UA STAR CERTIFICATION
SUPERIORITY IN PLUMBING

UA STAR
MASTERY EXAM

Plumber
Study Guide
International Pipe Trades Joint Training Committee, Inc

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ACKNOWLEDGEMENTS

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FORWARD

The International Pipe Trades Training Committee and the United Association Training Department have developed the following Study Guide to assist you in locating information in UA textbooks, which relate to the 12 categories and 44 tasks identified during the DACUM (Develop A CurriculuM) process administered by Ferris State University. The DACUM is an in-depth job and task analysis, which serves as the base for the UA STAR exam.

The 12 categories and 44 tasks identified during the DACUM are included in this Study Guide so that you see, first-hand, the results of the study and the items that you can expect to encounter on the UA STAR exam. Each category and task is numbered, and each task is broken into a number of smaller jobs, which a plumber would be expected to perform in order to complete the task.

Below each task you will find an underlined paragraph that looks like this and contains general reference to UA textbooks.

You will find that the UA STAR exam is a comprehensive exam. It is designed to test the knowledge of the experienced plumber. As such, this Study Guide is not intended to be a reference for the inexperienced plumber to use in preparing for the exam. It is not expected that the inexperienced plumber will be able to successfully compete the exam based on the Study Guide and the information contained in UA textbooks.

It is expected that the UA STAR test candidate is the plumber who has completed the UA training and has gained several years of experience in the field. Many of the tasks and jobs identified in the DACUM are those, which can only be learned by doing. The test candidate who expects to achieve success on the UA STAR exam by merely using the Study Guide to locate information in textbooks, will likely be disappointed.

It is recognized that even the best plumber does not work in all areas of the industry. Further, some knowledge can be forgotten through lack of use. As such, it is recommended that you study a number of UA textbooks in preparing for the UA STAR exam. A list is provided below this paragraph. These texts were cited throughout the Study Guide. You may wish to review those texts where you feel you need knowledge. In addition, there are many other excellent books on the market, which can serve as reference for you. They are far too numerous to list. You may know of some of them or even own them. Feel free to use them in your studies.
UA textbooks use as reference in this Study Guide

A guide to Service Work
Advanced Plan Reading and Related Drawing
Backflow Prevention & Cross-Connection Control
Certified medical Gas
Code Interpretation & Application
Drainage Manual
Drawing Interpretation & Plan Reading
Gas Installation
Gas Tungsten Arc-Welding
Job Safety and Health
Pipe Bending
Pipe, Fittings, Valves, Supports and Fasteners
Piping Handbook and Offset Formulas
Plumbing Fixtures & Appliances
Pumps
Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding
Related Mathematics
Related Science
Residential Service
Rigging
Soldering and Brazing
Use and Care of Tools
Valve Repair
Water Supply

Some UA textbooks contain questions, which provide excellent practice material and act as a learning tool. If you spend time and answer the questions at the back of the texts successfully, you will improve your chances of success on the UA STAR exam.

This Study Guide also contains practice questions. All questions are multiple choices, with four possible answers. Most questions contain explanations for each of the correct and incorrect answers. The questions are designed to help you review some of the material that you will need to know when taking the exam.

The UA STAR exam is a tough test. With some hard work, you can be successful in passing it. Good luck!
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<td>2.</td>
<td>Cut and join copper and brass pipe</td>
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<td>3.</td>
<td>Cut and join plastic pipe and tubing</td>
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<td>4.</td>
<td>Cut and join cast iron pipe</td>
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<td>5.</td>
<td>Hang pipe using pipe hangers, supports, anchors, guides and fasteners</td>
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<td>6.</td>
<td>Install adapters/transitions fittings</td>
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<td>Install/maintain valves</td>
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<td>Install/maintain sinks, lavatory, water closets, urinals and other fixtures</td>
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<td>13.</td>
<td>Install/maintain water heaters and circulating pumps</td>
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### D. WATER SUPPLY AND DISTRIBUTION

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<td>Install water distribution lines</td>
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<td>16.</td>
<td>Install/maintain backflow prevention devices</td>
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<td>17.</td>
<td>Protect piping and tubing</td>
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### E. DRAINAGE, WASTE AND VENTING SYSTEMS

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<td>Design and size water supply systems</td>
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<td>Install/maintain cleanout, laterals, mains, stacks and branches</td>
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<td>Install/maintain storm drains</td>
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<td>Install soil or waste pipe</td>
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<td>Install/maintain traps</td>
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<td>23.</td>
<td>Install/maintain interceptors</td>
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<td>24.</td>
<td>Install/maintain acid waste systems</td>
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### F. PUMPS

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<td>Install/maintain booster pumps</td>
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<td>26.</td>
<td>Install/maintain submersible and ejector pumps</td>
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### G. WELDING

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<td>28.</td>
<td>Perform brazing and soldering</td>
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<td>Perform SMAW and GTAW welding</td>
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<td>Perform cutting with torch</td>
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U.A. Reference Books - Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools
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<td>Install/maintain medical gas</td>
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<td>35.</td>
<td>Demonstrate knowledge of environmental issues</td>
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<td>36.</td>
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U.A. Reference Books - Code Interpretation & Application - Job Safety and Health – Rigging - Use and Care of Tools

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<td>Demonstrate knowledge of plumbing theories</td>
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<td>39.</td>
<td>Demonstrate knowledge of applicable codes</td>
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U.A. Reference Books - Code Interpretation & Application - Related Science

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<td>Interpret blueprints</td>
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<td>41.</td>
<td>Identify common plumbing symbols</td>
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<td>42.</td>
<td>Perform sleeving, inserts and layouts</td>
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U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

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<td>Perform applied math operation</td>
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<td>44.</td>
<td>Operate measuring tools</td>
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U.A. Reference Books - Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools
**PIPING AND TUBING**

Cut and join steel pipe

a. Cut steel with torch
   U.A. Reference: *Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding*

b. Cut with saws (band, hack, reciprocating, etc.)
   U.A. Reference: Use and Care of Tools

c. Cut with pipe cutters
   U.A. Reference: Use and Care of Tools

d. Differentiate between type of steel pipe - schedule 40, 80
   U.A. Reference: Use and Care of Tools

e. Lift with proper lifting equipment
   U.A. Reference: Use and Care of Tools

f. Join steel pipe to steel using flanges welding, threads
   U.A. Reference: *Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding, Use and Care of Tools*

g. Join steel pipe to copper using dielectric fittings and threaded
   U.A. Reference: Use and Care of Tools

h. Join pipe using grooved ends
   U.A. Reference: Use and Care of Tools

i. Thread steel pipe
   U.A. Reference: Use and Care of Tools

U.A. Reference: *Use and Care of Tools - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding*
Cut and join copper and brass pipe

a. Cut with tubing cutters
   U.A. Reference: Use and Care of Tools

b. Cut with various saws (hack, band, etc.)
   U.A. Reference: Use and Care of Tools

c. Identify class of copper piping and tubing-K, L, M, and DWV
   U.A. Reference: Use and Care of Tools, Soldering and Brazing

d. Flare copper pipe and tubing
   U.A. Reference: Use and Care of Tools, Soldering and Brazing

e. Join copper tubing to brass fittings
   U.A. Reference: Soldering and Brazing

f. Join copper tubing/pipes to copper pipe/tubing
   U.A. Reference: Use and Care of Tools, Soldering and Brazing, Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding

g. Join copper tubing to steel pipe using dielectric fittings adapter kit
   U.A. Reference: Use and Care of Tools

h. Join copper tubing with compression connectors
   U.A. Reference: Use and Care of Tools

i. Join pipe (tubing) to fittings using soldering method
   U.A. Reference: Soldering and Brazing

j. Join pipe (tubing) to fittings using brazing
   U.A. Reference: Soldering and Brazing

k. Prepare ends appropriately including cleaning and reaming
   U.A. Reference: Use and Care of Tools

l. Bend copper tubing
   U.A. Reference: Use and Care of Tools

m. Perform T drilling
   U.A. Reference: Use and Care of Tools

n. Perform pipe and tube grooving
   U.A. Reference: Use and Care of Tools
Cut and join plastic pipe and tubing

a. Cut with tubing cutters
   U.A. Reference: Use and Care of Tools

b. Cut with various saws (hack, bands, etc.)
   U.A. Reference: Use and Care of Tools

c. Solvent weld plastic pipe and tubing
   U.A. Reference: Use and Care of Tools

d. PVC, C-PVC, ABS, cross-linked polyethylene, polyethylene
   -schedules of plastic pipe
   U.A. Reference: Use and Care of Tools

e. Join plastic pipe to dissimilar metal pipe using threaded
   adapter or flange
   U.A. Reference: Use and Care of Tools

f. Prepare ends appropriately
   U.A. Reference: Use and Care of Tools

g. Weld plastic pipe (polyethylene)
   U.A. Reference: Use and Care of Tools

Cut and join cast iron pipe

a. Cut cast iron with cast iron cutters
   U.A. Reference: Use and Care of Tools

b. Cut with saws
   U.A. Reference: Use and Care of Tools

c. Cut with pipe cutters
   U.A. Reference: Use and Care of Tools

d. Differentiate between type of cast iron pipe -schedule
   service weight and extra heavy, hub and spigot and no-hub
e. Lift with proper lifting equipment  
   U.A. Reference: Use and Care of Tools

f. Join cast iron pipe to dissimilar materials  

g. Join hub and spigot with bad and oakum joints  

h. Join no hub pipe and finings with no hub couplings  

i. Join hub and spigot with compression joints  


Hang pipe using pipe hangers, supports, anchors, guides and fasteners

a. Identify various types of pipe hangers and clamps  
   • clevis hangers  
   • pipe clamp hanger  
   • clevis roller hanger  
   • adjustable pipe roller stand  
   • pipe saddles (high temperature service)  
   • riser clamps (support vertical riser through concrete floors)  
   • beam clamp structural attachments  
   • pipe shoe  
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

b. Install pipe anchor  
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

c. Install concrete anchor inserts  
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners
Install adapters/transitions fittings

a. Install dielectric nipples and unions (galvanized to copper)
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

b. Install to different piping and tubing using special approved adapters, such as
   • brass by C-PVC
   • plastic to cast iron
   • Fernco
   • MIP
   • compression adapter
   • flare adapter
   • flange adapter
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

c. Confirm approved adapter for application
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

Install/maintain valves

a. Select appropriate type of valve for the application
   • globe (compression) valve used for regulating flow of air and water
   • gate valve is either fully opened or closed
   • types-non-rising stem, (outside screw, quick closing)
   • ball valve is either fully opened or closed in only one-quarter turn; have synthetic seals (full, standard or reduced port
   • check valve controls direction of flow
   • relief valve is safety device that controls excess pressure or temperature
   • fixture shut off valve
   • stop and drain valves
   • butterfly valve

b. Shut off supply
   U.A. Reference: Valve Repair
c. Replace defective valve mechanically
   - flanged
   - threaded
   - sweated
   - glue
   - brazed
   - compression

U.A. Reference: Valve Repair

INSPECTION AND TESTING

Perform pressure test

a. Pressure test water distribution system
   U.A. Reference: Residential Service - Water Supply

b. Pressure test gas lines using mercury of Kuhlman or other approved gauges
   U.A. Reference: Residential Service - Water Supply

c. Cap and plug the lines
   U.A. Reference: Use and Care of Tools

d. Visually inspect for leaks
   U.A. Reference: Residential Service

e. Attached pressure gauge to the line; check for pressure loss
   U.A. Reference: Residential Service - Use and Care of Tools

f. Hold for sufficient time for type of line
   U.A. Reference: Residential Service

g. Locate and repair if there is a loss
   U.A. Reference: Residential Service - Water Supply

h. Test DWV systems
   U.A. Reference: Water Supply

i. Types of test
   - Compressed air
   - Water
   - Nitrogen

U.A. Reference: Use and Care of Tools
j. Perform peppermint test or smoke test  
   U.A. Reference: Residential Service - Water Supply  

k. Perform soap bubble test  
   U.A. Reference: Water Supply  

   U.A. Reference: Residential Service - Use and Care of Tools - Valve Repair - Water Supply  

Perform hydrostatic test  

   a. Increase the water pressure in the toe  
      U.A. Reference: Residential Service - Water Supply  

   b. Attach an water supply to the line using a hydraulic pump  
      U.A. Reference: Residential Service - Water Supply  

   c. Attach a pressure gauge to a line; measure drop in pressure  
      U.A. Reference: Water Supply  

   d. If there is a loss, repair the line  
      U.A. Reference: Residential Service - Water Supply  


Demonstrate knowledge of backflow test  

   a. Attach a backflow test kit to backflow device  
      Backflow test kit  
      U.A. Reference: Backflow Prevention & Cross-Connection Control  

   b. Test operation of the backflow prevention device  
      following certified procedure  
      U.A. Reference: Backflow Prevention & Cross-Connection Control  

   c. Interpret gauge reading to diagnose operation of device  
      U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair  

   d. Notify owner of faulty equipment  
      U.A. Reference: Backflow Prevention & Cross-Connection Control
e. Repair or replace faulty device  

f. Diagnose proper device for hazard  

g. Prepare testing certificate  


Perform purity test

a. Flush the system  
   U.A. Reference: Residential Service - Water Supply

b. Super chlorinate the system  
   U.A. Reference: Residential Service - Water Supply

c. Flush system second time  

d. Test for purity using test kit by sending to health dept.  

e. Re-purity  

Plumbing Fixture

Install/maintain sinks, lavatory, water closets, urinals and other fixtures

a. Install appropriate waste and water lines to the unit
   U.A. Reference: Code Interpretation & Application - Drainage
   Manual - Water Supply

b. Install appropriate mounting brackets and supports for the unit
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

c. Confirm appropriate mechanical installation per code
   • proper height
   • level
   • secure
   U.A. Reference: Code Interpretation & Application

d. Test operation of the units
   U.A. Reference: A guide to Service Work - Drainage Manual -
   Plumbing Fixtures & Appliances - Water Supply

e. Repair/replace faucets and washer and seal, o-rings
   U.A. Reference: A guide to Service Work - Plumbing Fixtures &
   Appliances –

f. Repair/replace traps
   U.A. Reference: A guide to Service Work - Drainage Manual -
   Plumbing Fixtures & Appliances

g. Repair/replace flush valves
   U.A. Reference: A guide to Service Work - Pipe, Fittings, Valves,
   Supports and Fasteners - Plumbing Fixtures & Appliances –

h. Repair/replace ballcocks
   U.A. Reference: A guide to Service Work - Pipe, Fittings, Valves,
   Supports and Fasteners

i. Repair/replace handles
   U.A. Reference: A guide to Service Work - Pipe, Fittings, Valves,
   Supports and Fasteners

j. Repair/replace wax ring
   U.A. Reference: A guide to Service Work - Plumbing Fixtures &
   Appliances
k. Repair/replace sensor valves

l. Repair/replace vacuum breaker

m. Repair/replace temperature mixing valves
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners - Plumbing Fixtures & Appliances

n. Caulk plumbing fixtures
   U.A. Reference: Plumbing Fixtures & Appliances


Install/maintain water heaters and circulating pumps

a. Install cold water lines to the unit

b. Install temperature and pressure relief valve

c. Install gas or electric supply to the unit per code regulations

d. Install flue pipe if gas per code regulations

e. Test operation of the unit
f. Replace dip tube

g. Replace thermocouple
   U.A. Reference: A guide to Service Work - Plumbing Fixtures & Appliances - Gas Installation

h. Replace gas control
   U.A. Reference: Gas Installation

i. Replace burner assembly
   U.A. Reference: Gas Installation

j. If no hot water, check circuit breaker or fuse
   U.A. Reference: A guide to Service Work - Plumbing Fixtures & Appliances - Gas Installation

k. If insufficient amount of hot water, determine sufficient capacity of water heater
   a. check thermostat; confirm setting and reset
   b. check leaking of dip tube near top of heater; remove and replace dip tube.
   U.A. Reference: Plumbing Fixtures & Appliances - Gas Installation

l. If water too hot; readjust thermostat and determine adequate operation
   U.A. Reference: Plumbing Fixtures & Appliances - Gas Installation

m. Replace thermostat
   • turn off energy supply
   • turn off water supply
   • drain tank
   • remove defective part
   U.A. Reference: Gas Installation

n. If leaking tank, turn off energy and water supply; drain tank
   U.A. Reference: A guide to Service Work - Plumbing Fixtures & Appliances - Gas Installation

o. Replace temperature and pressure relief valve and drip line equal to size to the line supplying water tank
   U.A. Reference: A guide to Service Work - Gas Installation
p. If noise in the tank, check for sediment in tank
   U.A. Reference: A guide to Service Work - Plumbing Fixtures & Appliances

q. Install expansion tank device
   U.A. Reference: Code Interpretation & Application - Pipe, Fittings, Valves, Supports and Fasteners - Plumbing Fixtures & Appliances


WATER SUPPLY AND DISTRIBUTION

Maintain water flow and pressure regulators

a. Inspect for leaks

b. Install and replace regulator; set and adjust pressure

c. Troubleshoot water flow problems
   - water hammer
   - plugged filters
   - corrosion/erosion
   - cavitations

d. Install water meter

e. Determine adequacy of size

f. Install pressure reducing valves or pump, per system requirements
g. Install protection against physical damage  

h. Determine need for a booster pump  
   • main water line to small  
   • main water line is too old or corroded  
   • high rise requires additional pressure  


Install water distribution lines  

   a. Install appropriate hangers and proper supports for the type of line to be installed  
      U.A. Reference: Use and Care of Tools  

   b. Comply with appropriate codes on type of materials and valves to be used  
      U.A. Reference: Code Interpretation & Application  

   c. Secure the appropriate prints to identify location and method of installation  
      U.A. Reference: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading  

   d. Identify the proper components to be instated  
      • Valves  
      • backflow prevention  
      • proper pipe sizes  
      • routing  
      • water softeners  
      • water meters  
      • water hammer arresters  
      • drinking water systems  
      • non-potable systems  
      U.A. Reference: Code Interpretation & Application - Backflow Prevention & Cross-Connection Control - Pipe, Fittings, Valves,
Supports and Fasteners - Plumbing Fixtures & Appliances - Residential Service - Water Supply

r. Label lines appropriately
U.A. Reference: Residential Service - Use and Care of Tools

s. Determine and install backflow prevention device as required
U.A. Reference: Backflow Prevention & Cross-Connection Control


Install/maintain backflow prevention devices

a. Install reduced pressure backflow device
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

b. Install double check valve assemblies
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

c. Install pressure vacuum breakers
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

d. Install atmospheric vacuum breakers
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

e. Install air gap
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

f. Identify purpose and function of backflow prevention device
U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair
g. Identify degree of hazards (high, contaminate, health, pollutant, etc.)
   U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

U.A. Reference: Backflow Prevention & Cross-Connection Control - Valve Repair

Protect piping and tubing

a. Insulate pipe
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

b. Install nail plates
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

c. Burial depths
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

d. Heat tracing
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

e. Cathodic protection
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

f. Protect against corrosion
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

g. Pipe coatings
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

h. Protect against abrasion
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

i. Install sleeving
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners
DRAINAGE, WASTE AND VENTING SYSTEMS

Design and size water supply systems

a. Determine WFU for each fixture to be installed
   • determine pipe sizes

b. Interpret ADA requirements, if appropriate for fixture installation
   U.A. Reference: Code Interpretation & Application - Plumbing Fixtures & Appliances

c. Determine equipment
   U.A. Reference: Code Interpretation & Application - Plumbing Fixtures & Appliances

d. Determine elevation

e. Determine minimum available water pressures
   U.A. Reference: Water Supply

f. Determine minimum available water pressure at top fixture
   U.A. Reference: Plumbing Fixtures & Appliances - Water Supply


Install/maintain cleanout, laterals, mains, stacks and branches

a. Comply with code regulations regarding cleanout installation and materials and locations

b. Determine proper grade
c. Determine proper drainage pattern fittings  

d. Determine proper sizing using DFU  

e. Determine proper supports  
   U.A. Reference: Pipe, Fittings, Valves, Supports and Fasteners

f. Determine proper clean out requirements: install as appropriate  


Install/maintain storm drains

a. Comply with proper size per rain fall in geographic region per code  
   U.A. Reference: Code Interpretation & Application

b. Determine proper clean out requirements: install as appropriate  

c. Install with proper pipe system and manhole  
   U.A. Reference: Code Interpretation & Application - Drainage Manual - Use and Care of Tools

d. Determine proper grade per pipe diameter per area served  

U.A. Reference: Code Interpretation & Application - Drainage Manual - Use and Care of Tools
Install soil or waste pipe

a. Select appropriate size pipe for application

b. Select appropriate vent for application for code
   • individual vent for venting every trap
   • unit vent where two similar fixtures discharge into waste piping
   • circuit vents on two or more fixtures that discharge into horizontal waste branch
   • relief vent for back pressure
   • wet vents portion of vent piping through which liquid waste from another fixture
   • looped vent is one that dips below flood rim of the fixture before rising to connect to stack
   • combination waste and vent systems
   • air admittance devices (mechanical), when allowed by code

c. Identify purpose of the vent - maintain atmospheric pressure

d. Install vent terminals/frost protection; locate appropriately

e. Identify purpose of vent is to protect trap seal


Install/maintain traps

a. Identify purpose of the trap-prevent sewer gases
   From enter building without effecting flow of pipe
b. Install trap into waste line
   - mechanically
   - slip joints
   - solder
   - glue

c. Define parts of a trap and trap seal
   - top dip
   - bottom dip
   - crown weir
   - inlet and outlet
   - cleanout

d. Identify minimum depth of trap seal

e. Install priming devices

f. Identify causes of trap seal failure
   - capillary action
   - evaporation
   - blow out
   - cavitations
   - siphonage

Install/maintain interceptors

a. Identify types of interceptors
   - grease
   - sand
   - oil
   - solids
b. Identify purpose of interceptors-prevent waste from entering public sewer system

c. Install components
- Basket
- flow control fitting
- vented
- baffle
- sample ports (as required)

Install/maintain acid waste systems

a. Identify materials required to install system
- glass piping
- plastic (polypropylene or PVDF)
- acid neutralization tanks
- duriron

b. Install as other drainage venting system

c. Install venting as separate system

PUMPS

Install/maintain booster pumps

a. Select appropriate size pump for application (gallons per minutes)
   U.A. Reference Books: Advanced Plan Reading and Related
   Drawing - Code Interpretation & Application - Drawing
   Interpretation & Plan Reading - Pumps - Water Supply

b. Shut off water supply and isolate at bypass

c. Attach pipe to the pump using approved fittings
   U.A. Reference Books: Code Interpretation & Application - Pumps
   - Water Supply

d. Test for leaks and operation of the pump
   U.A. Reference Books: Pumps

e. Replace impeller on booster pump
   U.A. Reference Books: Pumps

f. Install expansion tank
   U.A. Reference Books: Advanced Plan Reading and Related
   Drawing - Code Interpretation & Application - Drawing
   Interpretation & Plan Reading - Pumps - Water Supply

g. Pipe relief’s to drains
   U.A. Reference Books: Advanced Plan Reading and Related
   Drawing - Code Interpretation & Application - Drawing
   Interpretation & Plan Reading - Pumps - Water Supply

Interpretation & Application - Drawing Interpretation & Plan Reading - Pumps - Water Supply

Install/maintain submersible and ejector pumps

a. Verify o-rings are water tight in sump pumps
   U.A. Reference Books: Pumps

b. Change rotor on sump pump
   U.A. Reference Books: Pumps

C. Replace mechanical seals
   U.A. Reference Books: Pumps
d. Confirm rotation of pump before replacement  
U.A. Reference Books: Pumps

e. Seat pump during installation  
U.A. Reference Books: Pumps

f. Inspect guide rails for straightness and condition offsets  
U.A. Reference Books: Pumps

g. Check for ground on electrical supply  
U.A. Reference Books: Pumps

h. Set floats  
U.A. Reference Books: Pumps

i. Install check valve  
U.A. Reference Books: Pumps

**U.A. Reference Books: Pumps**

**Install/maintain circulating pumps**

a. Identify different types of pumps  
   - Centrifugal  
   U.A. Reference Books: Pumps

b. Install piping to the pump  

c. Interpret blueprint for accurate piping  
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

d. Install check valves, as required  

e. Install flow switch, as required  
   U.A. Reference Books: Code Interpretation & Application - Pumps
WELDING

Perform brazing and soldering

a. Braze and solder copper pipe
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing

b. Demonstrate proper methods of set up brazing and soldering equipment
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing

c. Use flux in appropriate applications (water soluble for soldering)
   U.A. Reference Books: Soldering and Brazing - Use and Care of Tools

d. Clean pipe, prepare ends
   U.A. Reference Books: Gas Tungsten Arc-Welding - Soldering and Brazing - Use and Care of Tools

e. Select appropriate gas and torch for brazing and soldering
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing

f. Identify proper theory of brazing and soldering
   U.A. Reference Books: Soldering and Brazing

g. Select appropriate soldier for application (lead free)
   U.A. Reference Books: Soldering and Brazing - Use and Care of Tools

U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools
Perform SMAW and GTAW welding

a. Weld metals
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools

b. Bevel pipe
   U.A. Reference Books: Use and Care of Tools

c. Perform arc welding equipment set up
   U.A. Reference Books: Gas Tungsten Arc-Welding - Use and Care of Tools

d. Perform butt weld

e. Perform welding in all position (such as. horizontal vertical up, overhead, vertical down, etc.)

f. Identify different types of welding procedures
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools

g. Select appropriate rod(s) for the job; set machine appropriate
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing

h. Set up the welding machine
   U.A. Reference Books: Gas Tungsten Arc-Welding - Use and Care of Tools

i. Identify process and correct polarities
   U.A. Reference Books: Gas Tungsten Arc-Welding

j. Identify theory of welding
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding Soldering and Brazing - Use and Care of Tools
Perform cutting with torch

a. Set up torch equipment using oxygen and acetylene
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools

b. Set pressures Select appropriate cutting tip
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools

c. Select appropriate cutting tip
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing

d. Identify function of each regulator
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Soldering and Brazing - Use and Care of Tools

e. Bevel pipe using torch
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Use and Care of Tools

f. Cut holes in tanks for repairs
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding

g. Cut pipe on various metals
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding

h. Fabricate brackets
   U.A. Reference Books: Gas Tungsten Arc-Welding - Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Use and Care of Tools

i. Use torch for heating and bending
   U.A. Reference Books: Oxy-Fuel Cutting and Welding and Shielded Metal-Arc Welding - Use and Care of Tools
Install/maintain natural gas lines

a. Identify demand load based on cfh; interpret blueprint
   U.A. Reference Books: Advanced Plan Reading and Related
   Drawing - Drawing Interpretation & Plan Reading - Gas
   Installation

b. Size line based on load demand
   Interpretation & Application - Gas Installation - Plumbing Fixtures
   & Appliances - Residential Service

c. Test line for leaks
   - Pipe, Fittings, Valves, Supports and Fasteners Plumbing Fixtures
   & Appliances - Residential Service

d. Install proper hangers and supports
   U.A. Reference Books: Pipe, Fittings, Valves, Supports and
   Fasteners

e. Install proper unions and Valves at appliances
   Interpretation & Application - Gas Installation - Plumbing Fixtures
   & Appliances - Residential Service - Pipe, Fittings, Valves,
   Supports and Fasteners

f. Install proper materials per code
   U.A. Reference Books: Code Interpretation & Application - Gas
   Installation

g. Purge air out of system and light appliances correctly
   - Residential Service

h. Check operation of appliances
   - Plumbing Fixtures & Appliances - Residential Service
Install/maintain appliance venting

a. Install per manufactures recommendations

b. Maintain proper clearances and slope

c. Terminate in approved location

d. Provide proper combustion air source

Install/maintain medical gas

a. May be required to be certified

b. Install per NFPA-99C or UPC/IPC Chapter 13

C. Piping and fitting must be clean for oxygen service
d. Identify correct type of pipe and label piping

e. All brazing must be performed with nitrogen purge
   U.A. Reference Books: Certified medical Gas - Code Interpretation & Application


SAFETY

Demonstrate knowledge of basic safety principles

a. Comply with shop and equipment safety rules
   U.A. Reference Books: Job Safety and Health

b. Apply basic emergency first aid techniques
   U.A. Reference Books: Job Safety and Health

c. Complete accident reports
   U.A. Reference Books: Job Safety and Health

d. Inspect workplaces for safe working environment
   U.A. Reference Books: Job Safety and Health – Use and Care of Tools

e. Identify and report shop, environmental and equipment safety violations
   U.A. Reference Books: Job Safety and Health – Use and Care of Tools

f. Demonstrate use of fire extinguishers
   U.A. Reference Books: Job Safety and Health

g. Demonstrate knowledge of disaster procedures (chlorine teaks, natural gas, methane, etc.)
   U.A. Reference Books: Job Safety and Health

h. Participate in safety meetings
   U.A. Reference Books: Job Safety and Health
i. Comply with OSHA regulations
   U.A. Reference Books: Job Safety and Health

j. Demonstrate cardio pulmonary resuscitation techniques
   U.A. Reference Books: Job Safety and Health

k. Comply with confined space entry regulations
   U.A. Reference Books: Job Safety and Health

l. Demonstrate common sense

m. Demonstrate knowledge of lock out and tag out
   U.A. Reference Books: Job Safety and Health – Use and Care of Tools

n. Welding safety principles; monitor gauge readings
   U.A. Reference Books: Job Safety and Health

o. Operation of lifting equipment; knowledge of hand signals
   U.A. Reference Books: Job Safety and Health – Rigging - Use and Care of Tools

p. Comply with forklift certification
   U.A. Reference Books: Job Safety and Health

q. Maintain good housekeeping
   • rubbish cleared away and disposed of
   • store combustible wastes proper
   • cleaning materials can be fire hazards
   • oily mops and rags should be stored in closed metal containers
   • clean up water or oil spills immediately to prevent falls
   • general lighting in work area kept in order
   U.A. Reference Books: Job Safety and Health – Rigging - Use and Care of Tools

r. Wear proper PPE
   U.A. Reference Books: Job Safety and Health

s. Comply with ladder and scaffolding safety
   U.A. Reference Books: Job Safety and Health

t. Comply with OSHA excavation procedures
   U.A. Reference Books: Job Safety and Health
u. Use GFCI/assured grounding program  
   U.A. Reference Books: Job Safety and Health

v. Comply with proper fall protection  
   U.A. Reference Books: Job Safety and Health

w. Locate MSDS (Cornel web site)  
   U.A. Reference Books: Job Safety and Health –

U.A. Reference Books: Code Interpretation & Application - Job Safety and Health – Rigging - Use and Care of Tools

Demonstrate knowledge of environmental issues

a. Confined space entry documentation  
   U.A. Reference Books: Job Safety and Health

b. Document backflow test results  
   U.A. Reference Books: Backflow Prevention & Cross-Connection Control

c. Eliminate cross connections between potable and any water unfit for human consumption  

d. Dispose of hazardous materials properly  
   U.A. Reference Books: Code Interpretation & Application - Job Safety and Health

   e. Demonstrate awareness of asbestos and tad abatement  
   U.A. Reference Books: Code Interpretation & Application - Job Safety and Health – Use and Care of Tools


Perform rigging

a. Use proper hand signals  
   U.A. Reference Books: Rigging - Use and Care of Tools

b. Tie proper knots  
   U.A. Reference Books: Rigging
c. Use of proper rigging chokers and sings
   U.A. Reference Books: Rigging

d. Use lifting equipment
   U.A. Reference Books: Rigging - Use and Care of Tools

e. Calculate loads
   Rigging

U.A. Reference Books: Code Interpretation & Application - Job Safety and Health – Rigging - Use and Care of Tools

RELATED SCIENCE AND CODE

Demonstrate knowledge of plumbing definitions

a. GPM

b. Potable and non-potable water

c. Fixture unit

d. Fittings
   U.A. Reference Books: Pipe, Fittings, Valves, Supports and Fasteners

e. Adapters
   U.A. Reference Books: Pipe, Fittings, Valves, Supports and Fasteners

f. Air gap and break
g. Air lock  

h. Backflow  
U.A. Reference Books: Backflow Prevention & Cross-Connection Control

i. Back pressure  

j. Drains  

k. Valves  

l. Ground water  

m. Rough-in  

n. Stack vent/vent stack  

o. Head pressure  
p. Stack, vent, laterals, main

q. Accessible and readily accessible

r. Vertical and horizontal

s. Sump and Ejector pump

t. Building drains and sewers

u. Riser

v. Leader or down spouts

w. Soil vs. waste

Demonstrate knowledge of plumbing theories

a. Hydraulic and pneumatic principles
   U.A. Reference Books: Related Science

b. Water heating principles
   U.A. Reference Books: Related Science

c. Pressurized systems
   U.A. Reference Books: Related Science - Water Supply

d. Venting principles

e. Welding principles
   U.A. Reference Books: Gas Tungsten Arc-Welding - Related Science

f. Water treatment principles

g. Waste disposal systems

h. Plumbing systems

i. Drainage systems

j. Siphonage principles
   U.A. Reference Books: Related Science - Water Supply

k. Expansion and contraction
   U.A. Reference Books: Related Science

l. Capillary attraction
   U.A. Reference Books: Soldering and Brazing

Demonstrate knowledge of applicable codes

a. Uniform Plumbing Code (IAPMO)
   U.A. Reference Books: Code Interpretation & Application

b. BOCA (Building Official Code Administration) code; PC
   U.A. Reference Books: Code Interpretation & Application

c. State or local codes
   U.A. Reference Books: Code Interpretation & Application

d. Codes define minimum requirements for such as:
   • number of fixtures
   • water pipe sizes
   • drain sizes
   • gas pipe sizes
   • storm drainage sizes
   U.A. Reference Books: Code Interpretation & Application - Related Science

U.A. Reference Books: Code Interpretation & Application - Related Science

BLUEPRINT READING

Interpret blueprints

a. Identify common plumbing fixtures related blueprint symbols
   • types of water closets
   • types of lavatories
   • types of other fixtures
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

b. Elevation, section, and plan views
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

c. Center lines
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

d. Dimensions
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading
e. Cold water and hot water lines (including recirculating)
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

f. Grade and benchmark
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

g. Riser diagrams
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

h. Isometric drawing
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

i. Architectural drawings
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

j. Interpret specifications
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

k. Identify conflicts with structural conditions and other trades
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

l. Coordinate plumbing, architectural structure, and mechanical drawings
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

m. Read cut sheets
   U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading
Identify common plumbing symbols

a. Symbols for fittings and valves
   • elbows (90, 45, turned up, turned down, with side inlet, reducing)
   • sanitary T
   • cross
   • reducer concentric
   • reducer offset
   • connector
   • Y or wye
   • valve (gate, glove)
   • union
   • bushing
   • increaser

U.A. Reference Books: Drawing Interpretation & Plan Reading

b. Piping symbols for plumbing
   • drain or waste above ground
   • drain or waste below ground
   • vent
   • storm drain
   • cold water
   • soft cold water
   • hot water
   • gas
   • compressed air
   • vacuum
   • sewer-cast iron, clay tile, plastic
   • hot water circulating

U.A. Reference Books: Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

Perform sleeving, inserts and layouts

a. Coordinate plumbing, architectural structure, and mechanical Drawings
   U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading
b. Create material list
   U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

c. Read cut sheets and fitting book
   U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

d. Sketch a basic isometric by hand
   U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

e. Transfer scaled drawing to actual installation
   U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

U.A. Reference Books - Advanced Plan Reading and Related Drawing - Drawing Interpretation & Plan Reading

MATHEMATICS AND MEASUREMENT

Perform applied math operation

a. Cubic inches and feet
   U.A. Reference Books: Related Mathematics

b. Calculate offsets and fitting take offs

c. Addition in feet, inches, and fraction
   U.A. Reference Books: Related Mathematics

d. Calculate psi
   U.A. Reference Books: Related Mathematics - Related Science

e. Calculate area of square and circle
   U.A. Reference Books: Related Mathematics

f. Convert feet to inches; vise versa
   U.A. Reference Books: Related Mathematics

g. Calculate flow rates
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Science
h. Calculate head pressure
   U.A. Reference Books: Related Mathematics - Related Science

i. Calculate volume
   U.A. Reference Books: Related Mathematics - Related Science

j. Convert decimals to feet and inches
   U.A. Reference Books: Related Mathematics

k. 3-4-5 rule

l. Calculate rolling offsets

m. Calculate square root

n. Calculate temperatures and BTUs
   U.A. Reference Books: Related Mathematics - Related Science

o. Calculate Pythagorean theory
   U.A. Reference Books: Related Mathematics - Related Science

p. Demonstrate knowledge of basic constants
   - 3.14 (pi)
   - 1.41 (45 degree offset)
   - .707 (45 degree offset)
   - 8.33 (weight of water per gallon)
   - 7.48 (gci)
   - .433 (head pressure)
   - .41 (advance on parallel offsets)
   - 231(cig)

q. Calculate grade
   U.A. Reference Books: Related Mathematics

Operate measuring tools

a. Read rule (tape or wooden)
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

b. Measure pressure with pressure gauge
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

c. Measure elevations with ruler, line, transit level
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

d. Measure with framing square
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

e. Read scale rule
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

f. Determine plumb, level and square
   U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools

U.A. Reference Books: Piping Handbook and Offset Formulas - Related Mathematics - Use and Care of Tools
Study Guide Questions

THE FOLLOWING QUESTIONS ARE PROVIDED AS EXAMPLES OF THE TYPES OF QUESTIONS FOUND ON UNITED ASSOCIATION PLUMBERS MASTERY EXAM AND WILL NOT BE FOUND ON THE EXAM ITSELF.

Category Piping & Tubing

1. The color code for type “K” copper tube is:
   A. Blue
   B. Green
   C. Red
   D. Yellow

2. Identify the copper fitting shown in the figure below.
   A. Coupling adapter
   B. CX FM adapter
   C. CX M adapter
   D. Dielectric adapter

3. The correct way to order the reducing tee shown in the figure below is?
   A. 1” x 1 ½” x 2”
   B. 1 ½” x 1” x 2”
   C. 2’ x 1 ½” x 1”
   D. 2” x 1” x 1 ½”
4. Which of the follow types copper tube has the smallest wall thickness?

A. M
B. DWV
C. K
D. L

5. What type of pipe hanger is shown below?

A. Double eye nut
B. Clevis
C. Split ring hanger
D. Double bolt pipe clamp

![Pipe hanger image]

6. The proper name for the clamp shown below is:

A. Top beam
B. “J” hook
C. Swivel adjuster
D. Socket

![Clamp image]
7. The proper name for the hanger shown below is:
   A. Ring swivel.
   B. Band.
   C. Clevis.
   D. Split.

Category Inspection & Testing

8. When testing a drainage system, the system should be filled with water or air for a minimum of:
   A. 15 minutes.
   B. 30 minutes.
   C. 1 hour.
   D. 2 hours.

9. When using water to test a drainage system the maximum feet of head allowed is:
   A. 10 feet.
   B. 20 feet.
   C. 30 feet.
   D. 40 feet.
Category Plumbing Fixtures

10. What is the minimum size required waste outlet for a shower?

   A. 1 ¼”
   B. 1 ½”
   C. 2”
   D. 2 ½”

11. What is required distance from the sidewall or partition to the centerline of a handicapped toilet?

   A. 18”
   B. 20”
   C. 22”
   D. 24”

12. The shape of a p-trap forms a/an:

   A. resistance to flow.
   B. positive trap seal.
   C. siphon.
   D. air chamber.

13. According to the ada 17” is the maximum height permitted for the flood level rim of a:

   A. water closet.
   B. urinal.
   C. lavatory.
   D. bidet.

14. A domestic hot water heater requires which of the following type of valve?

   A. globe
   B. Check
   C. Temperature and pressure relief
   D. Stop and waste
15. What type of wrench should be used to prevent marking the surface of polished chrome pipe?

A. Basin  
B. Pipe   
C. Strap  
D. Monkey

16. Water closets use what types of traps?

A. P-trap  
B. Integral  
C. Running  
D. S-trap

Category Water Supply

17. In a normal residential water heater what is the percentage of readily available hot water?

A. 50%  
B. 70%  
C. 90%  
D. 100%

18. What type of valve should be installed between the hot water heater and the relief valve?

A. Gate  
B. Ball  
C. Check  
D. No valve

19. The tube that extends into a water heater from the cold water supply is called the _________ tube.

A. Refill  
B. Thermostat  
C. Dip  
D. anode
20. Which of the following is used to eliminate water hammer in a water supply system?

A. Check valve  
B. Pressure regulator  
C. Shock absorber  
D. Vacuum breaker

21. Which of the following is the best device for preventing backflow?

A. RPZ  
B. Pressure vacuum breaker  
C. Double check valve assembly  
D. Dual check

22. There are ______ test cocks on a reduced pressure zone backflow prevention assembly.

A. one  
B. two  
C. three  
D. four

23. When can a potable water supply be connect to a non potable source?

A. When approved by an inspector.  
B. Never  
C. In an emergency.  
D. With the owners permission

Category Drainage and Waste

24. Calculate the total amount of slope at 1/8” per foot, for a drainpipe that is 56’ long.

A. 3”  
B. 7”  
C. 8”  
D. 9”
25. Storm sewers are designed to periodically run at:

A. 1/8 full  
B. 1/4 full  
C. 1/3 full  
D. Full or nearly full

26. Compute the grade of a drain line that falls 10”, in a run of 88”.

A. 1/16” per foot  
B. 1/8” per foot  
C. 3/16” per foot  
D. 1/4” per foot

27. The minimum size for a gravity water closet is:

A. 2”  
B. 3”  
C. 4”  
D. 5”

28. The minimum depth of a trap seal is:

A. 1”  
B. 2”  
C. 3”  
D. 4”

29. All of the following are reasons for at least one stack to extend through the roof except?

A. To prevent leakage in the system.  
B. Provide an outlet for pressure in the system.  
C. Provide an opening for an air supply.  
D. Provide an opening for odors to escape.
30. The total area to be drained in the figure below is ________ square feet.

A. 11,909
B. 12,240
C. 12,204
D. 12,804
31. In the drawing below pipe number 1 is a ________________:

A. combination building sewer.
B. combination building drain.
C. sanitary building sewer.
D. storm building drain.
32. One of the factors for determining the size of a vent is:

A. price of material.
B. it’s length.
C. space requires.
D. type of building.

**Category Pumps**

33. An ejector pump is typically used to pump ____________:

A. storm water.
B. subsurface water.
C. potable water.
D. sewage.

34. What is the purpose of a circulating pump on a hot water system?

A. To prevent backflow
B. To have instant hot water
C. To decrease the pressure
D. To throttle the water

**Category Welding**

35. What color hose is used for the oxygen, on oxy-acetylene welding and burning equipment?

A. Black
B. Blue
C. Green
D. Red

36. What type of flame should be used when using an oxy-acetylene torch?

A. Neutral
B. Carbonizing
C. Oxidizing
D. Reducing
37. What is the smallest size D.W.V. copper tube available?
   A. ¾”
   B. 1”
   C. 1 ¼”
   D. 1 ½”

38. In medical gas installations a purge is required while brazing, along with what percent penetration?
   A. At least 50%
   B. 75%
   C. 90%
   D. 100%

39. ½ inch copper water tubing is equal to what size A.C.R. tubing?
   A. 3/8”
   B. 1/2”
   C. 5/8”
   D. 3/4”

40. Which of the following joint types utilizes “capillary action”?
   A. Compression
   B. Flared
   C. Grooved
   D. Soldered

41. What is the maximum service temperature recommended for copper lines when solder joints are used?
   A. 250°F
   B. 350°F
   C. 400°F
   D. 450°F
Category Gas

42. The purpose of venting a hot water heater is to:
   A. remove combustion gas
   B. cool it off.
   C. Make it more efficient.
   D. Heat the water.

43. Insufficient primary air on a gas burner causes a type of _____ tipped flame.
   A. blue
   B. yellow
   C. red
   D. green

44. What type of valve is typically used on gas appliances?
   A. Ball
   B. Stop and waste
   C. Pressure reducing
   D. Gas cock

Category Safety and Rigging

45. When signaling a crane, which of the following signals designates lower the boom?
   A. Thumb up
   B. Thumb down
   C. Crossed arms
   D. Index finger circling down

46. When using a come-a-long or cable winch hoist, what safety feature will indicate overloading?
   A. Lower hook will bend
   B. Upper hook will bend
   C. Becomes hard to pull
   D. Handle will bend
47. What is the weakest part of a chain hoist?
   A. Chain
   B. Lower hook
   C. Hoist housing
   D. Upper hook

48. Compared to the strength of the rope, how much do knots usually develop?
   A. 50% to 60%
   B. 70% to 80%
   C. 80% to 90%
   D. 90% to 100%

49. When a loop is needed at any point between ends of a rope, the proper knot to tie is the ____________:
   A. Catspaw.
   B. Bowline.
   C. Clove hitch.
   D. Bowline on a bight.

50. What is the advantage of the screw jack over the ratchet jack?
   A. Faster operation
   B. Can be used in tight spots
   C. Easier to carry
   D. Lifts heavier loads

Category Related Science and Code

51. A neutral reading on a PH scale is _____.
   A. 4.1
   B. 7.0
   C. 9.8
   D. 12.4

52. 433 psig is equal to how high of a water column?
   A. 1'
   B. 2'
   C. 3'
   D. 4'
53. One cubic foot of water weighs?

A. 40 pounds  
B. 62.4 pounds  
C. 144 pounds  
D. 231 pounds

54. Standard atmospheric pressure at sea level is _______: 

A. 0 psia  
B. .491 psia  
C. 2.31 psia  
D. 14.7 psia

55. One gallon of water weighs ___________:

A. 1 pound  
B. 2.31 pounds  
C. 8.33 pounds  
D. 10.6 pounds

56. An increase in pressure will cause the boiling point of water to ____________:

A. Increase.  
B. decrease.  
C. remain the same.  
D. expand.
57. The bathroom blueprint shown below is a ________ view.

A. plan
B. floor
C. elevation
D. finish schedule
58. In the isometric sketch drawing below, in which direction are the three top outlets facing?

A. North  
B. South  
C. East  
D. West
59. The cold water (C.W.) sleeve in the drawing below is set at what dimension to the center line below the top of the wall (EL. 313.04)?

A. 307.16  
B. 312.16  
C. 313.92  
D. 318.92
60. What is the C to C measurement of the 45° offset in the drawing below?

A. 10”
B. 12”
C. 14 ½”
D. 24”

61. Which of the following engineer’s measurement and architectural measurement are a like?

A. 5” and .50’
B. 10” and 1.00’
C. 1’-2” and 1.17’
D. 1’-6” and 1.60’

62. What is the capacity in gallons of a water storage tank that measures 30” in diameter by 80” in length?

A. 2400 gallons
B. 1041 gallons
C. 600 gallons
D. 244 gallons

63. Which of the following is the decimal equivalent of 5/8”?

A. .625
B. .580
C. .400
D. .375
64. What is the total fall of a drain line with a run of 65’ and aq ¼” per foot of grade?
   A. 14 ¼”
   B. 16 ¼”
   C. 18 ¼”
   D. 26”

65. The weight of 47 gallons of water is ____________:
   A. 108.5 pounds
   B. 203 pounds
   C. 376 pounds
   D. 391.5 pounds
ANSWER KEY

1. B
2. B
3. D
4. C
5. C
6. B
7. C
8. A
9. C
10. C
11. A
12. B
13. B
14. C
15. C
16. B
17. B
18. D
19. C
20. C
21. A
22. D
23. B
24. B
25. D
26. D
27. B
28. B
29. A
30. C
31. C
32. B
33. D
34. B
35. C
36. A
37. C
38. D
39. C
40. D
41. A
42. A
43. B
44. D
45. B
46. D
47. B
48. A
49. D
50. D
51. B
52. A
53. B
54. D
55. C
56. B
57. C
58. D
59. A
60. B
61. C
62. D
63. A
64. B
65. D
Energy Calculations

\[ Q_{\text{Total}} = 4.5 \times \text{CFM} \times \Delta h \]
\[ Q_{\text{Latent}} = 4840 \times \text{CFM} \times \Delta g \]
\[ Q_{\text{Sensible}} = 1.10 \times \text{CFM} \times \Delta T \]

\( Q = \text{BTUH} \)
\( \Delta h = \text{difference in enthalpy} \)
\( \Delta g = \text{difference in grains of moisture} \)
\( \Delta T = \text{difference in temperature} \)

Heat transfer

\( \text{BTUH} = \text{LB} \times \Delta T \times \text{Specific heat (for any substance)} \)
\( \text{BTUH} = \text{CFM} \times \Delta T \times 1.08 \) (for standard air)
\( \text{BTUH} = \text{GPM} \times \Delta T \times 500 \) (for water)

Force exerted by a round diaphragm with a pressure applied and measured in psig

\[ \text{Force} = \text{Area} \times \text{Pressure} \]
\[ = \pi r^2 \times \text{psig} \]

Pressure conversions

1 psi = 2.31 feet of head
1 psi = 27.7 in. w.c.
1 psi = 2.04 in. Hg.
1 atmosphere = 34 feet of head
1 atmosphere = 29.9 in. Hg.
1 atmosphere = 14.7 psi

w.c. = water column
in. Hg. = inches Mercury

Air pressure in ducts

\[ V = 4005 \sqrt{\frac{VP}{V}} \]
\[ VP = \frac{V^2}{4005} \]

Airflow in duct:

\[ Q = A \times V \]
\[ Q = \text{CFM} \]
\( A = \text{Cross sectional area of duct (ft}^2\) \)
\( V = \text{Velocity of air (feet per minute – FPM)} \)
\( VP = \text{inches water gage, “WG}} \]

Mixed air temperature (MAT)

\[ \text{MAT} = \text{OAT} \times \%OA + \text{RA} \times \%RA \]

Percent of outside air

\[ \%OA = \frac{\text{RA} \times \text{MAT} - \text{OAT} \times \text{RA}}{\text{OAT} \times \text{MAT}} \]

MA=Mixed air
OA=Outside air
RA=Return air

Hydronic Pressure (Total Head)

Total Head = Static Head + Friction Head + Velocity Head

Static Head

Static Head = Static Discharge Head - Static Suction Head (calculated distance above pump as positive, distance below pump as negative)

Velocity Head (VH)

\[ \text{VH} = \frac{V^2}{2g} \]
\( g = 32.2 \text{ ft/sec}^2 \) (acceleration due to gravity)
\( V = \text{Velocity of liquid} \)

Total Dynamic Head

\[ \text{TDH} = (\text{DSH} + \text{SSH}) + (\text{DVK} + \text{SVK}) \]
\( \text{TDH} = \text{Total dynamic head} \)
\( \text{DSH} = \text{Discharge static head} \)
\( \text{SSH} = \text{Suction static head} \)
\( \text{DVK} = \text{Discharge velocity head} \)
\( \text{SVK} = \text{Suction velocity head} \)

Flow Coefficient (Cv) rating of valve

\[ \text{Cv} = \frac{Q}{\sqrt{H}} \]

\( Q = \text{flow rate in gpm} \)
\( H = \text{head loss (pressure drop) in PSI} \)

Cv = flow coefficient with valve wide open, equal to gpm of flow at a 1 PSI pressure drop across the valve. Cv decreases as the valve closes.

Temperature conversions

\( ^\circ \text{F (Fahrenheit)} = \frac{^\circ \text{C} \times 9}{5} + 32 \)
\( ^\circ \text{C (Celsius)} = \left( ^\circ \text{F} - 32 \right) \times \frac{5}{9} \)
\( ^\circ \text{R (Rankine)} = ^\circ \text{F} + 460 \)
\( ^\circ \text{K (kelvin)} = ^\circ \text{C} + 273 \)

Ohm’s Law

Volts = Amps x Ohms
or
\( E = I \times R \)

Watt’s Law

Watts = Volts x Amps
or
\( P = E \times I \)

Energy formula

\( W = P \times t \)

Formula Circle for Ohm’s and Watt’s Laws

\[ E = \text{voltage} \]
\( I = \text{current (amps)} \)
\( P = \text{power (watts)} \)
\( R = \text{resistance (ohms)} \)
\( W = \text{energy (kWh, or kilowatt-hour)} \)
\( t = \text{time (hours)} \)

Sum of resistance

Series circuits
\[ R_s = R_1 + R_2 + R_3 \]

Parallel circuits
\[ R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \]

Sum of capacitance (C)

Series circuits
\[ C_s = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} \]

Parallel circuits
\[ C_p = C_1 + C_2 + C_3 \]
Power factor calculations

Power Factor = \frac{\text{true power (kW)}}{\text{apparent power (kVA)}} = \cos \theta

\theta = \cos^{-1} \left( \frac{kVA\text{ (power apparent)}}{kW\text{ (power true)}} \right)

\text{Percent of motor load}

\% load = \frac{MA - 0.5NPA}{0.5NPA} \times \frac{MV}{MPV}

MA = \text{Measured amps}

NPA = \text{Nameplate amps}

MV = \text{Measured volts}

MPV = \text{Nameplate volts}

Transformer voltage/winding calculation

\text{E}_k = \frac{N_s}{N_p} \times \text{E}_p

\text{E}_k = \text{secondary voltage}

\text{E}_p = \text{primary voltage}

N_s = \text{number of secondary turns}

N_p = \text{number of primary turns}

Brake horsepower of a fan

BHP = \frac{\text{NPHP} \times MA \times MV}{NPA \times MPV} \times \text{LF}

NPHP = \text{Nameplate horsepower}

MA = \text{Measured amps}

NPA = \text{Nameplate amps (FLA)}

MV = \text{Measured volts}

NPV = \text{Nameplate volts}

LF = \text{Load factor (by table)}

Brake horsepower of a pump

BHP = \frac{\text{GPM} \times \text{TDH}}{3960 \times \text{Eff}} \times \text{specific gravity}

\text{Eff} = \text{Pump efficiency}

kW = \text{real input power}

Speed Calculation

Calculate new sheave diameter, changing motor sheave

\text{Dia}_{\text{new}} = \frac{\text{Dia}_{\text{old}} \times \text{RPM}_{\text{new}}}{\text{RPM}_{\text{old}}}

Calculate new sheave diameter, changing fan or pump sheave

\text{Dia}_{\text{new}} = \frac{\text{Dia}_{\text{old}} \times \text{RPM}_{\text{new}}}{\text{RPM}_{\text{old}}}

\text{R} = \frac{\text{Absolute discharge pressure}}{\text{Absolute suction pressure}}

Calculate new sheave diameter, changing motor sheave

\text{Dia}_{\text{new}} = \frac{\text{Dia}_{\text{old}} \times \text{RPM}_{\text{new}}}{\text{RPM}_{\text{old}}}

\text{Compression ratio (R)}

R = \frac{\text{Absolute discharge pressure}}{\text{Absolute suction pressure}}

\text{Boyle's Law and Charles' Law}

T_1 p_1 = T_2 p_2 \quad (\text{Charles' Law with constant volume})

T_1 V_1 = T_2 V_2 \quad (\text{Boyle's Law with constant pressure})

p V = m R T \quad (\text{Gas constant of the particular gas (foot-pounds per pound per degree Rankine)})

\text{General Gas Law}

pV = mRT

\text{Air} \quad 53.5 \quad \text{Hydrogen} \quad 765.9

\text{Ammonia} \quad 90.5 \quad \text{Nitrogen} \quad 55.1

\text{Carbon dioxide} \quad 35.1 \quad \text{Oxygen} \quad 48.3

\text{Carbon monoxide} \quad 55.1 \quad \text{Sulfur dioxide} \quad 24.1