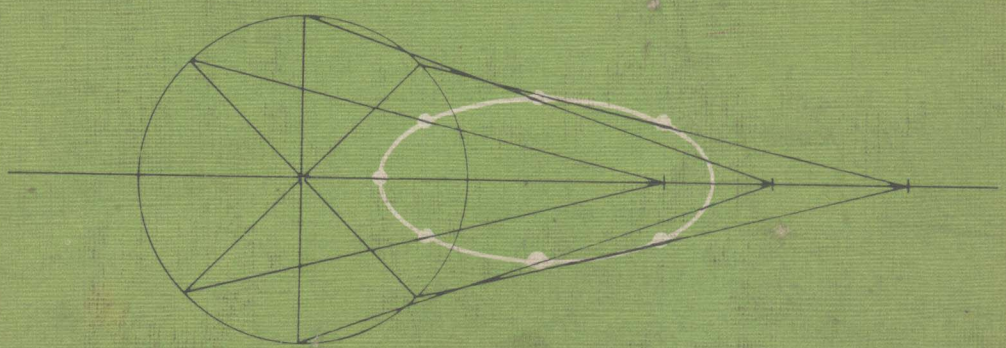
GEOMETRICAL AND TECHNICAL DRAWING

H. A. FREEBURY



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Book 1

Geometrical and technical drawing

part 1

SI metric edition

H. A. Freebury

Introduction by W. Gillespie
MEng, BSc(Eng), MIMechE, MIProdE, AFRAeS, AMIMarE

Cassell : London

Geometrical and technical drawing

Part One

GEOMETRICAL AND TECHNICAL DRAWING

a complete course in six parts

Book 1 : Part One

Book 2 : Parts Two and Three

Book 3 : Parts Four, Five, and Six

Cassell & Co. Ltd—an imprint of
Cassell & Collier Macmillan Publishers Ltd
35 Red Lion Square
London WC1R 4SG
Sydney, Auckland, Toronto, Johannesburg

An affiliate of Macmillan Inc., New York

First edition March 1959
Second edition January 1960
Third edition September 1960
Fourth edition January 1961
Fifth edition December 1962
Sixth edition August 1964
Seventh edition July 1966
Eighth (revised) edition 1970
Eighth edition, second impression August 1971
Eighth edition, third impression October 1972
Ninth edition, first impression June 1973
Tenth edition (revised) 1976

ISBN 0 304 29679 1

Throughout this book, the recommendations of B.S. 308 : 1972, *Engineering Drawing Practice* have been adopted, with the SI (Système International) metric units.

Filmset and printed in Great Britain by
BAS Printers Limited, Wallop, Hampshire

Introduction

The teaching of geometrical and technical drawing is one of growing importance in secondary schools, and it is most desirable that correct principles are observed from the outset of a course of drawing. In the past much work has been of reduced value to a student subsequently attending a technical college, because fundamental principles have not been established, and this work has to be repeated before the work of the college can proceed.

Mr Freebury has had considerable industrial experience, which must add to the value of the book he has produced. Industrial experience cannot be over-estimated in the teaching and preparation of drawing. The methods adopted are sound and, if his suggestions are followed, a student coming to a technical college will find the work progressive. He has produced an extensive cover of all aspects a student will need, which if properly assimilated will give an excellent knowledge of the subject.

W Gillespie

Preface

This is a new edition of a long-established and successful work, which has been extensively revised and produced in a new format, with new art work in close proximity to related text, and in accordance with latest British standards.

As with previous editions, the course, which is in three books, covers the GCE examination syllabus at Ordinary Level as set by most of the examining bodies. Books 1 and 2 comprise the technical drawing courses of the CSE regional boards and other comparable organizations.

Aimed at encouraging most groups in secondary schools, the work is set down in some detail and can be used almost as a self-educator by the brighter pupils, thus giving the instructor more opportunity to move around the class and help individually those in difficulty.

The diagrams have been kept as simple as the subject will allow, and the author feels, in the light of considerable experience in secondary schools and an evening institute, that many exercises included are within the capacity of the lower groups. Such constructions as the American method of drawing isometric circles have been retained for this reason.

Since the course begins with fundamentals, it could be started in the second year, with the harder problems in each chapter of Part 1 left until later. It is suggested that the whole course might be taken over a period of three years, for frequent revision is essential to ensure that the more difficult constructions have been thoroughly grasped.

No attempt has been made to give formal proofs of the geometrical problems included, but the principles underlying the more difficult constructions have been stated where considered to be of help.

I must again express my gratitude to Mr W Gillespie, Principal of the College, Swindon, for his continued interest in this course and for the valuable suggestions he has made.

Finally, I must thank the Senate of London University and the Associated Examining Board for their permission to use questions from past examination papers in the Tests to be found after each Part, and to convert British imperial dimensions to their approximate metric equivalents.

H A Freebury

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NOTE: *All dimensions in this book are in millimetres unless otherwise stated.*

*All exercises in Part 1 that are marked with one asterisk * are problems or part problems which have been set at GCE Ordinary Level.*

Part 1

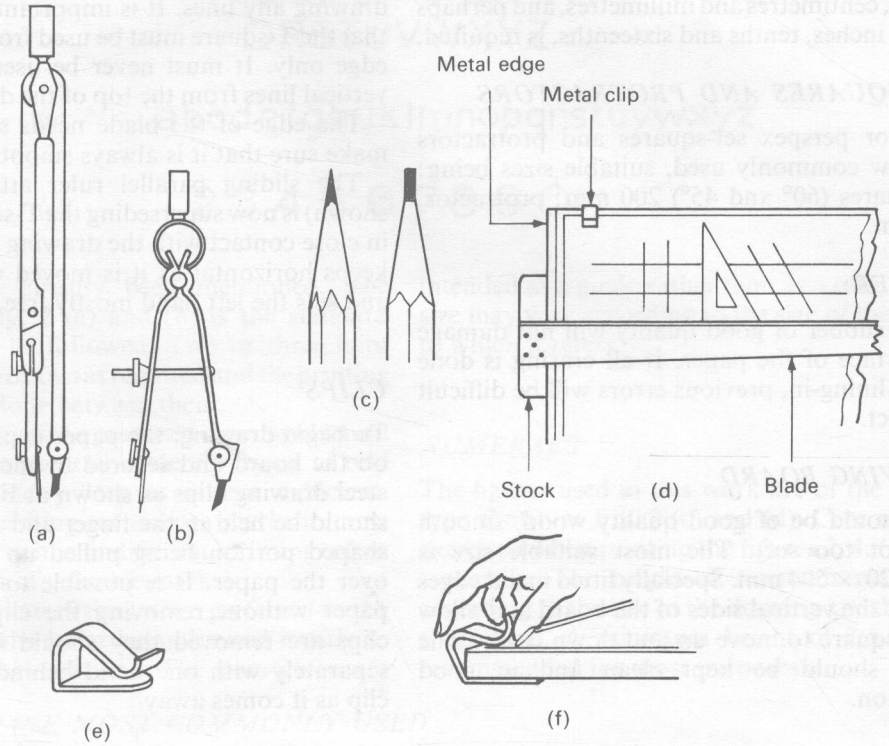
Plane Geometry

A Plane is a Surface. It has only Two Dimensions, Length and Breadth.

1

Drawing Equipment

Fig. 1



Neatness and accuracy are essential in all geometrical and technical drawing, and in order to achieve a high standard in both these directions it is important that the right equipment is used in the correct manner.

INSTRUMENTS

Most boys interested in this subject obtain their own set of drawing instruments. This should include a reliable chromium-plated compass as illustrated in Fig. 1 (a), a spring-bow compass for circles of smaller radius as shown at Fig. 1 (b), and a pair of dividers fitted with two needle points for transferring distances from the ruler to the drawing or from one view to another.

PENCILS

Two types of pencil are required, a 2H for drawing lines and an HB for lettering and dimensioning. Some draughtsmen prefer to sharpen the 2H pencil to a chisel edge as shown at Fig. 1 (c), the flat edge of the lead being kept close to the straight-edge (set-square or T-square) when drawing lines. Other draughtsmen

prefer a conical point for both the 2H and HB pencils, but the wood should always be cut away with a long taper, while a piece of fine sandpaper is always useful for maintaining the sharpness of the leads.

RULERS

A ruler clearly marked in metric units, decimetres, centimetres and millimetres, and perhaps also in inches, tenths and sixteenths, is required.

SET-SQUARES AND PROTRACTORS

Vinyl or perspex set-squares and protractors are now commonly used, suitable sizes being: set-squares (60° and 45°) 200 mm; protractor, 150 mm.

RUBBER

A soft rubber of good quality will not damage the surface of the paper. If all erasing is done before lining-in, previous errors will be difficult to detect.

DRAWING BOARD

This should be of good quality wood, smooth and not too soft. The most suitable size is A2—420 × 594 mm. Specially fitted metal edges protect the vertical sides of the board and allow the T-square to move up and down easily. The board should be kept clean and in good condition.

T-SQUARE

The T-square is used for drawing parallel lines across the paper and to assist in the drawing of angles and parallel lines with the aid of the set-squares, as at Fig. 1 (d).

The T-square is made up of the blade and the stock. Develop the habit of pressing the stock firmly against the edge of the board before drawing any lines. It is important to remember that the T-square must be used from one vertical edge only. It must never be used for drawing vertical lines from the top of the drawing board.

The edge of the blade needs special care to make sure that it is always smooth.

The sliding parallel ruler attachment (not shown) is now superseding the T-square. It keeps in close contact with the drawing board, always keeps horizontal as it is moved up and down, and sets the left hand mostly free.

CLIPS

To begin drawing, the paper is placed squarely on the board and secured by means of spring-steel drawing clips as shown at Fig. 1 (e). They should be held in the finger and thumb (f), the shaped portion being pulled up until it slides over the paper. It is possible to withdraw the paper without removing the clips, but if the clips are removed they should be pushed off separately with one hand behind to catch the clip as it comes away.

2

Lettering. Types of Line. Dimensioning

Fig. 2

(a) ABCDEFGHIJKLMNOP
QRSTUVWXYZ

(b) abcdefghijklmnopqrstuvwxyz

(c) 1 2 3 4 5 6 7 8 9 0

Neatness has already been mentioned. The printing of Fig. 2 (a) and (b) is the standard which should be followed. Two or three faint lines should be drawn as required and the printing of the letters done between them.

Lettering should be practised thoroughly until it can be done naturally. Merely trying at odd times in geometry lessons is not sufficient. Neatness of printing earns extra marks in most examinations, while indifferent printing often means the loss of valuable marks.

The capital letters shown are preferred to the smaller type; the latter being limited mostly to symbols or abbreviations. The sizes given are intended as a guide rather than as a rule, for the size may vary according to the size of the object to which it refers.

NUMERALS

The figures used in this work are of the capital type shown at Fig. 2 (c) and (d). Care must be exercised when printing the figures 2, 4, 6 and 9, especially. The height of numerals may vary according to the size of the drawing and drawing sheet used. A minimum height of 2·5 mm is recommended for most purposes.

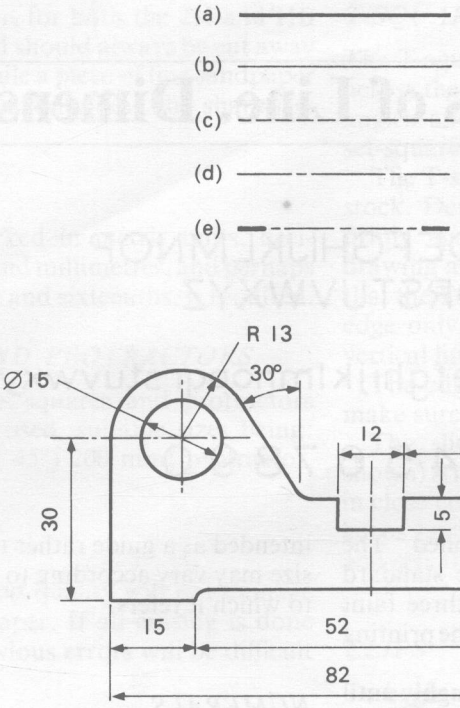
TYPES OF LINE MOST COMMONLY USED

The various types of line used are shown at Fig. 3 (a) to (e). They are:

	Type	Used for
(a)	Continuous (thick)	Visible outlines and edges.
(b)	Continuous (thin)	Construction work—the method used to obtain the final result. Dimension and projection lines. Hatching (i.e. shading).
(c)	Short dashes (thin) (About 2 mm long)	Hidden outlines and edges.
(d)	Long chain (thin) (About 20 mm and 2 mm alternately**)	Centre lines.
(e)	Short chain (thin, but thick at the ends and at changes of direction) (About 14 mm and 2 mm alternately**)	Cutting planes, generally in engineering drawing.

**These lengths may vary according to the size of the object to be drawn.

Fig. 3



(f)

DIMENSIONING

Dimensioning is important in this work. The more up-to-date method is shown in Fig. 3 (f), unbroken arrows being used, the nearest ones being about 10 mm from the object to allow for the figures. These are always printed at right angles to the arrows. Further they must always be *above* horizontal arrows and to the *left* of vertical arrows.

Finally, remember that the diameter is always quoted for circles, and radii are always used for arcs. Study Fig. 3 (f) carefully for it shows the method of dimensioning to be used on all drawings.

THE METRIC SYSTEM

This is based on the *metre* which is equivalent to 39·37 inches British imperial measure. The metre is usually divided into 1000 parts each called a millimetre (mille = French for 1000). The three commonest units are the *kilometre* (1000 metres), the metre itself and the millimetre (1000th part of a metre), but in engineering drawing only millimetres and metres are generally used, though it is as well to know the full range of metric units, as follows:

10 mm = 1 centimetre (cm)
10 cm (100 mm) = 1 decimetre (dm)
10 dm (1000 mm) = 1 metre (m)
10 m = 1 decametre (dam)
10 dam (100 m) = 1 hectometre (hm)
10 hm (1000 m) = 1 kilometre (km)

The following rules should be borne in mind:

1. A small 'm' is usually used for metres and double 'm', namely mm, for millimetres, as above.
2. On drawings the recommended decimal sign for metric units can be either a comma on the line through the base of the figures, e.g. 1,556 m, or a decimal point, e.g. 1·566 m. The latter is used in this book.

3. For dimensions less than unity the decimal sign should be prefixed with 'o', e.g. 0·5 mm, *not* ·5 mm.
4. Dimensions should be divided by a space between every three digits counting from the decimal sign, e.g. 10 000·5 m. A four-figure sequence need not be separated.
5. When both methods of measuring are used the units in use on the drawing should be shown *above* the dimension line with the equivalent below the line, e.g.:

   imperial based design: $\frac{3''}{76}$ metric based: $\frac{76}{3''}$.

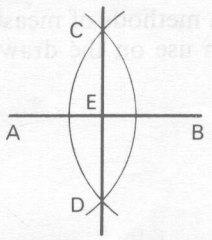
6. Normally metres or millimetres are not shown for individual dimensions, but a note is usually made on the drawing, e.g.: '*All dimensions in millimetres*'.

3

Lines and Angles

To bisect a given line (Fig. 4)
To bisect means to cut into two equal parts. If AB is the given line, with the leg of the compass on A and radius greater than half AB, draw an arc across AB**. With centre B and the same radius draw another arc to intersect (cut across) the first arc at C and D. The line CD drawn exactly through the intersections will bisect AB at E.

Fig. 4

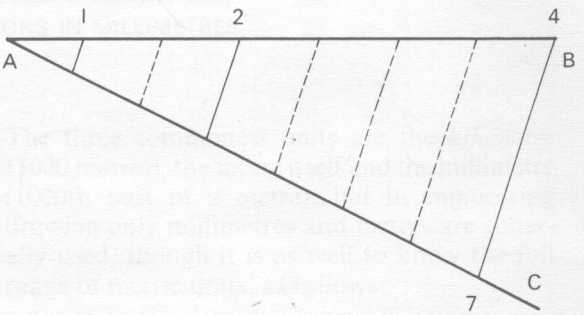


To bisect a line

To divide a straight line into a given number of equal parts, or into a given ratio (Fig. 5)
If it is required to divide the line AB into 7 equal parts, draw AC at a suitable angle to AB. Mark off 7 equal parts along AC using any convenient distance. Join 7 to B, and through each of the other points along AC draw lines parallel to 7B to cut AB into 7 equal parts as shown.

Suppose it is required to divide the line into a ratio of 1:2:4. As these numbers added together make 7, divide AB into 7 equal parts as above. Then mark off the required divisions as shown by the figures 1, 2, and 4.

Fig. 5



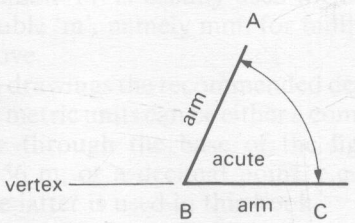
To divide a line into equal parts

ANGLES

An angle is said to be formed when two lines meet at a point. In Fig. 6, ABC is said to be the *angle*. AB and BC are said to be the *arms* of the angle and the corner B is called the *vertex*. The angle can be called ABC or CBA, but the vertex letter (B in this case) must always be written between the other two.

The unit of angle measurement is the *degree*, written °, for example, 30°. When the hand of a clock goes round the face once exactly, it is said to have turned through 360°. A circle is therefore said to contain 360°, and when it is divided into four equal parts the square corner formed by each pair of arms is called a *right angle*. Thus a right angle is an angle of 90°.

Fig. 6



** An arc is any part of the circumference of a circle.