PLUMBING

BASIC BUILDING SERIES

Plumbing

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Foreword

Recent revisions in the pattern of Building Education mark the biggest step forward that has taken place for almost thirty years, and in these changes it is right that training for craftsmanship should have been given a place of equal importance with that of technology and management.

It is intended that possession of the new City and Guilds of London Institute Craft Certificate shall denote that a satisfactory standard of competence in craftsmanship has been reached after (normally) three years of indentured apprenticeship including attendance at appropriate part-time day and/or evening classes at a Technical College.

It is not intended however that training should end at this stage and it is hoped that the keener and more able apprentice will continue his studies and obtain the Advanced Craft Certificate followed by the Full Technological Certificate of the City and Guilds Institute. Thereafter the way is open, through Foremanship studies or National Certificate Courses, to the examinations and professional qualifications of the Institute of Builders.

This series of books, largely consisting of simple notes and sketches in extension of lectures, should be of day-to-day assistance to Craft-Certificate students. Ancillary subjects such as Science and Calculations are treated separately and will probably be studied in this way at College, but they must at all times be considered as an integral part of the Trade Technology and related to that subject at the appropriate stage.

The easy reference method of presentation with ample illustrations has been based on the success of Mr Nichols' and Mr Keep's 'Geometry of Construction', and should, I am sure, have an equal appeal to students.

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Preface

The primary aim of this book is to assist the plumbing student to reach the standard required for the theoretical examinations of the City and Guilds of London Institute Ordinary Craft Certificate. It should prove useful to pupils in Secondary Technical Schools preparing for the G.C.E. examination.

The book is not intended to cover the subjects completely, but to give sufficient information to enable the student to grasp the basic principles, and then to extend his knowledge by further work in the theory class at his Technical College and by private study.

It is hoped that the student will copy the drawings to a larger scale. It has been the writer's experience that much more is learned by this method than by making small sketches in a notebook.

The student is also recommended to study information leaflets and booklets from the various development associations and manufacturers.

In the preparation of the book, constant reference has been made to the new City and Guilds Syllabuses, British Standards Specifications and Codes of Practice and Regulations.

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Metrication in the Building Industry

It is declared National policy that this country shall change to the SI (le Système International d'Unités) Metric System during the next few years.

As a result the Building Industry is now involved in changing over and by December 1972 it is hoped that the change to metric in the Industry will have been completed.

S.I. METRIC UNITS

Although the plumbing students will now be using S.I. Metric units it may assist if a list of units are given which may be referred to if doubt still exists. Also definitions, simple calculations. Use of symbols and scales for drawing have been added.

<u>Quantity</u>	<u>S.I. Unit</u>	<u>Unit Symbol</u>
Length	Metre	m
	Millimetre	mm
Area	Square metre	m ²
	Square millimetre	mm ²
Volume	Cubic metre	m ³
	Cubic millimetre	mm ³
Capacity	Litre	l
Mass	Kilogrammes	kg.
Density	Kilogrammes per cubic metre	kg/m ³
Mass flow rate	Kilogrammes per second	kg/s
Volume flow rate	Cubic metres per second	m ³ /s
Heat flow rate	Watts	W
Power	Watts	W
Energy	Joules	J
Force	Newton	N
Pressure and stress	Newtons per square metre	N/m ²
	Kilonewtons per square metre	kN/m ²
Calorific value	Kilojoules per cubic metre	kJ/m ³
Latent heat	Kilojoules per kilogramme	kJ/kg
Absolute temperature	Degree Kelvin	°K
Normal temperature	Degree Celcius	°C
Temperature interval	Degree Kelvin	K
Time	Second	s
U Value	Watts per square metre per degree Kelvin	W/(m ² K)

MULTIPLES AND SUB-MULTIPLES OF S.I. UNITS

<u>Multiplication Factor</u>		<u>Prefix</u>	<u>Symbol</u>
1 000 000	10^6	mega	M
1000	10^3	kilo	k
100	10^2	hecto	h
10	10^1	deca	da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ

MEANING OF TERMS

Newton Is that force which, when acting on a mass of one kilogramme gives it an acceleration of one metre per second per second.

Joule Is the work done by a force of one Newton when its point of application is moved through a distance of one metre in the direction of the force.

Watt is one Joule per second.

Note $W = J/s = Nm/s$

USE OF SYMBOLS

A space should be left between figures and symbols.

Examples 20.000 m (optional to use symbol).
20 mm. (optional to use symbol).
20 m (always use symbol).

Whenever confusion could arise between number and linear dimensions, use symbol.

Examples 20.6 mm. (always use symbol).
30 km. (always use symbol).
8 m² (always use symbol).
8 m³ (always use symbol).

DIMENSIONS ON DRAWINGS

One metre and over, to be written in metres to three places of decimals, e.g. 5.450

Under one metre to be written in millimetres only, e.g. 450

No symbols on dimensions on drawings unless decimals of mm e.g. 20.6 mm

Descriptions with single measurement should show symbol e.g. 3 mm sheet metal

Descriptions with two or more measurements need no symbol e.g. 51 × 25 timber battens

USEFUL NOTES

1m³ — 1000 litre

1 litre — 1000 000 mm³

1 litre of pure water = 1 kg.

Pressure of water in N/m² = Head of water in metres × 1000 × 9.81

Pressure of water in kN/m² = Head of water in metres × 9.81 or 10 approximately

Capacity of a tank in litres = Length × Breadth × Depth in metres × 1000

Specific heat capacity of air = 1010 J/kg K

Specific heat capacity of water = 4180

Density of water = 1000 kg/m³

Density of air = 1.20 kg/m³

Boiler power = mass flow rate in kg/s × temperature rise in K × specific heat capacity of water in J/kg K. (see page 81).

CALCULATIONS

A tank measures 1.5 m × 900 mm × 700 mm Calculate the volume in m³ and capacity in litres.

Volume = 1.5 m × 900 mm × 700 mm

= 1.5 × 0.9 × 0.7

= 0.945 m³

1m³ = 1000 litres

∴ capacity = 0.945 × 1000

= 945 litres

Calculate the pressure of water in N/m² when the head is 15 metres

1m³ of water has a mass of 1000 kg. ∴ pressure over an area of 1m² will equal 15 × 1000 × 9.81 = 147150 N/m² or 147.150 kN/m²

METRIC SCALES FOR DRAWING

Detail drawings

1 : 1

1 : 5

1 : 10

1 : 20

Constructional plans, elevations and sections

1 : 50

1 : 100

1 : 200

Layout and site plans.

1 : 500

1 : 1250

1 : 2500

To find the missing dimension in millimetres with the metric rule. Multiply this by the scale and the result equals the missing dimension.

To find the missing scale in millimetres with the metric rule. Divide the marked dimension by the measured dimension (but make marked dimension into whole numbers). Result equals the scale.

SIZES FOR COPPER FITTINGS

The International Standards Organisation (I.S.O.) hope to have their range of sizes internationally accepted.

The sizes are for the outside diameter of the tube in millimetres as follows: 6, 8, 10, 12, 15, 18, 22, 28, 35, 42, 54, 76.1, 108, 133, 159

They offer more sizes than are at present used in Britain but it is possible that we may adopt them in the new B.S. 864 for capillary and compression fittings for copper tube.

CONVERSION FACTORS

Although it is unnecessary to waste time in laborious conversion exercises, it may help the student to become familiar with the values in S.I. Metric Units, in the early stages, if he can see the equivalent in Imperial Units.

<u>To convert</u>	<u>into</u>	<u>multiply by</u>
pounds force	Newtons	4.45
kilogrammes force	Newtons	9.81
tons force	Kilonewtons	9.96
pounds per sq inch pressure	Newtons per square metre	6890
tons per sq ft pressure	Kilonewtons per square metre	107
inches of water	Newtons per square metre	249
feet of water	Newtons per square metre	2890
feet per second	metres per second	0.3048
feet per minute	millimetres per second	5.08
miles per hour	metres per second	0.447
miles per hour	kilometres per hour	1.61
acceleration in feet per second	metres per second ²	0.3048
calorific value in Btu/ft ³	kilojoules per cubic metre	37.3
Btu/lb	kilojoules per kilogramme	2.33

EQUIVALENT VALUES OF S.I. UNITS

Length

- 1 mile = 1,609 34 km
- 1 yard = 0.914 4 m
- 1 foot = 0.304 8 m
- 1 inch = 25.4 mm

Area

- 1 yd² = 0.836 127 m²
- 1 ft² = 0.092 903 0 m²
- 1 in² = 645.16 mm²
- 1 in² = 6.451 6 cm²

Volume

- 1 yd³ = 0.764 555 m³
- 1 ft³ = 28.316 8 dm³
- 1 in³ = 16.387 1 cm³

Capacity

- 1 quart = 1.137 litre
- 1 pint = 0.568 litre
- 1 gallon = 4.546 litre

Density

- 1 ton yd³ = 1328.94 kg/m³
- 1 lb/ft³ = 16.0185 kg/m³
- 1 lb/in³ = 27.679 9g/cm³

Force

- 1 ton f = 9.96402 KN
- 1 lb f = 4.448 N

Mass per unit area

- 1 lb/ft² = 703.070 kg/m²

Mass

- 1 ton = 1016.05 kg
- 1 cwt = 50.8023 kg
- 1 lb = 0.453 593 kg

ROUGH EQUIVALENTS

1 yard	= 1 metre
0.040 in	= 1 millimetre
$\frac{5}{8}$ mile	= 1 kilometre
1 Cwt	= 50 kilogrammes
1 ton force	= 10 kilonewtons
1 lb force	= 4.5 kilonewtons
2 lb	= 1 kilogramme
1 cubic yard	= 0.75 cubic metre
100 cubic ft	= 3 cubic metre
30 m.p.h.	= 50 k.m. per hour
70 m.p.h.	= 120 k.m. per hour
1 B.t.u.	= 1 kilojoule
10 B.t.u./hr.	= 3 watts = 3 Joules/second
1 therm	= 105 megajoules
10 gallons	= 45 litres
2 pints	= 1 litre
100 lb/in ²	= 700 KN/m ² or 7 Bar
1 ton/in ²	= 15 MN/m ² or 1.5 hectobar
1 horse power	= 750 W = 750 J/s.

THICKNESSES OF SHEET METALS

The S.I. Metric system recommends the use of the millimetre for the thicknesses of sheet metals and these thicknesses have been used in the book.

The B.S. 1178 Code No. 3 recommends that for sheet lead a code number should be used which corresponds to the old Imperial weights in pounds per square foot. A B.S.S. for sheet copper has not yet been published but it may also be possible for a code number to be used corresponding to the old standard wire gauge. (s.w.g.)

<u>Sheet lead</u>		<u>Sheet copper</u>	
BS Code No	Thickness mm	S.w.g.	Thickness mm
3	1.270	20	0.914
4	1.702	21	0.813
5	2.130	22	0.711
6	2.560	23	0.610
7	2.990	24	0.559
8	3.420	26	0.457

Sheet lead carries colour markings as follows

Code No 3 = Green	Code No 6 = Black
Code No 4 = Blue	Code No 7 = White
Code No 5 = Red	Code No 8 = Orange