	1.3	0.1686
4	40.8	0.648	1.0202	2.9	0.3405
6	61.9	0.982	1.0314	4.4	0.5166
8	83.4	1.324	1.0427	5.9	0.6960
10	105.4	1.673	1.0543	7.5	0.8796
12	127.9	2.030	1.0660	9.0	1.0673
16	174.4	2.768	1.0901	12.0	1.4554
20	223.0	3.538	1.1150	15.0	1.8610
30	354.0	5.618	1.1801	22.1	2.9542
40	498.7	7.913	1.2466	28.7	4.1617
50	655.0	10.41	1.310	34.3	5.4661

Nitric acid is not recommended for regeneration of ion exchange resins

APPROXIMATE pH VALUE OF PURE SOLUTIONS

Compound	Formula	Normality	pH value
Hydrochloric acid	HCl	1 N	0.1
	HCl	0.1 N	1.1
	HCl	0.01 N	2.0
Sulphuric acid	H ₂ SO ₄	1 N	0.3
	H ₂ SO ₄	0.1N	1.2
	H ₂ SO ₄	0.01 N	2.1
Acetic acid	CH ₃ COOH	1 N	2.4
	CH ₃ COOH	0.1 N	2.9
	CH ₃ COOH	0.01 N	3.4
Carbonic acid	H ₂ CO ₃	Sat .	3.8
Boric acid	H ₃ BO ₃	0.1 N	5.2
Sodium hydroxide	NaOH	1 N	14.0
	NaOH	0.1 N	13.0
	NaOH	0.01 N	12.0
Sodium silicate	Na ₂ SiO ₃	0.1 N	12.6
Sodium carbonate	Na ₂ CO ₃	0.1 N	11.6
Ammonia	NH ₃	IN	11.6
	NH ₃	0.1 N	11.1
	NH ₃	0.01 N	10.6
Calcium carbonate	CaCO ₃	Sat.	9.4
Sodium borate	Na ₂ B ₄ O ₇	0.1 N	9.2
Sodium bicarbonate	NaHCO ₃	0.1 N	8.4

DEGREES BAUME vs. DENSITY

°Bé	Density @ 15°C	°Bé	Density @ 15°C	°Bé	Density @ 15°C	°Bé	Density @ 15°C
0	0.999	17	1.133	34	1.307	51	1.545
1	1.006	18	1.142	35	1.319	52	1.562
2	1.013	19	1.151	36	1.331	53	1.579
3	1.020	20	1.160	37	1.344	54	1.597
4	1.028	21	1.169	38	1.356	55	1.615
5	1.035	22	1.179	39	1.369	56	1.633
6	1.042	23	1.189	40	1.382	57	1.652
7	1.050	24	1.199	41	1.396	58	1.671
8	1.058	25	1.209	42	1.409	59	1.690
9	1.066	26	1.219	43	1.423	60	1.710
10	1.074	27	1.229	44	1.437	61	1.731
11	1.082	28	1.240	45	1.452	62	1.752
12	1.090	29	1.250	46	1.467	63	1.773
13	1.098	30	1.261	47	1.482	64	1.795
14	1.106	31	1.273	48	1.497	65	1.818
15	1.115	32	1.284	49	1.513	66	1.841
16	1.124	33	1.295	50	1.529		

Degree Baumé vs. Density Formulas

$$D = \frac{145}{145 - \text{°Bé}}$$

$$\text{°Bé} = \frac{145 \times (D - 1)}{D}$$

For $D > 1$
 D = Specific gravity
 °Bé = degree Baumé

ACID-BASE INDICATORS

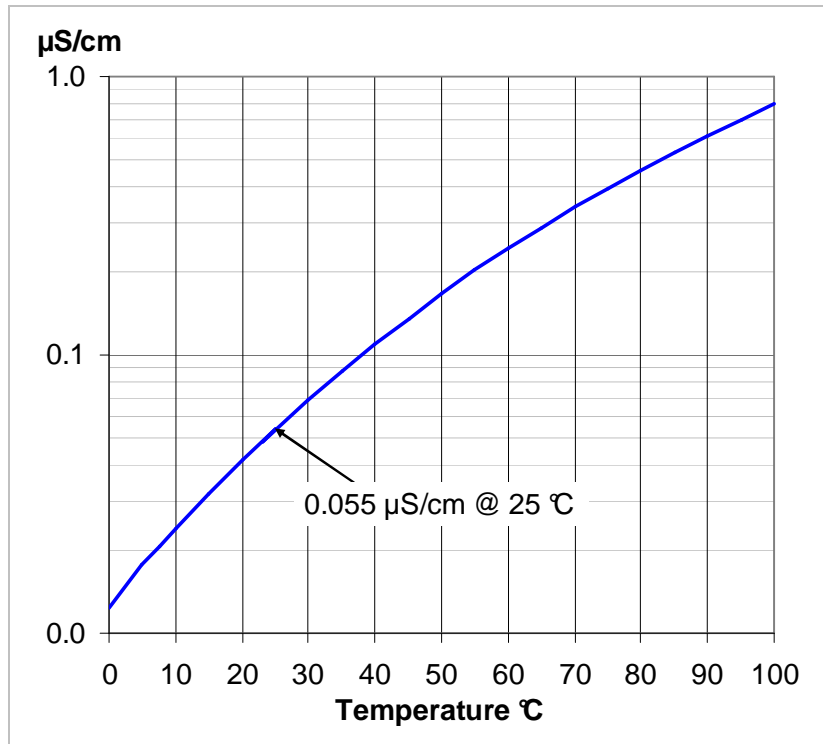
Range of pH	Indicator	Colour change	
		From	To
1.2 — 2.8	Thymol blue	Red	Yellow
1.2 — 2.8	Metacresol purple	Red	Yellow
2.9 — 4.0	N-n-dimethyl-p-phenylazo-aniline	Red	Yellow
3.0 — 4.6	Bromophenol blue	Yellow	Blue
3.0 — 5.0	Congo red	Blue	Red
3.2 — 4.4	Methyl orange	Red	Yellow
3.8 — 5.4	Bromocresol green	Yellow	Blue
4.4 — 6.2	Methyl red	Red	Yellow
5.2 — 6.8	Bromocresol purple	Yellow	Purple
5.2 — 6.8	Bromophenol red	Yellow	Purple
6.0 — 7.6	Bromothymol blue	Yellow	Blue
6.4 — 8.2	Phenol red	Yellow	Red
6.8 — 8.0	Neutral red	Red	Amber
7.0 — 8.8	Cresol red	Yellow	Red
7.4 — 9.0	Metacresol purple	Yellow	Purple
8.0 — 9.6	Thymol blue	Yellow	Blue
8.2 — 10.0	Phenolphthalein	Colourless	Pink
9.4 — 10.6	Thymolphthalein	Colourless	Blue
10.0 — 12.1	Alizarin yellow gg	Clear yellow	Brownish yellow
11.6 — 13.0	Epsilon blue	Orange	Violet

SCREEN ANALYSES

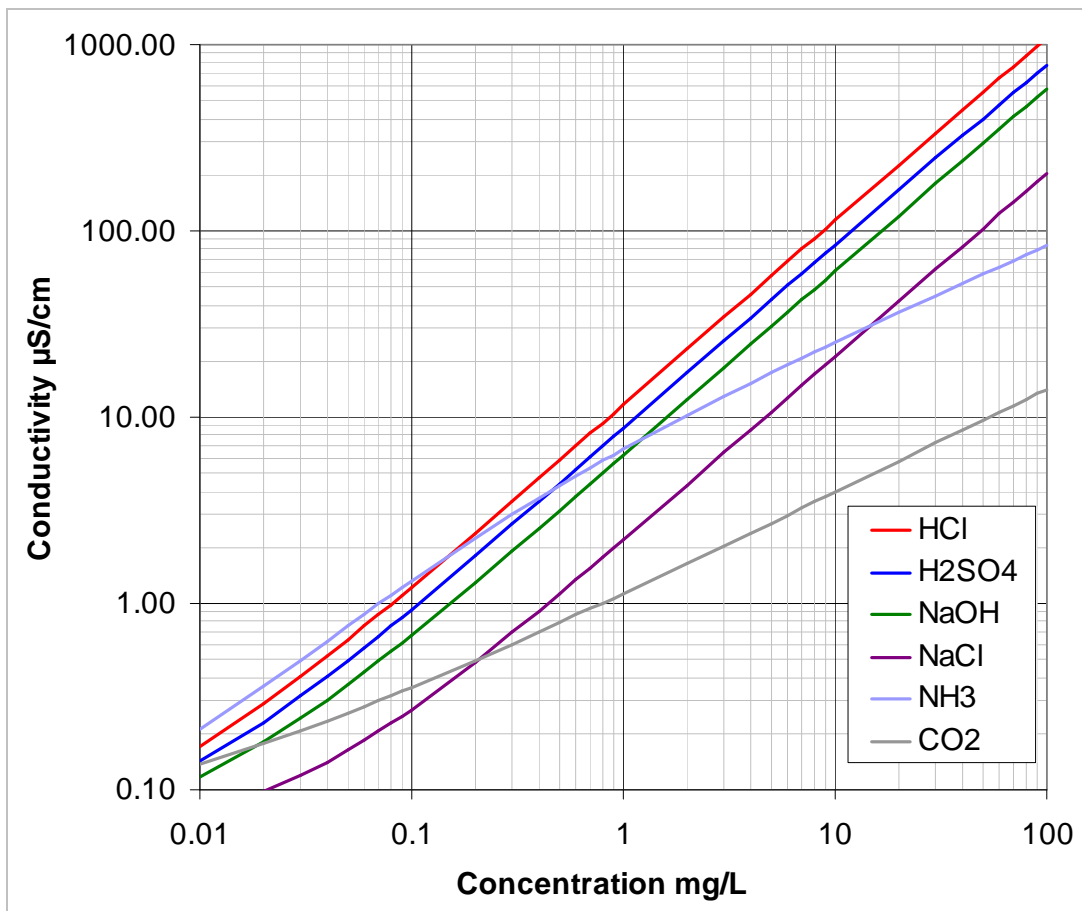
Mesh vs. mm

USA ASTM E 1181			ENGLAND BS 11 (1976)		FRANCE NFX 11-504 (197)	
mm	N°	Tyler mesh	Nominal aperture size	Nominal wire diameter	mm	N°
0.038	400	400	0.038	0.030	0.040	17
0.045	325	325	0.045	0.032		
0.053	270	270	0.053	0.036	0.050	18
0.063	230	250	0.063	0.045	0.063	19
0.075	200	200	0.075	0.050	0.080	20
0.090	170	170	0.090	0.063		
0.106	140	150	0.106	0.071	0.100	21
0.125	120	115	0.125	0.090	0.125	22
0.150	100	100	0.150	0.100	0.160	23
0.180	80	80	0.180	0.125		
0.212	70	65	0.212	0.140	0.200	24
0.250	60	60	0.250	0.160	0.250	25
0.300	50	48	0.300	0.200	0.315	26
0.355	45	42	0.355	0.224		
0.425	40	35	0.425	0.280	0.400	27
0.500	35	32	0.500	0.315	0.500	28
0.600	30	28	0.600	0.400	0.630	29
0.710	25	24	0.710	0.450		
0.850	20	20	0.850	0.500	0.800	30
1.00	18	16	1.00	0.56	1.00	31
1.18	16	14	1.18	0.63	1.25	32
1.40	14	12	1.40	0.71		

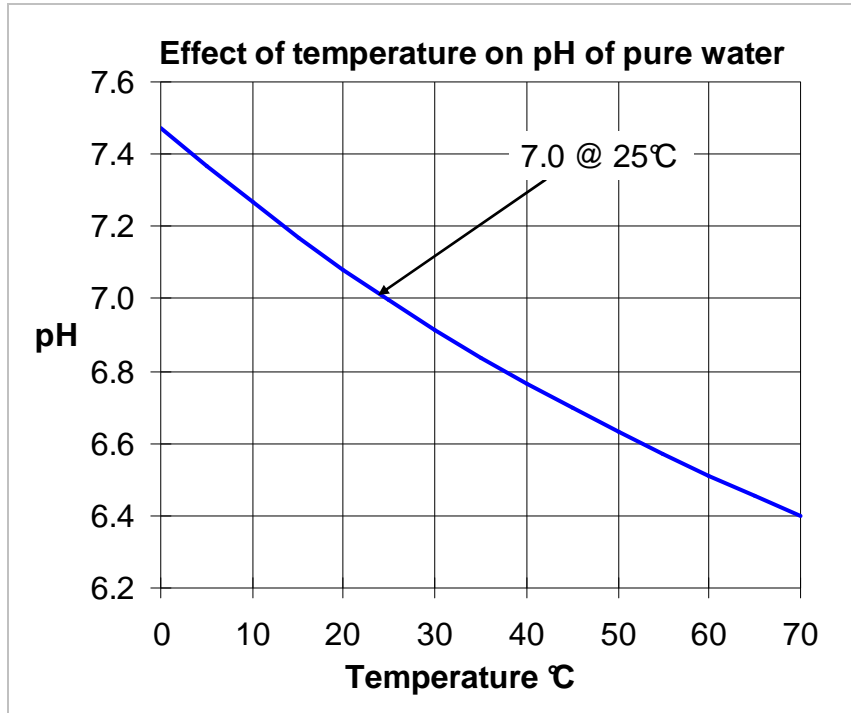
CONDUCTIVITY OF PURE WATER vs. TEMPERATURE



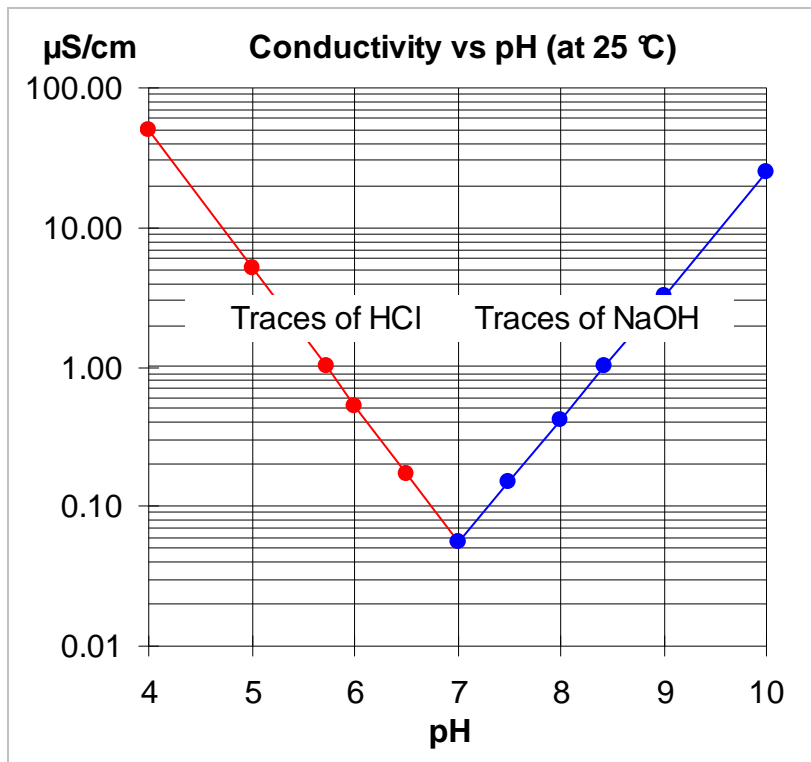
CONDUCTIVITY OF WATER vs. ELECTROLYTE CONCENTRATION @ 25°C



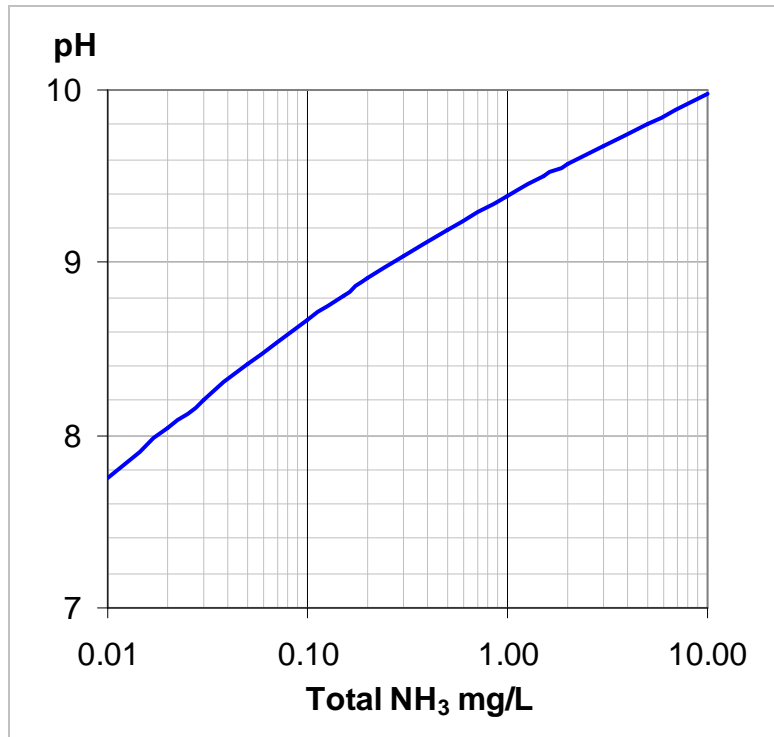
pH VALUE OF PURE WATER vs. TEMPERATURE



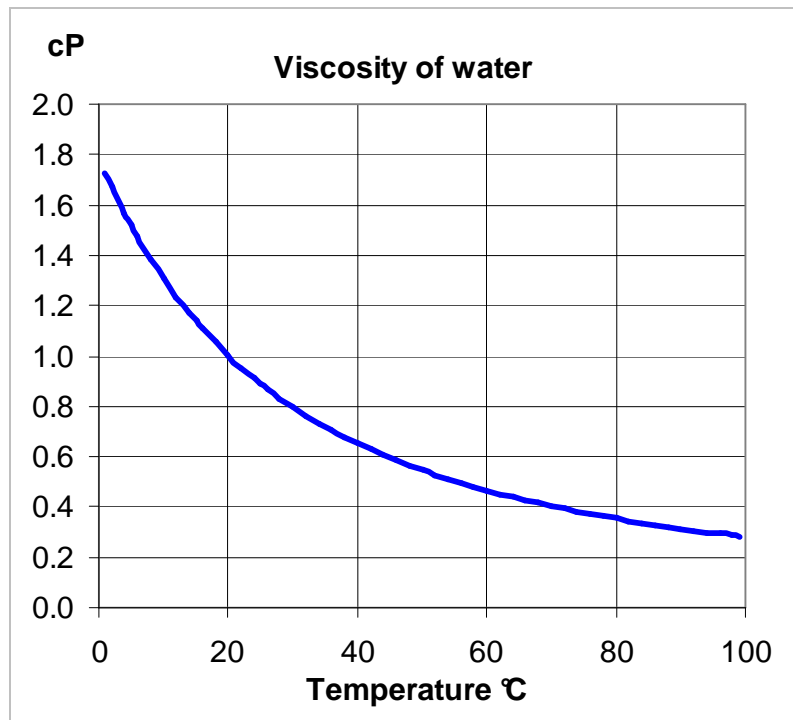
EFFECT OF TRACES OF HCl & NaOH ON WATER CONDUCTIVITY



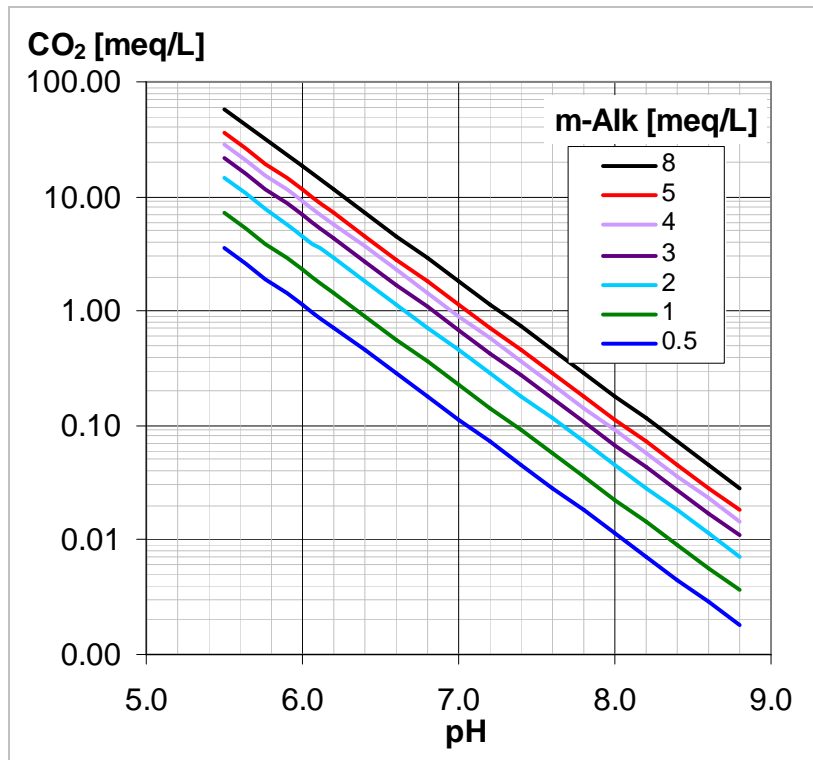
AMMONIA CONCENTRATION vs. pH VALUE



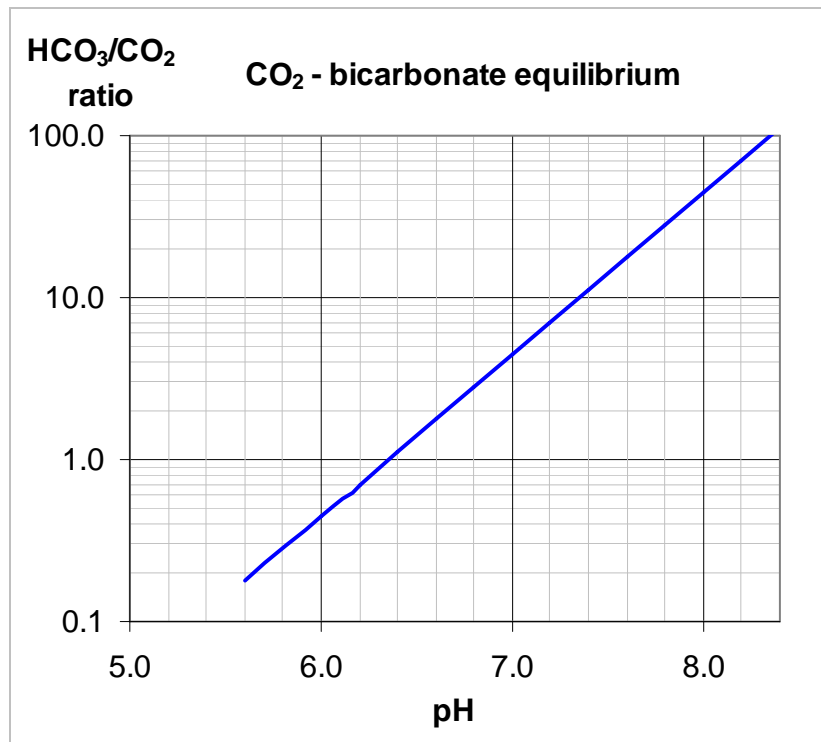
ABSOLUTE VISCOSITY OF WATER vs. TEMPERATURE



RELATION BETWEEN pH, FREE CARBON DIOXIDE & BICARBONATE ALKALINITY



The second graph shows the same equilibrium with the ratio of bicarbonate to free carbon dioxide vs. pH of the water



Examples

At pH 7.0 the ratio is equal to 4: $[HCO_3^-] = 4 \times [CO_2]$

At pH 8.0 the ratio is equal to 40: $[CO_2] = [HCO_3^-] / 40$: very little free carbon dioxide

At pH 6.0 the ratio is equal to 0.4: $[CO_2] = 2.5 \times [HCO_3^-]$: high carbon dioxide

Temperature scales

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F				
-273	-459.4	-26.1	-15	5.0	16.7	62	143.6	59.4	139	282.2	111.1	232	449.6
-268	-450	-25.6	-14	6.8	17.2	63	145.4	60.0	140	284.0	112.2	234	453.2
-262	-440	-25.0	-13	8.6	17.8	64	147.2	60.6	141	285.8	113.3	236	456.8
-257	-430	-24.4	-12	10.4	18.3	65	149.0	61.1	142	287.6	114.4	238	460.4
-251	-420	-23.9	-11	12.2	18.9	66	150.8	61.7	143	289.4	115.6	240	464.0
-246	-410	-23.3	-10	14.0	19.4	67	152.6	62.2	144	291.2	116.7	242	467.6
-240	-400	-22.8	-9	15.8	20.0	68	154.4	62.8	145	293.0	117.8	244	471.2
-234	-390	-22.2	-8	17.6	20.6	69	156.2	63.3	146	294.8	118.9	246	474.8
-229	-380	-21.7	-7	19.4	21.1	70	158.0	63.9	147	296.6	120.0	248	478.4
-223	-370	-21.1	-6	21.2	21.7	71	159.8	64.4	148	298.4	121.1	250	482
-218	-360	-20.6	-5	23.0	22.2	72	161.6	65.0	149	300.2	126.7	260	500
-212	-350	-20.0	-4	24.8	22.8	73	163.4	65.6	150	302.0	132.2	270	518
-207	-340	-19.4	-3	26.6	23.3	74	165.2	66.1	151	303.8	137.8	280	536
-201	-330	-18.9	-2	28.4	23.9	75	167.0	66.7	152	305.6	143.3	290	554
-196	-320	-18.3	-1	30.2	24.4	76	168.8	67.2	153	307.4	148.9	300	572
-190	-310	-17.8	0	32.0	25.0	77	170.6	67.8	154	309.2	154.4	310	590
-184	-300	-17.2	1	33.8	25.6	78	172.4	68.3	155	311.0	160.0	320	608
-179	-290	-16.7	2	35.6	26.1	79	174.2	68.9	156	312.8	165.6	330	626
-173	-280	-16.1	3	37.4	26.7	80	176.0	69.4	157	314.6	171.1	340	644
-169	-273	-15.6	4	39.2	27.2	81	177.8	70.0	158	316.4	176.7	350	662
-168	-270	-15.4	5	41.0	27.8	82	179.6	70.6	159	318.2	182.2	360	680
-162	-260	-14.6	6	42.8	28.3	83	181.4	71.1	160	320.0	187.8	370	698
-157	-250	-14.1	7	44.6	28.9	84	183.2	71.7	161	321.8	193.3	380	716
-151	-240	-13.3	8	46.4	29.4	85	185.0	72.2	162	323.6	198.9	390	734
-146	-230	-12.8	9	48.2	30.0	86	186.8	72.8	163	325.4	204.4	400	752
-140	-220	-12.2	10	50.0	30.6	87	188.6	73.3	164	327.2	210.0	410	770
-134	-210	-11.7	11	51.8	31.1	88	190.4	73.9	165	329.0	215.6	420	788
-129	-200	-11.1	12	53.6	31.7	89	192.2	74.4	166	330.8	221.1	430	806
-123	-190	-10.6	13	55.4	32.2	90	194.0	75.0	167	332.6	226.7	440	824
-118	-180	-10.0	14	57.2	32.8	91	195.8	75.6	168	334.4	232.2	450	842
-112	-170	-9.4	15	59.0	33.3	92	197.6	76.1	169	336.2	237.8	460	860
-107	-160	-8.9	16	60.8	33.9	93	199.4	76.7	170	338.0	243.3	470	878
-101	-150	-8.3	17	62.6	34.4	94	201.2	77.2	171	339.8	248.9	480	896
-95.6	-140	-7.8	18	64.4	35.0	95	203.0	77.8	172	341.6	254.4	490	914
-90.0	-130	-7.2	19	66.2	35.6	96	204.8	78.3	173	343.4	260.0	500	932
-84.4	-120	-184	20	68.0	36.1	97	206.6	78.9	174	345.2	265.6	510	950
-78.9	-110	-166	21	69.8	36.7	98	208.4	79.4	175	347.0	271.1	520	968
-73.3	-100	-148	22	71.6	37.2	99	210.2	80.0	176	348.8	276.7	530	986
-67.8	-90	-130	23	73.4	37.8	100	212.0	80.6	177	350.6	282.2	540	1004
-62.2	-80	-112	24	75.2	38.3	101	213.8	81.1	178	352.4	287.8	550	1022
-56.7	-70	-94	25	77.0	38.9	102	215.6	81.7	179	354.2	293.3	560	1040
-51.1	-60	-76	26	78.8	39.4	103	217.4	82.2	180	356.0	298.9	570	1058
-45.6	-50	-58.0	27	80.6	40.0	104	219.2	82.8	181	357.8	304.4	580	1076
-45.0	-49	-56.2	28	82.4	40.6	105	221.0	83.3	182	359.6	310.0	590	1094
-44.4	-48	-54.4	29	84.2	41.1	106	222.8	83.9	183	361.4	315.6	600	1112
-43.9	-47	-52.6	30	86.0	41.7	107	224.6	84.4	184	363.2	321.1	610	1130
-43.3	-46	-50.8	31	87.8	42.2	108	226.4	85.0	185	365.0	326.7	620	1148
-42.8	-45	-49.0	32	89.6	42.8	109	228.2	85.6	186	366.8	332.2	630	1166
-42.2	-44	-47.2	33	91.4	43.3	110	230.0	86.1	187	368.6	337.8	640	1184
-41.7	-43	-45.4	34	93.2	43.9	111	231.8	86.7	188	370.4	343.3	650	1202
-41.1	-42	-43.6	35	95.0	44.4	112	233.6	87.2	189	372.2	348.9	660	1220
-40.6	-41	-41.8	36	96.8	45.0	113	235.4	87.8	190	374.0	354.4	670	1238
-40.0	-40	-40.0	37	98.6	45.6	114	237.2	88.3	191	375.8	360.0	680	1256
-39.4	-39	-38.2	38	100.4	46.1	115	239.0	88.9	192	377.6	365.6	690	1274
-38.9	-38	-36.4	39	102.2	46.7	116	240.8	89.4	193	379.4	371.1	700	1292
-38.3	-37	-34.6	40	104.0	47.2	117	242.6	90.0	194	381.2	376.7	710	1310
-37.8	-36	-32.8	41	105.8	47.8	118	244.4	90.6	195	383.0	382.2	720	1328
-37.2	-35	-31.0	42	107.6	48.3	119	246.2	91.1	196	384.8	387.8	730	1346
-36.7	-34	-29.2	43	109.4	48.9	120	248.0	91.7	197	386.6	393.3	740	1364
-36.1	-33	-27.4	44	111.2	49.4	121	249.8	92.2	198	388.4	398.9	750	1382
-35.6	-32	-25.6	45	113.0	50.0	122	251.6	92.8	199	390.2	404.4	760	1400
-35.0	-31	-23.8	46	114.8	50.6	123	253.4	93.3	200	392.0	410.0	770	1418
-34.4	-30	-22.0	47	116.6	51.1	124	255.2	94.4	202	395.6	415.6	780	1436
-33.9	-29	-20.2	48	118.4	51.7	125	257.0	95.6	204	399.2	421.1	790	1454
-33.3	-28	-18.4	49	120.2	52.2	126	258.8	96.7	206	402.8	426.7	800	1472
-32.8	-27	-16.6	50	122.0	52.8	127	260.6	97.8	208	406.4	432.2	810	1490
-32.2	-26	-14.8	51	123.8	53.3	128	262.4	98.9	210	410.0	437.8	820	1508
-31.7	-25	-13.0	52	125.6	53.9	129	264.2	100.0	212	413.6	443.3	830	1526
-31.1	-24	-11.2	53	127.4	54.4	130	266.0	101.1	214	417.2	448.9	840	1544
-30.6	-23	-9.4	54	129.2	55.0	131	267.8	102.2	216	420.8	454.4	850	1562
-30.0	-22	-7.6	55	131.0	55.6	132	269.6	103.3	218	424.4	460.0	860	1580
-29.4	-21	-5.8	56	132.8	56.1	133	271.4	104.4	220	428.0	465.6	870	1598
-28.9	-20	-4.0	57	134.6	56.7	134	273.2	105.6	222	431.6	471.1	880	1616
-28.3	-19	-2.2	58	136.4	57.2	135	275.0	106.7	224	435.2	476.7	890	1634
-27.8	-18	-0.4	59	138.2	57.8	136	276.8	107.8	226	438.8	482.2	900	1652
-27.2	-17	1.4	60	140.0	58.3	137	278.6	108.9	228	442.4	510.0	950	1742
-26.7	-16	3.2	61	141.8	58.9	138	280.4	110.0	230	446.0	537.8	1000	1832

Conversion formulas:

$$°C = (°F - 32) \times 5/9$$

$$°F = (°C \times 9/5) + 32$$