RADIO ENGINEER'S POCKET BOOK

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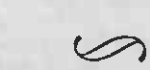
RADIO ENGINEER'S POCKET BOOK

BY

F. J. CAMM

Editor : "Practical Wireless," "Practical Engineering," and "Practical Mechanics"



3rd Edition

LONDON
GEORGE NEWNES LIMITED
TOWER HOUSE, SOUTHAMPTON ST.,
STRAND, W.C.2.

First Published . *July 1940*
2nd Edition . *Feb. 1941*
3rd Edition . *April 1941*

PRINTED IN GREAT BRITAIN

PREFACE

This Vest Pocket Book has been produced to meet the needs of all those engaged in the various branches of radio—service engineers, students, circuit designers, radio operators, transmitters, constructors, and manufacturers. The contents were originally published as a series of data sheets in *Practical Wireless*, and it is at the special request of readers of that journal that the series is now issued in the more convenient book-form. I have endeavoured to include most of the useful formulæ required by those to whom the book is designed to appeal. The index is fully cross-referenced to enable the reader rapidly to trace the formula or table he requires.

So far as I have been able to ascertain this is the first Pocket Book of its type, and it makes available for radio engineers a similar source of reference to that in existence for those engaged in other industries.

Extreme care has been exercised in checking the proofs. In order to make this Pocket Book as complete as possible I have also included arithmetical, geometrical, and trigonometrical formulæ, as well as the usual mensuration formulæ, whilst the English weights and measures, the metric system, decimal equivalents, slide rule gauge points, wire and other standard tables are included.

F. J. CAMM.

CONTENTS

ABBREVIATIONS

A.—Anode, or plate.
A.A.—Artificial aerial.
A.C.—Alternating current.
Ae.—Aerial.
A.F.—Audio frequency.
A.F.C.—Automatic frequency control.
A.G.C.—Antomatic gain control.
A.M.—Amplitude modulation.
A.T.C.—Aerial tuning condenser.
A.T.I.—Aerial tuning inductance.
A.V.C.—Automatic volume control.
A.V.E.—Automatic volume expansion.
B.A.—British Association.
B.C.L.—Broadcast listener.
B.F.O.—Beat frequency oscillator.
B.O.T. Unit—Board of Trade unit = 1,000 watt-hours, or 1 kilowatt-hour.
B.W.G.—Birmingham wire gauge.
C.C.C.—Closed circuit or secondary condenser, or S.T.C.
C.C.I.—Closed circuit or secondary tuning inductance, or S.T.I.
cm.—centimetre.
C.P.—Candle power.
C.W.—Continuous waves.
D.A.V.C.—Delayed A.V.C.
db.—decibel.
D.C.—Direct current.
D.C.C.—Double cotton covered.
D.E.—Dull emitter.
D.F.—Direction finding, or direction finder.
D.P.—Difference of potential.
D.P.D.T.—Double pole double throw.
D.P.S.T.—Double pole single throw.

ABBREVIATIONS—(*continued*)

D.S.C.—Double silk covered.
DX—Long distance.
E.—Earth.
E.M.F.—Electro-motive force.
F.—Filament.
F.M.—Frequency modulation.
G.—Grid.
G.B.—Grid battery or grid bias.
G.C.—Grid condenser.
G.L.—Grid leak.
H.F.—High frequency (same as radio frequency).
H.F.C.—High-frequency choke.
H.P.—Horse power.
H.R.—High resistance.
H.T.—High tension.
I.C.—Intermittent current.
I.C.W.—Interrupted continuous waves.
I.F.—Intermediate frequency.
I.P.—In primary (of transformer); start of primary.
I.S.—In secondary (of transformer); start of secondary.
kw.—Kilowatt = 1,000 watts.
L.F.—Low frequency.
L.F.C.—Low-frequency choke.
L.R.—Low resistance.
L.S.—Loudspeaker.
L.T.—Low tension.
mA.—Milliampere.
M.C.—Moving coil.
mfd.—micro-farad.
mhy.—microhenry.
mm.—millimetre.
mmfd.—micro-micro-farad.

ABBREVIATIONS—(*continued*)

O.F.—Outside Foil.
O.L.—Output load.
O.P.—Out primary (of transformer); end of primary. Also output.
O.S.—Out secondary (of transformer); end of secondary.
P.—Plate, or anode.
P.A.—Public address.
P.D.—Potential difference, same as D.P.
P.M.—Permanent magnet.
Pot.—Potentiometer.
P.V.—Power valve.
Q.A.V.C.—Quiet automatic volume control.
Q Code.—See pp. 68 & 69.
Q.M.B.—Quick make and break.
Q. P.-P.—Quiescent Push-pull.
R.F.—Radio frequency (same as high frequency).
R.M.S. Value.—Root-mean-square value.
Rx.—Receiver.
S.C.C.—Single cotton covered.
S.I.C.—Specific inductive capacity.
S.P.—Series parallel.
S.P.D.T.—Single pole double throw.
S.P.S.T—Single pole single throw..
S.R.—Specific resistance.
S.S.C.—Single silk covered.
S.T.C.—Secondary tuning condenser.
S.T.I.—Secondary tuning inductance.
S.W.G.—Standard wire gauge.
S.W.L.—Short-wave listener.
T.R.F.—Tuned radio frequency.
T.T.—Tonic train.
Tx.—Transmitter.

SYMBOLS

Admittance	Y
Amplification Factor	μ
Capacity	C
Current	I
Conductance	G
Dielectric Constant	ϵ
Efficiency	η
Electrostatic Flux Density	D
E.M.F. (voltage)	E
Energy	W
Frequency	f
Impedance	Z
Magnetic Field	H
Magnetic Flux	Φ
Magnetic Flux Density	B
Period Time	T
Permittivity	k
Phase Angle	φ
Power	P
Quantity	Q
Reactance	X
Reluctance	S
Resistance	R
Resistivity	ρ
Self-inductance	L

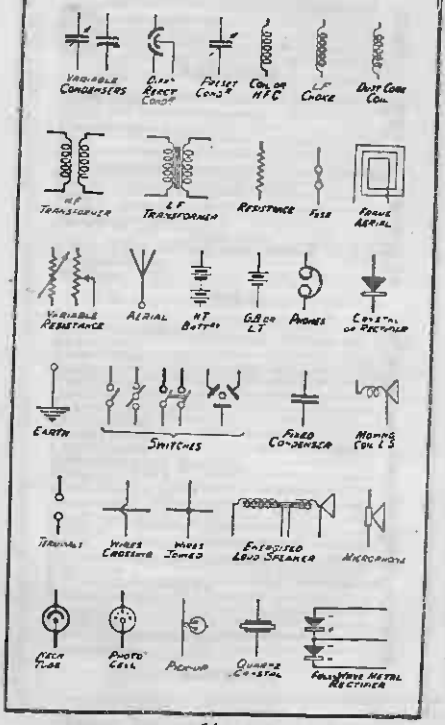
UNITS

Ampere	A
Ampere-hour	Ah
B.O.T. Unit = 1,000 watt-hours, or 1 kilowatt-hour	
Coulomb	C
Farad	F
Henry	H
Joule	J
Kilovolt-ampere	kVA
Ohm	Ω
Volt	V
Volt-ampere	VA
Watt	W
Watt-hour	Wh

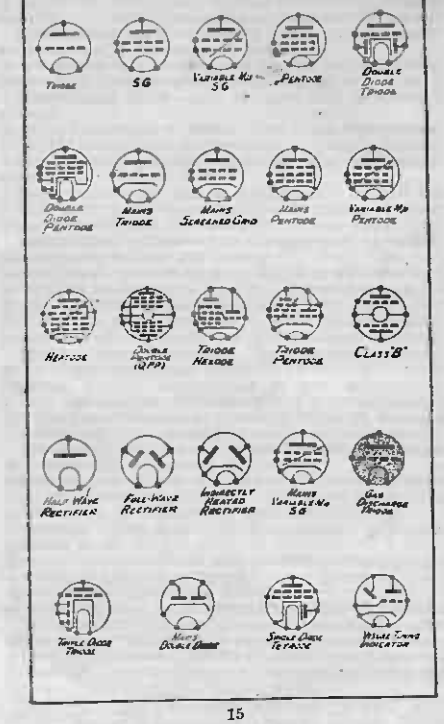
PREFIXES

Kilo	k
Mega	M
Micro	μ
Milli	m

THEORETICAL SIGNS



VALVE SYMBOLS



STANDARD UNITS.

Ampere.—Unit of current. A pressure of 1-volt will pass a current of 1-ampere through a resistance of 1-ohm (see Ohms Law). It represents a flow of 1 coulomb per second.

Ampere-hour.—Unit of quantity of electricity, equal to 3,600 coulombs. One unit is represented by a current of one ampere flowing for one hour.

Board of Trade Unit (B.O.T.).—The Board of Trade Unit is 1,000 watt hours, and is equal to 3,415 British Thermal units.

Coulomb.—Unit of quantity of electricity. It is equal to one-tenth of an absolute electromagnetic unit.

Dyne.—C.G.S. unit of force. The force which when acting on a mass of 1 gramme imparts to it an acceleration of 1 centimetre per second per second.

Erg.—C.G.S. unit of work. Equal to 1 dyne-centimetre.

Farad.—Unit of capacity. A condenser has a capacity of 1 farad when a charge of 1 coulomb raises the potential 1 volt. In wireless the practical unit is the microfarad (·000001 farad); sub-division is the micro-microfarad = ·000,000,000,001 farad.

Henry.—Unit of inductance. It is the unit of mutual inductance or self-inductance in the electromagnetic system. The henry is equal to 10^9 C.G.S. electromagnetic units. It represents the inductance of a circuit in which an induced electromotive force of 1 international volt is created when the current in it varies at the rate of 1 international ampere per second.

International Ampere.—The practical unit of electric current representing the unvarying current which when passed through a neutral solution of nitrate of silver deposits silver at the rate of 0·001118 of a gramme per second.

International Coulomb.—Practical unit of electric quantity, representing the quantity of electricity transferred in 1 second by a current equal to the international ampere.

International Farad.—The practical unit of capacity representing the capacity of a condenser which is charged to a potential of 1 international volt by imparting to it a quantity of 1 international coulomb.

International Ohm.—Practical unit of resistance, representing the resistance offered to an unvarying current of electricity by a column of pure mercury at the temperature of melting ice having a mass of 14·4521 grammes, a constant cross-section, and a length of 106·3 centimetres.

International volt.—Practical unit of electromotive force, representing that E.M.F. which when steadily applied to a conductor having a resistance of 1 international ohm creates in it a current of 1 international ampere.

International watt.—The energy used in 1 second by an international ampere when flowing at a pressure of 1 international volt.

Joule. Unit of energy. One joule equals 10^7 ergs. It represents the work expended per second on a circuit in which there is a current of 1 international ampere, and between the ends of which there is a difference of potential of 1 international volt.

Kilovolt-Ampere.—1,000-volt amperes.

Kilowatt.—1,000-watts or 1·34 horse-power.

Kilowatt-hour.—1,000-watt hours.

Line.—The practical method of measuring a magnetic field is in lines or kilolines. The line is identical with 1 electromagnetic unit of magnetic flux; kiloline equals 1,000 lines.

Mho.—Unit of Conductance ("ohm" reversed). It is the reciprocal of the ohm. Thus, a body having a resistance of 4 ohms would have a conductance of ·25 mhos

Ohm.—Unit of Resistance. The resistance which will permit the flow of 1 ampere when a pressure of 1 volt is applied.

Unit Electrostatic Charge.—The charge which in a vacuum at a distance of 1 centimetre from an equal charge will produce a force of repulsion of 1 dyne.

Unit Electrostatic Flux.—The electrostatic flux existent in a unit electrostatic tube of force.

Unit Magnetic Flux.—The magnetic flux existent in a unit magnetic tube of force. Unit is the Maxwell.

Unit Magnetic Pole.—That pole which located in a vacuum at a distance of 1 centimetre from a like pole produces a mechanical force of repulsion of 1 dyne. The total number of lines of force which passes through a unit magnetic pole equals π.

Volt. Unit of potential. It is the pressure required to pass a current of 1 ampere through a resistance of 1 ohm.

Volt-Ampere.—The product of the root mean square volts, and root mean square amperes.

Watt. Practical unit of power equivalent to a rate of working of 1 joule per second or 10,000,000 ergs per second. Volts times amps equals watts.

Light, Speed of.—Light waves travel at 186,000 miles per second. This is the speed also of wireless waves.

Sound, Speed of.—Sound waves travel at 1,142 feet per second.

FORCE

The absolute unit of force is the Poundal, which is that force, acting for unit time, which would impart unit velocity to unit mass.

1 dyne = 0.00007233 poundal.
1 dyne = 0.00102 gram.
1 dyne = 22.48×10^{7} pounds.
1 megadyne = 1,000,000 dynes.
1 poundal = 13.825 dynes.
1 poundal = 0.03108 pound.
1 poundal = 14.10 grams.

ENERGY

Energy refers to capacity for performing work, or for moving against a resistance.

1 erg = 2.373×10^{-6} foot poundals.
1 erg = 7.376×10^{-8} foot pounds.
1 g.cm. = 7.233×10^{-5} foot pounds.
1 joule = 10^{7} ergs.
1 foot poundal = 421.390 ergs.
1 foot pound = 1.35573 joules.
1 foot pound = 13,825.5 g.cm.

The actual energy, Kinetic energy, or dynamic energy of a moving body = $\frac{1}{2}$ mass $\times$ velocity^{2}.

HEAT

A therm is the heat equivalent of an erg on the C.G.S. system.

The Centigrade Heat Unit (C.H.U.) is the heat required to raise 1lb. water 1°C.

A calorie as used in engineering calculations represents the heat required to raise 1 kilogramme of pure water 1°C. This is the Great Calorie. The Small Calorie represents the heat required to raise 1 gramme of water 1°C.

1 calorie (g.c.) = 0.0039683 B.T.U.
1 calorie (g.c.) = 4.1862 joules.
1 calorie (g.c.) = 3.088 foot lb.
1 calorie (g.c.) = 0.005614 horse-power second.
1 B.T.U. = 252.00 calories or 0.252 kilogramme calories.
1 B.T.U. = 1,055 joules.
1 B.T.U. = 778.1 foot lb.
1 B.T.U. = 1.4147 horse-power second.
1 C.H.U. = 1.8 B.T.U.

TIME

1 sidereal second = 0.99727 second (mean solar).
1 second (mean solar) = 1.002738 sidereal second.
Length of seconds pendulum latitude 45° = 39.1163 in. 99.3555 cm.

UNITS AND EQUIVALENTS

One ft. lb.	1 lb. raised 1 foot high.
One BTU	1,055 joules.
One BTU	778.1 ft. lbs.
1 watt	10^7 ergs per second.
1 watt	23.731 foot poundals per second.
1 watt	0.7376 ft. lb. per second.
1 watt	0.001341 h.p.
One HP hour	0.746 kW. hour.
One HP hour	1,980,000 ft. lbs.
One HP hour	2.545 BTU's.
One kwH. (kilowatt hour)	2,654,200 ft. lbs.
One kwH.	1.000 watt hours.
One kwH.	1.34 HP hours.
One kwH.	3,412 BTU's.
One kwH.	3,600,000 joules.
One kwH.	859,975 calories.
One HP	746 watts.
One HP	0.746 kW.
One HP	33,000 ft. lbs. per minute
One HP	550 ft. lbs. per second.
One HP	2,545 BTU's per hour.
One HP	42.4 BTU's per minute.
One HP	0.707 BTU's per second.
One HP	178.122 calories per second.

POWER

1 watt	$=10^7$ ergs per second.
1 watt	=23.731 foot poundals per sec.
1 watt	=0.7376 foot lb. per second.
1 watt	=0.001341 h.p.
1 kilowatt-hour	=2,654,200 foot pounds.
1 kilowatt-hour	=1.3411 h.p. hour.
1 kilowatt-hour	=859,975 calories.
1 foot poundal per second	=421.390 ergs per second
1 foot pound per second	=1.35573 watts.
1 horse-power	=746 watts.
1 horse-power	=550 foot pounds per second.
1 horse-power	=178.122 calories per second.

ELECTRICAL EQUATIONS

Amperes × volts	=watts.
Joules ÷ seconds	=watts.
Coulombs per second	=amperes.
Watts ÷ 746	=effective h.p.
Coulombs ÷ volts	=farads.
0.7373 foot-lb. per second	=1 joule.
Volts × coulombs	=joules.
Watts × 44.236	=foot-lb. per minute.
Kilowatts × 1.34	=h.p.

Frequency Formula

Formula for frequency is : $f = \frac{10^6}{2\pi\sqrt{LC}}$ where L = inductance in microhenrys and C = capacity in microfarads.

Wavelength of Tuned Circuit.

Formula for the wavelength of a tuned oscillatory circuit is: $1884.96\sqrt{LC}$, where L = inductance in microhenrys and C = capacity in microfarads.

Inductance

The formula for inductance in microhenrys is: $L = \frac{9.87D^2N^2K}{1000}$, where L = inductance, D = diameter of coil in centimetres, l = length of coil in centimetres, N = uumber of turns per centimetre, and K = a constant. See table.

Inductive Reactance

Calculated from the formula $2\pi fL$, where f = frequency and L = the inductance.

This Table shows the Value of K, which must be Calculated from $\frac{D}{l}$

$\frac{D}{l}$	K	$\frac{D}{l}$	K
4.00	.3654	1.25	.6381
3.75	.3743	1.00	.6884
3.5	.3944	.90	.7110
3.25	.4111	.80	.7351
3.00	.4202	.70	.7609
2.75	.4545	.60	.7885
2.5	.4719	.50	.8181
2.25	.4972	.40	.8499
2.0	.5255	.30	.8838
1.75	.5579	.20	.9201
1.5	.5950	.10	.9588

Capacity of Variable Condensers

$$C = \frac{.0885NS}{1{,}000{,}000\ d}$$

Where N = Number of moving vanes.
S = Area of one moving vane in square centimetres.
d = Air gap between moving vanes and fixed vanes in centimetres.

H.F. Transformer Ratio. (n) $n^2 = \frac{R}{R_0}$

R being the dynamic resistance of the tuned circuit and R_0 the A.C. resistance of the valve.

Stability in Screen-Grid Stages.

One Stage.

Stable if $\frac{\omega\ g\ Co}{\sigma_1(\sigma_2+\sigma v)}$ is less than 2.

Co = residual anode-grid capacity in farads.
= $.001 \times 10^{-12}$ for Cossor S.G. Valves (all types).
= $.0045 \times 10^{-12}$ for Cossor MS/Pen A.

σ_1, σ_2 = conductance of grid and anode* circuits respectively.
= 1/R where R = dynamic resistance in ohms.

σv = anode filament conductance of valve.
= $1/R_0$.

Two Stages.

Assuming identical tuned circuits throughout, and ignoring damping effects of valves on tuned circuits.

Stable if $\frac{\omega\ Co\ g}{\sigma^2}$ is less than 1.14 (Tuned Anode).

or if $\frac{\omega\ Co\ g}{\sigma^2}$ less than $1.14n^2$ (Tuned Transformer).

where σ = conductance of tuned circuit (secondary) and n = transformer ratio.

* In the case of transformer coupling, or its equivalent, replace σ_2 by $n^2\sigma$, where n = transformer ratio, σ = conductance $\left(= \frac{1}{R}\right)$ of tuned secondary.

Capacity of a Fixed Condenser

$$C = \frac{.0885\ AKN}{1{,}000{,}000\ d.}$$

Where K = Specific Inductive Capacity of dielectric.
N = Number of dielectrics.
A = Area of overlap of plates in square centimetres.
d = Thickness in centimetres.

Another Formula :

$$C = \frac{AKN}{4{,}500{,}000\ d.}$$

Where A = Area of one plate in square inches.
K = S.I.C. of dielectric.
N = Number of plates minus one.
d = Thickness of dielectric in inches.

OHM'S LAW

For D.C.

$$I = \frac{E}{R}$$

Watts dissipated.
$= I^2R = EI.$

For A.C.

$$I = \frac{E}{Z}$$ where Z = impedance of circuit.

Watts dissipated.
$= I^2R$
$= E\ I \cos \emptyset$
where $\emptyset$ = phase angle between E and I.

Capacity of Condensers in Parallel.

$$C = C_1 + C_2$$

Capacity of Condensers in Series.

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} = \frac{C_1C_2}{C_1 + C_2}$$

Resistances in Parallel.

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{R_1R_2}{R_1 + R_2}$$

Resistances in Series. $R = R_1 + R_2$

Resistance, Capacity and Inductance in Series.

Resulting Impedance.

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{R^2 + X^2}$$

Reactance of Coil. $2\pi fL.$
π, 3·14 ; f, frequency ; L, inductance in henrys.

Reactance of Condenser. $\frac{1}{2\pi fC}$
C, capacity in farads.

Net Reactance. $X = X_L - X_C$

At Resonance, $f = \frac{1}{2\pi\sqrt{LC}}$ or $\omega^2 = \frac{1}{LC}$

Wavelength. $\lambda = 1884\ \sqrt{LC}$
λ, in metres ; L, in microhenrys ; C, in microfarads ; $\lambda \times f = 300{,}000{,}000$.

Resistance of a Tuned Circuit at Resonance (Dynamic Resistance).

$$R = \frac{L}{C \times r}$$

r being the equivalent series resistance.

Magnification of Tuned Circuit. $m = \frac{\omega L}{r}$

Current in Series Circuit at Resonance. $I_{\text{res.}} = \frac{E}{r}$

where r is equiv. series resistance of circuit at wavelength concerned (high-frequency resistance).

Peak Separation (Band-pass Tuners).

$$P = \frac{\sqrt{\omega^2M^2 - r^2}}{2\pi L} \text{ cycles (inductive coupling).}$$

$\omega = 2\pi f$; M, mutual inductance in henrys ; r, equivalent series resistance of tuned circuit ; L, inductance in henrys.

$$P = \frac{\sqrt{\frac{1}{\omega^2 C_m^2} - r^2}}{2\pi L} \text{ cycles (capacity coupling)}$$

C_m = coupling capacity in farads.

Inductance of Single Layer Coil.

$$L = \pi^2 n^2 D^2 k \div 10^9$$

L, in microhenrys ; π, 3·14 ; D, diameter in cms. ; number of turns to the cm. ; l, length in cms. ; k, a factor depending upon the length/diameter ratio.

When $\frac{D}{l}$ =	0·1	0·5	1·0	2·0	3·0	4·0
k =	0·96	0·82	0·69	0·526	0·429	0·365

Abbreviations used in Table on pages 28 and 29.

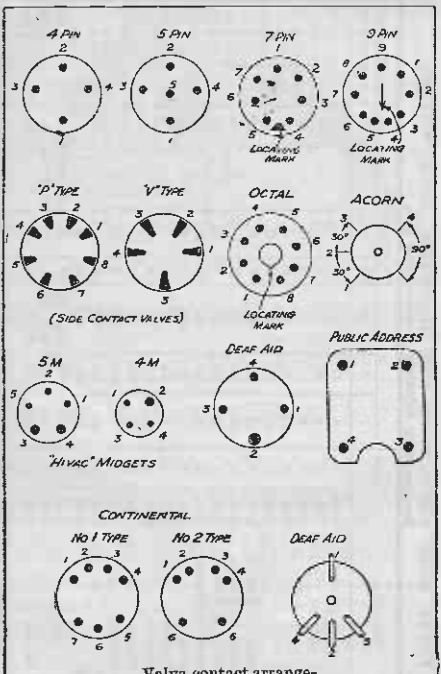
I.H.—Indirectly heated. D.H.—Directly heated
M.—Metallising. F.—Filament.
H.—Heater. C, C1, etc.—Cathodes.
A, A1, etc.—Anodes (Ao—Oscillator anode).
G or G1—Control grid (Go—Oscillator control grid).
G2—Screening grid. G3—Suppressor grid.
D, D1, etc.—Diodes (anodes).

Valve Base Connections for American (Octal) Valves.

Valve Type	*Base*	*Pin Connections*								
		1	2	3	4	5	6	7	8	*Top Cap*
Triode .. I.H.	Oct.	M	H	A	—	G	—	H	C	—
Triode .. I.H.	Oct.	M	H	—	A	—	—	H	C	G
H.F.Pentode I.H.	Oct.	M	H	A	G2	G3	—	H	C	G1
Output Pentode I.H.	Oct.	M	H	A	G2	G1	—	H	C	—
Heptode I.H.	Oct.	M	H	A	G3 G5	Go (G1)	Ao (G2)	H	C	G4
Double-diode I.H.	Oct.	M	H	D2	C2	D1	—	H	C1	—
Double-diode-triode I.H.	Oct.	M	H	A	D1	D2	—	H	C	G
Rectifier, Full-wave .. I.H.	Oct.	M	H	—	A	—	A	—	H, C	—
Rectifier, Full-wave .. I.H.	Oct.	—	H	H	A2	C2	A1	—	H, C1	—
Rectifier, Full-wave .. I.H.	Oct.	M	H	A	—	A	—	H	C	—
Rectifier, Full-wave, Gaseous	Oct.	M	—	A	—	A	—	—	C	—

Valve Base Connections for Acorn and Deaf-Aid Valves.

Type	*Base*	*Pin Connections*						
		1	2	3	4	5	*Top*	*Bottom*
ACORN								
Triode ..	1	H	C	H	G	A	—	—
H.F. Pentode ..	1	H	C	H	S	SG	A	G
DEAF AID								
Triode (D.H.) ..	2	A	G	F	F	—	—	—
Triode (I.H.) ..	2	A	C	H	H	—	G	—
Triode (Mullard)	3	A	G	F	F	—	—	—
PUBLIC ADDRESS								
Triode	4	A	F	G	F	—	—	—



Valve-contact arrangements for all types of valves. (See tables on pages 26, 28, 29, and 30, etc.)

VALVE BASE CONNECTIONS FOR STANDARD (B.V.A.) VALVES

See page 26 for definitions of abbreviations used.

Valve Type	Base	Pin Connections									Top Cap
		1	½	3	4	5	6	7	8	9	
Triode .. .. .. D.H.	4	A	G	F	F	—	—	—	—	—	—
Triode .. .. .. L.H.	5	A	G	H	H	C	—	—	—	—	—
Triode .. .. .. I.H.	7	M	—	—	H	H	C	A	—	—	G
Tetrode .. .. .. D.H.	4	G2	G1	F	F	—	—	—	—	—	A
Tetrode .. .. .. I.H.	5	G2	G1	H	H	C	—	—	—	—	A
H.F. Pentode or Tetrode .. D.H.	7	M	G1	G3	F	F	—	G2	—	—	A
H.F. Pentode or Tetrode .. I.H.	5	G2	G1	H	H	C, G3	—	—	—	—	A
H.F. Pentode or Tetrode .. I.H.	7	M	G1	G3	H	H	C	G2	—	—	A
H.F. Pentode or Tetrode .. I.H.	7	M	A	G3	H	H	C	G2	—	—	G1
H.F. Hexode .. .. D.H.	7	M	A	G3	F	F	G4	G2	—	—	G1
Output Pentode .. .. D.H.	4	A	G1	F	F	—	—	—	—	—	G2
Output Pentode .. .. D.H.	5	A	G1	F	F	G2	—	—	—	—	—
Output Pentode .. .. I.H.	5	A	G1	H	H	C	—	—	—	—	G2
Output Pentode .. .. I.H.	7	—	G1	G2	H	H	C	A	—	—	—
Heptode .. .. .. D.H.	7	Ao	Go	G2	F	F	—	A	—	—	G1
Heptode .. .. .. I.H.	7	Ao	Go	G2	H	H	C	A	—	—	G1
Octode .. .. .. D.H.	7	G2	G1	G3, G5	F	F	M, G6	A	—	—	G4
Octode .. .. .. I.H.	7	G2	G1	G3, G5	H	H	C, M, G6	A	—	—	G4
Class B Output .. .. D.H.	7	G2	G1	A1	F	F	—	A2	—	—	—
Double-diode .. .. .. D.H.	4	D1	D2	F	F	—	—	—	—	—	—

Double-diode .. .. I.H.	5	D1	D2	H	H	C	—	—	—	—	—
Double-diode-triode .. D.H.	5	A	D2	F, M	F	D1	—	—	—	—	G
Double-diode-triode .. I.H.	7	D1	M	D2	H	H	C	A	—	M	G
Triple-diode-triode .. .. I.H.	9	D2	D3	—	H	H	C	A	D1	—	G
Single-diode-tetrode .. I.H.	7	—	G1	G2	H	H	C, M	D	—	M	A
Triode-pentode .. .. D.H.	9	G2	A1	G3	F	F	—	Ao	Go	M	G1
Triode-pentode .. .. I.H.	9	G2	A1	G3	H	H	C	Ao	Go	—	G1
Triode-hexode .. .. D.H.	7	Ao	Go	G2	F	F	M	A	—	—	G1
Triode-hexode .. .. I.H.	7	Ao	Go	G2	H	H	C	A	—		G1
Double-pentode .. .. D.H.	7	G1[4]	G1[1]	A1	F	F	G2[4] G2[2]	A2	—	G1[3]	—
Double-pentode .. .. D.H.	9	G1[1]	A1	G2[1]	F	F	—	G2[3]	A2	M	—
Double-diode-H.F. Pentode I.H.	9	G2	A	—	H	H	C. G3	D1	D2		G1
Double-diode Output Pentode I.H.	7	D1	A	D2	H	H	C	G2			G1
Double-diode Output Pentode I.H.	7	D1	C	D2	H	H	A	G2			G1
Rectifier, Half Wave .. D.H.	4	A	—	F	F	—	—	—	—	—	—
Rectifier, Half Wave (H. Volt) D.H.	4	—	—	F	F	—	—				A
Rectifier, Half Wave .. .. I.H.	5	A	—	H	H	C	—	—	—	—	—
Rectifier, Half Wave (H. Volt) I.H.	4	—	—	H, C	H	—	—	—	—	—	A
Rectifier, Full Wave .. .. D.H.	4	A	A	F	F	—	—	—	—	—	—
Rectifier, Full Wave .. I.H.	4	A	A	H, C	H	—	—	—	—	—	—
Rectifier, Full Wave .. I.H	5	A	A	H	H	C	—	—	—	—	—
Rectifier, Full Wave .. I.H.	7	H,C,T	A1	C1	H	H	C2	A2	—		—
Barretter	4	—	—	F	F	—	—	—	—	—	—
Tuning Indicator (C.R.) .. I.H.	7	—	G	Targ.	H	H	C	A	—	—	—

Valve Base Connections for Continental Valves. See p.26.

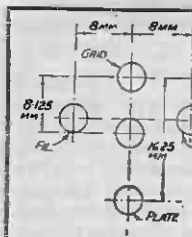
Type	Base	Pin Connections. 1	2	3	4	5	6	7	Top Cap
H.F. Pentode	1	G2	H	H	C	A	G3	—	G1
H.F. Pentode	2	G2	H	H	C	A	M	G3	G1
Triode ..	2	—	H	H	C	A	M	G1	—
Double-diode	2	G2	H	H	C	D1	—	—	D2
Freq. Changer	2	G2	H	H	C	A	Ao	Go	G1
O. Pentode ..	1	G2	H	H	C	A	G1 G3	—	—
O. Pentode ..	2	G2	H	H	C	A	G3 .	G1	—
Rectifier ..	1	C1	H	H	C2	A2	A1	—	—
Rectifier ..	2	C1	H	H	C2	A2	—	A1	—

Valve Base Connections for Hivac Midget Valves.

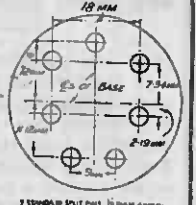
Type	Base	Pin Connections 1	2	3	4	5	Top Cap
Tetrode (S.G.) ..	1	A	G	F	F	—	—
Triode	1	G2	G1	F	F	—	A
Output Pentode ..	2	A	G1	F	F	G2	—

Mullard Universal Side-Contact Valves

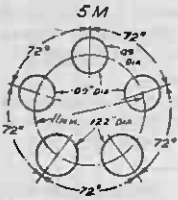
Valve Type	Base	Contact Connections 1	2	3	4	5	6	7	8	Top Cap
Triode ..	P	M	H	H	C	—	—	—	A	G
H.F. Pentode	P	M	H	H	C	G3	—	G2	A	G1
O. Pentode ..	P	—	H	H	C	—	—	G2	A	G1
Octode ..	P	M	H	H	G3 C, G6	G2	G1	G3 G5	A	G4
Double-diode	V	D2	H	H	C, M	D1	—	—	—	—
Double-diode	V	M	H	H	C	D1	—	—	—	D2
Rect., Half-wave ..	P	—	H	H	C	—	—	—	A	—
Rect., Volt. Doub. ..	P	C1	H	H	C2	A1	—	—	—	—
V. T. Indicator (TV4) ..	P	—	H	H	C	—	G	Target	A	—



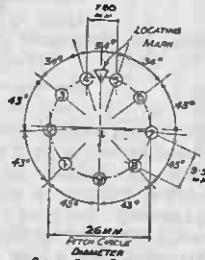
Valve-leg spacing for standard 4- and 5-pin valves. The diameter of the valve pins is 3.2 mm



Valve-leg spacing for 7-pin valves.



The two diagrams above show the valve-leg spacing for the Hivac Midget valves.



Valve-leg spacing for 9-pin valves.

AERIAL DATA

NATURAL WAVELENGTH.—The natural wavelength of an aerial is approximately four and a half times its electrical length (length between insulators plus length of lead-in). Standard aerial of 100ft. has a natural wavelength of about 120 metres. If connected direct to the grid of the detector valve, it would receive transmissions on this wavelength.

The maximum length of aerial, inclusive of lead-in, permitted by the Postmaster-General is 150ft.

REFLECTOR.—An arrangement generally employing a dipole aerial, for preventing a signal from being radiated in all directions, or for ensuring maximum reception in a given direction. It consists of a vertical or horizontal aerial behind which is erected a similar aerial (not connected to anything), the spacing between these being adjusted according to the frequency of the signals. A multi-reflector system will generally have the reflectors arranged in the form of a parabola with the aerial at the focal point.

Stranded 7/22 insulated copper wire is best for both aerial and lead-in.

FRAME AERIAL DATA

Length of Side of Square Frame.	*No. of Turns.*	*Space between Wires*	*Inductance. (Micro-henrys).*	*Self-capacity. (Micro-farads.*	*Natural Wave-length in Metres.*
8 ft.	3	½ in.	96	75	180
6 ,,	4	½ ,,	124	66	170
4 ,,	6	½ ,,	154	55	175
3 ,,	8	½ ,,	193	49	185

The Wire for the Aerial. The wire for these aerials consists of thin flex, usually 14/36, that is, fourteen strands of No. 36-gauge wire, covered with art. silk in various colours. For the normal broadcast band 75 ft. should be sufficient, although the exact length will depend upon the shape of the aerial, the size of the condenser used for tuning, and the spacing between the turns. As a rule, the wire should be wound on with a space of about $\frac{1}{10}$in. between each turn.

LONG-WAVE COIL DATA

Diameter of Former	Inductance 1,600 Microhenrys. No. of Slots.	Wire.	Turns per Slot.	Inductance 2,100 Microhenrys. No. of Slots.	Wire.	Turns per Slot.	Inductance 3,000 Microhenrys. No. of Slots.	Wire.	Turns per Slot.
1 in.	4	36 enam.	80	4	36 enam.	92	5	38 D.S.C.	95
	5	36 D.S.C.	69	5	36 enam.	80	6	36 enam.	85
1½ in.	3	36 D.S.C.	71	3	36 enam.	81	3	36 enam.	97
	4	36 D.S.C.	57	4	36 D.S.C.	65	4	36 enam.	78
	5	34 D.S.C.	53	5	34 enam.	60	5	36 D.S.C.	72
2 in.	3	34 enam. or 36 D.S.C.	56	3	36 D.S.C.	65	3	36 enam.	77
	4	34 D.S.C.	45	4	34 D.S.C.	51	4	36 D.S.C.	61
	5	34 D.S.C.	38	5	34 D.S.C.	44	5	34 enam. or 36 D.S.C.	53

MEDIUM-WAVE COIL DATA

Diameter of Former.	Inductance 175 Microhenrys. Wire.	Turns	Length in inches.	Inductance 200 Microhenrys. Wire.	Turns	Length in inches.	Inductance 280 Microhenrys. Wire.	Turns	Length in inches.
1½ in.	32 enam.	84	1.01	32 enam.	93	1.11	30 D.S.C.	115	1.71
	30 D.S.C.	93	1.38	30 D.S.C.	102	1.52	32 enam.	102	1.22
1¾ in.	30 D.S.C.	74	1.10	30 D.S.C.	82	1.22	30 D.S.C.	90	1.34
	28 D.C.C.	94	2.24						
1⅞ in.	30 D.S.C.	63	0.94	30 D.S.C.	68	1.01	30 D.S.C.	76	1.13
	28 D.S.C.	67	1.16	28 D.S.C.	73	1.26	28 D.S.C.	80	1.38
2 in.	30 D.S.C.	54	0.805	30 D.S.C.	59	0.88	30 D.S.C.	65	0.97
	28 D.S.C.	58	1.01	28 D.S.C.	64	1.13	28 D.S.C.	70	1.24
2¼ in.	26 D.C.C.	70	1.96	26 D.C.C.	78	2.18	26 D.C.C.	86	2.40
	28 D.S.C.	52	0.925	28 D.S.C.	57	1.01	28 D.S.C.	62	1.10
	24 D.C.C.	65	2.08	24 D.C.C.	72	2.30	24 D.C.C.	80	2.56
2½ in.	28 D.S.C.	47	0.835	28 D.S.C.	51	0.91	28 D.S.C.	56	1.0
	24 D.C.C.	58	1.85	24 D.C.C.	64	2.04	24 D.C.C.	70	2.24
3 in.	26 D.S.C.	41	0.86	26 D.S.C.	45	0.95	26 D.S.C.	49	1.03
	22 D.C.C.	50	1.90	22 D.C.C.	55	2.09	22 D.C.C.	61	2.32

SHORT-WAVE COIL DATA

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) Min. .0001	Max. .0001	Max. .00015	Max. .00035
$\frac{1}{2}$″	18	$10\frac{1}{2}$	$\frac{1}{8}$″	$5\frac{1}{4}$	5	9	11	16
,,	,,	,,	$\frac{1}{4}$″	$7\frac{7}{8}$	$6\frac{1}{2}$	$11\frac{1}{2}$	$14\frac{1}{2}$	22
,,	,,	,,	1″	$10\frac{1}{2}$	$7\frac{1}{2}$	$13\frac{1}{2}$	17	26
,,	,,	,,	$1\frac{1}{4}$″	$13\frac{1}{8}$	$8\frac{1}{2}$	$15\frac{1}{2}$	19	30
,,	,,	,,	$1\frac{1}{2}$″	$15\frac{3}{4}$	$9\frac{1}{2}$	18	$21\frac{1}{2}$	33
$\frac{3}{4}$″	18	$10\frac{1}{2}$	$\frac{1}{8}$″	$5\frac{1}{4}$	$6\frac{3}{4}$	$12\frac{1}{2}$	$15\frac{1}{2}$	$24\frac{1}{2}$
,,	,,	,,	$\frac{1}{4}$″	$7\frac{7}{8}$	$9\frac{1}{4}$	17	$20\frac{1}{2}$	32
,,	,,	,,	1″	$10\frac{1}{2}$	11	20	$24\frac{1}{2}$	37
,,	,,	,,	$1\frac{1}{4}$″	$13\frac{1}{8}$	$12\frac{3}{4}$	23	28	43
,,	,,	,,	$1\frac{1}{2}$″	$15\frac{3}{4}$	$14\frac{1}{4}$	26	$31\frac{1}{2}$	48
$\frac{7}{8}$″	18	$10\frac{1}{2}$	$\frac{1}{8}$″	$5\frac{1}{4}$	8	$14\frac{1}{2}$	$17\frac{3}{4}$	$26\frac{1}{2}$
,,	,,	,,	$\frac{1}{4}$″	$7\frac{7}{8}$	$10\frac{1}{2}$	$19\frac{1}{4}$	$23\frac{1}{2}$	36
,,	,,	,,	1″	$10\frac{1}{2}$	$12\frac{1}{2}$	23	28	43
,,	,,	,,	$1\frac{1}{4}$″	$13\frac{1}{8}$	$14\frac{1}{2}$	$26\frac{1}{2}$	32	50

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) Min. .0001	Max. .0001	Max. .00015	Max. .00035
$\frac{3}{4}$″	18	$10\frac{1}{2}$	$1\frac{1}{8}$″	$15\frac{3}{4}$	$16\frac{1}{2}$	30	36	55
1″	18	$10\frac{1}{2}$	1″	$5\frac{1}{4}$	$8\frac{2}{4}$	16	$19\frac{1}{2}$	30
,,	,,	,,	$\frac{3}{4}$″	$7\frac{7}{8}$	12	$21\frac{1}{2}$	26	40
,,	,,	,,	1″	$10\frac{1}{2}$	14	$25\frac{1}{2}$	31	47
,,	,,	,,	$1\frac{1}{4}$″	$13\frac{1}{8}$	16	30	$35\frac{1}{2}$	55
,,	,,	,,	$1\frac{1}{2}$″	$15\frac{3}{4}$	18	$33\frac{1}{2}$	40	62
$1\frac{1}{4}$″	18	$10\frac{1}{2}$	$\frac{1}{8}$″	$5\frac{1}{4}$	$10\frac{1}{2}$	19	$23\frac{1}{2}$	36
,,	,,	,,	$\frac{3}{4}$″	$7\frac{7}{8}$	$14\frac{1}{2}$	26	$31\frac{1}{2}$	$49\frac{1}{2}$
,,	,,	,,	1″	$10\frac{1}{2}$	17	$31\frac{1}{2}$	$38\frac{1}{2}$	58
,,	,,	,,	$1\frac{1}{4}$″	$13\frac{1}{8}$	20	36	44	66
,,	,,	,,	$1\frac{1}{2}$″	$15\frac{3}{4}$	23	42	50	73
$1\frac{1}{2}$″	18	$10\frac{1}{2}$	$\frac{1}{8}$″	$5\frac{1}{4}$	12	22	27	41
,,	,,	,,	$\frac{3}{4}$″	$7\frac{7}{8}$	$16\frac{1}{2}$	30	37	56
,,	,,	,,	1″	$10\frac{1}{2}$	20	36	44	67

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) Min. .0001	Max	.00015 Max.	.00035 Max.
1½″	18	10½	1¼″	13⅛	23	43	52	78
,,	,,	,,	1½″	15¾	26½	48	58	90
½″	20	14	½″	7	6½	12	14½	22
,,	,,	,,	¾″	10½	8¾	16	19	29
,,	,,	,,	1″	14	10	18½	22½	34
,,	,,	,,	1¼″	17½	11½	21	25	40
,,	,,	,,	1½″	21	13	23½	29	45
¾″	20	14	½″	7	9	17	21	32
,,	,,	,,	¾″	10½	12½	22	27	42
,,	,,	,,	1″	14	14	27	33	50
,,	,,	,,	1¼″	17½	17	30	37	57
,,	,,	,,	1½″	21	19	35	42	65
⅞″	20	14	½″	7	11	19	23	35
,,	,,	,,	¾″	10½	14	25	31½	48

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) Min. .0001	Max.	.00015 Max.	.00035 Max.
⅞″	20	14	1″	14	17	30	37	57
,,	,,	,,	1¼″	17½	19	34½	42½	65
,,	,,	,,	1½″	21	22	40	48	72
1″	20	14	½″	7	11½	21	26	40
,,	,,	,,	¾″	10½	15½	28	34½	53
,,	,,	,,	1″	14	18½	34	41	63
,,	,,	,,	1¼″	17½	21½	39	48	71
,,	,,	,,	1½″	21	24	45	54	82
1¼″	20	14	½″	7	14	25½	31	47
,,	,,	,,	¾″	10½	19	35	43	65
,,	,,	,,	1″	14	23	42	51	74
,,	,,	,,	1¼″	17½	27	48½	59	90
,,	,,	,,	1½″	21	30	55	67	103

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) .0001 Min.	.0001 Max.	.00015 Max.	.00035 Max.
1½″	20	14	½″	7	16	29	35½	54
,,	,,	,,	9/16″	10½	22	40	49	73
,,	,,	,,	⅝″	14	26½	48	59	90
,,	,,	,,	1¼″	17½	31	56	69	105
,,	,,	,,	1⅜″	21	35	63	78	120
⅜″	22	18	1/16″	9	8½	15	18½	28
,,	,,	,,	1/16″	13½	11	20	25	38
,,	,,	,,	1″	18	13	24	29	44
,,	,,	,,	1¼″	22½	15	27	33	51
,,	,,	,,	1⅜″	27	17	31	37	57
¾″	22	18	1/16″	9	12	21½	26	40
,,	,,	,,	1/16″	13½	16	29	35	54½
,,	,,	,,	1″	18	19	34	42	64

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) .0001 Min.	.0001 Max.	.00015 Max.	.00035 Max.
¼″	22	18	1⅛″	22½	22	40	48	72
,,	,,	,,	1⅛″	27	25	45	54½	82
7/16″	22	18	¼″	9	13½	25	30	45
,,	,,	,,	¼″	13½	18	32	40	62
,,	,,	,,	1″	18	22	40	47	71
,,	,,	,,	1¼″	22½	25	45	55	82
,,	,,	,,	1½″	27	28	50	62	92
1″	22	18	½″	9	15	27	33	50
,,	,,	,,	⅝″	13½	20	36	45	68
,,	,,	,,	¾″	18	24	44	53	81
,,	,,	,,	1¼″	22½	27	50	61	92
,,	,,	,,	1½″	27	31½	57	70	107
1¼″	22	18	½″	9	18	33	40	51

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) .0001 Min.	.0001 Max.	.00015 Max.	.00035 Max.
1¼″	22	18	5/16″	13½	25	45	55	82
,,	,,	,,	1″	18	30	53	65	100
,,	,,	,,	1¼″	22½	34	62	76	115
,,	,,	,,	1⅜″	27	39	70	85	135
1½″	22	18	1/2″	9	20	36½	46	70
,,	,,	,,	5/16″	13½	28	51	62	96
,,	,,	,,	1″	18	34	62	76	115
,,	,,	,,	1¼″	22½	40	72	88	135
,,	,,	,,	1½″	27	45	83	100	150
¼″	24	22½	1/4″	11¼	11	19	23½	35½
,,	,,	,,	3/8″	16⅞	14	25	30	42
,,	,,	,,	1″	22½	16	29	36	55
,,	,,	,,	1¼″	28	18½	34	41	63

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G.	Turns per Inch Spaced approx. One Diam. of S.W.G.	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mm'd.) .0001 Min.	.0001 Max.	.00015 Max.	.00035 Max.
½″	24	22½	1/2″	33¾	21	38	46	72
5/16″	24	22½	5/16″	11¼	15	27	33	50
,,	,,	,,	3/8″	16⅞	20	36	45	68
,,	,,	,,	1″	22½	23	43	52	80
,,	,,	,,	1¼″	28	27	50	60	92
,,	,,	,,	1½″	33¾	30	56	68	105
7/16″	24	22½	1/2″	11¼	16⅛	31	37	56
,,	,,	,,	3/8″	16⅞	22½	41	51	76
,,	,,	,,	1″	22½	27	49	60	90
,,	,,	,,	1¼″	28	31	55	67	100
,,	,,	,,	1½″	33¾	35	64	78	120
1″	24	22½	1/2″	11¼	17½	33	41	65
,,	,,	,,	3/8″	16⅞	25	46	56	86

SHORT-WAVE COIL DATA—(*continued*)

Diam. of Former	No. S.W.G	Turns per Inch Spaced approx. One Diam. of S.W.G	Length of Winding	No. of Turns	Tuning Range (Min. Cap. 30 mmfd.) .0001 Min.	.00015 Max.	.00035 Max.
1″	24	22½	1″	22½	29⅜	65	100
,,	,,	,,	1 1/16″	28	34	77	115
,,	,,	,,	1⅛″	33¾	39	86	135
1¼″	24	22⅓	1 3/16″	111	22	50	76
,,	,,	,,	1¼″	16½	31	68	105
,,	,,	,,	1 5/16″	22½	36½	80	125
,,	,,	,,	1⅜″	28	43	95	147
,,	,,	,,	1 7/16″	33¾	48½	107	165
1½″	24	22¼	⅝″	11¼	26	57	88
,,	,,	,,	11/16″	16½	35	78	120
,,	,,	,,	¾″	22½	43	94	145
,,	,,	,,	1 1/16″	28	50	110	170
,,	,,	,,	1⅛″	33¾	56¼	125	192

TRANSFORMER DATA

DETAILS OF STALLOY CORE STAMPINGS.

Size No.	Dimensions. A	B	C	Number of Stampings.	Approx. Watts.	Turns per Volt A (Secondary) (S)	Approx. Build.
	in.	in.	in.	doz. prs.			sq. in.
4	15/16	25/16	7/16	6	50	8	1 7/16
5	5/8	1 1/2	3/4	6	30	12	1 1/16
28	1¼	3	1/2	6	250	6	3
29	2	4½	1 3/16	6	300	4	5 1/16
30	15/16	1⅛	5/16	6	45	8	1 1/16
31	1	3½	1	6	100	8	2 5/16
32	1	2¼	1	6	75	8	1½
33	1¼	2¾	1	6	125	6	2¼
35	1⅜	3⅜	15/16	6	200	5	5¼

This table covers most of the commoner sizes of stampings, but some makers give different numbers to stampings of similar size.

UREKA RESISTANCE WIRE

S.W.G.	Diameter in inches.	Turns per in. D.S.C.	Length per ohm in inches.	Ohms per yard.	Wt. per 1,000 yards in lb.
16	.064	14.7	173.8	0.21	37.20
18	.048	19.6	96.8	0.37	20.93
20	.036	25.6	54.4	0.66	11.77
22	.028	32.2	32.9	1.10	7.120
24	.022	40.0	20.3	1.77	4.392
26	.018	48.8	13.7	2.64	2.942
28	.014	57.8	9.2	3.91	1.989
30	.012	67.1	6.5	5.57	1.399
32	.010	75.2	4.9	7.35	1.059
34	.009	85.5	3.6	10.12	0.7688
36	.007	90.1	2.4	14.84	0.5240
38	.006	118.0	1.5	23.80	0.3272

MAINS TRANSFORMER DATA

By means of a Constant obtained from the table below the turns of wire for a primary of a transformer may easily be ascertained. For example, the constant of a transformer for a supply of 220 volts 50 cycles is 1,760. Therefore, with a core of 1 sq.in. cross sectional area you use 1,760 turns of wire for primary. For a core of 2 sq. in. you use $\frac{1760}{2}$=880 turns and so on. The secondary is directionally proportional to the voltage ratio.

Reactive Voltage	Frequency cycles per second								
	20	30	40	50	60	70	80	90	100
50	525	485	444	400	362	325	287	250	206
100	1050	975	888	800	725	650	575	500	412
110	1155	1073	976	880	797	715	632	550	453
150	1575	1455	1332	1200	1086	975	861	750	618
200	2100	1950	1775	1600	1450	1300	1150	1000	825
210	2205	2048	1864	1680	1533	1365	1207	1050	868
220	2310	2146	1952	1760	1594	1430	1284	1100	906
230	2415	2243	2041	1840	1666	1495	1321	1150	947
240	2520	2341	2130	1920	1739	1560	1378	1200	988
250	2625	2425	2220	2000	1810	1625	1435	1250	1030

CRYSTAL DATA

Crystals and their Symbols

Bornite	$3Cu_2S_3Fe_2S_3$
Carborundum	SiC
Cassiterite (tinstone)	SnO_2
Copper pyrites	$Cu_2S_2FeS_2$
Galena	PbS
Graphite	C
Hertzite	PbS
Iron Pyrites	FeS_2
Malachite	$CuCo_3CuH_2O$
Molybdenite	MoS_2
Silicon	Si
Tellurium	Te
Zincite	ZnO

Crystal Combinations

Carborundum with Steel Tellurium with Zincite
Iron pyrites with Silicon Carborundum with Silicon
Galena with Tellurium Copper Pyrites with Tellurium

Resistance Values for Decoupling and Voltage Dropping

Current mA	VOLTAGE DROPPED									
	8	9	10	20	30	40	50	60		
1	8,000	9,000	10,000	20,000	30,000	40,000	50,000	60,000		
2	4,000	4,500	5,000	10,000	15,000	20,000	25,000	30,000		
3	2,500	2,500	5,000	7,000	10,000	15,000	17,500	20,000		
4	2,000	2,500	2,500	5,000	9,000	10,000	12,000	15,000		
5	1,500	2,000	2,000	5,000	7,000	9,000	10,000	12,000		
10	1,000	1,000	1,000	2,000	2,500	5,000	5,000	7,000		
15	500	500	1,000	1,500	2,000	2,500	5,000	5,000		
20	500	500	500	1,000	1,500	2,000	2,500	5,000		
25	500	500	500	1,000	1,500	2,000	2,500	2,500		
30	300	300	500	1,000	1,500	2,000	2,000	2,500		
40	250	250	300	500	1,000	1,500	1,500	2,000		
50			250	500	1,000	1,000	1,500	2,000		
60				500	500	1,000	1,000	1,500		
				1 watt	2 watt	3 watt				
									1 watt	2 watt	3 watt
									1,000	1,500	2,000
									2,500	2,500	2,500
									5,000	5,000	7,000
									12,000	15,000	20,000
									30,000	40,000	60,000

The values given above are correct to the nearest standard value.

Resistance Values for Decoupling and Voltage Dropping *(Cont.)*

Current mA	70	80	90	100	125	150	175	200	
				VOLTAGE DROPPED					
1	70,000	80,000	90,000	100,000	125,000	150,000	175,000	200,000	
2	35,000	40,000	45,000	50,000	62,500	75,000	87,500	100,000	
3	25,000	30,000	30,000	30,000	40,000	50,000	50,000	75,000	1 watt
4	17,500	20,000	25,000	25,000	30,000	40,000	40,000	50,000	
5	15,000	17,500	20,000	20,000	25,000	30,000	40,000	40,000	
10	7,000	9,000	9,000	10,000	12,000	15,000	17,500	20,000	2 watt
15	5,000	5,000	6,000	7,000	9,000	10,000	12,000	15,000	3 watt
20	5,000	5,000	5,000	5,000	7,000	9,000	9,000	10,000	4 watt
25	2,500	2,500	5,000	5,000	5,000	5,000	7,000	8,000	5 watt
30	2,500	2,500	2,500	5,000	5,000	5,000	7,000	7,000	6 watt
40	2,000	2,000	2,500	2,500	2,500	5,000	5,000	5,000	8 watt
50	1,500	1,500	2,000	2,000	2,500	2,500	2,500	5,000	10 watt
	4 watt		5 watt		7 watt	8 watt	9 watt	10 watt	

The values given above are correct to the nearest standard value.

ACCUMULATOR DATA.

ACID OF 1.840 SPECIFIC GRAVITY

Required Specific Gravity at 70°F.	Water — Parts by Volume.	Acid, 1.840 Specific Gravity. — Parts by Volume.
1.400	14	10
1.350	18	10
1.300	21	10
1.250	27	10
1.225	29	10

ACID OF 1.400 SPECIFIC GRAVITY

Required Specific Gravity at 70° F.	Water. — Parts by Volume.	Acid, 1.400 Specific Gravity. — Parts by Volume.
1.300	4.5	10
1.280	5.5	10
1.275	6.25	10
1.265	6.4	10
1.255	6.65	10
1.250	6.75	10

CURRENT-CARRYING CAPACITY OF LAMPS FOR CHARGING PURPOSES

Carbon-filament Lamps

Candle-power.	Voltage.	Current passed.
8	110	.254
16	110	.509
32	110	1.018
8	220	.127
16	220	.209
32	220	.509

Metal-filament Lamps

Candle-power.	Voltage.	Current passed.
8	110	.09
16	110	.18
32	110	.36
8	220	.049
16	220	.09
32	220	.18

Condition of Cells.	Actual Hydrometer Readings at Temperatures shown below to give 1.280 at 60° F.						
	40°F.	50°F.	60°F.	70°F.	80°F.	90°F.	100°F.
Fully charged	1.288	1.284	1.280	1.276	1.272	1.268	1.264
Half discharged	1.207	1.204	1.200	1.196	1.193	1.189	1.186
Fully discharged	1.115	1.113	1.110	1.107	1.104	1.101	1.098

ACCUMULATOR PASTES.—The following ingredients are required: 4 parts by weight redlead (Pb_3O_4), 1 part by weight litharge (PbO), 1 part by weight sulphuric acid (1.22 specific gravity). Add the acid gradually to the mixture of redlead and litharge, stirring well until a fairly stiff paste has been formed. Thorough mixing is essential, and care must be taken not to make the paste too thin.

How to Apply. Place the grid on a flat board and use a scoop to place the paste in the grid. A wooden spreader should then be used to force the paste into the pockets of the grid. A piece of newspaper is then placed on top of the plate, and another flat board on top of that. This enables the plate to be turned over so that it can be pasted on the opposite side.

Drying. Stack the plates carefully in a warm room to dry. After three or four days dip the plates in sulphuric acid (1.25 specific gravity) and re-dry.

Paste for Negative Plates. Use the following ingredients: 5 parts by weight litharge, 1 part by weight of 1.10 specific gravity sulphuric acid. Mix, apply, and dry as for positive plates.

For a high-rate discharge cell, the paste for the negative plates can be varied as below:

Litharge, 99.96 per cent.; lamp-black, .03 per cent.; wood flour, .01 per cent. One-sixth of the total weight of the above of 1.10 specific gravity sulphuric acid.

Use acid of 1.12 specific gravity, charge at the rate of about .02 amp. per square inch of the plate area, counting both sides of the plate.

Neutralising Spilled Electrolyte. If electrolyte is spilled, it should be immediately treated with a neutralising solution, such as sodium carbonate (soda) and water, or ammonia and water. Either of these liquids is excellent for checking the effects of acid on clothing. Benches, trays, and other fittings which have become acid-sodden should be treated with a solution of 1lb. of soda to 1 gallon of water, and then dried before coating with acid-proof paint.

JELLY ELECTROLYTE.—Jelly electrolyte consists of sulphuric acid to which a given proportion of sodium silicate has been added. Jellification takes place at varying speeds according to the proportions in which the two chemicals are mixed. A suitable mixture which jellifies in five or six minutes is—1 part of pure sodium silicate (1.200 specific gravity) to 3 parts of cold sulphuric acid (1.400 specific gravity).

As jellification takes place fairly rapidly it is essential to arrange that the entire operation may be carried through without any hitch or delay. The cell to be filled with jelly acid should be given a first charge, using ordinary free sulphuric acid. This acid should then be poured off, and the cell inverted and allowed to drain for about half an hour.

H.T. METAL RECTIFIERS

Style	Rated Smoothed Output		Max. Current	INPUT Open Circuit Voltage				Capacity of each Voltage Doubler Condenser	Working Voltage of each Condenser
				Half Wave		Voltage Dblr.			
	Volts	mA	mA	Volts	mA	Volts	mA		
H.T.14	130 120	15 20	30	135	30	80	60	4 6	200
H.T.15	200	30	40	250	80	140	120	4	200
H.T.16	300	60	60	400	90	240	200	4	400
H.T.17	200	100	150	250	150	150	300	8	250
H.T.17 used for Class B	150	25	—	150	40	—	—	Reservoir Condenser 8 mfd	350
Two H.T.17 used in Series	500	120	150	—	—	300	550	6	500

H.F. METAL RECTIFIERS

Model	Type	Length	Max. Safe Input Voltage	Max. Current Output	Colour of Label
W.4	Half-wave	1 15/16 in.	24-v. peak carrier	0.25 mA.	Yellow
W.6	Half-wave	1 15/16 in.	36-v. peak carrier	0.28 mA.	Blue
WX.6	Half-wave	1 15/16 in.	36-v. peak carrier	0.12 mA.	White-Blue
WM.24	Full-wave, centre tap	3 in.	24-v. each side of centre tap.	0.5 mA.	Yellow
WM.26	Full-wave, centre tap	3 in.	36-v. each side of centre tap.	0.5 mA.	Blue

Formulæ Relative to Circles

To find Circumference of a Circle :
Multiply diameter by 3.1416 ; or
Divide diameter by 0.3183.

To find Diameter of a Circle ;
Multiply circumference by 0.3183 ; or
Divide circumference by 3.1416.

To find Radius of a Circle :
Multiply circumference by 0.15915 ; or
Divide circumference by 6.28318.

To find the Area of a Circle :

Multiply circumference by one-quarter of the diameter ; or

Multiply the square of diameter by 0.7854 ; or

Multiply the square of circumference by 0.07958 ; or

Multiply the square of ½ diameter by 3.1416.

L.T. METAL RECTIFIERS

Rectifier	With Tapped Transformer				With Tapped Resistance			
	Charging Rate Amps	No. of 2-volt cells	Resistance Ohms	A.C. Input Volts	Charging Rate Amps	No. of 2-volt cells	Resistance Ohms	A.C. Input Volts
L.T.4	1	1	1.75	7.5	1	1	5.25	11
		2		9		2	3.25	
		3		11		3	1.75	
L.T.5	1	3	1.75	15	1	3	7	22
		5		18		5	3.5	
		6		22		6	1.75	
L.T.7	—	—	—	—	0.5	1	2.5	4+4
L.T.8	—	—	—	—	0.5	1	4.5	8+8
						2	3.5	
						3	2.5	
L.T.9	—	—	—	—	0.5	3	11	16+16
						5	7	
						6	5	
L.T.10	2	3	1	14	2	3	4.5	20
		5		17		5	2.5	
		6		20		6	1.0	
L.T.11	4	1	0.25	6	4	1	1.5	11
		2		8		2	0.75	
		3		11		3	0.25	
A.4	2	1	0.5	5.5	2	1	3.5	14
		2		7.5		2	3	
		3		9		3	2	
		4		14		4	1.5	

Note.—The L.T.7, L.T.8 and L.T.9 are unsuitable for use with tapped transformer for control.

DIELECTRIC CONSTANTS.—The following table gives the specific inductive capacities of various materials. These figures represent the dielectric constants.

Material.	*S.I.C.*
Air	1
Paper	1.5
Paraffin Wax	2.5
Ebonite	2.75
Shellac	3
Presspahn	3
Flint Glass	4 to 6
Plate Glass	4.5
Mica	5 to 8

DIELECTRIC STRENGTHS.

Material.	*Dielectric Strength per Mm.*
Glass	8,000
Shellac	10,000
Presspahn	6,000 to 15,000
Porcelain	16,300
Rubber	18,000
Mica	17,000 to 28,000
Ebonite	30,000
Micanite	40,000

SPECIFIC RESISTANCE OF VARIOUS MATERIALS.

SUBSTANCE	SPECIFIC RESISTANCE	SUBSTANCE	SPECIFIC RESISTANCE
Advance ..	19.2×10^{-6}	Krupp Metal ..	33.4×10^{-6}
Argentan ..	11.2×10^{-6}	Lead	7.8×10^{-6}
Calido	39.3×10^{-6}	Manganin ..	16.5×10^{-6}
Climax	34.7×10^{-6}	Monel Metal ..	16.1×10^{-6}
Constantan ..	19.3×10^{-6}	Nichrome I ..	38.8×10^{-6}
Copper	0.63×10^{-6}	Nichrome II ..	42.6×10^{-6}
Eureka	18.5×10^{-6}	Nickel	3.9×10^{-6}
Excello	36.0×10^{-6}	Platinoid ..	18.4×10^{-6}
Ferro-Nickel ..	11.1×10^{-6}	Resista	29.9×10^{-6}
German Silver ..	13.0×10^{-6}	Rheostan ..	17.5×10^{-6}
Ideal	19.3×10^{-6}	Rheostine ..	29.9×10^{-6}
Pure Iron ..	3.48×10^{-6}	Rose's Metal ..	25.4×10^{-6}
Soft Steel ..	4.6×10^{-6}	Superior ..	34.3×10^{-6}
Hard Steel ..	17.9×10^{-6}	Therlo	18.4×10^{-6}
Soft Cast Iron..	29.3×10^{-6}	Wood's Metal ..	22.2×10^{-6}
Hard Cast Iron	38.9×10^{-6}	Zinc	2.1×10^{-6}

WEIGHT OF SHEET EBONITE.

Thickness (inch)	*Weight of 1 sq. ft. (oz.)*	*Area (sq. in.) of 1 lb.*	*Area (sq. in.) of 1 oz.*
$\frac{1}{8}$	13	176	11
$\frac{3}{16}$	20	$117\frac{1}{2}$	$7\frac{1}{2}$
$\frac{1}{4}$	26	88	$5\frac{1}{2}$
$\frac{3}{8}$	39	56	$3\frac{1}{2}$
$\frac{1}{2}$	52	44	$2\frac{3}{4}$

APPROXIMATE WEIGHT OF 1 CUBIC INCH OF METALS

	Lb.		*Lb.*
Platinum	0.78	Nickel	0.31
Gold	0.69	Wrought Iron ..	0.28
Mercury	0.49	Steel	0.28
Lead	0.41	Cast Iron	0.26
Silver	0.36	Tin	0.26
Bismuth	0.35	Zinc	0.26
Copper	0.32	Antimony	0.24
Brass	0.31	Aluminium	0.097
Magnesium	0.063	Duralumin	0.101

SCREWS: BRITISH ASSOCIATION (B.A.)

No.	Absolute Dimensions in Millimetres: Full Diameter	Absolute Dimensions in Millimetres: Pitch	Approximate Number of Threads per Inch	Approximate Dimensions in Inches: Full Diameter	Approximate Dimensions in Inches: Pitch
25	0.25	0.070	362.8	0.010	0.0028
24	0.29	0.080	317.5	0.011	0.0031
23	0.33	0.09	282.2	0.013	0.0035
22	0.37	0.10	254.0	0.015	0.0039
21	0.42	0.11	230.9	0.017	0.0043
20	0.48	0.12	211.6	0.019	0.0047
19	0.54	0.14	181.4	0.021	0.0055
18	0.62	0.15	169.3	0.024	0.0059
17	0.70	0.17	149.4	0.028	0.0067
16	0.79	0.19	133.7	0.031	0.0075
15	0.90	0.21	121.0	0.035	0.0083
14	1.0	0.23	110.4	0.039	0.0091
13	1.2	0.25	101.6	0.047	0.0098
12	1.3	0.28	90.7	0.051	0.0110
11	1.5	0.31	81.9	0.059	0.0122
10	1.7	0.35	72.6	0.067	0.0138
9	1.9	0.39	65.1	0.075	0.0154
8	2.2	0.43	59.1	0.087	0.0169
7	2.5	0.48	52.9	0.098	0.0189
6	2.8	0.53	47.9	0.110	0.0209
5	3.2	0.59	43.0	0.126	0.0232
4	3.6	0.66	38.5	0.142	0.0260
3	4.1	0.73	34.8	0.161	0.0287
2	4.7	0.81	31.4	0.185	0.0319
1	5.3	0.90	28.2	0.209	0.0354
0	6.0	1.00	25.4	0.236	0.0394

It is recommended that for screws less than ¼-in. diameter British Association Threads should be adopted. It was originally proposed by the British Association in 1884, and finally adopted by them in 1904. It is, however, not yet the usual practice in this country to use the sizes ranging from No. 17 upwards. Moreover, makers of taps, dies, screwplates, etc., usually supply sizes to No. 16.

DRILLS AND DRILLING

WHITWORTH THREADS

Diameter	1/8in.	5/32in.	3/16in.	1/4in.	5/16in.	5/16in.
Tapping size	8/32in.	No. 31	9/64in.	8/16in.	Letter D
Clearing size	9/64in.	11/64in.	13/64in.	17/64in.	21/64in.

B.S.F. THREADS

Diameter	1/4in.	9/32in.	5/16in.	3/8in.	3/8in.
Tapping size	No. 5	Letter B	Letter G	Letter O
Clearing size	17/64in.	19/64in.	21/64in.	28/64in.

B.A. THREADS

Diameter ..	0	1	2	3	4	5	6	7	8
Tapping size	No. 10	No. 17	No. 24	No. 29	No. 32	No. 37	No. 43	No. 46	No. 50
Clearing size	Letter B	No. 3	3/16in.	No. 19	No. 27	No. 30	No. 33	No. 39	No. 43

WOOD SCREWS

Size No.	00	0	1	2	3	4	5	6	7	8
Clearing size ..	No. 52	No. 51	No. 50	No. 44	No. 40	7/64in.	1/8in.	9/64in.	5/32in.	11/64in.

Twist Drill Gauge Sizes

No. Drill.	Decimal Sizes.	No. Drill.	Decimal Sizes.
1	.2280	31	.1200
2	.2210	32	.1160
3	.2130	33	.1130
4	.2090	34	.1110
5	.2055	35	.1100
6	.2040	36	.1065
7	.2010	37	.1040
8	.1990	38	.1015
9	.1960	39	.0995
10	.1935	40	.0980
11	.1910	41	.0960
12	.1890	42	.0935
13	.1850	43	.0890
14	.1820	44	.0860
15	.1800	45	.0820
16	.1770	46	.0810
17	.1730	47	.0785
18	.1695	48	.0760
19	.1660	49	.0730
20	.1610	50	.0700
21	.1590	51	.0670
22	.1570	52	.0635
23	.1540	53	.0595
24	.1520	54	.0550
25	.1495	55	.0520
26	.1470	56	.0465
27	.1440	57	.0430
28	.1405	58	.0420
29	.1360	59	.0410
30	.1285	60	.0400

Letter Sizes of Drills

A	.234	H	.266	O	.316	U	.368
B	.238	I	.272	P	.323	V	.377
C	.242	J	.277	Q	.332	W	.386
D	.246	K	.281	R	.339	X	.397
E	.250	L	.290	S	.348	Y	.404
F	.257	M	.295	T	.358	Z	.413

$\frac{1}{64} = .0156$

WOOD SCREW PROPORTIONS

Twist Drills for Wood Screws

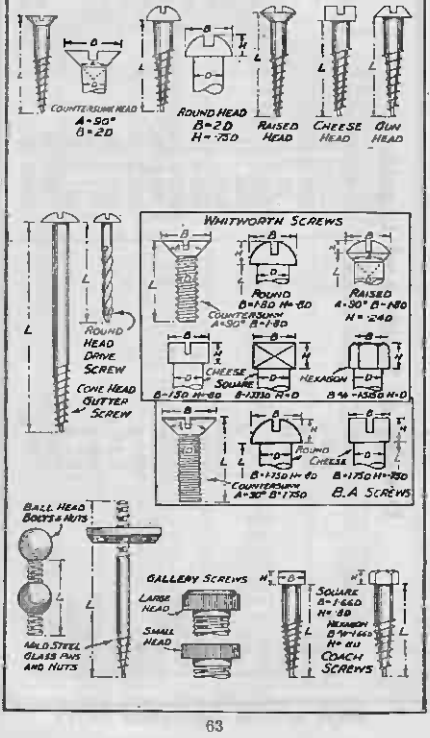
No. (or) size) of Screw.	Diameter of Neck or Shank.	For Wood or Metal.		With Side Lips and Centre for Wood only.	
		No., etc.	Diameter.	Size.	Diameter.
1	.066	Stub's Wire Gauge Drills. 51	.067	—	—
2	.080	46	.081	—	—
3	.094	41	.096	—	—
4	.108	35	.110	—	—
5	.122	30	.128	1/8	.125
6	.136	28	.140	—	—
7	.150	23	.154	5/32	.156
8	.164	18	.169	—	—
9	.178	14	.182	3/16	.187
10	.192	9	.196	—	—
11	.206	4	.209	7/32	.218
12	.220	1	.228	—	—
13	.234	B	.238	—	—
14	.248	E	.250	1/4	.250
15	.262	H	.266	—	—
16	.276	K	.281	9/32	.281
17	.290	M	.295	—	—
18	.304	Letter Gauge Drills. O	.316	5/16	.312
19	.318	P	.323	—	—
20	.332	R	.339	11/32	.343
21	.346	S	.348	—	—
		T	.358		
22	.360	U	.368	3/8	.375
23	.374	V	.377	3/8	.375
24	.388	X	.397	—	—
25	.402	Z	.413	13/32	.406
26	.416	27/64	.421	—	—
27	.430	7/16	.437	7/16	.437
28	.444	29/64	.453	—	—
29	.458	15/32	.468	15/32	.468
30	.472	31/64	.484	—	—
31	.486	1/2	.500	1/2	.500
32	.500	33/64	.515	1/2	.500

All dimensions in parts of an inch.

STANDARD WOOD SCREWS

No. of Screw Gauge	Diameter. A in Dec.	A in. Approx. Fraction.	B In.	Depth of C' sink.	Slot. Width	Slot. Depth.
0	.05784	1/16	7/64	1/32	1/64	1/64
1	.07100	5/64	9/64	3/64	1/64	1/32
2	.08416	5/64	11/64	3/64	1/64	1/32
3	.09732	3/32	3/16	3/64	1/64	1/32
4	.11048	7/64	7/32	1/16	1/32	1/32
5	.12364	1/8	15/64	1/16	1/32	1/32
6	.13680	9/64	17/64	5/64	1/32	3/64
7	.14996	5/32	19/64	5/64	1/32	3/64
8	.16312	5/32	21/64	3/32	3/64	3/64
9	.17628	11/64	23/64	3/32	3/64	3/64
10	.18944	3/16	3/8	7/64	3/64	1/16
11	.20260	13/64	13/32	7/64	3/64	1/16
12	.21576	7/32	7/16	1/8	3/64	1/16
13	.22892	15/64	29/64	1/8	1/16	1/16
14	.24208	1/4	31/64	9/64	1/16	1/16
15	.25524	1/4	33/64	9/64	1/16	1/16
16	.26840	17/64	17/32	5/32	1/16	5/64
17	.28156	9/32	9/16	5/32	1/16	5/64
18	.29472	19/64	19/32	11/64	5/64	5/64
19	.30788	5/16	39/64	11/64	5/64	5/64
20	.32104	21/64	41/64	11/64	5/64	5/64
21	.33420	21/64	43/64	3/16	5/64	3/32
22	.34736	11/32	11/16	3/16	3/32	3/32
23	.36052	23/64	23/32	13/64	3/32	3/32
24	.37368	3/8	3/4	13/64	3/32	3/32

WOOD SCREW PROPORTIONS



Density of Solids and Liquids

Aluminium	2.68 g. per cub cm.	161.1 lb. per cub. ft.
Copper	8.9 g. " "	555.4 lb. " "
Gold	19.3 g. " "	1205.0 lb. " "
Ice	0.9167 g. " "	57.2 lb. " "
Iron	7.87 g. " "	491.3 lb. " "
Lead	11.0 g. " "	686.7 lb. " "
Mercury	13.596 g. " "	848.7 lb. " "
Nickel	8.80 g. " "	549.4 lb. " "
Platinum	21.50 g. " "	1342.2 lb. " "
Sea Water	1.025 g. " "	64.0 lb. " "
Silver	10.5 g. " "	655.5 lb. " "
Tin	7.18 g. " "	448.2 lb. " "
Tungsten	18.6 g. " "	1161.2 lb. " "
Uranium	18.7 g. " "	1167.4 lb. " "
Water	1.000 g. " "	62.4 lb. " "
Zinc	7.19 g. " "	448.6 lb. " "

Wavelength-Frequency Conversion Table.
Metres to Kilocycles.

Metres.	*Kilocycles.*	*Metres.*	*Kilocycles.*
5	60,000	370	810.8
6	50,000	380	789.5
7	42,857	390	769.2
8	37,500	400	750
9	33,333	410	731.7
10	30,000	420	714.3
25	12,000	430	697.7
50	6,000	440	681.8
100	3,000	450	666.7
150	2,000	460	652.2
200	1,500	470	638.3
205	1,463	480	625
210	1,429	490	612.2
215	1,395	500	600
220	1,364	510	588.2
225	1,333	520	576.9
230	1,304	530	566
235	1,277	540	555.6
240	1,250	550	545.4
245	1,225	560	535.7
250	1,200	570	526.3
255	1,177	580	517.2
260	1,154	590	508.5
265	1,132	600	500
270	1,111	650	461.5
275	1,091	700	428.6
280	1,071	750	400
290	1,034	800	375
295	1,017	850	352.9
300	1,000	900	333.3
310	967.7	950	315.9
320	937.5	1,000	300
330	909.1	1,250	240
340	882.3	1,500	200
350	857.1	1,750	171.4
360	833.3	2,000	150

Note.—To convert kilocycles to wavelengths in metres, divide 300,000 by the number of kilocycles.

To convert wavelengths in metres to kilocycles, divide 300,000 by the number of metres. One megacycle = 1,000,000 cycles or = 1,000 kilocycles. Thus, 30,000 kilocycles = 30 megacycles.

STANDARD COLOUR CODES.

Resistances and Condensers.

The colour codes for fixed condensers and fixed resistors are identical, the standard for resistors being ohms and for fixed condensers mmfd.

Colour	Fig.	No. of Noughts.
Black	0	None
Brown	1	0
Red	2	00
Orange	3	000
Yellow	4	0000
Green	5	00000
Blue	6	000000
Violet	7	
Grey	8	
White	9	

The order of reading these colours is: Body Tip, Dot.

Example: Resistance with red body, black tip and orange spot will have value of 20,000 ohms. If there is no dot on the body it indicates that it is of the same colour as the body.

Multiple Condenser Blocks.

The highest capacity positive voltage	Red
The second highest do.	Yellow
The third highest do.	Green
The fourth highest do.	Blue
The fifth highest do.	Violet
Principal negative connection	Black
Second do.	Brown
Third do.	Grey
Centre connection for voltage doubler condensers	White

Where only two leads are used, positive is red and negative black.

Fuses.

60 mA.	Black	1 amp.	Dark Blue
100 mA.	Grey	1½ amp.	Light Blue
150 mA.	Red	2 amp.	Purple
250 mA.	Brown	3 amp.	White
500 mA.	Yellow	5 amp.	Black and White
750 mA	Green		

Standard Colour Codes—*(continued)*

Mains Transformer Data

Primary zero	Black
„ 10 volts	Black & Green
„ 210 „	Black & Yellow
„ 230 „	Black & Red
„ 250 „	Black & Brown
Secondary Rectifier Heater	Green
„ High Voltage	Red
„ Valve Heaters	Brown
„ Additional Valve Heaters	Blue

Centre-tap leads are marked with the same colour as the appropriate secondary winding, but with a yellow line interwoven.

Battery Leads

Highest voltage positive	Red
Second do	Yellow
Third do	Green
Fourth do	Blue
Low-tension positive	Pink
Common negative (L.T., H.T., G.B.)	Black
Max. G.B. negative	Brown
Second do	Grey
Third do	White

Any additional point, such as the fourth greatest G.B. negative, or fifth greatest H.T. positive, or positive bias, is violet, and any centre-tap is white.

INTERNATIONAL "Q" CODE

Abbrev.	Question	Answer for Advice
QRA	What is the name of your station ? ...	The name of my station is . . .
QRB	How far approximately are you from my station ?	The approximate distance is . . . miles
QRD	Where are you bound and where are you from ?	I am bound for . . . from . . .
QRG	Will you tell me my exact frequency in kilocycles ? ...	Your exact frequency is . . . kc
QRH	Does my frequency vary ?	Your frequency varies.
QRI	Is my note good ? ...	Your note varies.
QRJ	Do you receive me badly ?	I cannot receive you.
	Are my signals weak ?	Your signals are too weak.
QRK	Do you receive me well ?	I receive you well.
	Are my signals good ?	Your signals are good.
GRL	Are you busy ? ...	I am busy. Please do not interfere.
QRM	Are you being interfered with ? ...	I am being interfered with.
QRN	Are you troubled by atmospherics ? ...	I am troubled by atmospherics.
QRO	Shall I increase power ?	Increase power.
QRP	Shall I decrease power ?	Decrease power.
QRQ	Shall I send faster ?	Send faster (. . . words per minute).
QRS	Shall I send more slowly ?	Send more slowly (. . . words per minute)
QRT	Shall I stop sending ?	Stop sending.
QRU	Have you anything for me ?	I have nothing for you.

INTERNATIONAL "Q" CODE

Abbrev.	Question	Answer for Advice
QRV	Are you ready ?	I am ready.
QRX	Shall I wait ? When will you call me again ?	Wait (or wait until I have finished communicating with . . .) I will call you at . . . GMT.
QRZ	Who is calling me ?	You are being called by . . . .
QSA	What is the strength of my signals ? (1 to 5)	The strength of your signals is . . . (1 to 5).
QSB	Does the strength of my signals vary ?	The strength of your signals varies.
QSD	Is my keying correct? Are my signals distinct ?	Your keying is indistinct. Your signals are bad.
QSL	Can you give me acknowledgment of receipt ? ...	I give you acknowledgment of receipt.
QSM	Shall I repeat the last telegram (message) I sent you ? ...	Repeat the last telegram (message) you have sent me.
QSO	Can you communicate with . . . direct (or through the medium of . . .) ? ...	I can communicate with . . . direct or through the medium of . . .).
QSP	Will you retransmit to . . . ?	I will retransmit to . . .
QSV	Shall I send a series of V's ?	Send a series of V's.
QSX	Will you listen for . . . (call sign) on . . . kc ?	I am listening for . . . (call sign) on . . kc.
QSZ	Shall I send each word or group twice ? ...	Send each word or group twice.
QTH	What is your position in latitude and longitude ?... ...	My position is . . . latitude . . . longitude.
QTR	What is the exact time ?	The exact time is . . .

MISCELLANEOUS INTERNATIONAL ABBREVIATIONS

Abbrev.	Meaning	Abbrev.	Meaning
C ..	.. Yes	QA ..	.. Resume sending
N ..	.. No	MN ..	.. Minute/minutes
W ..	.. Word	NW ..	.. I resume transmission
AA ..	.. All after . . .	OK ..	.. Agreed
AB ..	.. All before . . .	UA ..	.. Are we agreed?
AL ..	.. All that has just been sent	WA ..	.. Word after . . .
BN ..	.. All between	WB ..	.. Word before . . .
CL ..	.. I am closing my station	XS ..	.. Atmospherics

AMATEUR ABBREVIATIONS

Abbrev.	Meaning	Abbrev.	Meaning
ABT	.. About	NM ..	.. No more
AGN	.. Again	NR ..	.. Number
ANI	.. Any	NW ..	.. Now
BA ..	.. Buffer amplifier	OB ..	.. Old boy
BCL	.. Broadcast listener	OM ..	.. Old Man
BD ..	.. Bad	OT ..	.. Old timer
BY ..	.. By	PA ..	.. Power amplifier
BK	.. Break in	PSE	.. Please
BN ..	.. Been	R ..	.. Received all sent
CK ..	.. Check	RAC	.. Rectified A.C.
CKT	.. Circuit	RCD	.. Received
CLD	.. Called	RX ..	.. Receiver
CO ..	.. Crystal oscillator	SA ..	.. Say
CUD	.. Could	SED	.. said
CUL	.. See you later	SIGS	.. Signals
DX ..	.. Long distance	SIGN	.. Signature
ECO	.. Electron-coupled oscillator	SSS	.. Single Signal superheterodyne receiver
ES ..	.. And		
FB ..	.. Fine business (good work)	SKD	.. Schedule
		TKS	.. Thanks
FD	.. Frequency doubler	TMN	.. To-morrow
FM	.. From	TNX	.. Thanks
GA	.. Go ahead, or Good afternoon	TPTG	.. Tuned plate tuned grid
GB ..	.. Good-bye	TX ..	.. Transmitter
GE ..	.. Good evening	U ..	.. You
GM	.. Good morning	UR ..	.. You are
GN ..	.. Good night	VY ..	.. Very
HAM	.. Radio amateur	WDS	.. Words
HA ..	.. Laughter	WKG	.. Working
HR ..	.. Hear, or here	WL ..	.. Will
HRD	.. Heard	WUD	.. Would
HV ..	.. Have	WX	.. Weather
LTR	.. Later	YF ..	.. Wife
MILS	.. Milliamperes	YL ..	.. Young lady
MO ..	.. Meter Oscillator	YR ..	.. Your
ND ..	.. Nothing doing	73 ..	.. Kind regards
NIL	.. Nothing	88 ..	.. Love and kisses

QSA CODE (Signal Strength)

QSA1 .. Hardly perceptible; unreadable.
QSA2 .. Weak, readable now and then.
QSA3 .. Fairly good; readable but with difficulty.
QSA4 .. Good; readable.
QSA5 .. Very good; perfectly readable.

QRK CODE (Audibility)

R1 .. Unreadable.
R2 .. Weak signals; barely readable.
R3 .. Weak signals; but can be copied.
R4 .. Fair signals; easily readable.
R5 .. Moderately strong signals.
R6 .. Good signals.
R7 .. Good strong signals.
R8 .. Very strong signals.
R9 .. Extremely strong signals.

RST CODE (Readability)

1 .. Unreadable.
2 .. Barely readable, occasional words distinguishable.
3 .. Readable with considerable difficulty.
4 .. Readable with practically no difficulty.
5 .. Perfectly readable.

(Signal Strength)

1 .. Faint, signals barely perceptible.
2 .. Very weak signals.
3 .. Weak signals.
4 .. Fair signals.
5 .. Fairly good signals.
6 .. Good signals.
7 .. Moderately strong signals.
8 .. Strong signals.
9 .. Extremely strong signals.

(Tone)

1 .. Extremely rough hissing note.
2 .. Very rough A.C. note, no trace of musicality.
3 .. Rough, low-pitched A.C. note, slightly musical.
4 .. Rather rough A.C. note, moderately musical.
5 .. Musically modulated note.
6 .. Modulated note, slight trace of whistle.
7 .. Near D.C. note, smooth ripple.
8 .. Good D.C. note, just a trace of ripple.
9 .. Purest D.C. note.

(If the note appears to be crystal-controlled add an X after the appropriate number).

INTERNATIONAL MORSE CODE.

A	dit dah	· –
B	dah dit dit dit	– · · ·
C	dah dit dah dit	– · – ·
D	dah dit dit	– · ·
E	dit	·
F	dit dit dah dit	· · – ·
G	dah dah dit	– – ·
H	dit dit dit dit	· · · ·
I	dit dit	· ·
J	dit dah dah dah	· – – –
K	dah dit dah	– · –
L	dit dah dit dit	· – · ·
M	dah dah	– –
N	dah dit	– ·
O	dah dah dah	– – –
P	dit dah dah dit	· – – ·
Q	dah dah dit dah	– – · –
R	dit dah dit	· – ·
S	dit dit dit	· · ·
T	dah	–
U	dit dit dah	· · –
V	dit dit dit dah	· · · –
W	dit dah dah	· – –
X	dah dit dit dah	– · · –
Y	dah dit dah dah	– · – –
Z	dah dah dit dit	– – · ·
Number Code		
1	dit dah dah dah dah	· – – – –
2	dit dit dah dah dah	· · – – –
3	dit dit dit dah dah	· · · – –
4	dit dit dit dit dah	· · · · –
5	dit dit dit dit dit	· · · · ·
6	dah dit dit dit dit	– · · · ·
7	dah dah dit dit dit	– – · · ·
8	dah dah dah dit dit	– – – · ·
9	dah dah dah dah dit	– – – – ·
0	dah dah dah dah dah	– – – – –
Note of interrogation	dit dit dah dah dit dit	· · – – · ·
Note of exclamation	dah dah dit dit dah dah	– – · · – –
Apostrophe	dit dah dah dah dah dit	· – – – – ·
Hyphen	dah dit dit dit dit dah	– · · · · –
Fractional bar	dah dit dit dah dit	– · · – ·
Brackets	dah dit dah dah dit dah	– · – – · –
Inverted commas	dit dah dit dit dah dit	· – · · – ·
Underline	dit dit dah dah dit dah	· · – – · –
Prelim. call	dah dit dah dit dah	– · – · –
Break sign	dah dit dit dit dah	– · · · –
End message	dit dah dit dah dit	· – · – ·
Error	dit dit dit dit dit dit dit dit	· · · · · · · ·

INTERNATIONAL AMATEUR CALL-SIGNS

AC4	Tibet	FU	French New Hebrides
AR	Syria	FY	Guyane (French Guiana)
CE	Chile	G	British Isles (G-England ; GM-Scotland ; GW-Wales)
CM	Cuba		
CN1	Tangier Zone		
CNB	Morocco		
CO	Cuba (fone)		
CP	Bolivia	GI	North Ireland
CR4	Cape Verde Islands	HA	Hungary
CR5	Portuguese Guinea	HB	Switzerland
CR6	Angola	HC	Ecuador
CR7	Mozambique	HH	Haiti
CR8	Portuguese India	HI	Dominican Republic
CR9	Macao		
CR10	Timor	HK	Colombia
CT1	Portugal	HP	Republic of Panama
CT2	Azores		
CT3	Madeira Island	HR	Honduras
CX	Uruguay	HS	Siam
D	Germany	HZ	Hedjaz
EA	Spain	I	Italy
EA6	Balearic Islands	J	Japan
EA8	Canary Islands	J8	Chosen (Korea)
EA9	Spanish Morocco	J9	Formosa
EI	Irish Free State	K4	Virgin Islands
EL	Liberia	K5	Canal Zone
EP	Iran (Persia)	K6	Hawaii
EQ	Iran (Persia)	K8	Guam
ES	Estonia	K6	Samoa
ET	Ethiopia (Abyssinia)	K6	Midway and Wake Islands
F	France	K7	Alaska
FA	Algeria	KA	Philippines
FB	Madagascar	LA	Norway
FD	French Togoland	LU	Argentina
FE	French Cameroons	LX	Luxembourg
FF	French West Africa	LY	Lithuania
FG	Guadeloupe	LZ	Bulgaria
FI	French Indo-China	MX	Manchukuo
FK	New Caledonia	NY	Canal Zone
FL	French Somaliland	OA	Peru
FM	Martinique	OE	Austria
FN	French India	OH	Finland
FO	French Oceania	OK	Czechoslovakia
FP	St. Pierre and Miquelon	OM	Guam
		ON	Belgium
FQ	French Equatorial Africa	OQ5	Belgian Congo
		OX	Greenland
FR	Reunion Island	OY	Faroe Islands
FT	Tunisia	OZ	Denmark

INTERNATIONAL AMATEUR CALL-SIGNS

PA	Netherlands	VS3	Non-Fed. Malay States
PJ	Curacao	VS4	Sarawak North Borneo
PK	Dutch East Indies	VS5	Labuan, Brunei
PX	Andorra	VS6	Hong Kong
PY	Brazil	VS7	Ceylon
PZ	Surinam	VS8	Bahrein
SM	Sweden	VS9	Maldive Is.
SP	Poland	VU	British India
ST	Sudan	VU4	Laccadive Is.
SU	Egypt	W, WA	United States of America
SV	Greece		
SV8	Crete	XH	Mexico
TA	Turkey	XU	China
TF	Iceland	XZ	Burma
TG	Guatemala	YA	Afghanistan
TI	Costa Rica	YI	Iraq
U, UE, IK	U.S.S.R.	YL	Latvia
VE	Canada	YM	Danzig
VK	Australia	YN	Nicaragua
VO	Newfoundland Labrador	YR	Rumania
		YS	Salvador
VP1	British Honduras	YT, YU	Jugo-Slavia
VP2	Leeward Is. and Windward Is.	YV	Venezuela
		ZA	Albania
VP3	British Guiana	ZB1	Malta
VP4	Trinidad and Tobago	ZB2	Gibraltar
VP5	Jamaica, Cayman Is., Turks and Caicos Is.	ZC1	Transjordania
		ZC2	Cocos Is.
VP6	Barbados	ZC3	Christmas Is.
VP7	Bahamas	ZC4	Cyprus
VP8	Falkland Is., South Georgia Is.	ZC6	Palestine
		ZD1	Sierra Leone
VP9	Bermuda	ZD2	Nigeria, British
VQ1	Zanzibar	ZD3	Gambia
VQ2	Northern Rhodesia	ZD4	Gold Coast, British Togoland
VQ3	Tanganyika		
VQ4	Kenya	ZD6	Nyasaland
VQ5	Uganda	ZD7	St. Helena
VQ6	British Somaliland	ZD8	Ascension Is.
VQ8	Mauritius	ZD9	Tristan da Cunha
VQ9	Seychelles	ZE1	Southern Rhodesia
VR1	Gilbert and Ellice Is.	ZK1	Cook Is.
VR2	Fiji	ZK2	Niue
VR3	Fanning Is.	ZL	New Zealand
VR4	British Solomon Is.	ZM	Western Samoa
VR5	Tonga	ZP	Paraguay
VR6	Pitcairn	ZS	Union of S. Africa
VS1	Straits Settlements	ZS3	South West Africa
VS2	Fed. Malay States		

PHONETIC ALPHABET

To avoid the possibility of the letters of a call-sign being misunderstood, it is usual to use the words given below in place of the letters. For example, G6PY would be given as G6 Paris Yokohama.

Letters to be spelt	Words to be used for spelling
A	Amsterdam
B	Baltimore
C	Casablanca
D	Denmark
E	Edison
F	Florida
G	Gallipoli
H	Havana
I	Italy
J	Jerusalem
K	Kilogram (or Kilowatt)
L	Liverpool
M	Madagascar
N	New York
O	Oslo
P	Paris
Q	Quebec
R	Roma
S	Santiago
T	Tripoli
U	Upsala
V	Valencia
W	Washington
X	Xanthippe
Y	Yokohama
Z	Zurich

AMATEUR WAVEBANDS (BRITISH)

Five-metre Band - 56,020—59,980 kc/s.
Ten-metre Band - 28,010—29,990 kc/s.

Twenty-metre Band

Metres	*Kilocycles*	*Metres*	*Kilocycles*
20.9	14,353	21.2	14,151
21.0	14,285	21.3	14,085
21.1	14,218	21.4	14,019

Forty-metre Band

Metres	*Kilocycles*	*Metres*	*Kilocycles*
41.2	7,281.5	42.1	7,125.9
41.3	7,263.8	42.2	7,109.0
41.4	7,246.3	42.3	7,092.2
41.5	7,228.8	42.4	7,075.4
41.6	7,211.5	42.5	7,058.8
41.7	7,194.2	42.6	7,042.2
41.8	7,177.0	42.7	7,025.7
41.9	7,159.9	42.8	7,009.3
42.0	7,142.8		

Eighty-metre Band

Metres	*Kilocycles*	*Metres*	*Kilocycles*	*Metres*	*Kilocycles*
80.5	3,726.6	82.2	3,649.7	83.9	3,575.6
80.6	3,722.0	82.3	3,645.2	84.0	3,571.3
80.7	3,717.4	82.4	3,640.7	84.1	3,567.1
80.8	3,712.8	82.5	3,636.3	84.2	3,562.9
80.9	3,708.2	82.6	3,631.9	84.3	3,558.7
81.0	3,703.6	82.7	3,627.5	84.4	3,554.5
81.1	3,699.1	82.8	3,623.1	84.5	3,550.3
81.2	3,694.5	82.9	3,618.7	84.6	3,546.1
81.3	3,690.0	83.0	3,614.3	84.7	3,541.9
81.4	3,685.5	83.1	3,610.0	84.8	3,537.7
81.5	3,681.0	83.2	3,605.7	84.9	3,533.5
81.6	3,676.5	83.3	3,601.4	85.0	3,529.3
81.7	3,672.0	83.4	3,597.1	85.1	3,525.2
81.8	3,667.5	83.5	3,592.8	85.2	3,521.0
81.9	3,663.0	83.6	3,588.5	85.3	3,516.9
82.0	3,658.5	83.7	3,584.2	85.4	3,512.8
82.1	3,654.2	83.8	3,579.9	85.5	3,508.7

Note.—Wavelengths in Metres are not given for the 5- and 10-metre bands, owing to the narrow band width, which would result in awkward decimal fractions.

Copper Wire Data

Standard Wire Gauge.	*Diameter in Inches.*	*Resistance in Ohms per Yard.*	*Resistance in Ohms per Pound.*	*Pounds per Ohm.*	*Weight in Pounds per 1,000 Yds.*	*Yards per Pound.*	*Turns per Inch.* Enamel Covered.	Single Silk Covered.	Double Silk Covered.	Single Cotton Covered.	Double Cotton Covered.
10	.128	.001868	.0120	83.3	148.8	6.67	↓	7.64	7.55	7.35	7.04
11	.116	.002275	.0200	50.0	122.9	8.16		8.41	8.30	8.00	7.69
12	.104	.002831	.0280	35.7	98.22	10.23		9.35	9.22	8.93	8.48
13	.092	.003617	.0550	18.1	76.86	13.00		10.5	10.4	10.0	9.43
14	.080	.004784	.0820	12.2	58.12	17.10		12.1	11.8	11.4	10.6
15	.072	.005904	.1400	7.14	47.08	21.28		13.3	13.1	12.5	11.6
16	.064	.007478	.2091	4.95	37.20	26.80	15.0	14.9	14.6	14.1	13.2
17	.056	.009762	.3423	2.38	28.48	35.00	17.1	16.9	16.5	15.9	14.7
18	.048	.01328	.6351	1.58	20.92	47.60	19.8	20.0	19.4	18.5	17.2
19	.040	.01913	1.815	.757	14.53	68.06	23.7	23.8	23.0	21.7	20.0
20	.036	.02362	2.012	.497	11.77	85.00	26.1	26.3	25.3	23.8	21.7
21	.032	.02990	3.221	.309	9.299	107.6	29.4	29.4	28.2	26.3	23.8
22	.028	.03905	5.498	.181	7.120	140.6	33.3	33.3	31.8	29.4	26.3
23	.024	.05313	10.14	.098	5.231	191.6	38.8	38.5	36.4	33.3	29.4
24	.022	.06324	14.38	.069	4.396	228.3	42.1	42.1	40.0	35.7	31.3
25	.020	.07653	21.08	.0471	3.632	275.3	46.0	46.0	43.5	38.5	33.3
26	.018	.09448	32.21	.0309	2.942	340.0	50.6	50.6	47.6	41.7	35.7
27	.0164	.11138	46.55	.0215	2.442	410.0	55.9	55.1	51.6	44.0	37.9

Copper Wire Data—(*continued*)

Standard Wire Gauge.	Diameter in Inches.	Resistance in Ohms per Yard.	Resistance in Ohms per Pound.	Pounds per Ohm.	Weight in Pounds per 1,000 Yds.	Yards per Pound.	Turns per Inch. Enamel Covered.	Single Silk Covered.	Double Silk Covered.	Single Cotton Covered.	Double Cotton Covered.
28	.0148	.1398	70.12	.0141	1.989	503.0	61.4	60.4	56.2	48.1	40.2
29	.0136	.1655	98.65	.0101	1.639	596.6	66.2	65.2	60.2	51.0	42.4
30	.0124	.1991	142.75	.0069	1.396	716.6	73.3	72.0	67.1	54.4	44.7
31	.0116	.2275	185.80	.0054	1.222	820.0	77.8	76.3	70.9	56.8	46.3
32	.0108	.2625	243.20	.0040	1.059	943.3	83.0	81.3	75.2	68.3	50.5
33	.0100	.3061	337.50	.0029	.9081	1,100	88.9	87.0	80.6	66.7	52.6
34	.0092	.3617	471.00	.0022	.7986	1,300	98.0	93.4	85.5	70.4	54.9
35	.0084	.4338	676.50	.0014	.6468	1,556	106	101	91.8	80.6	61.0
36	.0076	.5300	1,009	.00098	.5254	1,903	116	110	102	86.2	64.1
37	.0068	.6620	1,574	.00064	.4199	2,380	128	120	110	92.6	67.6
38	.0060	.8503	2,598	.000385	.3239	3,056	143	133	121	100	71.4
39	.0052	1.132	4,645	.000217	.2456	4,066	168	149	134	109	75.8
40	.0048	1.328	6,360	.000156	.2092	4,766	180	159	142	144	78.1
41	.0044	1.581	9,020	.000112	.1758	5,700	194	169	150		
42	.0040	1.913	13,150	.000076	.1453	6,866	211	191	167		
43	.0036	2.362	20,120	.000050	.1177	7,500	230	206	179		
44	.0032	2.989	32,210	.000030	.0929	10,766	253	225	192		
45	.0028	3.904	54,980	.000015	.0712	14,066	282	247	208		

Wire and Sheet-metal Gauges—I

Number of Gauge	British Imperial Standard or English Legal Standard		American or Brown & Sharpe		Birmingham or Stubs Iron.		Gold and Silver (Birmingham)		Lancashire Steel Pinion Wire.	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
7/0	.500	12.70	—	—	—	—	—	—	—	—
6/0	.464	11.78	—	—	—	—	—	—	—	—
5/0	.432	10.97	—	—	—	—	—	—	—	—
4/0	.400	10.16	.46	11.68	.454	11.53	—	—	—	—
3/0	.372	9.44	.409	10.386	.425	10.787	—	—	—	—
2/0	.348	8.83	.364	9.24	.380	9.65	—	—	—	—
1/0	.324	8.23	.324	8.23	.340	8.63	—	—	—	—
1	.300	7.62	.289	7.336	.300	7.62	.004	0.101	.227	5.757
2	.276	7.06	.257	6.527	.284	7.21	.005	0.127	.219	5.558
3	.252	6.40	.229	5.808	.259	6.578	.008	0.203	.212	5.380
4	.232	5.89	.204	5.18	.238	6.04	.010	0.254	.207	5.257
5	.212	5.38	.181	4.59	.220	5.58	.013	0.330	.204	5.181
6	.192	4.88	.162	4.11	.203	5.156	.013	0.330	.201	5.105
7	.176	4.46	.144	3.68	.180	4.57	.015	0.381	.199	5.048
8	.160	4.06	.128	3.24	.165	4.187	.016	0.406	.197	4.997
9	.144	3.66	.114	2.89	.148	3.753	.019	0.482	.194	4.921
10	.128	3.24	.101	2.565	.134	3.40	.024	0.61	.191	4.845
11	.116	2.94	.090	2.28	.120	3.04	.029	0.736	.188	4.777
12	.104	2.642	.080	2.03	.109	2.768	.034	0.863	.185	4.697
13	.092	2.336	.071	1.79	.095	2.413	.036	0.914	.182	4.620
14	.080	2.03	.064	1.625	.083	2.108	.041	1.041	.180	4.57

Wire and Sheet-metal Gauges—2

Number of Gauge	British Imperial Standard or English Legal Standard		American or Brown & Sharpe		Birmingham or Stubs Iron		Gold and Silver (Birmingham)		Lancashire Steel Pinion Wire	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
15	.072	1.828	.057	1.447	.072	1.828	.047	1.143	.178	4.513
16	.064	1.625	.050	1.27	.065	1.65	.051	1.295	.175	4.437
17	.056	1.422	.045	1.14	.058	1.473	.057	1.447	.172	4.360
18	.048	1.219	.040	1.016	.049	1.244	.061	1.549	.168	4.263
19	.040	1.016	.035	0.889	.042	1.066	.064	1.625	.164	4.161
20	.036	0.914	.031	0.787	.035	0.889	.067	1.701	.161	4.085
21	.032	0.812	.028	0.711	.032	0.812	.072	1.828	.157	3.988
22	.028	0.711	.025	0.635	.028	0.711	.074	1.879	.155	3.937
23	.024	0.61	.022	0.558	.025	0.635	.077	1.955	.153	3.886
24	.022	0.558	.020	0.508	.022	0.558	.082	2.082	.151	3.835
25	.020	0.508	.017	0.431	.020	0.508	.095	2.413	.148	3.753
26	.018	0.457	.015	0.381	.018	0.457	.103	2.616	.146	3.702
27	.016	0.406	.0148	0.376	.016	0.406	.113	2.87	.143	3.620
28	.0148	0.376	.012	0.304	.0148	0.376	.120	3.04	.139	3.528
29	.0136	0.345	.0116	0.29	.0136	0.345	.120	3.04	.134	3.401
30	.012	0.304	.010	0.254	.012	0.304	.126	3.193	.127	3.217
31	.0116	0.29	.008	0.203	.010	0.254	.133	3.378	.120	3.04
32	.0108	0.274	.0079	0.199	.009	0.228	.143	3.626	.115	2.917
33	.010	0.254	.007	0.177	.008	0.203	.145	3.677	.112	2.840
34	.009	0.228	.006	0.152	.0076	0.192	.148	3.753	.110	2.79
35	.008	0.203	.0056	0.142	.005	0.127	.150	4.013	.108	2.743
36	.0076	0.193	.005	0.127	.004	0.101	.167	4.237	.106	2.692

Wire and Sheet-metal Gauges—3

Number of Gauge	Lancashire Steel Wire Letter Gauge.		London or Old English		Morse Steel Wire Gauge for Drills.		Music Wire Gauge, English.		Music Wire Gauge, Washburn & Moen.	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
7/0	—	—	—	—	—	—	—	—	.008	0.203
6/0	—	—	—	—	—	—	—	—	.009	0.228
5/0	—	—	—	—	—	—	—	—	.010	0.254
4/0	—	—	.454	11.53	—	—	—	—	.011	0.279
3/0	—	—	.425	10.787	—	—	—	—	.012	0.304
2/0	—	—	.380	9.65	—	—	—	—	.013	0.330
1/0	—	—	.340	8.63	—	—	—	—	.014	0.355
1	Z	.413	10.48	.300	7.62	.228	5.783	.011	0.279	.015	0.381
2	Y	.404	10.26	.284	7.21	.221	5.60	.012	0.304	.016	0.406
3	X	.397	10.07	.259	6.578	.213	5.403	.013	0.330	.017	0.431
4	W	.386	9.80	.238	6.04	.209	5.308	.014	0.355	.018	0.457
5	V	.377	9.56	.220	5.58	.205	5.207	.015	0.381	.020	0.508
6	U	.368	9.34	.203	5.156	.204	5.101	.016	0.406	.021	0.533
7	T	.358	9.09	.180	4.57	.201	5.105	.017	0.431	.023	0.584
8	S	.348	8.83	.165	4.187	.199	5.048	.019	0.482	.024	0.609
9	R	.339	8.60	.148	3.753	.196	4.972	.020	0.508	.025	0.635
10	Q	.332	8.43	.134	3.40	.193	4.921	.022	0.558	.027	0.685
11	P	.323	8.17	.120	3.04	.191	4.845	.024	0.609	.028	0.711
12	O	.316	8.02	.109	2.768	.189	4.798	.025	0.635	.029	0.736

Wire and Sheet-metal Gauges—4

Number of Gauge	Lancashire Steel Wire Letter Gauge		London or Old English		Morse Steel Wire Gauge for Drills		Music Wire Gauge, English		Music Wire Gauge, Washburn & Moen	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
13	N .302	7.67	.095	2.413	.185	4.697	.027	0.685	.031	0.787
14	M .300	7.62	.083	2.108	.182	4.620	.028	0.711	.033	0.838
15	L .295	7.49	.072	1.828	.180	4.57	.031	0.787	.034	0.863
16	K .290	7.36	.065	1.651	.177	4.497	.0314	0.797	.036	0.914
17	J .277	7.03	.058	1.473	.173	4.395	.034	0.863	.037	0.939
18	I .272	6.90	.049	1.244	.169	4.293	.035	0.889	.039	0.990
19	H .266	6.75	.042	1.067	.166	4.212	.039	0.990	.041	1.041
20	G .261	6.62	.035	0.889	.161	4.089	.041	1.041	.043	1.092
21	F .257	6.5	.031	0.787	.159	4.038	.046	1.168	.046	1.168
22	E .250	6.35	.029	0.736	.157	3.988	.049	1.244	.048	1.219
23	D .245	6.24	.027	0.685	.154	3.911			.051	1.295
24	C .242	6.14	.025	0.635	.152	3.860			.055	1.397
25	B .238	6.04	.023	0.584	.149	3.777			.058	1.473
26	A .234	5.94	.020	0.508	.147	3.727			.062	1.574
27			.018	0.457	.144	3.651			.065	1.651
28			.016	0.406	.140	3.55			.072	1.828
29			.015	0.381	.136	3.452			.076	1.930
30			.013	0.330	.128	3.243			.080	2.03
31			.012	0.304	.120	3.04				
32			.011	0.279	.116	2.942				
33			.010	0.254	.113	2.866				
34			.0095	0.241	.111	2.815				
35			.009	0.228	.110	2.79				
36			.0075	0.19	.106	2.692				

DECIBEL.—The comparative unit of sound strength. The value chosen for 1 decibel is the sound which can just be discerned by the trained ear.

RELATIONSHIP BETWEEN DECIBELS AND POWER RATIO

Decibels.	*Power Ratio.*	*Decibels.*	*Power Ratio.*
1	1.25	— 1	$\frac{1}{1.25} = .8$
2	1.6	— 2	$\frac{1}{1.6} = .625$
3	2.0	— 3	$\frac{1}{2} = .5$
4	2.5	— 4	$\frac{1}{2.5} = .4$
5	3.2	— 5	$\frac{1}{3.2} = .3125$
6	4.0	— 6	$\frac{1}{4} = .25$
7	5.0	— 7	$\frac{1}{5} = .2$
8	6.0	— 8	$\frac{1}{6} = .166$
9	8.0	— 9	$\frac{1}{8} = .125$
10	10.0	—10	$\frac{1}{10} = .1$
20	100.0	—20	$\frac{1}{100} = .01$
30	1000.0	—30	$\frac{1}{1000} = .001$

THE GREEK ALPHABET.—The Greek alphabet is as follows:

A α (alpha), B β (bēta), Γ γ (gamma), Δ δ (delta), E ε (epsilon), Z ζ (zēta), H η (ēta), Θ θ (thēta), I ι (iōta), K κ (kappa), Λ λ (lambda), M μ (mu), N ν (nu), Ξ ξ (xi), O ο (ŏmĭcron), Π π (pi), P ρ (rho), Σ σ ς (sigma), T τ (tau), Y υ (ūpsilon), Φ φ (phi), X χ (chi), Ψ ψ (psi), Ω ω (ōmĕga).

MUSICAL NOTES FREQUENCY.—The frequency of the notes of the pianoforte covers the band from 26 to 4,096 vibrations per second. The lowest note, A, has a frequency of 26, middle C (the centre note of the standard piano keyboard) a frequency of 256, and the top note of the standard piano has a frequency of 4,096. The following table shows the piano notes and their frequencies:

A 26	G 96	F 341	E 1,280
B 30	A 106	G 384	F 1,365
C 32	B 120	A 426	G 1,536
D 36	C 128	B 480	A 1,706
E 40	D 144	C 512	B 1,920
F 42	E 160	D 576	C 2,048
G 48	F 170	E 640	D 2,304
A 53	G 192	F 682	E 2,560
B 60	A 213	G 768	F 2,730
C 64	B 240	A 853	G 3,072
D 72	C 256	B 960	A 3,413
E 80	D 288	C 1,024	B 3,840
F 85	E 320	D 1,152	C 4,096

HORSE-POWER

The unit of work (Horse power) is based on the assumption that a horse can travel 2½ miles per hour for 8 hours a day, performing the equivalent of pulling a load of 150lb. out of a shaft by means of a rope. Thus 2½ miles an hour is 220ft. per minute, and at that speed the load of 150lb. is raised vertically the same distance. Therefore, 300lb. would be raised 110ft. or 3,000lb. raised 11ft., or 33,000lb. raised 1ft. high per minute. The latter is the unit of horse-power, i.e., *33,000lb. raised 1ft. high per minute, or 33,000 foot-lb. per minute. Electrical equivalent is 746 watts.*

Horse Power of an Electric Motor

$$\text{I.H.P.} = \frac{\text{Volts} \times \text{Amperes}}{746}$$

Horse Power (Indicated) of a Steam Engine (Single-acting)

$$\text{I.H.P.} = \frac{\text{PLAN}}{33{,}000}$$

where P=Mean effective steam pressure in lb. per sq. in.
L = Length of stroke in feet.
A = Area of piston in sq. in.
N = Number of revolutions per minute

For a double-acting engine the formula is:

$$\text{I.H.P.} = \frac{2\text{PLAN}}{33{,}000}$$

Horse Power of Petrol Engines

R.A.C. Formula: $\text{H.P.} = \frac{D^2N}{16.13}$

Dendy Marshal Formula: $\text{H.P.} = \frac{D^2SNR}{200{,}000}$

Where S=Stroke in centimetres.
D=Diameter of cylinder in centimetres
R=Revolutions per minute.
N=Number of cylinders.

A.C.U. Formula: 100 c.c. = 1 h.p.

CHORDS OF CIRCLES

No. of Spaces.	Multiply Dia. by	No. of Spaces	Multiply Dia. by	No. of Spaces	Multiply Dia. by	No. of Spaces	Multiply Dia. by	No. of Spaces	Multiply Dia. by
3	.8660	23	.1362	43	.0730	63	.0499	83	.0378
4	.7071	24	.1305	44	.0713	64	.0491	84	.0374
5	.5878	25	.1253	45	.0698	65	.0483	85	.0370
6	.5000	26	.1205	46	.0682	66	.0476	86	.0365
7	.4339	27	.1161	47	.0668	67	.0469	87	.0361
8	.3827	28	.1120	48	.0654	68	.0462	88	.0357
9	.3420	29	.1081	49	.0641	69	.0455	89	.0353
10	.3090	30	.1045	50	.0628	70	.0449	90	.0349
11	.2817	31	.1012	51	.0616	71	.0442	91	.0345
12	.2588	32	.0980	52	.0604	72	.0436	92	.0341
13	.2393	33	.0951	53	.0592	73	.0430	93	.0338
14	.2225	34	.0923	54	.0581	74	.0424	94	.0334
15	.2079	35	.0896	55	.0571	75	.0419	95	.0331
16	.1951	36	.0872	56	.0561	76	.0413	96	.0327
17	.1838	37	.0848	57	.0551	77	.0408	97	.0324
18	.1736	38	.0826	58	.0541	78	.0403	98	.0321
19	.1646	39	.0805	59	.0532	79	.0398	99	.0317
20	.1564	40	.0785	60	.0523	80	.0393	100	.0314
21	.1490	41	.0765	61	.0515	81	.0388		
22	.1423	42	.0747	62	.0507	82	.0383		

METALLIC ELEMENTS AND THEIR PROPERTIES

Number of Symbol.	Colour	Date.	Atomic Weight	Specific Gravity or Density.	Specific Heat.	Melting-point (°Centigrade.)	Coefficient of Linear Expansion.
Aluminium ... Al	Tin-white	1827	27.1	2.67	.2140	657	.0000231
Antimony ... Sb	Bluish-white	—	120.2	6.71-6.86	.0509	630	.0000105
Arsenic ... As	Steel-grey	—	75.0	5.72	.081	450	.0000055
Barium ... Ba	Pinkish-grey	1808	137.4	3.8	.068	850	—
Beryllium (see *Glucinum*)							
Bismuth ... Bi	Pinkish-white	—	208.0	9.823	.0305	268	.000014
Bromine ... Br	—	—	79.6	—	—	—	—
Cadmium ... Cd	Tin-white	1817	112.4	8.546-8.667	.0548	322	.000027
Cæsium ... Cs	Silver-white	18 0	132.8	1.9	.048	27	—
Calcium ... Ca	Yellow	1807	40.1	1.573	.1700	800	.0000269
Cerium ... Ce	Grey	1819	140.2	7.64	.0448	623	—
Chromium ... Cr	Grey	1797	52.0	6.81-7.3	.1200	1,700	—
Cobalt ... Co	Greyish-white	1742	59.0	8.5-8.7	.1070	1,490	.0000123
Columbium ... Cb (see *Niobium*)							
Copper ... Cu	Red	—	63.6	8.92-8.95	.0952	1,100	.0000167
Erbium ... E	—	1843	166.0	—	—	—	—
Gadolinium ... Gd	—	1886	156.0	—	—	—	—
Gallium ... Ga	Bluish-white	1875	69.9	5.9	.079	30	—
Germanium ... Ge	Bluish-white	1885	72.5	5.5	.074	900	.0000167
Glucinum ... Gl	Silver-white	1828	9.1	1.9	.5620	—	—
Gold ... ... Au	Yellow	—	197.2	19.265	.0324	1,065	.0000136
Indium ... In	White	1863	114.8	7.42	.0570	176	.0000417

METALLIC ELEMENTS AND THEIR PROPERTIES (continued)

Number of Symbol.	Colour.	Date.	Atomic Weight	Specific Gravity or Density.	Specific Heat.	Melting-point (°Centigrade.)	Coefficient of Linear Expansion.
Iridium ... Ir	Steel-white	1803	193.1	22.38	.0326	2,250	.0000065
Iron ... ... Fe	Silver-white	—	55.9	7.84	.1140	1,550	.0000116
Lanthanum ... La	Grey	1839	139.0	6.163	.0449	826	—
Lead ... ... Pb	Bluish-white	—	207.1	11.254-11.388	.0314	328	.000027
Lithium ... Li	Silver-white	1818	7.02	.589-.598	.9410	180	—
Magnesium ... Mg	Silver-white	1808	24.3	1.75	2500	632	.0000269
Manganese .. Mn	Reddish-grey	—	55.0	8.0	.1220	1,245	—
Mercury ... Hg	Bluish-white	300 B.C.	200.0	13.594	.0319	-40	.0000610
Molybdenum Mo	Silver-white	1782	96.0	8.6	.0722	2,450	—
Neodymium Nd	—	—	143.6	7.0	—	840	—
Nickel ... Ni	—	1754	58.7	8.9	.1080	1,450	.0000127
Niobium ... Nb	Steel-grey	1846	93.5	12.1	.071	1,950	—
Osmium ... Os	Bluish-white	—	190.9	22.5	.0311	2,500	.0000065
Palladium ... Pd	Tin-white	1804	106.7	11.4	.0593	1,549	.0000117
Platinum ... Pt	—	1558	195.2	21.5	.0324	1,780	.0000089
Potassium .. K	Silver-white	1807	39.10	.875	.1660	60	.0000841
Praseodymium Pr	—	—	140.5	6.5	—	940	—
Radium ... Ra	—	1901	225.0	—	—	—	—
Rhodium ... Rh	Tin-white	1804	102.9	12.1	.0580	2,000	.0000085
Rubidium ... Rb	Silver-white	1861	85.5	1.52	.077	38.5	—
Ruthenium ... Ru	—	1828	101.7	12.261	.0611	Over 2,400	.0000096
Samarium ... Sm	—	1879	150.3	7.7	—	1,350	—

METALLIC ELEMENTS AND THEIR PROPERTIES (continued)

Number of Symbol.	Colour.	Date.	Atomic Weight	Specific Gravity or Density.	Specific Heat.	Melting point (° Centigrade.)	Coefficient of Linear Expansion.
Scandium .. Sc	—	—	44.1	—	—	—	—
Silver ... Ag	White	—	107.9	10.4-10.57	.0560	962	.0000192
Sodium .. Na	Silver-white	1807	23.0	.98	293	96	.000071
Strontium ... Sr	Yellow	1808	87.6	2.5	—	800	—
Tantalum ... Ta	Black	1802	181.6	16.8	.0365	2,910	.0000079
Tellurium .. Te	—	—	127.5	6.25	.049	452	.0000167
Terbium .. Tb	—	1843	160	—	—	—	—
Thallium ... Tl	Bluish-white	1861	204.0	11.8	.0335	309	.0000302
Thorium ... Th	Grey	1828	232.4	11.2	.0278	1,690	—
Thulium ... Tm	—	—	171	—	—	—	—
Tin ... ... Sn	White	—	119.0	7.293	.0559	232	.0000203
Titanium .. Ti	Dark grey	1789	48.1	3.6	.13	1,800	—
Tungsten .. W	Light grey	1783	184.0	19.129	.0334	3,000	—
Uranium ... U	Greyish-white	1789	238.5	18.33	.0277	1,500	—
Vanadium ... V	Whitish-grey	1801	51.1	5.9	.125	1,660	—
Ytterbium ... Yb	—	—	173.0	—	—	—	—
Yttrium ... Yt	Grey	1797	89.0	3.80	—	—	—
Zinc ... ... Zn	Bluish-white	—	65.4	7.1	.0935	419	.0000274
Zirconium ... Zr	Grey	1789	90.6	4.15	.0662	Over 1,300	—

FLUXES FOR SOLDERING

Metals.	*Fluxes.*	*Fluxes generally used.*
Iron	Chloride of zinc	Chloride of zinc (killed spirit)
Steel	Sal-ammoniac	
Copper	Chloride of zinc	
Brass	Resin Sal-ammoniac	Resin
Zinc (new) Zinc (old)	Chloride of zinc	
Lead (with fine solder)	Hydrochloric acid	
Lead (with coarse solder)	Tallow and resin	
Tin	Tallow	
Pewter	Resin or sweet oil	

COMPOSITION OF SOFT SOLDERS

Solder.	*Composition.*	*Melting-point*
Fine	1½ parts tin, 1 part lead	334°F.
Tinman's	1 part tin, 1 part lead	370°F.
Plumber's	1 part tin, 2 parts lead	440°F.
Pewterer's	1 part tin, 1 part lead and 2 parts bismuth	203°F.
Wood's Metal	1 part tin, 2 parts lead 4 parts bismuth, 1 part cadmium	165°F.

A mixture of 1½ parts tin and 1 part lead fuses at a lower temperature than any other mixed proportion of these metals.

COMPOSITION OF HARD SOLDERS

Solder.	*Composition.*
Hard brazing	3 parts copper, 1 part zinc
Hard brazing	1 part copper, 1 part zinc
Softer brazing	4 parts copper, 3 parts zinc, and 1 part tin

TABLE OF DECIMAL EQUIVALENTS

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.1250	5/8	.6250
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
13/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.2500	3/4	.7500
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.8750
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5000	1	1.0000

List of Prefixes

mega means a million times.
kilo means a thousand times.
hecto means a hundred times.
deca means ten times.
deci means a tenth part of.
centi means a hundredth part of.
milli means a thousandth part of.
micro means a millionth part of.

Square Measure

100 sq. metres	=1 are.
10,000 sq. metres	=1 hectare.

Weight

10 grammes	=1 decagramme.
10 decagrammes	=1 hectogramme.
10 hectogrammes	=1 kilogramme.
1,000 kilogrammes	=1 tonne.

Capacity

1 litre	=1 cubic decimetre.
10 litres	=1 decalitre.
10 decalitres	=1 hectolitre.
10 hectolitres	=1 kilolitre.

Length

10 millimetres	=1 centimetre.
10 centimetres	=1 decimetre.
10 decimetres	=1 metre.
10 metres	=1 decametre.
10 decametres	=1 hectometre.
10 hectometres	=1 kilometre.
10 kilometres	=1 myriametre.

Linear Measure Equivalents

1 inch	=2.54 centimetres, or 25.4 millimetres.
1 foot	=30.4799 centimetres, 304.799 millimetres, or .3047 metre.
1 yard	=.914399 metre.
1 mile	=1.6093 kilometres= 5,280 feet.
1 millimetre	=.03937 inch.
1 centimetre	=.3937 inch.
1 decimetre	=3.937 inches.
1 metre	=39.370113 inches. 3.28084 feet. 1.093614 yards.
1 kilometre	=.62137 mile.
1 decametre (10 metres)	=10.936 yards.

METRIC CONVERSION FACTORS

To convert—	
Millimetres to inches	× .03937 or ÷ 25.4
Centimetres to inches	× .3937 or ÷ 2.54
Metres to inches	× 39.37
Metres to feet	× 3.281
Metres to yards	× 1.094
Metres per second to feet per minute	× 197
Kilometres to miles	× .6214 or ÷ 1.6093
Kilometres to feet	× 3,280.8693
Square millimetres to square inches	× .00155 or ÷ 645.1
Square centimetres to square inches.	× .155 or ÷ 6.451
Square metres to square feet	× 10.764
Square metres to square yards	× 1.2

METRIC CONVERSION FACTORS

To convert—	
Square kilometres to acres	× 247.1
Hectares to acres	× 2.471
Cubic centimetres to cubic inches	× .06 or ÷ 16.383
Cubic metres to cubic feet	× 35.315
Cubic metres to cubic yards	× 1.308
Cubic metres to gallons (231 cubic inches)	× 264.2
Litres to cubic inches	× 61.022
Litres to gallons	× .2642 or ÷ 3.78
Litres to cubic feet	÷ 28.316
Hectolitres to cubic feet	× 3.531
Hectolitres to bushels (2,150.42 cubic inches)	× 2.84
Hectolitres to cubic yards	× .131
Hectolitres to gallons	÷ 26.42
Grammes to ounces (avoirdupois)	× .035 or ÷ 28.35
Grammes per cubic cm. to lb. per cubic inch	÷ 27.7
Joules to foot-lb.	× .7373
Kilogrammes to oz.	× 35.3
Kilogrammes to lb.	× 2.2046
Kilogrammes to tons	× .001
Kilogrammes per sq. cm. to lb. per sq. inch	× 14.223
Kilogramme - metres to foot-lb.	× 7.233
Kilogramme per metre to lb. per foot	× .672
Kilogramme per cubic metre to lb. per cubic foot	× .062
Kilogramme per cheval-vapeur to lb. per h.p.	× 2.235
Kilowatts to h.p.	× 1.34
Watts to h.p.	÷ 746
Watts to foot-lb. per second	× .7373
Cheval-vapeur to h.p.	× .9863
Gallons of water to lb.	× 10
Atmospheres to lb. per sq. inch	× 14.7

Equivalents of Imperial and Metric Weights and Measures

Imperial

Linear Measure

1 Inch	=	25.400 Millimetres.
1 Foot	=	0.30480 Metre.
1 Yard	=	**0.914399 Metre.**
1 Fathom	=	1.82968 Metres.
1 Pole	=	5.0292 ,,
1 Chain	=	20.1168 ,,
1 Furlong	=	201.168 ,,
1 Mile	=	1.6093 Kilometres.

Square Measure

1 Square Inch	=	6.4516 Square Centimetres.
1 Square Foot	=	9.2903 Square Decimetres.
1 Square Yard	=	0.836128 Square Metre
1 Rood	=	10.117 Ares.
1 Acre	=	0.40468 Hectare.
1 Square Mile	=	259.00 Hectares.

Metric

Linear Measure

1 Millimetre (mm.) (1/1000 m.)	=	0.03937 Inch.
1 Centimetre (1/100 m.)	=	0.3937 ,,
1 Decimetre (1/10 m.)	=	3.937 Inches.
1 Metre (m.)	=	**39.370113 Inches.** **3.280843 Feet.** **1.0936142 Yards.**
1 Decametre (10 m.)	=	10.936 Yards
1 Kilometre (1000 m.)	=	0.62137 Mile

Square Measure

1 Square Centimetre	=	0.15500 Square Inch.
1 Square Decimetre	=	15.500 Square Inches.
1 Square Metre	=	10.7639 Square Feet 1.1960 Square Yards.
1 Are	=	119.60 Square Yards.
1 Hectare	=	2.4711 Acres.

Equivalents of Imperial and Metric Weights and Measures—continued

Imperial		Metric	Metric		Imperial
Cubic Measure					
1 Cubic Inch	=	16.387 Cubic Centimetres.	1 Cubic Centimetre	=	0.0610 Cubic Ins.
1 Cubic Foot	=	0.028317 Cubic Metre.	1 Cubic Decimetre (c.d.)	=	61.024 Cubic Ins.
1 Cubic Yard	=	0.764553 Cubic Metre.	1 Cubic Metre	=	35.3148 Cubic Feet. 1.307954 Cubic Yards.
Measure of Capacity					
1 Pint	=	0.568 Litre.	1 Centilitre (1/100 litre)	=	0.070 Gill.
1 Quart	=	1.136 Litres.	1 Decilitre (1/10 litre)	=	0.176 Pint.
1 Gallon	=	4.5459631 Litres.	1 Litre	=	1.75980 Pints.
Weight					
Avoirdupois					*Avoirdupois*
1 Grain	=	0.0648 Gramme.	1 Milligramme (1/1000 grm.)	=	0.015 Grain.
1 Dram	=	1.772 Grammes.	1 Centigramme (1/100 grm.)	=	0.154 "
1 Ounce	=	28.350 "	1 Gramme (1 grm.)	=	15.432 "
1 Pound (7,000 Grains)	=	0.45359243 Kilogramme.	1 Kilogramme (1,000 grm.)	=	2.2046223 Lb. or 15,432.3564 Grains.
1 Hundredweight	=	50.80 Kilogrammes. 0.5080 Quintal.	1 Quintal (100 kilog.)	=	1.968 cwt.
1 Ton	=	1.0160 Tonnes or 1016 Kilogrammes.	1 Tonne (1,000 kilog.)	=	0.9842 Ton.
1 Grain (Troy)	=	0.0648 Gramme.	1 Gramme (1 grm.)	=	0.03215 Oz. Troy. 15.432 Grains.
1 Troy Ounce	=	31.1035 Grammes.			

MENSURATION

A and a = area; b = base; C and c = circumference; D and d = diameter; h = height; n° = number of degrees; p = perpendicular; R and r = radius; s = span or chord; v = versed sine.

Square: a = side^2; side = $\sqrt{a}$; diagonal = side × $\sqrt{2}$.

Rectangle or parallelogram: a = bp.

Trapezoid (two sides parallel): a = mean length parallel sides × distance between them.

Triangle: a = $\frac{1}{2}$bp.

Irregular figure: a = weight of template ÷ weight of square inch of similar material.

Side of square multiplied by 1.4142 equals diameter of its circumscribing circle.

A side multiplied by 4.443 equals circumference of its circumscribing circle.

A side multiplied by 1.128 equals diameter of a circle of equal area.

Square inches multiplied by 1.273 equals square inches of an equal circle.

MENSURATION *(continued)*

To find side of an equal square :

Multiply diameter by 0.8862 ; or divide diameter by 1.1284 ; or multiply circumference by 0.2821 ; or divide circumference by 3.545.

To find area of a circle :

Multiply circumference by $\frac{1}{4}$ of the diameter ; or multiply the square of diameter by 0.7854 ; or multiply the square of circumference by 0.07958 ; or multiply the square of $\frac{1}{2}$ diameter by 3.1416.

To find the surface of a sphere or globe:

Multiply the diameter by the circumference ; or multiply the square of diameter by 3.1416 ; or multiply 4 times the square of radius by 3.1416.

Cylinder.

To find the area of surface :

Multiply the diameter by $3\frac{1}{7} \times$ length.

Capacity $= 3\frac{1}{7} \times \text{radius}^2 \times \text{height}$.

Values and Powers of :

$\pi = 3.1415926536$, or 3.1416, or $\frac{22}{7}$ or $3\frac{1}{7}$;

$\pi^2 = 9.86965$; $\sqrt{\pi} = 1.772453$;

$\frac{1}{\pi} = 0.31831$; $\frac{\pi}{2} = 1.570796$;

$\frac{\pi}{3} = 1.047197$.

MENSURATION *(continued)*

Circle : $a = \pi r^2 = d^2 \frac{\pi}{4} = 0.7854 d^2 = 0.5$ cr. ; $c = 2\pi r = d\pi = 3.1416 d = 3.54 \sqrt{a} =$ (approximately) $\frac{22}{7} d$. Side of equal square $= 0.8862 d$; side of inscribed square $= 0.7071 d$; $d = .3183 c$. A circle has the maximum area for a given perimeter.

Annulus of circle : $a = (D+d)(D-d) \frac{\pi}{4} = (D^2 - d^2) \frac{\pi}{4}$.

Segment of Circle : a = area of sector − area of triangle $= \frac{4v}{3} \sqrt{(0.625v)^2 + (\frac{1}{2}S)^2}$.

Length of Arc $= 0.0174533 n°r$; length of arc $= \frac{1}{3} (8 \sqrt{\frac{S^2}{4} + v^2} - s)$;

approximate length of arc $= \frac{1}{3}$ (8 times chord of $\frac{1}{2}$ arc − chord of whole arc).

$d = \frac{(\frac{1}{2} \text{ chord})}{v} + v$; radius of curve $= \frac{S^2}{8V} + \frac{V}{2}$

Sector of circle : $a = 0.5r \times$ length arc ; $= n° \times$ area circle $\div 360$.

MENSURATION *(continued)*

Ellipse: $a = \frac{\pi}{4}Dd = Rr$; c (approx.) $= \sqrt{\frac{D^2+d^2}{2}} \times \pi$; c (approx.) $= \pi\frac{Da}{2}$.

Parabola: $a = \frac{2}{3}bh$.

Cone or pyramid: surface = $\frac{\text{circ. of base} \times \text{slant length}}{2}$ + base; contents = area of base $\times \frac{1}{3}$ vertical height.

Frustum of cone: surface = $(C + c) \times \frac{1}{2}$ slant height + ends; contents $= 0.2618h\,(D^2 + d^2 + Dd)$; $= \frac{1}{3}h\,(A + a + \sqrt{A \times a})$.

Wedge: contents $= \frac{1}{6}$ (length of edge +2 length of back) bh.

Prism: contents = area base × height.

Sphere: surface $= d^2\pi = 4\pi r^2$; contents $= d^3\frac{\pi}{6} = \frac{4}{3}\pi r^3$.

Segment of sphere: r = rad. of base; contents $= \frac{\pi}{6}h\ (3r^2+h^2)$; r = rad. of sphere; contents $= \frac{\pi}{3}h^2\ (3r-h)$.

Spherical zone: contents $= \frac{\pi}{2}h\ (\frac{1}{3}h^2 + R^2 + r^2)$; surface of convex part of segment or zone of sphere $= \pi d$ (of sph.) $h = 2\pi rh$.

MENSURATION *(continued)*

Mid. sph. zone: contents $= (r + \frac{2}{3}h^2)\ \frac{\pi}{4}$.

Spheroid: contents = revolving axis^2 × fixed axis × $\frac{\pi}{6}$.

Cube or rectangular solid: contents = length × breadth × thickness.

Prismoidal formula, contents = $\frac{\text{end areas} + 4 \text{ times mid. area} \times \text{length}}{6}$

Solid of revolution: contents = a of generating plane × c described by centroid of this plane during revolution.

Areas of similar plane figures are as the squares of like sides. Contents of similar solids are as the cubes of like sides.

Rules relative to the circle, square, cylinder, etc.:

To find circumference of a circle:
Multiply diameter by 3.1416; or divide diameter by 0.3183.

To find diameter of a circle:
Multiply circumference by 0.3183; or divide circumference by 3.1416.

To find radius of a circle:
Multiply circumference by 0.15915; or divide circumference by 6.28318.

To find side of an inscribed square:
Multiply diameter by 0.7071; or multiply circumference by 0.2251; or divide circumference by 4.4428.

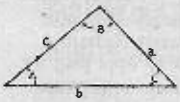


Fig. 1. Diagram for Table A

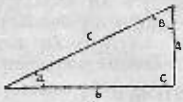


Fig. 2. Diagram for Table B.

TABLE A

See Fig. 1

Parts Given.	Parts to be Found.	Formulæ.
$a\ b\ c$	A	$\cos A = \frac{b^2+c^2-a^2}{2bc}$
$a\ b\ A$	B	$\sin B = \frac{b \times \sin A}{a}$
$a\ b\ A$	C	$C = 180° - (A+B)$
$a\ A\ B$	b	$b = \frac{a \times \sin B}{\sin A}$
$a\ A\ B$	c	$c = \frac{a \sin C}{\sin A} = \frac{a \sin (A+B)}{\sin A}$
$a\ b\ C$	B	$B = 180° - (A+C)$

TABLE B

See Fig. 2.

Parts Given.	Parts to be Found. A	B	a	b	c
a & c	$\sin A = \frac{a}{c}$	$\cos B = \frac{a}{c}$		$b = \sqrt{c^2 - a^2}$	
a & b	$\tan A = \frac{a}{b}$	$\cot B = \frac{a}{b}$			$c = \sqrt{a^2 + b^2}$
c & b	$\cos A = \frac{b}{c}$	$\sin B = \frac{b}{c}$	$a = \sqrt{c^2 - b^2}$		
A & a		D = 90°—A	$a = b \times \tan A$	$b = a \times \cot A$	$c = \frac{a}{\sin A}$
A & b		B = 90°—A			$c = \frac{b}{\cos A}$
A & c		B = 90°—A	$a = c \times \sin A$	$b = c \times \cos A$	

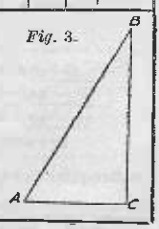
Fig. 3.—In any right-angled triangle :

$$\tan A = \frac{BC}{AC}, \quad \sin A = \frac{BC}{AB}$$

$$\cos A = \frac{AC}{AB}, \quad \cot A = \frac{AC}{BC}$$

$$\sec A = \frac{AB}{AC}, \quad \operatorname{cosec} A = \frac{AB}{BC}$$

Fig. 3.



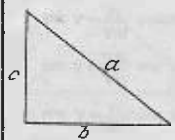


Fig. 4.

Fig. 4.—In any right-angled triangle :

$$a^2 = c^2 + b^2$$
$$c = \sqrt{a^2 - b^2}$$
$$b = \sqrt{a^2 - c^2}$$
$$a = \sqrt{b^2 + c^2}$$

Fig. 5.— $c + d : a + b :: b - a : d - c$.

$$d = \frac{c+d}{2} + \frac{d-c}{2}$$
$$x = \sqrt{b^2 - d^2}$$

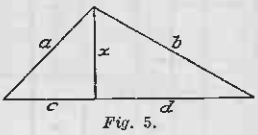
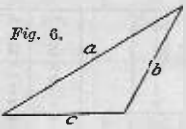


Fig. 5.

Fig. 6.



In Fig. 6, where the lengths of three sides only are known :

$$\text{area} = \sqrt{s(s-a)\ (s-b)\ (s-c)}$$

where $s = \frac{a+b+c}{2}$

Fig. 7.—In this diagram :

$a : b :: b : c$, or $\frac{b^2}{a} = c$.

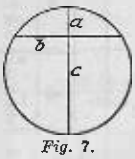


Fig. 7.

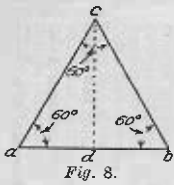


Fig. 8.

Fig. 8.—In an equilateral triangle $ab = 1$, then $cd = \sqrt{0.75} = 0.866$, and $ad = 0.5$; $ab = 2$, then $cd = \sqrt{3.0} = 1.732$, and $ad = 1$; $cd = 1$, then $ac = 1.155$ and $ad = 0.577$; $cd = 0.5$, then $ac = 0.577$ and $ad = 0.288$.

Fig. 9.—In a right-angled triangle with two equal acute angles, $bc = ac$. $bc = 1$, then $ab = \sqrt{2} = 1.414$; $ab = 1$, then $bc = \sqrt{0.5} = 0.707$.

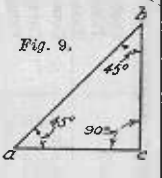


Fig. 9.

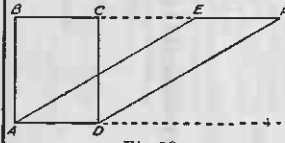


Fig. 10.

Fig. 10 shows that parallelograms on the same base and between the same parallels are equal ; thus ABCD = ADEF.

Fig. 11 demonstrates that triangles on the same base and between the same parallels are equal in area ; thus ABC = ADC.

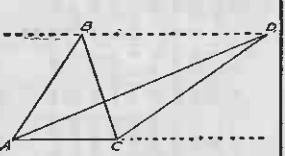


Fig. 11.

TRIGONOMETRICAL EQUIVALENTS

Sine = $\sqrt{1 - \text{Cos}^2}$.
Sine = 1 ÷ Cosec.
Sine = Cos ÷ Cotan.
Sine = Tan ÷ Sec.
Cosine = $\sqrt{1 - \text{Sin}^2}$.
Cosine = 1 ÷ Sec.
Cosine = Sin × Cotan.
Cosine = Sin ÷ Tan.
Secant = 1 ÷ Cos.
Secant = Tan ÷ Sin.
Cosecant = 1 ÷ Sin.
Tangent = 1 ÷ Cotan.
Tangent = Sin ÷ Cos.
Cotangent = 1 ÷ Tan.
Cotangent = Cos ÷ Sin
Versine = 1 − Cos.
Coversine = 1 − Sin.
1 = Tan × Cotan.
1 = $\text{Sin}^2 + \text{Cos}^2$.
$\text{Secant}^2 = 1 + \text{Tan}^2$.

TRIGONOMETRICAL FUNCTIONS

RIGHT-ANGLED TRIANGLES
(See Fig. 1.)

$\text{Sin A} = \frac{a}{b}$ $\quad \text{Sec A} = \frac{b}{c}$ $\quad \text{Tan A} = \frac{a}{c}$

$\text{Cos A} = \frac{c}{b}$ $\quad \text{Cosec A} = \frac{b}{a}$ $\quad \text{Cotan A} = \frac{c}{a}$

$\text{Versin A} = \frac{b - c}{b}$ $\quad \text{Coversin A} = \frac{b - a}{b}$

TABLE OF SLIDE RULE GAUGE POINTS

Known value on Slide	Required value on Rule	Set to: On Slide	Set to: On Rule
Pounds per square inch	Atmospheres	485	33
Pounds per square inch	Water, head, feet	13	30
Pounds per square inch	Water, head, metres	33	25
Pounds per square inch	Inches, mercury gauge	25	51
Inches, water gauge	Pounds per square inch	360	13
Inches, water gauge	Inches, mercury gauge	14	1
Inches, mercury gauge	Atmospheres	30	1
Atmospheres	Kilos per square centimetre	80	92
Pounds per square foot	Kilos per square metre	87	425
Pounds per lineal foot	Kilos per lineal metre	41	61
Pounds per lineal mile	Kilos per kilometre	71	20
Pounds per cubic foot	Kilos per cubic metre	39	625
Cubic feet of water	Weight in pounds	17	1060
Cubic feet of water	Gallons (imperial)	17	100
Gallons of water	Weight, kilos	108	490
Pounds of water (fresh)	Pounds of water (sea)	38	39
British thermal unit	Calories	250	63
British thermal unit per pound	Calories per kilogramme	9	5
Foot pounds	Kilogrammetres	340	47
Horse-power	Force de cheval	72	73

TABLE OF SLIDE RULE GAUGE POINTS—(*continued*)

Known value on Slide	Required value on Rule	Set to On Slide	Set to On Rule
Pounds per H.P.	Kilos per cheval	300	134
Horse-power per hour	Kilowatts (B.T.U.)	134	100
Watts	Horse-power	5	.0067
Circle, diameter	Circle, circumference	225	710
Circle, diameter	Circle, side of inscribed square	99	70
Circle, diameter	Circle, side of equal square	79	70
Circle, diameter	Circle, side of equal equilateral triangle	172	97
Circle, circumference	Circle, side of inscribed square	40	9
Circle, circumference	Circle, side of equal square	30	11
Circle, area	Inscribed square area	300	191
Square, side	Square, diagonal	70	99
Inches	Centimetres	50	127
Inches, eighths	Millimetres	40	127
Feet	Metres	292	89
Yards	Metres	85	32
Miles	Kilometres	87	140
Square inches	Square centimetres	31	200
Square feet	Square metres	140	13
Square yards	Square metres	101	51

TABLE OF SLIDE RULE GAUGE POINTS—(*continued*)

Known value on Slide	Required value on Rule	Set to On Slide	Set to On Rule
Square miles	Square kilometres	112	290
Acres	Hectares	42	17
Cubic inches	Cubic centimetres	36	590
Cubic feet	Cubic metres	106	3
Cubic feet	Litres	3	85
Cubic yards	Cubic metres	51	39
Gallons	U.S. Gallons	5	6
Bushels	Cubic metres	110	4
Ounces (Avoirdupois)	Grammes	67	1900
Ounces (Avoirdupois)	Kilogrammes	670	19
Pounds (Avoirdupois)	Kilogrammes	280	127
Hundredweights	Kilogrammes	5	254
Tons	Tonnes	62	63
Feet per second	Metres per minute	7	128
Feet per second	Miles per hour	22	15
Feet per minute	Miles per hour	204	3
Yards per minute	Miles per hour	88	3
Miles per hour	Metres per minute	12	322
Knots	Metres per hour	33	38
Pounds per square inch	Kilogrammes per square centimetre	128	9

POWERS AND ROOTS OF π AND g

n	$\frac{1}{n}$	n^2	n^3	$\sqrt{n}$	$\frac{1}{\sqrt{n}}$	$\sqrt[3]{n}$	$\frac{1}{\sqrt[3]{n}}$
$\pi = 3.142$	0.318	9.870	31.006	1.772	0.564	1.465	0.683
$2\pi = 6.283$	0.159	39.478	248.050	2.507	0.399	1.845	0.542
$\frac{\pi}{2} = 1.571$	0.637	2.467	3.878	1.253	0.798	1.162	0.860
$\frac{\pi}{3} = 1.047$	0.955	1.097	1.148	1.023	0.977	1.016	0.985
$\frac{4}{3}\pi = 4.189$	0.239	17.546	73.496	2.047	0.489	1.612	0.622
$\frac{\pi}{4} = 0.785$	1.274	0.617	0.484	0.886	1.128	0.923	1.084
$\frac{\pi}{6} = 0.524$	1.910	0.274	0.144	0.724	1.382	0.806	1.241
$\pi^2 = 9.870$	0.101	97.409	961.390	3.142	0.318	2.145	0.466
$\pi^3 = 31.006$	0.032	961.390	29,809.910	5.568	1.796	3.142	0.318
$\frac{\pi}{32} = 0.098$	10.186	0.0095	0.001	0.313	3.192	0.461	2.168
$g = 32.2$	0.031	1036.84	33,386.24	5.674	0.176	3.181	0.314
$2g = 64.4$	0.015	4147.36	267,090	8.025	0.125	4.007	0.249

POWERS AND ROOTS

No.	Squares.	Cubes.	Square Roots.	Cube Roots.
1	1	1	1.000	1.000
2	4	8	1.414	1.260
3	9	27	1.732	1.442
4	16	64	2.000	1.587
5	25	125	2.236	1.710
6	36	216	2.449	1.817
7	49	343	2.646	1.913
8	64	512	2.828	2.000
9	81	729	3.000	2.080
10	100	1 000	3.162	2.154
11	121	1 331	3.317	2.224
12	144	1 728	3.464	2.289
13	169	2 197	3.606	2.351
14	196	2 744	3.742	2.410
15	225	3 375	3.873	2.466
16	256	4 096	4.000	2.520
17	289	4 913	4.123	2.571
18	324	5 832	4.243	2.621
19	361	6 859	4.359	2.668
20	400	8 000	4.472	2.714
21	441	9 261	4.583	2.759
22	484	10 648	4.690	2.802
23	529	12 167	4.796	2.844
24	576	13 824	4.899	2.884
25	625	15 625	5.000	2.924
26	676	17 576	5.099	2.962
27	729	19 683	5.196	3.000
28	784	21 952	5.292	3.037
29	841	24 389	5.385	3.072
30	900	27 000	5.477	3.107
31	961	29 791	5.568	3.141
32	1 024	32 768	5.657	3.175
33	1 089	35 937	5.745	3.208
34	1 156	39 304	5.831	3.240
35	1 225	42 875	5.916	3.271

POWERS AND ROOTS (*continued*)

No.	Squares.	Cubes	Square Roots.	Cube Roots.
36	1 296	46 656	6.000	3.302
37	1 369	50 653	6.083	3.332
38	1 444	54 872	6.164	3.362
39	1 521	59 319	6.245	3.391
40	1 600	64 000	6.325	3.420
41	1 681	68 921	6.403	3.448
42	1 764	74 088	6.481	3.476
43	1 849	79 507	6.557	3.503
44	1 936	85 184	6.633	3.530
45	2 025	91 125	6.708	3.557
46	2 116	97 336	6.782	3.583
47	2 209	103 823	6.856	3.609
48	2 304	110 592	6.928	3.634
49	2 401	117 649	7.000	3.659
50	2 500	125 000	7.071	3.684
51	2 601	132 651	7.141	3.708
52	2 704	140 608	7.211	3.733
53	2 809	148 877	7.280	3.756
54	2 916	157 464	7.348	3.780
55	3 025	166 375	7.416	3.803
56	3 136	175 616	7.483	3.826
57	3 249	185 193	7.550	3.849
58	3 364	195 112	7.616	3.871
59	3 481	205 379	7.681	3.893
60	3 600	216 000	7.746	3.915
61	3 721	226 981	7.810	3.936
62	3 844	238 328	7.874	3.958
63	3 969	250 047	7.937	3.979
64	4 096	262 144	8.000	4.000
65	4 225	274 625	8.062	4.021
66	4 356	287 496	8.124	4.041
67	4 489	300 763	8.185	4.062
68	4 624	314 432	8.246	4.082
69	4 761	328 509	8.307	4.102

POWERS AND ROOTS (*continued*)

No.	Squares.	Cubes.	Square Roots.	Cube Roots.
70	4 900	343 000	8.367	4.121
71	5 041	357 911	8.426	4.141
72	5 184	373 248	8.485	4.160
73	5 329	389 017	8.544	4.179
74	5 476	405 224	8.602	4.198
75	5 625	421 875	8.660	4.217
76	5 776	438 976	8.718	4.236
77	5 929	456 533	8.775	4.254
78	6 084	474 552	8.832	4.273
79	6 241	493 039	8.888	4.291
80	6 400	512 000	8.944	4.309
81	6 561	531 441	9.000	4.327
82	6 724	551 368	9.055	4.344
83	6 889	571 787	9.110	4.362
84	7 056	592 704	9.165	4.380
85	7 225	614 125	9.220	4.397
86	7 396	636 056	9.274	4.414
87	7 569	658 503	9.327	4.431
88	7 744	681 472	9.381	4.448
89	7 921	704 969	9.434	4.465
90	8 100	729 000	9.487	4.481
91	8 281	753 571	9.539	4.498
92	8 464	778 688	9.592	4.514
93	8 649	804 357	9.644	4.531
94	8 836	830 584	9.695	4.547
95	9 025	857 375	9.747	4.563
96	9 216	884 736	9.798	4.579
97	9 409	912 673	9.849	4.595
98	9 604	941 192	9.899	4.610
99	9 801	970 299	9.950	4.626
100	10 000	1 000 000	10.000	4.642

COMPARATIVE RESISTANCE OF VARIOUS METALS AND ALLOYS

Material.	Resistivity in International Microhms at 0° Cent.		Relative Resistance.
	Centimetre Cube.	Inch Cube.	
Annealed Silver	1.48	0.583	1
Annealed Copper	1.55 to 1.61	0.610 to 0.633	1.04 to 1.09
Hard-drawn Silver	1.58	0.622	1.07
Hard-drawn Copper	1.59 to 1.64	0.626 to 0.646	1.07 to 1.11
Annealed Gold	2.05	0.807	1.38
Hard-drawn Gold	2.089	0.822	1.41
Annealed Aluminium	2.43	0.96	1.64
Silicium Bronze	2.5	0.98	1.69
Pressed Zinc	5.61	2.21	3.79
Tungsten	6.4	2.5	4.3
Annealed Nickel	6.94	2.73	4.69
Phosphor Bronze	7.80	3.07	5.27
Annealed Platinum	9.04	3.55	6.09
Annealed Iron	9.7	3.82	6.56
Gold-Silver alloy (2 oz. gold, 1 oz. Silver) hard or annealed	10.8	4.27	7.33
Pressed Tin	13.2	5.19	8.9

COMPARATIVE RESISTANCE OF VARIOUS METALS AND ALLOYS (*continued.*)

Material.	Resistivity in International Microhms at 0° Cent.		Relative Resistance.
	Centimetre Cube.	Inch Cube.	
Pressed Lead	19.6	7.71	13.2
German Silver	19.0 to 42.2	7.48 to 11.8	12.8 to 20.2
Platinum-Iridium alloy (density 21.32)	22.2	8.73	15.0
Platinum-Silver alloy (1 oz. Pt., 2 oz. Silver) hard or annealed	24.3	9.58	16.4
Platinoid	34	13.4	23
Pressed Antimony	35.4	13.9	23.8
Manganin	42	16.7	28.7
Nickelin	43	17	29
Eureka	47	18.5	32
Ja Ja	51	20	34.5
Kruppin	85	33	57
Mercury	94.08	37.04	63
Pressed Bismuth	108	42.5	73
Carbon	4,000 to 10,000	1,600 to 4,000	2,700 to 6,700

ENGLISH WEIGHTS & MEASURES

LONG MEASURE

12 inches (in.)	=1 foot (ft.)
3 feet	=1 yard (yd.)
5½ yards.	=1 rod, pole or perch
40 poles (220 yards)	=1 furlong (furl.)
8 furlongs (1,760 yards)	=1 mile (m.)
3 miles	=1 league
1 chain	=100 links (22 yards)
10 chains	=1 furlong
6 feet	=1 fathom
6,080 feet per hour	=1 knot
4 inches	=1 hand

AREA (Square Measure)

144 square inches	=1 square foot.
9 square feet	=1 square yard
30¼ square yards	=1 square pole
40 square poles	=1 rood
4 roods	=1 acre (4,840 square yards)
640 acres	=1 square mile

MEASURES OF VOLUME AND CAPACITY (Cubic Measure)

1,728 cubic inches	=1 cubic foot.
27 cubic feet	=1 cubic yard
1 marine ton	=40 cubic feet
1 stack	=108 cubic feet
1 cord	=128 cubic feet

MEASURE OF CAPACITY (Liquid or Dry Measure)

4 gills	=1 pint
2 pints	=1 quart
2 quarts	=1 pottle
2 pottles	=1 gallon
4 quarts	=1 gallon
2 gallons	=1 peck
4 pecks	=1 bushel
8 bushels	=1 quarter
12 bags	=1 chauldron
5 quarters	=1 load
2 loads	=1 last

Wine Measure

2 pints	=1 quart
4 quarts	=1 gallon
10 gallons	=1 anker
18 gallons	=1 runlet or rundlet
42 gallons	=1 tierce
2 tierces	=1 puncheon
1½ puncheons	=1 pipe or butt
2 pipes	=1 tun

Ale and Beer Measure

4 gills	=1 pint
2 pints	=1 quart
4 quarts	=1 gallon
9 gallons	=1 firkin
2 firkins	=1 kilderkin
2 kilderkins	=1 barrel
1½ barrels	=1 hogshead
1⅓ hogshead	=1 puncheon
1½ puncheons	=1 butt or pipe

Avoirdupois Weight

27.34375 grains	= 1 dram
16 drams	= 1 ounce
16 ounces	= 1 pound (lb.)
14 pounds	= 1 stone
2 stone (28 lb.)	= 1 quarter
4 quarters	= 1 hundredweight (cwt.)
20 cwt.	= 1 ton
100 lbs.	= 1 cental

Apothecaries Weight

20 grains	= 1 scruple
3 scruples	= 1 drachm
8 drachms	= 1 ounce
12 ounces	= 1 pound

Apothecaries' Fluid Measure

60 minims	= 1 fluid drachm
8 drachms	= 1 fluid ounce
20 ounces	= 1 pint
8 pints	= 1 gallon

Diamond and Pearl Weight

3.17 grains	= 1 carat, or
4 pearl grains	= 1 carat
151½ carats	= 1 ounce (troy)

Paper Measure

24 sheets	= 1 quire
20 quires	= 1 ream
2 reams	= 1 bundle
10 reams	= 1 bale

Troy Weight

3.17 grains	= 1 carat
24 grains	= 1 pennyweight (dwt.)
20 pennyweights	= 1 ounce
12 ounces	= 1 pound
1 lb.	= 5,760 grains
1 lb. avoir.	= 7,000 grains

NATURAL SINES, COSINES, AND TANGENTS

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
0° 0′	0.0000	1.0000	0.0000	8° 0′	0.1392	.9903	0.1405
30′	0.0087	.9999	0.0087	30′	0.1478	.9890	0.1495
1° 0′	0.0174	.9998	0.0174	9° 0′	0.1564	.9877	0.1584
30′	0.0262	.9997	0.0262	30′	0.1650	.9863	0.1673
2° 0′	0.0349	.9994	0.0349	10° 0′	0.1737	.9848	0.1763
30′	0.0436	.9991	0.0437	30′	0.1822	.9833	0.1853
3° 0′	0.0523	.9986	0.0524	11° 0′	0.1908	.9816	0.1944
30′	0.0610	.9981	0.0612	30′	0.1994	.9800	0.2035
4° 0′	0.0698	.9976	0.0699	12° 0′	0.2079	.9782	0.2126
30′	0.0785	.9969	0.0787	30′	0.2164	.9763	0.2217
5° 0′	0.0872	.9962	0.0875	13° 0′	0.2249	.9744	0.2309
30′	0.0963	.9954	0.0963	30′	0.2334	.9724	0.2401
6° 0′	0.1045	.9945	0.1051	14° 0′	0.2419	.9703	0.2493
30′	0.1132	.9936	0.1139	30′	0.2504	.9682	0.2586
7° 0′	0.1219	.9926	0.1228	15° 0′	0.2588	.9659	0.2679
30′	0.1305	.9914	0.1317				

NATURAL SINES, COSINES, AND TANGENTS—*Continued*

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
15°30′	0.2672	.9636	0.2773	23° 0′	0.3907	.9205	0.4245
16° 0′	0.2756	.9613	0.2867	30′	0.3987	.9170	0.4348
30′	0.2840	.9588	0.2962	24° 0′	0.4067	.9136	0.4452
17° 0′	0.2924	.9563	0.3057	30′	0.4147	.9099	0.4557
30′	0.3007	.9537	0.3153	25° 0′	0.4226	.9063	0.4663
18° 0′	0.3090	.9510	0.3249	30′	0.4305	.9025	0.4770
30′	0.3173	.9483	0.3346	26° 0′	0.4384	.8988	0.4877
19° 0′	.03256	.9455	0.3443	30′	0.4462	.8949	0.4986
30′	0.3338	.9426	0.3541	27° 0′	0.4540	.8910	0.5095
20° 0′	0.3420	.9397	0.3640	30′	0.4617	.8870	0.5206
30′	0.3502	.9367	0.3739	28° 0′	0.4695	.8829	0.5317
21° 0′	0.3584	.9336	0.3839	30′	0.4772	.8788	0.5430
30′	0.3665	.9304	0.3939	29° 0′	0.4818	.8746	0.5543
22° 0′	0.3746	.9272	0.4040	30′	0.4929	.8704	0.5658
30′	0.3827	.9239	0.4142	30° 0′	0.5000	.8660	0.5774

NATURAL SINES, COSINES, AND TANGENTS—*Continued*

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
30°30′	0.5075	.8616	0.5891	38° 0′	0.6157	.7880	0.7813
31° 0′	0.5150	.8572	0.6009	30′	0.6225	.7826	0.7954
30′	0.5225	.8526	0.6128	39° 0′	0.6293	.7772	0.8098
32° 0′	0.5299	.8480	0.6249	30′	0.6361	.7716	0.8243
30′	0.5373	.8434	0.6371	40° 0′	0.6428	.7660	0.8391
33° 0′	0.5446	.8387	0.6494	30′	0.6494	.7604	0.8541
30′	0.5519	.8339	0.6619	41° 0′	0.6561	.7547	0.8693
34° 0′	0.5592	.8290	0.6745	30′	0.6626	.7490	0.8847
30′	0.5664	.8241	0.6873	42° 0′	0.6691	.7431	0.9004
35° 0′	0.5736	.8192	0.7002	30′	0.6756	.7373	0.9163
30′	0.5807	.8142	0.7133	43° 0′	0.6820	.7314	0.9325
36° 0′	0.5878	.8090	0.7265	30′	0.6884	.7254	0.9489
30′	0.5948	.8039	0.7400	44° 0′	0.6947	.7193	0.9657
37° 0′	0.6018	.7986	0.7536	30′	0.7009	.7132	0.9827
30′	0.6088	.7934	0.7673	45° 0′	0.7071	.7071	1.0000

NATURAL SINES, COSINES, AND TANGENTS—*Continued*

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
45°30′	0.7133	.7009	1.0176	53° 0′	0.7986	.6018	1.3270
46° 0′	0.7193	.6947	1.0355	30′	0.8039	.5948	1.3514
30′	0.7254	.6884	1.0538	54° 0′	0.8090	.5878	1.3764
47° 0′	0.7314	.6820	1.0724	30′	0.8141	.5807	1.4020
30°	0.7373	.6756	1.0913	55° 0′	0.8192	.5736	1.4282
48° 0′	0.7431	.6691	1.1106	30′	0.8241	.5664	1.4550
30′	0.7490	.6626	1.1303	56° 0′	0.8290	.5592	1.4826
49° 0′	0.7547	.6561	1.1504	30′	0.8339	.5519	1.5108
30′	0.7604	.6495	1.1709	57° 0′	0.8387	.5446	1.5399
50° 0′	0.7660	.6428	1.1918	30′	0.8434	.5373	1.5697
30′	0.7716	.6361	1.2131	58° 0′	0.8480	.5299	1.6003
51° 0′	0.7771	.6293	1.2349	30′	0.8526	.5225	1.6319
30′	0.7826	.6225	1.2572	59° 0′	0.8572	.5150	1.6643
52° 0′	0.7880	.6157	1.2799	30′	0.8616	.5075	1.6977
30′	0.7934	.6088	1.3032	60° 0′	0.8660	.5000	1.7321

NATURAL SINES, COSINES, AND TANGENTS—*Continued*

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
60°30′	0.8704	.4924	1.7675	68° 0′	0.9272	.3746	2.4751
61° 0′	0.8746	.4848	1.8041	30′	0.9304	.3665	2.5387
30′	0.8788	.4772	1.8418	69° 0′	0.9336	.3584	2.6051
62° 0′	0.8830	.4695	1.8807	30′	0.9367	.3502	2.6746
30′	0.8870	.4618	1.9210	70° 0′	0.9397	.3420	2.7475
63° 0′	0.8910	.4540	1.9626	30′	0.9426	.3338	2.8239
30′	0.8949	.4462	2.0057	71° 0′	0.9455	.3256	2.9042
64° 0′	0.8988	.4384	2.0503	30′	0.9483	.3173	2.9887
30′	0.9026	.4305	2.0965	72° 0′	0.9510	.3090	3.0777
65° 0′	0.9063	.4226	2.1445	30′	0.9537	.3007	3.1716
30′	0.9100	.4147	2.1943	73° 0′	0.9563	.2924	3.2907
66° 0′	0.9135	.4067	2.2460	30′	0.9588	.2840	3.3759
30′	0.9171	.3988	2.2998	74° 0′	0.9613	.2756	3.4874
67° 0′	0.9205	.3907	2.3559	30′	0.9636	.2672	3.6059
30′	0.9239	.3827	2.4142	75° 0′	0.9659	.2588	3.7321

NATURAL SINES, COSINES, AND TANGENTS—*Continued*

Degrees.	Sine.	Cosine.	Tangent.	Degrees.	Sine.	Cosine.	Tangent.
75°30′	0.9682	.2504	3.8667	83° 0′	0.9926	.1219	8.1444
76° 0′	0.9703	.2419	4.0108	30′	0.9936	.1132	8.7769
30′	0.9724	.2335	4.1653	84° 0′	0.9945	.1045	9.5144
77° 0′	0.9744	.2249	4.3315	30′	0.9954	.0959	10.3851
30′	0.9763	.2164	4.5107	85° 0′	0.9962	.0872	11.4301
78° 0′	0.9782	.2079	4.7046	30′	0.9969	.0785	12.7062
30′	0.9800	.1994	4.9152	86° 0′	0.9976	.0698	14.3007
79° 0′	0.9816	.1908	5.1446	30′	0.9981	.0610	16.3499
30′	0.9833	.1822	5.3955	87° 0′	0.9986	.0523	19.0811
80° 0′	0.9848	.1737	5.6713	30′	0.9990	.0436	22.9038
30′	0.9863	.1650	5.9758	88° 0′	0.9994	.0349	28.6363
81° 0′	0.9877	.1564	6.3138	30′	0.9997	.0262	38.1885
30′	0.9890	.1478	6.6912	89° 0′	0.9998	.0174	57.2900
82° 0′	0.9903	.1392	7.1154	30′	0.9999	.0087	114.5887
30′	0.9914	.1305	7.5958	90° 0′	1.0000	.0000	∞

LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4 8 12	17 21 25	29 33 37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4 8 11	15 19 23	26 30 34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3 7 10	14 17 21	24 28 31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3 6 10	13 16 19	23 26 29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3 6 9	12 15 16	21 24 27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3 6 8	11 14 17	20 22 25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3 5 8	11 13 16	18 21 24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2 5 7	10 12 15	17 20 22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2 5 7	9 12 14	16 19 21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2 4 7	9 11 13	16 18 20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2 4 6	8 11 13	15 17 19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2 4 6	8 10 12	14 16 18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2 4 6	8 10 12	14 15 17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2 4 6	7 9 11	13 15 17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2 4 5	7 9 11	12 14 16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2 3 5	7 9 10	12 14 15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2 3 5	7 8 10	11 13 15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2 3 5	6 8 9	11 13 14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2 3 5	6 8 9	11 12 14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1 3 4	6 7 9	10 12 13

LOGARITHMS—(*continued*)

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	8	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7

LOGARITHMS—(*continued*)

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	3	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5

LOGARITHMS—(*continued*)

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

ANTILOGARITHMS

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	2	2	2	3	3
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	3	3
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4

ANTILOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	3	3	4	4	5
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	6	6
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	5	6

ANTILOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7
.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	6	7
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
.60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12

ANTILOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.75	5623	5638	5649	5660	5675	5690	5702	5716	5728	5741	1	3	4	5	7	8	9	10	12
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	2	3	4	6	7	9	10	12	13
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	4	5	7	9	11	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	13	14	16
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	15	16
.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

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