CHAPTER 6 Technical Drawing Tools

Based on Technical Graphics Communication by Bertoline, *et al*
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OBJECTIVES

After completing this chapter, you will be able to:

1. Identify the important parts of a CAD system used to create technical drawings.
2. Define the important terms related to CAD systems.
3. Identify the important traditional tools used to create technical drawings.
4. Define the important terms related to traditional tools.
5. Use traditional tools and CAD to draw lines, circles, arcs, and curves.
6. Use scales, dividers, and CAD to measure and scale drawings.
7. Identify standard metric, U.S., and architectural drawing sheet sizes.
8. Identify standard pencil grades, and identify those most commonly used for technical drawings.
9. Identify the types and thicknesses of the various lines in the alphabet of lines.
10. Use traditional tools and CAD to erase parts of a drawing.

INTRODUCTION

Just as the graphics language has evolved over the years into a sophisticated set of standards and conventions, so have the tools used to graphically communicate technical ideas. Tools are used to produce three basic types of drawings: freehand sketches, instrument drawings, and computer drawings and models.

6.1 TECHNICAL DRAWING TOOLS

Computer-aided design/drafting (CAD) is computer software and related computer hardware that supplements or replaces traditional hand tools in creating models and technical drawings.

Engineers use computer-aided design/computer-aided manufacturing (CAD/CAM) in the design and production processes.

6.2 COMPUTER-AIDED DRAWING TOOLS

A CAD system consists of hardware devices used in combination with specific software. The hardware for a CAD system consists of the physical devices used to support the CAD software.

6.2.2 **Operating systems** are programs that controls the internal operations of the computer, such as the memory, storage drives, input and output devices, and data transmission circuitry. **Software** comprises the written and coded instructions that govern the operation of the computer and the functions it performs.

6.2.3 A **display device** is a type of output device, that is, a device through which information flows from the computer "out" to the user. A **vector device** locates the endpoints of a line and then draws the line by electronically charging a continuous stream of phosphors on the screen. A **raster device**, which is the most common, creates an image by electronically charging individual points called pixels, which are arranged in horizontal rows. In a CAD system, the display device can be thought of as the drawing paper or medium upon which technical drawings and models are produced.

Movement of a screen cursor is controlled by an **input device**, such as a keyboard, tablet, or mouse, through which information flows from the user "in" to the computer.

6.2.4 A **tablet** is an **input device** used to control cursor movement and select menu items.

A **scanner** is an input device used for converting a drawing created with traditional tools to a CAD drawing.

The **mouse** is an input device used to control cursor movement and to make menu selections.

The **keyboard** is a device used to input alphanumeric data and to make CAD menu selections.

A **modem** is an electronic input/output device used to send and receive data via telephone lines.

6.2.5 The **output devices** used to make hard copies of the drawings created on screen are categorized as: printers, plotters, or film recorders.

A **printer** is an output device that creates characters, numbers, and graphics on paper. Printers are used with CAD to create check prints. A check print is a low quality hard copy made at high speed.

Inkjet plotters and printers spray ink using small nozzles to create color images on A to E size paper.

Dye-sublimation printers mix cyan, magenta, yellow, and black pigments to create any of 16.7 million hues, without dithering or banding.

Laser printers use a laser beam to record an image in the form of tiny dots on a light sensitive drum.

6.2.6 A **storage device** is used to store information on a specific medium andø retrieve that information as needed. Storage devices are combination input/output (I/O) devices, and are grouped into five categories:

External disk drives and USB flash drives

Fixed hard disk drives

Tape drives, which use tape cartridges

Optical storage drives, such as CD and DVD

Network attached storage (NAS)

6.3 TRADITIONAL TOOLS

Traditional tools are devices used to assist the human hand in making technical drawings.

6.3.1 Mechanical drawings are started by taping the drawing paper to the working surface. A **straightedge**, such as a T-square, parallel edge or drafting machine, is used to draw horizontal lines.

Paper is positioned on the drawing surface by aligning the bottom of the paper to the horizontal blade of the drafting machine, and then taping the paper at the corners.

6.3.2 The protractor is used to measure and mark angles on a technical drawing.

Drafting machines are devices that supplement the T-square, triangles, protractors, and scales. The protractor head on a drafting machine is used to draw lines at any angle.

The adjustable triangle can be set to a specified angle.

6.3.3 Mechanical pencils used for engineering drawings come in different lead sizes for drawing the different thicknesses of lines required on technical drawings.

A pencil pointer for mechanical lead pencils.

Line weight refers to the relative darkness of the line. Uniform thickness means that the line should not vary.

Pencils are graded by lead hardness, from 9H to 7B: 9H is the hardest, and 7B is the softest.

6.3.4 **Media** are the surfaces upon which an engineer or technologist communicates graphical information. The media used for technical drawings are different types or grades of paper such as tracing paper, vellum, and polyester film.

Preprinted standard borders and title blocks on drafting paper are commonly used in industry.

6.3.5 Drafting triangles are either 30/60- or 45- degree triangles and come in various sizes.

By combining the straight edges with the 45-, and 30/60-degree triangles, you can draw lines at any 15-degree increment.

6.4 LINE DRAWING TECHNIQUES

A horizontal line is drawn using the top edge of the blade of the T-square, drafting machine, or parallel edge.

Vertical lines are drawn by pulling the pencil alone the edge of a triangle or the vertical blade of the drafting machine, slowly rotating the pencil as it is pulled.

Drawing inclined lines using a drafting machine requires setting the protractor head to the desired angle and locking the head in place.

6.4.1 To erase in small areas, or protect areas not to be erased, use an erasing shield. An erasing shield is a thin piece of metal with various sizes and shapes of holes cut in it.

6.4.2 To draw a line through two points, align the edge of a triangle to the two points and then pull the pencil along the edge of the triangle.

6.4.3 To draw a line parallel to a given line using a drafting machine, align one blade with the given line by adjusting the protractor head and locking it in place. Then move the drafting machine to the new location and draw the line along the parallel blade.

To use two triangles to draw parallel lines, set up one of the triangles so that one edge aligns along the given line. Use the other triangle as a guide or base for the first triangle. Hold the base triangle stationary and slide the other triangle along the edge of the base triangle to the new position.

6.4.4 To draw a line perpendicular to a given line using the drafting machine, align one blade with the given line and draw the perpendicular line with the other blade.
To use two triangles to draw perpendicular lines, align one of the triangles so that one edge is parallel to the given line and slide the other triangle along the edge of the base triangle.
To draw a line at an angle to a given line using a drafting machine, align one blade with the given line by adjusting the protractor head, and then read its angle. Adjust the drafting machine head to the new angle, lock it and draw the line.

6.4.5 Two triangles can be used to draw a line at an angle to a given line by using one triangle as a guide or base and aligning the other triangle so that one edge is parallel to the given line. Hold the base triangle stationary and slide the other triangle along the edge of the base triangle to the new position, and draw the line.

6.4.6 Irregular or French curves come in many shapes and sizes and are used to draw irregular curves.

A spline is a flexible device used to draw long, irregular curves through a series of points.
Steps in drawing an irregular curve through a series of points.

6.5 SCALES

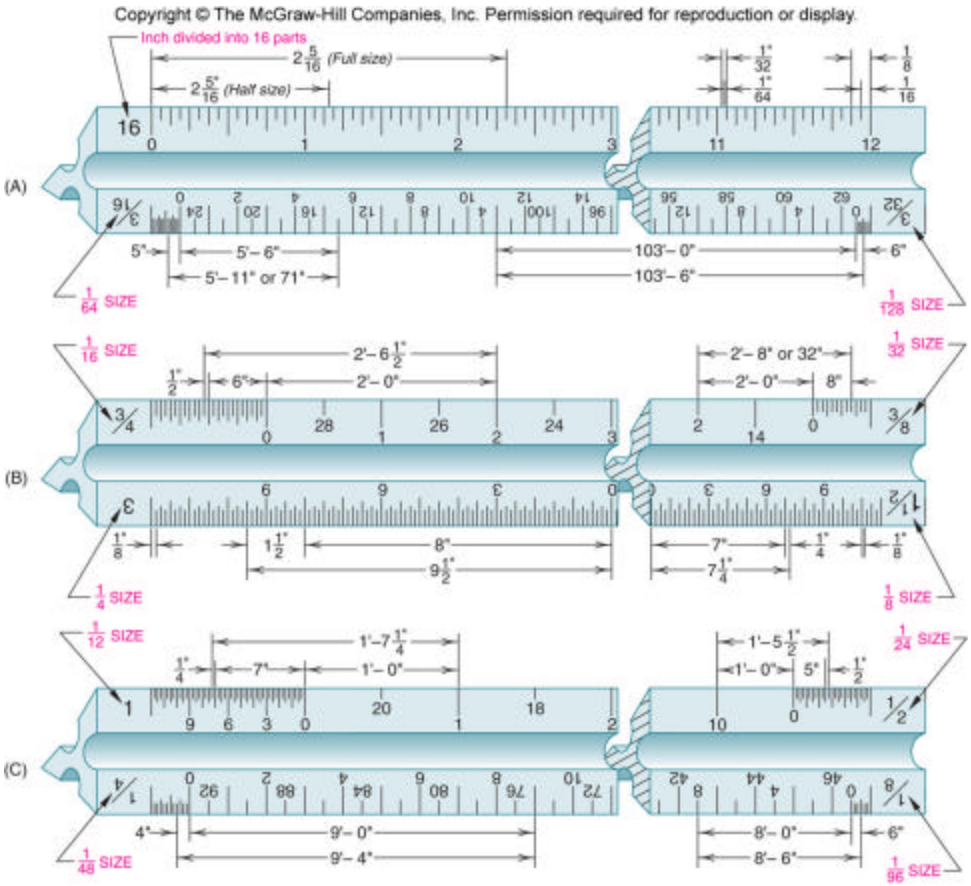
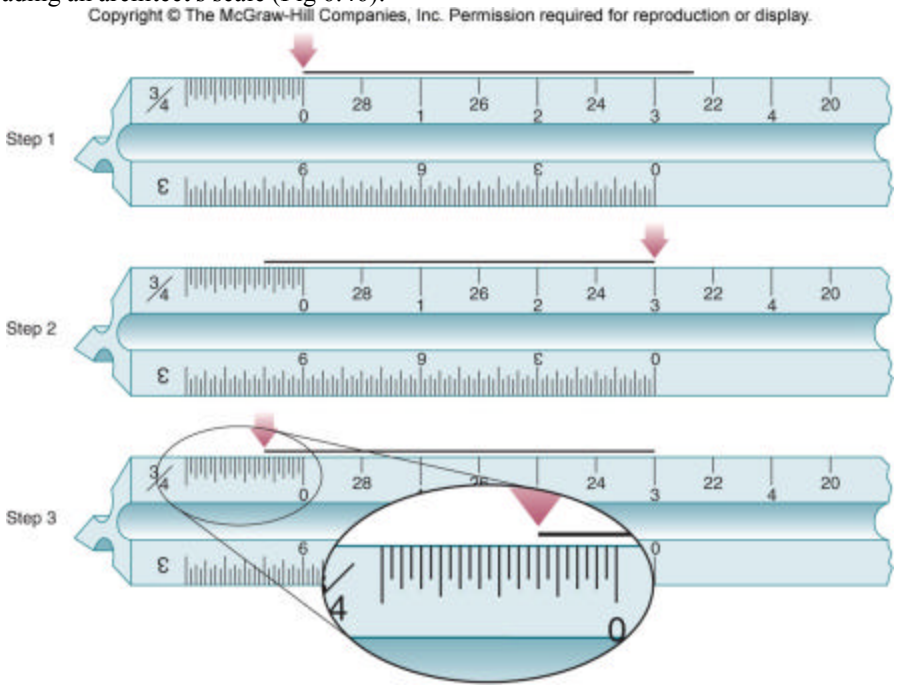


Fig 6.45- Architect' scale

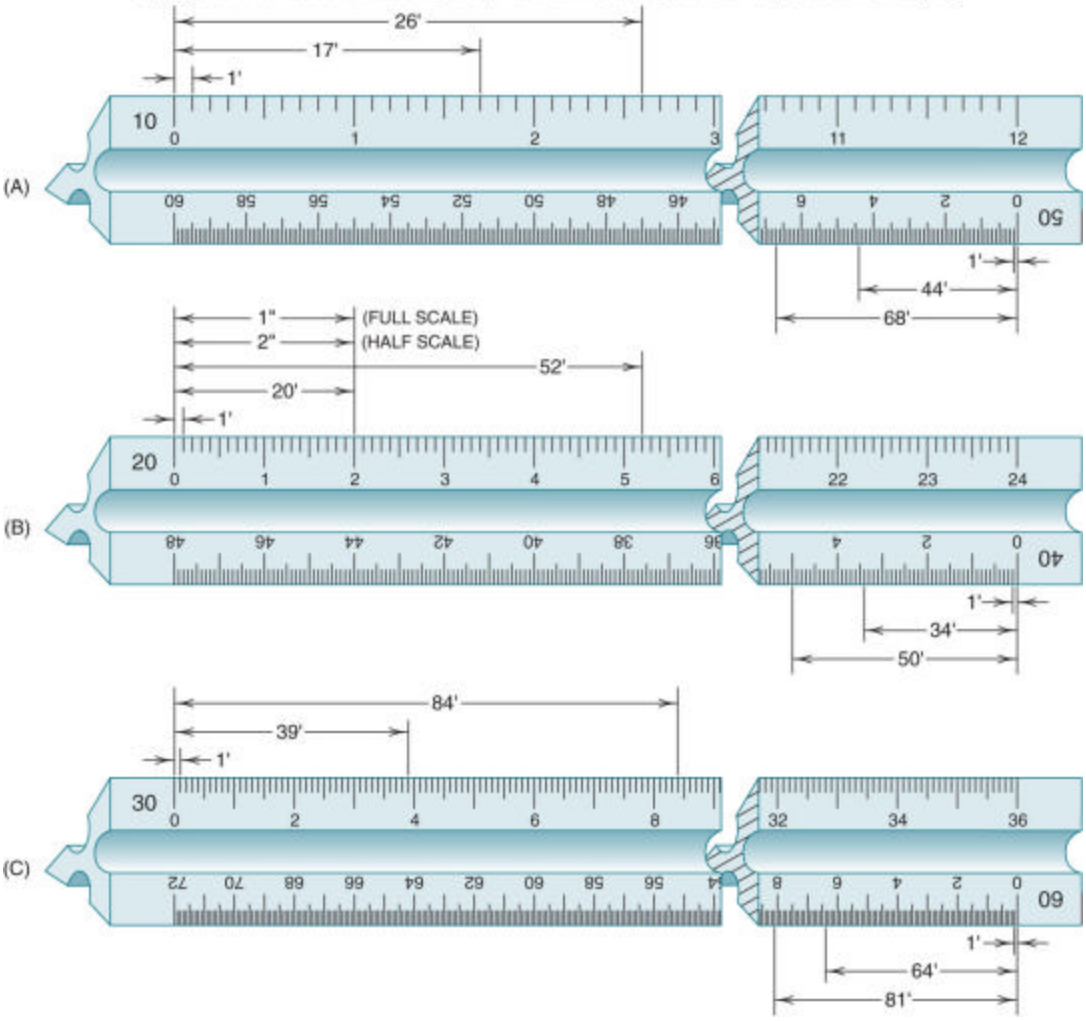
Scales are used to measure distances on technical drawings. They are usually 6-12 inches long. The available scales are **Architect, Civil, Mechanical and Metric** scales.

An **architect's scale** is used to create drawings of structures, such as a building or a factory floor layout.

6.5.1 Steps in reading an architect's scale (Fig 6.46):



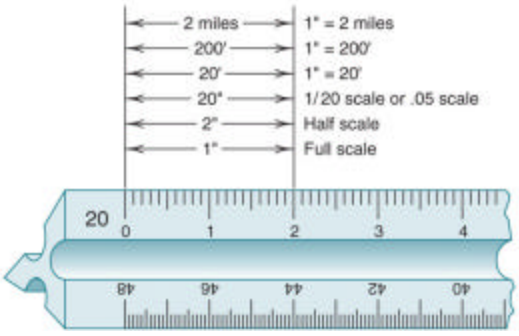
6.5.2 The **civil engineer's scale** is a decimal scale divided into multiple units of 10 and is called a fully divided scale (Fig 6-47).

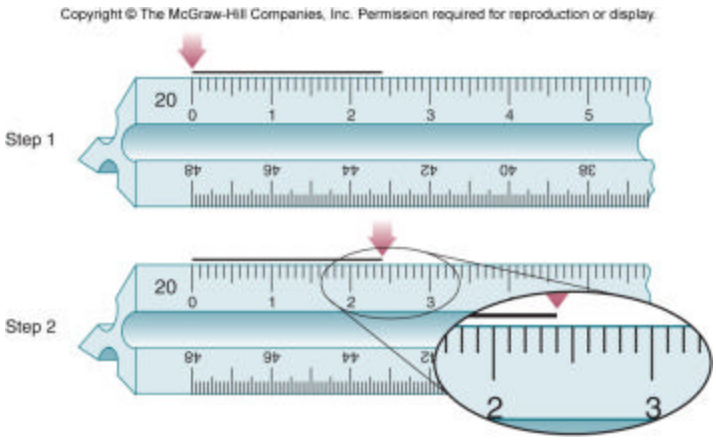


Steps in reading a civil engineer's scale (Fig 6.48 & 49):

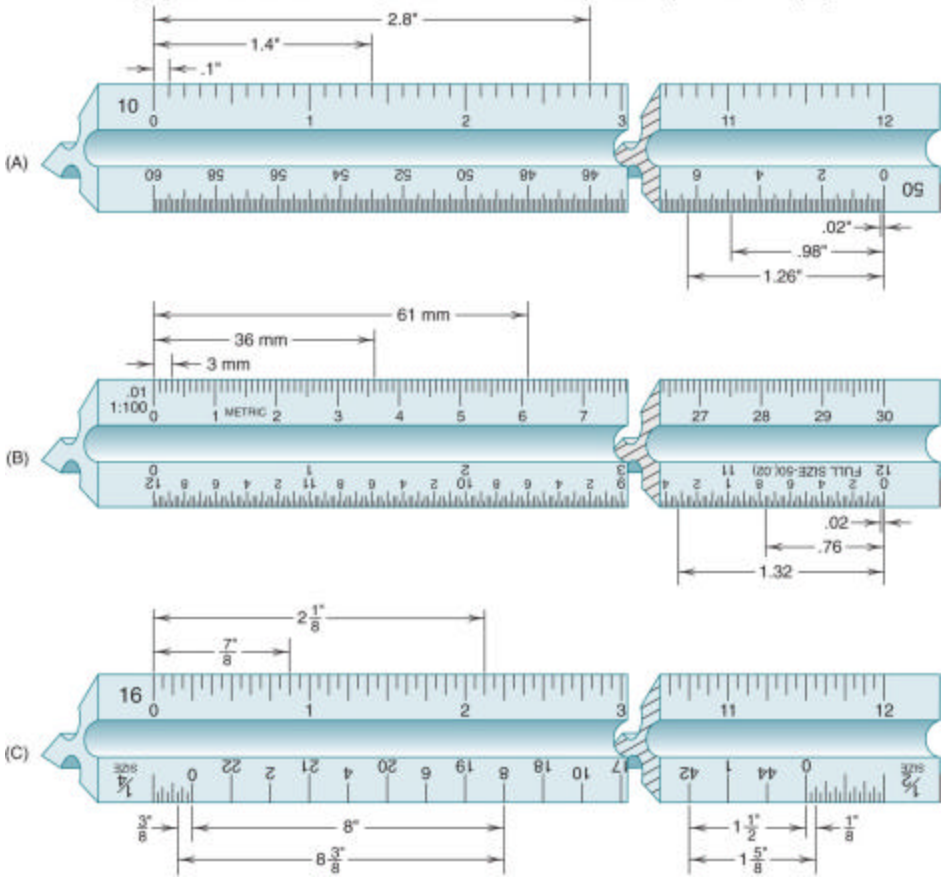
CIVIL ENGINEER'S SCALE

Divisions	Ratio	Scales Used with This Division			
10	1:1	1" = 1"	1" = 1'	1" = 10'	1" = 100'
20	1:2	1" = 2"		1" = 20'	1" = 200'
30	1:3	1" = 3"		1" = 30'	1" = 300'
40	1:4	1" = 4"		1" = 40'	1" = 400'
50	1:5	1" = 5"		1" = 50'	1" = 500'
60	1:6	1" = 6"		1" = 60'	1" = 600'

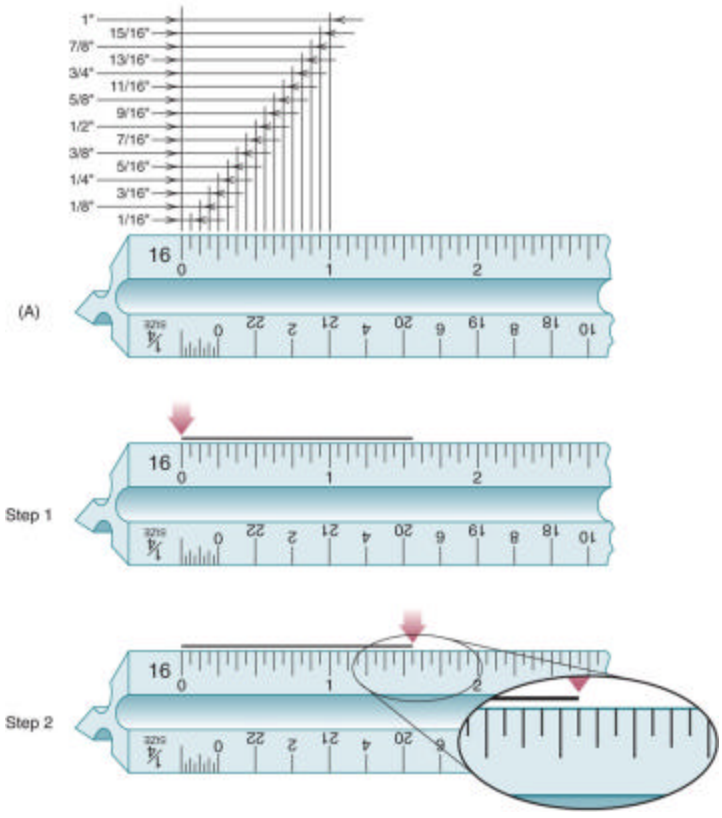




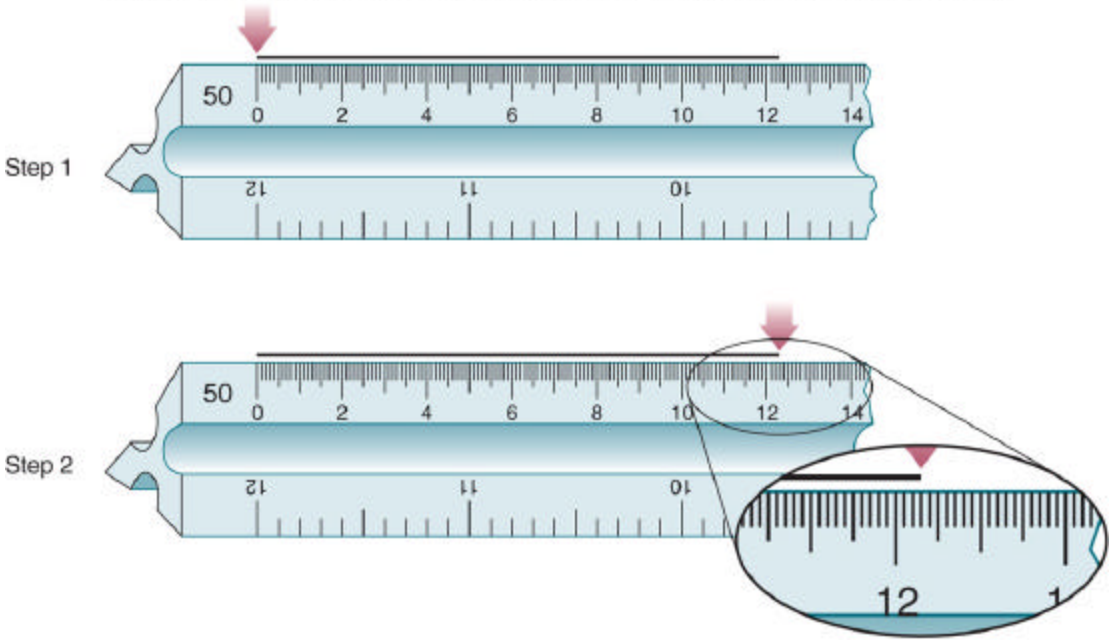
6.5.3 The **mechanical engineer's scale** is used to draw mechanical parts and is either fractionally divided into 1/16 or 1/32, or decimally divided into 0.1 or 0.02 (Fig 6-50).



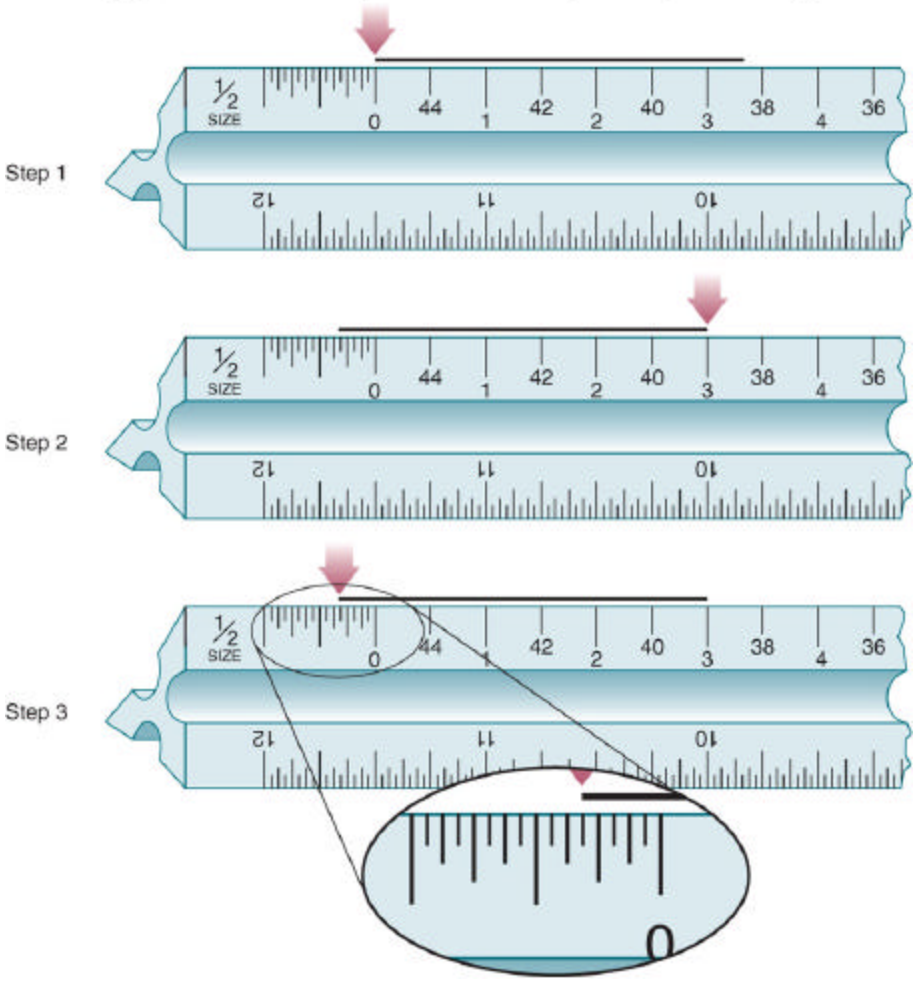
Steps in reading a mechanical engineer's scale (Fig 6-51):



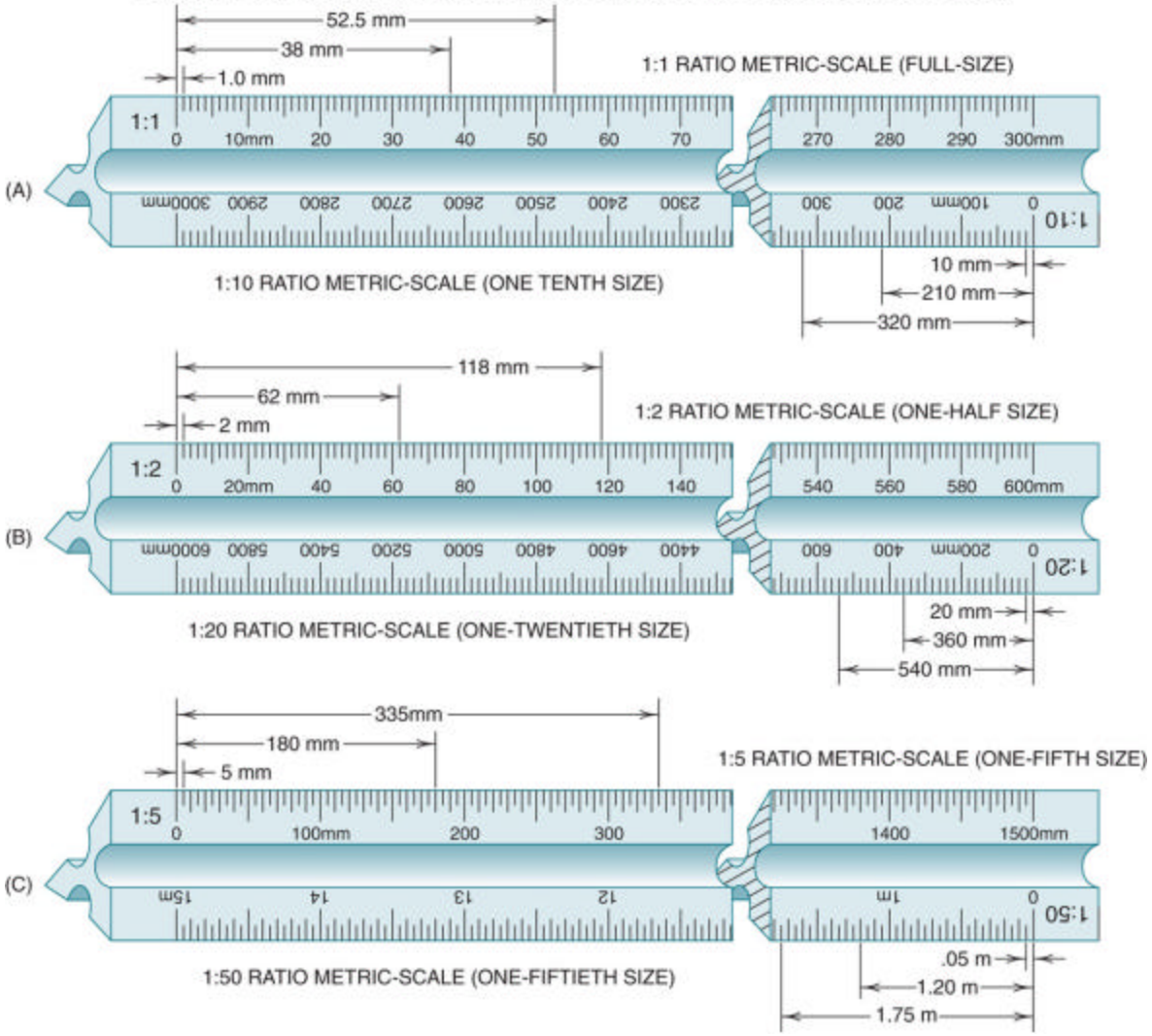
Reading a 50 scale (Fig 6-52):



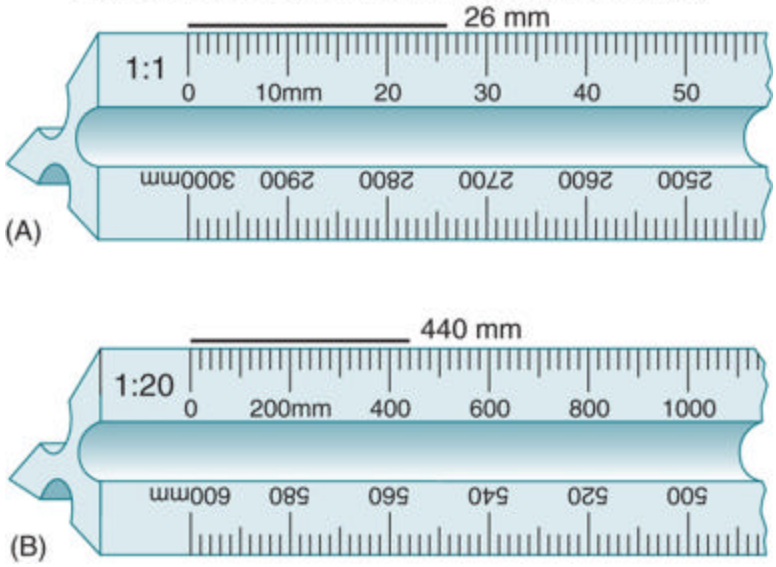
Reading a half-size scale (Fig 6-53):



6.5.4 The international organization that established the metric standard is the **International Standards Organization (ISO)**. The system is called the **International System of Units** or Systeme Internationale, abbreviated **SI.** The **metric scale** is used to create scaled technical drawings using SI units (Fig 6-54).



Reading the full and 1:20 metric scale (Fig 6-55):



6.6 DRAWING INSTRUMENT SET

Drawing instrument set commonly used for technical drawings.

6.6.1 The **compass** is used to draw circles and arcs of varying diameters.

The lead in a compass is sharpened to a bevel using sandpaper.

A beam is a special attachment to a regular compass and is used to draw large circles and arcs.

Steps used to draw a circle with a compass.

6.6.2 A divider is used to transfer measurements.

6.7 TEMPLATES

Templates are devices used to assist in the drawing of repetitive features, such as circles, ellipses, threaded fasteners, and architectural symbols.

An architectural symbol template.

6.8 TECHNIQUE FOR LAYING OUT A DRAWING SHEET

Steps in laying out a drawing sheet.

6.9 TECHNIQUE FOR DRAWING USING TRADITIONAL TOOLS

Engineering and technical drawings are used to communicate technical information. In order to communicate the technical idea clearly, the drawing must be neat and must have consistent lines.

Examples of good and poor drawing technique for lines and arcs using traditional tools.

6.10 SUMMARY

The tools used for technical drawing include traditional ones, such as the triangle and the compass, and CAD. Traditional tools are used to make technical drawings by hand, and it takes practice and repetition to become proficient at their use. Although with CAD there is less emphasis on developing good technique, it still requires practice and repetition to attain proficiency.