

Industrial Maintenance

Piping Fundamentals

Courseware Sample

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By the staff of Festo Didactic

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



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








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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

| Symbol | Description |
|---|---|
|  | DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury. |
|  | WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury. |
|  | CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury. |
|  | CAUTION used without the <i>Caution, risk of danger</i> sign  , indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage. |
|  | Caution, risk of electric shock |
|  | Caution, hot surface |
|  | Caution, risk of danger |
|  | Caution, lifting hazard |
|  | Caution, hand entanglement hazard |
|  | Notice, non-ionizing radiation |
|  | Direct current |
|  | Alternating current |
|  | Both direct and alternating current |
|  | Three-phase alternating current |

Safety and Common Symbols

| Symbol | Description |
|---|--|
|  | Earth (ground) terminal |
|  | Protective conductor terminal |
|  | Frame or chassis terminal |
|  | Equipotentiality |
|  | On (supply) |
|  | Off (supply) |
|  | Equipment protected throughout by double insulation or reinforced insulation |
|  | In position of a bi-stable push control |
|  | Out position of a bi-stable push control |

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

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To the Instructor

Care and Maintenance of the Piping Training System

Every week

- Check the general condition of the Piping Training System.
- Make sure the pump-to-tank connections, located under the water pans, are leak free.
- Make sure the water pans are solidly fixed to the Mobile Workstation.

Every 6 months

- Replace the water in the reservoir.
- Add the following solutions to the water in the reservoir:
 - 2 fl oz (60 ml) of Antibacterial, Lab-Volt p/n 38097.
 - 8 fl oz (240 ml) of Rust Inhibitor, Lab-Volt p/n 38096.

Sample Work Order
Extracted from
Piping Fundamentals

Piping Circuit Layout and Measurement

Task: To become familiar with circuit layout and measurement.

PROCEDURE

- 1. Perform the Basic Safety Procedures listed in Appendix C.
- 2. Draw the graphic symbol of the threaded pipe fittings identified in Table 3-1.

| | | |
|---|--|--|
| 90° Street Elbow, ½" Malleable Iron Threaded | 90° Reducing Elbow ¾" x ½" Malleable Iron Threaded | 45° Elbow, ½" Malleable Iron Threaded |
| 90° Elbow, ½" Malleable Iron Threaded | Union - Ground Joint, ½" Malleable Iron Threaded | Union - Flange, ½" Forged Steel (with Gasket, Bolts, Nuts) |
| Coupling, ½" Malleable Iron Threaded | Reducer Coupling, ¾" x ½" Malleable Iron Threaded | Bushing, ¾" x ½" Brass |
| Cross, ½" Malleable Iron Threaded | Tee, ½" Malleable Iron Threaded | Cap, ½" Malleable Iron Threaded |

Table 3-1. Graphic symbols for pipe fittings.

3. What type of sketch is shown in Figure 3-1?

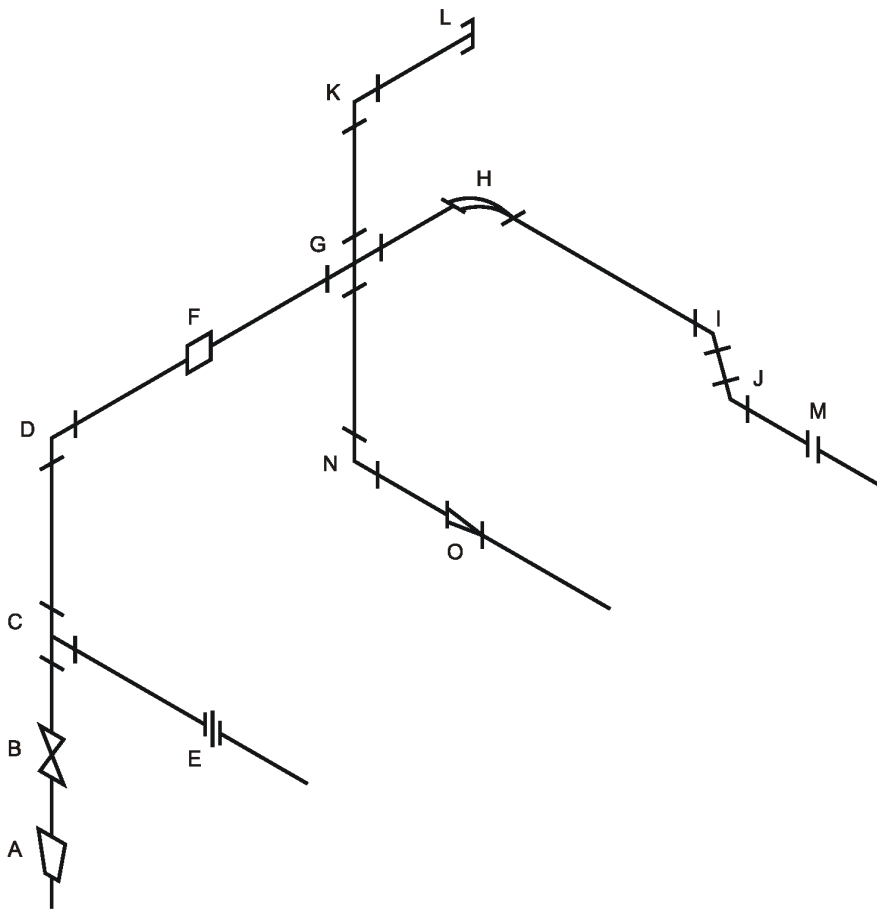


Figure 3-1. Typical sketch of a pipe circuit.

4. Identify the items labeled in the sketch shown in Figure 3-1.

| | |
|----|-----|
| A: | I: |
| B: | J: |
| C: | K: |
| D: | L: |
| E: | M: |
| F: | N : |
| G: | O: |
| H: | |

- 5. At which angles are the vertical and horizontal lines drawn in an isometric sketch?

Pipe Measurements

- 6. As shown in Table 3-2, pipe measurements are based on the center, end, and face of the pipe or fitting. Complete the distance descriptions.

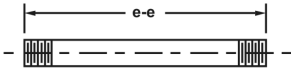
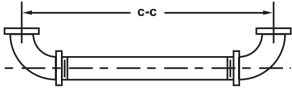
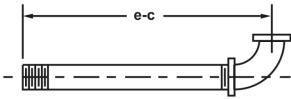
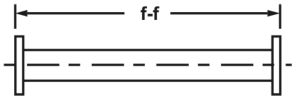
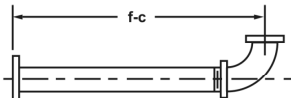
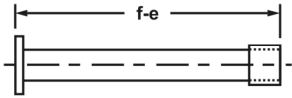
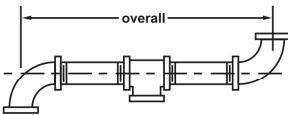
| | |
|---|---|
|  <p>End-to-End (e-e)</p> |  <p>Center-to-Center (c-c)</p> |
|  <p>End-to-Center (e-c)</p> |  <p>Face-to-Face (f-f)</p> |
|  <p>Face-to-Center (f-c)</p> |  <p>Face-to-End (f-e)</p> |
|  <p>Overall</p> | |

Table 3-2. Pipe measurements.

end-to-end (e-e): Distance from one end of the pipe to the other end of the pipe.

center-to-center (c-c): Distance from _____

end-to-center (e-c): *Distance from* _____

face-to-face (f-f): *Distance from* _____

face-to-center (f-c): *Distance from* _____

face-to-end (f-e): *Distance from* _____

overall: The total overall distance, including allowances, of pipe and fittings put together.

Fitting allowances

- 7. Give a brief description of the following terms (see Figure 3-2):

Thread engagement (T):

Fitting allowance (F):

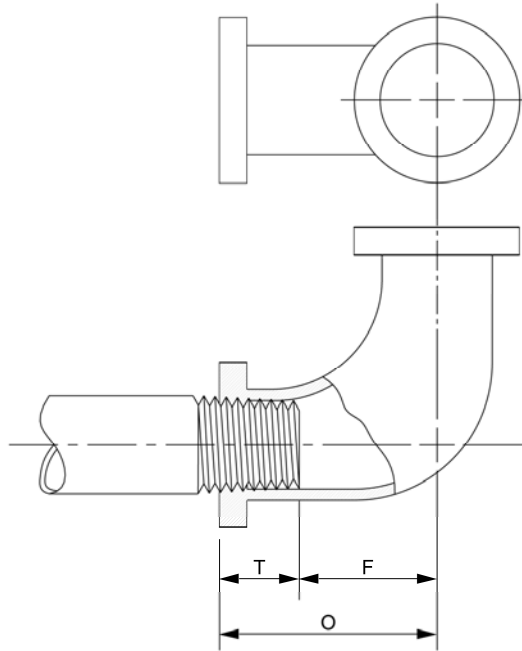


Figure 3-2. Fitting allowances.

- 8. Calculate the length of pipes to cut in Figure 3-3. The NPS of the pipes is 2 inches.

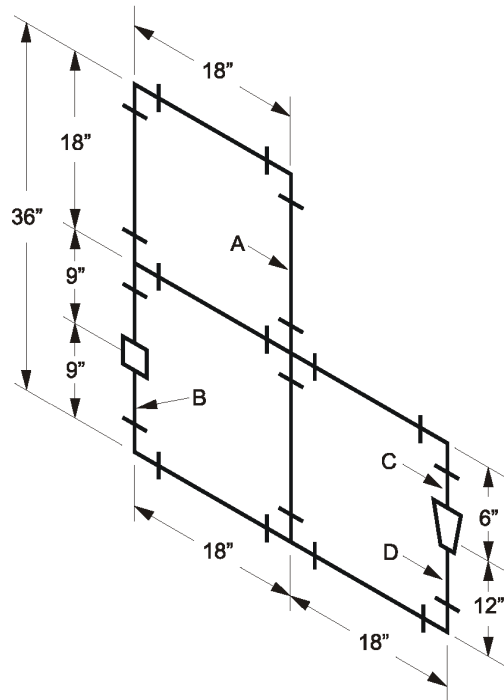


Figure 3-3. Determine the length of the pipes A, B, C, and D.

Pipe A: _____

Pipe B: _____

Pipe C: _____

Pipe D: _____

Offsets

- 9. Figure 3-4 shows a simple offset having two parallel pipes and two fittings of the same angle in the same plane. Name the three designated terms used to describe the various parts of the offset.

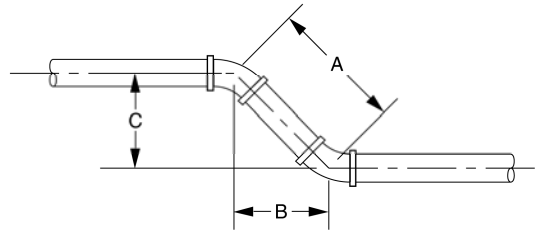


Figure 3-4. Simple offset.

A: _____

B: _____

C: _____

10. Calculate the hypotenuse (travel) of the triangle shown in Figure 3-5 using squares and square roots.

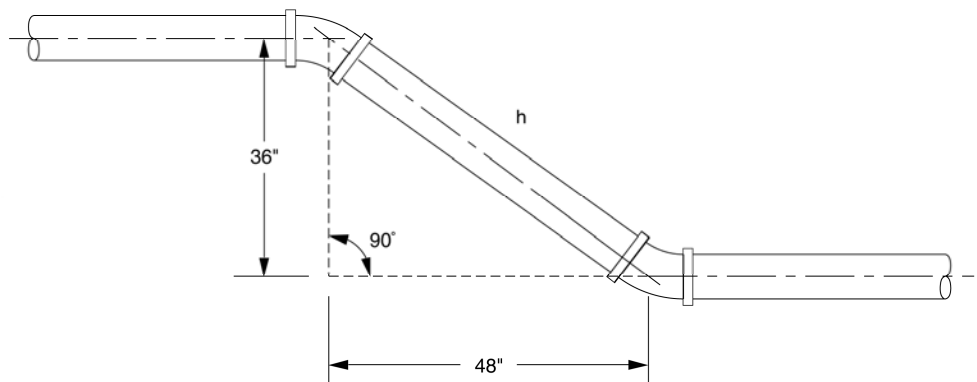


Figure 3-5. Calculate the hypotenuse of the right triangle using squares and square roots.

Hypotenuse: _____

- 11. Calculate the hypotenuse (travel) of the triangle shown in Figure 3-6 using trigonometry concepts.

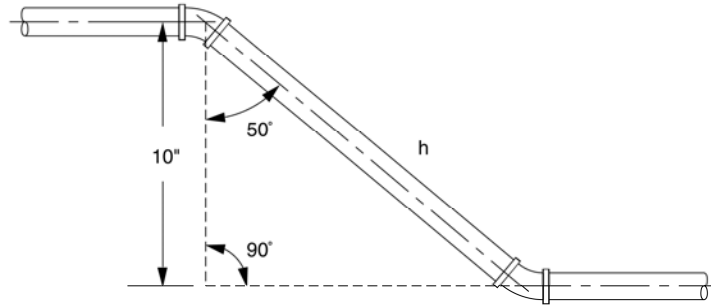


Figure 3-6. Calculate the hypotenuse of the right triangle using trigonometry concepts.

Hypotenuse: _____

- 12. Calculate the hypotenuse (travel) of the triangle shown in Figure 3-7 using constants (refer to your reference material).

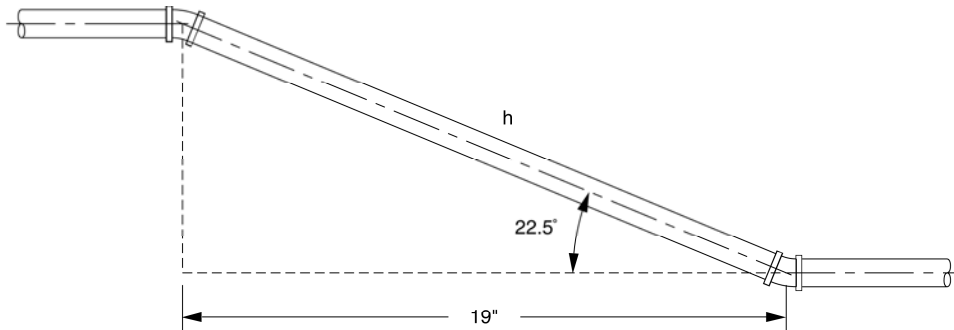


Figure 3-7. Calculate the hypotenuse (travel) of the right triangle using constants.

Hypotenuse: _____

- 13. Ask the instructor to check and approve your work.

Name: _____ Date: _____

Instructor's approval: _____

Instructor Guide Sample
Extracted from
Piping Fundamentals

Piping Circuit Layout and Measurement

ANSWERS TO PROCEDURE STEP QUESTIONS

□ 2.

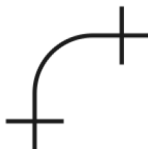


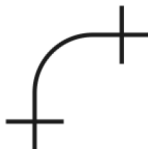
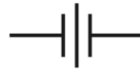

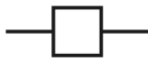

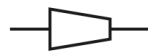
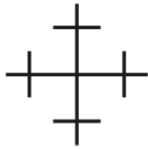
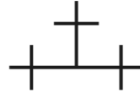
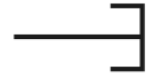
| | | |
|---|--|--|
|  <p>90° Street Elbow, 1/2" Malleable Iron Threaded</p> |  <p>90° Reducing Elbow 3/4" x 1/2" Malleable Iron Threaded</p> |  <p>45° Elbow, 1/2" Malleable Iron Threaded</p> |
|  <p>90° Elbow, 1/2" Malleable Iron Threaded</p> |  <p>Union - Ground Joint, 1/2" Malleable Iron Threaded</p> |  <p>Union - Flange, 1/2" Forged Steel (with Gasket, Bolts, Nuts)</p> |
|  <p>Coupling, 1/2" Malleable Iron Threaded</p> |  <p>Reducer Coupling, 3/4" x 1/2" Malleable Iron Threaded</p> |  <p>Bushing, 3/4" x 1/2" Brass</p> |
|  <p>Cross, 1/2" Malleable Iron Threaded</p> |  <p>Tee, 1/2" Malleable Iron Threaded</p> |  <p>Cap, 1/2" Malleable Iron Threaded</p> |

Table 3-1. Graphic symbols for pipe fittings.

□ 3. Isometric

4.

| | |
|------------------------------------|------------------------------|
| A: Bushing (threaded) | I: 45° Elbow (threaded) |
| B: Gate Valve (threaded) | J: 45° Elbow (threaded) |
| C: Tee (threaded) | K: 90° Elbow (threaded) |
| D: 90° Elbow (threaded) | L: Cap (threaded) |
| E: Union - Ground Joint (threaded) | M: Union - Flange (threaded) |
| F: Coupling (threaded) | N: 90° Elbow (threaded) |
| G: Cross (threaded) | O: Reducer Coupling |
| H: 90° Reducing Elbow (threaded) | |

5. Vertical lines are drawn in the vertical direction, and the horizontal lines are drawn at an angle of 30° to an imaginary horizontal line.

6.

end-to-end (e-e): Distance from one end of the pipe to the other end of the pipe.

center-to-center (c-c): Distance from the center of one pipe, or pipe fitting, to the center of another.

end-to-center (e-c): Distance from the center of a pipe fitting to the other end of the pipe.

face-to-face (f-f): Distance from the face of a flanged pipe to the flange face at the other end of the pipe. Allowance must be made for welding and gaskets.

face-to-center (f-c): Distance from the flange face to the center of the fitting. Allowance must be made for the distance to the center of the fitting.

face-to-end (f-e): Distance from the flange face to the end of the pipe.

overall: The total overall distance, including allowances, of pipe and fittings put together.

7. Thread engagement (T): The distance which a piece of pipe screws into a fitting.

Fitting allowance (F): The distance from the end of the threaded pipe to the centerline of the fitting.

- 8. Pipe A: 15"
Pipe B: 6 63/64"
Pipe C: 3 27/32"
Pipe D: 9 27/32"

- 9. A: Travel
B: Run
C: Set or offset

- 10. $h^2 = 36^2 + 48^2$
 $h = 60$

- 11. **cosine (60°) = $\frac{\text{side adjacent (10 inches)}}{\text{hypotenuse}}$**
 $h = 15.56"$

- 12. To find T when R is known, multiply R by 1.082 if the angle is 22 ½°.
 $T = 19 \times 1.082$
 $T = 20.56"$