Electromechanical Technician Skills Questionnaire.

Anoka-Hennepin Technical Coll., Minneapolis, MN.

137p.

Tests/Evaluation Instruments (160)

MF01/PC06 Plus Postage.

Adult Education; *Educational Needs; *Electronic Technicians; *Job Skills; *Manufacturing; Mathematical Applications; Mechanics (Process); *On the Job Training; *Technical Education; Test Items

This document contains test items to measure the job skills of electromechanical technicians. Questions are organized in four sections that cover the following topics: (1) shop math; (2) electricity and electronics; (3) mechanics and machining; and (4) plumbing, heating, ventilation and air conditioning, and welding skills. Questions call for short answers or problem solving. For each page of questions, respondents are requested to rate their knowledge level, from one ("could use a refresher class") to 5 ("have mastered this area"). The results of the skills questionnaire can be used to determine where a company should focus future training and development efforts. (KC)
Electromechanical Technician

Skills Questionnaire

Print Name ____________________________
Signature _____________________________
Shift _________________________________
Today’s Date __________________________
Supervisor ____________________________
Welcome to the Onan Electromechanical Technician skills questionnaire.

You are completing this questionnaire to determine where Onan should focus future training and development efforts.

You will find questions on:
- Shop math
- Electricity
- Electronics
- Welding
- Plumbing
- HVAC
- Machining
- Mechanics

This questionnaire package is your property. This package will not be collected by Onan.
Tabulating the Questionnaire: Page 1

There are four sections in the questionnaire:

1. Shop math
2. Electricity and electronics
3. Mechanics and machining
4. Plumbing, HVAC and welding skills

On each page, you will be asked to complete questions or to evaluate your understanding of certain skills.

You will find boxes like the one illustrated below. It is your job to complete each box to the best of your ability and to tabulate your scores in each section. Your shift supervisor will lead discussions about the scores of your questionnaires to determine where training is needed.

I have mastered this area

I could use a refresher class
**How do you complete the box on each page?**

<table>
<thead>
<tr>
<th>I could use a refresher class</th>
<th>I have mastered this area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

1 = You would attend a training class on this subject because you need the information to do your job more effectively.

2 = You think training on this subject would be helpful for some of your co-workers.

3 = A course in this subject may or may not be necessary.

4 = You probably wouldn't attend a training class on this subject because you have a working knowledge in that area.

5 = You have the skills and knowledge to teach this class.
Section 1: Shop Math Skills
<table>
<thead>
<tr>
<th>Add</th>
<th>Add</th>
<th>Subtract</th>
<th>Subtract</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>47111</td>
<td>156</td>
<td>1,564</td>
</tr>
<tr>
<td>33</td>
<td>3134</td>
<td>–</td>
<td>34</td>
</tr>
<tr>
<td>125</td>
<td>256</td>
<td></td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>9989</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I could use a refresher class: 1
I have mastered this area: 2 3 4 5
Math Skills

Do you understand how to convert English to metric and metric to English: temperature, length, area and volume? See the next page for more conversions.

What is 86°F in °C?

Convert 82°F to Celsius.

\[ ^\circ C = \frac{(^\circ F - 32)}{1.8} \]

\[ ^\circ C = \frac{(82 - 32)}{1.8} \]

\[ ^\circ C = \frac{50}{1.8} \]

\[ ^\circ C = 27.8^\circ C \]

82°F = 27.8°C

I could use a refresher class 1 2 3 4 5

I have mastered this area

2

15
# Commonly Used English-Metric Equivalents

<table>
<thead>
<tr>
<th>English to Metric</th>
<th>Metric to English</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LENGTH</strong></td>
<td></td>
</tr>
<tr>
<td>1 in = 25.4 mm (millimeters)</td>
<td>1 mm = 0.0394 in</td>
</tr>
<tr>
<td>1 in = 2.54 cm (centimeters)</td>
<td>1 cm = 0.394 in</td>
</tr>
<tr>
<td>1 ft = 304.8 mm</td>
<td>1 ft = 30.48 cm</td>
</tr>
<tr>
<td>1 ft = 0.305 m (meter)</td>
<td>1 ft = 0.305 m (m)</td>
</tr>
<tr>
<td>1 yd = 0.915 m</td>
<td>1 yd = 0.915 m</td>
</tr>
<tr>
<td>1 mi = 1609.34 m</td>
<td>1 mi = 1.609 km</td>
</tr>
<tr>
<td>1 mi = 1.609 km (kilometers)</td>
<td>1 mi = 1.609 km</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AREA</strong></td>
<td></td>
</tr>
<tr>
<td>1 sq in = 645.16 sq mm (mm²)</td>
<td>1 sq cm = 0.155 sq in</td>
</tr>
<tr>
<td>1 sq in = 6.45 sq cm (cm²)</td>
<td>1 sq cm = 0.0011 sq ft</td>
</tr>
<tr>
<td>1 sq ft = 929.03 sq cm (cm²)</td>
<td>1 sq ft = 0.093 sq m (m²)</td>
</tr>
<tr>
<td></td>
<td>1 sq m = 1.2 sq yd (yards)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VOLUME</strong></td>
<td></td>
</tr>
<tr>
<td>1 cu in = 16.38 cc (cm³)</td>
<td>1 cc = 0.061 cu in</td>
</tr>
<tr>
<td>1 cu in = 0.016 liter (L or l)</td>
<td>1 L = 61.02 cu in</td>
</tr>
<tr>
<td>1 cu ft = 28.32 (L or l)</td>
<td>1 cu ft = 28.32 (L or l)</td>
</tr>
<tr>
<td>1 liquid qt = 0.9475 (L or l)</td>
<td>1 L = 1.056 liquid qt</td>
</tr>
<tr>
<td>1 liquid gal = 3.79 (L or l)</td>
<td>1 L = 0.264 liquid gal</td>
</tr>
</tbody>
</table>
Math Skills

Multiply

93
×
12

Solve through Multiplication

An Onan machine shop supervisor spends $2,368 to buy tools. Each tool costs an average of $16. How many tools can be bought?

A machine screw has 8 threads to the inch. How many threads are there in a threaded piece 7 inches long?

Solve through Division

I have mastered this area

I could use a refresher class
Math Skills

Solve the problems

(4) (6) - 2 = 
(4) (6-2) = 
(4/5) (5/8) (3) + 3-1 = 
(4/5) (5/8) (3+3-1) = 

I could use a refresher class

1 2 3 4 5

I have mastered this area

1 2 3 4 5

5

20
Which is greater?

.015 or -.215

Which is greater?

-.024 or -.026

A screw 4 inches long has 52 threads.
   a. How many threads per inch are there? ________________
   b. What is the pitch? ________________

A screw is 3 1/2 inches long and has 56 threads.
   a. Find the number of threads per inch. ________________
   b. Find the pitch of the screw. ________________

I could use a refresher class

I have mastered this area

1 2 3 4 5

1 2 3 4 5

I could use a refresher class

I have mastered this area

1 2 3 4 5

1 2 3 4 5
Math Skills

Multiply

3.4567
x 3.9876

Divide

5.35
29.425

Subtract

983.456
298.179

I could use a refresher class

I have mastered this area

5
4
3
2
1

I have mastered this area

24
25
Math Skills

Express these subdivisions of an inch in machinists' terms.

Two problems have been done for you.

Convert the fraction 7/8 to a decimal number.

Convert .75 to a fraction.

I could use a refresher class.

I have mastered this area.

<table>
<thead>
<tr>
<th>Millionth</th>
<th>Hundredth</th>
</tr>
</thead>
<tbody>
<tr>
<td>.000001</td>
<td>.01</td>
</tr>
<tr>
<td>.0001</td>
<td>.001</td>
</tr>
</tbody>
</table>
I have mastered this area in Electricity & Electronics.

Define the following terms:

- Volt
- Ampere
- Ohm

Explain the relationship between the three terms above.

I could use a refresher class.
Define the following terms:
Watts

How many watts in a...
Kilowatt
Megawatt
Milliwatt
Microwatt

3 volts x 120 amps = 360 watts
? volts x 6 amps = 360 watts

I could use a refresher class
I have mastered this area

1 2 3 4 5
Electricity & Electronics

Answer the following questions

If the ends of a 1000 ft. length of No. 10 copper wire are connected to a 1 volt source of electricity, 1 amp will flow through the wire. Why?

Define Ohm's Law

How would you determine the number of amperes in a circuit?

I could use a refresher class

I have mastered this area

1 2 3 4 5
A wiring device is a component that carries current but does not consume it. List four types of wiring devices.

A fitting is an accessory that is intended to perform a mechanical rather than an electrical function. List three types of fittings.

Define the following terms:

Resistors

Conductors

Insulators

I could use a refresher class

I have mastered this area

1 2 3 4 5
Electrical Symbols

Refer to the next two pages and complete the boxes.

I can identify the electrical symbols shown on page 14.

I could use a refresher class

1 2 3 4 5

I have mastered this area

I successfully matched the 20 symbols found on the electrical working drawings shown on page 15.

I could use a refresher class

1 2 3 4 5

I have mastered this area
Shown below are 20 symbols commonly found on electrical working drawings. In the space provided, place the letter corresponding to the correct answer found in the list.

1. □ ——— A. Fluorescent fixture
2. ◊ ——— B. Incandescent fixture, recessed
3. □ ——— C. Incandescent fixture, wall-mounted
4. F ——— D. Exit light, surface- or pendant-mounted
5. ——— E. Exit light, wall-mounted
6. ——— F. Indicates fixture type
7. □ ——— G. Receptacle, duplex-grounded
8. □ ——— H. Receptacle, weatherproof
9. □ ——— I. Combination switch and receptacle
10. □ ——— J. Receptacle, floor-type
11. □ ——— K. Switch, three-way
12. □ ——— L. Light or power panel
13. ——— M. Disconnect switch
14. ◊ ——— N. Conduit, exposed
15. s3 ——— O. Home run to panel
16. △ ——— P. Telephone conduit
17. ◊ ——— Q. Fan coil-unit connection
18. □ ——— R. Fire-alarm striking station
19. ——— T ——— S. Smoke detector
20. F ——— T. Telephone outlet, wall
Define the following terms:

Controls

Components

Circuits

I could use a refresher class

I have mastered this area

1 2 3 4 5
Electricity & Electronics

Answer the following questions:

What is a short circuit and how would you troubleshoot it?

What is a ground fault and how would you troubleshoot it?

What problems can a loose electrical connection cause?

I could use a refresher class

1 2 3 4 5

I have mastered this area
Answer the following questions:

Define ac?

Define dc?

What are the similarities and differences between ac and dc?

I could use a refresher class

I have mastered this area
The commutator is a vital part of every dc machine. How well a machine performs depends largely on how well the commutator is maintained.

Below are possible causes of commutator damage. List suggested corrections.

1. Excessive current load on the machine
   Correction:

2. Electrical adjustment is off
   Correction:

3. Wrong brush grade
   Correction:

4. Rough commutator surface
   Correction:

5. Contaminated atmosphere
   Correction:

I could use a refresher class

I have mastered this area
You will find possible causes for a motor running hot on an ac synchronous motor. List suggested corrections.

1. Mechanical overload
   Correction:

2. Improper vent
   Correction:

3. Shorted or open coils in motor
   Correction:

4. High line voltage
   Correction:

5. Stator grounded
   Correction:

6. Incorrect field current
   Correction:

<table>
<thead>
<tr>
<th>I could use a refresher class</th>
<th>I have mastered this area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
Electrical Troubleshooting

You will find possible causes why an ac motor will not start.

List suggested corrections.

1. No power supply
   Correction:

2. Mechanical overload
   Correction:

3. Improper brush - armature contact
   Correction:

4. Field coil open
   Correction:

5. Armature circuit open
   Correction:

I could use a refresher class

I have mastered this area

1 2 3 4 5
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multirange meter</td>
<td>Measures various electrical parameters</td>
</tr>
<tr>
<td>Oscilloscope</td>
<td>Displays electrical signals</td>
</tr>
<tr>
<td>Audio frequency signal generator</td>
<td>Measures audio frequencies</td>
</tr>
<tr>
<td>Logic probe</td>
<td>Identifies logic signals</td>
</tr>
<tr>
<td>Frequency meter</td>
<td>Measures frequency</td>
</tr>
</tbody>
</table>
Explain the following basic motor control functions as they relate to equipment:

Start

Stop

Running

Speed Regulation

Protection

I could use a refresher class  
1  2  3  4  5  
I have mastered this area 

1  2  3  4  5
Electricity & Electronics

Answer the following questions:

Why should electronic equipment be deenergized before servicing?

_____________________________________________________________________

How should electronic equipment be cleaned?

_____________________________________________________________________

I could use a refresher class

1 2 3 4 5

I have mastered this area
Below you will find an elementary diagram of a pushbutton motor control.

1. What is the purpose of a pushbutton motor control circuit.

2. Explain one pushbutton motor control circuit found at Onan.
These are typical methods of industrial control: parts f and g represent three-wire control, the others, two-wire control.

Explain the purpose of a motor control center

Identify the location and purpose of a motor control center at the Fridley plant

I could use a refresher class
I have mastered this area
Below you will find a schematic of an electrical distribution system. Identify an electrical distribution system located at Onan and explain its purpose.

- Electrical service
- Panel BA
  - 100 A
  - 30 A
  - 30 A
  - 30 A
- Panel B
  - 200 A
  - 200 A
  - 60 A
  - 60 A
  - 60 A
- Panel A
  - 200 A
  - 200 A
  - 60 A
  - 60 A
- To other loads in structure
- To fan coil unit
- To air compressor
  - To condensing unit 1
  - To condensing unit 2
- Panel AA
  - Lighting
- I could use a refresher class
- I have mastered this area

1  2  3  4  5
Using this diagram, identify and explain the components of an adjustable speed drive from a motor generator.

Would you be able to identify the missing control component device terminology on the following page?

Yes

No

I could use a refresher class

1 2 3 4 5

I have mastered this area
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Device</th>
<th>Symbol</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Ground connection symbol" /></td>
<td>Ground connection</td>
<td><img src="image" alt="Crossing conductors not connected symbol" /></td>
<td>Crossing conductors not connected</td>
</tr>
<tr>
<td><img src="image" alt="Fuse symbol" /></td>
<td>Fuse</td>
<td><img src="image" alt="Connected conductors symbol" /></td>
<td>Connected conductors</td>
</tr>
<tr>
<td><img src="image" alt="Resistor symbol" /></td>
<td>Resistor</td>
<td><img src="image" alt="Transformer symbol" /></td>
<td>Transformer</td>
</tr>
<tr>
<td><img src="image" alt="Slide wire rheostat symbol" /></td>
<td>Slide wire rheostat</td>
<td><img src="image" alt="Current transformer symbol" /></td>
<td>Current transformer</td>
</tr>
<tr>
<td><img src="image" alt="Rheostat symbol" /></td>
<td>Rheostat</td>
<td><img src="image" alt="Three-pole circuit breaker symbol" /></td>
<td>Three-pole circuit breaker</td>
</tr>
<tr>
<td><img src="image" alt="Indicating lamp symbol" /></td>
<td>Indicating lamp</td>
<td><img src="image" alt="Three-pole power breaker for a-c circuits rated in excess of 1500 volts symbol" /></td>
<td>Three-pole power breaker for a-c circuits rated in excess of 1500 volts</td>
</tr>
<tr>
<td><img src="image" alt="Capacitor symbol" /></td>
<td>Capacitor</td>
<td><img src="image" alt="Switch symbol" /></td>
<td>Switch</td>
</tr>
<tr>
<td><img src="image" alt="Diode symbol" /></td>
<td>Diode</td>
<td><img src="image" alt="Reactor or field winding symbol" /></td>
<td>Reactor or field winding</td>
</tr>
<tr>
<td><img src="image" alt="Silicon controlled rectifier (SCR) symbol" /></td>
<td>Silicon controlled rectifier (SCR)</td>
<td><img src="image" alt="Bell symbol" /></td>
<td>Bell</td>
</tr>
<tr>
<td><img src="image" alt="Overload heater symbol" /></td>
<td>Overload heater</td>
<td><img src="image" alt="Buzzer symbol" /></td>
<td>Buzzer</td>
</tr>
<tr>
<td><img src="image" alt="Blowout coil symbol" /></td>
<td>Blowout coil</td>
<td><img src="image" alt="Horn or siren symbol" /></td>
<td>Horn or siren</td>
</tr>
<tr>
<td><img src="image" alt="Operating coil symbol" /></td>
<td>Operating coil</td>
<td><img src="image" alt="Limit switches symbol" /></td>
<td>Limit switches</td>
</tr>
<tr>
<td><img src="image" alt="Contact normally open symbol" /></td>
<td>Contact normally open</td>
<td><img src="image" alt="Normally open contact symbol" /></td>
<td>Normally open contact</td>
</tr>
<tr>
<td><img src="image" alt="Contact normally closed symbol" /></td>
<td>Contact normally closed</td>
<td><img src="image" alt="Normally open contact held closed symbol" /></td>
<td>Normally open contact held closed</td>
</tr>
<tr>
<td><img src="image" alt="Spring-return pushbutton normally open symbol" /></td>
<td>Spring-return pushbutton normally open</td>
<td><img src="image" alt="Normally closed contact symbol" /></td>
<td>Normally closed contact</td>
</tr>
<tr>
<td><img src="image" alt="Spring-return pushbutton normally closed symbol" /></td>
<td>Spring-return pushbutton normally closed</td>
<td><img src="image" alt="Normally closed contact held open symbol" /></td>
<td>Normally closed contact held open</td>
</tr>
<tr>
<td><img src="image" alt="Sustaining type pushbutton symbol" /></td>
<td>Sustaining type pushbutton</td>
<td><img src="image" alt="Mechanical interlock symbol" /></td>
<td>Mechanical interlock</td>
</tr>
<tr>
<td><img src="image" alt="Plug-type contact symbol" /></td>
<td>Plug-type contact</td>
<td><img src="image" alt="Mechanical interlock with fulcrum symbol" /></td>
<td>Mechanical interlock with fulcrum</td>
</tr>
</tbody>
</table>
Section 3: Mechanical & Machining Skills
What are the drilling machines at Onan designed to do:

Describe the major components of a drilling machine:

Machine Base
Work Table
Drill Press Table
Drive Mechanism
Other

I could use a refresher class

I have mastered this area

1 2 3 4 5
List the important preventative maintenance strategies for preserving Onan's lathes.

What functions do lubricants serve and what problems are caused when lubricant levels are not sufficient?
What are the components of automatic tool machines at Onan? List the single spindle and multiple-spindle ASM components.

What are some logical troubleshooting steps that you use when working with ASM machines.

I could use a refresher class

I have mastered this area

1 2 3 4 5
What are the milling machines at Onan designed to do?

-----------------------------

Define the following terms:
Spindle Speed

-----------------------------

Feed

-----------------------------

How would you maintain the lubricating system on a milling machine?

-----------------------------
List the important preventative maintenance strategies for preserving Onan's lathes.

What functions do lubricants serve and what problems are caused when lubricant levels are not sufficient?

I could use a refresher class.

I have mastered this area.
Hydraulic and Pneumatic Systems

Define a hydraulic system and identify one within the Onan plant

Define a pneumatic system and identify one within the Onan plant

How is the speed control regulated on a hydraulic system?

How are travel limits determined on a hydraulic system?

I could use a refresher class I have mastered this area

1 2 3 4 5
Hydraulic and Pneumatic Systems

Can you explain how a pneumatic system works?

_________________________________________________________________________
_________________________________________________________________________

How is air delivered to each pneumatic system at Onan?

_________________________________________________________________________
_________________________________________________________________________

Explain the differences between electrical, hydraulic and pneumatic systems

_________________________________________________________________________
_________________________________________________________________________

I could use a refresher class

1 2 3 4 5

I have mastered this area
**Do you understand the differences between electrical, hydraulic and pneumatic systems?**

<table>
<thead>
<tr>
<th></th>
<th>Electrical</th>
<th>Hydraulic</th>
<th>Pneumatic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy source</strong></td>
<td>Usually from outside supplier</td>
<td>Electric motor or diesel driven</td>
<td>Electric motor or diesel driven</td>
</tr>
<tr>
<td><strong>Energy storage</strong></td>
<td>Limited (batteries)</td>
<td>Limited (accumulator)</td>
<td>Good (reservoir)</td>
</tr>
<tr>
<td><strong>Distribution system</strong></td>
<td>Excellent, with minimal loss</td>
<td>Limited, basically a local facility</td>
<td>Good, can be treated as a plant wide service</td>
</tr>
<tr>
<td><strong>Energy cost</strong></td>
<td>Lowest</td>
<td>Medium</td>
<td>Highest</td>
</tr>
<tr>
<td><strong>Rotary actuators</strong></td>
<td>AC &amp; DC motors. Good control on DC motors. AC motors cl..ap</td>
<td>Low speed. Good control. Can be stalled</td>
<td>Wide speed range. Accurate speed control difficult</td>
</tr>
<tr>
<td><strong>Linear actuator</strong></td>
<td>Short motion via solenoid. Otherwise via mechanical conversion</td>
<td>Cylinders. Very high force</td>
<td>Cylinders. Medium force</td>
</tr>
<tr>
<td><strong>Controllable force</strong></td>
<td>Possible with solenoid &amp; DC motors. Complicated by need for cooling</td>
<td>Controllable high force</td>
<td>Controllable medium force</td>
</tr>
<tr>
<td><strong>Points to note</strong></td>
<td>Danger from electric shock</td>
<td>Leakage dangerous and unsightly. Fire hazard</td>
<td>Noise</td>
</tr>
</tbody>
</table>
Hydraulic and Pneumatic Systems

Explain the components of this hydraulic system

Components common to many motions

I could use a refresher class

I have mastered this area

1  2  3  4  5
Is it estimated that 3/4 of all hydraulic system failures are caused by oil problems. Why is it important to adhere to the following preventative maintenance strategies?

Regular checks on oil condition and level

Checking the oil temperature

Checking the filters

Checking the motor currents

Regular maintenance of actuators

I could use a refresher class

I have mastered this area

1 2 3 4 5
What is a positive displacement pump on a hydraulic system? What are the types of positive displacement pumps?

What are the types of filters (filter positions) found in hydraulic systems? Label them below:

(a) Inlet line filter

(b) Pressure line filter

(c) Return line filter

I could use a refresher class

I have mastered this area

1 2 3 4 5
What are the component parts of a pneumatic system? Describe the functions of each component below:

- Compressor: Primary air treatment
- Filter
- Cooler
- Separator
- Receiver
- Secondary air treatment
- Motor control centre
- Pressure switch
- Load
- Exhaust air

I could use a refresher class

I have mastered this area

1  2  3  4  5
The maintenance of pneumatic systems involves many areas. Why is it important to check the following components?

- Piping
- Filters
- Fitting
- Sequences
- Validation of safety valve operation on the receiver
- Replenishment of oil in the air lubrication drainage of water from air dryers

I could use a refresher class

1  2  3  4  5

I have mastered this area
The maintenance of pneumatic systems involves many areas. Why is it important to check the following components on the compressors?

Belt condition and tension

Crankcase oil level

Air breather

What is the compressor efficiency determined by?

I could use a refresher class I have mastered this area

1 2 3 4 5
Section 4: Plumbing & HVAC & Welding Skills
Plumbing

Do you know the standard symbols for plumbing, piping and valves? Review the following page and complete this box.

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1 2 3 4 5

List the three most basic plumbing systems of a building:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
# Standard Symbols for Plumbing, Piping and Valves

## Plumbing

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corner Bath</td>
<td>![Corner Bath Symbol]</td>
</tr>
<tr>
<td>Recessed Bath</td>
<td>![Recessed Bath Symbol]</td>
</tr>
<tr>
<td>Roll Rim Bath</td>
<td>![Roll Rim Bath Symbol]</td>
</tr>
<tr>
<td>Sit Bath</td>
<td>![Sit Bath Symbol]</td>
</tr>
<tr>
<td>Foot Bath</td>
<td>![Foot Bath Symbol]</td>
</tr>
<tr>
<td>Bidet</td>
<td>![Bidet Symbol]</td>
</tr>
<tr>
<td>Shower Stall</td>
<td>![Shower Stall Symbol]</td>
</tr>
<tr>
<td>Shower Head</td>
<td>![Shower Head Symbol]</td>
</tr>
<tr>
<td>Overhead Garg Shower</td>
<td>![Overhead Garg Shower Symbol]</td>
</tr>
<tr>
<td>Pedestal Lavatory</td>
<td>![Pedestal Lavatory Symbol]</td>
</tr>
<tr>
<td>Wall Lavatory</td>
<td>![Wall Lavatory Symbol]</td>
</tr>
<tr>
<td>Corner Lavatory</td>
<td>![Corner Lavatory Symbol]</td>
</tr>
<tr>
<td>Manicure Lavatory</td>
<td>![Manicure Lavatory Symbol]</td>
</tr>
<tr>
<td>Medical Lavatory</td>
<td>![Medical Lavatory Symbol]</td>
</tr>
<tr>
<td>Dental Lavatory</td>
<td>![Dental Lavatory Symbol]</td>
</tr>
<tr>
<td>Plain Kitchen Sink</td>
<td>![Plain Kitchen Sink Symbol]</td>
</tr>
<tr>
<td>Kitchen Sink, R &amp; L Drain Board</td>
<td>![Kitchen Sink, R &amp; L Drain Board Symbol]</td>
</tr>
<tr>
<td>Kitchen Sink, L N Drain Board</td>
<td>![Kitchen Sink, L N Drain Board Symbol]</td>
</tr>
<tr>
<td>Combination Sink &amp; Dishwasher</td>
<td>![Combination Sink &amp; Dishwasher Symbol]</td>
</tr>
<tr>
<td>Combination Sink &amp; Laundry Tray</td>
<td>![Combination Sink &amp; Laundry Tray Symbol]</td>
</tr>
<tr>
<td>Service Sink</td>
<td>![Service Sink Symbol]</td>
</tr>
<tr>
<td>Wash Sink (Wall Type)</td>
<td>![Wash Sink (Wall Type) Symbol]</td>
</tr>
<tr>
<td>Wash Sink</td>
<td>![Wash Sink Symbol]</td>
</tr>
<tr>
<td>Laundry Tray</td>
<td>![Laundry Tray Symbol]</td>
</tr>
<tr>
<td>Water Closet (Low Tank)</td>
<td>![Water Closet (Low Tank) Symbol]</td>
</tr>
<tr>
<td>Water Closet (No Tank)</td>
<td>![Water Closet (No Tank) Symbol]</td>
</tr>
<tr>
<td>Urinal (Pedestal Type)</td>
<td>![Urinal (Pedestal Type) Symbol]</td>
</tr>
<tr>
<td>Urinal (Wall Type)</td>
<td>![Urinal (Wall Type) Symbol]</td>
</tr>
<tr>
<td>Urinal (Corner Type)</td>
<td>![Urinal (Corner Type) Symbol]</td>
</tr>
<tr>
<td>Urinal (Bathtub Type)</td>
<td>![Urinal (Bathtub Type) Symbol]</td>
</tr>
<tr>
<td>Drinking Fountain (Pedestal Type)</td>
<td>![Drinking Fountain (Pedestal Type) Symbol]</td>
</tr>
<tr>
<td>Drinking Fountain (Wall Type)</td>
<td>![Drinking Fountain (Wall Type) Symbol]</td>
</tr>
</tbody>
</table>

## Piping

- Soil and Waste
- Soil and Waste, Underground
- Vent
- Cold Water
- Hot Water
- Hot Water Return
- Fire Line
- Gas
- Acid Waste
- Drinking Water Supply
- Drinking Water Return
- Vacuum Cleaning
- Compressed Air

## Pipe Fittings

### For Tapped or Soldered Fittings, use joint indicator shown in Diagram A

<table>
<thead>
<tr>
<th>Fitting Type</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint</td>
<td>![Joint Symbol]</td>
</tr>
<tr>
<td>Elbow - 60 deg</td>
<td>![Elbow - 60 deg Symbol]</td>
</tr>
<tr>
<td>Elbow - 45 deg</td>
<td>![Elbow - 45 deg Symbol]</td>
</tr>
<tr>
<td>Elbow - Turned Up</td>
<td>![Elbow - Turned Up Symbol]</td>
</tr>
<tr>
<td>Elbow - Turned Down</td>
<td>![Elbow - Turned Down Symbol]</td>
</tr>
</tbody>
</table>

### Valves

- Gate Valve
- Globe Valve
- Angle Globe Valve
- Angle Gate Valve
- Check Valve
- Angle Check Valve
- Stop Cock
- Safety Valve
- Quick Opening Valve
- Float Opening Valve
- Motor Operated Gate Valve

---

Figure 1-3. Symbols used for plumbing fixtures, piping, fittings, and valves. (American National Standards Institute)
Define the functions of the following plumbing systems:

<table>
<thead>
<tr>
<th>Potable water system</th>
<th>Sanitary drainage and vent piping system</th>
<th>Storm water drainage system</th>
</tr>
</thead>
</table>

I could use a refresher class (I have mastered this area)
Plumbing

Explain where you would use the following materials.

<table>
<thead>
<tr>
<th>Materials</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast iron soil pipe and fittings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galvanized steep pipe and fittings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper tubing with solder joint and flare joint fittings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic pipe end fittings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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I have mastered this area
Plumbing

Complete the following questions:

What are plumbing valves used for?

List types of valves that you have installed or maintained

Why is it important to understand the thread measurement on pipes and fittings?

Do you understand the charts located on the next two pages?

I could use a refresher class

I have mastered this area

1 2 3 4 5
<table>
<thead>
<tr>
<th>NOMINAL PIPE SIZE (INCHES)</th>
<th>THREADS PER INCH</th>
<th>APPROXIMATE LENGTH OF THREAD (INCHES)</th>
<th>APPROXIMATE NUMBER OF THREADS TO BE CUT</th>
<th>APPROXIMATE TOTAL THREAD MAKEUP, HAND AND WRENCH (INCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>27</td>
<td>7/8</td>
<td>10</td>
<td>1/4</td>
</tr>
<tr>
<td>1/4</td>
<td>18</td>
<td>5/8</td>
<td>11</td>
<td>3/8</td>
</tr>
<tr>
<td>3/8</td>
<td>18</td>
<td>5/8</td>
<td>11</td>
<td>3/8</td>
</tr>
<tr>
<td>1/2</td>
<td>14</td>
<td>3/4</td>
<td>12</td>
<td>7/16</td>
</tr>
<tr>
<td>3/4</td>
<td>14</td>
<td>3/4</td>
<td>12</td>
<td>7/16</td>
</tr>
<tr>
<td>11/2</td>
<td>11 1/2</td>
<td>7/8</td>
<td>10</td>
<td>9/16</td>
</tr>
<tr>
<td>1 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
</tr>
<tr>
<td>2 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
</tr>
<tr>
<td>3 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
</tr>
<tr>
<td>4 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
</tr>
<tr>
<td>5 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
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<tr>
<td>6 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
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<tr>
<td>7 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
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<tr>
<td>8 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
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<tr>
<td>9 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
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<tr>
<td>10 1/2</td>
<td>11 1/2</td>
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<td>11</td>
<td>9/16</td>
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<td>11 1/2</td>
<td>11 1/2</td>
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<td>9/16</td>
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<tr>
<td>12 1/2</td>
<td>11 1/2</td>
<td>1</td>
<td>11</td>
<td>9/16</td>
</tr>
</tbody>
</table>

*Dimensions given do not allow for variations in tapping and threading.*
### Electrical Symbols

<table>
<thead>
<tr>
<th>Fuses</th>
<th>Conductors</th>
<th>Motors</th>
<th>Power</th>
<th>Connected</th>
<th>Not Connected</th>
<th>Line Connection</th>
<th>Humidifier</th>
<th>Transformer</th>
<th>Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

#### Switches
- Toggle switch: open, closed
- Contact types: NO, NC, NC, NC, NC
- Relay contacts: open, closed
- Temperature contacts: NO, NC
- Pressure contacts: NO, NC
- Circuit breaker: NO, NC
- Liquid contacts: NO, NC
Complete the following questions:

What are the mechanical components of HVAC systems?

Explain the chemicals used in HVAC systems.

What are the components of a forced air heating system?

I have mastered this area.

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5

1 2 3 4
Complete the following questions:

Explain the components of the hydronic heating system illustrated below.
Complete the following questions:

1. Explain the difference between a low pressure and a high pressure boiler.
2. Define mechanical compression refrigeration.
3. Define absorption refrigeration.
4. What is the function of the low pressure side of a refrigeration system?

I could use a refresher class in this area.
What are the functions of the components in the expansion device illustrated below?

SOME REFRIGERANT VAPORIZES

LOW-PRESSURE VAPOR AND LIQUID REFRIGERANT TO EVAPORATOR

EXPANSION DEVICE

HIGH-PRESSURE LIQUID REFRIGERANT FROM CONDENSER

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I have mastered this area

1 2 3 4 5

54
HVAC

Complete the following questions:

What is the function of the high-pressure side of a mechanical compression refrigeration system?

What are the components of a forced air conditioning system?

What are the components of a hydronic air conditioning system?

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1 2 3 4 5

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55
HVAC

Explain the power controls shown below

DISCONNECT ON EXTERIOR WALL IN SIGHT OF CONDENSER
ELECTRIC POWER FROM MAIN PANEL
OTHER CIRCUITS
ELECTRICAL SERVICE PANEL
CONDENSER

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I have mastered this area

1 2 3 4 5
Explain the functions of the pneumatic control system illustrated.

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I have mastered this area

1  2  3  4  5
Welding

Complete the following questions:

What type of welding process is most pipe welding done in?

What are the most common weld processes done at Onan and why are they used?

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I have mastered this area

1 2 3 4 5
Identify the types of welds below and explain where you would use each one.

- SURFACING WELD
- GROOVE WELD
- PLUG WELD
- SLOT WELD
- FILLET WELD

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1 2 3 4 5
Welding

Identify the types of weld joints below and explain where you would use each one.

1. BUTT
2. CORNER
3. LAP
4. EDGE

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I have mastered this area 1 2 3 4 5

132 61 133
Explain where you have used each of the welding test positions identified below.

1G POSITION
PIPE HORIZONTAL ROLLED
WELD FLAT (±15°)

2G POSITION
PIPE VERTICAL
WELD FLAT (±15°)

5G POSITION
PIPE HORIZONTAL FIXED (±15°)
WELD FLAT, VERTICAL, OVERHEAD

6G POSITION
PIPE INCLINED
FIXED (45° ± 5°)

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1  2  3  4  5
Why would you weld a thin walled pipe and a thick walled pipe differently?

**Included Angle**

- **Thin Wall Pipe**
  - 35°
  - 70°
  - Included Angle
  - 1/8" - 5/16"
  - 1/16"
  - Root Face: 3/32" to 1/8"
  - Root Opening: 3/32" to 1/8"

- **Thick Wall Pipe**
  - 75°
  - Included Angle
  - Over 5/16"
  - Root Face: 3/32" to 1/8"
  - Root Opening: 3/32" to 1/8"

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1 2 3 4 5