

Block C: Routine Trade Activities and Electrical Concepts



Plumbing Apprenticeship Program Level 1 Series

Block C: Routine Trade Activities and Electrical Concepts

BC Plumbing Apprenticeship, Level 1

SKILLEDTRADESBC

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Block C: Routine Trade Activities and Electrical Concepts of the Plumbing Apprenticeship Program Level 1 Series features Skilled Trades BC industry-authority content on the routine trade activities and foundational electrical concepts that support accurate, efficient, and code-compliant plumbing work. This block emphasizes the knowledge apprentices rely on to interpret information, apply standards, and make informed decisions on the job site.

In Block C, apprentices develop core skills in mathematics and science as they apply to the trades, build an understanding of basic electrical concepts and principles of electricity, and learn how to read and interpret drawings and specifications. The block also introduces codes, regulations, and standards, along with the effective use of manufacturer and supplier documentation. Together, these competencies help apprentices work safely, communicate clearly with other trades, and ensure installations meet required technical and regulatory expectations.

Plumbing Apprenticeship Program Level 1 Series

The *Plumbing Apprenticeship Program Level 1 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Safety Related Functions

- A-1: Workplace Hazards
- A-2: WorkSafeBC Regulations
- A-3: Safe Handling of Hazardous Materials
- A-4: Personal Safety Practices
- A-5: Fire Safety

Block B: Tools and Equipment

- B-1: Use Hand Tools and Measuring Tools
- B-2: Use Portable Power Tools and Use
- B-3: Use Access Equipment
- B-4: Use Rigging, Hoisting, Lifting and Positioning Equipment, and Rigging
- B-5: Use Soldering and Brazing Equipment and Oxy-Fuel Cutting Equipment
- B-6: Use Welding Equipment

Block C: Routine Trade Activities and Electrical Concepts

- C-1: Mathematics and Science
- C-2: Electrical Concepts and Principles of Electricity
- C-3: Drawings and Specifications

C-4: Codes, Regulations and Standards

C-5: Manufacturer and Supplier Documentation

Block D: Piping and Components

D-1: Install Pipe and Tubing

D-2: Install Valves

D-3: Install Fittings

D-4: Penetrate Structures

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** can be found in the TRU Open Press Collection.
- **Plumbing Apprenticeship Program Level 2 Series** can be found in the TRU Open Press Collection.
- **Plumbing Apprenticeship Program Level 3 Series** can be found in the BCCampus Open Collection.
- **Plumbing Apprenticeship Program Level 4 Series** can be found in the BCCampus Open Collection.
(Block F: Commission and Service will be available soon.)

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Safety Advisory

The current Standards and Regulation in BC can be obtained at the WorkSafeBC website: <http://www.worksafebc.com>

Please note that it is always the responsibility of any person using these materials to inform themselves about the Occupational Health and Safety Regulation pertaining to their areas of work.

[From previous 2021 book – confirm this message with Skilled Trades]

Symbol Legend



Important Information



Potentially Toxic/ Poisonous Situation



Required or Optional Resources



Potentially Flammable Situation



Complete a Self-Test



Possibly Explosive Situation



Use Protective Equipment



Potential Electric Shock

Acknowledgements

The development of the *Plumbing Apprenticeship Level 1* learning resources was a collaborative effort driven by a commitment to excellence in trades education. These resources were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose contributions, leadership, and guidance have been instrumental in shaping high-quality, industry-aligned training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.

The content for *Block C: Routine Trade Activities and Electrical Concepts* is adapted from the Piping Trades Apprenticeship Program from SkilledTradesBC (2019 Harmonized) and the Trades Access Common Core (TACC) resources developed by Camosun College, created in 2015 and revised in 2019, and made available through BCcampus:

- Line D: Organizational Skills: Competency D-1: Solve Trades Mathematical Problems
- Line D: Organizational Skills: Competency D-2: Apply Science Concepts to Trades Applications
- Line D: Organizational Skills: Competency D-3: Read Drawings and Specifications
- Line D: Organizational Skills: Competency D-4: Use Codes, Regulations and Standards
- Line D: Organizational Skills: Competency D-5: Use Manufacturer and Supplier Documentation
- Line D: Organizational Skills: Competency D-6: Plan Projects

The original materials were produced in collaboration with industry partners and aligned with the Industry Training Authority (ITA)/SkilledTradesBC harmonized program outlines for Plumbing, Steamfitting/Pipefitting, and Sprinkler Fitting. These works were released under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence, except where otherwise noted.

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This adapted version has been reformatted and integrated into the current Thompson Rivers University/TRU Open Press open educational resource in collaboration with the BC Piping Articulation and Curriculum Subcommittee and SkilledTradesBC, in support of open, accessible, and up-to-date apprenticeship training.



The Open Press

The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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Resources

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- Open School BC
- Camosun College
- Trades Training BC

For the latest BC Plumbing Trades Program Outline (2025), see the SkilledTradesBC website: www.skilledtrades.bc.ca

To order printed copies of Program Outlines or learning resources (where available) for BC Trades, contact:

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If you are using a printed copy, you can scan the QR code with your digital device to go directly to the video: Introducing SkilledTradesBC



Starting December 1, 2022, Industry Training Authority was officially renamed to SkilledTradesBC. Hear more in this video from SkilledTradesBC CEO, Shelley Gray, on what this means for the trades industry and British Columbians. Closed captioning and transcripts are available with this video, Introducing Skilled Trades BC (2022) on YouTube.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://c-tradeactivities-electrical-bcplumbingapprl1.pressbooks.tru.ca/?p=2618>

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- Camosun College. (n.d.). *Line D: Organizational Skills*. BCcampus. <https://collection.bccampus.ca/textbook/qFKGAJ78/>
- SkilledTradesBC. (2025). Plumber program outline (Implementation date: August 18, 2025; Last revised: December 16, 2025) [PDF]. Province of British Columbia. <https://skilledtradesbc.ca/media/2776/download>
- SkilledTradesBC. (2022, December 1). Introducing Skilled Trades BC. YouTube. <https://www.youtube.com/watch?v=OQgwdP0rNog>

Accessibility

The web version of *Block C: Routine Trade Activities and Electrical Concepts* has been designed to meet Web Content Accessibility Guidelines 2.0, level AA. In addition, it follows all guidelines in Appendix A: Checklist for Accessibility of the Accessibility Toolkit – 2nd Edition.

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Tables	Tables do not have merged or split cells.	
Tables	Tables have adequate cell padding.	
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Links	Links do not open new windows or tabs. If they do, a textual reference is included in the link text.	
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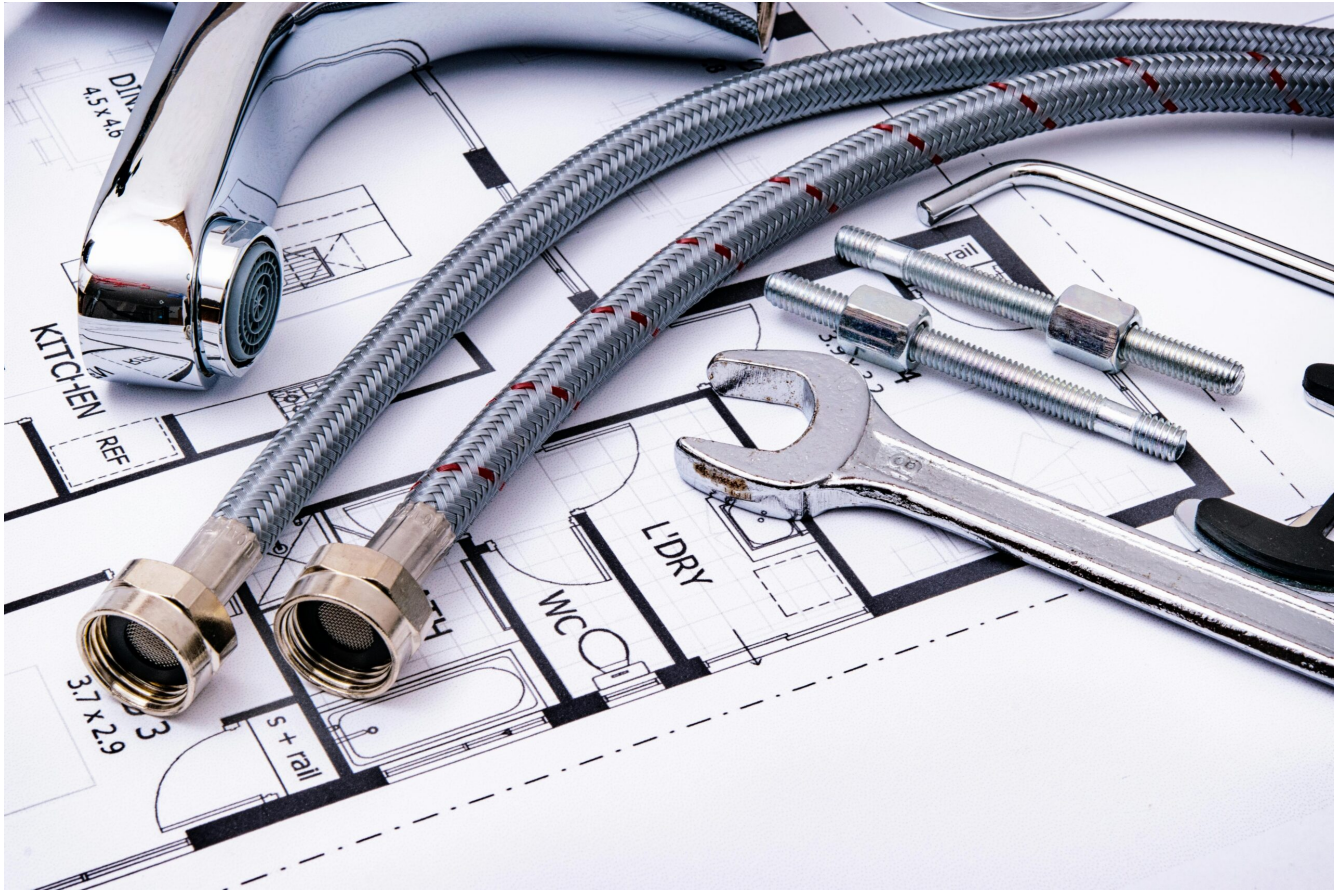
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Other Formats Available

- In addition to the web version, this book is available in a number of file formats, including PDF. The Print PDF has passed our Accessibility Check.

C-3 DRAWINGS AND SPECIFICATIONS

Plumber Apprenticeship Program – Level 1



Close-up of plumbing tools and faucet on top of an architectural blueprint (AS Photography/Pexels) Pexels License

C-3 Drawings and Specifications Introduction

Drawings and specifications are essential tools in the pipe trades. They provide the information needed to plan, install, and maintain piping systems safely and accurately. Drawings show the layout, dimensions, and relationships between components, while specifications describe the materials, standards, and requirements that must be followed.

In this section, you will learn how to read and interpret common types of trade drawings, understand symbols and dimensions, and use basic drafting tools. These skills are critical for communicating with other tradespeople, following project requirements, and ensuring that work is completed correctly and efficiently.

Learning Objectives

After completing this section, you should be able to:

- Describe the drafting tools and materials.
- Use scale rulers to determine actual dimensions from a piping diagram.
- Describe piping and fixture symbols used in the pipe trades.
- Describe lettering and dimensioning of piping diagrams.
- Describe drawing projections.
- Use drawing projections.
- Use tools to sketch irregular shapes.

Topic areas covered in this publication are in alignment with SkilledTradesBC Harmonized 2018 Program Outlines.



You will be required to reference publications and videos available online at WorkSafeBC.

Supplementary Resources

- Trades Access Common Core Line C: Tools and Equipment Videos – BCcampus by Camosun College.
 - Tape Measures
 - Understanding the Imperial Ruler
 - Chalk Lines

Terminology

The following terms may be used throughout this section. Note that some glossary terms may be in italics throughout the section content but are not included in this list. A complete list of terms for this section can be found in the **Glossary**.

- **compass:** A tool used to draw circles or curved lines. (Section C-3.1)
- **divider:** A tool with two sharp points used to measure or copy distances. (Section C-3.1)
- **drafting board:** A flat surface used for drawing plans and diagrams. (Section C-3.1)
- **French curve:** A tool with curved edges used to draw smooth curved lines. (Section C-3.1)
- **mechanical pencil:** A pencil that uses replaceable graphite sticks instead of wood. (Section C-3.1)
- **protractor:** A tool used to measure and draw angles. (Section C-3.1)
- **radian:** Another way to measure angles (used mainly in advanced math). (Section C-3.1)
- **scale rule:** A ruler used to measure and draw objects at a smaller or larger size. (Section C-3.1)
- **spline (flexible curve):** A flexible tool used to draw smooth curves. (Section C-3.1)
- **steel straightedge:** A straight metal ruler used to check if a line is perfectly straight. (Section C-3.1)
- **T-square:** A T-shaped tool used to draw straight horizontal lines. (Section C-3.1)
- **template:** A tool with cut-out shapes used to trace standard drawings. (Section C-3.1)
- **triangle (set-square):** A flat tool used in drafting to draw straight lines and angles. (Section C-3.1)

C-3.1 Describe the Drafting Tools and Materials Tools

Drafting is an essential skill in the piping and plumbing trades. Whether you are preparing a simple sketch for a jobsite layout or reading detailed construction drawings, the ability to understand and create accurate drawings ensures that work is completed safely, efficiently, and to specification. Before you begin drafting, it is important to become familiar with the tools and materials used to produce clear and precise drawings.

This section introduces the most common drafting tools—such as *drafting boards*, *T-squares*, *triangles*, and *scale rules* (or *scales*)—and explains how to select, maintain, and use them correctly. A good understanding of these tools will help you develop accuracy and consistency in your drawings and prepare you for more advanced drafting tasks later in your training.

Drafting Board or Table



Figure 1 Drafting Table (Czapp Árpád/Pexels) Pexels License

The surface of the **drafting board** should be smooth. It should have a true, flat surface, with no warps or twists. The surfaces of most drafting boards are covered with vinyl because it is smooth and even. To allow the vinyl to expand and contract, fasten it only at the top and on one side.

The drafting board or table should have two parallel outside working edges, made of either hardwood or steel. The working edges should be tested for straightness with **asteel straightedge**. If the edges are not parallel or straight, they should be corrected before you use the board.

Most drafting table tops can be set at different heights from the floor and at any angle from vertical to horizontal. Other drafting tables may not have the same adjustments and can be raised only from a horizontal position to a low slope.

To reduce back strain, use an adjustable drafting stool when working at a drafting table. Tables or boards should be a minimum of 1.2 m (4 ft) in width and 0.9 m (3 ft) in height.

T-Square

The fixed head **T-square** is used for most work. It should be made of durable materials and have a transparent edge on the blade. To do accurate work, the blade must be perfectly straight. To check the straightness of the blade, mark two points on a sheet of paper. Then, draw a line to join the two points using the blade of the T-square as your guide. Turn the blade over and draw another line to join the same two points (Figure 2). Both lines should be directly over each other if the blade is perfectly straight. T-squares typically have blades that are 0.75 m (30") to 1 m (42") long.

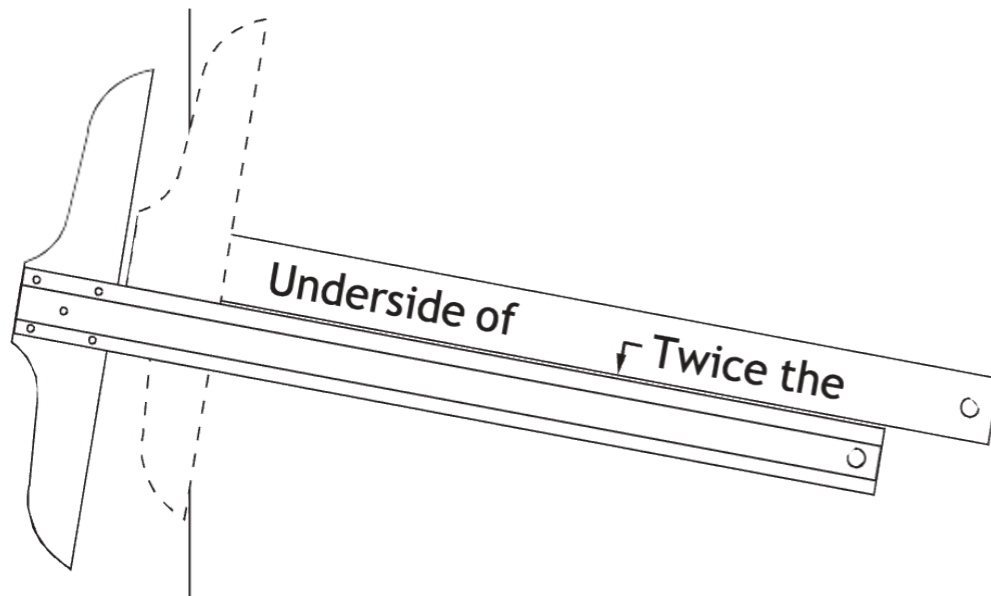


Figure 2 Testing the straightness of a T-square (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

The T-square is used to draw horizontal lines on paper. For right-handed people, it is held tightly against the left edge of the drawing board and moved up and down as required. When making close adjustments, place the fingers of your left hand on top of the square and use your thumb to control the T-square's movement.

When drawing horizontal lines, incline your pencil in the direction of the line. Hold the pencil point as close as possible to the blade and roll the pencil between your fingers to prevent the point from becoming flat on one side.

Triangles

Triangles (set-squares) are made of a clear plastic with **rabbeted edges** (Figure 3), so that when you draw lines, the edge raised from the tracing paper. This helps prevent smudges and ink blotches.

Triangles are available in 45°–90°–45° or 30°–60°–90° combinations. For most work, triangles should be about 200 mm to 250 mm (8–10") long. Triangles should be stored flat to prevent warping and should not be placed under other objects. This prevents any pressure put on them, which will cause them to deform.

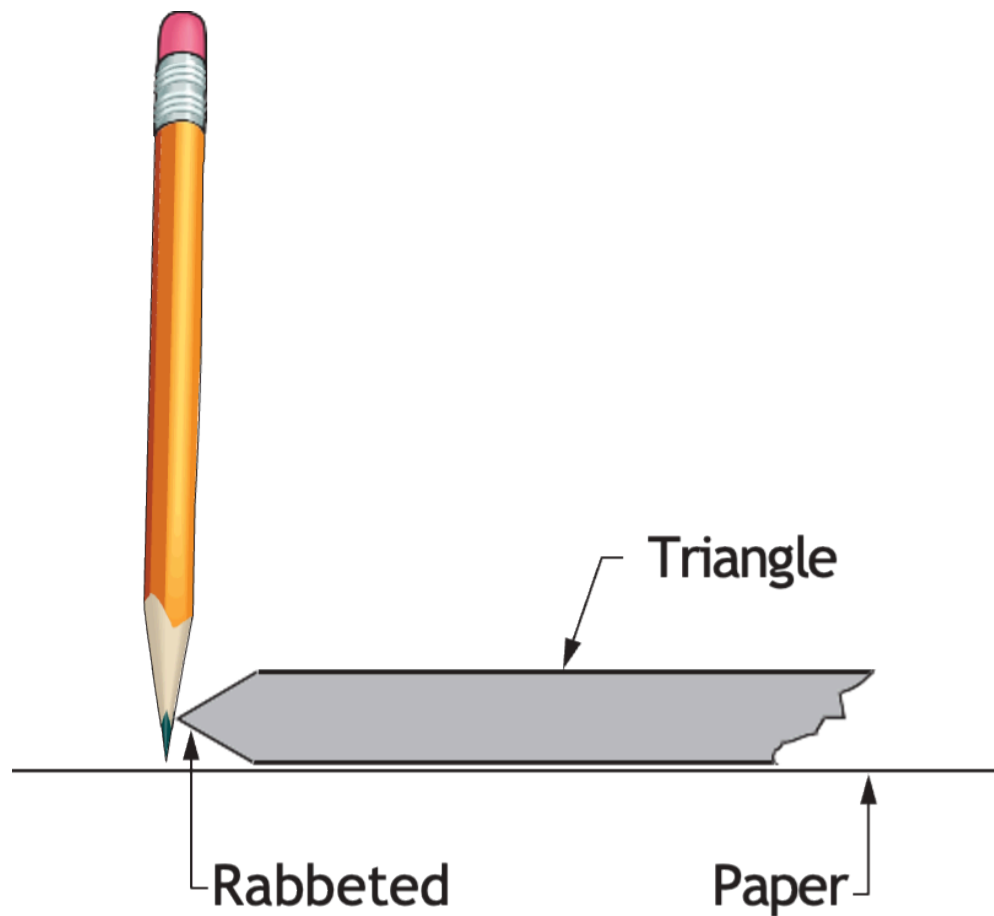


Figure 3 Rabbeted edge (side view) (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

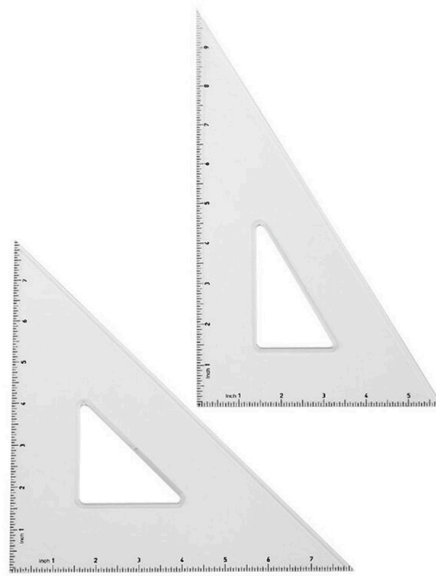


Figure 4 Triangle30-60 (Cletzrodt/ Wikimedia Commons) License

Triangles are used to draw vertical lines and other lines at set angles. Rest the triangle on the T-square blade and slide it along the blade to the desired location. Draw the full length of the vertical line in one pass if possible. Hold the blades of the T-square and the triangle together firmly to prevent any movement when you are drawing. Hold the pencil point as close as possible to the triangle when you are drawing.

Check a triangle for accuracy by drawing a perpendicular line, then reversing the triangle and drawing another perpendicular line (Figure 5).

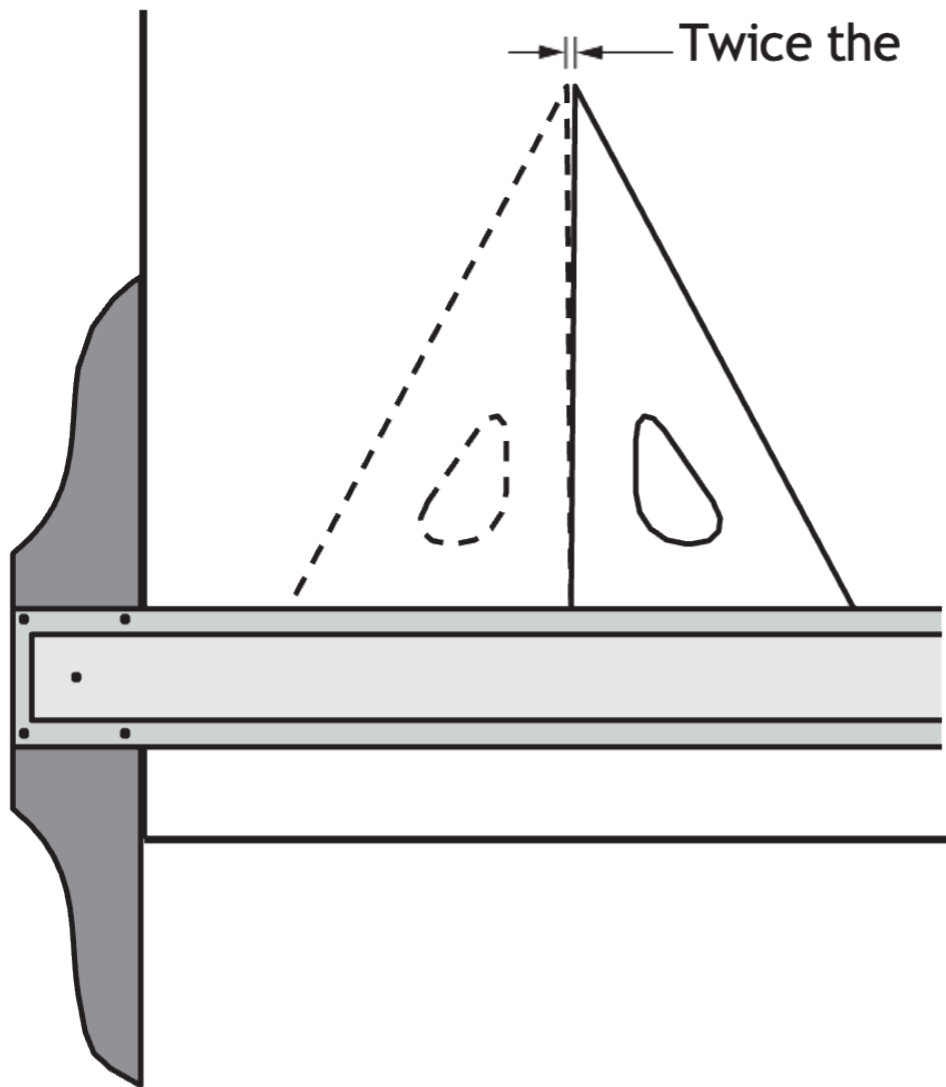


Figure 5 Testing the straightness of a T-square (BC Industry Training Authority, 2019).CC BY-NC-SA 4.0

You can also draw 15° and 75° angles by using both a $45^\circ-90^\circ-45^\circ$ and a $30^\circ-60^\circ-90^\circ$ in combination. Figure 6 shows how triangles are placed to draw angles that are every multiple of 15° .

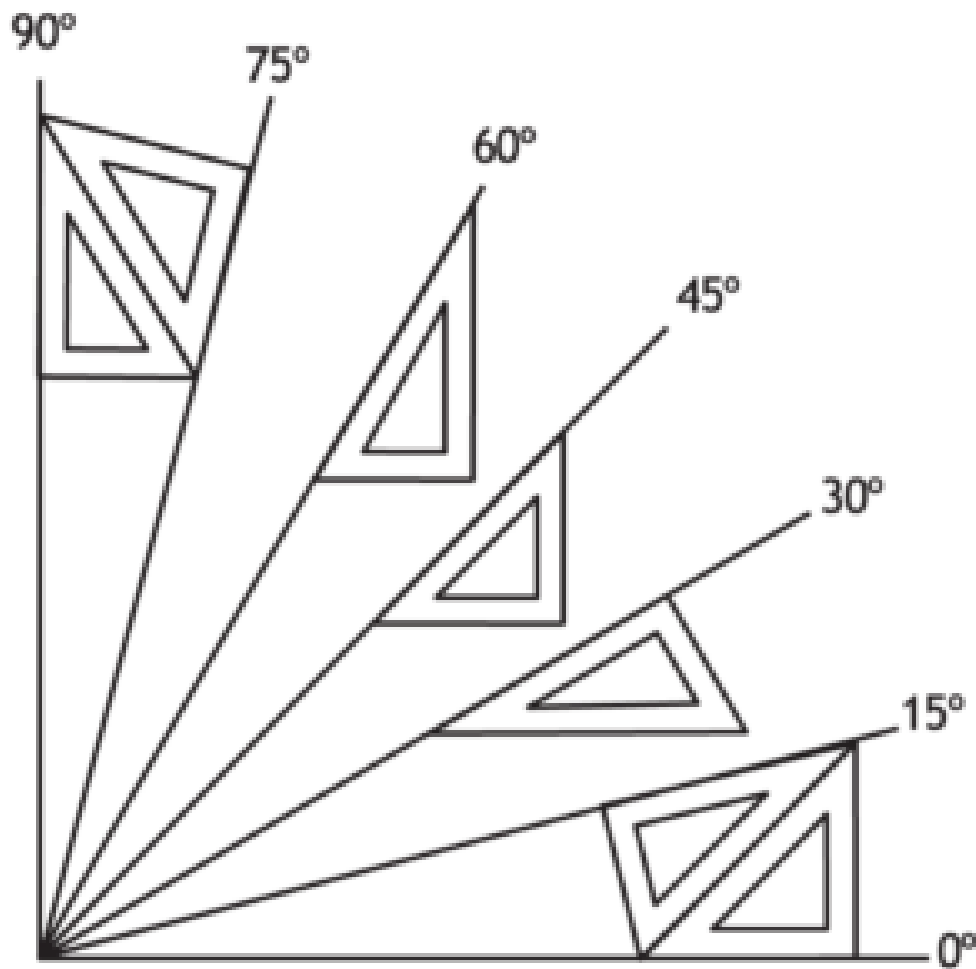


Figure 6 Drawing angles with one or two triangles (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Protractor

A **protractor** is a square, circular, or semicircular tool, typically made of transparent plastic or glass, for measuring angles. Most protractors measure angles in **degrees** while some measure in **radians** (Figure 7).

Protractors are used for a variety of mechanical and engineering-drafting applications to transfer angles to the drawing sheet. Some protractors are simple half-discs, while others, such as the **bevel protractor**, have one or two adjustable swinging arms, which can be used to measure angles more precisely.

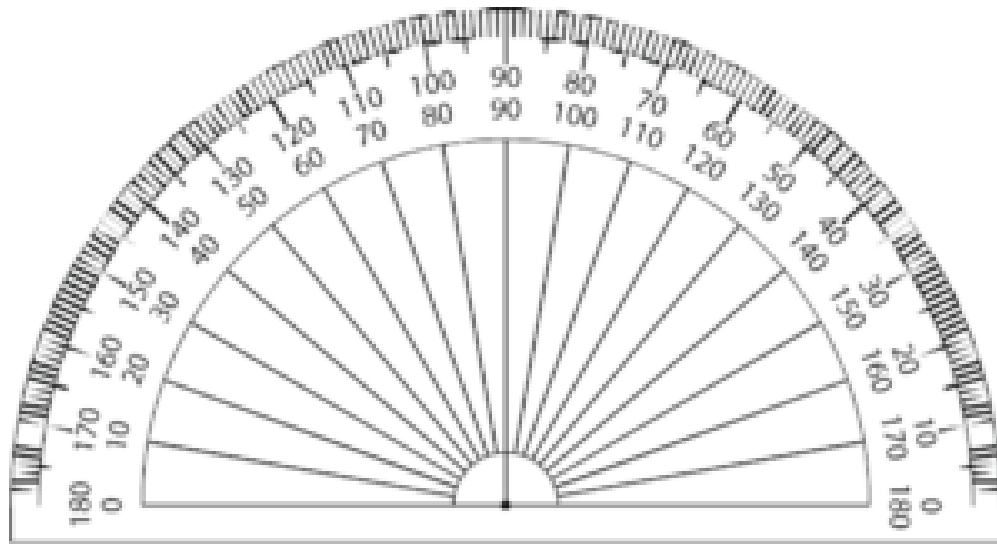


Figure 7 Protractor (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

French Curves and Splines

A **French curve** (Figure 8) is a plastic or metal template designed to help you draw curves. It is often used in the design of cars and dresses. The French curve contains many different curve shapes, but each one is represented over a very short distance only. The French curve allows you to draw and connect curves together so they fit together perfectly without using mathematics calculations.

To use a French curve, align one section with the two points you want to connect, then trace along the edge of the French curve with your pencil. One radius of the curve blends into another radius. It takes a lot of practice to use French curves effectively!



Figure 8 French curve (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

A **spline**, or the more modern term, *flexible curve* (Figure 9), can be used instead of a French curve to draw most curves.

A spline is a bendable plastic or rubber rod that is reinforced with metal. To use a spline, bend it to the shape of the curve you need and draw along its edge. The design of the spline lets you hold a pencil against an edge and draw an accurate line without smudging. A spline cannot be used to draw tight curves that have a very short radius because the spline will not bend sharply enough. Sometimes a spline is temporarily held in position with small weights.



Figure 9 Spline (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Drawing Pencils

Manufacturers grade drawing pencils by numbers and letters. These range from 6B (very soft and black) to 9H (the hardest). From 6B the pencils progress through 5B, 4B, 3B, 2B, B and HB, and then to F, the medium grade. After that, they move to the harder graphite: H, 2H, 3H, 4H, 5H, 6H, 7H, 8H and finally 9H. The softer grades are used for sketching and rendering (shading and texturing) drawings. The harder grades are used for more precise instrument drawings.

Mechanical pencils are made to hold leads that are bought separately. (Although they are called leads, they are made of graphite.) Most draftspeople use four or five different mechanical pencils with a different lead grade in each. Pipe trades workers are likely to find a 0.7 mm pencil handy. Most mechanical pencils come in different colours so that you can keep track of which lead is in each.

Special pencil sharpeners are used to sharpen wooden pencils and mechanical pencils (Figure 10). However, thin-lead mechanical pencils, with leads as small as 0.5 mm, are available in different grades of lead and do not require sharpening.



Figure 10 Wood and mechanical pencils (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Eraser Shields

An **erasing shield** is a thin metal tool used to erase small areas precisely. It has cut-out shapes that allow you to erase only the desired section without affecting surrounding lines. Figure 11 shows two erasers and an erasing shield.



Figure 11 Erasers and erasing shield (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Scale Rules

Scale rules enable you to draw diagrams of piping systems and other objects at a reduced scale and measure distances on scaled drawings.

Scale rules come in a variety of types to meet the requirements of many different kinds of work. Most scale rules have three sides and six different scales. The scales are read from either end of the rule.

Common metric scales are expressed in ratios of 1:1, 1:2, 1:5, 1:10, 1:20 and 1:50, or 1:100, 1:200, and 1:500. Because metric units are based on multiples of 10, they are easy to convert between scales to suit your purpose (Figure 12).

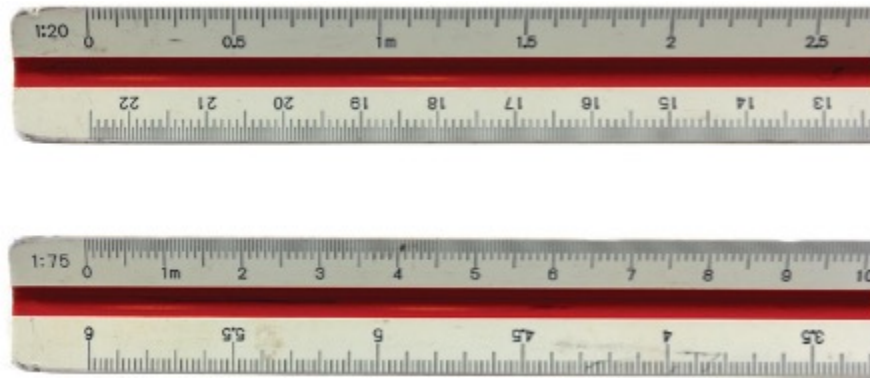


Figure 12 Metric scale rule (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Imperial scale rules may be an *architect's rule*, a *mechanical engineer's rule* or a *civil engineer's rule* (Figure 13); each uses different units. The architect's scale rule is in inches and fractions of inches. A mechanical engineer's scale rule comes in inches and decimals of inches. A civil engineer's scale rule comes in feet and decimals of feet. The most common scale rules are the metric and architect's scales.

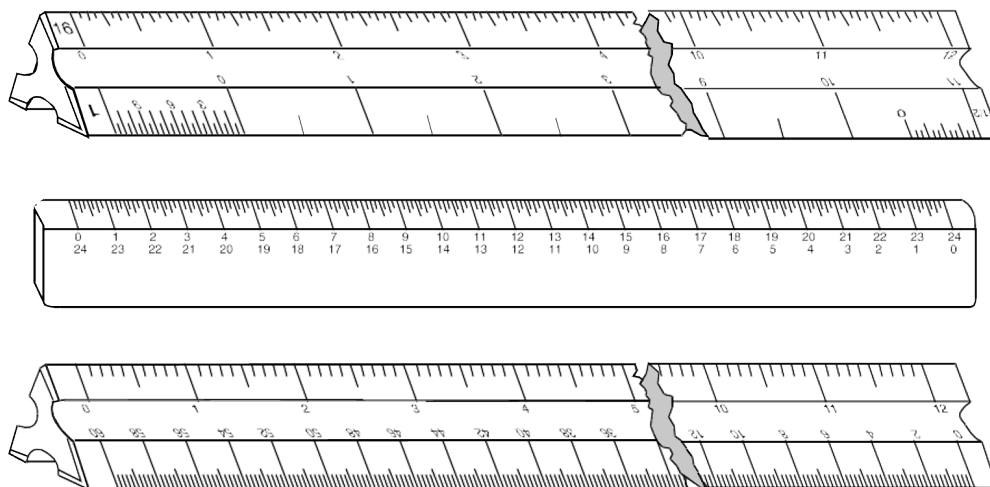


Figure 13 Inch-feet scale rules (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Templates

Templates are thin plastic tools with cut-out shapes. They are used to draw standard symbols and fixtures that are commonly used in a trade. These cut-outs make it easy to trace shapes onto drawing paper quickly and accurately.

Templates contain pre-dimensioned holes in the right scale to accurately draw a symbol or sign. They are available in many forms and sizes, including circles, geometric shapes, and trade-specific symbols such as plumbing fixtures.

Circle templates are used for drawing circles and circle-arcs of certain dimensions. Models are also available for other geometric shapes such as squares and ellipses, as well as many specialized varieties for other purposes.

There are also specific templates that contain the most common symbols in use in different branches of designing. For

example, architect templates can be used to draw different sized doors with their opening arcs, building and equipment symbols, plumbing fixtures, and furniture. The templates also provide the symbols for thermal insulation.

There are templates available for many different trades. Templates that are used by pipe trades workers are the isometric, plumber's and heating templates (Figure 14).



Figure 14 Templates (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Compasses

For larger circles and arcs that cannot be drawn with the circle template, you can use a **bow**, **wing** or a **friction compass**. For very large circles, you can use a **beam compass**. These four types of compasses are shown in Figure 15.

Most compasses can be fitted with leads, pens, or points. For best results, adjust the lead so that it is about $1/32$ " shorter than the needle. Both legs will be the same length when the needle penetrates the paper. Fit the **compass** with lead that is one grade softer than the pencil used to make the drawing. The lead must be kept sharp.



Friction compass

Bow compass



Wing compass



Beam compass

Figure 15 Four types of compasses (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

To set the compass to size, draw a line on a piece of clean scrap paper and measure off the required radius. Set the compass on this line. Avoid setting a compass on a scale. Sticking the compass needle into the scale will eventually destroy its accuracy. When using the compass, tilt it in the direction of movement as you draw the line, as shown in Figure 16.

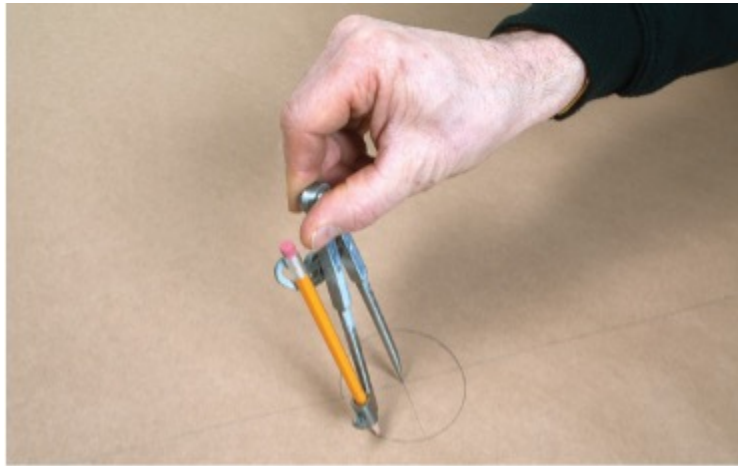


Figure 16 Drawing circles with a compass (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Dividers

A **divider** is an instrument used for measuring, transferring, or marking off distances. It consists of two straight, adjustable legs hinged together and ending in sharp points (Figure 17). It is used principally in drafting for accurate transfer of dimensions from a drawing sheet to a measuring device, such as a ruler.



Figure 17 Divider (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0



Self-Test C-3.1: Describe the Drafting Tools and Materials Tools

Complete Self-Test C-3.1 and check your answers.

If you are using a printed copy, please find Self-Test C-3.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
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C-3.2 Use Scale Rulers to Determine Actual Dimensions from a Piping Diagram

In the piping trades, most of the drawings you work from are not shown at their actual size. Buildings, mechanical rooms, and piping systems are far too large to fit on a page, so designers reduce the size of the drawing while keeping every part in proportion. To understand these drawings and to correctly determine the real-world lengths of pipe and the locations of **fittings**, you must be able to use a **scale ruler**.

A scale ruler allows you to read measurements that have been reduced by a certain ratio, such as $1/4" = 1'-0"$ in imperial units or 1:50 in metric. When you understand how these ratios work, you can accurately interpret piping diagrams, estimate material lengths, and verify **dimensions** on both imperial and metric plans.

This section will teach you how to read and use **architect's (imperial) scales** and metric scales, how to convert scale measurements into real-world dimensions, and how to avoid common mistakes when measuring from drawings. By the end, you will be able to confidently obtain approximate pipe lengths directly from a drawing whenever written dimensions are not provided.

Scale drawings are accurate and convenient visual representations made and used by engineers, architects, and people in the construction trades. The accuracy is achieved because the drawing is **proportional** to the real object. The convenience comes from the reduced size of the drawing. It is large enough to provide the desired detail but small enough to be manageable.

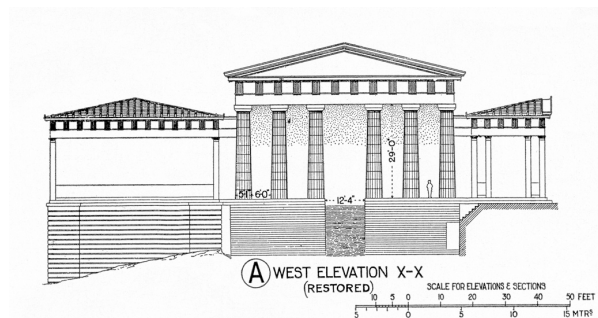


Figure 1 House numeric labels (Mnesicles, Flickr) CC BY-NC 2.0

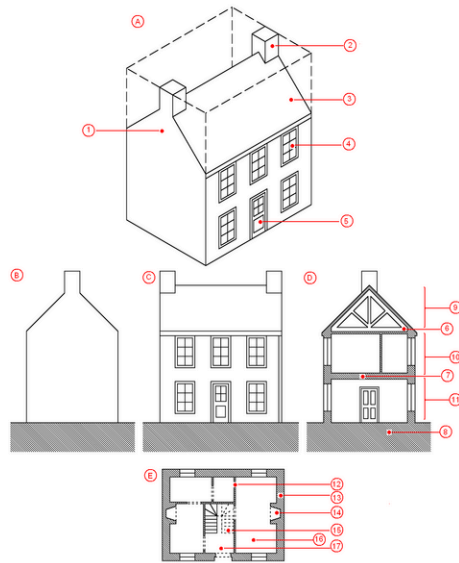


Figure 2 House Numeric Labels (Cmdrjameson, InfoCan/Wikimedia Commons) CC BY-SA 3.0

The flexibility to draw proportionally in different sizes is provided by the use of scales. Since piping systems are large compared to piping drawings, we will only be concerned with **reduction scales**. Reduction scales make the drawing smaller than the object. The kinds of rules we will typically use to make scaled drawings are the architect's scale and the metric scale, both shown in Figure 3.

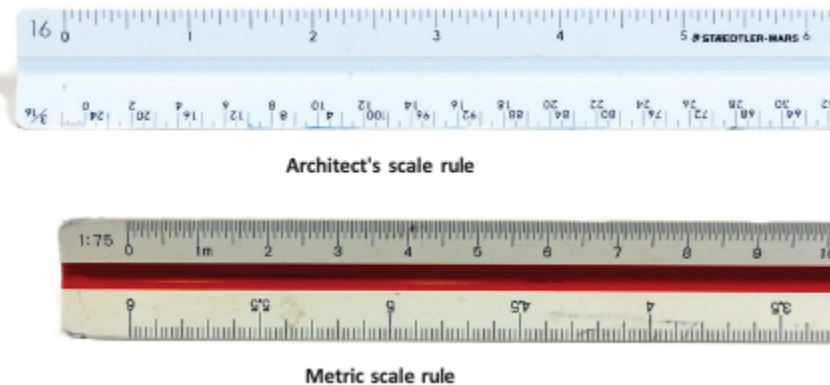


Figure 3 Architect's and metric scale rules (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Proportional Scaling

The scale of the drawing is always written on the drawing. The **scale** is the ratio of the size of the drawing to the object. For drawings smaller than the object, the ratio will be that of a smaller distance to a larger one.

Architect's scales use ratios of inches to a foot. The most common architect's scale used is $\frac{1}{4}$ " to the foot, written on drawings as:

$$\text{Scale } \frac{1}{4}" = 1' - 0"$$

This means that a line $\frac{1}{4}"$ long on the drawing represents an object that is 1 foot long. At the same scale, a line $1\frac{1}{2}"$

long represents an object 6' long, because $1\frac{1}{2}"$ contains six quarter-inches.

Metric scale ratios use the same units in both ratio terms, resulting in an expression of how many times smaller than the object the drawing is. For example, the standard metric scale ratio that approximately corresponds to $\frac{1}{4}" = 1' - 0"$ is written on drawings as:

Scale 1:50

This means that the object is actually 50 times as large as what's shown on the drawing, so 50 mm on the object is represented by 1 mm on the drawing. For another example, 30 mm on the drawing represents 50×30

$$= 1,500 \text{ mm (or 1.5 metres) on the object} \quad \cdot$$

Table 1 lists the scale ratios commonly used for building plans and construction drawings in both metric and the equivalent architectural scale ratios.

Table 1 Preferred Scales for Building Drawings

Type of Drawing	Common Metric Ratios	Use	Imperial Equivalents and Ratios	
Site Plan	1:500 1:200	To locate the building, the services and reference points on the site.	1" = 40'-0" $\frac{1}{16}$ " = 1'-0"	(1:480) (1:192)
Sketch Plans General Locations Drawings	1:200 1:100 1:50	To show the overall design of the building. To indicate the juxtaposition of the rooms and locate the positions of piping systems and components.	$\frac{1}{16}$ " = 1'-0" $\frac{1}{8}$ " = 1'-0" $\frac{1}{4}$ " = 1'-0"	(1:192) (1:96) (1:48)
Construction Details	1:20 1:10 1:5 1:1	To show the detail of system components and assemblies.	$\frac{1}{2}$ " = 1'-0" 1" = 1'-0" 3" = 1'-0" Full size	(1:24) (1:12) (1:4) (1:1)

Architect's (Imperial) Scales

Traditional architectural measurements of length are written very precisely in feet and inches using the appropriate symbols for feet and inches, separated by a hyphen (e.g., 4' - 3 $\frac{1}{2}$ " and 7' - 0"). This is the way that all imperial measurements should be written on construction drawings.

Listed below are the scales found on the architect's triangular scale rule.

- | | |
|-------------------------------|--------------------------------|
| 1. $\frac{3}{32}$ " = 1' - 0" | 7. 1" = 1' - 0" |
| 2. $\frac{3}{16}$ " = 1' - 0" | 8. $\frac{1}{2}$ " = 1' - 0" |
| 3. $\frac{1}{8}$ " = 1' - 0" | 9. 1 $\frac{1}{2}$ " = 1' - 0" |

4. $\frac{1}{4}" = 1' - 0"$ 10. $3" = 1' - 0"$
5. $\frac{3}{4}" = 1' - 0"$ 11. $1" = 1' - 0"$ (full size - use the scale labelled "16")
6. $\frac{3}{8}" = 1' - 0"$

Figure 4 shows the ends of one face of an architect's imperial triangular scale rule. There are two edges on each face, and each edge contains two scales that run in opposite directions. At each end of an edge, a number or fraction indicates the distance in inches that represents 1 foot. The top edge is in eighths of an inch from left to right and in quarters of an inch from right to left. Note that on a full rule the $\frac{1}{8}"$ scale from 0 to the right end represents 95 feet and the $\frac{1}{4}"$ scale from 0 to the left end represents 47 feet.

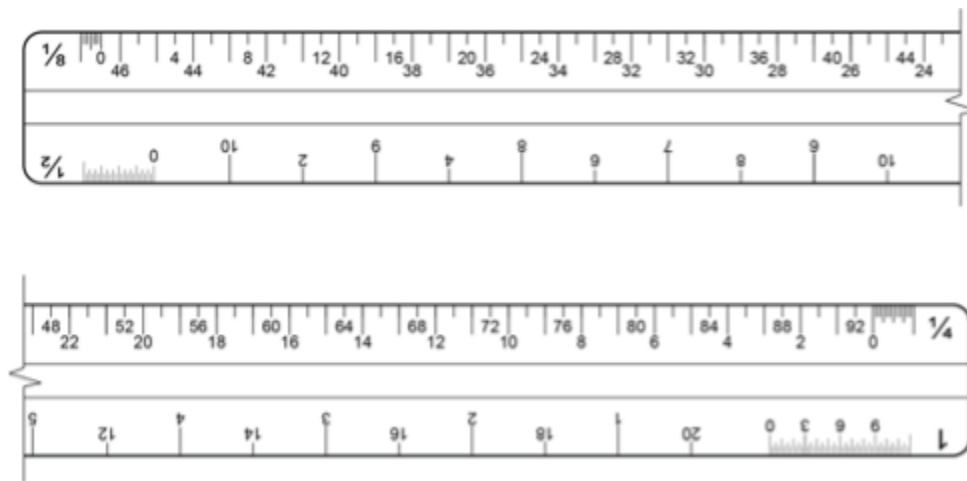


Figure 4 One face of an architect's rule (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Watch the following video by MTCopeland (2020) on YouTube titled "How to Use an Architect Scale Ruler" [3:40].



One or more interactive elements has been excluded from this version of the text. You can view them online here:
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If you are using a printed copy, you can scan the QR code with your digital device to go directly to the video:
How to Use an Architect Scale Ruler



At each end, between the zero and the number indicating scale, the length representing 1 foot is subdivided into 6, 12, 24 or more parts to indicate inches and, in some scales, fractions of an inch. For example, each of the six marks on the $\frac{1}{8}$ ” scale represents 2 inches, while each mark equals a quarter of an inch on the 1” foot-reduction scale and 1 inch on

the $\frac{1}{4}$ ” scale.

Now look at the $1\frac{1}{2}$ ” scale in Figure 5. The subdivided foot unit is divided into inches and fractions of an inch. Reading left from the zero, notice the figures “3”, “6” and “9,” which represent measurements of 3”, 6” and 9”. From the zero to the first long mark represents 1 inch. Between the zero and the 1-inch mark there are four lines, each of which represents one quarter of an inch.

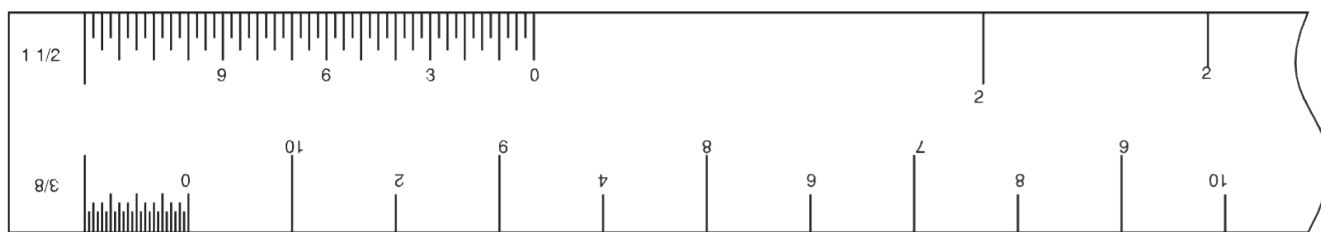


Figure 5 Units on an architect's scale rule (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Piping drawings usually use a $\frac{1}{8}$ ” scale for larger buildings, a $\frac{1}{4}$ ” scale for smaller buildings and houses and a $\frac{1}{2}$ ” scale for details.

Each drawing will state in the **title box** the scale that is used. Sometimes when special details are given, the scale is placed directly under the detail.

To draw or measure a length to scale, first find the edge of the rule containing the scale. One end of the length will rest exactly on one of the foot marks of the scale, and the other end should rest either on the zero marker or somewhere on the inch subdivision of the scale. The length can then be marked and drawn or read off from a drawing.

Figures 6 and 7 demonstrate this manner of reading dimensions from four of the ratios on the architect's scale.

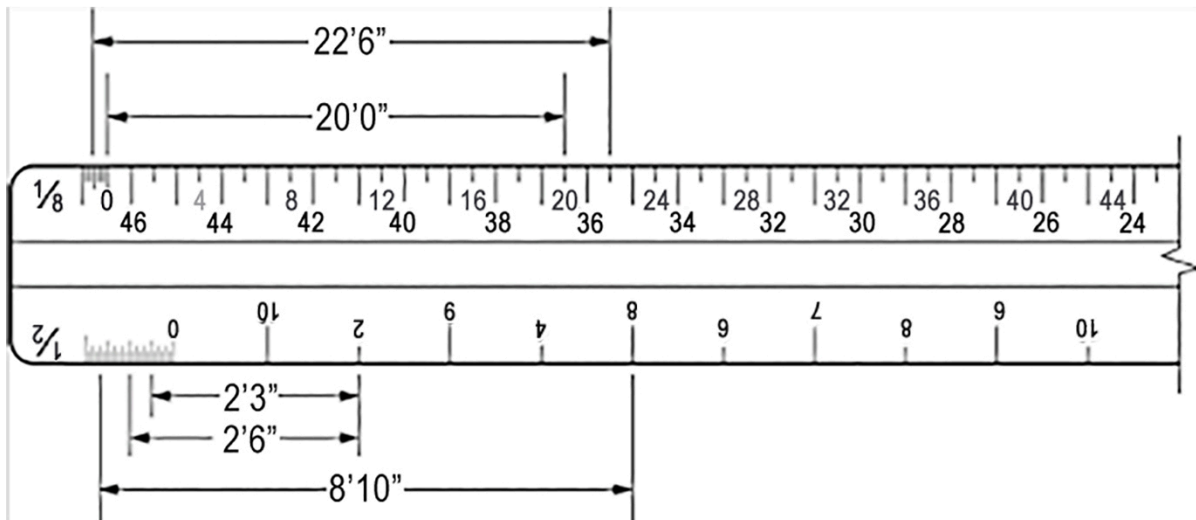


Figure 6 Reading dimensions using an architect's scale rule ([adapted] BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

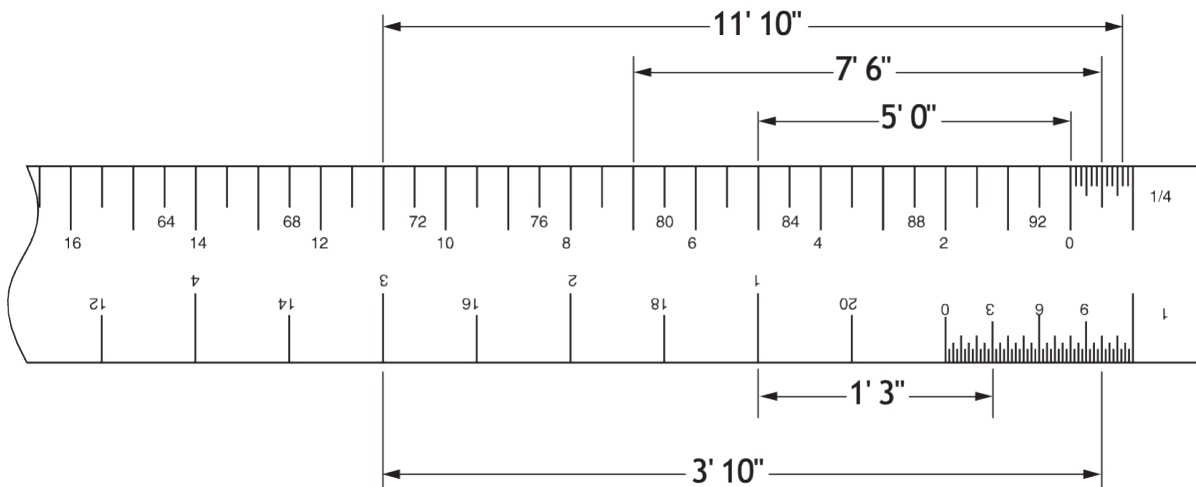


Figure 7 Reading dimensions using an architect's scale rule (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0



Architectural units have feet divided into inches, whereas engineering units divide feet into tenths and hundredths. Engineer's scales are not used to make piping drawings.

Metric Scales

A **triangular metric scale** is similar to the architectural scale in that it has six edges, but it has only one scale ratio per edge. The ratio is marked at the left end of the scale. For example, the scale of 1:50 means that 1 mm on the drawing represents 50 mm on the object. This means that the object is 50 times larger than the drawing of it. An object 450 mm

long would be represented by a line 9 mm long $\left(\frac{450 \text{ mm}}{50}\right)$.

Figure 8 shows one of the three sides of a **metric scale**. The scale labelled 1:50 is read from left to right, from 0 to 15 m. The scale labelled 1:2 can also be read from left to right (0 to 600 mm) by turning the scale around.

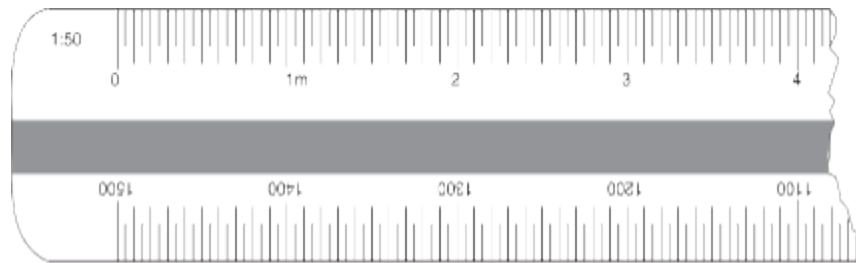


Figure 8 One side of a metric scale rule (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Watch the following video by Steve Bailes (2012) on YouTube titled “Metric Scale” [2:07].



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Metric Scale



If the ratio is 1:1, it means that 1 mm on the drawing represents 1 mm. In other words, the object in the drawing is being drawn to its actual size.



The ratios most often used in piping drawings are 1:100 for larger buildings, 1:50 for smaller buildings, and 1:20 for details.

You will notice that all the edges on a metric scale are marked with spaces that are 1 mm apart, similar to a metric tape measure. The difference is that each edge is marked off or labelled according to a different ratio, so that proportionate lengths are read directly from the scale. This eliminates the need to calculate dimensions.

Figure 9 shows common metric scales for comparison. Notice that all the scales shown are labelled in metres and that 0.5 m = 500 mm. All the scales in Figure 9 are marked at the scaled position of 250 mm.

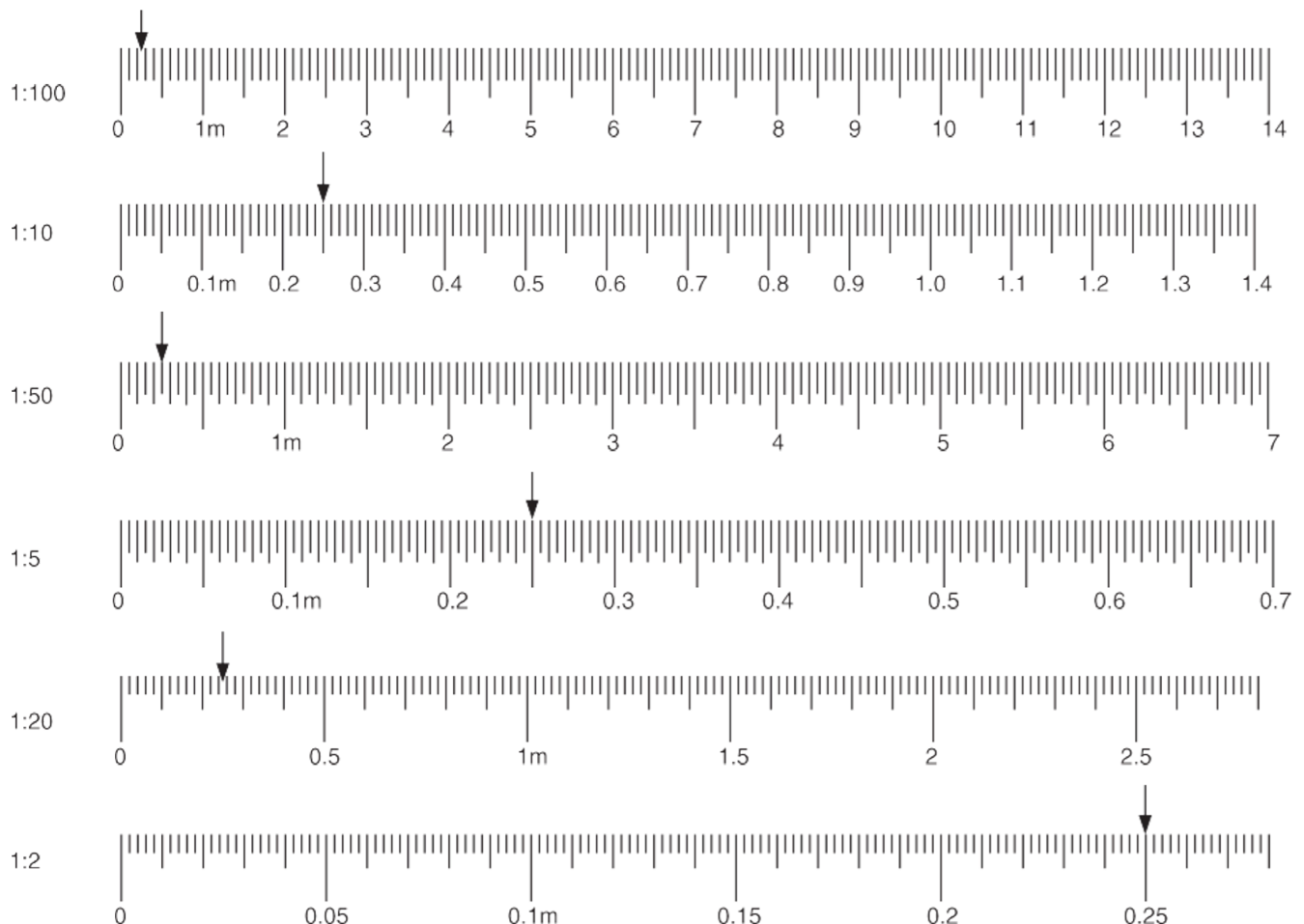


Figure 9 Metric scales marked at 250 mm (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0



The length of an object represented on a drawing in a metric scale is found by measuring the drawn object with a metric rule of the proper scale. You can also measure the drawing with any metric tape measure and multiply the result by the scale ratio.

Obtain Dimensions From Drawings

The best way to get exact dimensions from drawings is to use the explicit dimensions (in millimetres or in feet and inches) written between the dimension lines. Any measurements that you need should be somewhere on the drawings. Drawings normally only give each dimension once. If there are a number of parallel lengths, only one will have a measurement. To find the dimension you need, you may need to refer to other views, or you may have to add or subtract other dimensions.

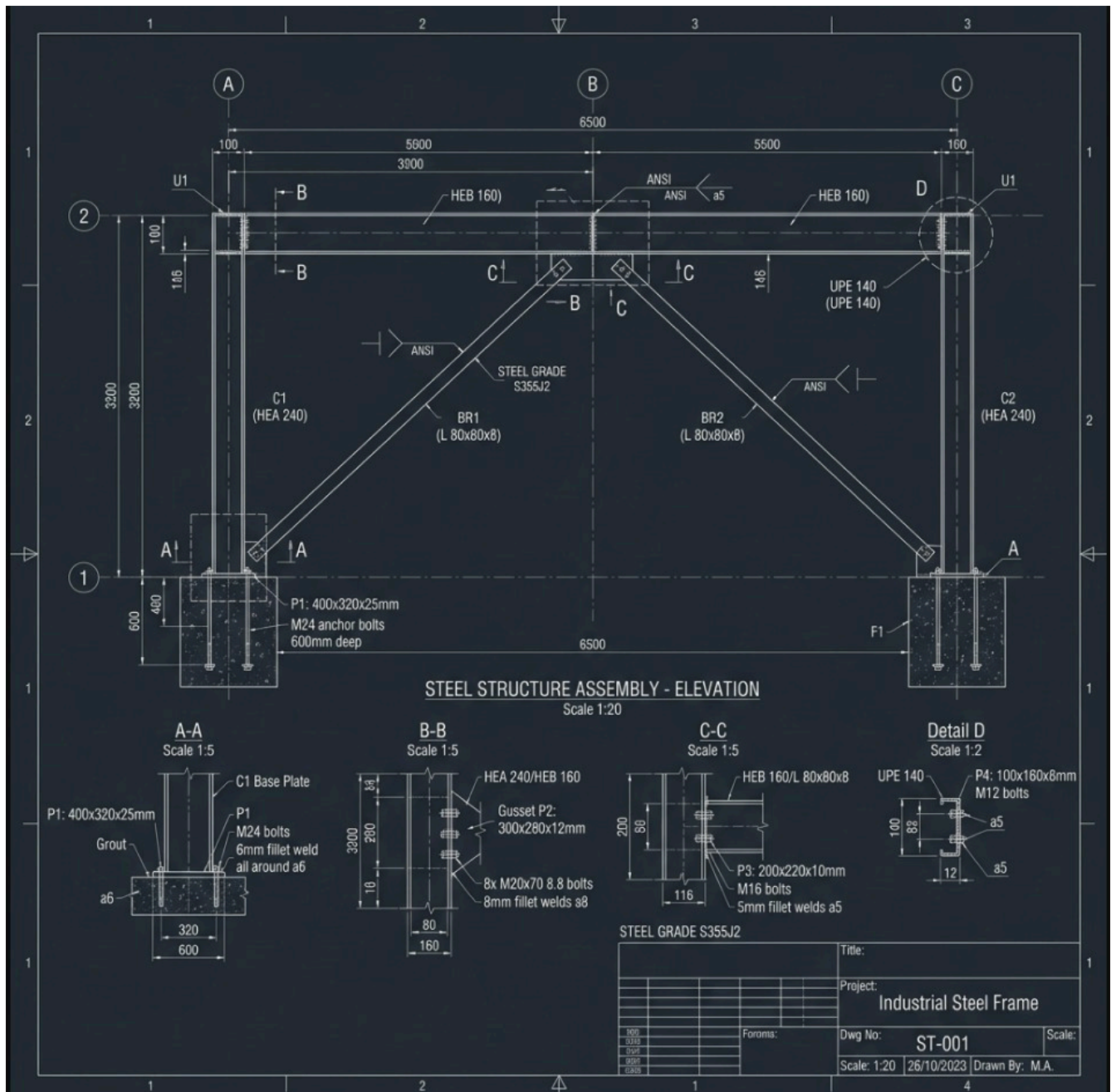


Figure 10 Detailed 2D Steel Structure CAD Drawing with 1:20 scale [Model: Nano Banana 2] (Easy-Peasy.AI) CC BY 4.0 License

Measuring lines of a drawing to determine the measurement is not an accurate way to extract dimensions. This is because the drawing is only a representation and may not be exact. Photocopies and reproductions of drawings also may not be to the scale of the original.

The scale of the drawing and lack of attention in measuring can lead to inaccuracies. For example, if the scale of a drawing is $\frac{1}{8}'' = 1' - 0''$, an error of $\frac{1}{32}''$ in measuring the plan amounts to 3" of error in the actual object measured. Detail drawings permit more exact precision because they are proportionately larger. However, details often require more exactness and usually contain any needed dimensions.

When accuracy is not required and approximate dimensions are adequate, measuring plans is a quick method of taking off material for estimating the cost of a job. In such cases, about 10% is usually added for cut-off and waste allowance.



Measuring plans to scale is not accurate enough for measuring pipe for cutting and installation purposes.

If you use the scale of the drawing, it will be simple to read off the measurements. However, in the field you will often need approximate measurements and the only measuring tool at hand will be a **measuring tape**.

A **steel pocket tape measure** has a movable hook on the end that allows accurate measuring, either when butted against a surface or when hooked on the end of an object (Figure 11). The end of the flexible tape itself is shortened to allow for the hook.



Figure 11 Tape measure with movable hook (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

To avoid any error, and to place the tape flat on the drawing, use a convenient unit mark, such as 100 mm as the starting point for measuring, as in Figure 12.

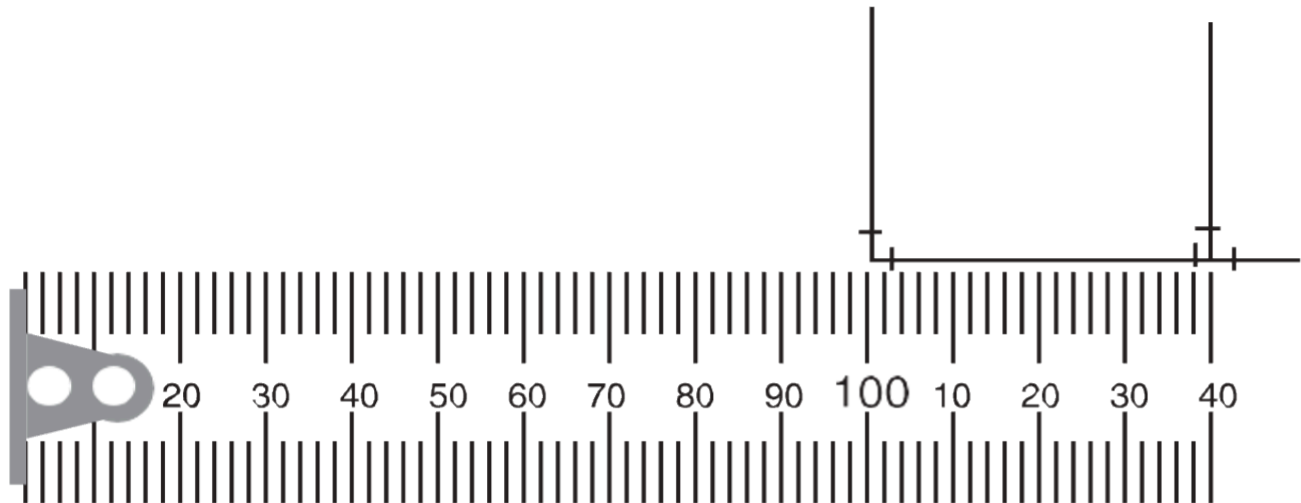


Figure 12 Measuring metric drawings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

The distance between the dimension lines is 40 mm. Since the scale is 1:50, the centre-to-centre length is:

$$40 \text{ mm} \times 50 = 2,000 \text{ mm}$$

If the scale had been 1:100 the length would be $40 \text{ mm} \times 100 = 4,000 \text{ mm}$.

Determining approximate piping lengths from imperial scale drawings follows the same procedure. An imperial tape measure is used in the same way to find a length on the drawing in inches. As an example, suppose the length is $7\frac{1}{2}$."

To find the length represented, use the scale of the drawing.

In every case, if you divide the length on the drawing by the scale fraction or number, you will be calculating the length in feet. Since dividing by a fraction is the same as multiplying by its reciprocal, you multiply the drawn length in inches by:

- 4 when the scale is $\frac{1}{4}" = 1' - 0"$
- 8 when the scale is $\frac{1}{8}" = 1' - 0"$
- 2 when the scale is $\frac{1}{2}" = 1' - 0"$



Helpful tip! The reciprocals of all standard scales used by architects are shown in Table 2.

Table 2 Reciprocals of Standard Scales

Scale	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{2} (\frac{3}{2})$	3
Reciprocal	$\frac{32}{3}$	8	$\frac{16}{3}$	4	$\frac{8}{3}$	2	$\frac{4}{3}$	1	$\frac{2}{3}$	$\frac{1}{3}$

The $7\frac{1}{2}$ " length on a drawing scaled $\frac{1}{4}" = 1' - 0"$ would represent:

$$7\frac{1}{2}" \times 4 = 30'$$

On a scale of $\frac{3}{8}" = 1' - 0"$, the same $7\frac{1}{2}"$ drawing length represents:

$$7\frac{1}{2}" \times \frac{8}{3} = 20'$$

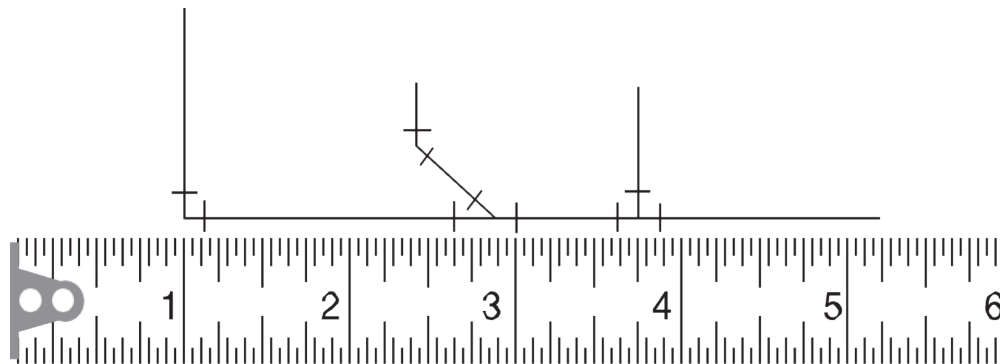


Figure 13 Reading lengths of piping runs (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0

Figure 13 is part of a piping run drawn to the scale of $\frac{1}{8}" = 1' - 0"$. The total length of the run is:

$$4\frac{1}{4}" \times 8 = 34'$$



Self-Test C-3.2: Use Scale Rulers to Determine Actual Dimensions from a Piping Diagram

Complete Self-Test C-3.2 and check your answers.

If you are using a printed copy, please find Self-Test C-3.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



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- **Figure 1** Acropolis, Propylaea: reconstruction elevation from the west, by Mnesicles on Flickr is used under the CC BY-NC 2.0 license.
- **Figure 2** House Numeric Labels , by Cmdrjameson (adapted original by InfoCan) on Wikimedia Commons is used under the CC BY-SA 3.0 license.
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C-3.3 Describe Piping and Fixture Symbols Used in the Piping Trades

Symbols

In the piping trades, drawings are a universal language. Before any pipe is cut, assembled, or installed, the entire system is communicated through symbols that represent pipes, fittings, valves, and fixtures. These symbols allow designers, plumbers, inspectors, and other trades to understand a piping layout quickly without needing detailed written explanations.

Because every symbol has a specific meaning, using the correct one is essential. A single incorrect symbol on a drawing can lead to wrong materials being ordered, improper installation, or costly delays. For this reason, piping symbols are intentionally simple, standardized, and easy to draw accurately.

This section introduces the different types of piping symbols—single-line, double-line, and symbols that identify specific pipe materials. Understanding these symbols is a foundational skill for anyone working in the piping trades, as they appear in virtually every plan, sketch, schematic, and installation drawing you will encounter.

Single-Line Symbols

Piping systems are usually drawn with single-line symbols because they are quick and easy to draw yet convey a great deal of information. The single-line symbol represents the centre line of the pipe and fittings as seen from the side. Figure 1 shows the same piping run represented by double- and single-line symbols.

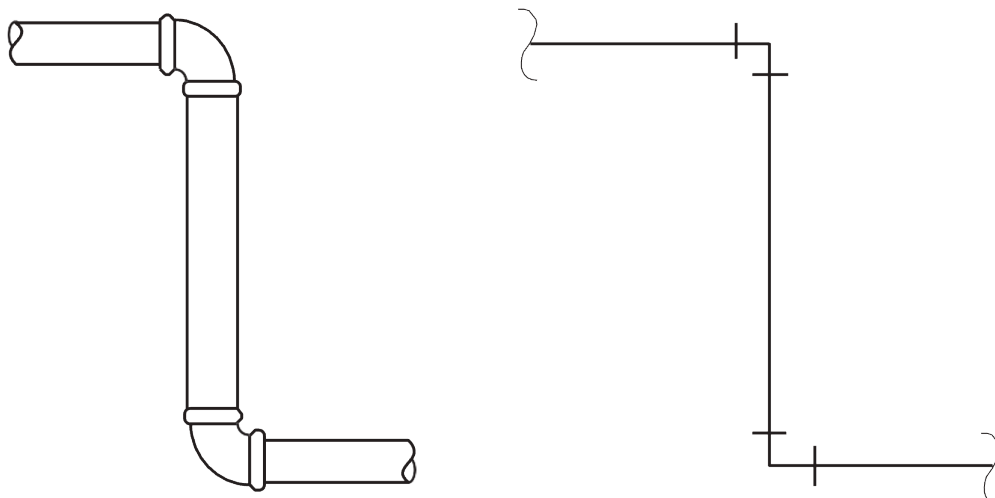


Figure 1 Double- and single-line drawings

Single-line symbols are often used on drawings:

- when speed of execution is important
- of extensive piping systems that have long runs
- when the size of the piping is less than NPS 12"
- that only show processes or principles of operation ("diagram drawings" or "flow charts")
- that are produced in order to make materials lists

On single-line drawings, the piping run lengths may or may not be drawn to scale, but the sizes of the valves or fittings are always drawn to scale. The exception is the flow chart.

Double-Line Symbols

A double-line drawing is used when accurate scale and a more realistic appearance are needed. In this method, two lines that are spaced to scale represent both the length of each pipe and its nominal pipe size.

Double-line drawings are usually made for the purpose of giving more detailed information than can be shown on single-line drawings of smaller scale. Many companies use single-line drawings for piping smaller than NPS 12" and double-line drawings for NPS 12" pipe and larger.

Double-line symbols may be used for fittings, such as tees and elbows, making them look very real. Valve bodies are often drawn exactly like the single-line symbol and do not look real.

On double-line drawings, flanged and welded fittings and valves are drawn to scale with respect to both fitting run length and the perpendicular flange length. Threaded fitting and valve lengths are scaled only if there are close clearances.

Figure 2 illustrates some of the common symbols used in double-line pipe drawings. Note that threaded fittings are drawn to a close approximation of the actual shape of the fitting. The valve is strictly symbolic.

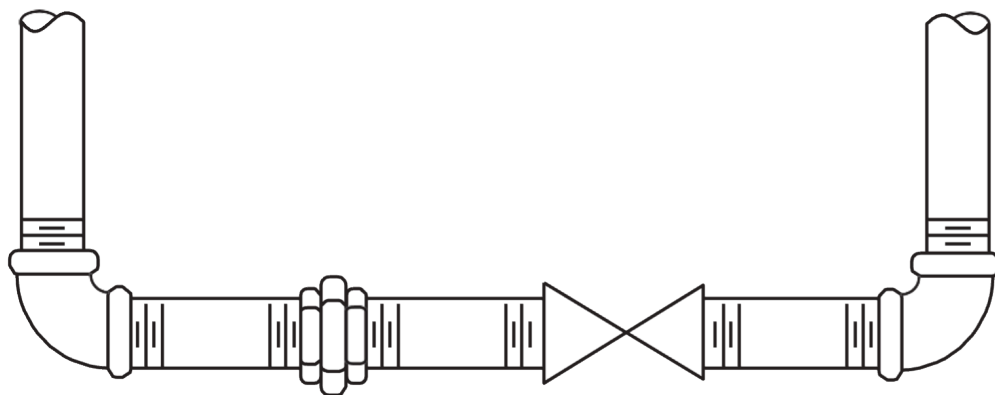


Figure 2 Double-line drawing

Due to the more intricate details of double-line drawings, do not use a scale smaller than 1:50 ($\frac{1}{4}" = 1' - 0"$) unless

the pipe sizes are large enough to show up well on the drawing. $\frac{3}{8}'' = 1' - 0''$ is the standard process area pipe drawing scale.

Symbols for Pipe Process Type

Letters or dash symbols can be placed in convenient locations along the drawing of a pipe to identify the fluid that it will carry. Table 1 shows some examples. A legend that looks like Table 1 should be added to the drawing to identify the symbols used.

Table 1 Pipes identified for intended fluid

Symbol	Description	Abbreviation
	Cold water	CW
	Hot water (140°F)	HW
	Hot water return (140°F)	HWR
	Automatic fire sprinkler	SP
	Gas - low pressure	G
	Compressed air	A
	Medical compressed air	MA
	Vacuum	V
	Oxygen	O
	Acetylene	AC
	Liquified petroleum gas	LPG
	Flow - in direction of arrow	
	Pitch - in direction of arrow	

Piping Break Lines

Piping break lines indicate the termination of the drawing of a piping run, although the piping does not end. Break lines are illustrated in Figure 3.



Figure 3 Piping break lines

Piping breaks may be used where a pipe runs past the end of a drawing or to show piping that is hidden behind another piping run (Figure 4). When the drawing is complex, as in an isometric drawing of a complete system, the break lines may be omitted. A small gap is used to indicate that the piping run behind does not connect with the piping run in front.

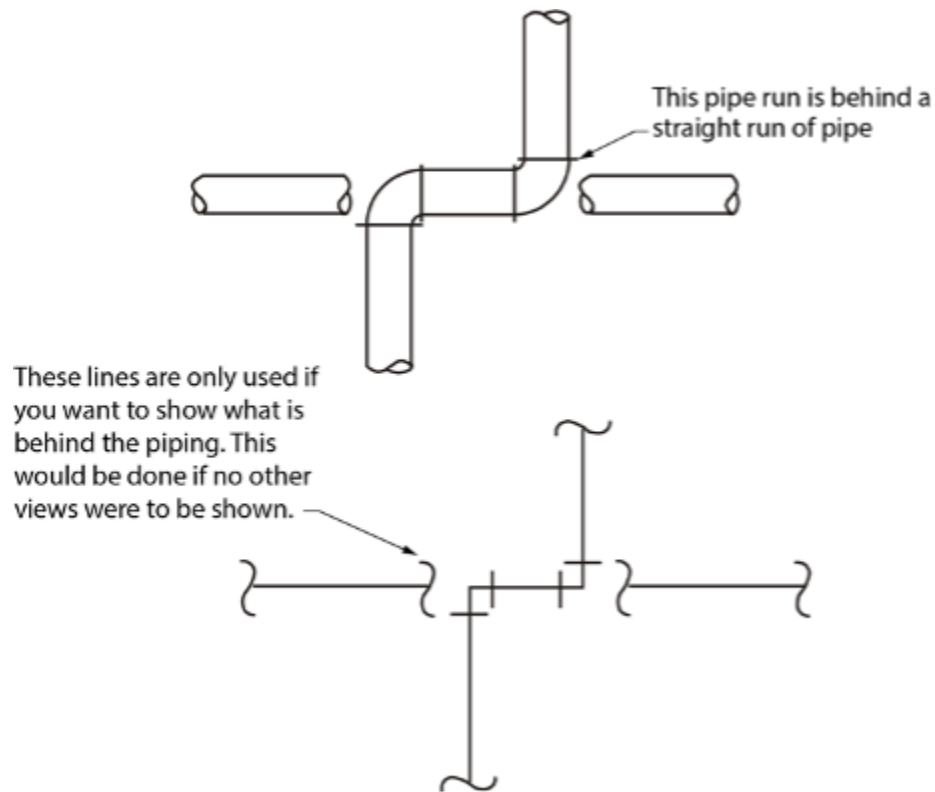


Figure 4 Piping break lines

Piping Joints

Some common piping joints include:

- screwed
- welded
- flanged
- soldered

In single-line drawings, a short line has traditionally been used to indicate a screwed pipe joint. It is drawn at right angles (perpendicular) to and centred on the piping run (Figure 5). This symbol is now used for almost any kind of pipe joint in single-line drawings, except that flanged and welded joints may use their own symbols. Figure 5 illustrates the various methods of drawing pipe joints in both single- and double-line forms, using a 90° elbow as an example.

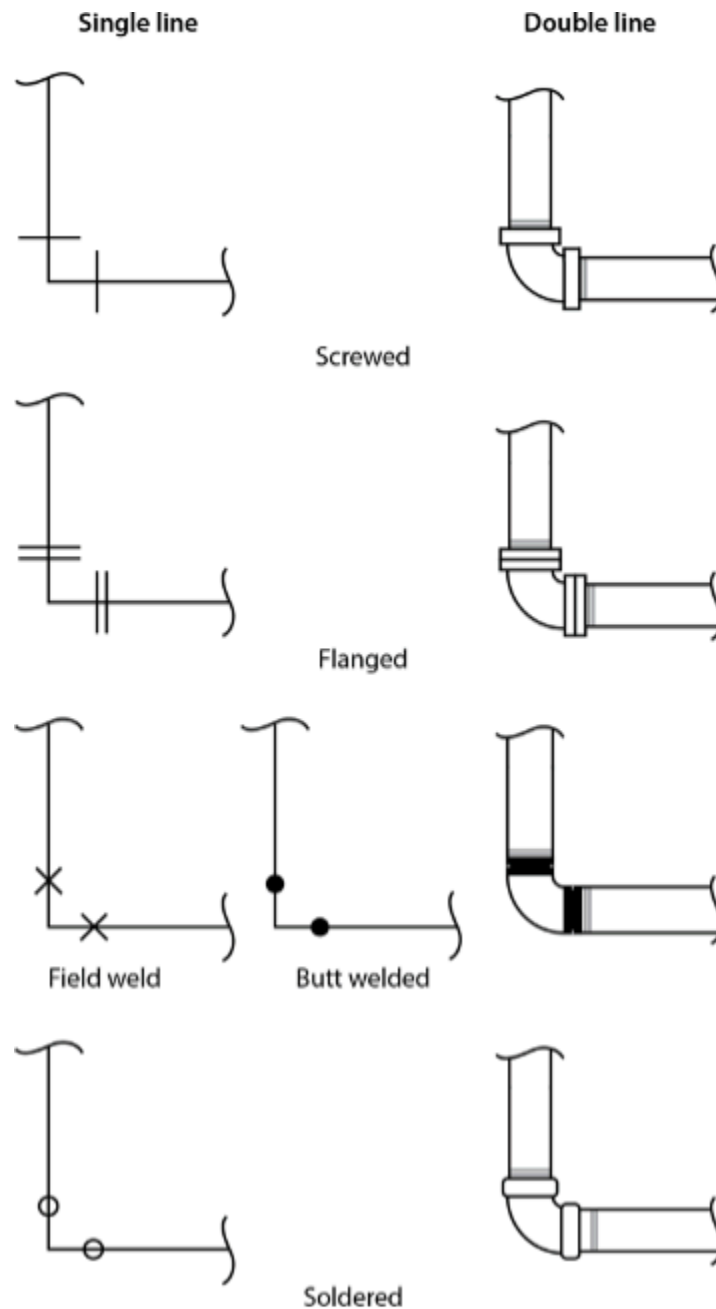


Figure 5 Piping joint symbols

Drawing Views

The appearance of a fitting changes when it is viewed from a different direction. The piping symbols are different for every view to reflect the change in their appearance.

For example, the front view of an elbow and its joining pipes (Figure 6) is at right angles (perpendicular) to both pipes. The symbol is drawn with single lines, and the joints are drawn with short, straight lines. The short, straight line represents the viewed edge of the fitting. The application is the same for both single- and double-line drawings.

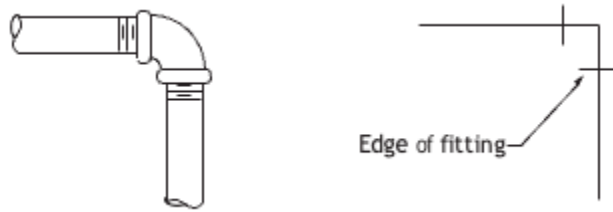


Figure 6 Front view of elbow and symbol

If the elbow is viewed from the right side, the vertical pipe is perpendicular to the line of sight, but the horizontal pipe is viewed on end. The corresponding view symbol represents the vertical pipe by a vertical line and the joint by a short crossing line, as expected.



Figure 7 Right view of elbow in Figure 6

The end view of the fitting is represented by a circle (Figure 7). The circle is the true appearance of the edge of the fitting. The back of the elbow is shown by the centre line continuing to the centre of the circle.



Figure 8 Left view of elbow in Figure 6

The left view is shown in Figure 8. This view faces the pipe and an open end of the fitting, which is represented by a dot at the centre of the circle, as if it were a hole. Again, the circle appears like the true edge of the fitting.

Occasionally, pipes and joints are viewed neither on end nor perpendicular but receding at an angle (usually 45°). In those cases, the symbol for the near edge of the fitting is a curved line (Figure 9). Note that the curve is the true appearance, as if the far edge were obscured by the pipe or fitting.

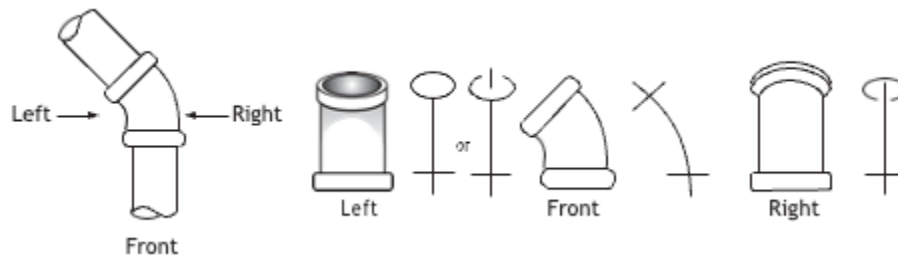


Figure 9 Views of a 45° elbow

One end of a 90° elbow angled at 45° (Figure 10) will also use the curved symbol on one end.

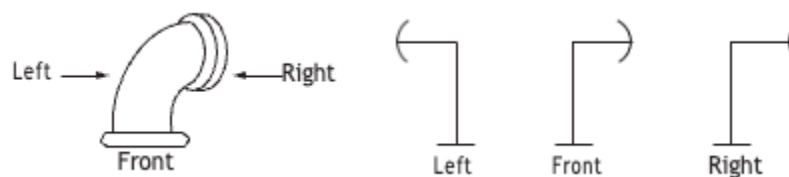


Figure 10 90° elbow at 45° view

This example of views for drawing fitting symbols should help you recognize the symbols for single-line and double-line drawings presented in Table 2.

Name	Single Line			Double Line		
	Left	Front	Right	Left	Front	Right
90 elbow						
45 elbow						
Tee						
Wye						
Cross						

Table 2 Fitting symbols

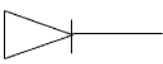
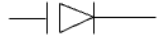
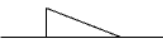
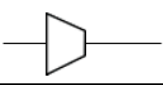
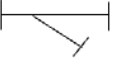
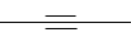
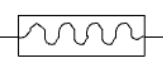
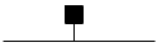
Name	Single Line	
	FRONT	
Cap		
Plug		
Reducing bushing		
Eccentric reducer		
Concentric reducer		
Union flange (screwed)		
Union (flanged)		
Expansion joint		
Strainer		
Fire department connection		
Cleanout		
Floor cleanout		
Pipe anchor		
Pipe guide		
Flexible connector		
Water hammer arrestor		

Table 3 Specialized single-line symbols

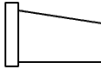
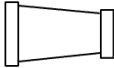
Name	Double Line
	FRONT
Cap	
Eccentric reducer	
Concentric reducer	
Union flange (screwed)	

Table 4 Specialized double-line symbols

Symbols for Valves, Air Eliminators, Pumps and Other Components

Valves, air eliminators, pumps and other components are generally shown on drawings by their symbols, even when double-line piping drawings are used. Table 5 shows some of the most common symbols.

Type of component	Symbol	Type of component	Symbol
Gate		Motor operated*	
Globe		Pressure reducing	
Check*		Pressure relief	
Angle		Pressure-temperature relief	
Butterfly		Flow switch	
Hose (utility)		Pressure switch	
Fire hose		Control valve	
Post indicator		Vacuum relief	
Backwater		Pressure gauge with gauge cock	
Backflow preventer*		Thermometer	
Gas cock		Automatic air vent	
Balancing*		Air vent	
Pump			
PRV			

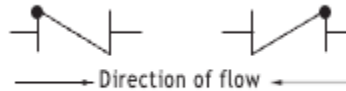
**specify type in legend or specifications*

Table 5 Types of components and examples of their symbols

Check Valves

The symbol for a check valve is positioned to indicate the direction of flow (Figure 11). It is important to draw the symbol in the correct position or the diagram could be misinterpreted, leading to the valve being installed incorrectly. The

symbols are typically used without the arrows shown in Figure 11, which are shown here to help you understand the correct orientation of the symbol. Specifications or notations on the drawing will indicate what type of check valve is needed (i.e., swing check, lift check, etc.).



Think of the dot as the hinge (symbol is typical regardless of check valve type)

Figure 11 Symbol for check valve showing direction of flow

These are just a few commonly used symbols for piping fittings, valves and other components. Symbols for other components may be more or less standard or may be modified as required. Such modifications should be labelled with a reference legend that identifies the symbol.

Symbols for Plumbing Fixtures

Plumbing fixtures are generally shown on plan and elevation drawings by their actual size and shape according to the drawing scale (Figures 12 to 18). This is required to determine if the fixture location in the building is in compliance with Building Code clearances to walls and other fixtures.

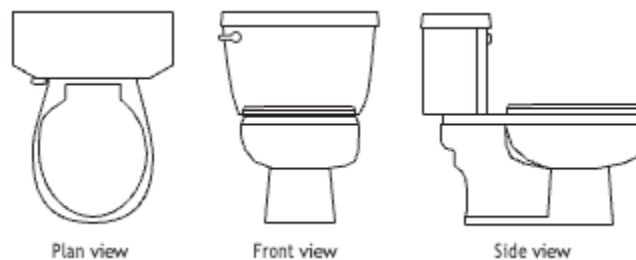


Figure 12 Floor mounted water closet

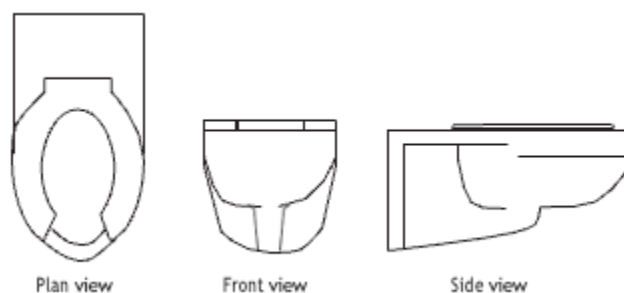


Figure 13 Wall-hung water closet

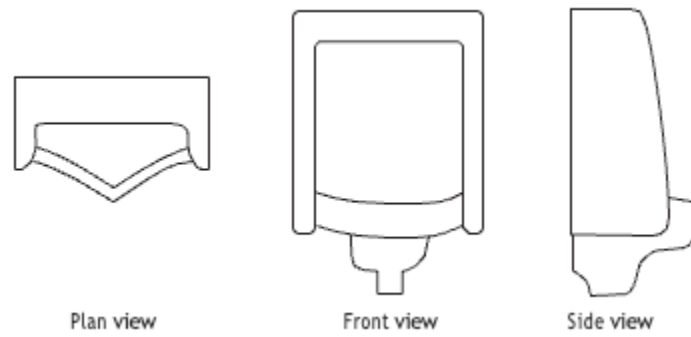


Figure 14 Wall-hung urinal

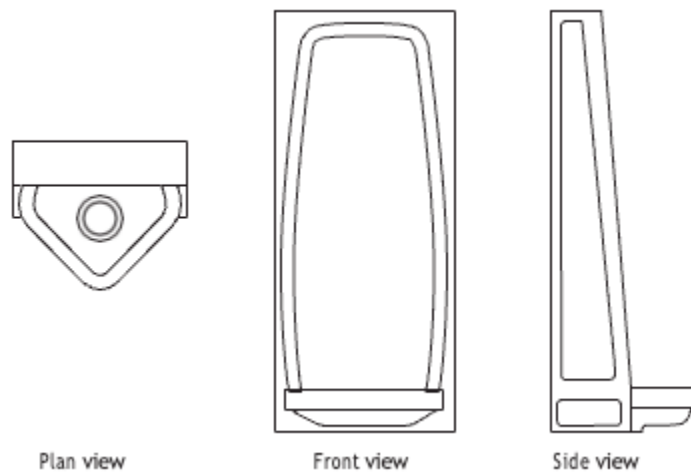


Figure 15 Floor mount (stall) urinal

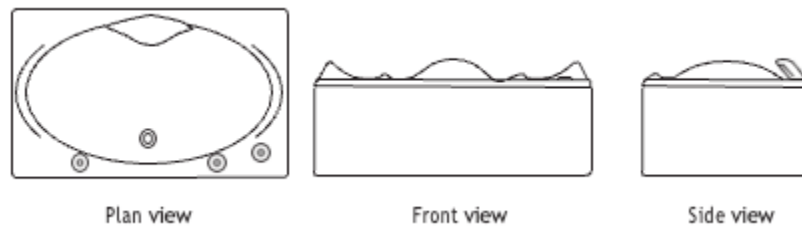


Figure 16 Roman bathtub

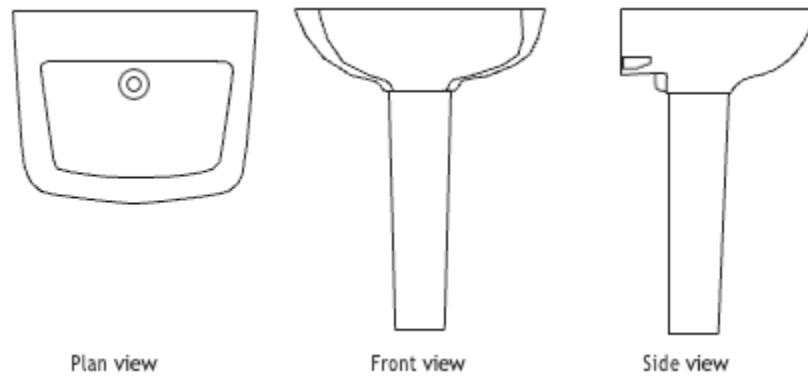


Figure 17 Pedestal basin

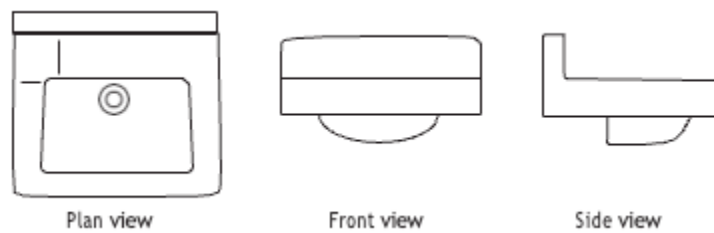


Figure 18 Wall-hung basin

Unlike free-standing fixtures, cabinet-mounted fixtures would only be represented in plan view (Figure 19). In elevation views only the cabinet that houses the fixture would be shown, as the fixture itself is recessed.

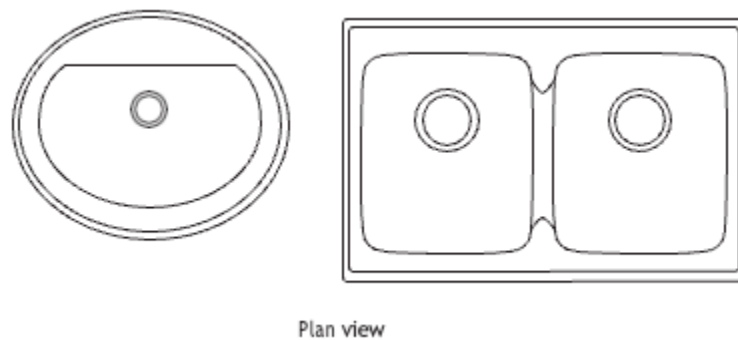


Figure 19 Plan views of vanity basin and kitchen sink



Self-Test C-3.3: Describe Piping and Fixture Symbols Used in the Piping Trades

Complete Self-Test C-3.3 and check your answers.

If you are using a printed copy, please find Self-Test C-3.3 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://c-tradeactivities-electrical-bcplumbingapprl1.pressbooks.tru.ca/?p=2465#h5p-35>

References

BCcampus. (n.d.). *Playlist: Tools and equipment videos*. BCcampus MediaSpace. https://media.bccampus.ca/playlist/details/0_3g8xp22x/categoryId/175673 Playlist Details – Trades Access Common Core Line C: Tools and Equipment Videos – BCcampus

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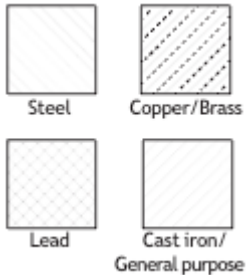
C-3.4 Describe Lettering and Dimensioning of Piping Diagrams

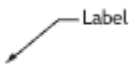
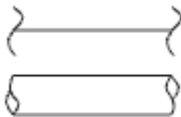
Standard lines for drawings have been developed so that lines in every drawing or sketch convey the same meaning or information. In order to convey that meaning, the lines used in technical drawings have both a definite pattern and a definite thickness. Some lines are complete and others are broken. Some lines are thick and others are thin. A *visible line*, for example, is used to show the edges (or *outline*) of an object and to make it stand out for easy reading. This line is made thick and dark. A *centre line*, on the other hand, which locates the precise centre of a hole or shaft, is drawn thin and made with long and short dashes. This makes it easily distinguishable from the visible lines.

Study the standard line thicknesses (or *line weights*) shown in Figure 1 and practise making them. Use a fairly sharp pencil when you draw. Maintaining an even, consistent pressure will make it easier for you to produce acceptable lines.

In computer drafting, the line shape remains the same, but line thickness may not vary as in manually created drawings. Some lines, such as centre lines, may not cross in the same manner as in a manual drawing. For most computer drafting, line thickness is not important.

Table 1: Standard line weights

Type	Weight	Line	Description
Object line Margin line	Heavy		Solid line to show visible shape, edges and outlines.
Hidden body line	Medium		Broken line of short dashes to show hidden object lines not visible to the eye.
Phantom line	Light		Broken line of short dashes to show alternate positions or movement of a part.
Section line	Light	 Steel Copper/Brass Lead Cast iron/ General purpose	Unbroken lines arranged in a pattern, usually straight and at a 45° diagonal.
Projection line	Light		Unbroken lines that extend away from the object or feature for emphasis.
Centre line	Light		A broken line of long and short dashes to show the centre of an object.
Extension line/ Dimension line	Light		Extension lines are small lines that extend outward from an object or feature. Dimension lines span between the extension lines with arrow heads and a given dimension.

Leader line	Light		Unbroken line usually drawn at an angle often with a “dogleg” and an arrowhead. A dot is used in place of an arrowhead where a surface is referenced. Usually accompanied by a label.
Cutting plane line	Heavy		A broken line of one long and two short dashes to show an imaginary cross-section. The arrowheads show the direction from where the cross-section is viewed. A corresponding image will show the view of A.
Break lines for wood and metal	Heavy		Unbroken freehand or straight zig-zag lines to abbreviate longer spans of wood or metal.
Break lines for piping	Heavy		Curled lines to abbreviate a longer span of pipe.

When you are able to consistently reproduce lines of equal blackness and thickness, study Figure 1, which shows the nature of each line and explains how they are used in a technical drawing. You must be able to identify each line by name and describe its application.

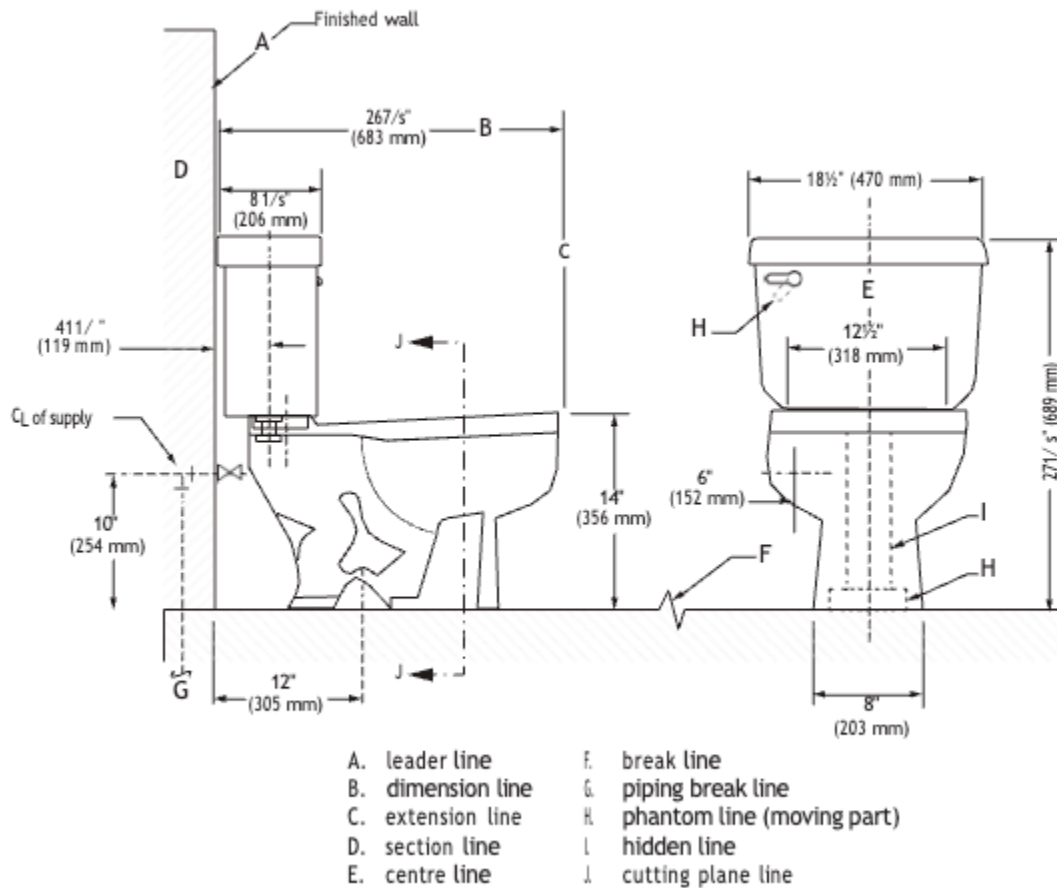


Figure 1 Use of standard lines

Standard Lettering

The letters and numbers on a drawing or sketch are as important as the lines. Scribbled, smudged or badly written letters and numbers can become impossible to read. This may lead to time-consuming and costly errors. Lettering is necessary to describe:

- the name or title of a drawing
- when it was made
- the scale
- who sketched it
- the dimensions
- the special notations that describe the size
- the materials to be used
- the construction methods

In making drawings and sketches, there is a need for simplicity, uniformity and speed of execution.

The American standard vertical letters have become the most accepted style of lettering used in the production of

manual drafting (Figure 2). Font styles and sizes may vary in computer drafting. Note that all letters are written as capital (or *uppercase*) letters. Practise these characters, concentrating on forming the correct shape. Remember that letters and numbers must be black so that they will stand out and be easy to read.

Lettering and figures should have the same weight and darkness as hidden lines.



Figure 2 American standard vertical letters

Figure 3 shows a simple drawing. Notice that the dimensions are given between arrows that point to extension lines. By using this method, the dimensions do not get in the way of the drawing. One extension line can be used for several dimensions. Notice also that the titles require larger letter sizes than those used for dimensions and notations. It is important that the title and sketch number on your sketches stand out, as shown in Figure 3. When you begin lettering, you may wish to use very light lettering guide lines to ensure uniformity in lettering size and alignment.

Typically, drawings are placed on the page within containment lines called a border. The border lines help bring the drawing together and give it a professional feel.

On an $8\frac{1}{2}'' \times 11''$ sheet of paper, borders are drawn approximately 1 cm from the edge for the top and sides, but approximately 2 cm from the bottom to compensate for an optical illusion that occurs when the border is equal around all four sides. Unless the bottom border is larger, the eye is drawn to the bottom of the page because the border appears too short.

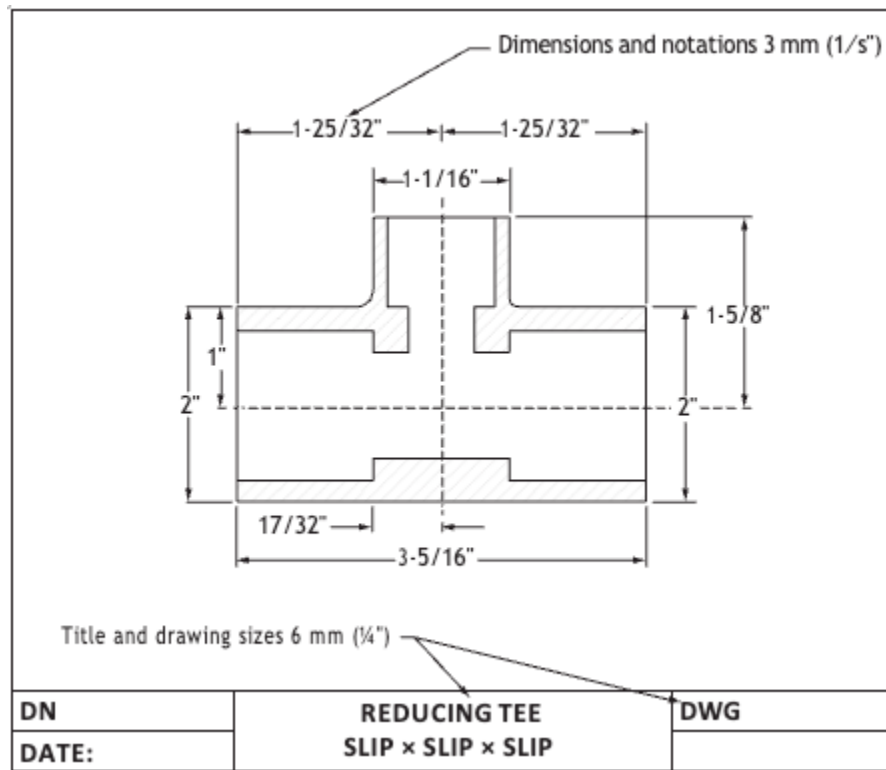


Figure 3 Standard lettering sizes



Self-Test C-3.4: Describe Lettering and Dimensioning of Piping Diagrams

Complete Self-Test C-3.4 and check your answers.

If you are using a printed copy, please find Self-Test C-3.4 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



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References

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C-3.5 Describe Drawing Projections

You need accurate information to complete a piping installation, no matter how simple or complex the system.

Information for a project is provided by mere drawings or by drawings and specifications. Drawings provide dimensions and details of materials of construction. Specifications give details on installation procedures and the standards required for materials. Some installations may have the specifications and all other pertinent information on the drawings in the form of notes.

These drawings are known as *working drawings*. Working drawings are sometimes referred to as *blueprints*, a term that is a carry-over from when all prints had a blue background and the lines and lettering were in white.

Types of Views Used in Drawings

The two main types of views (or *projections*) used in drawings are:

- pictorial
- orthographic

Pictorial Views

Pictorial views show how something should physically look when completed. There are three types of pictorial views:

- perspective
- isometric
- oblique

Perspective View

A *perspective view* presents a building or an object just as it would look to you. A perspective view has a *vanishing point*: that is, lines that come together in the distance as they move away from you. For example, in Figure 1, we see a road and line of telephone poles. Even though the poles get smaller in their actual measurement, we recognize them as being the same size, but more distant.

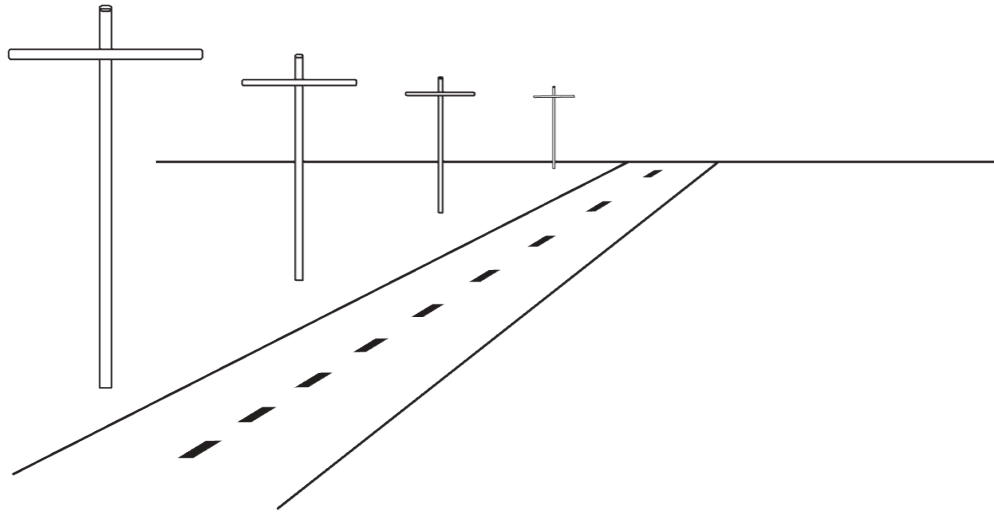


Figure 1 *Perspective view*

Isometric View

An *isometric view* is a three-dimensional view. The plumb lines are vertical. The horizontal lines are set at 30° angles from a line parallel to the bottom of the page. Isometric views have no vanishing point, so the objects do not appear as they would in a perspective view. Lengths are exact on isometric drawings only when the item is parallel to one of the axes of the drawing. Figure 2 shows an isometric view of a simple object, as well as the lines that represent the three dimensions.

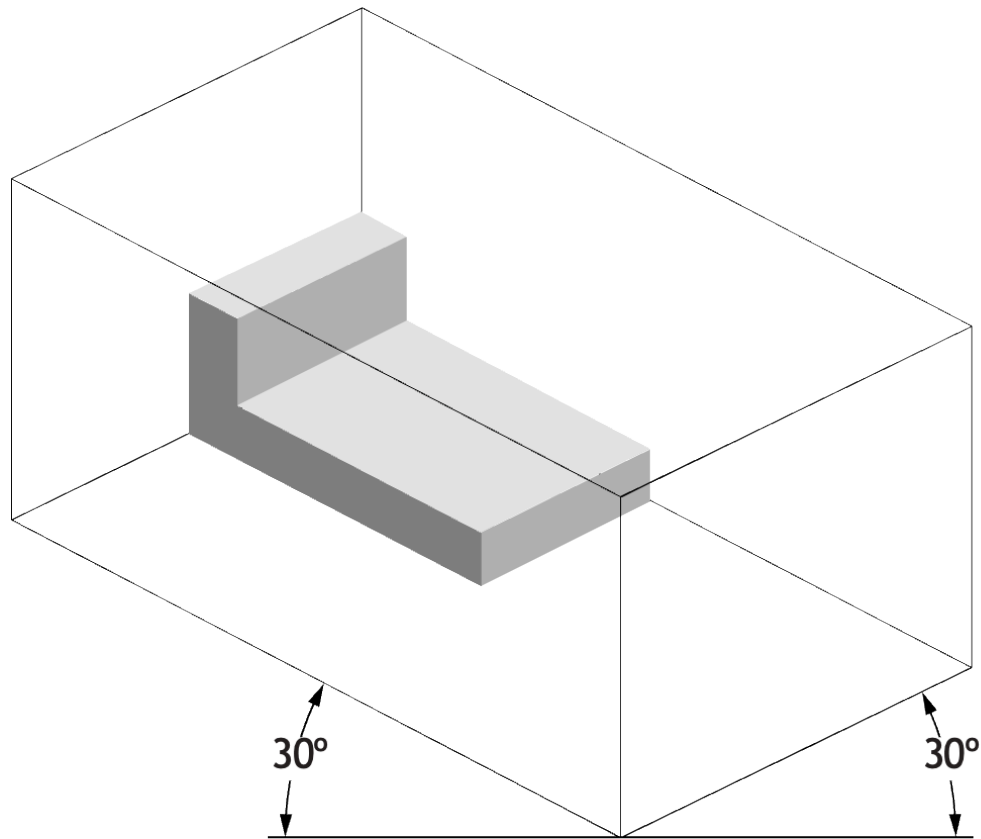


Figure 2 Isometric view

Oblique View

An *oblique view* is similar to an isometric view, except that the face or front view is drawn to exact scale and the oblique lines are extended at a 30° to 45° angle to create a three-dimensional representation (Figure 3).

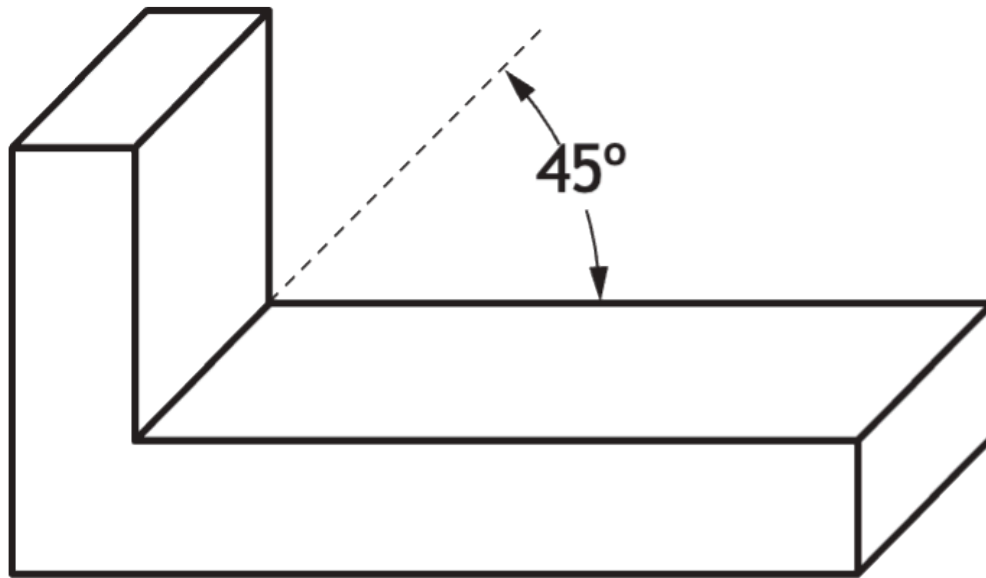


Figure 3 Oblique view of the object in Figure 2

Orthographic Views

Orthographic views (or *orthographic projections*) are the most common views used for working drawings. Each projection is a view that shows only one face of an object, such as the front, side, top or back. These views are not pictorial. Orthographic views are used in all fields of architecture and engineering. Figure 4 shows how the pictorial view from Figure 2 is opened to produce six orthographic views. Figure 5 shows how the same views are drawn.

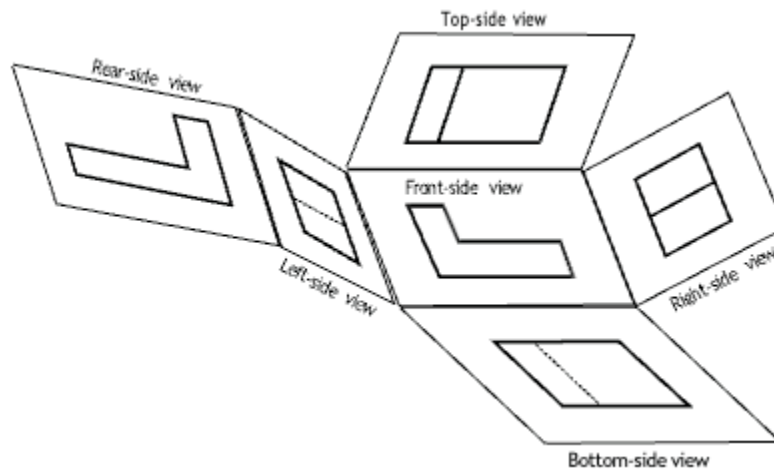


Figure 4 How a pictorial view is opened to produce orthographic views

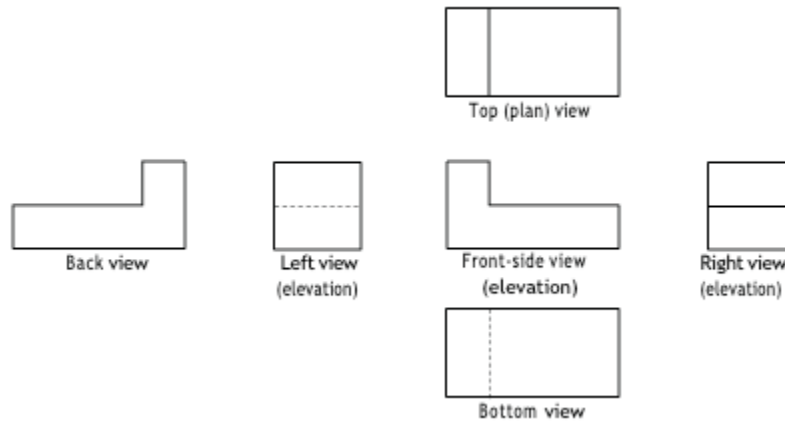


Figure 5 Orthographic views of the object in Figure 2

Unless the object is very complex, only the front, top and right-side views are necessary. If the object has a uniform thickness, only two views are necessary. The front, left, back and right views are also referred to as *elevations*.

Piping systems normally require two or three orthographic views, either a *plan view* and one elevation drawing or a plan view and two elevation drawings. Some systems may be illustrated with a three-dimensional (isometric) drawing or with three orthographic drawings.

The plan (top), the front and the side views are the three usual orthographic views from which you should choose the views to represent piping systems. If the side view shown is not specified, the right side is normally used. Bottom and back views are used less often.

Floor Plan

The floor plan is an orthographic view of a building that is commonly the most important projection for the pipe trade worker because it gives the most pertinent information about the building. Floor plans identify room names and numbers, place them within the building as a whole, and provide the following relevant info:

- room dimensions
- size, location, and swing of doors
- size and location of windows
- size and spacing of beams and floor joists

Floor plans show the location of:

- plumbing fixtures
- tub drains
- appliances
- cabinets, closets and shelves



Figure 6 Floor plan

Elevation View

An elevation view is a front, side, or back orthographic projection of a building, that contains important information such as:

- finished grade or ground level
- exterior details, including material, dimensions roof pitch -see figure 7
- scale

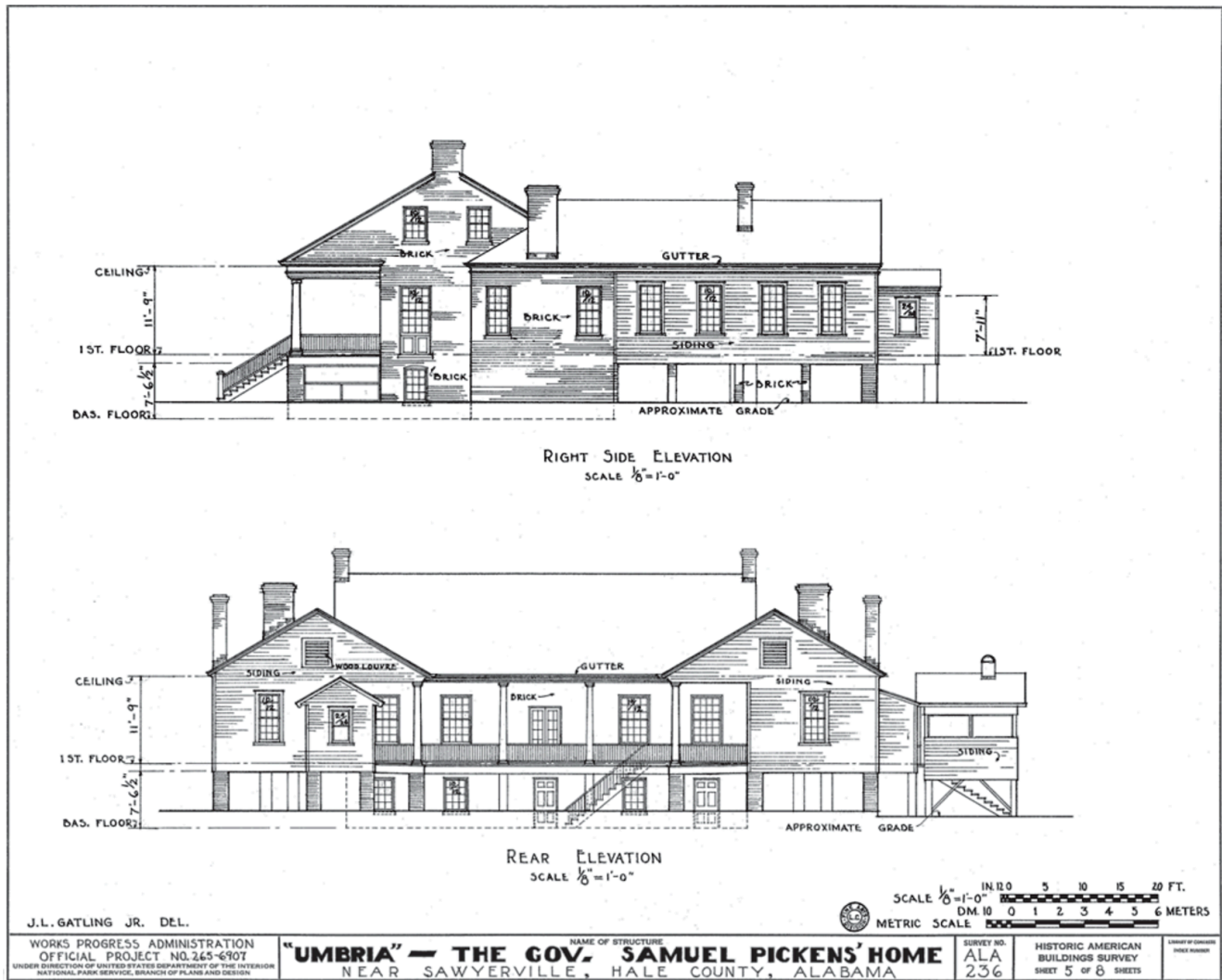


Figure 7 Elevation view (Public domain image from Library of Congress, Prints and Photographs Division, AL-236)

Section Plan

A section drawing provides details on a cross-section of a building or wall. The section drawing is usually quite detailed, showing scale, material selection, dimensions and typical construction choices.

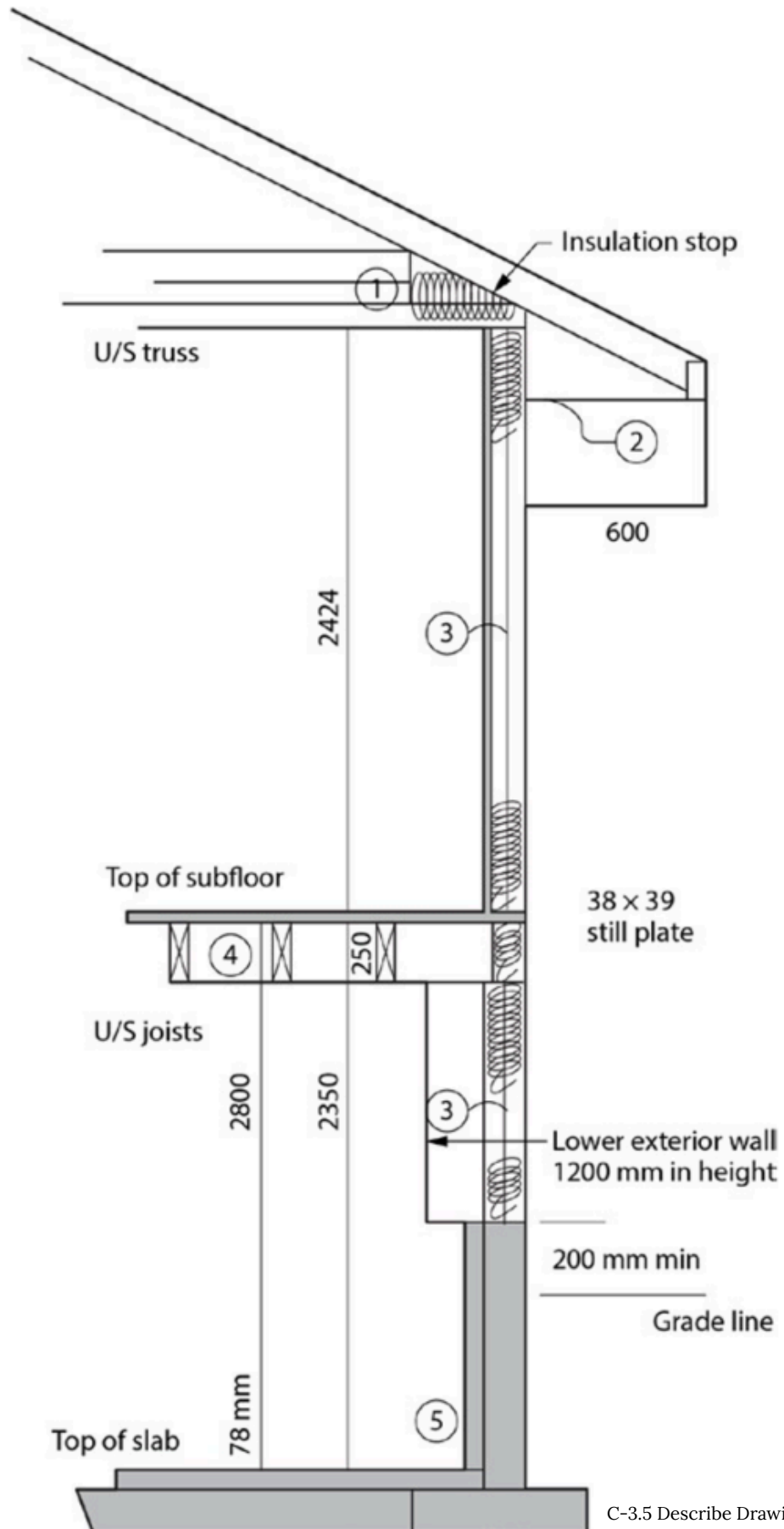


Figure 8 Section drawing



Self-Test C-3.5: Describe Drawing Projections

Complete Self-Test C-3.5 and check your answers.

If you are using a printed copy, please find Self-Test C-3.5 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



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<https://c-tradeactivities-electrical-bcplumbingapprl1.pressbooks.tru.ca/?p=2469#h5p-37>

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BC Industry Training Authority. (2019). *Piping trades apprenticeship program: Use Tools and Equipment—Level 1 harmonized* [Binder]. Crown Publications, Queen's Printer for British Columbia. https://www.crownpub.bc.ca/Product/Details/7960000261_S

- Plumber: Competency C-2 Interpret Drawings and Specifications
- Steamfitter: Competency C-2 Interpret Drawings and Specifications
- Sprinkler Fitter: Competency C-2 Interpret Drawings and Specifications

Camosun College. (2019). Line D: Tools and Equipment—Competency D-3: Competency D-3: Read Drawings and Specifications (Rev. ed.) [Learning guide]. BCcampus. <https://collection.bccampus.ca/textbook/yxJ3AwTa/>

Camosun College. (2015). Trades Access Common Core Competency D-3: Competency D-3: Read Drawings and Specifications. Victoria, B.C.: Crown Publications. Download for free from the B.C. Open Textbook Collection (<https://open.bccampus.ca/browse-ourcollection/find-open-textbooks/>).

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C-3.6 Use Drawing Projections

Orthographic Fitting Symbols

To help you recognize piping symbols in different orthographic views, the following fittings are shown first in a pictorial drawing (Figure 1) then as three orthographic views (Figure 2).

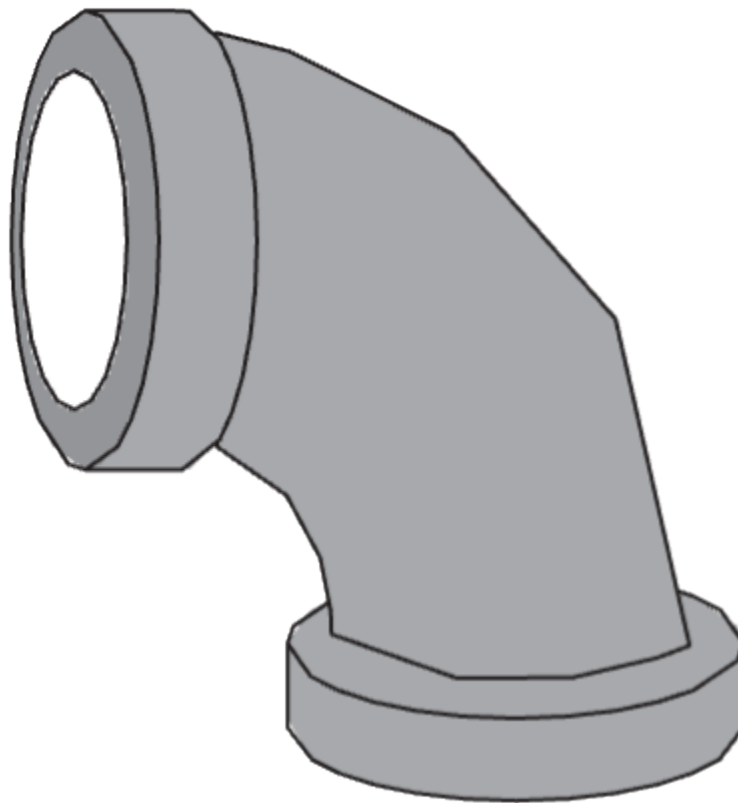


Figure 1 Pictorial drawing

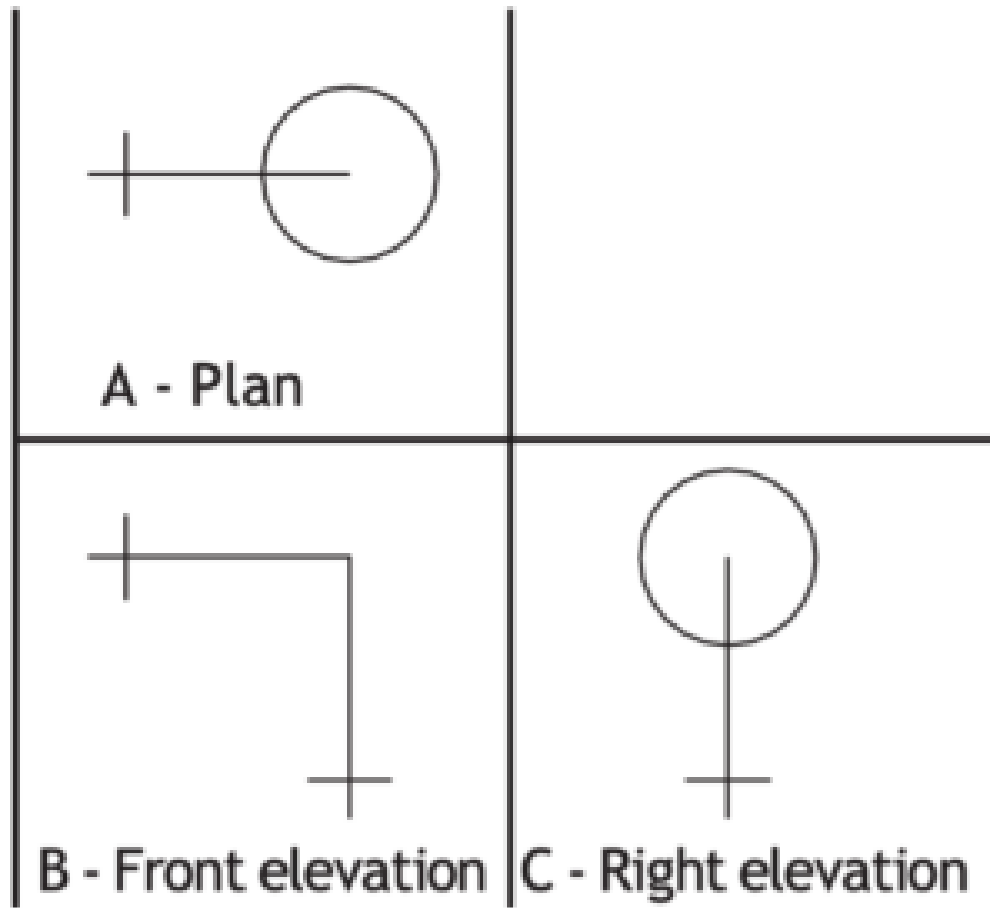


Figure 2 Orthographic views

In Figure 3, the same elbow is shown from the opposite side. Figure 4 reflects the corresponding changes to the orthographic views.

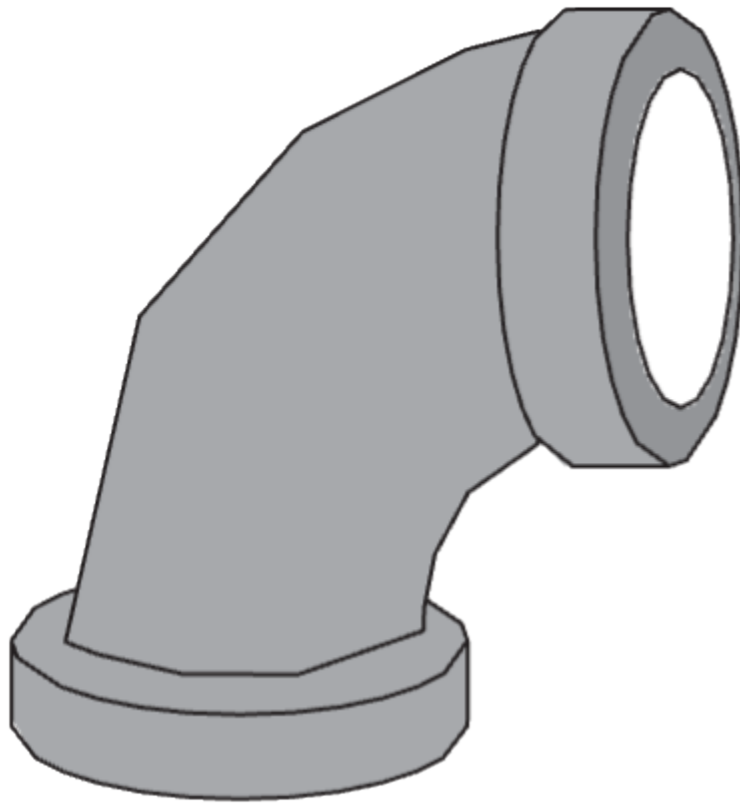


Figure 3 Pictorial drawing

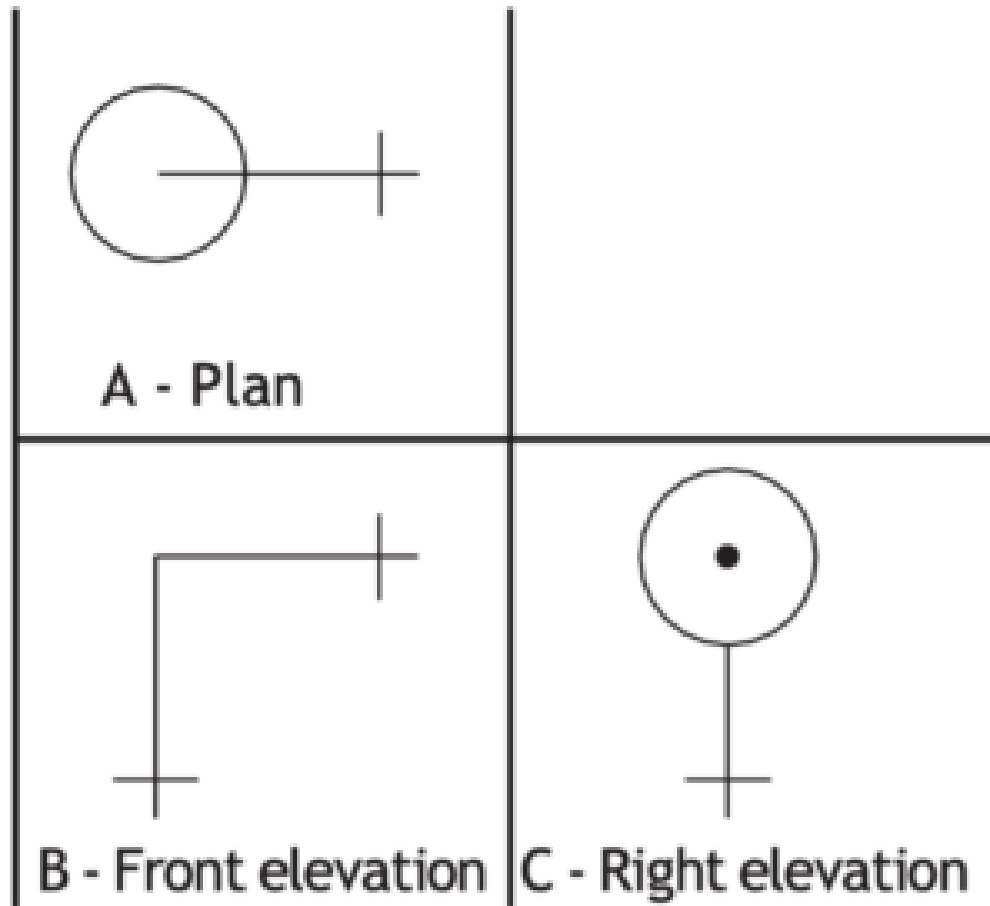


Figure 4 Orthographic views

As stated previously, side and front views are normally called elevations and at times are referred to as sections, especially if the drawing only contains part of a piping system.

Figure 5 shows a drawing of a tee and the three standard orthographic views. Notice that the right view, facing the end of the tee, cannot be distinguished from the same view facing the end of a 90° elbow. This is why multiple views of an object are preferred for clarity.

The frontal drawing of a 45° elbow in Figure 6 is shown with the corresponding standard orthographic views. Notice the curved fitting lines dictate that part of the fitting is not at right angles in the view.

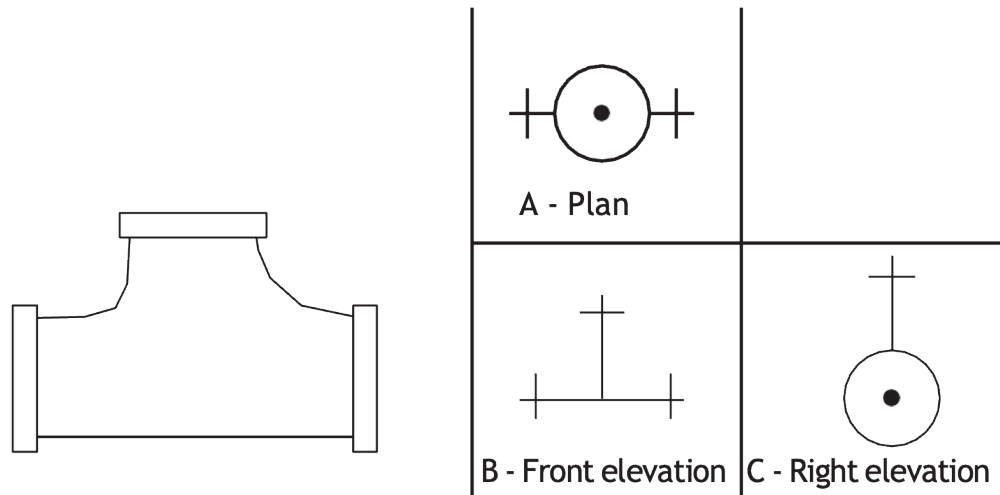


Figure 5 Front elevation and single-line orthographic views of a tee

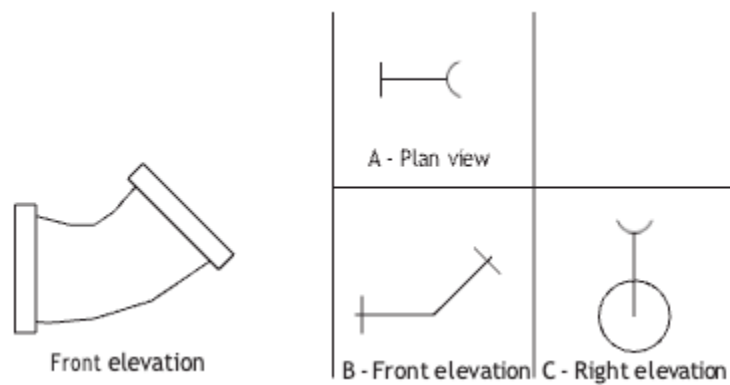


Figure 6 Front elevation and single-line orthographic views of a 45° elbow

Each fitting has a different appearance depending on the direction from which it is viewed. With practice, you will be able to quickly draw three orthographic views for any fitting. If you know what the fitting is and see one view of it, with practice, you will be able to draw the remaining views.

Example

Cover the answer on the right and draw in the remaining views of the tee for which the plan view is given in Figure 7.

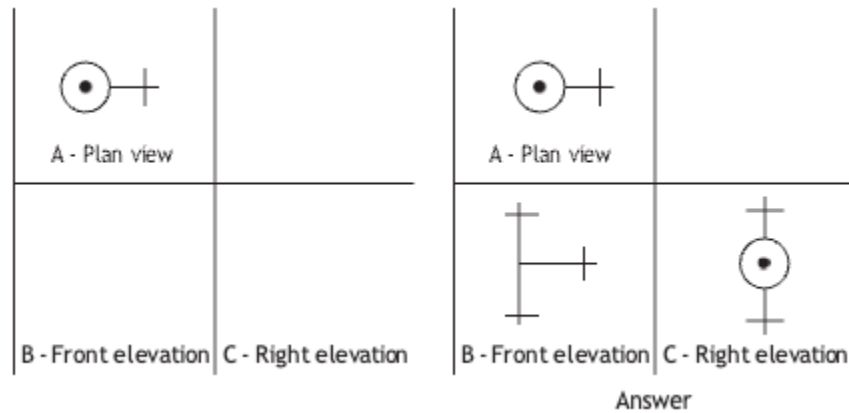


Figure 7 Remaining views of a tee

Use Orthographic Piping Drawings

As we have discussed, when orthographic projections are used, three views of an object are usually shown. These are typically the plan view, the front view and a side view.

The two or three orthographic views used for piping drawings are usually shown grouped together in typical fashion. All views are required for a complete understanding of the piping system. It is not unusual to find only one orthographic view of a two- or three-dimensional piping run. A single view would only be used when the second view would convey little or no information. For example, the plan view of a horizontal drainage piping system is often shown without any accompanying elevation drawings, as there may be no elevation changes (other than the pipe's slope).

The chief advantage of orthographic drawings is that they can be used to pinpoint the exact location of components. For example, orthographic piping layouts drawn on building plans show the exact relationship between the piping system and the building's features. Any lengths that are on the drawing are considered to be accurate. Because orthographic drawings are so often used to show exact component locations, they are usually drawn to scale.

Orthographic drawings have limitations. They are not suitable for complicated systems that have many overlapping pipes, valves and fittings. An orthographic drawing of an intricate piping system can confuse even the most experienced blueprint reader. Orthographic drawings of complicated piping systems are generally accompanied by an isometric diagram that shows the system in one clear view.

Figures 8 to 15 show various orthographic views of simple piping systems. Be sure to allow for hidden items when considering different views. In each case, two of the three views are enough to depict clearly the piping layout. For example, if the front views were not chosen in Figures 8 and 9, the figures could appear to depict two tees and two elbows, respectively.

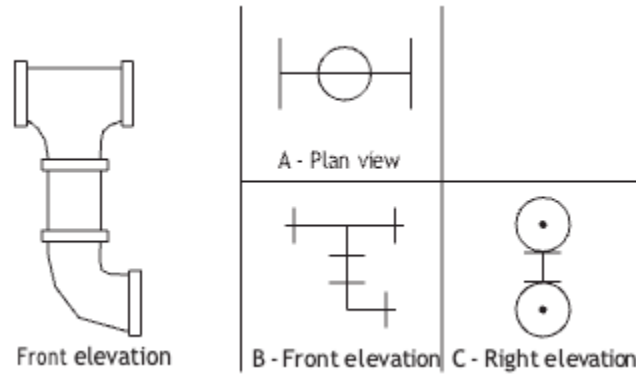


Figure 8 Single-line orthographic views of a tee and 90° elbow

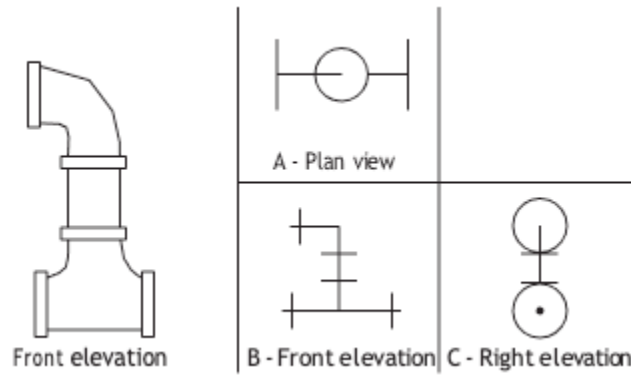


Figure 9 Single-line orthographic views of a tee and 90° elbow

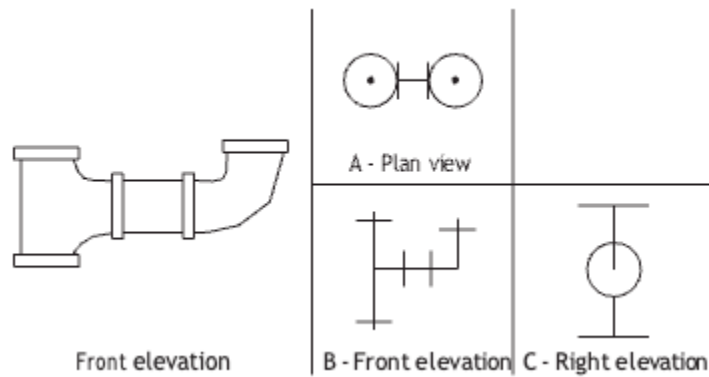


Figure 10 Single-line orthographic views of a tee and 90° elbow

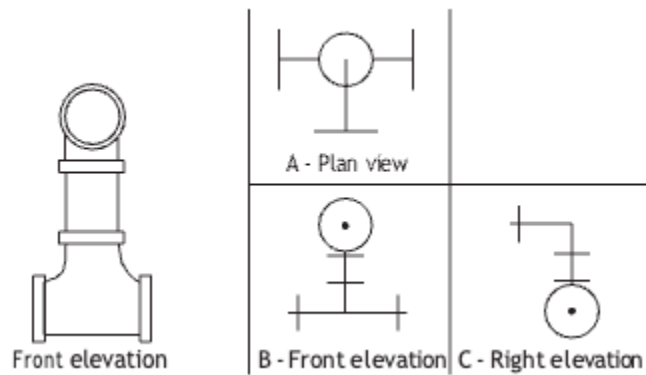


Figure 11 Single-line orthographic drawings of a tee and 90° elbow

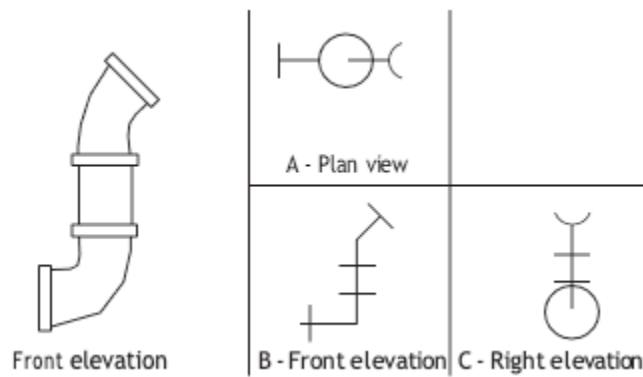


Figure 12 Single-line orthographic drawings of a 90° and 45° elbow

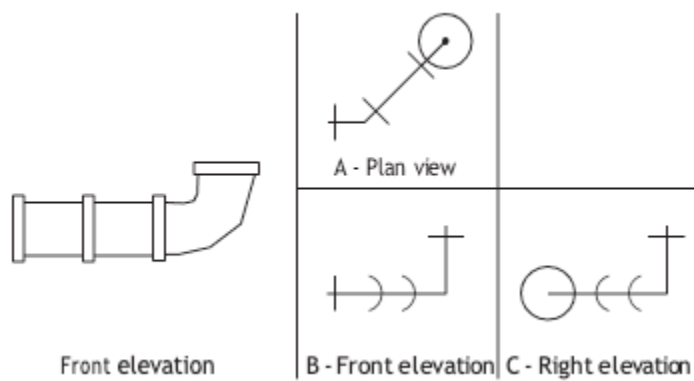


Figure 13 Single-line orthographic drawings of a 90° and 45° elbow

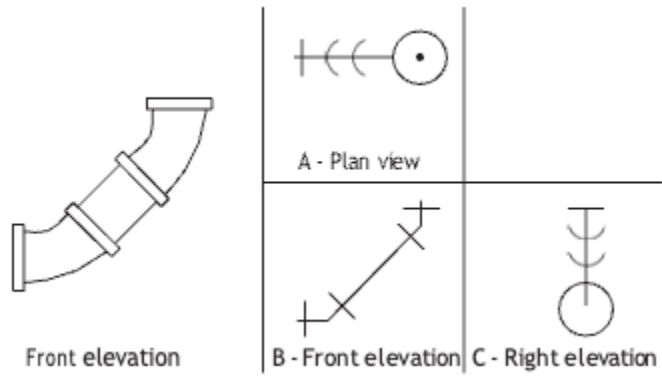


Figure 14 Single-line orthographic drawings of two 45° elbows

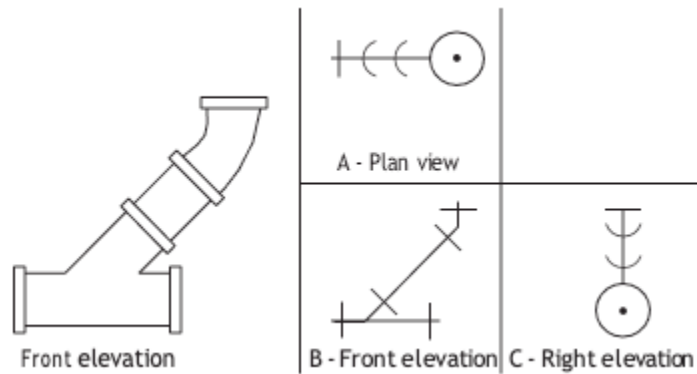


Figure 15 Single-line orthographic drawings of a wye and 45° elbow

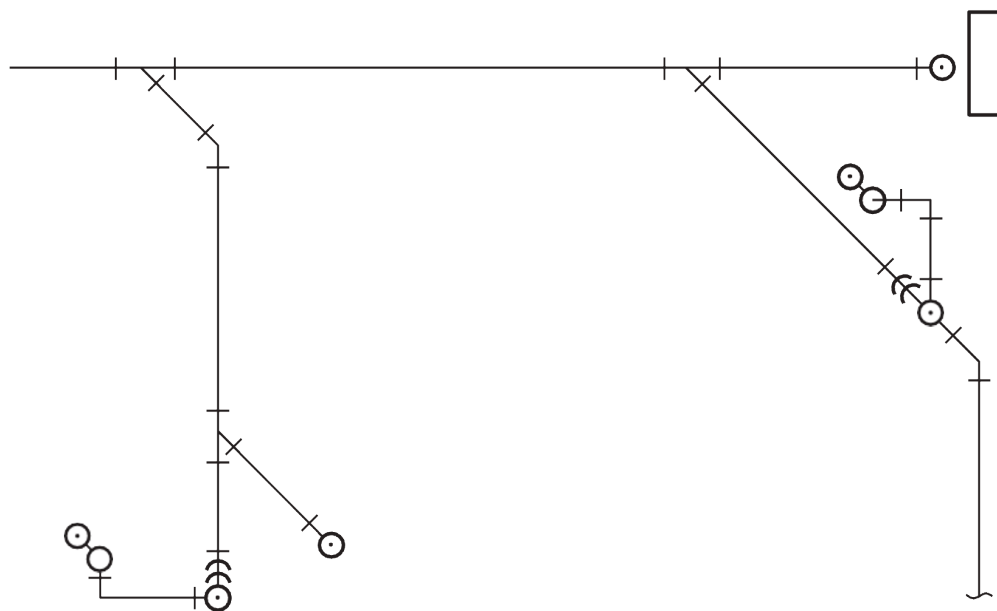


Figure 16 Drainage plan

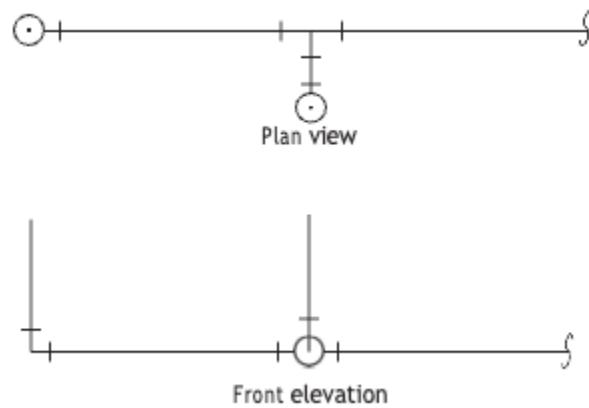


Figure 17 Orthographic views of a simple pipe assembly

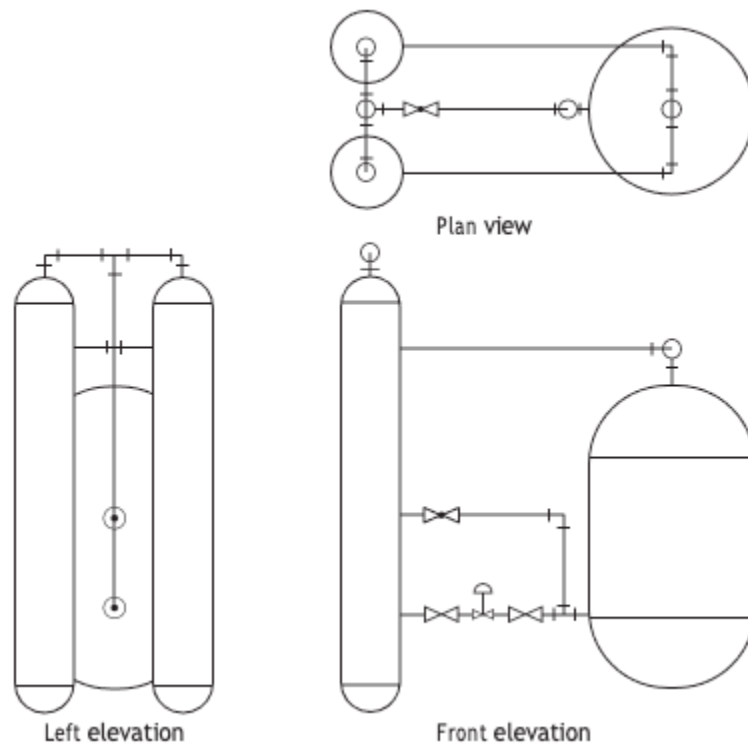


Figure 18 Orthographic drawing, plan and elevation views

Note that in Figure 18, the plan view is unable to show the control valve and isolation valves. A supplementary elevation view is therefore required to understand the piping arrangement.

Once you can distinguish which view of a piping system is depicted, you will be able to read and understand the drawing.

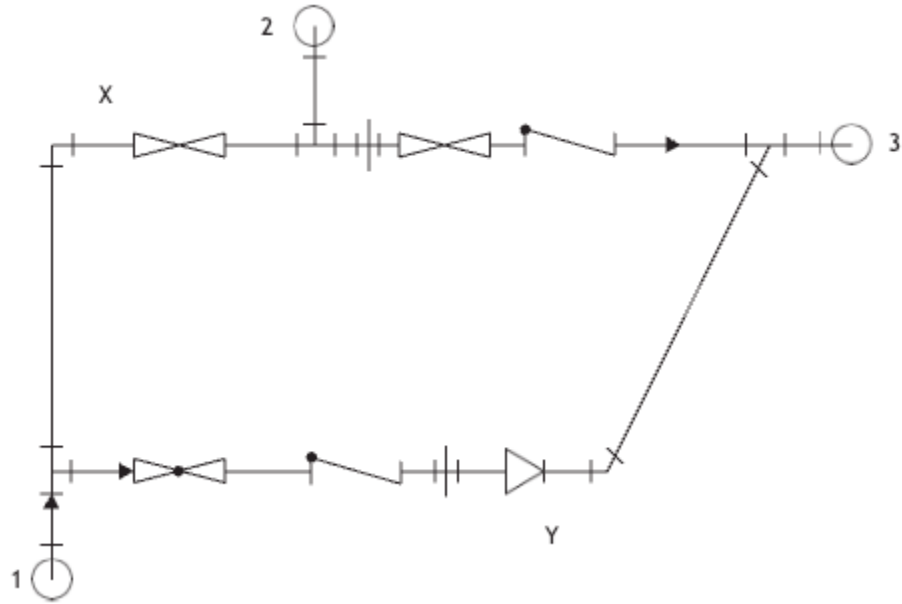


Figure 19 Piping system

Figure 19 shows an orthographic plan view of a portion of a piping system, incorporating standard graphic piping symbols. The small solid arrowheads placed on the pipeline indicate the direction of flow. The flow originates from below point 1. The direction of flow is through section X to point 2 and on to point 3. Point 3 is also supplied by flow through piping section Y when the bypass globe valve is open. Note also the direction of flow indicated by the check valve symbols.



Self-Test C-3.6.1: Use Drawing Projections

Complete Self-Test C-3.6.1 and check your answers.

If you are using a printed copy, please find Self-Test C-3.6.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



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<https://c-tradeactivities-electrical-bcplumbingapprl1.pressbooks.tru.ca/?p=2471#h5p-38>

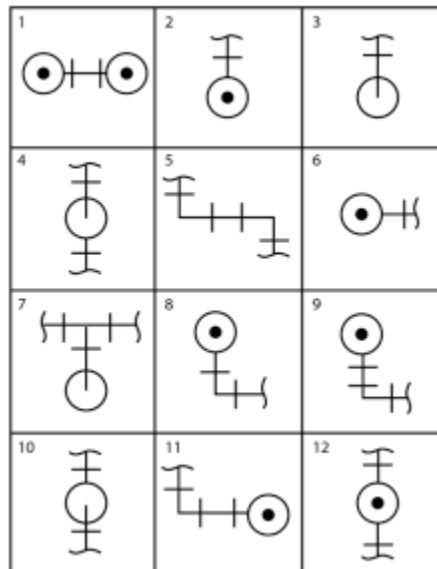


Figure 1 Symbol table for questions 19-23

Use Isometric Piping Drawings

Isometric drawings are used because they clearly represent both simple and complicated piping arrangements. This clarity comes from using angular lines to represent the three dimensions, much like a picture. The three dimensions of

length, width and height are drawn along the isometric axes shown in Figure 20. The lengths of objects running parallel to these axes can be drawn to scale.

Lines at other angles will not be to scale.

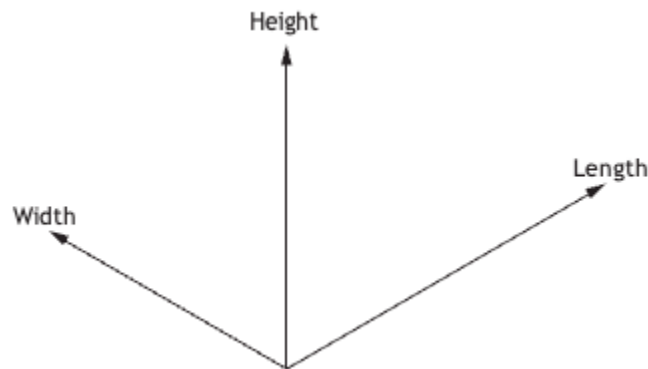


Figure 20 Isometric axes—all lines along these axes can be drawn to scale

The two vertical directions (up and down) are represented by vertical lines. The four horizontal directions (front and back; left and right) are represented by lines at 30° from the horizontal. These six directions are parallel to the three isometric axes, as shown in Figures 21 and 22.

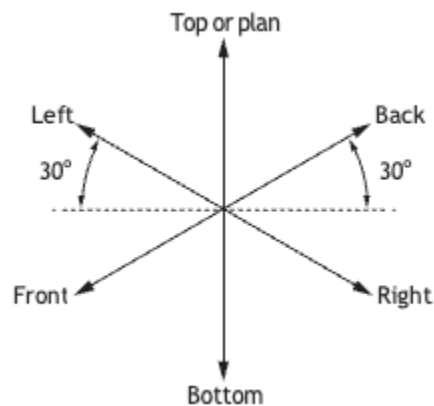


Figure 21 Isometric axes for a front-right view

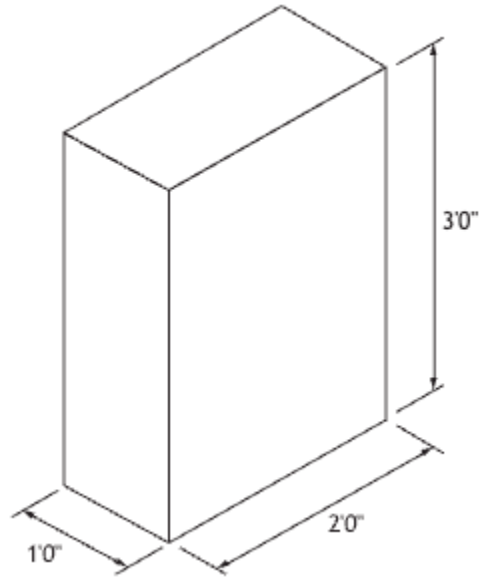


Figure 22 A box drawn isometrically

Most piping is installed parallel to these directions, so the piping can be drawn along the isometric lines. Lines that are not isometric on scaled drawings will not be to scale. Notice the clarity of the piping layout shown in Figure 23.

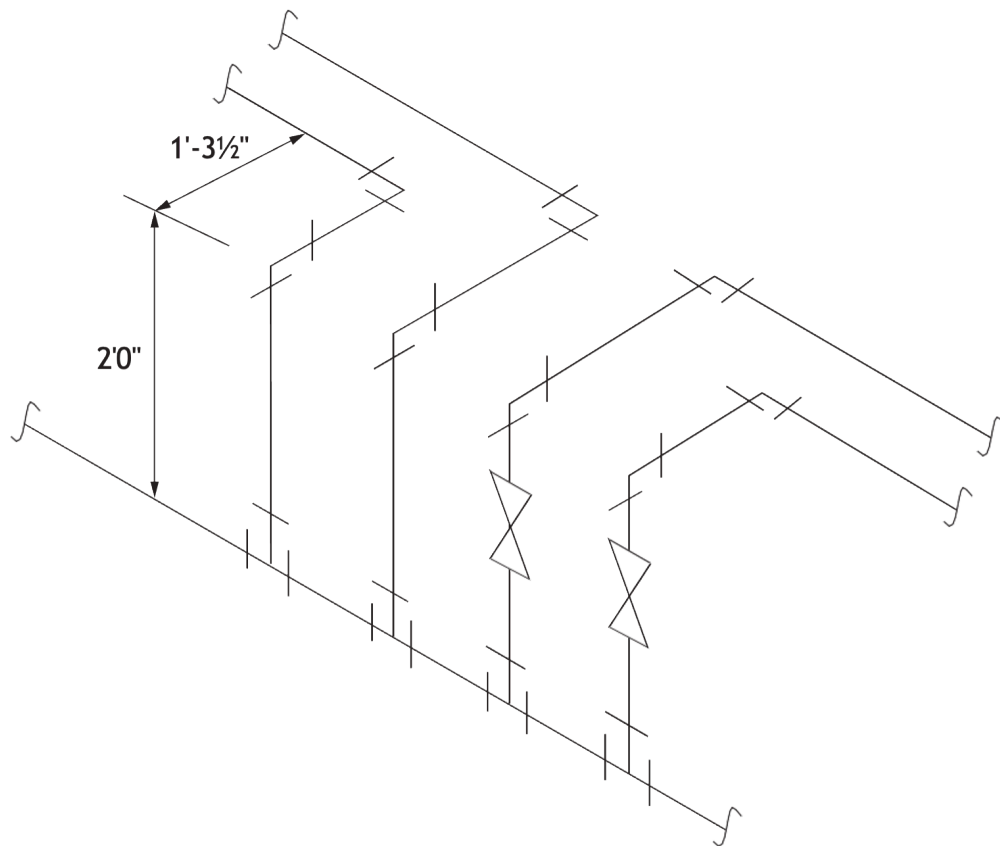


Figure 23 Isometric piping drawing at a scale of 1' = 1'-0"

This type of drawing of a piping layout can be easily drawn with practice. The drawing style is useful for taking off materials such as the type and number of fittings and the lengths of pipe required. This can only be done accurately if the drawing is to scale or dimensions are provided.

Isometric lines are parallel to the three isometric axes. They are also drawn parallel to one of the three edges of the isometric plane. Figure 24 shows the isometric lines that correspond to the isometric axes. Notice that the pipes, fittings and lines indicating fittings, joints or connections are all parallel to the edges of the plane of view.

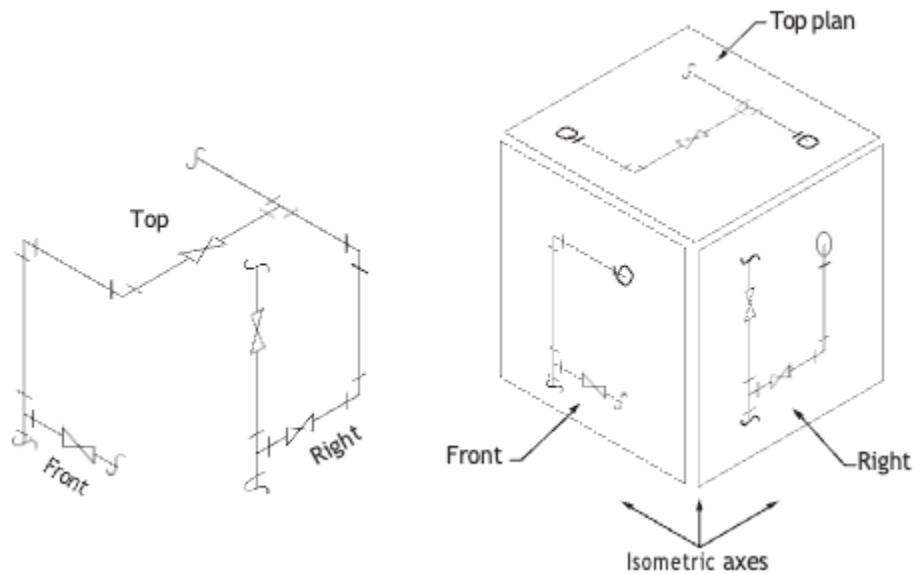


Figure 24 Isometric planes and isometric axes

All the piping connected to a fitting is in the same plane. This determines how the fitting is drawn. The runs and joints are parallel to the edges of the plane. Figure 25 shows two tees on the same vertical pipe. Notice how the joints are drawn differently because the horizontal parts are in different planes. The upper tee faces the left, but the lower tee faces the back.

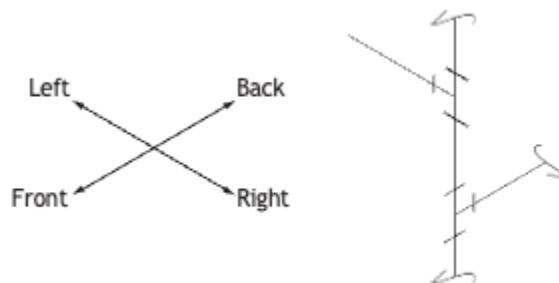


Figure 25 Tees on a vertical pipe

Piping runs that are not parallel to the isometric axes will not be to scale. Two examples of lines that will not be to scale are the 45° run from one end of a 45° elbow and the branch of a 45° wye fitting. Such runs are drawn by proper orientation to the isometric axes, and the joint is drawn perpendicular to the pipe it crosses (Figure 26). The pipe between the two 45° elbows is non-isometric, and the joints are perpendicular to the pipe.

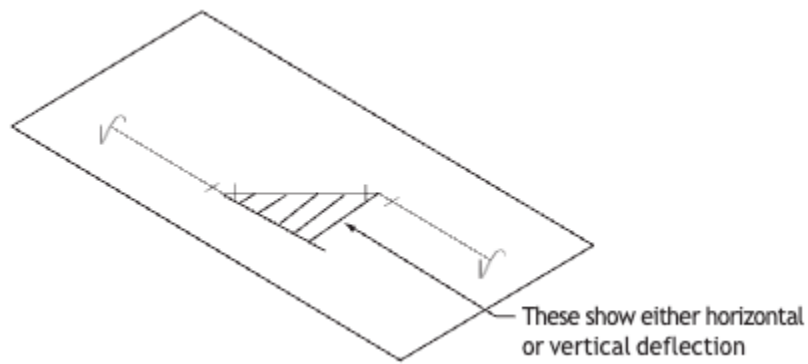


Figure 26 Two horizontal 45° elbows

Figures 27 and 28 show objects drawn both orthographically and isometrically. Notice that the isometric drawing is three dimensional and shows height, width and depth in one view. This typically makes isometric drawings easier to interpret than orthographic drawings. Figure 28 contains piping in only one plane, so only the vertical axis and the left-right axis are needed for the isometric drawing. The isometric drawing in Figure 29 is three-dimensional and uses all three isometric axes.

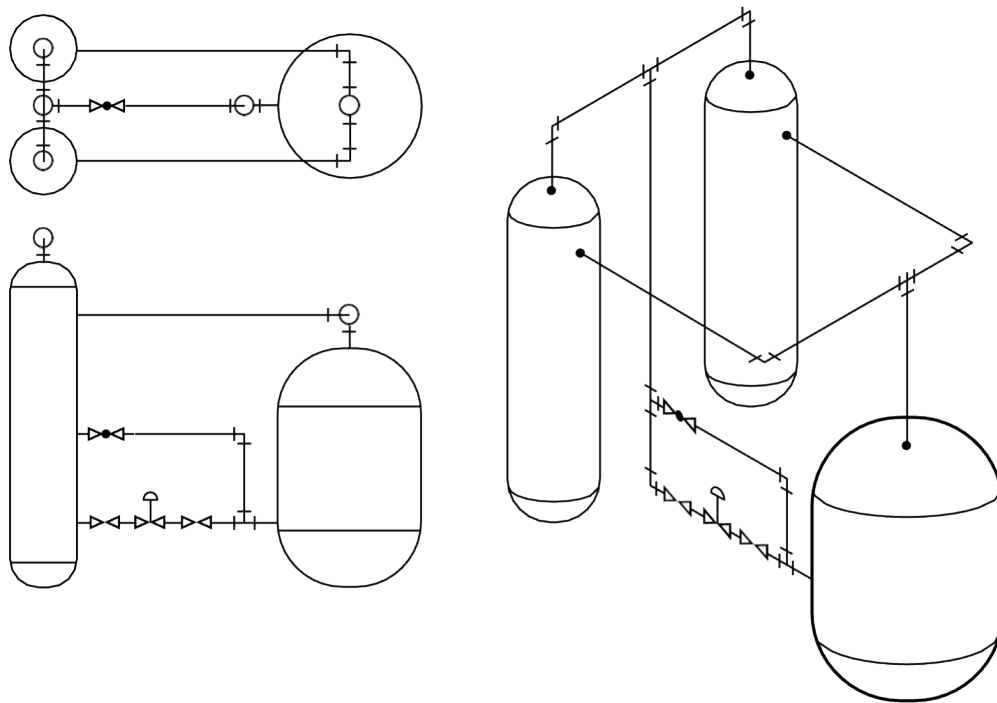


Figure 27 Objects drawn orthographically and isometrically

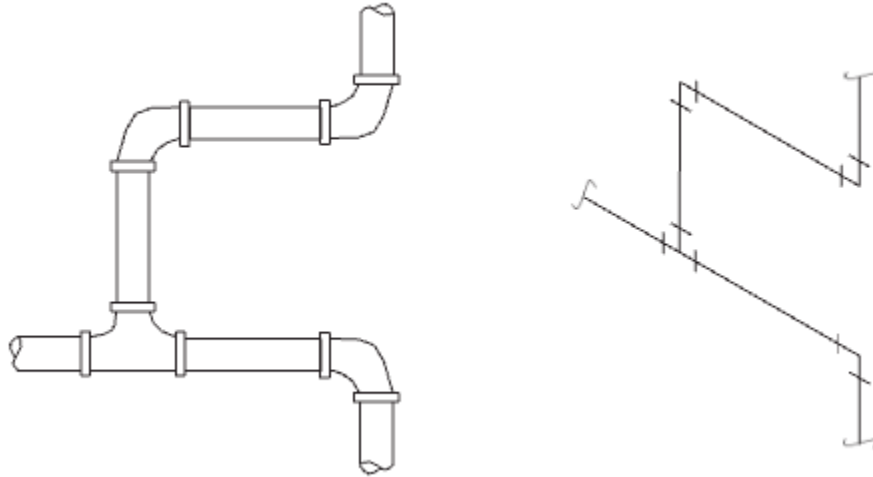


Figure 28 Orthographic and isometric drawings of piping in one plane

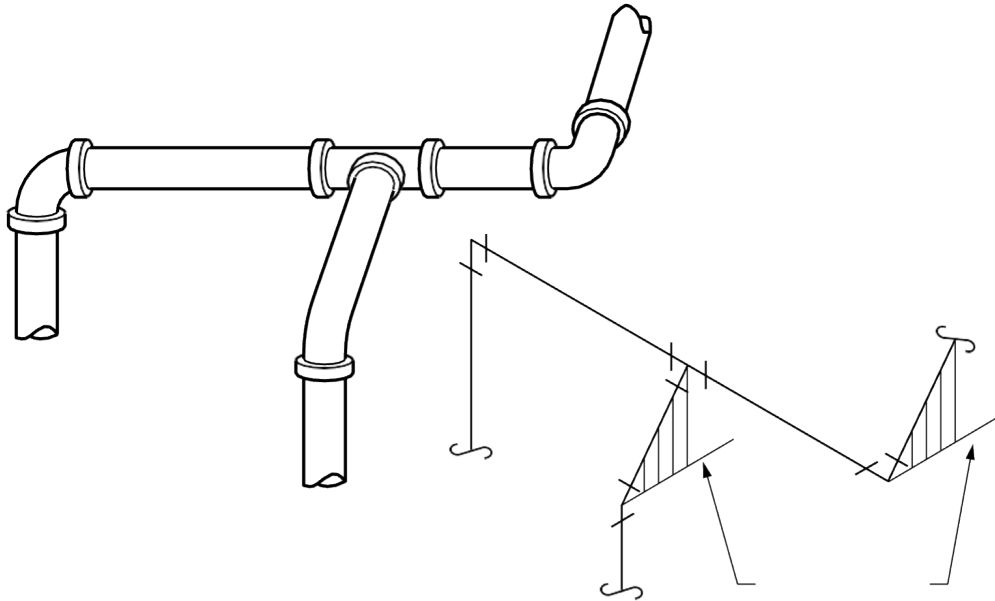


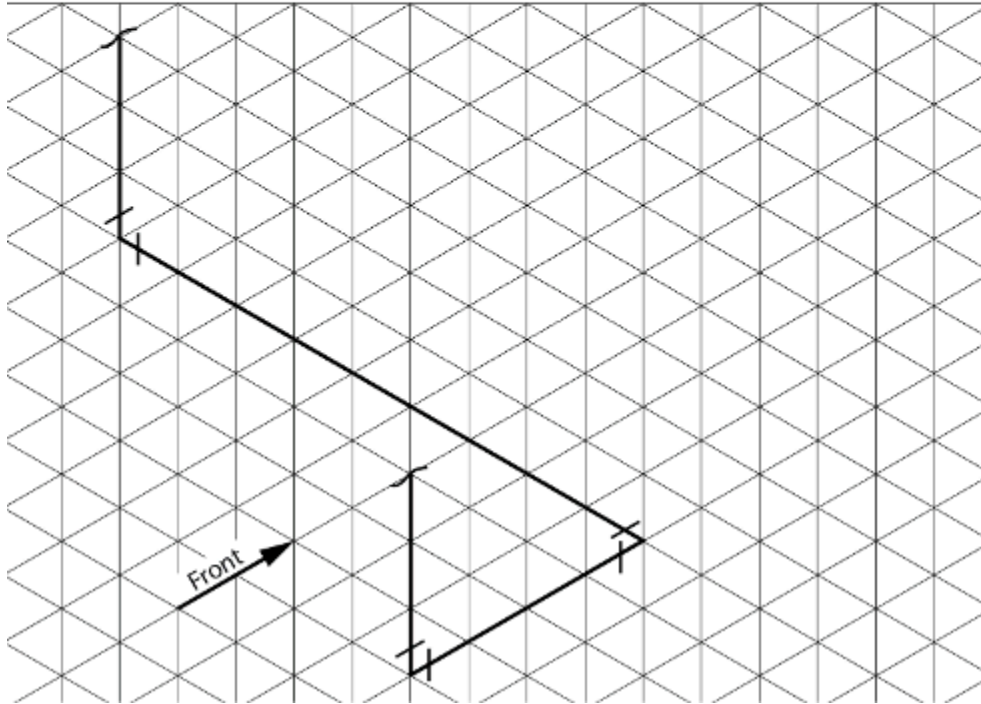
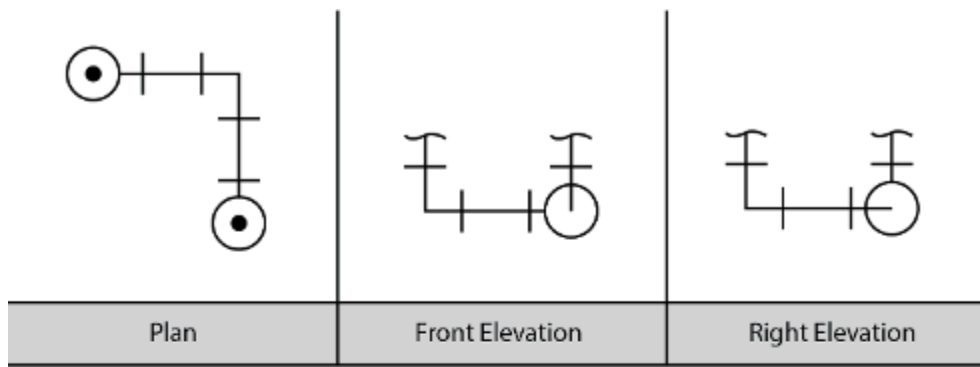
Figure 29 Pictorial and isometric drawings of a three-dimensional piping system

Conversion Between Orthographic and Isometric Drawings

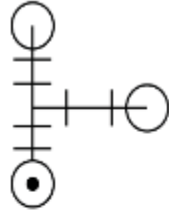
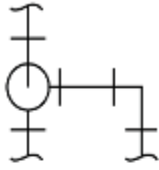
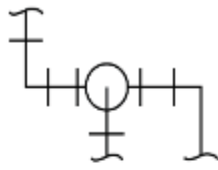
To convert a multi-view orthographic projection to a three-dimensional isometric projection is quite simple. Orient the isometric grid to match the side of the orthographic projection. In this case use the front view.

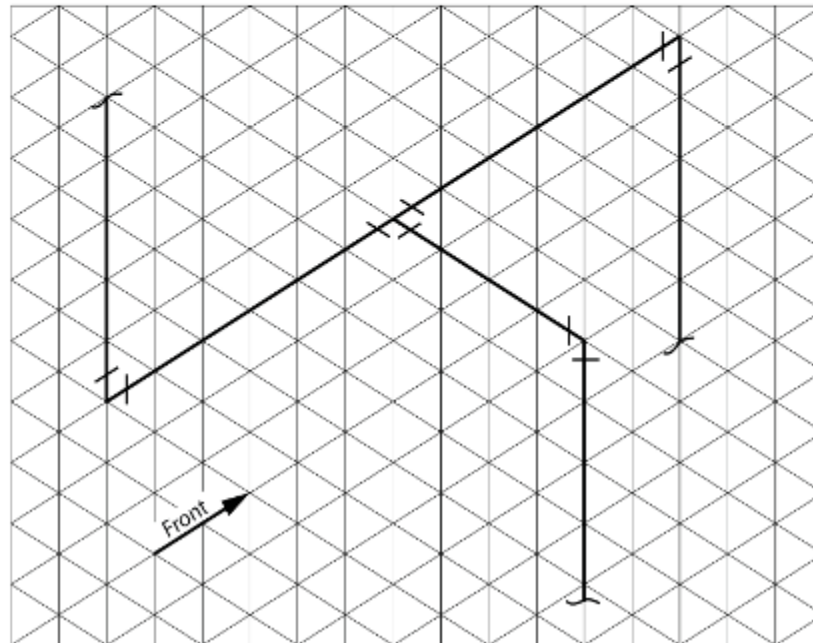
Remember that the two vertical directions (up and down) are represented by vertical lines. The four horizontal directions (front and back; left and right) are represented by lines at 30° from the horizontal. Plot the line segments at the proper orientation, as shown in the examples.

Example 1



Example 2

		
Plan	Front Elevation	Right Elevation



Self-Test C-3.6.2: Use Drawing Projections

Complete Self-Test C-3.6.2 and check your answers.

If you are using a printed copy, please find Self-Test C-3.6.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



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- BC Industry Training Authority. (2019). *Piping trades apprenticeship program: Use Tools and Equipment—Level 1 harmonized* [Binder]. Crown Publications, Queen's Printer for British Columbia. https://www.crownpub.bc.ca/Product/Details/7960000261_S
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 - Sprinkler Fitter: Competency C-2 Interpret Drawings and Specifications
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- Camosun College. (2015). *Trades Access Common Core Competency D-3: Competency D-3: Read Drawings and Specifications*. Victoria, B.C.: Crown Publications. Download for free from the B.C. Open Textbook Collection (<https://open.bccampus.ca/browse-ourcollection/find-open-textbooks/>).

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Self-Test C-3.1: Describe Drafting Tools and Materials

Complete Self-Test C-3.1 and check your answers.

1. What material is used to provide a smooth surface on drafting boards and tables?
 - a. Hardwood
 - b. Vinyl
 - c. Plastic
 - d. Rubber
2. What would you use a hard lead pencil for?
 - a. Writing reports
 - b. Instrument drawings
 - c. Sketching
 - d. Drafting
3. What would you use a soft lead pencil for?
 - a. Writing reports
 - b. Instrument drawings
 - c. Sketching
 - d. Drafting
4. What is an erasing shield used for?
 - a. To erase mistakes
 - b. To hold an eraser
 - c. To keep erasures within a desired area
 - d. To prevent the need for erasures
5. What do you use a T-square for?
 - a. To draw horizontal lines
 - b. To draw vertical lines
 - c. To place the paper squarely on the drafting table
 - d. To draw horizontal and vertical lines
6. What can you use to draw complex curves besides a French curve?
 - a. A spline
 - b. A triangle
 - c. A circle template
 - d. A compass
7. A 1:50 scale would likely be found on a(n)
 - a. Metric scale
 - b. Architect's scale
 - c. Mechanical engineer's scale
 - d. Civil engineer's scale
8. A $\frac{1}{4}$ " to 1' scale would likely be found on a(n)

- a. Metric scale
 - b. Architect's scale
 - c. Mechanical engineer's scale
 - d. Civil engineer's scale
9. Which triangle is of most use to a plumber?
- a. $15^{\circ}-75^{\circ}-90^{\circ}$
 - b. $30^{\circ}-60^{\circ}-90^{\circ}$
 - c. $45^{\circ}-90^{\circ}-45^{\circ}$
 - d. $60^{\circ}-60^{\circ}-60^{\circ}$
10. What is the name given to the drafting tool used in the design of cars and dresses?

Answer: _____

11. What name is given to the drafting tool that contains pre-dimensioned holes in the right scale to accurately draw a symbol for equipment?

Answer: _____

12. When adjusting the pencil lead on a compass, how much shorter than the needle should the lead be?

Answer: _____

13. What is the more modern name given to the drafting tool known as a spline?

Answer: _____

Answer Key: Self-Test C-3.1 is on the other page.

Answer Key: Self-Test C-3.1

1. What material is used to provide a smooth surface on drafting boards and tables?
 - a. Vinyl
2. What would you use a hard lead pencil for?
 - a. Instrument drawings
3. What would you use a soft lead pencil for?
 - a. Sketching
4. What is an erasing shield used for?
 - a. To keep erasures within a desired area
5. What do you use a T-square for?
 - a. To draw horizontal lines
6. What can you use to draw complex curves besides a French curve?
 - a. A spline
7. A 1:50 scale would likely be found on a(n)
 - a. Metric scale
8. A $\frac{1}{4}$ " to 1' scale would likely be found on a(n)
 - a. Architect's scale
9. Which triangle is of most use to a plumber?
 - a. 30°–60°–90°
10. What is the name given to the drafting tool used in the design of cars and dresses?
 - a. French curve
11. What name is given to the drafting tool that contains pre-dimensioned holes in the right scale to accurately draw a symbol for equipment?
 - a. Template
12. When adjusting the pencil lead on a compass, how much shorter than the needle should the lead be?
 - a. $\frac{1}{32}$ "
13. What is the more modern name given to the drafting tool known as a spline?
 - a. Flexible curve

Self-Test C-3.2: Use Scale Rulers to Determine Actual Dimensions from a Piping Diagram

Complete Self-Test C-3.2 and check your answers.

1. List the correct measurements for the lettered dimensions in Figure 1.

a: _____ f: _____
b: _____ g: _____
c: _____ h: _____
d: _____ i: _____
e: _____ j: _____

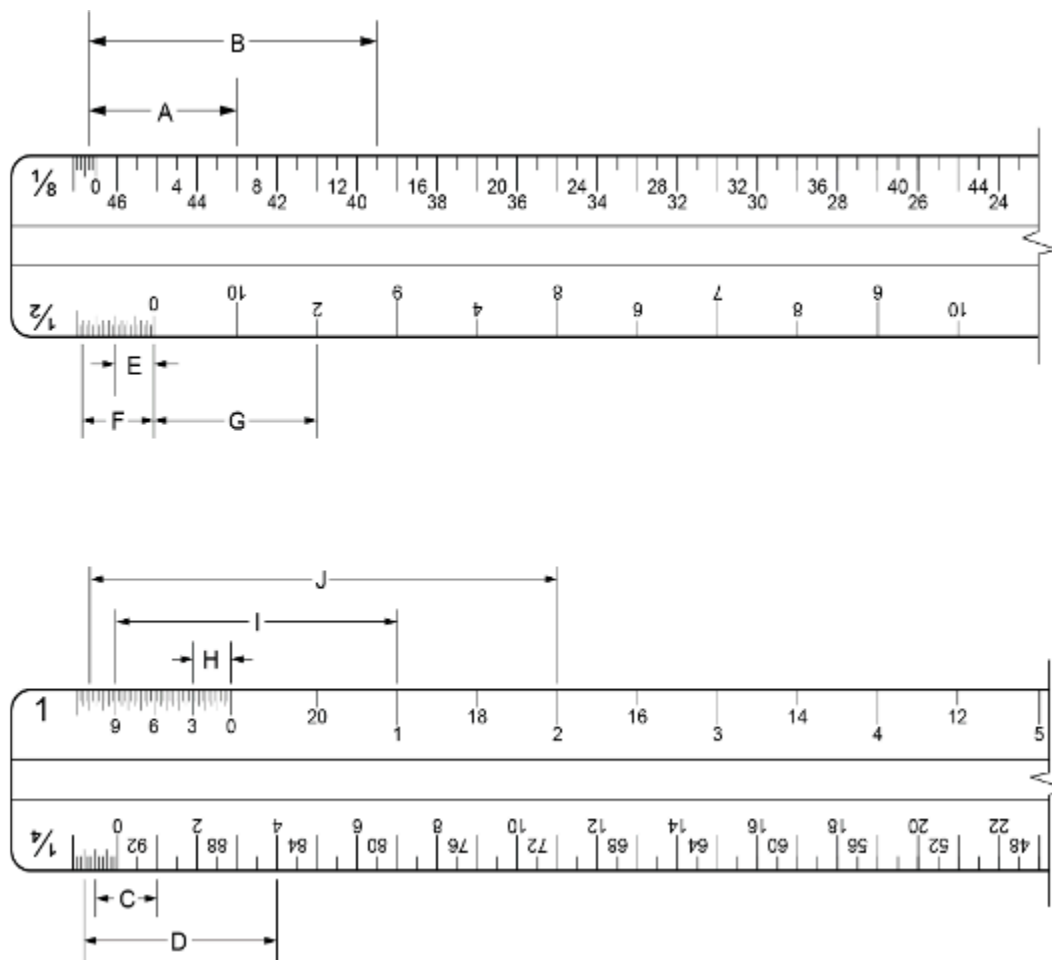


Figure 1 Illustration for question 1

2. Find the lengths of the sections of pipe (Figure 2), centre to centre, using an architect's rule. Scale

$$\frac{3}{4}'' = 1' - 0'' \quad . \quad \text{**measurements may vary from answer key with different printed versions**}$$

a: _____

b: _____

c: _____

d: _____

e: _____

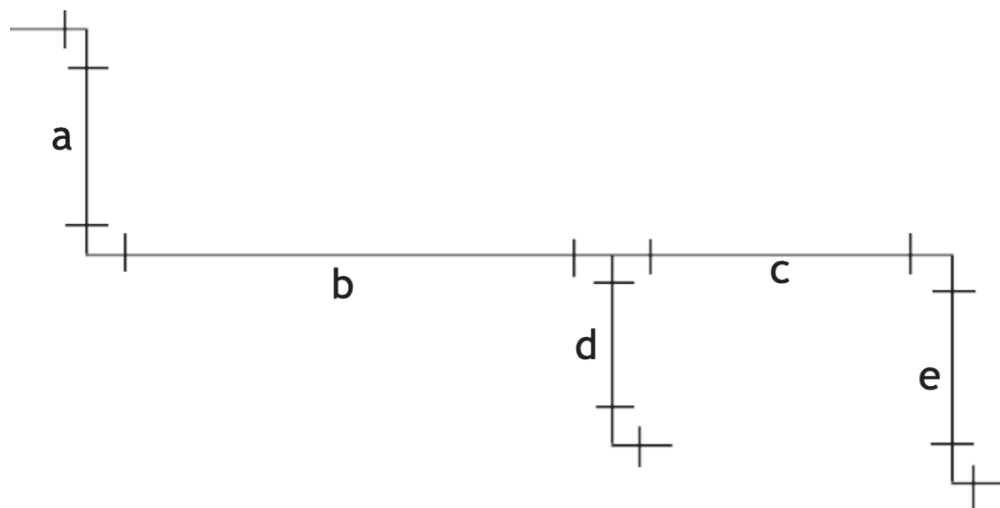
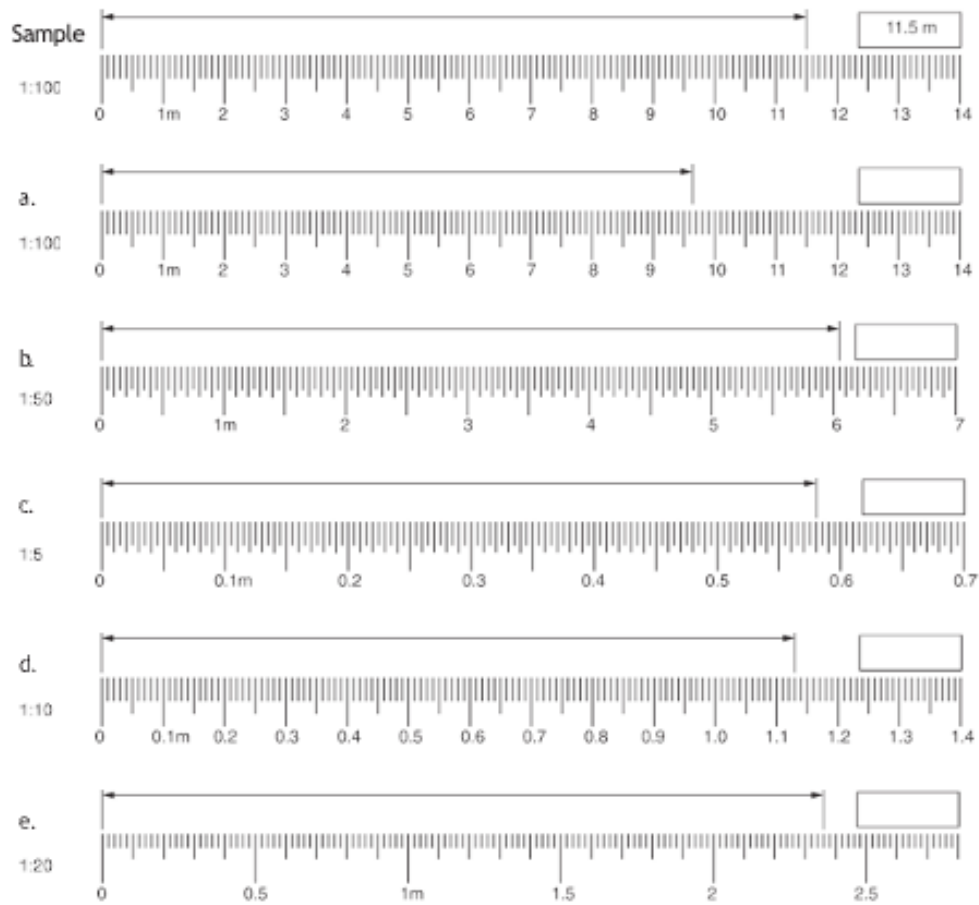
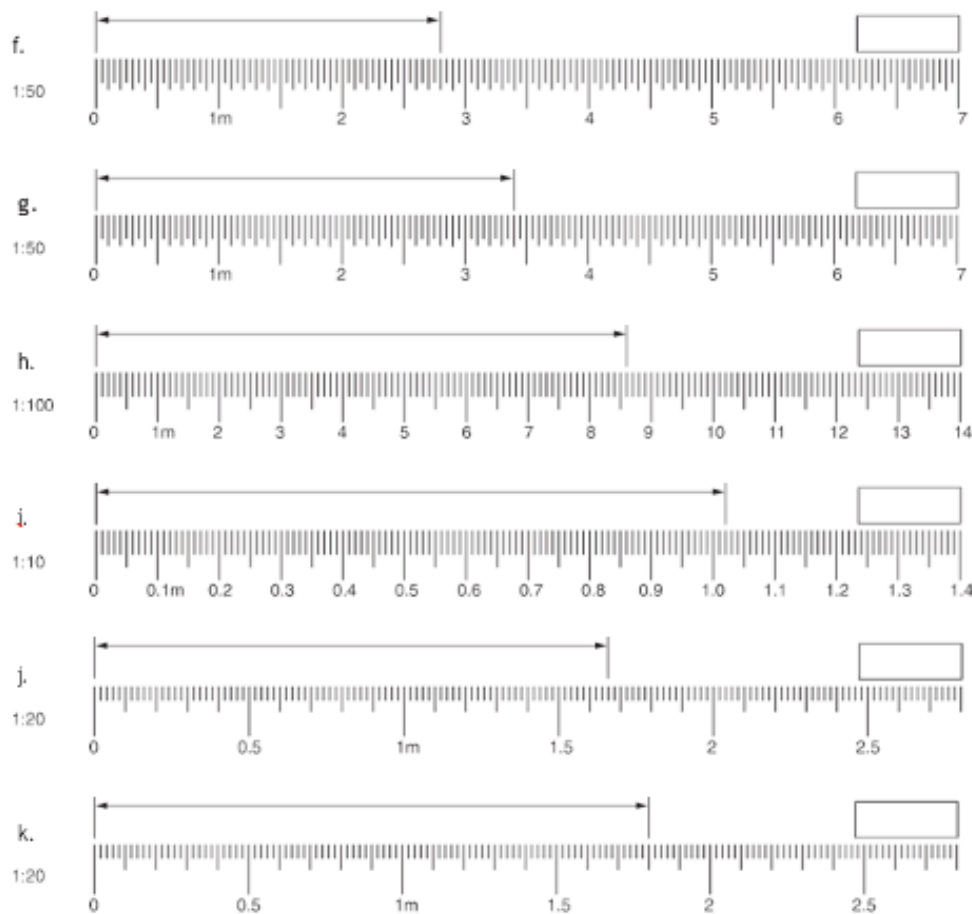


Figure 2 Illustration for question 2

3. Write the correct measurement of the dimensions shown below in the box at the right:





4. Using Figure 3 give the C—C (centre to centre) lengths of each section of pipe in mm, using a metric scale.

****measurements may vary from answer key with different printed versions****

a: _____

b: _____

c: _____

d: _____

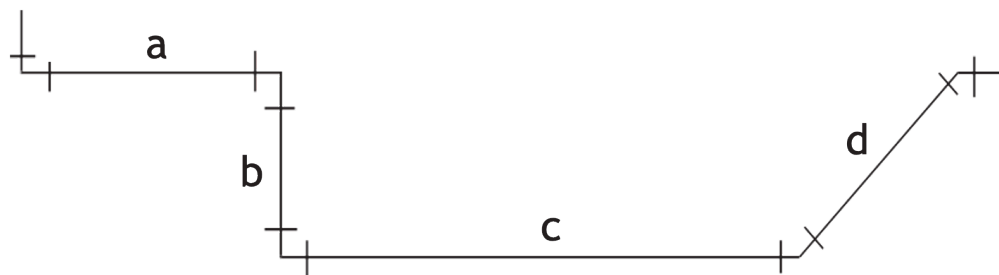


Figure 3 Scale 1-20 illustration for Questions 4 and 5

5. What would the lengths be in Figure 3 if the scale was 1:50?

a: _____

b: _____

c: _____

d: _____

6. Find the millimetre lengths of the sections of pipe, centre-to-centre, in each of the four scales in Figure 4, using a metric rule. ****measurements may vary from answer key with different printed versions****

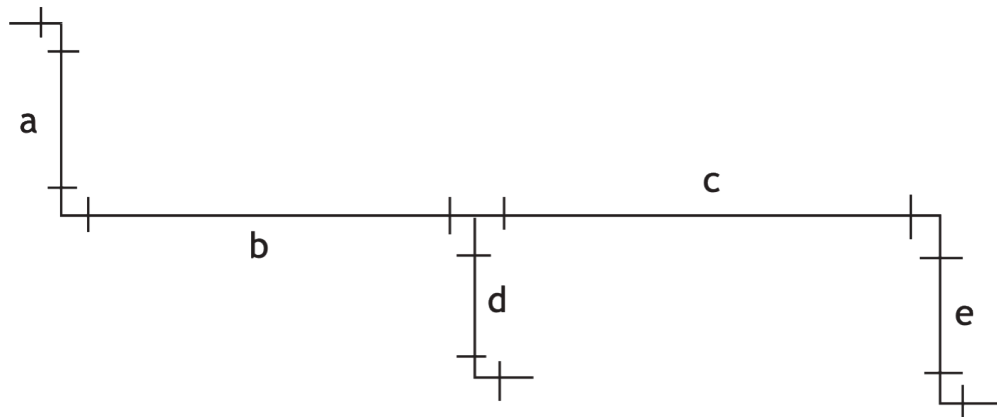


Figure 4 Illustration for Question 6

Table 1: Scale's Table

Scale	1:5	1:50	1:20	1:100
a.				
b.				
c.				
d.				
e.				

7. State the two reasons why it is poor practice to obtain dimensions by measuring drawings.

a: _____

b: _____

8. State reasons why it is not usually necessary to measure drawings for dimensions.

Answer: _____

9. State the procedure required to obtain dimensions that appear to be missing.

Answer: _____

10. State why arithmetic is necessary occasionally for finding dimensions.

Answer: _____

11. Using a metric tape, calculate the lettered dimensions in Figure 5. The scale is 1:20.

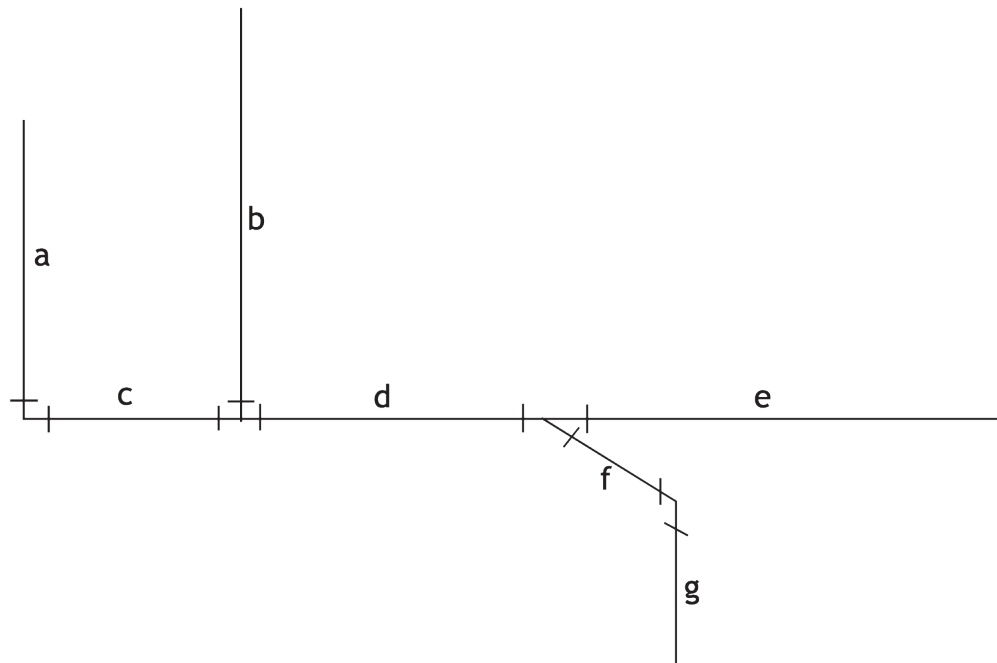


Figure 5 Illustration for Question 11 and 12

a: _____

b: _____

c: _____

d: _____

e: _____

f: _____

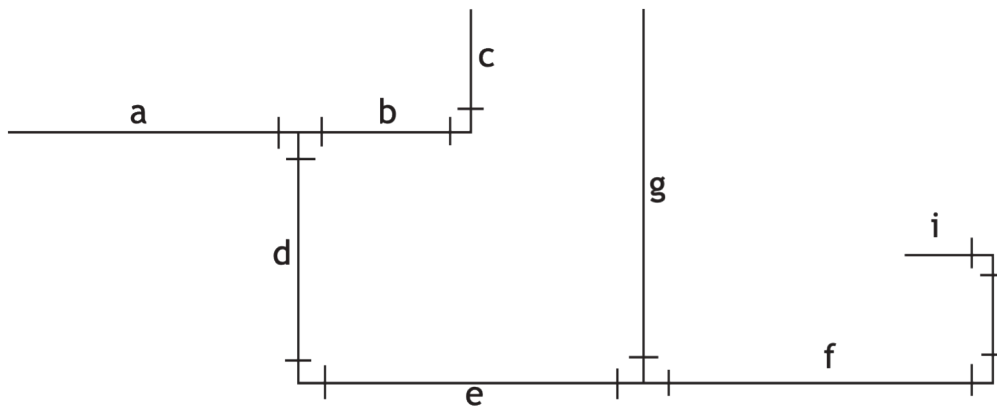
g: _____

12. If the scale in Figure 5 were 1:50, what would the dimensions be?

a: _____
 b: _____
 c: _____
 d: _____
 e: _____
 f: _____
 g: _____

13. Using an imperial tape measure, calculate the lettered dimensions in Figure 6 at a scale of $\frac{1}{8}$ inch = 1 foot.

****measurements may vary from answer key with different printed versions****



a: _____ f: _____
 b: _____ g: _____
 c: _____ h: _____
 d: _____ i: _____
 e: _____

14. Find the exact length of the lettered dimensions in Figure 7, according to the scale. ****measurements may vary from answer key with different printed versions****

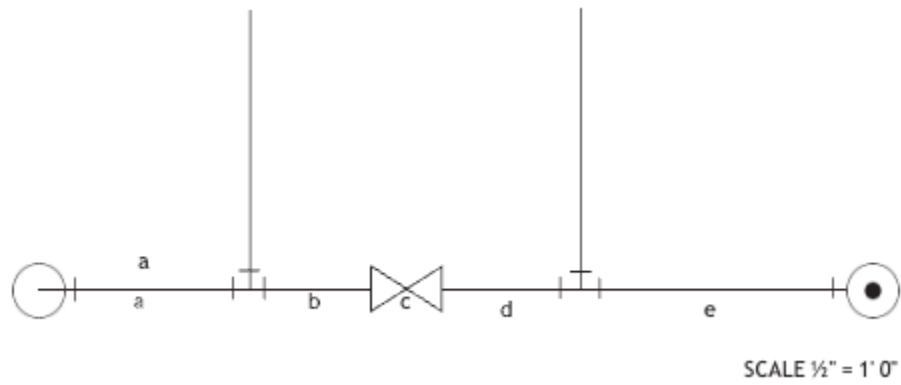


Figure 7 Illustration for Question 14

a: _____

b: _____

c: _____

d: _____

e: _____

Answer Key: Self-Test C-3.2 is on the other page.

Answer Key: Self-Test C-3.2

1. List the correct measurements for the lettered dimensions in Figure 1.

- a. 6'-5"
- b. 12'-10"
- c. 1'-6"
- d. 4'-9"
- e. 0'-6"
- f. 0'-11"
- g. 2'-0"
- h. 0'-3"
- i. 1'-9"
- j. 2'-11"

2. Find the lengths of the sections of pipe (Figure 2), centre to centre, using an architect's rule. Scale

$$\frac{3}{4}'' = 1' - 0''$$

- a. 1' - $\frac{1}{2}$ ''
- b. 2' - $4\frac{1}{2}$ ''
- c. 1'-10"
- d. 0'-10"
- e. 1'-1"

3. Write the correct measurement of the dimensions shown below in the box at the right:

- a. 9.65 m
- b. 6.05 m
- c. 0.58 m
- d. 1.13 m
- e. 2.36 m
- f. 2.8 m
- g. 3.4 m
- h. 8.6 m
- i. 1.02 m
- j. 1.66 m
- k. 1.8 m

4. Using Figure 3 give the C—C (centre to centre) lengths of each section of pipe in mm, using a metric scale.

- a. 560 mm
- b. 400 mm
- c. 1,140 mm
- d. 540 mm

5. What would the lengths be in Figure 3 if the scale was 1:50?

- a. 1,400 mm
- b. 1,000 mm

- c. 2,850 mm
 - d. 1,350 mm
6. Find the millimetre lengths of the sections of pipe, centre-to-centre, in each of the four scales in Figure 4, using a metric rule.

Scale	1:5	1:50	1:20	1:100
a.	100 mm	1 m	0.4 m	2 m
b.	225 mm	2.25 m	0.89 m	4.5 m
c.	175 mm	1.75 m	0.7 m	3.5 m
d.	80 mm	0.8 m	0.32 m	1.6 m
e.	105 mm	1.05 m	0.42 m	2.1 m

7. State the two reasons why it is poor practice to obtain dimensions by measuring drawings.
- a. Shrinkage may occur in the reproduction process.
 - b. Drawing is not necessarily to scale.
8. State reasons why it is not usually necessary to measure drawings for dimensions.
- a. All necessary dimensions are generally included on the blueprints (drawings).
9. State the procedure required to obtain dimensions that appear to be missing.
- a. Examine several or all prints in the set. Measure only after you are sure that dimensions cannot be found from information given on any of the prints.
10. State why arithmetic is necessary occasionally for finding dimensions.
- a. To obtain dimensional (size) information.
11. Using a metric tape, calculate the lettered dimensions in Figure 5. The scale is 1:20.
- a. 0.7 m
 - b. 0.94 m
 - c. 0.5 m
 - d. 0.7 m
 - e. 1.06 m
 - f. 0.36 m
 - g. 0.38 m
12. If the scale in Figure 5 were 1:50, what would the dimensions be?
- a. 1.75 m
 - b. 2.35 m
 - c. 1.25 m
 - d. 1.65 m
 - e. 2.45 m
 - f. 0.9 m
 - g. 0.95 m
13. Using an imperial tape measure, calculate the lettered dimensions in Figure 6 at a scale of $\frac{1}{8}$ inch = 1 foot.
- a. 10'
 - b. 6'

- c. 4'
- d. 8'
- e. 12'
- f. 12'
- g. 12'
- h. 4'
- i. 3'

14. Find the exact length of the lettered dimensions in Figure 7, according to the scale.

- a. $2' - 7\frac{1}{2}"$
- b. $1' - 0"$
- c. $0' - 10\frac{1}{2}"$
- d. 4'
- e. $10' - \frac{3}{4}"$

Self-Test C-3.3: Describe Piping and Fixture Symbols Used in the Piping Trades

Complete Self-Test C-3.3 and check your answers.

1. Why are piping symbols used?

Answer: _____

2. State the two basic requirements for symbols.

Answer: _____

3. Why are single-line symbols usually used in piping drawings?

Answer: _____

4. Lengths of valves and fittings in single-line drawings are always drawn to scale.
 - a. true
 - b. false
5. Flanged or welded valves and fittings in double line drawings are always drawn to scale.
 - a. true
 - b. false
6. The joint in Figure 1 is
 - a. screwed
 - b. flanged
 - c. butt welded
 - d. socket welded

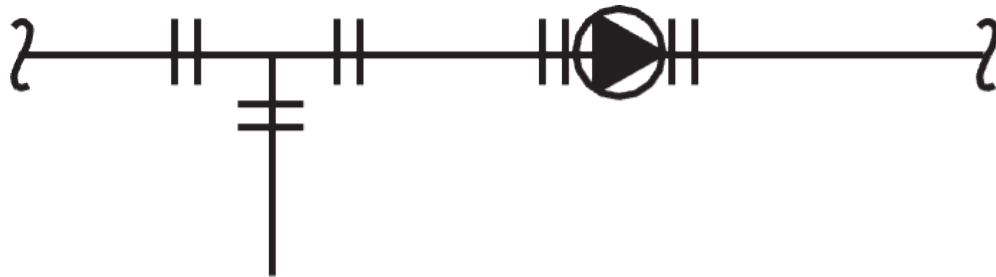


Figure 1 Illustration for Question 6

7. The joint in Figure 2 is
 - a. screwed

- b. flanged
- c. butt welded
- d. socket welded

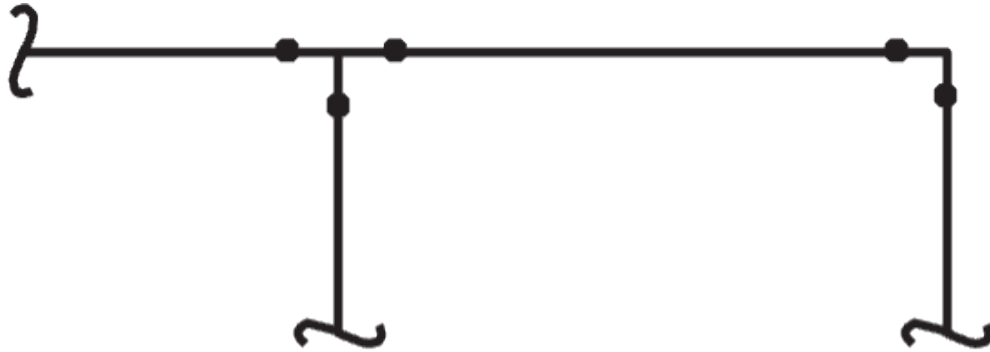


Figure 2 Illustration for Question 7

8. The joint in Figure 3 is
- a. screwed
 - b. flanged
 - c. butt welded
 - d. socket welded



Figure 3 Illustration for Question 8

9. The joint in Figure 4 is
- a. screwed
 - b. flanged
 - c. butt welded
 - d. socket welded

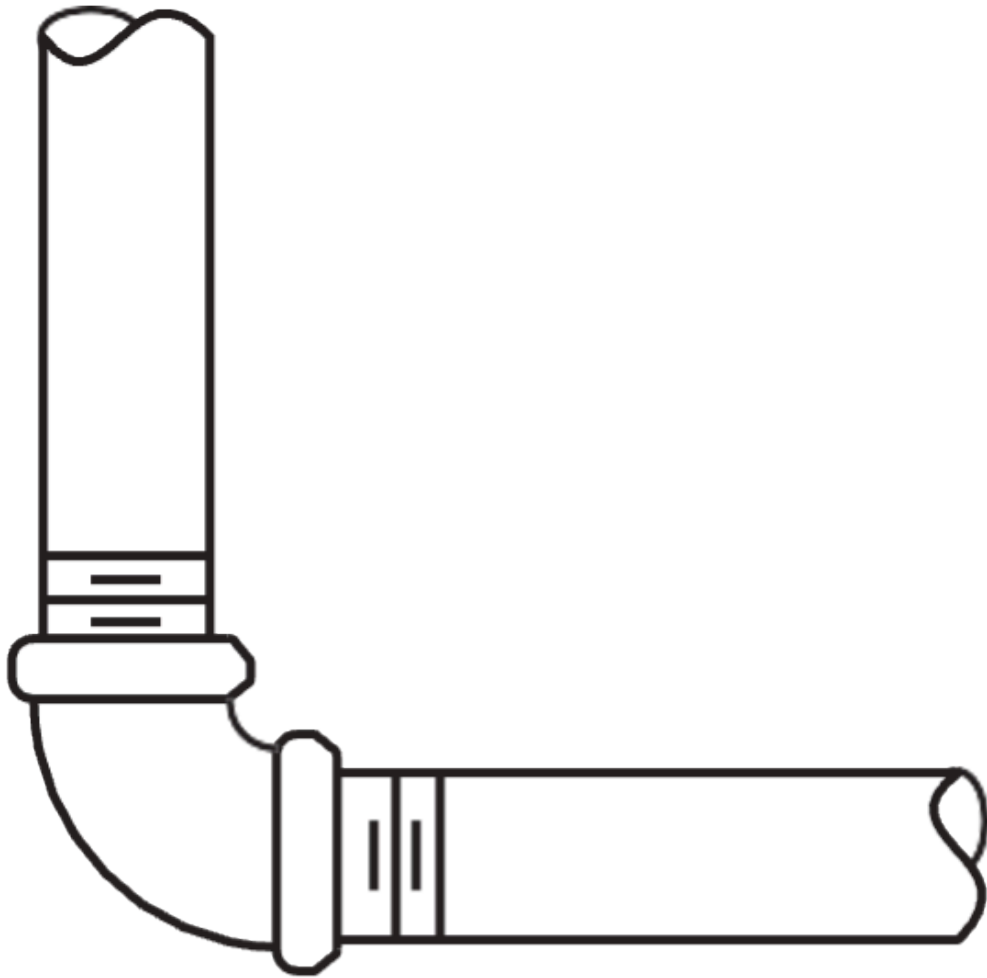


Figure 4 Illustration for Question 9

10. The joint in Figure 5 is
- a. screwed
 - b. flanged
 - c. butt welded
 - d. socket welded

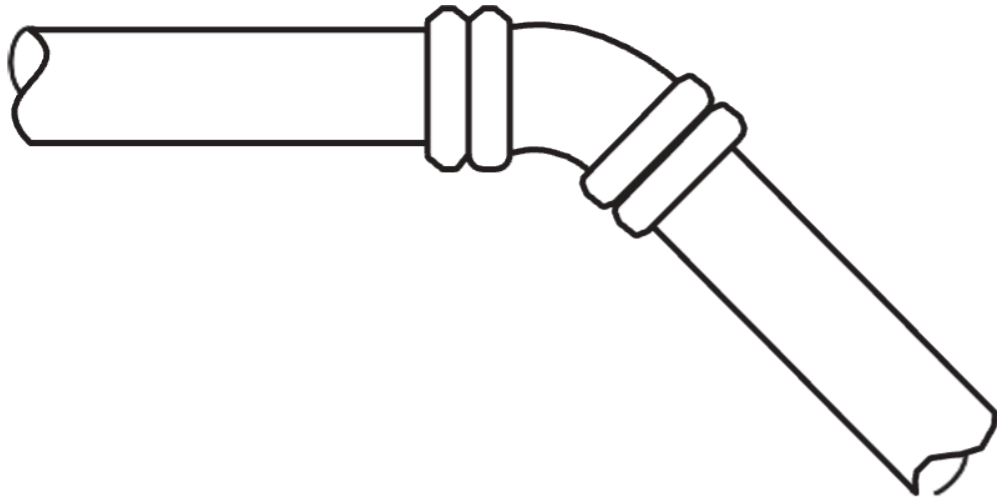


Figure 5 Illustration for Question 10

11. The symbol in Figure 6 is a
- a. 90° elbow
 - b. tee
 - c. 45° elbow
 - d. union

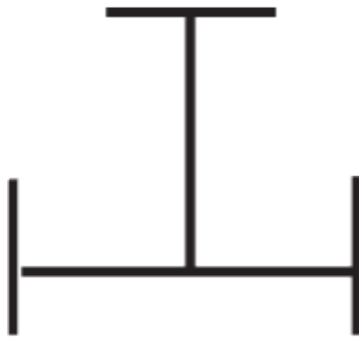


Figure 6 Illustration for Question 11

12. The symbol in Figure 7 is a
- a. 90° elbow
 - b. tee
 - c. 45° elbow
 - d. union

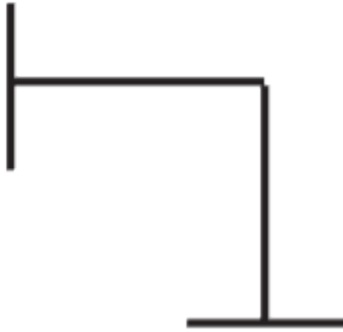


Figure 7 Illustration for Question 12

13. The symbol in Figure 8 is a
- a. 90° elbow
 - b. tee
 - c. 45° elbow
 - d. union



Figure 8 Illustration for Question 13

14. The symbol in Figure 9 is a
- a. globe valve
 - b. gate valve
 - c. check valve
 - d. relief valve



Figure 9 Illustration for Question 14

15. The symbol in Figure 10 is a
- a. globe valve
 - b. gate valve
 - c. check valve
 - d. relief valve



Figure 10 Illustration for Question 15

16. The symbol in Figure 11 is a
- a. globe valve
 - b. gate valve
 - c. check valve
 - d. relief valve



Figure 11 Illustration for Question 16

17. The symbol in Figure 12 is a
- a. safety valve
 - b. pump
 - c. control valve
 - d. pressure-reducing valve



Figure 12 Illustration for Question 17

18. The symbol in Figure 13 is a

- a. safety valve
- b. pump
- c. control valve
- d. pressure-reducing valve



Figure 13 Illustration for Question 18

19. The symbol in Figure 14 is a

- a. safety valve
- b. pump
- c. control valve
- d. pressure-reducing valve

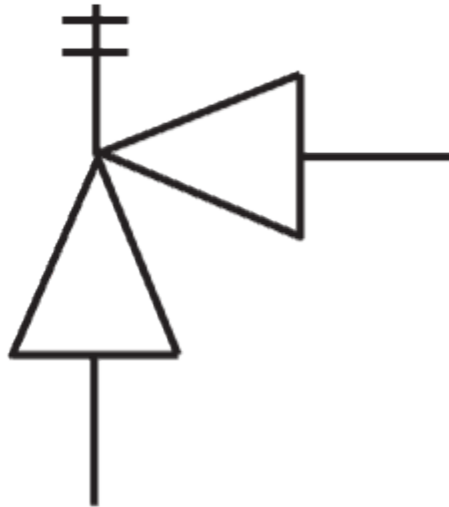


Figure 14 Illustration for Question 19

20. The symbol in Figure 15 is a

- a. safety valve
- b. pump
- c. control valve
- d. pressure reducing valve

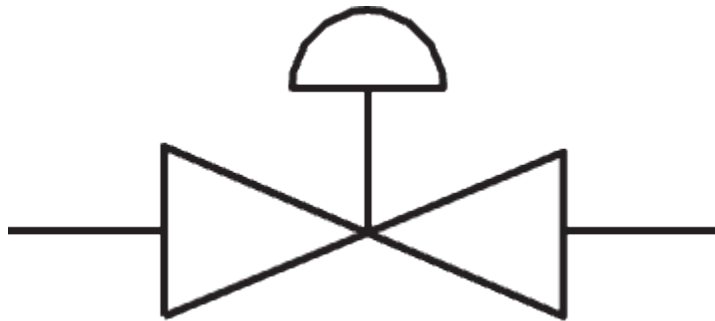
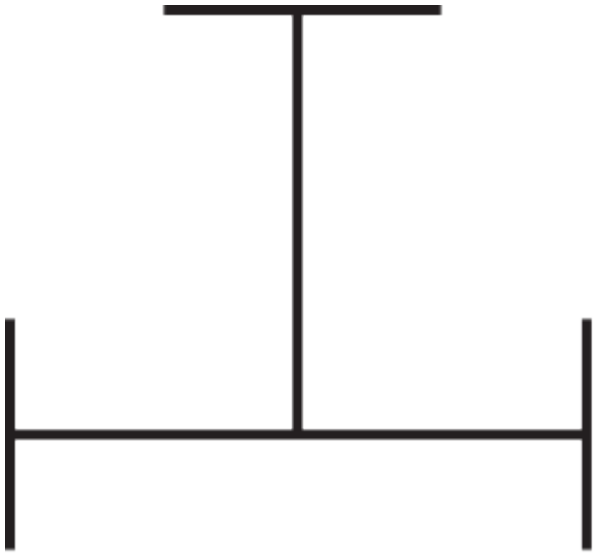
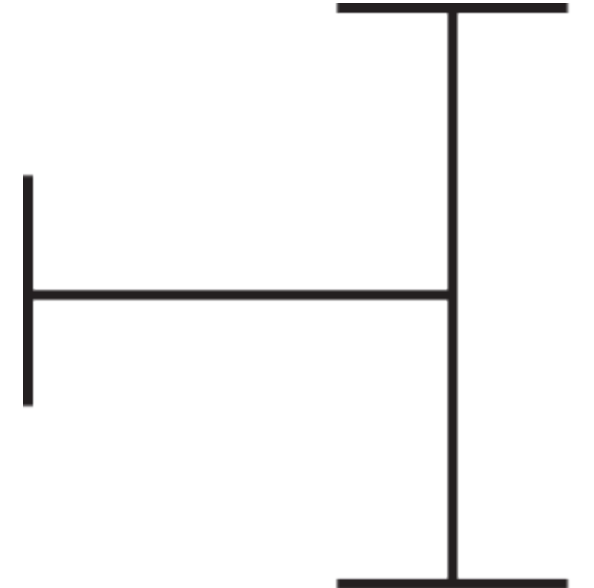
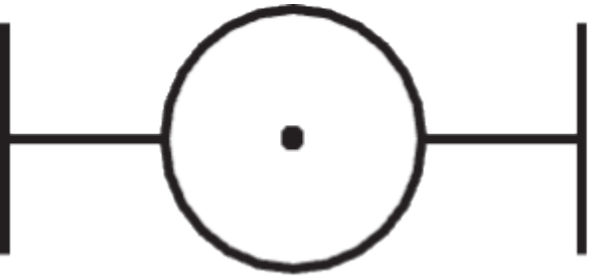
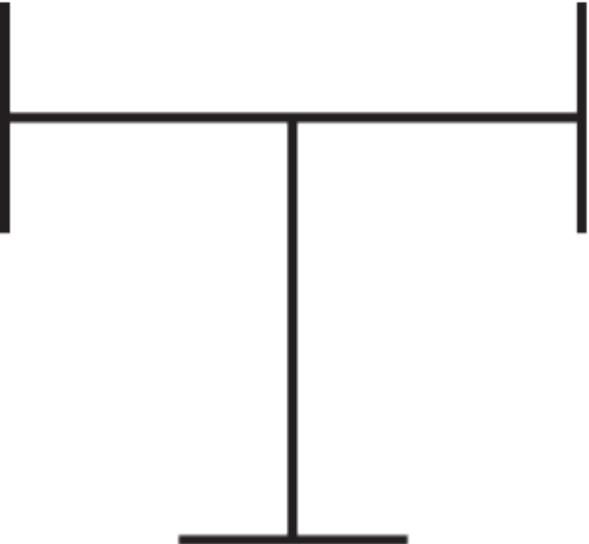
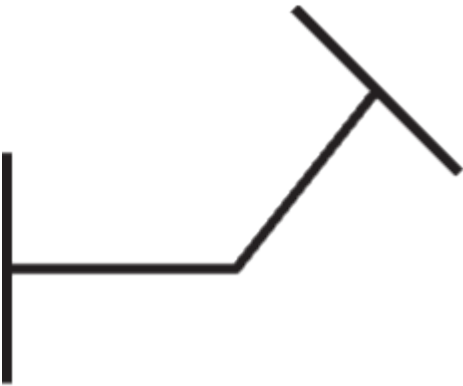
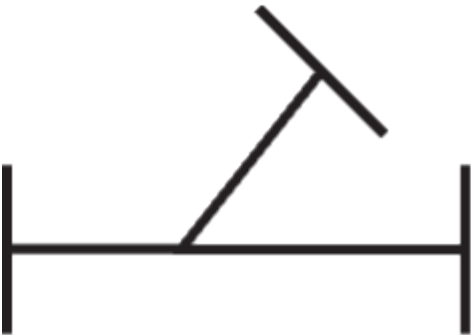
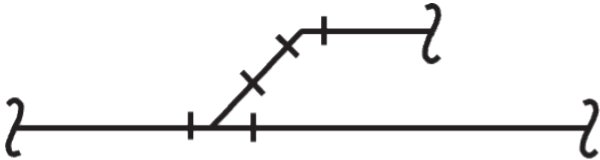


Figure 15 Illustration for Question 20

21. Draw the right view of the following front views.

	Front view	Right view
a.		
b.		

c.		
d.		
e.		

f.		
g.		
h.		
i.		

22. Identify the symbols A to G in Figure 16.

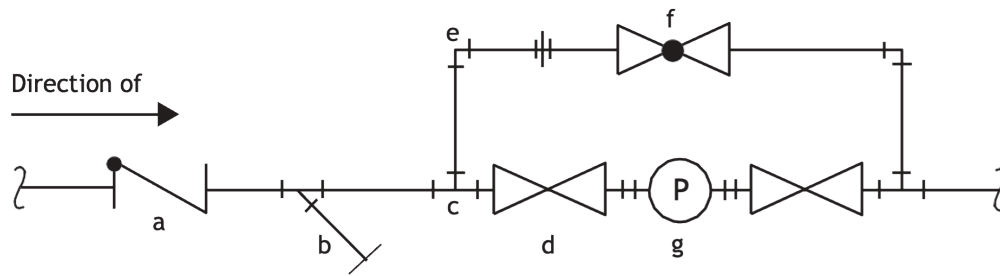


Figure 16 Illustration for Question 21

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

Answer Key: Self-Test C-3.3 is on the other page.

Answer Key: Self-Test C-3.3

1. Why are piping symbols used?
 - a. to visually represent pipes, fittings, etc.
2. State the two basic requirements for symbols.
 - a. must be simple
 - b. must be easy to draw
3. Why are single-line symbols usually used in piping drawings?
 - a. because they are simplest and easiest to draw
4. Lengths of valves and fittings in single-line drawings are always drawn to scale.
5. Flanged or welded valves and fittings in double line drawings are always drawn to scale.
 - a. true
6. The joint in Figure 1 is
 - a. flanged

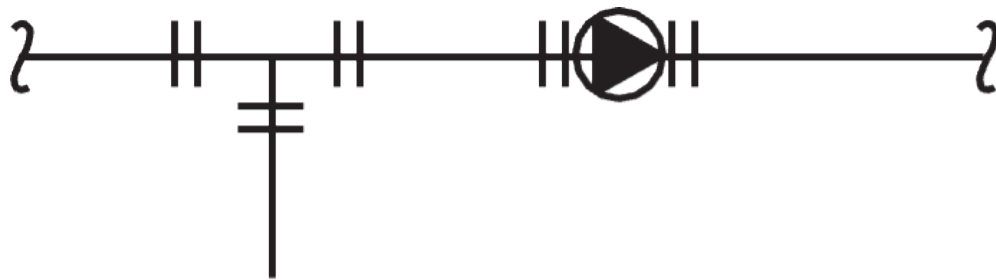


Figure 1 Illustration for Question 6

7. The joint in Figure 2 is
 - a. butt welded

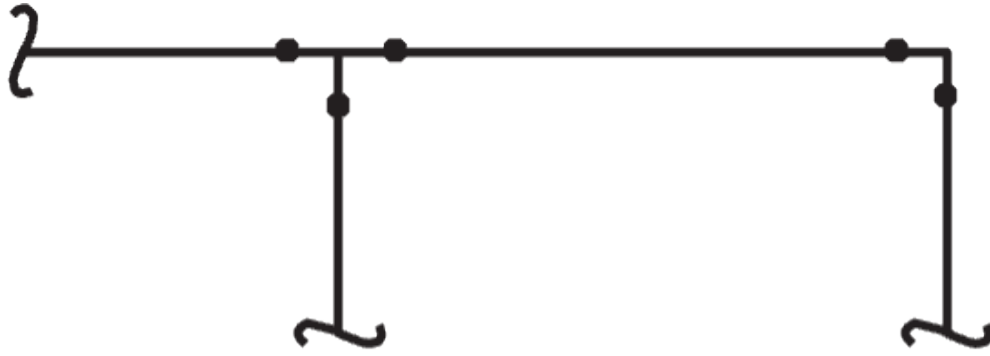


Figure 2 Illustration for Question 7

8. The joint in Figure 3 is
- butt welded



Figure 3 Illustration for Question 8

9. The joint in Figure 4 is
- screwed

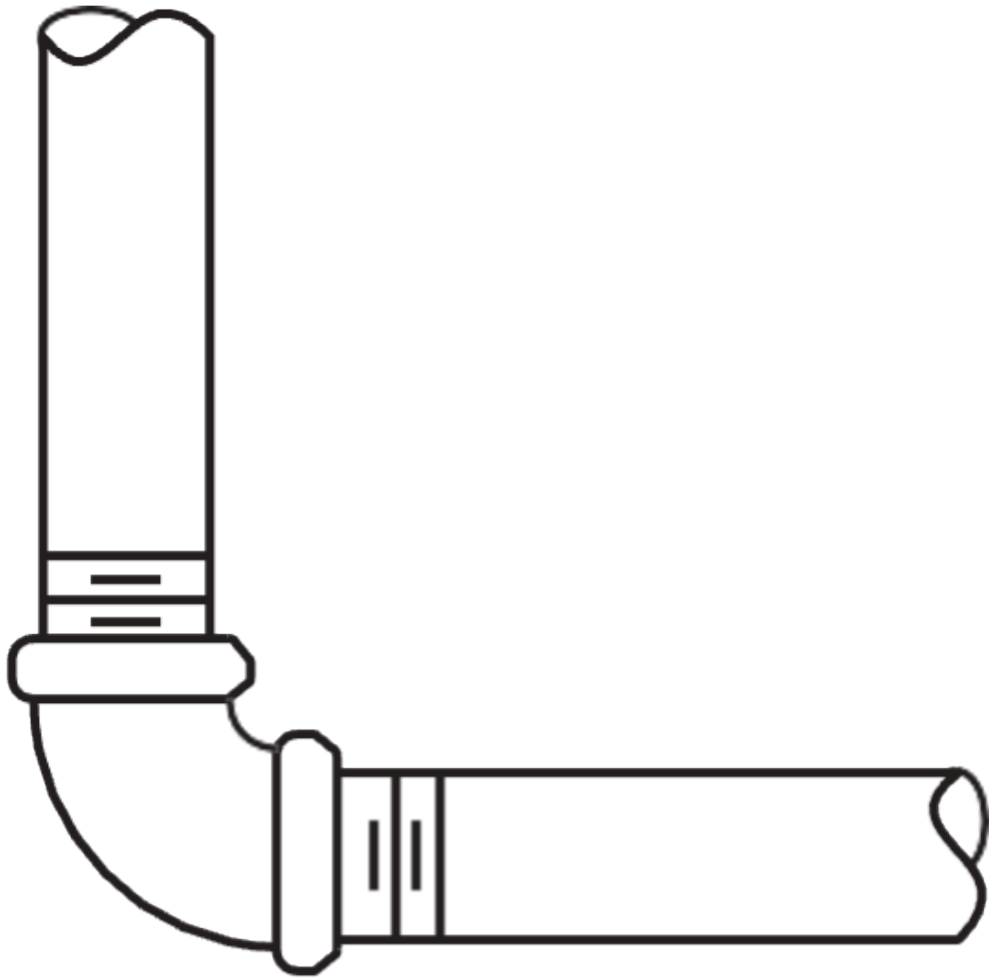


Figure 4 Illustration for Question 9

10. The joint in Figure 5 is
- a. flanged

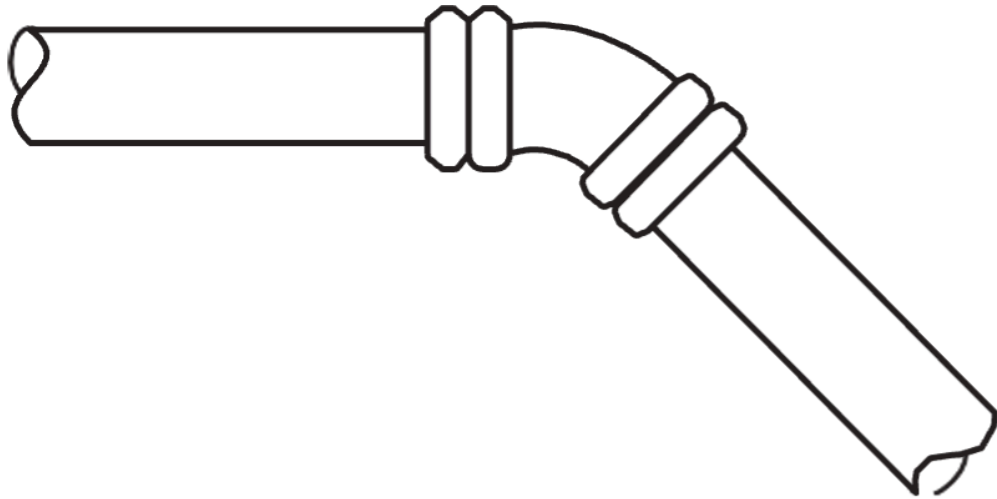


Figure 5 Illustration for Question 10

11. The symbol in Figure 6 is a
- a. tee

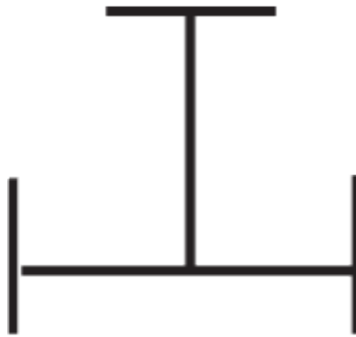


Figure 6 Illustration for Question 11

12. The symbol in Figure 7 is a
- a. 90° elbow

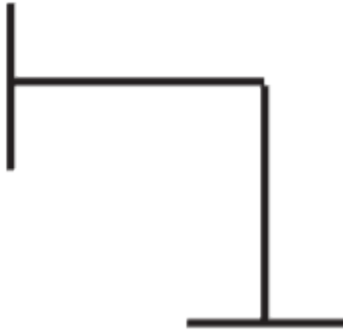


Figure 7 Illustration for Question 12

13. The symbol in Figure 8 is a
a. union



Figure 8 Illustration for Question 13

14. The symbol in Figure 9 is a
a. gate valve



Figure 9 Illustration for Question 14

15. The symbol in Figure 10 is a
a. globe valve



Figure 10 Illustration for Question 15

16. The symbol in Figure 11 is a
- check valve



Figure 11 Illustration for Question 16

17. The symbol in Figure 12 is a
- pump



Figure 12 Illustration for Question 17

18. The symbol in Figure 13 is a
- a. pressure-reducing valve



Figure 13 Illustration for Question 18

19. The symbol in Figure 14 is a
- a. safety valve

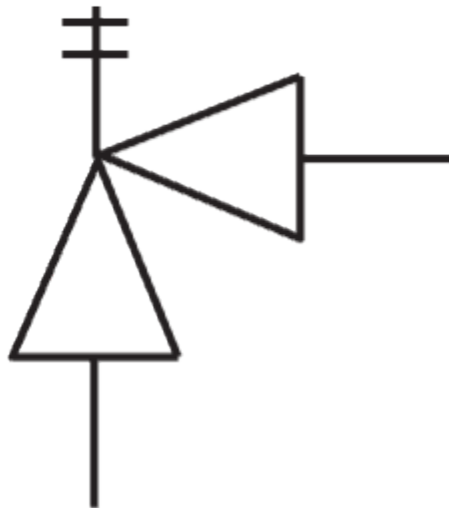


Figure 14 Illustration for Question 19

20. The symbol in Figure 15 is a
- a. control valve

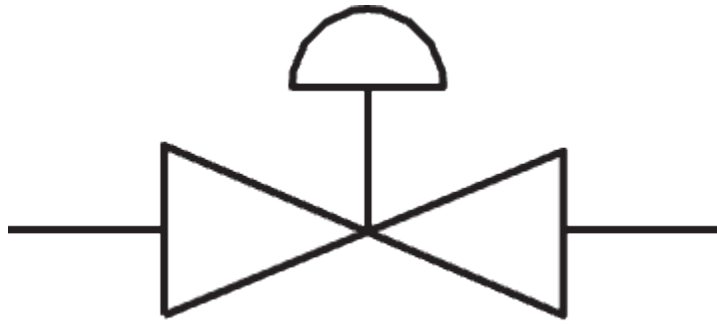
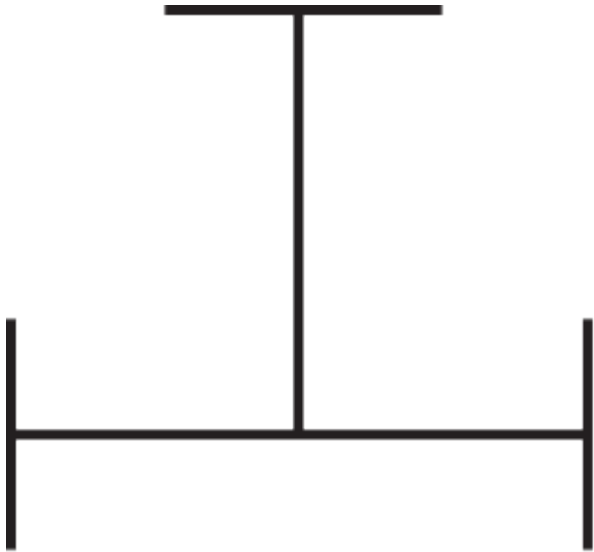
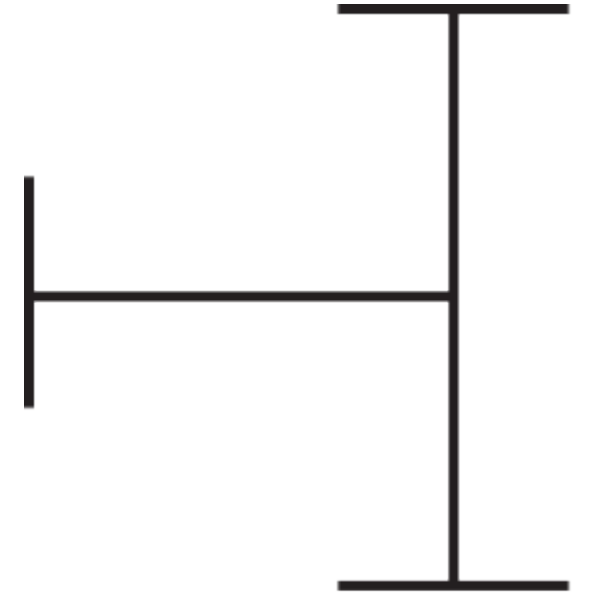
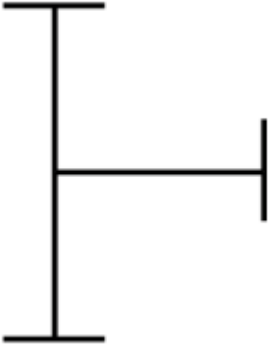
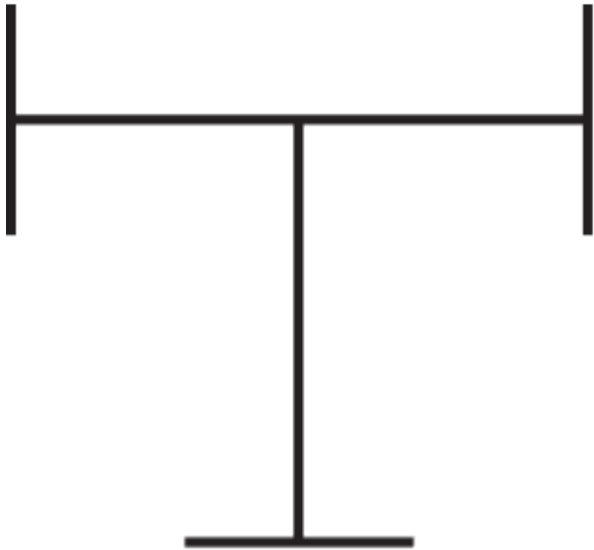
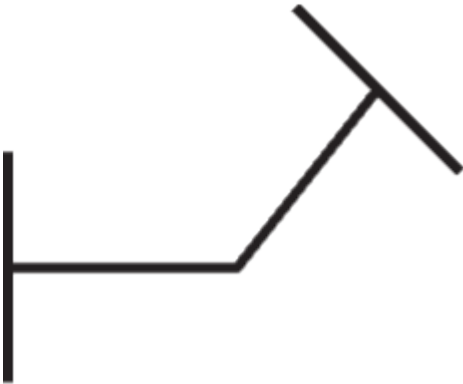
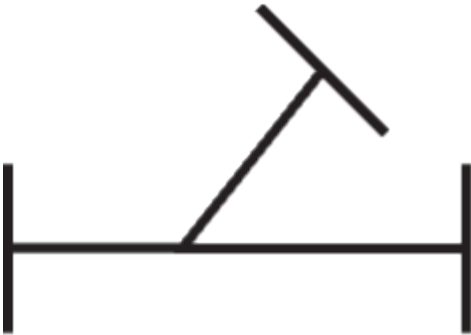


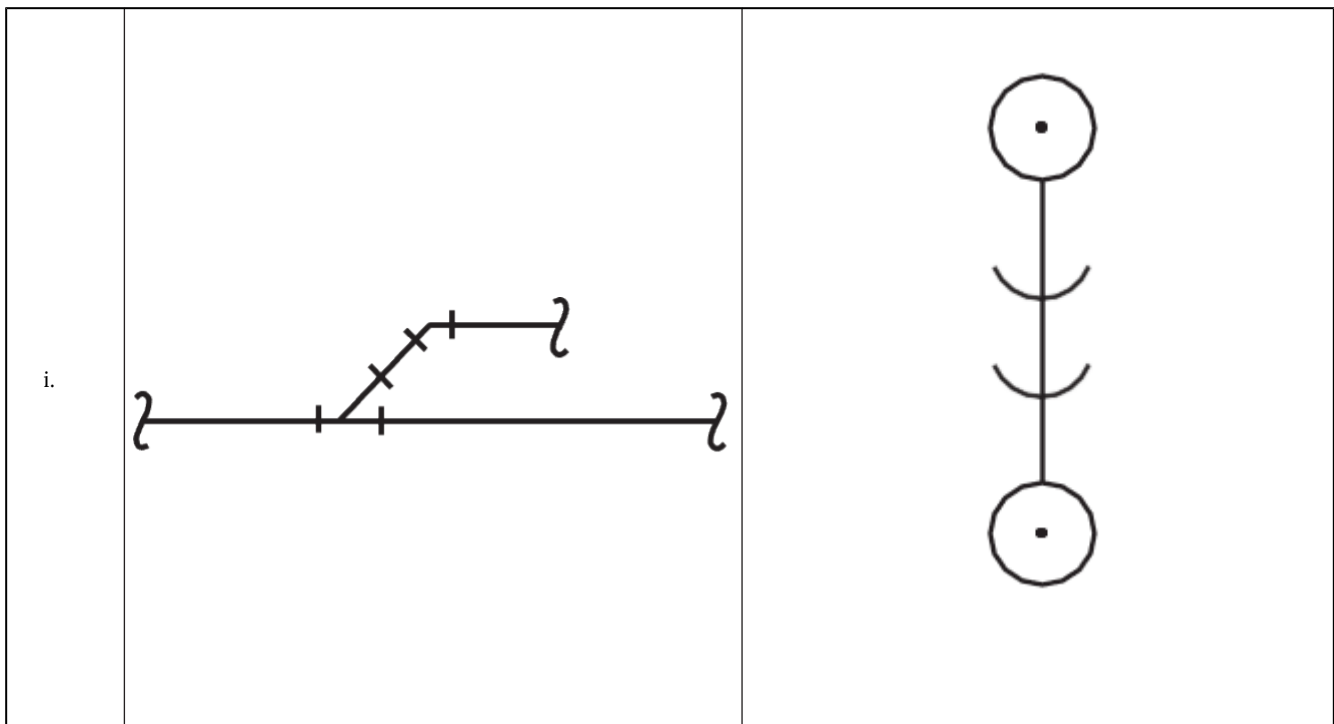
Figure 15 Illustration for Question 20

21. Draw the right view of the following front views.

	Front view	Right view
a.		
b.		

c.		
d.		
e.		

f.		
g.		
h.		



22. Identify the symbols A to G in Figure 16.

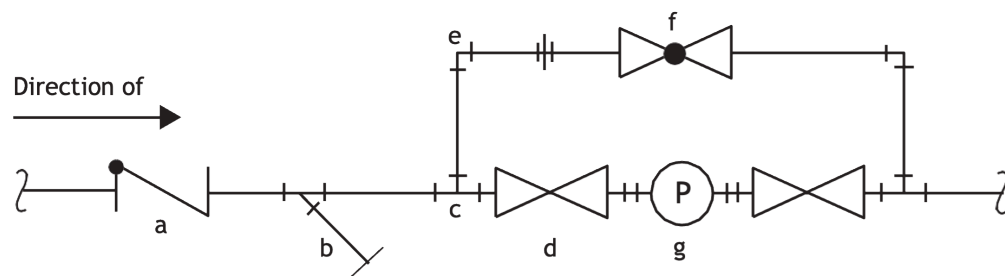


Figure 16 Illustration for Question 21

- a. check valve
- b. strainer
- c. tee
- d. gate valve
- e. 90° elbow
- f. globe valve
- g. pump

Self-Test C-3.4: Describe Lettering and Dimensioning of Piping Diagrams

Complete Self-Test C-3.4 and check your answers.

Identify each type of line in Figure 1 below by stating:

- a. its name (visible line, hidden line, centre line, etc.)
- b. its main use (shows object outline, shows centre of hole, shows location of sections, etc.)

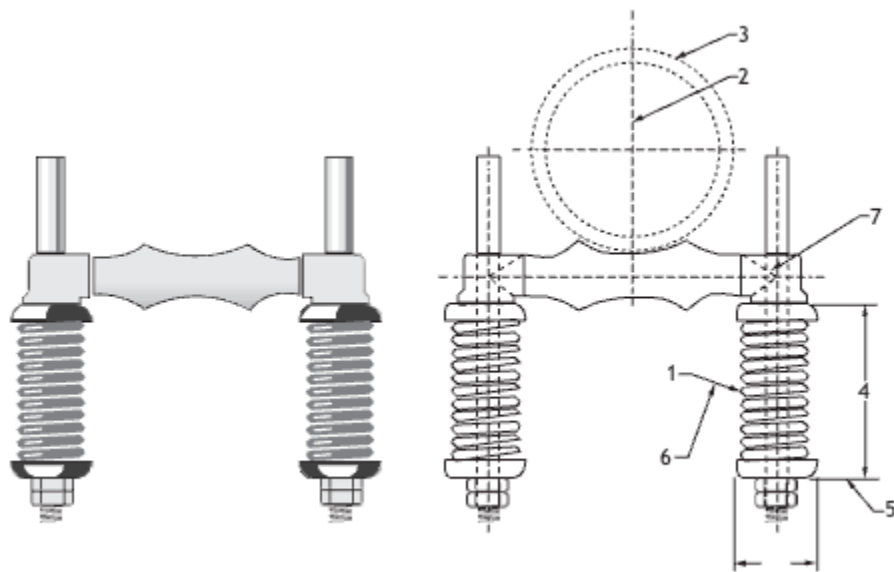


Figure 1 Illustration for Self-Test 4

1. Line 1
 - a. _____
 - b. _____
2. Line 2
 - a. _____
 - b. _____
3. Line 3
 - a. _____
 - b. _____
4. Line 4
 - a. _____
 - b. _____

5. Line 5

a. _____

b. _____

6. Line 6

a. _____

b. _____

7. Line 7

a. _____

b. _____

Answer Key: Self-Test C-3.4 is on the other page.

Answer Key: Self-Test C-3.4

Identify each type of line in Figure 1 below by stating:

- a. its name (visible line, hidden line, centre line, etc.)
- b. its main use (shows object outline, shows centre of hole, shows location of sections, etc.)

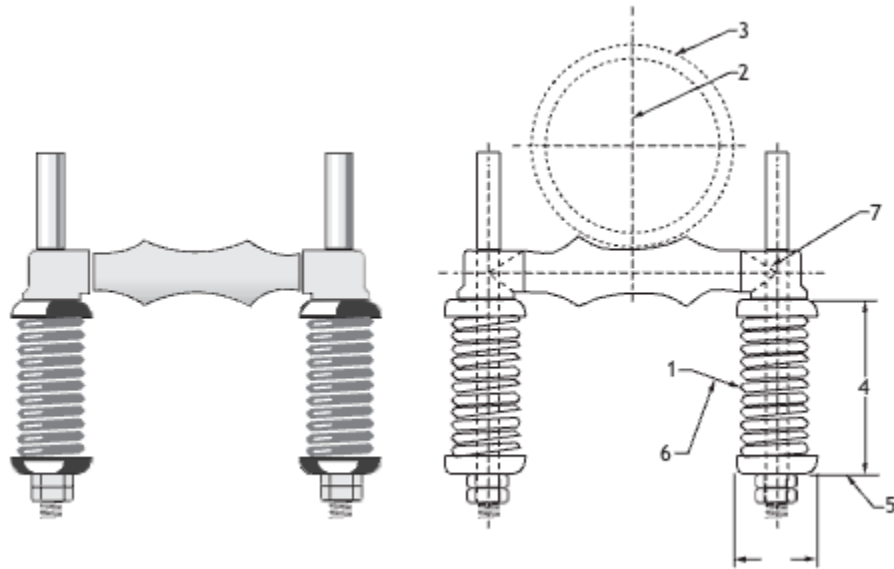


Figure 1 Illustration for Self-Test 4

1. Line 1
 - a. outline
 - b. outline of a part
2. Line 2
 - a. centre line
 - b. centre of an object
3. Line 3
 - a. phantom
 - b. shows location of removed parts not detailed
4. Line 4
 - a. dimension line
 - b. shows dimension of a part
5. Line 5
 - a. extension lines
 - b. shows where a dimension is taken from
6. Line 6

- a. leader line
 - b. points out a dimension or part
7. Line 7
- a. hidden
 - b. shows hidden surfaces

Self-Test C-3.5: Describe Drawing Projections

Complete Self-Test C-3.5 and check your answers.

1. Orthographic drawings accurately represent the length of piping systems from all directions.
 - a. true
 - b. false
2. Isometric drawings are three-dimensional.
 - a. true
 - b. false
3. List the three orthographic views that are used in piping drawings.
 - a. _____
 - b. _____
 - c. _____
4. What is the term to describe an orthographic drawing of a building showing the front exteriors?
 - a. street view
 - b. store front
 - c. civic address
 - d. front elevation
5. Which of the following information is found on an architectural plan view of a building?
 - a. exterior siding material
 - b. concrete slab thickness
 - c. location of building services
 - d. location of plumbing fixtures
6. What is the term used to describe a cross-sectional drawing of a wall?
 - a. section
 - b. cut away
 - c. material list
 - d. interior elevation

Answer Key: Self-Test C-3.5 is on the other page.

Answer Key: Self-Test C-3.5

1. Orthographic drawings accurately represent the length of piping systems from all directions.
 - a. true
2. Isometric drawings are three-dimensional.
 - a. true
3. List the three orthographic views that are used in piping drawings.
 - a. front
 - b. plan (top)
 - c. side
4. What is the term to describe an orthographic drawing of a building showing the front exteriors?
 - a. front elevation
5. Which of the following information is found on an architectural plan view of a building?
 - a. location of building services
6. What is the term used to describe a cross-sectional drawing of a wall?
 - a. section

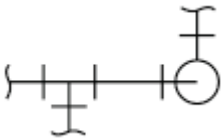
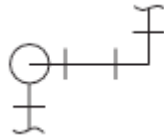
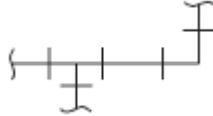
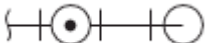
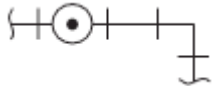
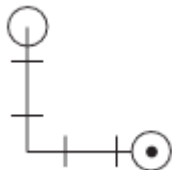
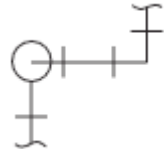
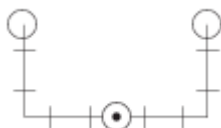
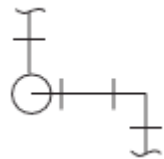
Self-Test C-3.6.1: Use Drawing Projections

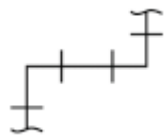
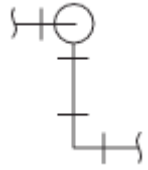
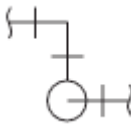
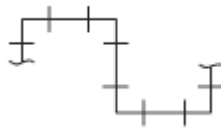
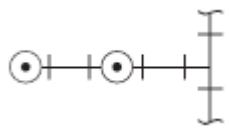
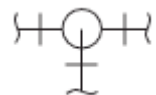
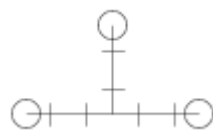
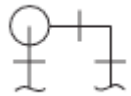
Complete Self-Test C-3.6.1 and check your answers.

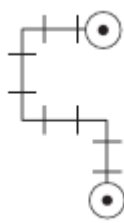
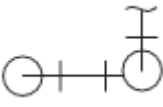
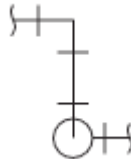
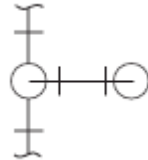
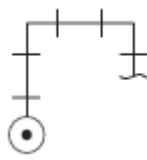
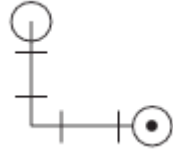
1. One advantage of orthographic projections is that
 - a. they can be used for complex piping systems
 - b. they pinpoint the exact location of equipment
 - c. if the drawing is to scale, all the items are to scale
 - d. the building appears just as it would look to you
2. Orthographic piping drawings normally include how many views?
 - a. 1
 - b. 2
 - c. 3
 - d. 4

In questions 3–18, draw the remaining view in the space provided. Complete your drawings neatly at a scale proportional to the given views.

Table 1 Drawings at a scale

	Plan	Front Elevation	Right Elevation
3.			
4.			
5.			
6.			
7.			
8.			
9.			

10.			
11.			
12.			
13.			
14.			
15.			

16.		
17.		
18.		
		
		
		

For questions 19–23, select the correct numbers from the chart on the right below. In questions 19–21 identify:

- Top view
- Right elevation for the front views shown. (The same number may be used more than once.)

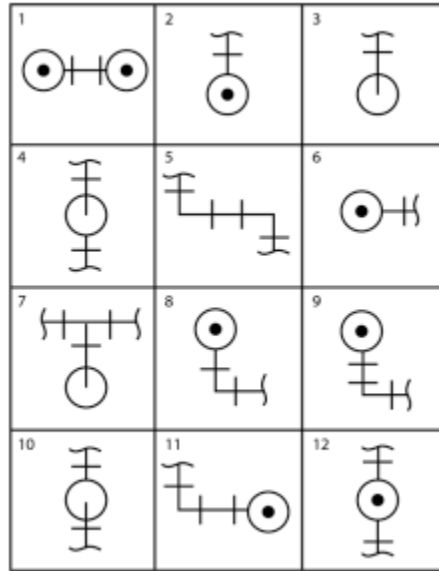
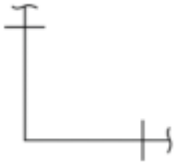


Figure 1 Perspective's Drawings

Figure 2 Image for question 19



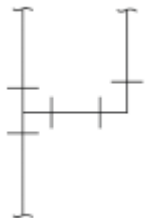
19. a. _____
b. _____

Figure 3 Image for question 20



20. a. _____
b. _____

Figure 4 Image for question 21



21. a. _____
b. _____

In Questions 22 and 23 select the correct numbers that identify:

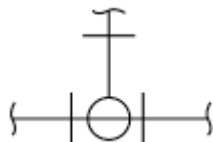
- a. Front view
b. Right view for the top views shown.

Figure 5 Image for question 22



22. a. _____
b. _____

Figure 6 Image for question 23



23. a. _____
b. _____

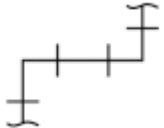
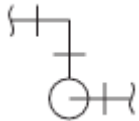
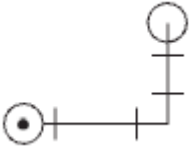
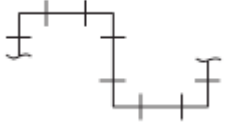
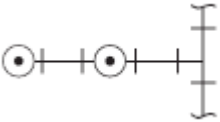
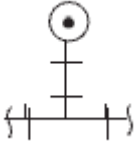
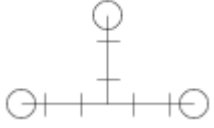
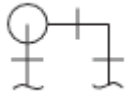
Answer Key: Self-Test C-3.6.1 is on the other page.

Answer Key: Self-Test C-3.6.1

1. One advantage of orthographic projections is that
 - a. they pinpoint the exact location of equipment
2. Orthographic piping drawings normally include how many views?
 - a. 3

In questions 3–18, draw the remaining view in the space provided. Complete your drawings neatly at a scale proportional to the given views.

	Plan	Front Elevation	Right Elevation
3.			
4.			
5.			
6.			
7.			
8.			
9.			

10.			
11.			
12.			
13.			
14.			
15.			

16.			
17.			
18.			

For questions 19–23, select the correct numbers from the chart on the right below. In questions 19–21 identify:

- Top view
- Right elevation for the front views shown. (The same number may be used more than once.)

19. Question 19

- 6
- 2

20. Question 20

- 6
- 12

21. Question 21

- 1
- 4

In Questions 22 and 23 select the correct numbers that identify:

- Front view
- Right view for the top views shown.

22. Question 22

- a. 5
- b. 10

23. Question 23

- a. 7
- b. 9

Self-Test C-3.6.2: Use Drawing Projections

Complete Self-Test C-3.6.2 and check your answers.

1. Which of the following is an isometric diagram?

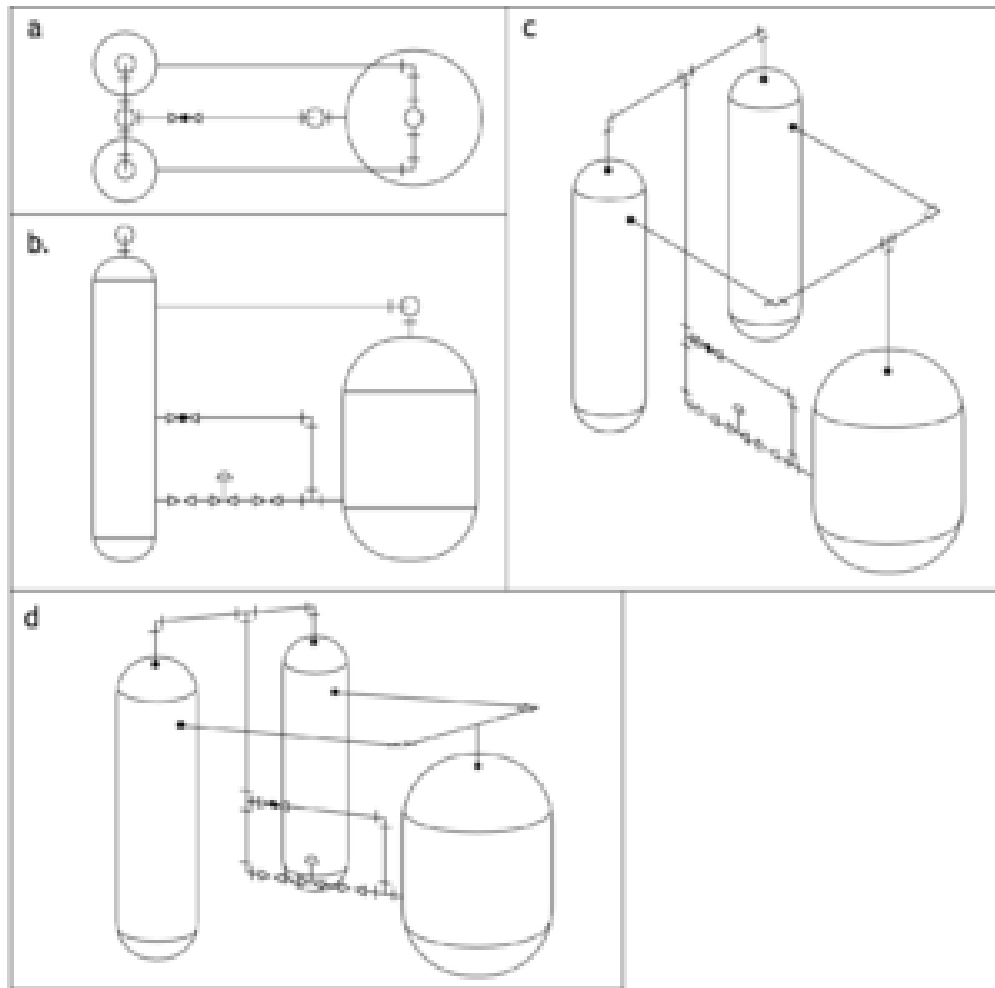


Figure 1 Image for question 1

2. The left-right and the back-front axes of isometric drawings are drawn
 - a. 30° from the horizontal
 - b. 30° from the vertical
 - c. 45° from the horizontal
 - d. 45° from the vertical
3. An isometric drawing showing 45° fittings and pipes can be drawn to scale.
 - a. true
 - b. false
4. One advantage of isometric projections is that
 - a. they show perspective

- b. they pinpoint the exact location of equipment
 - c. if the drawing is to scale, all the items are to scale
 - d. the drawing is three dimensional
5. Convert the orthographic projections to an isometric projection.

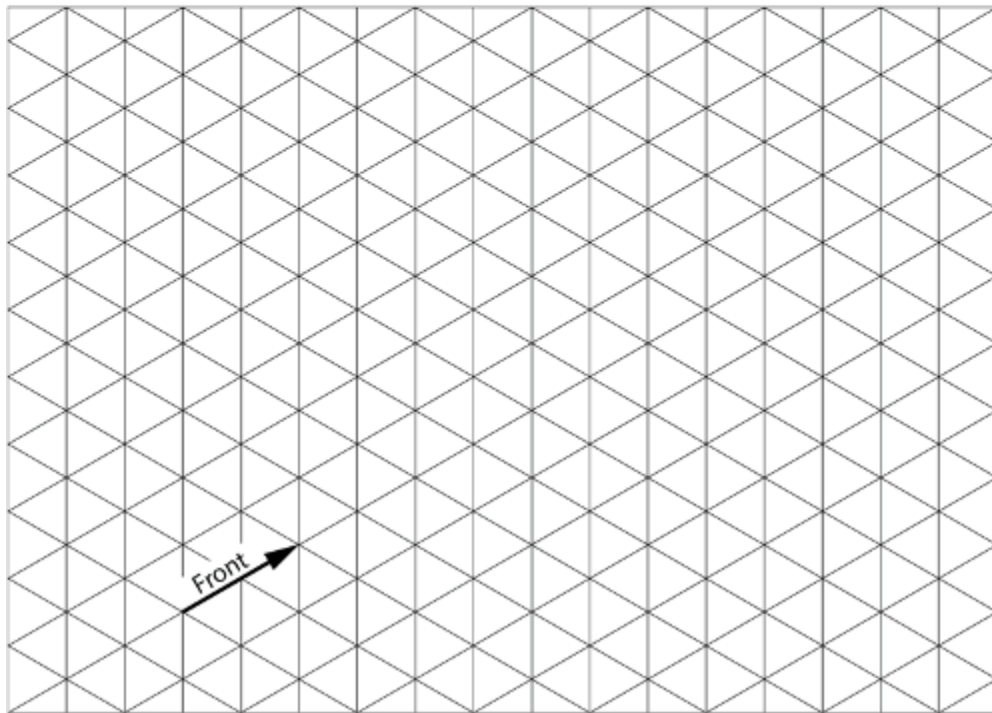
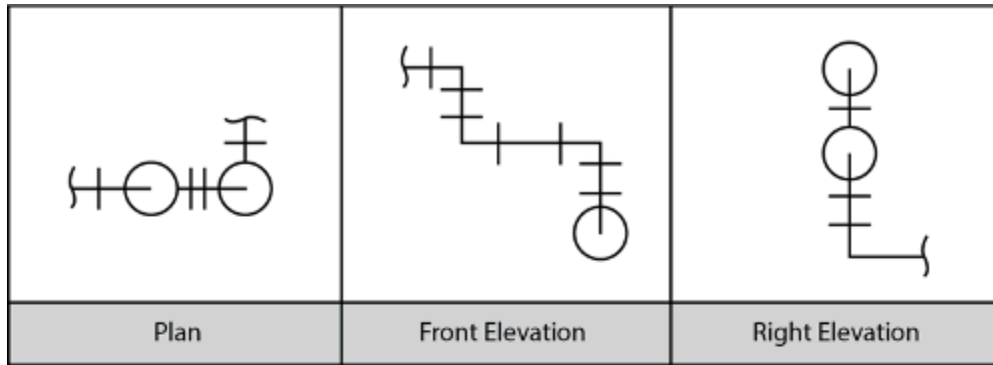


Figure 2 Image for question 5

6. Convert the orthographic projections to an isometric projection.

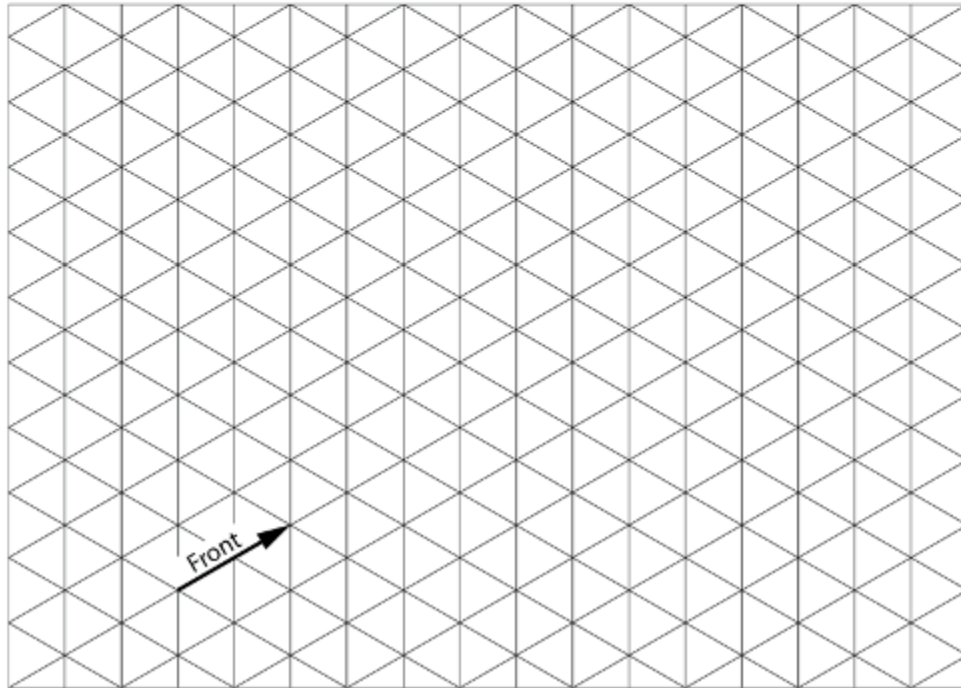
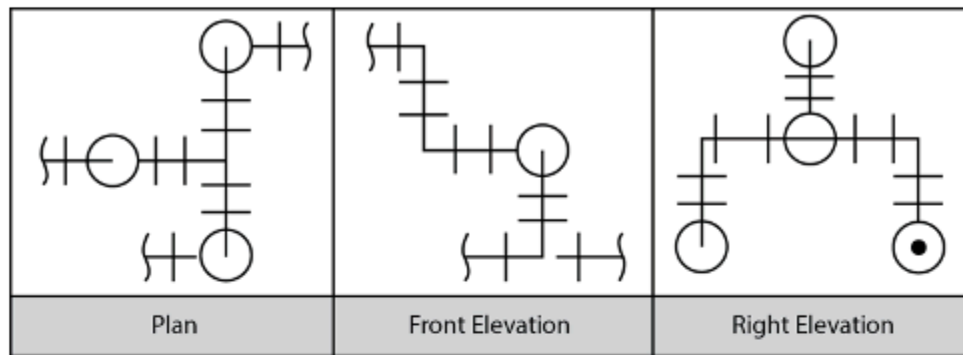
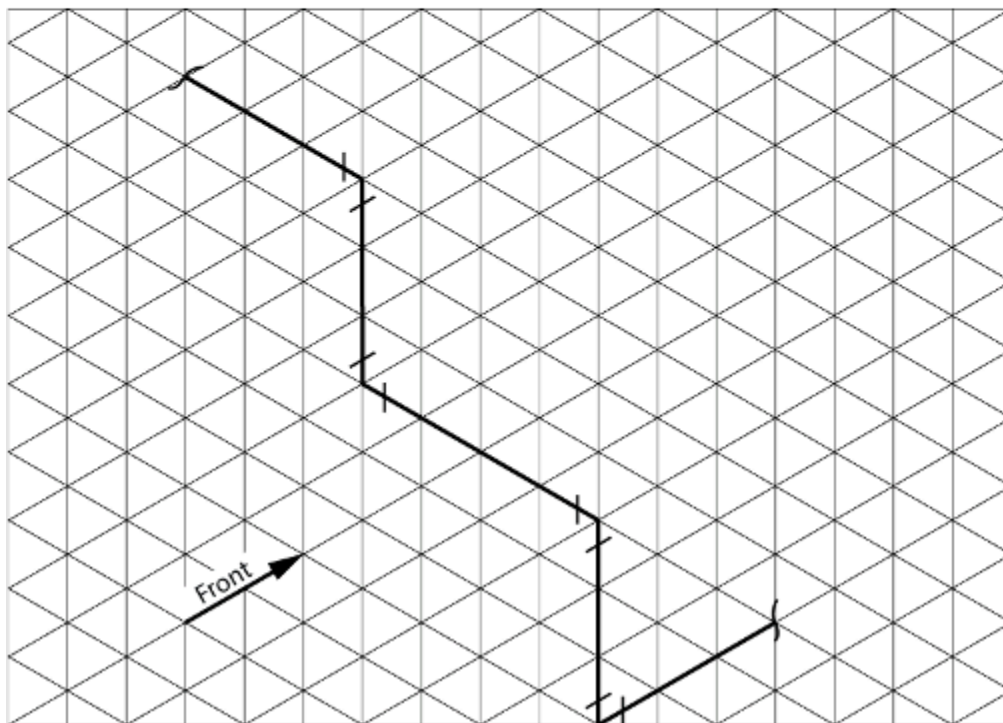
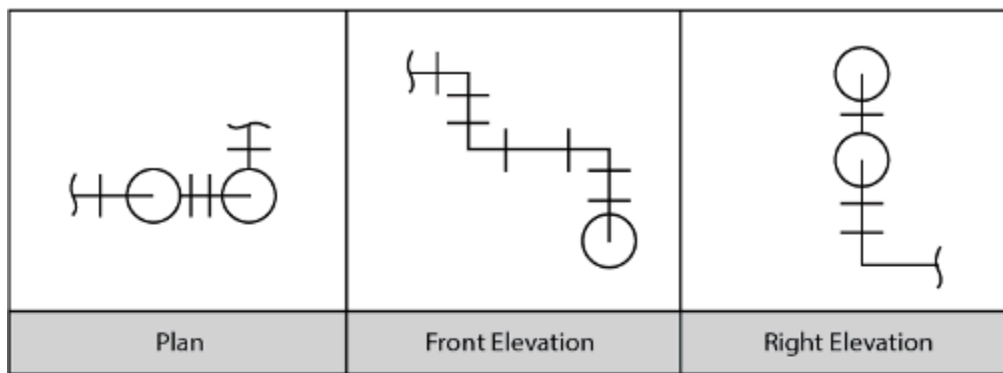


Figure 3 Image for question 6

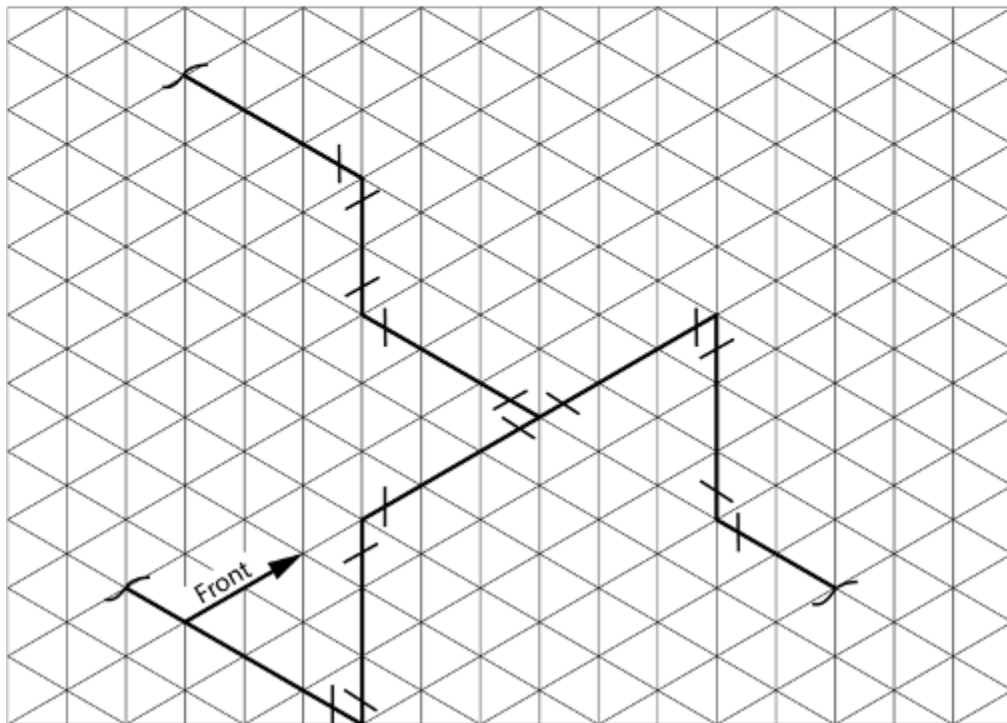
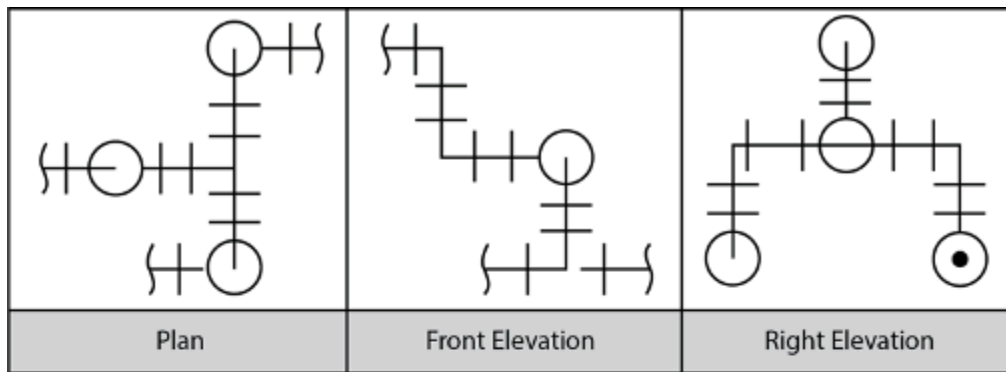
Answer Key: Self-Test C-3.6.2 is on the other page.

Answer Key: Self-Test C-3.6.2

1. Which of the following is an isometric diagram?
 - a. C
2. The left-right and the back-front axes of isometric drawings are drawn
 - a. 30° from the horizontal
3. An isometric drawing showing 45° fittings and pipes can be drawn to scale.
 - a. false
4. One advantage of isometric projections is that
 - a. the drawing is three dimensional
5. Convert the orthographic projections to an isometric projection.



6. Convert the orthographic projections to an isometric projection.



Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship** – Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber** – National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards** – Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC** – Essential safety resources for plumbers, including:
 - Health & Safety – WorkSafeBC
 - Report Unsafe Working Conditions
 - Report a Workplace Injury or Disease
 - Submit a Notice of Project Form
 - Get Health and Safety Resources (Videos, Posters, Publications, and More)
 - Search the OHS Regulations (and Related Materials)
 - Conduct an Incident Investigation
- **CCOHS: OHS Answers Fact Sheets – Plumber** – Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** – Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training (ISET) program.
- **StudentAidBC** – Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** – Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** – HealthLink BC resources for mental health and wellness support.
- **Here2Talk** – Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** – A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** – 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
 - First Nations Health Authority Mental Health Supports Info Sheet [PDF] by First Nations health Authority – List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** – Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** – Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** – Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** – Call 1-888-353-2273 for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** – An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** – Call 250-310-6789 for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** – Call 1-800-784-2433 if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** – Call 1-833-804-8111 between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** – Call 1-800-588-8717 for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** – Call 1-800-663-1441 to find resources and support.



Emergency Services – For life-threatening situations, call 911 or visit your nearest emergency department.

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 1, Block C. Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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Version	Date	Change	Details
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