A GUIDE TO PASSING THE PLUMBING EXAM
BASED ON THE INTERNATIONAL PLUMBING AND FUEL GAS CODES

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REVISED 2014

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ABOUT THIS GUIDE

This guide has been designed as an aid for students preparing to take the Plumbing Exam based on the *International Plumbing and Fuel Gas Codes*, hereinafter referred to as the “IPC” or “IFGC” in this guide. It is not intended to replace any code books, manuals, or material required for study.

Preparing a study guide for the IPC is a challenging event, as many states and jurisdictions that have adopted the IPC have added their own amendments. For example, the IPC states the building drain ends 30 inches outside the foundation wall. Some states, however, have amended this to 5 or 10 feet.

Some tables in this guide have had footnotes added. In some instances, entire sections have been added or deleted. Therefore, our section numbers may not correspond to those in your state’s IPC; however, they should be close. **If any information in this guide disagrees with your state’s IPC, then accept your code as the final authority.**

The student must obtain the following reference material in order to use this guide:
- International (or your state) Plumbing Code
- International (or your state) Fuel Gas Code*

*Note: If the plumbing license you plan to obtain does not allow for gas piping or gas appliance installation, you will not need the Fuel Gas Code and you may skip the Fuel Gas section of this guide.*
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Introduction

International Plumbing Exam Prep Course

No course or standard classroom course is able to read the IPC for you. It is important that you read through the IPC to at least become familiar with its content. You are not expected to commit every word to memory. That is why the exam is open book. You don’t have to remember that horizontally installed PVC pipe must be supported every four feet, but you should at the very least know there is a code requirement and approximately where to find it in the book.

As you read through each code chapter of the IPC, refer to the corresponding chapter in this guide. If you should have difficulty understanding a code section of the IPC, there is a good chance this guide has a good explanation for you.

This guide includes an appendix that contains 150 questions. Answering these questions will give you a clear and comprehensive grasp of the IPC.

An extensive effort has been made to present accurate information in this third edition. Should you have questions or comments please feel free to contact us by email at jrwmto@gotricounty.com

**Highlighting**

Highlighting is a useful aid for finding and identifying important items throughout the IPC. Too much highlighting, however, will negate all your efforts. The trick is to highlight the least number of words and still catch the main idea. For example, look at Section 2 of Chapter 3. The entire section discusses tests and inspections. Section 312.1 mentions required tests. It should be obvious that plumbing must be tested. What’s important is the sentence in the middle of the paragraph: “All plumbing system piping must be tested with either water or air.” This is the only sentence that should be highlighted in the paragraph.

312.1.1 Test gauges. Gauges used for testing shall be as follows:

1) Tests requiring pressures of 10 pounds per square inch (PSI) or less shall utilize a testing gauge having increments of 0.01 PSI or less.

2) Test requiring a pressure greater than 10 PSI but less than or equal to 100 PSI shall utilize a testing gauge having increments of 1 PSI or less.
3) Tests requiring a pressure \textcolor{red}{\textbf{greater than 100 PSI}} shall utilize a testing gauge having increments of \textcolor{red}{\textbf{2 PSI}} or less.

The following paragraph is Section 312.2 of the IPC and titled “Drainage and vent water test.” What’s important in this paragraph? First, it’s talking about drainage and vent water testing (not water supply piping or air testing). So highlight \textcolor{red}{\textbf{Drainage and vent water test}}. The center of the paragraph explains the pressure needed. Highlight \textcolor{red}{\textbf{10-foot}}. The end of the paragraph explains how long. Highlight \textcolor{red}{\textbf{15 minutes}}. Get the idea? If you were to highlight the entire paragraph or sentence the important details would not stand out.
Section 101

This Chapter is brief and easy to understand. Read and highlight the Scope and Intent or Purpose.
Many of the answers to questions on the Plumbing Exam will come from this chapter. The following is an example of such a question.

Question: A room containing a water closet, lavatory and bathtub is a _______.
   a. bath room
   b. toilet room
   c. toilet
   d. all of the above

Answer: After reading through the three definitions, you should recognize “a” as the correct answer.

You should read and understand all the definitions. Below are the definitions that people tend to misunderstand the most.

**Air admittance valve**

Same as a studor vent. A vent that allows air to enter the vent pipe only in the direction toward the sewer.

**Air break**

Air space is below the flood level rim
**Air gap (water system)**

![Diagram of air gap (water system)](image)

Air gap (drainage) air space is above flood level of receptacle

**Base flood elevation** = 100 year flood level

**Building drain**

Extends 30 inches beyond building wall (Note: some states have amended this distance to as much as 10 feet, check the definition in your code book)

Building sewer-pipe between building drain and street

![Diagram of building drain and sewer](image)

IPC states building drain extends 30” beyond foundation walls. Some states have extended this distance to up to 10 feet. Check your code book.
Circuit vent
A vent connected to a horizontal drainage branch that serves at least two traps (max eight). Connects to the horizontal branch drain just before (downstream), the last fixture trap.

**Circuit Vent**

Combination fixture
A single fixture comprised of two or more fixtures, such as a three compartment sink.

Developed length of vents
There are two definitions of developed length for vents:
- The developed length of a stack vent or vent stack is measured from the vent connection at the drain to the open air.
- The developed length of other vents (ie. individual vent) is the measured length from its point of connection to the drainage system to its point of connection to a venting stack or outside termination. (The developed length of the circuit vent above is the distance measured from the point of connection at the horizontal drain to the point of connection to the main vent.)

Fixture branch
Drain must have at least two fixtures to be called a branch.

Grease interceptor
Handles more than 50GPM, outside of building (2006 code)

Grease trap
Handles less than 50 GPM (2006 code). Note: 2009 IPC has done away with the term grease trap. All grease receptacles are referred to as grease interceptors.
**Horizontal pipe**

Less than 45 degrees off the horizon. Go to **vertical pipe** definition now.

**Hot water**

Water that is 110 degrees or greater. Note: Water with a temperature greater than 140 degrees must discharge into an indirect waste receptor before entering the drainage system. (803.1).

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**Indirect waste receptor**

May be floor sink, mop receptor, service sink and standpipe with air gap.

**Lead-free pipe and fittings**

Contains 8% or less lead.

**Lead-free solder and flux.**

Contains .2% or less lead. (Notice the .)

**Plumbing appurtenance**

An item that does not consume water. Plumbing appurtenances include instruments, gauges, relief valves, limit switches, backflow assemblies, solenoid valves, and devices between solenoid valves.

**Plumbing fixture**

An item that consumes water. Examples include sinks, tubs, and water closets.

**Plumbing system**

According to IPC includes the storm sewer.

**Sanitary sewer**

Carries sewage, not storm water.
Slope

A pipe with a 1/4-inch per foot slope is also described as “having 4 units vertical and 12 units horizontal.” A 1/4-inch per foot drop produces a drop of one inch for each 4-foot length, likewise, and 1/8-inch drop produces a drop of one inch for each 8-foot length of pipe. **To determine the drop of a pipe in inches, divide the length (feet) by the lower number of the slope.**

Example: A 75 ft. pipe requiring a ¼-inch slope would have a drop of 18.75 inches (75/4 = 18.75).

Stack vent

A vent attached to a soil (main) stack.

![Typical residential drain and vent system](image-url)
Swimming pool
   A construction that must have at least a 2-foot depth.

Tempered water
   Water that is 85-110 degrees.

Vent stack
   A separate stack that serves as only a vent for a drain pipe. A vent stack is always dry. See illustration above.

Vertical pipe
   A pipe that is 45 degrees or greater.
   Is a pipe that makes an angle of 45 degrees with the horizontal a vertical or horizontal pipe? Answer: vertical (carefully read definition of both).

Water pipe (types)
   Riser Pipes that extend upward one story or greater.
   Water distribution pipe-piping inside of a building.
   Water service pipe-Water pipe that is located outside of a building (see Section 605.3 to determine the point of termination).
Yoke vent

See illustrations below and Sections 914 and 915 (if available in your IPC book).

SECTION 914

main vent stack

Only place an inverted wye is allowed.

Must be connected at least 3 ft. above floor

10th branch interval from top floor

Yoke vent—used as relief vent (must be same size as vent)
SECTION 915

Yoke vent. Located between offset and next lower horizontal branch

Offset with five or more branch intervals above

main vent stack

drainage stack
Plumbing math and other interesting stuff

Quarter bend, eighth bend, sixteenth bend

How many eighth bends are needed to make a 45 degree turn?  
Answer: 1

How many sixteenth bends are required to make a 45 degree turn?  
Answer: 2 (45 degrees/ 22.5 degrees = 2)

Facts about water:
- Boils at 212 degrees F or 100 degrees C
- Freezes at 32 degrees F or 0 degrees C
- It takes 1 btu to raise the temperature of 1 lb of water 1 degree F  
  \[(\text{btu} = 1 \times \text{lbs} \times \text{temp. rise})\]
- Weighs 8.33 lbs/gal. or 64 lbs per cubic ft.
- Exerts a pressure of .433 lbs / ft. of elevation

How many btu's are required to raise 40 gals of water 60 degrees F?  
Answer: Use formula,  \[\text{btu} = 1 \times \text{lbs} \times \text{temp rise}\]  
First, convert 40 gals. to lbs. \(40 \times 8.33 = 333.2 \text{ lbs.}\)  
Second, apply formula  
\[1 \times 333.2 \times 60 = 19,992 \text{ btu's}\]

How many psi are required to raise a column of water 30 ft.  
Answer: 30 x .433 = 12.99 psi
If the water pressure entering a home is 45 psi, what would be the pressure at a third floor fixture located 27 ft above the entrance point.

Answer: First, determine the pressure required to elevate the water 27 feet

\[ 27 \times 0.433 = 11.69 \text{ psi pressure loss} \]

Second, subtract the *pressure loss* from the entering pressure.

\[ 45 - 11.69 = \textbf{33.31 psi} \text{ remains for the third floor fixtures} \]

**Calculating the volume of vessels and pipes**

Many times you may need to know the amount of water (gallons) a vessel will hold or the weight of a filled vessel or pipe to determine the amount of support needed.

<table>
<thead>
<tr>
<th>Volume = length x width x height</th>
</tr>
</thead>
<tbody>
<tr>
<td>= ( 62\text{&quot;} \times 24\text{&quot;} \times 36\text{&quot;} )</td>
</tr>
<tr>
<td>= 53,568 cubic inches</td>
</tr>
</tbody>
</table>

Convert to cubic feet

\[ 1 \text{ cubic foot} = 1728 \text{ cubic inches} \]

\[ \frac{53,568}{1728} = 31 \text{ cubic feet} \]

<table>
<thead>
<tr>
<th>Volume = area x height</th>
</tr>
</thead>
<tbody>
<tr>
<td>First, calculate area of circle</td>
</tr>
<tr>
<td>Area of circle = ( \pi R^2 )</td>
</tr>
<tr>
<td>( \pi = 3.14, \quad R = 0.5 \times \text{diameter} )</td>
</tr>
<tr>
<td>= 0.5 \times 36&quot;</td>
</tr>
<tr>
<td>= 18&quot;</td>
</tr>
<tr>
<td>Area = 3.14 \times (18&quot; \times 18&quot;)</td>
</tr>
<tr>
<td>= 3.14 \times 324</td>
</tr>
<tr>
<td>= 1017 \text{ sq. inches}</td>
</tr>
</tbody>
</table>

Volume

\[ 1017 \times 12 = \textbf{12,204 cubic inches} \]

Convert to cubic ft .

\[ \frac{12,204}{1728} = 7.06 \text{ cu.ft.} \]

*1 cubic ft. = 1728 cubic in. (12 x 12 x12)*

Convert to weight

\[ 7.06 \text{ cu ft} \times 64 = 451.8 \text{ lbs} \]

Convert to gallons

\[ \frac{451.8}{8.33} = 54.2 \text{ gals} \]
Pipe

40' x 4"
riser

Calculate the volume of a pipe just like that of a cylinder above.

Volume = area x length

If the pipe is 4” diameter x 40 ft. long

First, calculate area of circle (pipe opening)

Area of circle = \( \pi R^2 \)

\[ = 3.14 \times (2 \times 2) \]
\[ = 3.14 \times 4 \]
\[ = 12.56 \text{ sq. in.} \]

Second, calculate the volume

Volume = area x length

\[ = 12.56 \text{ sq. in.} \times 480 \text{ in*} \]
\[ = 6028.8 \text{ cubic inches} \]

* 40 ft must to be converted to inches (40 x 12)

The pipe will hold 3.49 cubic feet of water

6028.8 cu. ft./1728 cu. in. = 3.49

The weight of the water will be 223 lbs.

3.49 cu. ft. x 64 lbs = 223

Calculate length of a 45 degree offset pipe =

**Run or rise X 1.414 – 2 X fitting allowance**

Assume a fitting allowance of 1.5 inches
(obtained from manufacturers specs)

40” X 1.414 – (2 x 1.5”)
56.56” - 3”
53.56”
### STANDARD SYMBOLS FOR PLUMBING, PIPING, AND VALVES

<table>
<thead>
<tr>
<th>Plumbing</th>
<th>Plumbing (continued)</th>
<th>Pipe Fittings (continued)</th>
</tr>
</thead>
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<tr>
<td>Corner Bathhtub</td>
<td>Drinking Fountain (Projecting-Type)</td>
<td>Elbow—Long Radius</td>
</tr>
<tr>
<td>Recessed Bathhtub</td>
<td>Hot Water Tank</td>
<td>Side Outlet Elbow—Outlet Down</td>
</tr>
<tr>
<td>Sitz Bath</td>
<td>Water Heater</td>
<td>Side Outlet Elbow—Outlet Up</td>
</tr>
<tr>
<td>Bidet</td>
<td>Meter</td>
<td>Base Elbow</td>
</tr>
<tr>
<td>Shower Stall</td>
<td>Hose Rack</td>
<td>Double Branch Elbow</td>
</tr>
<tr>
<td>Shower Head</td>
<td>Hose Bibb.</td>
<td>Single Sweep Tee</td>
</tr>
<tr>
<td>Overhead Gang Shower</td>
<td>Gas Outlet</td>
<td>Double Sweep Tee</td>
</tr>
<tr>
<td>Pedestal Lavatory</td>
<td>Vacuum Outlet</td>
<td>Reducing Elbow</td>
</tr>
<tr>
<td>Wall Lavatory</td>
<td>Drain</td>
<td>Tee</td>
</tr>
<tr>
<td>Corner Lavatory</td>
<td>Grease Separator</td>
<td>Tee—Outlet Up</td>
</tr>
<tr>
<td>Handicapped Lavatory</td>
<td>Oil Separator</td>
<td>Tee—Outlet Down</td>
</tr>
<tr>
<td>Dental Lavatory</td>
<td>Cleanout</td>
<td>Side Outlet Tee—Outlet Up</td>
</tr>
<tr>
<td>Standard Kitchen Sink</td>
<td>Garage Drain</td>
<td>Side Outlet Tee—Outlet Down</td>
</tr>
<tr>
<td>Kitchen Sink, R &amp; L Drain Board</td>
<td>Floor Drain with Backwater Valve</td>
<td>Cross</td>
</tr>
<tr>
<td>Kitchen Sink, L H Drain Board</td>
<td>Roof Sump</td>
<td>Concentric Reducer</td>
</tr>
<tr>
<td>Combination Sink &amp; Dishwasher</td>
<td></td>
<td>Eccentric Reducer</td>
</tr>
<tr>
<td>Combination Sink &amp; Laundry Tray</td>
<td></td>
<td>Lateral</td>
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<td>Service Sink</td>
<td></td>
<td>Expansion Joint</td>
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<td>Laundry Tray (Single)</td>
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<tr>
<td>Laundry Tray (Double)</td>
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<td>Water Closet (Tank-Type)</td>
<td>Hot Water</td>
<td></td>
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<tr>
<td>Water Closet (Integral Tank)</td>
<td>Hot Water Return</td>
<td></td>
</tr>
<tr>
<td>Water Closet (Flush Valve, Floor Outlet)</td>
<td>Fire Line</td>
<td></td>
</tr>
<tr>
<td>Water Closet (Flush Valve, Well-Hung)</td>
<td>Gas Line</td>
<td></td>
</tr>
<tr>
<td>Urinal (Wall-Hung)</td>
<td>Acid Waste</td>
<td></td>
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<tr>
<td>Urinal (Stall)</td>
<td>Drinking Water Supply</td>
<td></td>
</tr>
<tr>
<td>Urinal (Trough-Type)</td>
<td>Drinking Water Return</td>
<td></td>
</tr>
<tr>
<td>Drinking Fountain (Recessed)</td>
<td>Vacuum Cleaning</td>
<td></td>
</tr>
<tr>
<td>Drinking Fountain (Semi-Recessed)</td>
<td>Compressed Air</td>
<td></td>
</tr>
</tbody>
</table>

#### Piping

- Fire Line
- Gas Line
- Acid Waste
- Drinking Water Supply
- Drinking Water Return
- Vacuum Cleaning
- Compressed Air

#### Fittings

- Joint
- Elbow—90°
- Elbow—45°
- Elbow—Turned Up
- Elbow—Turned Down
- Motor-Operated Gate Valve
- Gate Valve
- Globe Valve
- Angle Globe Valve
- Angle Gate Valve
- Check Valve
- Angle Check Valve
- Stop Cock
- Safety Valve
- Quick-Opening Valve
- Float Valve
- Motor-Operated Gate Valve
Common Plumbing Symbols

Note the difference in lines representing cold water, hot water, sanitary drains and vent pipe. Also note the symbols for a pipe turning up and down.
Chapter 3
General Regulations

Section 303
Plumbing products and materials must be tested or certified by a third party agency before being used.

Tested means a third party does a one-time testing (for example, UL makes a one-time test of the product and publishes the results. No follow-up test or inspection is required.)

Certified means the third party will test the product, then follow up with unannounced random tests or inspections.

When using Table 303.4, it is important to understand which category the product falls under. For example, a lavatory faucet would be a water fixture fitting, as defined in Chapter 2. Therefore, third party certification is required.

Section 307 Cutting, notching, or bored holes
A 2 x 10 floor joist has an actual depth of 9-1/2 inches. According to the IPC, the largest hole that can be cut is 1/3 times the joist depth. Decimally 1/3 = .33 and 9-1/2 inches is 9.5 inches; therefore, .33 X 9.5 = 3.135 inches. The largest hole may be 3.135 inches in diameter.

How to Convert a Fraction to a Decimal Equivalent Using Your Calculator
Divide the top number by the bottom number. To get the decimal equivalent of 1/3 enter 1 divided by 3 = .33. Likewise, for 1/6, enter 1 divided by 6 = .166, or for 2/3, enter 2 divided by 3 = .66

A 2" X 8" ceiling joist may be notched 1/6th it’s depth. What is the maximum size notch that can be cut if the actual joist depth is 7-1/2 inches? .166 is the decimal equivalent of 1/6 (1 divided by 6 = .166) and 7.5 is the decimal equivalent of 7-1/2 (7 + 1 divided by 2), which is 7 + .5.
Therefore, \(0.166 \times 7.5 = 1.245\) inches (the largest allowable notch) is 40% of the width of 40% of the width of a single load bearing stud may be bored and 60% of a non-bearing stud or doubled up stud may be bored. Therefore, the largest hole that may be bored in a single load bearing 2\” X 4\” (3-1/2\” actual) stud would be 1.4 inches (.40 \times 3.5 = 1.4).

To convert percent to a decimal equivalent, drop the % sign and move the decimal to the left two places.

\[
30\% = .30, \ 7\% = .07, \ 150\% = 1.50
\]

According to Table 308.5, what is the maximum horizontal spacing of hangers for 10 foot lengths of cast iron pipes?

Answer: 10 feet. Refer to footnote a.

Under a floor joist, PEX must be supported every 32 inches.

Section 312.1 states that plastic water supply pipe cannot be pressure-tested with air; however, all piping materials may be pressure-tested with water. Section 312.3 does not disallow plastic drainage pipe from being tested by 5 PSI air. Therefore, plastic drainage pipe may be tested by air.
Chapter 4
Fixtures, Faucets, and Fixture Fittings

Section 403
The minimum number of plumbing facilities required in various occupancies.
The following is an example for calculating the minimum facilities required in a 350-seat restaurant with 10 employees. The building measures 60 feet X 100 feet.

Look at Table 403.1 in the IPC. Find No. 1, A-2 Restaurants. Look first at sections 403.2, 403.5 and 403.6 as noted in the Classification column. When using any table, be sure to read all applicable footnotes.

Section 403.2
We must provide separate facilities for each sex if the minimum occupancy is greater than a certain number. Since 350 quests will be occupying this building, we must provide separate facilities for each sex.

Section 403.5
If an employee is any farther than 500 feet from a restroom then we need to build him another one. Our restaurant measures 60' x 100', so it is impossible for an employee to be farther than 500 feet from the restroom. Therefore, the employees may use the public facilities. However, we must add the number of employees to the number of guests. Also, note the restrooms may be located one story above or below the occupied story, but no higher or lower.

Section 403.6 states that public facilities shall be provided and that the public shall not have to travel more than 500 feet and more than one story up or down.

Calculating number of water closets
1) Determine the number of occupants.
   350 guests + 10 employees = 360 people
2) Determine number of males and females.
   403.3 states that you should assume 50% for each sex unless statistical data indicate otherwise. For the example we would have the following:
   360 people X .50 = 180 males
   360 people X .50 = 180 females

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3) Go to Table 403.1, Restaurants. Under the Water Closets column there is one WC for every 75 males and one WC for every 75 females. Since we have 180 males and 180 females we divide each by 75 to get the number of WC’s required for each sex. 180 males / 75 = 2.4 (3 water closets are required)* 180 females / 75 = 2.4 (3 water closets are required).

Section 419.2

Urinals shall not be substituted for more than 67% of the required water closets. In other words, two-thirds of the water closets may be substituted for with urinals. Therefore, the men’s room may have 1 water closet and 2 urinals. (3 x .67 = 2.01 urinals, rounded down to 2. If the math came out to 1.9 urinals, then only one urinal could be substituted because you must round down)

Calculating number of lavatories

Under the Lavatories column it shows 1 per 200 of each sex. 180 male / 200 = .9 (rounded up = 1 lavatory), 180 females / 200 = .9 (rounded up = 1 lavatory). Note- lavatories must be in the same room as the water closet (some codes have exceptions for daycare or K-5 classes, see section 405.3.2)

Calculating number of drinking fountains

Under the Drinking Fountain column we use the total number of occupants (360). 360 / 500 = .72 (rounded up = 1 drinking fountain. Because this is a restaurant serving water, a water fountain is optional. See the note below.

Important Notes

• Drinking fountains are not allowed in toilet rooms.
• If the restaurant serves water, a drinking fountain is not required. (This exception only applies to restaurants. Refer to Section 410.1.)
• Bottled water dispensers may be substituted for not more than 50% of the required water fountains.
• IPC states that code enforcement official may approve bottled water or faucet water if there are less than 10 employees. Some states do not require water fountains in restaurants, nightclubs or bars, see Section 410

Service sinks

Under the other column, one service sink is required. Some states allow a can wash or mop sink as a substitute. Read all footnotes.
Section 405, Installation of fixtures

Expect a question from this section, especially Section 405.3.1.

Sections 406-428

These sections discuss the requirements for the installation of various fixtures. If you have a question about food grinders, can washes, showers, etc. it will likely be answered by these pages.

Section 406.3 Waste connection of washing machine

*Note:* Clothes washer waste may be conveyed through a 2" **trap and fixture drain.** However, the **branch drain** or **stack** the fixture connects to, must be minimum 3". *(see definition of horizontal branch drain or fixture branch).*

**International Accessibility Code**

The accessibility code is relatively cut and dry. Almost all answers to questions dealing with handicap or disability issues will be found in Chapters 1, 11, 12, 13, 18, 28, 30, or 39.

Chapter 1 lists all the occupancy groups required to be made usable by persons with disabilities. The other chapters deal with specifics. Do not forget to use the index, as it is very detailed.

Generally, all public toilets and toilets installed in commercial buildings must be made handicap accessible. The one exception is a private toilet room in a private office, which must be made to be adaptable to be accessible. Below are the highlights of the Accessibility Code:

- Each occupancy must have at least one assessable toilet.
- The turnaround area must be at least 60 inches in diameter. If the toe space under cabinets and fixtures is at least 8 ¾ inches high, then a maximum of 6 inches for each side may be used toward this requirement.
- The water closet must be 16 ½ - 19 1/2 inches high, extend a maximum of 18 inches away from one side wall and a minimum of 18 inches from center of water closet to side wall, and flush handle to be on widest side no more than 44 inches off the floor.
• The lavatory must extend a minimum of 17 inches from the wall, extend 34-36 inches off the floor, and offer a 29-inch knee clearance beneath.

• Grab bars must be 33-36 inches above the floor. In a stall, the bars must be on both side walls unless one sidewall is located greater than 18 inches from the edge of the water closet. Then, a rear bar must also be installed. The side bar must be at least 42 inches long and begin within 12 inches from the back wall. The rear bar must be at least 36 inches long and begin within 6 inches of the side wall.

• Urinals - The lip must be a maximum of 17 inches off the floor and extend a minimum of 14 inches from the rear wall.

• Drinking fountains - If drinking fountains are required, 50% of them must have spouts no more than 36 inches from the floor. If only one fountain is required, then both a high and low or a single combination hi/low fountain must be installed. If an odd number of fountains are required, round down the number and divide by 2 to determine the number of low fountains needed (5 fountains required, round down to 4, divide by 2 = 2 low fountains).

• Handicap stall dimensions:
  o Type I - Door swings inward- 60 inches wide, 59 inches deep (56 inches if wall hung WC is used).
  o Type II - Door swings inward- 60 inches wide, 95 inches deep (92 inches if wall hung WC is used).
  o All doors must be 32 inches wide.
  o If six or more WC stalls are provided, then an additional stall measuring at least 42 inches wide, 66 inches deep (69 inches deep with floor mounted WC) must be provided.

•
This chapter is very self-explanatory. Note that both the Gas and Mechanical Codes state that a water heater cannot be used for space heating unless listed for such use.

The maximum temperature setting of a domestic water heater is 140 degrees, unless a master tempering valve is installed. Some states have laws stating that the maximum allowable temperature setting is 120 degrees when installed. **The occupant, however, may re-set or request to have re-set the thermostat to a higher temperature.**

Section 502.2 states that water heaters installed in garages must have the ignition source elevated 18 inches above the floor. This rule does not apply to water heaters that are resistant to flammable vapor ignition (FVIR). Today, all new gas water heaters meet this standard. Most electric and oil water heaters must have the ignition source elevated 18 inches (the bottom thermostat on an electric water heater arcs when energized; therefore it is an ignition source.)
Section 603.2 Separation of water service and building drain/sewer

This section explains that the buried water line and sewer line cannot be closer than five feet to each other, either horizontally or vertically. However, if the sewer is made of ABS, PVC, or cast iron material listed in either Table 702.2 or 702.3, you may place the waterline closer than five feet, but keep the water line at least 12 inches above the sewer pipe.

Section 604 Design of water distribution system

GPM (gallons per minute) – fixtures require a certain amount of water to work properly.

PSI (pounds per square inch) – fixtures require a certain pressure to work properly.

Design criteria for installing a plumbing fixture:

Using a water closet, tank, close coupled (standard tank type water closet) as our example, look at Table 604.3. The chart says it takes 3 gallons per minute @ 8 pounds per square inch pressure in order to work. Table 604.4 says the water closet better not use more than 1.6 gallons per flush no matter what the GPM or PSI is. Table 604.5 says, in order to assure the water closet will get 3 GPM @ 20 PSI (2006 IPC states 8 PSI) that a 3/8" supply pipe must feed it.
Table 604.10.1 says, if you were to install a manifold capable of handling 15 GPM at a velocity of 4 feet per sec., then the manifold would have to be 1-1/4 inch.

![Manifold](image)

Note: Read footnote “a” located below Table 604.5, as some fixtures may qualify for smaller piping than indicated in the Table. For example, a 40-foot run from a central manifold to a kitchen sink may be served by a 3/8-inch pipe in lieu of a 1/2-inch pipe if the water pressure is greater than 35 PSI.

Section 606.5.4-606.7 Overflow pipes and drain pipes for water tanks

Table 606.5.4 says determine the capacity of the pipe that is supplying the water to the tank (tank size is irrelevant). If our tank is being supplied at a rate of 350 GPM, the overflow pipe must be 4 inches.

The tank must have a drain. The minimum drain pipe size is determined using Table 606.5.7. If the tank were 4000 gallons, a 2-1/2-inch drain pipe would be required.
Table 608.15.1 Minimum required air gaps

See Air gap (water system) in Chapter 2 (Definitions) of this guide for an illustration. This table specifies the minimum air gap requirement between the fixture rim and the water supply outlet. Read the footnote that describes the difference between away from a wall and close to a wall. To help visualize the difference, suppose we had a 1-1/2-inch diameter whirlpool spout protruding from a wall. If the inside edge of the spout opening is 4 inches away from the wall, it would be close to a wall because 4 inches is less than three times the spout diameter (1-1/2 inches x 3 = 4-1/2 inches). The air gap would also have to be 4-1/2 inches (3 x 1-1/2), as we would use the last row in the table, Effective opening greater than 1inch.

Appendix E Sizing a water distribution system

The method used to size a water distribution system in Appendix E is only one example of many approved engineering practices used to size piping. Section E 101.1.2 states that alternative engineering practices are acceptable. If you try to read and follow along the segmented loss method example presented in Appendix E, you may become frustrated and confused. The following discussion will give you the basic principles for sizing water pipes. Understanding these principles should allow you to answer any test questions regarding pipe sizing.
Understanding Friction Charts

The length of a pipe is not the length of a pipe.

A pipe has two lengths: (1) a **developed length**, which is the actual measured length and (2) an **effective length**, which is caused by the addition of fittings and valves.

Table E103 lists the **equivalent lengths** of various fittings and valves. A 3/4-inch, 90-degree elbow has an equivalent length of 2.5 feet. If seven elbows were used in 130 feet of developed length of pipe, we would have to add 17.50 feet (7 x 2.5) to the pipe to determine its total effective length. The **total effective length (TEL)** would therefore be 147.5 feet (130 +17.5).
If the street pressure is 45 PSI, and you were to run a pipe with a total effective length of 100 feet, to a fixture requiring 12 gallons per minute @ 10 PSI, what size would the pipe have to be if the total pressure losses through a meter, backflow preventer, valves, tees and elbows equal 25 PSI.

First, we must determine the pressure left to push the water down the pipe. This is called the available pressure or allowable pressure drop.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street pressure</td>
<td>+45 PSI</td>
</tr>
<tr>
<td>Pressure losses through meter, bfp, valves,</td>
<td>-25 PSI</td>
</tr>
<tr>
<td>tees, and elbows</td>
<td></td>
</tr>
<tr>
<td>Pressure needed to operate fixture</td>
<td>-10 PSI</td>
</tr>
<tr>
<td><strong>Pressure left to size pipe (allowable pressure</strong></td>
<td><strong>10 PSI</strong></td>
</tr>
<tr>
<td>drop)**</td>
<td></td>
</tr>
</tbody>
</table>

Second, go to Figure E103, located in Appendix E, *Friction Loss in Smooth Pipe (type I in some codes)*. Place a dot at the intersection of 12 gallons per minute and 10 PSI pressure drop (Point A). It falls between a 3/4 inch and 1 inch (diagonal lines). If you were to install a 3/4-inch pipe, the GPM would be at 10 (Point B), therefore, the fixture would starve for water. A 1-inch pipe, however, will have the capability to deliver up to 20 GPM (Point C) before suffering a pressure loss below 10 PSI. A 1-inch pipe would be the correct choice.

Go back to point B. At this point, a 3/4-inch pipe will deliver 10 GPM @ 10 PSI. However, if we were to increase the pressure to 20 PSI without changing the pipe size, the new intersection will be at point D. If you draw a horizontal line to the left, it would indicate 17 GPM will flow through the pipe @ 20 PSI. However, the velocity would be somewhat high at 10 GPM.

Finding the allowable pressure drop for pipe measuring other than 100 linear feet (TEL)

Notice at the bottom of the chart: PRESSURE DROP PER 100 FEET OF TUBE. The above illustration for using a friction chart is correct only if the pipe is exactly 100 feet in total effective length. If the pipe is any other length, which is almost always the case, the pressure drop must be adjusted. To determine the adjusted-pressure drop of the above pipe (assume 147.5 feet to be the TEL) we would use the following formula:

\[
\text{Adjusted pressure drop} = \frac{\text{Available pressure drop} \times 100}{\text{Total effective length}}
\]

\[
= \frac{10 \text{ PSI} \times 100}{147.5 \text{ ft.}} = 6.78 \text{ PSI}
\]

The pipe must not allow a pressure drop greater than 6.78 PSI/100 feet
Now that we know the adjusted pressure drop (6.78 PSI) and the required flow rate (12 GPM), we can return to the friction chart and select the correct pipe size that in this example happens to remain 1 inch (Point E).

**Velocity**

Always check the **velocity** (feet per second, FPS) using the opposite diagonal lines on the friction chart. In this example the velocity is about 6 feet per second (8 FPS is max, 5 FPS is recommended). High velocities cause noise and pipe erosion. If the velocity is too high, you must select a larger pipe size by moving directly to the left, along the GPM line until an acceptable velocity is obtained.

**Practice question**

If you wish to obtain 12 GPM through a 450 foot (TEL) pipe at an available pressure of 10 PSI, what is the adjusted pressure drop and what size pipe would you select?

**Answer:**

\[
\frac{10 \text{ PSI} \times 100}{450} = 2.22 \text{ PSI adjusted pressure drop}
\]

12 GPM @ 2.22 PSI pressure drop shows 1 1/4-inch pipe should be selected (point F). Check velocity (less than 5 feet per second is OK)

**Let’s throw a few more things into a piping system**

Below is a diagram of a commercial dishwasher installation.
In the above illustration, we have a number of items that contribute to pressure drop, as you will see below. These pressure drops must be subtracted from the street pressure in order to determine the available pressure left for sizing the pipe.

**Minimum pressure required to operate fixtures or appliances.** Table 604.3 lists the minimum pressure and flow rates to operate various fixture and appliances. If the appliance is not listed use the manufacturer’s specs. Since this is a commercial dishwasher we will use the manufacturer’s specification of 10 PSI.

**Developed length or measured length**

This is the actual measure length between the tap at the main and the fixture or appliance. The total **developed length above is 188 feet.**

**Valves and fittings**

When a valve or fitting is added to a system it restricts the flow. The resistance is expressed as **equivalent feet.** If a 90-degree elbow is equal to 2 equivalent feet than a 10-foot pipe with 1 elbow would offer the same resistance as a 12-foot straight pipe (10 ft. developed length +2 ft. equivalent length). In the above illustration we have four 90-degree elbows. Looking at Table E103B, (E103.3(5) in some codes), a 1-1/4-inch, 90-degree elbow is equivalent to 4 feet. Since there are four elbows, we must add 16 feet to the developed length of the pipe. The globe valve adds another 35 feet. When the **equivalent lengths** are added to the **developed length,** we have the **total effective length.** The total **effective length of our pipe is 239 feet (188 + 16 +35=239).**

You may be asking yourself, “How do I know what size valves and fittings to use if I don’t know the pipe size yet?” Answer: You don’t know. You must guess or estimate the final pipe size so you have a fitting size to work with. In the end, you may find you need a 2-inch pipe, then you must redo the procedure to be sure the 2-inch pipe works.

**Taps and tees**

Unlike valves and fittings, the pressure losses caused by taps and tees (off the main) are **expressed in PSI.** Table E103A, (E103.3(4) in some codes), lists these losses. At the main, our pipe is connected with a 1-1/4-inch tap; the required GPM is 20, therefore, the tap offers a pressure loss of .31 PSI.

**Note: Branch tees are expressed in equivalent lengths.** See Table 103B (Table E1 03.3 (5) in some codes).

**Appurtenances**

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Includes meters, backflow preventers, and grease traps. The pressure drop produced by these items is expressed in PSI and can be found in the manufacturer’s specifications. The backflow preventer in our illustration offers a pressure drop of 10 PSI.

**Height or elevation**

Water exerts a pressure of .433 PSI per foot elevation. A 10-foot high column of water would have 4.33 PSI at the base (10 ft. x .433 = 4.33). The height of our dishwasher connection from the tap is 22 feet. Therefore, there is a pressure loss of 9.53 PSI to lift the water (22 ft. x .433 = 9.53).

If the dishwasher were located below the tap, say 15 feet, there would be a pressure gain of 6.50 PSI (15 x .433 = 6.50). Thus, we would add the gain to the street pressure.

**Let’s size the pipe using the four steps below:**

1) Using the following table, determine the available pressure to size pipe.

<table>
<thead>
<tr>
<th>A</th>
<th>PRESSURE AT TAP</th>
<th>+40 PSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>PRESSURE NEEDED TO OVERCOME HIEGHT (.43 3 lbs X 22’)</td>
<td>-9.53 PSI</td>
</tr>
<tr>
<td>C</td>
<td>PRESSURE NEEDED TO OPERATE APPLIANCE</td>
<td>- 10 PSI</td>
</tr>
<tr>
<td>D</td>
<td>PRESSURE DROP OF BACKFLOW PREVENTER</td>
<td>-10 PSI</td>
</tr>
<tr>
<td>E</td>
<td>PRESSURE LOSS OF TAP</td>
<td>-.31PSI</td>
</tr>
<tr>
<td>F</td>
<td>TOTAL PRESSURE LOSS (B+C+D+E)</td>
<td>-29.84 PSI</td>
</tr>
<tr>
<td></td>
<td>AVAILABLE PRESSURE DROP PER 100 FT. ALLOWED TO SIZE PIPE</td>
<td>10.16PSI</td>
</tr>
</tbody>
</table>
2) Determine the total effective length (TEL)
   Total effective length = developed length + equivalent lengths
   = 188 + 16 + 35
   = 239 feet

3) Determine the adjusted pressure drop.
   Adjusted pressure drop = Available pressure x 100
   \[ \frac{10.16 \times 100}{239} \]
   \[ = \frac{1016}{239} \]
   \[ = 4.25 \text{ PSI} \]

4) Go to Figure E103, located in Appendix E, Friction Loss in Smooth Pipe (Type I in some codes). Find the intersection of 20 gallons per minute and 4.25 PSI pressure drop (point G). The chart indicates a 1-1/4-inch pipe will work. Check the velocity; looks like about 5.5 fps - OK.

Below is a sample commercial building.
1) Determine the available pressure drop.

The available static pressure is the pressure remaining after the pressure losses due to valves, meters, devices and height are deducted from the street pressure.

<table>
<thead>
<tr>
<th>Description</th>
<th>Pressure Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure at city main</td>
<td>+65.00 psi</td>
</tr>
<tr>
<td>Highest pressure needed to operate a fixture. See Table 604.3 water closet, siphonic, flushometer valve</td>
<td>-15.00 psi</td>
</tr>
<tr>
<td>Note: 2009-2012 code lists a pressure drop of 35 psi</td>
<td></td>
</tr>
<tr>
<td>Tap loss - (assume we have a 2 inch tap) Appendix E. The example above has a total of 318 water supply fixture units (WSFU). Table For Estimating Demand shows 318 WSFU = 127 gallons per minute (when a figure falls between two bins use the higher bin, 400 in this case). Go to Table, &quot;Loss of Pressure Through Taps and Tees&quot;, 127 GPM falls between 120-140, use 140. The pressure loss of a 2&quot; tap @ 140 GPM = 2.20</td>
<td>-2.20 psi</td>
</tr>
<tr>
<td>Meter loss - manufacturer’s specs says 10.00 psi loss</td>
<td>-10.00 psi</td>
</tr>
<tr>
<td>Backflow preventer-manufacturer’s specs says 9.50 psi loss</td>
<td>-9.50 psi</td>
</tr>
<tr>
<td>Allowance for future demand (estimate)</td>
<td>-3.00 psi</td>
</tr>
<tr>
<td>Allowance for height of fixture. Water exerts a pressure of .433 pounds per foot of elevation. The highest fixture is 37 feet above the tap, therefore a pressure of 16.02 psi will be lost in order to lift the water (37 x .433)</td>
<td>-16.02 psi</td>
</tr>
<tr>
<td>Available pressure drop-this is the friction rate for sizing the piping system</td>
<td>+9.28 psi</td>
</tr>
</tbody>
</table>

2) **Determine the longest effective length**

The longest length from the tap to point D. 257 feet is the measured or developed length. There are also 3 elbows from the tap to the farthest fixture. These fittings add friction loss to the system and are treated as equivalent lengths to pipe. Using table E1 03.3 (6), a 2 inch, 90-degree elbow is equivalent to 5.5 feet of straight pipe. Since there are 3 elbows between the tap and point D, we must add 16.5 feet to the measured length. There are 8 tees along the way, which are ignored because they
are not used by the farthest fixture. So, a total of 16.5 feet must be added to the 257 measured feet to come up with 273.5 effective feet.

3) Determine the **adjusted pressure drop**

\[
\text{Adjusted pressure drop} = \frac{\text{available pressure drop} \times 100}{\text{Longest total effective length}}
\]

\[
= \frac{9.28 \times 100}{273.5} = 3.39
\]

*This is the only pressure drop you will use to size all pipes connected to the same main.*

4) Determine gallons per minute for each **branch section** of piping by converting the fixture units to GPM using the Table for Estimating Demand (appendix)

1) 127 GPM.
2) Main section B-C must deliver water to 2nd and 3rd floors (125 + 55 = 178fu), 85.5 GPM.
3) Section c-d delivers only water to the third floor (53 fu) 54 GPM
4) Go to friction chart and size each section using the same adjusted pressure (3.39) for each section with its respective GPM requirement.

**Note:** The velocities are close to 8 feet per second which is the upper limit but not forbidden by this code. Increasing the pipes by one size will slow the velocity if desired.

1st floor branch (77 GPM @ 3.39 PSI) 2.5"
2nd floor branch (77GPM @3.39 PSI) 2.5"
3rd floor branch (54 GPM @3.39 PSI) 2"
Main- tap to B (127 GPM @ 3.39 PSI) 2.5"
Main- B-C (85.5 GPM @3.39 PSI) 2.5"
Main- C- 3rd floor (54 GPM @3.39 PSI) 2"
Chapter 7
Sanitary Drainage

Section 704.1 Slope of horizontal drainage piping

Older codes required a 1/4 inch per foot slope for any pipe 3 inch diameter or less. This code has changed the rule to 2-1/2" diameter or less. A 3-inch drain now, needs only a 1/8-inch slope. (See Table 704.1)

Section 704.3 Connections to offsets and bases of stacks

Horizontal branches cannot be connected to the base of a horizontal stack or horizontal stack offsets within 10 times the diameter of stack.

Section 711.2

If there are more than four branch intervals above the offset, the horizontal branch cannot connect in any portion of the offset. The horizontal branch must be connected at least two feet above or below the offset.

Table 706.3

This table is full of important footnotes. You are assured to have questions from it on the exam.

Note: A sanitary tee cannot lie on its side or come off the top of a drainage pipe under any circumstances.

Double sanitary tees cannot be used to discharge back-to-back appliances with pumping action discharge. Most codes also prohibit the discharge of back-to-back water closets into double sanitary tees unless the water closet outlets are 18 inches or more from the stack. Double check both the footnotes in Table 706.3 and Section 706.3.
Sanitary Drainage 40

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A **wye is not permitted** when the upper section of fixture drain is a vent because the vent opening is below the trap seal.

![Wye Diagram](image)

### 709.3 Continuous and semi-continuous flow fixtures

A fixture with a continuous flow of 3 gallons per minute is equal to ____ fixture units.

\[
\text{Fixture units} = \text{GPM} \times 2 \\
= 3 \times 2 \\
= 6
\]

### 709.4 A three-compartment sink must empty into an indirect waste receptor

What is the minimum size drain and trap of the waste receptor? Table 709.1 indicates a sink has a load factor of 2 fixture units for a sink.

2 fixture units x 3 sinks = 6 fixture units

Table 709.2 indicates a 4-inch drain and trap are required to handle 6 fixture units.

### Using the Drainage Tables

**Table 709.1**

**Fixture units** are probability factors for sizing drains in order to provide an uninterrupted flow of waste in pipes. The fixture units were developed by the National Bureau of Standards in 1940 and are still used today.

As always, when using a plumbing chart, be sure to read the footnotes.
For our example, we will use a three-story house with two bathroom groups (1.6 GPF water closet). One group includes a bidet, laundry sink, kitchen sink with disposal, dishwasher, and clothes washer. The total fixture units for sizing the sewer, building drain, and stack are as follows:

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Fixture units</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom group 1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Bathroom group 2</td>
<td>5*</td>
<td>Some state codes allow a reduction in fixture units for additional full baths. Read the footnotes. DFU could be as low as 2 for each additional bath beyond the first one.</td>
</tr>
<tr>
<td>Bidet</td>
<td>0</td>
<td>Section 202 defines a bathroom group as including a bidet. Therefore the bidet is included in bathroom group above.</td>
</tr>
<tr>
<td>Laundry sink</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Kitchen sink</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Clothes washer</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dishwasher</td>
<td>0</td>
<td>Dishwasher is included with kitchen sink</td>
</tr>
<tr>
<td>First floor water closet</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>First floor lavatory</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total fixture units</strong></td>
<td><strong>20</strong></td>
<td>17– if additional bathroom groups only count as 2 DFUs</td>
</tr>
</tbody>
</table>

Notes: Urinals and water closets have integral traps; therefore, the drainage pipe must be the size of the outlet. Although the trap size for a kitchen sink is 1 ½ inches, the vertical drain must be 2 inches according to some state codes. Read the footnotes.
Tables 710.1 (1) and 710.1 (2)

Below is a schematic of the three-story home. The first floor has a kitchen sink, water closet, and lavatory. The second floor has two bathroom groups and the third floor has a clothes washer and sink. Each floor is served by a **horizontal drain branch** (to be a branch it must serve two or more fixtures). The fixture units are taken from Table 709.1 and are in parentheses. The slope per ft. is 1/4 inch.

Beginning at the sewer, we will size the drain system.

According to Table 710.1(1), a 2-inch sewer can handle up to 21 DFUs. Therefore, a 2-inch sewer would be the obvious choice. However, according to the footnotes, a 3-inch sewer is the minimum size allowed because water closets are being served. Furthermore, many states have added footnotes stating **4 inches is the minimum size of any sewer**.

The **building drain** must be 3 inches. Again, Table 710.1(1) indicates a 2-inch drain will work, but the footnote states that the minimum size of any building drain serving a water closet shall be 3 inches.

**Stacks** and **horizontal fixture drains** are sized using Table 710.1(2). The second column of the table is used to size the horizontal drain for each fixture branch. The third, fourth, and fifth columns are used to size the stack. Since this home has three branch intervals (three stories of plumbing), we must use the fourth column to size the stack.

The stack between the building drain and first floor (first interval) is 3 inches. According to the table, a 2 1/2-inch stack will work, but remember, it has to serve two water closets. Therefore, its minimum size must be 3 inches.
Table 704.2 also states that we cannot reduce the size of the pipe in the direction of flow. The horizontal drain for which the stack is serving is 3 inches.

The stack between the first and second interval story is serving the second and third floors for a total of only 14* fixture units (5 FU + 5 FU + 4 FU). Because the stack must serve the water closets on the second floor, it must be 3” inches.

* Some state codes reduce the bathroom group DFUs for each additional bathroom added. For example, in our example above bathroom group 1 would count as 5 DFUs, but bathroom group 2 may only count as 2 DFUs and the total DFUs would be 17 instead of 20. Read every footnote below the tables.

The stack between the second and third floor serves only 4 fixture units. Table 710.1(2) indicates a 1 1/2-inch stack will work. However, the second column indicates the horizontal drain on the third floor must be 2 inches. But, section 406.3 states that if an automatic clothes washer is connected to a horizontal branch drain, the branch drain must be 3-inches in diameter. Section 704.2 states, “The size of drainage piping shall not be reduced in size in the direction of flow.” Therefore, the stack, which is the third floor drainage pipe, must also be 3 inches.

The horizontal drains for the first and second intervals must be 3 inches” because they serve water closets.

Note for states where the 2nd bathroom group may be counted as 2 DFU. When sizing the horizontal drain branch for bathroom group 2, use five DFU, even if two were used to size the building drain and sewer.

Factory locker room

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Sizing Drainage for a Factory

Let’s size the drainage system for the factory locker rooms in the illustration below.

Determine fixture units

Table 709.1 gives us the fixture units needed to size the various components of the system.

Branch at point B

5 showers x 2 FU = 10 fixture units
2 urinals x 4 FU = 8 fixture units
8 water closets x 4 FU = 32 fixture units
8 feet wash sink (5 faucets) x 1 = 5 fixture units

(See 416.1) - 96"/20" = 4.8
Total fixture units for interval B = 55 fixture units

Branch at point C

10 showers (x2) = 20 fixture units
3 urinals (x) = 12 fixture units
12 water closets (x4) = 48 fixture units
10 lavatories (x1) = 10 fixture units
Total fixture units for interval C = 90 fixture units

Total fixture units on sewer (branches B + C) = 149 fixture units

Determine component sizes

Sewer @ 1/8" slope: 4" Table 710.1(1) column 3
Building drain @ 1/4" slope: 4" Table 710.1(1) column 4
Horizontal branch drain B: 4" Table 710.1 (2) column 2
Horizontal branch drain C: 4" Table 710.1 (2) column 2
Stack A-B: 4" Table 710.1 (1) column 4
Stack B-C: 4" Table 710.1 (1) column 4
Section 711

When horizontal offset is located more than 4 branch intervals (4 stories) below the top of the stack, a horizontal branch drain may not connect to the offset. It must connect at least two feet above or below the offset.
Chapter 8
Indirect and Special Waste

The illustrations in Chapter 2 (Definitions) of this guide show the difference between an air break and an air gap. Basically, any food-handling equipment (excluding those for residential use), sterilizers, potable clear water waste (such as relief valves on water heaters), and swimming pools must have an air gap when drained. **Non-potable** clear water waste from equipment such as boiler drips or process tanks is the **only** type of waste that may be drained through **either** an air gap or air break.

The size of all air gaps must be twice the waste pipe opening. If the waste pipe from the fixture or equipment is greater than two feet horizontally or four feet in total length, a trap must be installed on the waste pipe. Therefore, an indirect waste pipe from a food prep sink that extends 1½ feet horizontally and 3 feet vertically must be trapped before dumping into a drain receptacle.

Sections 802.3 and 802.4 describe the requirements for waste receptors and washing machine standpipes; expect a question from these sections.
When waste water flows down a drain pipe, it must displace air that is in front of it. If this air is not given a place to go, such as up a vent, it will bubble into the fixture. This effect is experienced when emptying a soda bottle. Another reason for venting is to give the sewer gases a means to escape to the outside air. A third reason for venting is to prevent the discharged waste water from siphoning water from the primary fixture or other fixtures and traps. And lastly, venting also prevents water from backing up into lower fixtures.
A stack is any vertical soil, waste or vent with or without offsets that extend through at least one story. A vent stack is for venting only and does not carry, nor is it designed to carry, any waste. A stack vent is that portion of a soil or waste stack above the highest fixture or branch drain connection.

Section 903

Every building must have at least one vent extended to the outside 1/2 size of building drain (for most states, 2” minimum size). A vent stack is only required in buildings with five branch intervals or more. When a vent stack is installed, its base must be connected to the drainage stack at or below the lowest horizontal branch on the stack. It may, however, be connected to the building drain as long as it is within a distance of 10 times the diameter of the drainage stack.

Section 904

The vent terminal (the part that goes out the roof) must be increased to three inches when located in freezing climates.

Sections 914 and 915

(Refer to the illustration for Yoke vent in Chapter 2 (Definitions) of this guide.)

If the building has more than ten branch intervals then a relief vent must be installed on the drainage stack at each tenth interval, beginning with the top floor. If there is a horizontal offset in the drainage stack then a relief vent must be installed if five or more branch intervals are above the offset.
Section 906

If the distance between a trap and vent is too great, the fixture drain will totally fill with water and siphoning of the trap seal may occur during discharge. Table 906.1 dictates the maximum distance allowed between a trap weir (see illustration below) and vent. If the trap size is unknown refer to Table 709.1 in Chapter 7. The drain size is determined by fixture units, using Table 710.1(2).

Example: The maximum distance of a drain, sloped \( \frac{1}{4} \)-inch, measured from the trap weir to the vent fitting connection for a 1 ½-inch trap, shall be six feet.

*Note: Although it is not indicated in the table or written in the IPC, if the slope is greater than \( \frac{1}{4} \)-inch, the distance has to be reduced. Otherwise, the trap will be siphoned.*

![Diagram of vent opening and trap weir](image)

*Note: Even though a sink with a disposal has a 1-1/2-inch trap, some states require a 2-inch vertical drain. Read the footnotes.*

Section 908 Common vents

The illustration below shows two fixtures at different levels sharing an individual vent. Use Table 908.3 to size the vertical section between the fixtures.

*Note: A water closet is not allowed to be the upper fixture when common venting.*

![Diagram of common vent](image)
The illustration below is an illustration of wet venting back-to-back bathrooms.

The fixture units are obtained from Table 709.1:

- Drain size is from table 710.1(2) column 2 (total 12 DFU).
- Section A-C is a wet vent.
- Section A-B must handle 6 DFU. Table 909.3 indicates a 2-1/2” pipe is needed as a wet vent.
- Section B-C must handle 2 DFU. Table 909.3 indicates a 2 “pipe is needed as a wet vent.
- The dry vent beyond point C must be 1-1/2 inches as section 916.2 says vents, other than stack vents or vent stacks, must be at least one half the diameter of the drain served (3 inches).

**Section 911 Circuit vents**

Determine vent size - 4 dfu x 6 w,c. =24 dfu (Table709.1).

Table 710.1(2) states that a 4 inch drain is required (this is a horizontal branch).

Section 916.2 states that vents other than stack vents or vent stacks must be 1/2 diameter of drain. Therefore, the circuit vent size is 2 inches.
Section 916 Vent pipe sizing

There are only four rules for sizing vents. Remember these rules and you will have no trouble with vent sizing.

1) Table 916.1 is used only to size stack vents, vent stacks and combination vent systems.

2) All other vents shall be sized as 1/2 the diameter of the drain served but never smaller than 1-1/4 inch.

3) If the developed length of the vent is greater than 40 feet, you must increase the size by one pipe size.

4) If the vent is a common vent or wet vent use Tables 908.3 or Table 909.3.

Using Table 916.1

The base of a vent stack is connected to a waste stack handling 450 DFU and extends 50 feet upward where it connects to a stack vent. The stack vent continues another 15 feet to the outside air. What is the minimum vent stack size if the waste stack is handling 3 branch intervals?

The first thing we need to know is the size of the building drain stack. Table 710.1(2) indicates a 5-inch drain is needed to handle 450 DFU (540 DFU maximum).
Next, we’ll turn to Table 916.1 and find a row corresponding to a 5-inch waste stack and 450 DFU (about half way down the chart is 5-inch waste stack @ 490 DFU). The total developed length of our stack is 65 feet (50 feet + 15 feet). Therefore slide your finger to the right until you find a column containing at least 65 feet (250 is correct, 63 is too short). At the top of the chart it indicates a 4” vent stack is required.

**Sump vents** (Using Table 9 16.5.1)

A 40-gallon per minute sewage pump is feeding a sump. A pipe with a developed length of 55 feet must vent it. What is the minimum allowed size for the vent pipe?

Footnote (a) says to add 50% to the developed length for entrance and friction loses; therefore the maximum developed length would be 55 ft. plus 27.5 ft. (.5 x 55) for a total of 82.5 feet. Table 916.5.1 indicates a 1- 1/2 inch vent is needed.
Chapter 10

Sizing drains and vents using isometric drawings

The inability to read and understand isometric drawings is the number one reason for most examinees' failures. The following pages contain isometric drawings of various plumbing configurations. It is important for you to complete the blanks for each drawing. Then review the answers and cited sections. Do not leave this chapter until you feel completely comfortable with sizing the following examples.
Size pipe A ______”
Size pipe B ______”

Both pipes are serving as wet vents.
A 1-1/4” 916.2
B 1-1/2” 916.2 vent B is serving drain F. drain B is wet vent (Table 909.3)
C 1-1/2” Table 709.2
D 2” Table 909.3, tub and lav (3 dfu) discharge into it
E 3” Table 710.1(1) footnote a
F 3” Serves water closets, plus cannot be smaller than E or G
G 3” see E
H 2” see D
I 1-1/2” see C
J 1-1/2” see B
K 1-1/4” see A

A 3” Table 710.1(1), footnote a
B 3” Table 710.1(1) footnote a
C 3” see A
D 2-1/2” Table 909.3, 6 dfu discharge into it
E 1-1/2” Table 709.3
F 1-1/2” Table 709.3
G 1-1/4” Table 709.3
H 1-1/2” section 916.2, ½ of B
I 1-1/4” Table 709.3
J 2” Table 909.3, 2 dfu discharge into it

A 3” - Table 710.1(1), footnote a
B 3” - Drain serves only 10 dfu (2 bathroom groups), but WC requires 3” Table 710.1(1) footnote a
C 2” - Table 710.1(2) horizontal drain serves 6 dfu
D 1-1/2” Table 710.1(2) drain serves 3 dfu
E 1-1/2” see D
F 1-1/2” wet vent to tub, Table 909.3, lav (1 dfu) drains into it
G 1-1/4” lav fixture drain (1 DFU), use Table 709.2
H 1-1/4” section 916.2, vent to be ½ of drain C, 1-1/4” smallest allowable
I 1-1/4” Vent for C (½ largest drain)
J 1-1/4” see H
K 1-1/4” see G
L 1-1/2” see F
All piping 1/4" slope

<table>
<thead>
<tr>
<th>A</th>
<th></th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td>H</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>J</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>K</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A 2" - vent for waste stack (stack vent) shall not be smaller than waste stack - Sec 910.3

B 2" - Table 710.1(2) - Stack is greater than three intervals and serves 24 dfu

C 2" - Same as above (B)

D 2" - Same as above (B)

E 2" - Same as above (B)

F 2-1/2" - Table 710.1(1) - 2" pipe at 1/4" slope may only serve 21 dfu, must go with 2-1/2"

G 2" - Table 710.1(2) - 2" horizontal branch will handle 6 dfu, (three showers)

H 1-1/4" - Sec. 916.2, vents other than stack vents or vent stacks to be 1/2 size of drain.

I 1-1/4" - Same as above (H)

J 2" - This is a drain serving as a wet vent for the shower. Use Table 909.3 to size the pipe. Use the dfu of the upper fixtures (showers)

K 2" - Table 916.1, The vent stack must handle all 24 dfu, (use 42) It is over 30 feet in developed length (use 100), vent diameter indicates 2". Note: diameter of waste stack must be disregarded with this example.
Chapter 11
Traps, Interceptors, and Separators

Traps

Fixtures must be trapped within 24 inches vertically and in some newer codes, 30 inches horizontally from the fixture drain. (Refer to Section 1002.) The depth of seal must be at least two inches, but no more than four inches.

The diameter (size) is according to Table 709.1

*Note: Trap cannot be larger than drainage pipe it’s connected to.*
Size the storm drainage system for the above roof if it were 6300 square feet, located in Charlotte, North Carolina (choose another city if you’re not in North Carolina).

1) Determine the hourly rainfall rate using figure 1106.1 (some state codes also have an Appendix B). Looks like 3.7 inches.

2) Using Table 1106.2 located in the rainfall rate column 4, we find 6300 square feet falls between 4600 and 8650; choose 8650. To the left, under diameter of leader we find 5 inches to be the correct leader or conductor size. If we wish to use a square pipe, the minimum size would have to be 5” x 5” (footnote a).

3) Using Table 1106.3, if the storm drain slopes 1/8 inch per foot, then the drain would need to be 8 inches.
4) If we were to install gutters, we’d go to Table 1106.6 and find that under 4 inches, rainfall the best we could do is 10 inch diameter gutters with a 1/4-inch per foot slope.

1106.4 Vertical walls

If the above building has a taller building attached directly to it, with a 100 ft. long wall extending 20 feet higher, then 1/2 of the exposed wall must be added to the roof of our building before sizing the roof drainage system.

Our roof 6300 sq.ft.

Neighbor’s wall 20’ x 100’ = 2000 sq. ft. (2000 sq. ft. x .5 = 1000 sq. ft.)

Square footage used to size roof drain components 7300 sq.ft.

Section 1108

If the storm drain for our building is also used as a sanitary drain to discharge 375 DFU, we would size the drain and sewer as follows (paragraph 1108.1):

Square footage of roof 6300 sq. ft.

First 256 DFU 4000 sq. ft.

Remaining 119 DFU 15.6 sq.ft./DFU 1856 sq. ft.

According to Table 1106.3, a 12,156 sq. ft. roof requires a 10-inch drain @ 1/8-inch slope.
INTERNATIONAL PRIVATE SEWAGE DISPOSAL CODE

This code, separate from the International Plumbing Code, may be required study material for some state exams. We have, therefore, provided the following explanation for sizing septic systems.
Chapter 13

Soil Absorption Systems

Sizing an absorption field for other than one and two family residential

To size the trench area required for a 36-unit, 2-bedroom apartment project on percolation class 2 soil use the following formula:

\[
\text{Area} = \text{number of units} \times \text{Conversion factor} \times \text{Absorption area from table 604.1(1)}
\]

\[
\text{Area} = 72 \times 1.5 \times 165
\]

\[
= 17,820 \text{ square feet}
\]

Section 605.3 Seepage pit sizing

According to Table 603.1, a single-family home on percolation class 2 soil requires 250-square feet of trench. If a 10-foot total diameter pit were to be used, what would the depth of the permeable strata be?

Looking at column 1 of Table 605.3, to find the 10-foot, slide your finger to the right until at least 250 sq. ft. is located (251). Go to the top and you’ll see 8 feet as the answer.
The size septic tank for our apartment building from the example in the previous chapter would be calculated according to Section 802.7.2 and Table 802.7.2 as follows:

Start with 750 gallons, then, according to Table 802.7.2, add 150 gallons for each bedroom.

\[
\text{Tank size} = 750 \text{ gallons} + (150 \text{ gallons} \times 72 \text{ bedrooms}) \\
= 750 + 10,800 \\
= 11,550 \text{ gallons}
\]

Obviously, you may use 6–2000 gallon tanks.
Combustion air requirements

Section 304.5

Question: According to section 304.5, If the infiltration rate is unknown, does a room measuring 10’ x 10’ x 8’ high with two 40,000 BTUH water heaters require outdoor air for combustion?

Answer: Yes. The volume is less than 50 cu. ft. per 1000 BTUH

Solution: Divide the total BTUH by 1000

\[
\frac{80,000}{1000} = 80 \text{ (1000's)}
\]

Then multiply the number of 1000's by 50 cubic ft.

\[
80 \times 50 = 4000
\]

If the room is less than 4000 cu. ft., then it needs combustion air. If it is more than 4000 cu. ft. no additional combustion air is required.

The room is 10’ x 10’ x 8’ = 800 cu. ft.; therefore, additional combustion air is required.

If the infiltration rate is known, the following formula may be used in lieu of the above to determine the minimum volume needed without having to add outside air. However, if the infiltration rate is known to be less than .40 air changes per hour, then the following formula must be used.

Question: An area measuring 20 ft. x 30 ft. x 9 ft. is being heated by a 45,000 btuh fan assisted furnace. If the infiltration rate is .35 air changes per hour, is additional combustion air needed?

For fan assisted appliances (most 80+ AFUE furnaces), the required volume must be greater than:

\[
\left(\frac{15 \text{ cu. ft}}{.35}\right) \times \left(\frac{45,000}{1000 \text{ btuh}}\right) =
\]

\[
42.857 \times 45 = 1928 \text{ cubic feet}
\]

The building is: 20 ft. x 30 ft. x 9 ft. = 5400 cubic feet

Therefore, no additional outdoor air is required for this building.

Section 304 Combustion air

Question: Using the two opening method, how many sq. inches must each duct be if outside air is horizontally introduced into a confined space containing a 140,000 BTUH furnace?

Answer: 70 sq. inches

\[
140,000/2000 = 70
\]
Divide to total BTUH in room by 2000

**Gas Pipe Sizing**

Appendix A gives an example for gas pipe sizing. Simply measure the distance between the meter and the farthest appliance; let’s call this the *distance factor*, then use this distance factor to size each *run* off the *main line*. Each time part of the load is dropped off the main line resize the line using the remaining load and same distance factor.

The toughest part is making sure you use the correct sizing table. Pay attention to specifics. Is the gas pressure less than 2 psi, .5 psi, 2psi, or 5 psi.? Is the pipe copper, or stainless steel?

For the example below we will use Table 402.4(2) 2007-9 IFGC

*Note: 2003 and 2006 Gas Code may have slightly different charts but the methodology is the same.*

The distance from the meter to the farthest appliance is 82’ (distance factor). Looking at Table 402.4(2) go down to the 90 foot row. **You will size all pipe using this row.** The number 13 directly to the right of 90 means a 1/4” schedule 40 metallic pipe will handle 13,000 BTUs (approx. 1000 BTUs/cu. ft. nat. gas). To get pipe size, slide your finger across the 90 foot row until you find a pipe size large enough to handle the load.

**To size the main**

Beginning at the meter, the first 20’ must handle the entire system load, 210,000 BTUH.

Thus, the pipe must be 1-1/4” (good for 430,000 BTUH).
After dropping off the water heater load, the next 20’ must handle 170,000 BTUH. Thus the pipe must be 1” (good for 205,000 BTUH).

After dropping off the furnace, the remaining 42’ must only handle the gas log, 50,000 BTUH. Thus, the pipe must be 1/2” (good for 53,000 BTUH).

**To size the runs off the main**

The 10’ pipe between the main and water heater must handle 40,000 BTUH. Thus, the pipe must be 1/2” (good for 53,000 BTUH). Remember to stay on the 90 foot row.

The 25’ pipe between the main and the furnace must handle 120,000 BTUH. Thus, the pipe must be 1” (good for 205,000 BTUH)

Size L-P gas piping the same way once you’ve passed the second stage regulator. To size between the first stage regulator (at the tank) and the second stage regulator (at the house), use the distance between regulators as the distance factor and size according to total connected load. **Be sure to read and use the correct sizing Tables.**

Venting (section 503)

Look at paragraph 503.5.4 and figure 503.5.4. This requirement is for chimneys and single wall vents (Not B Vent).

Look at figure 503.6.6. This requirement is for UL listed B and BW vents.

**Single appliance -Table 504.2(1) Sizing vents**

What size B vent is needed for a 160,000 BTUH, naturally ventilated appliance if the total vent height is 18’ and the lateral 2’?

Under the height column you have to choose either 15’ or 20’. **Remember this.** The taller the vent the more capacity it has, therefore, if the 20’ row is used the vent may be under sized. **Always use the shorter height.** In this case use 15’. Now use the 2’ lateral and select a vent size under NAT. A 5” vent will handle only 150,000 BTUH, while a 6” vent will handle 225,000 BTUH, therefore select a 6” vent.

**Venting two or more appliances with a single vent –Table 504.3(1)**

When connecting two or more appliances to a common vent, the smaller appliance should be connected above the larger appliance.
This Table has two parts. The top section is for sizing the **connectors** and the lower section is for sizing the common **vent**.

**First**, size the connector of each appliance using vent height and connector rise. **Second**, size the vent using the total vent height and the total BTUH of all appliances connected to it. The same rule as above applies to height; always select the shorter height on the chart.

**Example:**

A standard 40,000 BTUH water heater with a connector rise of 3 feet and a 120,000 BTUH fan assisted furnace with a 1 foot connector rise are connected to a 22 foot common vent. Size the vent system.

**Solution**

Using the upper section of the chart, size the **vent connectors** of each appliance.

**Water heater**

Since the vent height is 22 ft., use 20 on the chart. Locate 3 feet under the connector rise column and slide to the right until you find at least 40 under a NAT column. At the top, it indicates a **3” connector** will handle 42,000 BTUH.

**Furnace**

Again, at the 20 foot vent height row choose 1 foot in the connector rise column. Slide to the right until you find at least 120 under the FAN/MAX column. At the top it indicates a **5” connector** will handle 157,000 BTUH.

**To size the common vent:**

Go to the lower section of the chart. Since one appliance is naturally vented and the other is fan assisted we will locate the 20 foot row and slide to the right until we reach 160,000 BTUH (total of both appliances) under FAN+NAT. A **5” common vent** will work, as it will handle up to 183,000 BTUH.

**Note section 504.2 Vent offsets**

This section states the capacities in the tables allow for **no offsets** (elbows) in single appliance vents with 0 laterals or two elbows for vents **with** laterals. If additional offsets are placed in the vent then the capacities must be reduced by 5% for each 45 degree elbow and 10% for each 90 degree elbow.

**Example:** Using Table 504.2 (1), a 10 foot vent with two offsets (laterals), 2 foot each, would have a total lateral of 4 feet. A 3 inch diameter vent, venting a NAT appliance is good for 57,000 btuh with a 5 foot lateral. However, since this vent has a second lateral which consists of two extra 90 degree elbows, the capacity must be reduced by 20% (10% x 2). Therefore the vent capacity will be reduced to 45,600 btuh (57,000 x .80)

Be sure to read and apply to vent sizing Paragraphs 504.2.2 and 504.2.3.
vent connector

vent

Appl.
CONTRACTING BUSINESS
Joey’s Story Profit

While Joey was walking down the street he found a yo-yo. On the following corner a friend saw it and purchased it from Joey for $1.25. Joey was delighted, as he had just made 100% profit. His cost was $0 and his sale was $1.25; therefore, all the money (100%) he received was profit.

Joey thought he stumbled on a great money making idea; if he could only get a hold of more yo-yos he might get rich. So, he went to yard sales and bought up all the yo-yos he could find for 60 cents each. Again, he sold them for $1.25 each. This time he made only 65 cents per yo-yo or 52% profit.

<table>
<thead>
<tr>
<th>sale price</th>
<th>$1.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>minus cost</td>
<td>$.60</td>
</tr>
<tr>
<td>profit</td>
<td>$.65</td>
</tr>
</tbody>
</table>

Joey’s percent of profit is calculated below:

\[
\text{Percent of profit} = \frac{\$\text{Profit}}{\text{Sale price}} \\
\quad = \frac{.65}{1.25} \\
\quad = .52 \text{ or } 52\%
\]

Note: Joey cannot make any more than 100% profit. In the business world there is no such thing as 150%, 1000%, or any other wild percentage above 100.

Joey was on to something big. He thought he would manufacture his own yo-yos. His material costs would be $1.50, but since they would be new yo-yos he’d get $4.00 each. Therefore, his profit would be $2.50 each; increasing his percentage of profit to 63%.

\[
\text{Percent of profit} = \frac{\$\text{Profit}}{\text{Sales price}} \\
\quad = \frac{2.50}{4.00} \\
\quad = .63 \text{ or } 63\%
\]

Well, Joey went into the yo-yo manufacturing business. He rented a building, bought a delivery truck, got a telephone, had the lights turned on, and purchased a wood lathe. He hired a secretary to send out sales letters, keep the books, and answer the telephone. Soon he was overwhelmed with orders and had to hire part-time labor to help make yo-yos. At the end of his first year he had sold 10,000 yo-yos @ $4.00 each and his profit and loss statement (Income Statement) looked like the following:
**Joey’s Yo-Yo Company**

**Income Statement**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (sales)</td>
<td>$40,000</td>
</tr>
<tr>
<td>Direct costs</td>
<td></td>
</tr>
<tr>
<td>Materials (1.50 x 10,000)</td>
<td>15,000</td>
</tr>
<tr>
<td>Labor</td>
<td>4,500</td>
</tr>
<tr>
<td>Total direct costs</td>
<td>19,500</td>
</tr>
<tr>
<td>Gross profit</td>
<td>20,500</td>
</tr>
<tr>
<td>Overhead</td>
<td></td>
</tr>
<tr>
<td>Secretary salary</td>
<td>5,000</td>
</tr>
<tr>
<td>Rent</td>
<td>3,600</td>
</tr>
<tr>
<td>Telephone</td>
<td>1,200</td>
</tr>
<tr>
<td>Depreciation (for lathe)</td>
<td>1,500</td>
</tr>
<tr>
<td>Depreciation (for truck)</td>
<td>3,000</td>
</tr>
<tr>
<td>Office supplies (stamps, envelopes, etc...)</td>
<td>600</td>
</tr>
<tr>
<td>Total overhead</td>
<td>14,900</td>
</tr>
<tr>
<td>Total costs and overhead</td>
<td>34,400</td>
</tr>
<tr>
<td>Net income (net profit)</td>
<td>$ 5,600</td>
</tr>
</tbody>
</table>
Joey studied his income statement to find ways to increase his income. He calculated the **direct costs** to be **49% of sales**:

**Direct cost/sales**

\[
\frac{19,500}{40,000} = 0.4875 \text{ or } 49\%
\]

**Direct costs** are those costs directly associated with producing the product you are selling. In Joey’s case, his cost of materials and labor increases or decreases depending on his sales volume; therefore materials and labor are direct costs.

**His gross profit** is **51% of sales**:

\[
\frac{20,500}{40,000} = 0.5125 \text{ or } 51\%
\]

**Gross profit** is the profit made on sales before taking out overhead.

His **overhead** is **37% of sales**.

\[
\frac{14,900}{40,000} = 0.3725 \text{ or } 37\%
\]

**Overhead** are those expenses incurred whether or not Joey does any business: secretary salaries, insurance, advertising, telephone bills and rent. These are all considered overhead. He must pay these expenses although he may not get any business. Overhead generally stays constant, it does not increase or decrease proportionally to the amount of sales volume.

**His total costs and overhead expenses** were **86% of sales**:

\[
\frac{34,400}{40,000} = 0.86
\]

And his **net profit** was **14% of sales**:

\[
\frac{5600}{40,000} = 0.14
\]

**How can Joey increase profit?**

Joey has three practical ways to increase profit: (1) raise the price of the yo-yo or (2) sell more yo-yos at the same price or (3) reduce expenses

Looking at **direct costs** Joey has no choice because these costs *increase or decrease directly as the sales volume fluctuates*. Direct costs will always remain very close to 49% of sales.

**Overhead** is *relatively constant*. He stands a good chance of increasing sales without increasing overhead or possibly increasing profit by cutting overhead.
Reducing overhead expenses is tough, as overhead expenses occur whether or not he sells anything.

Let's see what happens if Joey decides to increase his income by raising his price 10%:

1) Hopefully, his sales will increase to $44,000 (40,000 + 10%).
2) His direct cost will increase 10%, to $21,450 (19,500 + 10%).
3) His overhead should remain the same, $14,500.
4) Therefore, his new profit will be $8050.
5) He will increase his profit from 14% to 18.3% (8050/44,000).
6) Meanwhile his overhead has dropped to 34% (14,900/44,000).

Another question Joey might ask himself is, “What would my sales have to be if I wanted to make $60,000 gross profit to cover both overhead and profit?

If Joey’s gross profit is traditionally running 51%, as his income statement indicates, then he would use the following formula:

\[
\text{Sales needed for target profit} = \frac{\text{target profit} \, \$}{\text{historical profit} \, \%} \\
= \frac{60,000}{.51} \\
= 117,647
\]

Up to this point, Joey was keeping his books on a notebook he kept beneath the trash on the floorboard of his truck. He was beginning to accumulate a lot of customers who owed him money (account receivables) and he had a lot of suppliers who he owed money (accounts payable). It was becoming difficult to keep up with these accounts, so he hired Sally, a bookkeeper (more overhead).

As daily orders and bills came in, Sally would enter the amounts in a general journal or day sheet. When she had time, perhaps once a week, she would transfer the information in the journal to ledgers. The ledgers were books containing a page for each account that he did business with. If the account was a customer, she would enter the amount owed to Joey in the debt column of the accounts receivable ledger. When the customer paid, she would enter the amount paid in the credit column. If the account were a supplier, she would enter the amount Joey owes in the credit column of the accounts payable ledger. When Joey paid the bill, she would enter the amount paid in the debt column. Each ledger had a third column in which a balance was kept. At the end of the month she would send a statement with the balance to each customer and a check for the balance to each supplier.

To keep up with each employee’s compensation, taxes, profit sharing, etc, Sally would keep a payroll ledger.
In order to keep up with the **money**, she would keep a **cash receipts and disbursement ledger**. Whenever the company received money, she would debit cash in the ledger and whenever the company paid out money, for any reason, she would credit cash in the ledger. It was like keeping a checkbook.

At the end of the month, Sally would prepare a **balance sheet** to let Joey know how much he owned (**assets**), how much he owed (**liabilities**), and how much he was worth (**equity**). She also prepared an income statement to let Joey know where his money was going and if he was making a profit. The income statement included his total sales (**revenue**), labor and material costs (**direct costs**), general and administrative expenses (**overhead**), and his net profit (**income**).

Now that Joey has all these financial tools, he can use them to plan his business strategy.

If Joey wants to make $75,000 and he knows his net profit is running about 12.75%, he would have to increase sales to $588,235

\[
\text{Sales} = \frac{\text{Net income}}{\text{Net profit \%}}
\]

\[
= \frac{75,000}{.1275}
\]

\[
= 588,235
\]

**END OF JOEY’S STORY**

Now that you know Joey’s story, let’s look at the contracting business.

**How to price a job.**

Suppose you purchase a gas water heater for $350 and it costs $150 for venting, piping plus $140 labor, and $35 for a permit. If your company overhead is 15%, what will the sales price of the job be if you want to make 20% net profit?

First, you need to calculate the cost of the job

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water heater</td>
<td>$350</td>
</tr>
<tr>
<td>Venting and piping</td>
<td>$150</td>
</tr>
<tr>
<td>Labor</td>
<td>$140</td>
</tr>
<tr>
<td>Permit</td>
<td>$35</td>
</tr>
<tr>
<td><strong>Total job cost</strong></td>
<td><strong>$675</strong></td>
</tr>
</tbody>
</table>

---

**A Guide to Passing the Plumbing Exam**

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Second, you must calculate a price that will include: your cost + overhead + profit. We know the cost is $675 and we know the overhead and profit will be 35% (15% + 20%) of the sales price.

To calculate sales price (this method must be used on the exam):

1) Subtract your overhead and profit % from 100%.
   
   \[ 1.00 - .15 - .20 = .65 \text{ or } 65\% \]

2) Divide the cost by the above answer.

\[ \frac{675}{.65} = 1038.46 \text{ sales price} \]

*Note: Most students would add 35% to the cost or multiply the cost by 135% and come up with $911.25. This is not correct.*

*What if?*

If you were working on a net profit of 15%. What would your annual sales have to be to make $75,000?

Solution

\[
\text{Sales} = \frac{\text{Target profit amount}}{\text{Profit \%}}
\]

\[
= \frac{75,000}{.15}
\]

\[
= 500,000
\]

If you increase your % net profit to 25%, what would your sales have to be?

\[
\frac{75,000}{.25} = 300,000
\]

*Moral:* The above contractor increases his prices by 10% and only has to do 60% of the work he used to do.

*Similar problems will likely be on the test.*
INCOME STATEMENT
An income statement is an orderly accounting of where the revenue came from, a list of the expenses, and a total of the gross and net profit or loss. The figures entered in the statement may be based on an **accrual** or **cash basis**. An *accrual basis* means your accounting system uses income and expenses that are expected to be received or incurred, while a *cash basis* uses income and expenses that have actually occurred. If Joey sells $1000 worth of yo-yos on credit, he will show $1000 as income on an accrual basis. However, on a cash basis, he will show no income, as he has not received the funds yet. Once you select a basis for your accounting method you must continue using it. You cannot switch back and forth from year to year.

Items found on an income statement are listed below.

**Revenues**
Revenues are the same as *sales* of the product your company is primarily involved in. If you sell a water heater, the money received is revenue (sales). If you sell a surplus truck, which is not your primary business, then the money received is considered a *gain (or loss) on sale of asset*. See Other Income/Expenses.

**Direct Costs**
Any money you spend (usually labor and material) to complete a particular job is considered *direct costs*. Job A might require $2600 (direct costs) in labor and material while Job B requires $4800 (direct costs) in labor and material.

**Project Overhead**
Project overhead is money spent just to do the job but does not contribute to its completion. Examples would be superintendent’s salary, expense of vehicles used for the job, special insurance, repairs on job equipment or office trailer rent.

**Cost of Construction**
The total of *direct costs and project overhead* is called *cost of construction*. In accounting terms it is sometimes called cost of goods sold.

**Gross profit**
Gross profit is revenue (sales) minus cost of construction (cost of goods sold). On the income statement, the revenue is $1,077,760. If you deduct the cost of construction (which includes direct cost and job overhead), of $842,460 from the revenue we would have $235,300 gross profit.
If you purchase an air conditioner for $600 and pay $150 labor to install it, the total cost of construction would be $750. If you sell it for $1400, your gross profit would be $650.

**General and Administrative Expenses**

Also called company **overhead**, general and administrative expenses are any monies spent to keep the doors open and bring in business, whether you do any business of not. Your salary, the office salary, stamps, insurance, telephone, rent and advertising are examples.

**Depreciation**

Most expenses are cut and dry. If you spend $160 on utilities, the expense is $160. Depreciation, on the other hand, must be calculated. Two common methods used to calculate depreciation are the **straight line** and the **accelerated depreciation** method. To illustrate each method we will depreciate a backhoe purchased in July for $19,500.

Under the **straight line method**, $5000 will be estimated to be the **salvage value** (what you think you can sell it for at the end of five years); therefore, $14,500 is to be depreciated evenly throughout a five-year period. In each of the five years you can deduct $2900. Since you purchased the backhoe in July and your **fiscal year** ends in December, you are only entitled to six months depreciation the first year, which is 1/2 year or $1450. The fifth year of ownership will fall on July so you will also get 1/2 of that year’s depreciation ($1450).

IRS rules allow for methods of **accelerated depreciation**, which allows a business to claim a higher amount of depreciation for assets in the first years of operation. One such method is the **double declining balance method**. For example; the backhoe above has a life of five years, therefore each year 1/5 or 20% may be depreciated. The double declining balance method allows the business to take 40% (double the 20% allowed under the straight line method above) of the asset balance as depreciation expense each year until its useful life comes to an end.

<table>
<thead>
<tr>
<th>Year</th>
<th>Depreciation</th>
<th>Book Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.40 x $19500 = $7800</td>
<td>balance = $11700</td>
</tr>
<tr>
<td>2</td>
<td>.40 x $11700 = $4680</td>
<td>balance = $7020</td>
</tr>
<tr>
<td>3</td>
<td>.40 x $7020 = $2808</td>
<td>balance = $4212</td>
</tr>
<tr>
<td>Etc….</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What happens if the backhoe is sold after six years for $3500? If, you used the straight line method you will have to show $1500 as a **loss on sale of assets** under other income/expenses on your income statement because the books are showing it is worth $5000. If you used the accelerated depreciation method, $3500 would
show up as *again in sale of assets* because the books are showing it to be worth $0.

**Net income**

This is the profit made after every conceivable expense has been deducted from revenue. A corporation (except S type) will also deduct taxes as an expense. Proprietorships, S type corporations and partnerships do not deduct taxes on their income statements. Taxes on these type organizations are paid as ordinary income taxes.

**Using the example above where you made $650 gross profit on the air conditioner, your net income or net profit would be what is left after deducting your overhead (gas, cost of invoice, insurance, truck depreciation, etc…).**

**Financial Ratios**

Many exams will ask you to calculate financial ratios. Usually, study guides are provided by each individual state and contain numerous financial formulas.

Test questions may give you more information than you need, but will be specific in what is being asked.

Example: Acme Heating has an annual revenue of $875,000. Its total debt is $125,000 and its equity is $145,000. What is the Debt/Equity Ratio?

Solution: Looking at one popular business guide, *Business and Project Management for Contractors*, you will see the formula for Debt/Equity Ratio. The formula only needs two figures, **total debt** and **equity**. The revenue figure ($875,000) is not needed.

\[
\text{Debt to Equity Ratio} = \frac{\text{Debt}}{\text{Equity}} = \frac{125,000}{145,000} = 0.862
\]

**Payroll Taxes**

Three federal tax items are withheld from an employee’s income:

1) Income tax from circular E chart.

2) Social security tax (employees share = 6.2%. (Rates as of 2010, current rates should be proved on exam)

3) Medicare tax (1.45%).

Using the information and tax tables on the next page, obtain the net take home pay of a married employee with 3 allowances (dependents) making $483 weekly. Be sure to take out all three items above.

Solution: Using the circular E table on the next page, go down the first two columns to find the employees’ pay range 480-490. Slide your finger to left to column under 3 withholding allowances. You should see $19.
Base pay $483.00
Fed income tax from table -19.00
Social security ($483 x .062) -29.94
Medicare tax ($483x.0145) -7.00
Take home pay $427.06
Appendix

Practice Plumbing Questions

Carefully read each question and then circle the letter of the best answer.

Note: Because each state has deleted or amended the International Codes to meet individual state needs, a few answers may not be found in your code book and some answers may differ from ours. If you find that your code disagrees with our answer, you should accept your code as the correct answer.

1) The minimum size fixture water supply pipe for a hose bibb is______.
   a. 1/2 inch
   b. 3/4 inch
   c. 1 inch
   d. 1-1/4 inch

2) Notches on the end of joists shall not exceed ______ of the joist depth.
   a. 1/8
   b. 1/5
3) The minimum diameter of a circuit vent totaling 55 feet developed length and serving a horizontal drain branch, handling 120 dfus is ____ inches.

   a. 1.5
   b. 2
   c. 2.5
   d. 3
4) Cleanouts are required to be brought to the outside or be flush with the outside wall if the crawlspace is less than ____ inches high.
   a. 18
   b. 22
   c. 30
   d. 24

5) Solder used on copper shall conform to ____.
   a. ASTMF80
   b. ASTMS75
   c. ASTMB32
   d. ASTMM55

6) Backflow protection assemblies must be inspected at least ____.
   a. every 6 months
   b. annually
   c. every two years
   d. every five years

7) A cast iron mechanical joint coupling for hubless pipe and fittings shall comply with ____.
   a. CISP 310 or ASTM C 1277
   b. ASTM C564 or CAN/CSA B602
   c. ASTM C310
   d. ASME A1053

8) A short sweep may be used to direct waste from vertical to horizontal only if it is ____ inches in diameter or greater.
   a. 2
   b. 3
   c. 4
   d. 6
9) Back pressure less than or equal to 4.33 PSI is classified as______.
   a. Drainage
   b. low head backpressure
   c. high head backpressure
   d. medium head backpressure

10) Copper pipe shall be horizontally supported at a maximum of ____ feet intervals.
    a. 5
    b. 6
    c. 12
    d. ?

11) A 20 ft. length of pipe with slope per foot of 1/4 will produce a drop of ____ inches.
    a. 3
    b. 4
    c. 5
    d. 6

12) A building drain extends _______ beyond the exterior walls of a building.
    a. 30 inches
    b. 5 feet
    c. 10 feet
    d. 48 inches

13) According to Table 604.3 the required flow rate for a flushometer tank type water closet is ____ GPM.
    a. 4
    b. 1.6
    c. 3
    d. 1.8
14) A device or means to prevent backflow is a ______.
   a. Reverse valve assembly
   b. Stopcock
   c. Backflow preventer
   d. Critical valve

15) Hot water faucets, except tub/shower mixing valves, on a fixture shall be____.
   a. on the right
   b. on the left
   c. either left or right
   d. labeled hot

16) A waste stack also serving as a vent+ shall______.
   a. be vertical only
   b. not have vertical or horizontal offsets
   c. not receive discharge form water closets
   d. all of the above

17) A 1-1/2 inch P trap with slip joints may be used as a cleanout for a maximum _____ inch drain pipe.
   a. 1-1/4
   b. 1-1/2
   c. 2
   d. 2-1/2

18) Lead free pipe contains no more than ___% lead.
   a. 2
   b. 6
   c. 8
   d. 10
19) A forced sewer test must maintain a pressure of ___ PSI greater than the pump pressure.
   a. 10
   b. 15
   c. 20
   d. 5

20) A three compartment sink rated at 2 DFU per compartment has a total of ______ drainage fixture units discharging into a single indirect drain.
   a. 6
   b. 8
   c. 3
   d. 4

21) The vent connection to a combination drain and vent pipe shall extend vertically a minimum of ____ inches above the highest fixture before offsetting horizontally.
   a. 4
   b. 6
   c. 8
   d. 12

22) A sanitary tee may only be used to change the drains direction from___.
   a. horizontal to vertical
   b. vertical to horizontal
   c. horizontal to horizontal
   d. vertical to vertical

23) A child care facility containing four water closets may have a maximum of ______ water closet(s) without an enclosing compartment.
   a. 1
   b. 2
   c. 3
   d. 4
24) All ______ shall have two water service piped install in such a manner so as to minimize the potential for an interruption of the supply of water in the event of a water main or water service pipe failure.
   a. health care facilities
   b. nursing homes
   c. hospitals
   d. all the above

25) The minimum wall thickness of sheathing or wrapping used to protect pipes passing through concrete walls is ___ inches.
   a. .010
   b. .10
   c. .025
   d. .25

26) Non-metallic auxiliary drain pans shall have a minimum thickness of _____.
   a. .0276 inches
   b. .0375 inches
   c. .0625 inches
   d. .0867 inches

27) Extruded composite solid core PVC DWV sewer pipe shall conform to ASTM ______.
   a. A888
   b. F 1488
   c. C 1053
   d. D2665

28) The components of all condensate system for a gas fired water heater may be made of______.
   a. cast iron
   b. PVC
   c. CPVC
   d. all the above
29) The minimum depth of an accessible stall enclosing a wall hung water closet is ____ inches.
   a. 56
   b. 57
   c. 58
   d. 59

30) A vent stack handling 25 dfu’s with a developed length of 35 feet shall be ____ inches minimum diameter.
   a. 2
   b. 2.5
   c. 3
   d. 4

31) A water supply tank that is being supplied by water at the rate of 175 GPM requires an overflow pipe at least ____ inches diameter.
   a. 2
   b. 3
   c. 4
   d. 5

32) To prevent frost closure, any increase in the size of a vent, to be run through a roof shall be made at least ____ feet below the roof.
   a. .5
   b. 1
   c. 1.5
   d. 2

33) An indirect waste pipe that exceeds _____ feet in total developed length must be trapped.
   a. 1.5
   b. 2
   c. 3
   d. 4
34) The minimum diameter of a circuit vent totaling 45 feet developed length and serving a horizontal drain branch, handling 85 DFUs is ____ inches.
   a. 1.5
   b. 2
   c. 2.5
   d. 3

35) The minimum vent size of a sewage pump sump with a pump capacity of 10 GPM is ____ inches.
   a. 1-1/4
   b. 1-1/2
   c. 2
   d. 2-1/2

36) In covered malls, the travel distance to public toilet facilities shall not exceed ____ feet.
   a. 200
   b. 300
   c. 400
   d. 500

37) To be classified as tempered water, the minimum temperature must be ____ degrees.
   a. 100
   b. 95
   c. 90
   d. 85

38) Vacuum breakers for hose connections in health care or laboratory areas shall not be less than ____ feet above the floor.
   a. 2
   b. 3
   c. 5
   d. 6
39) Gauges used to test pressures of 10 PSI or less shall have increments of ____ PSI or less.
   a. .05
   b. .10
   c. .20
   d. 1

40) All strainer plates on drain inlets shall be designed and installed so that all openings are not greater than ____ inches in the least dimension.
   a. .5
   b. .25
   c. .75
   d. .3

41) Grease interceptors shall conform to any of the following except ______.
   a. PDIG101
   b. ASME A112.14.3
   c. ASME A112.14.4
   d. NSF 1020

42) The minimum size combination drain and vent pipe connecting to a horizontal drain used to serve a floor drain and lavatory is _____ inches.
   a. 1-1/2
   b. 2
   c. 2-1/2
   d. 3

43) PVC pipe may be threaded only if it is schedule ______ or heavier.
   a. 20
   b. 40
   c. 60
   d. 80

44) In non-fire-resistant-rated assemblies, any penetrating item may connect up to _____ stories.
   a. 1
   b. 2
   c. 3
   d. 4
45) The minimum diameter of a drainage stack pipe (total discharge into one branch interval) handling 96 dfu's is _____ inches.
   a. 3
   b. 4
   c. 5
   d. 6

46) A grease interceptor whose flow rate exceeds 50 GPM is a ______.
   a. Grease interceptor
   b. Grease receptor
   c. Grease trap
   d. Grease filter

47) According to Table 604.3 the required flow rate for a bathtub is ___ GPM.
   a. 4
   b. 8
   c. 3
   d. 5

48) The maximum flow rate for a hand held shower is _____ GPM @80 PSI.
   a. 1.5
   b. 2.5
   c. 2.2
   d. 3.1

49) A piping arrangement in which a drain from a fixture discharges indirectly into another fixture below the flood level rim and above the trap seal is an ______.
   a. Air gap
   b. Air space
   c. Air break
   d. Air drain

50) Sheet lead for pans shall not weigh less than ______.
   a. six pounds per square foot.
   b. twelve ounces per square foot
   c. four pounds per square foot
   d. four ounces per square foot
51) The following types of water pipe joints and connections are prohibited except______.
   a. cement joints  
   b. solvent-cement between different types of plastic  
   c. solders joints  
   d. saddle-type fittings  

52) Which of the following may not be deposited by any means into a public sewer system?
   a. gray water  
   b. industrial waste  
   c. poisonous liquids  
   d. detergents  

53) Which of the following is not required to be protected by a vacuum breaker?
   a. outdoor hose bibb  
   b. water heater drain  
   c. commercial dishwasher  
   d. wall hydrant  

54) Pipe applied vacuum breakers shall be installed not less than _____ inches above the flood level rim of the fixture served.
   a. 2  
   b. 4  
   c. 6  
   d. 8  

55) The minimum water supply air gap for a fixture with an effective open of 1/2 inch, located away from a wall is ______ inch(s).
   a. 1/2  
   b. 2  
   c. 1-1/2  
   d. 1  

56) A cleanout for a 3 inch PVC drain pipe shall be minimum ___ inches.
   a. 1.5  
   b. 2  
   c. 2.5  
   d. 3
57) Truss members and components may be_____without approval of a registered design professional.
   a. drilled
   b. nailed
   c. cut
   d. notched

58) A macerating toilet assembly that serves a single water closet may have a discharge opening as small as _____inches.
   a. .5
   b. 1.5
   c. 1.25
   d. .75

59) Where more than one change in direction occurs in a run of piping. Only one cleanout shall be required for each ___ feet of developed length of the drainage piping.
   a. 25
   b. 30
   c. 50
   d. 40

60) The maximum flow rate for a private lavatory is _____ GPM @ 60 PSI.
   a. 1.5
   b. 2.5
   c. 2.2
   d. 3.1

61) A 4-inch copper pipe, passing through a fire-resistance-rated wall may be protected______.
   a. by filling the annular space with concrete
   b. by an approved firestop system
   c. by either a or b
   d. by neither a or b

62) A reduce pressure principle backflow preventer shall______
   a. not be submerged.
   b. conform to ASSE 1-12.
   c. not allow the relief opening to discharge.
   d. not be installed when subject to continuous pressure conditions.
63) A wheelchair accessible compartment shall be ___ inches (1525 mm) minimum in width.
   a. 60
   b. 59
   c. 56
   d. 62

64) A business requiring 5 water fountains may substitute ______ fountains with bottled water dispensers.
   a. 1
   b. 2
   c. 3
   d. 4

65) When testing a drainage system with air, there shall be a uniform gauge pressure of ___ PSI or sufficient to balance a 10-inch column of mercury.
   a. 5
   b. 10
   c. 15
   d. 12

66) When testing a drainage system in sections with water, no section shall be tested with less than ___ foot head of water.
   a. 3
   b. 5
   c. 10
   d. 15

67) Load bearing studs may be cut or notched a maximum of ____% of its width.
   a. 10
   b. 15
   c. 20
   d. 25
Practice Plumbing Questions

68) The effluent level in a sump shall be prevented from rising within _____ inches of the gravity drain inlet.
   a. 2
   b. 4
   c. 6
   d. 8

69) The minimum diameter of a 1/4-inch sloped building drain handling 75 DFUs is_____ inches
   a. 3
   b. 4
   c. 5
   d. 6

70) Sheet copper used for general applications shall not weigh less than_____.
   a. six ounces per square foot
   b. twelve ounces per square foot
   c. four pounds per square foot
   d. four ounces per square foot

71) Accessible bathtubs shall deliver water that is_____degrees F maximum.
   a. 95
   b. 100
   c. 110
   d. 120

72) A combination drain and vent system shall not serve a ______.
   a. sink
   b. water closet
   c. floor drain
   d. drinking fountain

73) Copper pipe shall be vertically supported at a maximum of ____ feet intervals.
   a. 5
   b. 6
   c. 12
   d. 10

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74) For water distribution pipe, a standard for cross-linked polyethylene (PEX) plastic tubing pipe is_______.
   a. ASTM B43
   b. ASTM B 75
   c. ASTM F 877
   d. ASTM F 876

75) Domestic food grinders shall be connected to a drain not less than ____ inches in diameter.
   a. 1-1/2
   b. 1-1/4
   c. 2-1/2
   d. 2

76) For water service pipe, a standard for galvanized steel pipe is_______.
   a. ASTM B43
   b. ASTM B 75
   c. ASTM A53
   d. ASTM F 876

77) A gravity sewer test must maintain 10 feet of head for _____minutes.
   a. 10
   b. 5
   c. 15
   d. 30

78) Water heaters (except those resistant to flammable vapor ignition) having an ignition source shall be elevated such that the source of ignition is not less than ____ inches off a garage floor.
   a. 12
   b. 18
   c. 20
   d. 24

79) Commercial laundries shall be equipped with an interceptor that prevents the passage of solids ____ or larger into the public sewer system.
   a. .25
   b. .5
   c. .37
d. .75

80) When 10 foot lengths of cast iron pipe are used, the maximum horizontal spacing shall be_____.
   a. 5
   b. 8
   c. 10
   d. 12

81) The vent pipe shall extend a minimum of ___ if the roof is used only for weather protection.
   a. 18 inches
   b. 24 inches
   c. 30 inches
   d. 36 inches

82) In an accessible bathroom, the centerline of the water closet shall be ___inches (405 mm) minimum to 18 inches (455 mm) maximum from the side wall or partition.
   a. 14
   b. 15
   c. 16
   d. 17

83) A grease interceptor whose flow rate is 50 GPM or less is a_______.
   a. Grease remover
   b. Grease receptor
   c. Grease trap
   d. Grease filter

84) A branch vent, 50 feet in developed length, serving a 3" drain, must be at least ___inches in diameter.
   a. 1-1/2
   b. 2
   c. 2-1/2
   d. 3

85) A wet vent may____.
   a. serve only one bathroom group
   b. allows for water closets to be connected at different levels
   c. accept drainage from fixtures above water closets
d. Extend from the connection of the dry vent down to the lowest fixture drain connection

86) An oil separator shall have an outlet water seal of not less than ___ inches.
   a. 18
   b. 16
   c. 12
   d. 6

87) Protective shield plates placed on sole plates shall ____ inches thick
   a. .010
   b. .0125
   c. .062
   d. .048

88) The minimum size combination drain and vent pipe connecting to a building drain used to serve two floor drains and five sinks is _____ inches.
   a. 1-1/2
   b. 2
   c. 2-1/2
   d. 3

89) In a health care facility, the velocity of airflow in a central vacuum (fluid suction) system shall not be less than _______ feet per minute.
   a. 100
   b. 1000
   c. 2500
   d. 5000

90) Which of the following is not required to discharge its waste through an air gap?
   a. swimming pool
   b. health care sterilizer
   c. food storage floor drain
   d. residential lavatory

91) Expose soil or waste pipes may be installed above working, storage or eating surfaces in food service areas if _______.
   a. a water detection device is installed on the pipe

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b. the pipe is inspected for leaks
c. a secondary containment with its own drain is provided
d. the engineer specifies it on the plans

92) When the fixture drains, being common vented, connect at the same level, the vent connection may not be made______,
   a. at the interconnections of the fixture drains
   b. upstream of the interconnection
   c. downstream of the interconnection
   d. at all

93) The water connection to an automatic dishwasher shall be protected by _______.
   a. an air gap built into the machine
   b. a backflow preventer
   c. either a or b
   d. b only

94) In one and two family dwellings, the discharge piping form a sewage pump or ejector shall have a _______.
   a. full open valve installed
   b. check valve installed
   c. both a and b
   d. either a or b

95) A pipe, located outside a building, that conveys water from the roof or a gutter to an approved means of disposal is a ______?
   a. Conductor
   b. Rain pipe
   c. Standdown
   d. Leader

96) When a bathtub outlet is not used with a shower, the shower waste outlet strainer must have a minimum diameter of ________ inches.
   a. 1-1/2
   b. 2
   c. 2-1/2
   d. 3

97) According to Table 604.3 the required water pressure for a temperature controlled shower is ___ PSI.
a. 25  
b. 8  
c. 15  
d. 20

98) The space between the wall and the grab bar shall be _____ inches.  
   a. 1-1/2  
b. 1-3/4  
c. 2  
d. 2-1/4

99) The side grab bar in an accessible water closet stall shall be a minimum of ___ inches in length.  
   a. 30  
b. 36  
c. 40  
d. 42

100) At a velocity of 4 feet per second, a manifold serving a demand of 8 GPM must have a minimum diameter of______ inches.  
    a. 1/2  
b. 3/4  
c. 1  
d. 1-1/4

101) The center to center distance between water closets and urinals shall not be closer than ___ inches.  
     a. 30  
b. 36  
c. 32  
d. 42

102) A 3-inch quarter bend may always be used to change the drain direction from ___.  
     a. horizontal to vertical  
b. vertical to horizontal  
c. horizontal to horizontal  
d. either a or c

103) All plastic pipe and fittings shall be third party certified as conforming to ____?
a. ASME-56  
b. ASTM 888-05  
c. ASSE1002-90  
d. ANS/NSF 14

104) A stack vent handling 125 DFUs with a developed length of 35 feet shall be _____ inches minimum in diameter.
   a. 2  
   b. 2.5  
   c. 3  
   d. 4

105) CPVC solvent cement shall be ______ in color and conforming to ASTM F 493 when primer is used.
   a. orange  
   b. red  
   c. purple  
   d. green

106) A pressure reducing valve must be designed to remain _____ in case of valve failure.
   a. closed  
   b. open  
   c. There is no requirement  
   d. partially closed

**Questions from the Fuel Gas Code**

107) Plastic pipe shall be used to convey gas only_____
   a. when located in wet locations  
   b. when passing through masonry or plaster  
   c. outside and underground  
   d. when the hydrogen sulfide is too high
108) Which of the following methods of joining pipes in a concealed location is acceptable?
   a. brazing
   b. unions
   c. bushings
   d. compression couplings

109) A room measuring 8' x 6' with 8 feet ceiling height is _____ cubic feet.
   a. 48
   b. 64
   c. 384
   d. 488

110) Listed B-vent installed through an 8 /12 pitch roof shall extend _____ feet above the roof surface.
   a. 1.5
   b. 2
   c. 2.5
   d. 3.25

111) Adding height to a vent_____.
   a. increases the vent capacity
   b. decreases the vent capacity
   c. does not affect the vent capacity
   d. will cause the appliance to back draft

112) The maximum length of a gas connector to a water heater shall be _____ feet.
   a. 3
   b. 4
   c. 5
   d. 6

113) Which of the following gas piping systems must be pressure tested?
   a. new installations
   b. minor repairs
   c. additions
   d. all of the above
114) A 1 inch diameter iron gas pipe shall be threaded with approximately ___ threads.
   a. 8
   b. 9
   c. 10
   d. 12

115) The slope of a vent connector shall be upward at least ____ inch per foot.
   a. 1/16
   b. 1/8
   c. 1/4
   d. 1/2

116) If the calculated free area of a combustion air duct is 60 square inches then a selected louver with 60% free area would have a total area of ____ square inches
   a. 36
   b. 136
   c. 100
   d. 90

117) Which of the following is not within the scope of the Fuel Gas Code?
   a. LP gas piping in a residence
   b. natural gas piping of a brooder on a farm
   c. installation of a gas log
   d. Venting of a gas water heater

118) The minimum burial depth of an individual gas pipe feeding a gas light is ____ inches.
   a. 6
   b. 8
   c. 12
   d. 18
119) Non-direct vent water heaters may not be installed in the work area of _____.
   a. garages
   b. commercial kitchens
   c. beauty shops
   d. butcher shops

120) A boiler used to heat water to be used externally for other than heating is a ____.
   a. Hot water heating boiler
   b. Steam boiler
   c. hydro heat boiler
   d. hot water supply boiler

121) One gallon of propane gas contains approximately_____BTUs of energy.
   a. 91,500
   b. 100,000
   c. 105,000
   d. 144,000

122) The unthreaded portion of gas piping shall extend a minimum of ____.
   a. 1/2 inch
   b. 1 inch
   c. 1-1/2 inches
   d. 2 inches

123) Which of the following is a registered design professional?
   a. A licensed plumber
   b. professional draftsman
   c. a licensed professional engineer
   d. any of the above

124) Condensate piping to a condensing appliance shall be minimum _____inches diameter.
   a. 3/8
   b. 1/2
   c. 5/8
   d. 3/4
125) A category I appliance cannot be connected to vent whose effective area is_________times or greater than the appliance draft hood outlet area.
   a. 3
   b. 5
   c. 7
   d. 8

126) Type L or type B gas vent shall terminate minimum of ____ feet above the highest connected equipment draft hood or flue collar.
   a. 10
   b. 6
   c. 5
   d. 4

127) A BTU equals the amount of heat required to raise the temperature of one lb. of water one degree F, therefore _______ BTUs are required to raise 10 lbs. water 60 degrees F.
   a. 60
   b. 6
   c. 600
   d. 6000

128) The maximum design operating pressure for gas piping systems located inside a residence shall nor exceed __ PSI unless the piping system is welded or in a ventilated chase.
   a. 1/2
   b. 2
   c. 5
   d. 10
Common Business and Law Questions

129) Conspiring with others to influence the outcome of a bid is called _____.
   a. bid shopping
   b. bid rigging
   c. conspiracy bidding
   d. good business

130) Comprehensive general liability insurance protects your company against claims for_____.
   a. inferior product quality
   b. bodily injury to non-employees
   c. bodily injury to employees and non-employees
   d. injury caused by your motor vehicles

131) A company has annual sales of $850,000 with $230,000 overhead. What is the percentage?
   a. 27%
   b. 32%
   c. 37%
   d. 18%

132) A federal ID number (EIN) is required by all businesses except.
   a. a sole proprietorship with no employees
   b. a partnership with no employees
   c. an S corporation
   d. a corporation with no employees

133) When an acceptance of a contract changes any of the terms, it is considered_____.
   a. binding
   b. voided
   c. a counter-offer
   d. illegal
134) A bond that guarantees to the owner that a project will be completed according to the terms and conditions of the contract is called a _____.
   a. performance bond
   b. bid bond
   c. c. payment bond
   d. d. completion bond

135) The fine for a first time code violation is _____.
   a. $25
   b. $50
   c. $100
   d. $150

136) Disabilities covered by the Americans with Disabilities Act include all the disabilities below except_____.
   a. hearing
   b. seeing
   c. breathing
   d. broken bones

137) A plumbing license expires on_____ each year.
   a. June 31
   b. September 30
   c. January 31
   d. December 31

138) If you annual sales are $897,200 what would your overhead be if your company has been operating with 15% overhead?
   a. $13,458
   b. $134,580
   c. $15,867
   d. $158,670

139) Generally, the most difficult aspect of estimating a job is estimating _____.
   a. material costs
   b. interest expense
   c. equipment needed
   d. labor costs
140) The most accurate method of estimating cost is _____.
   a. the square foot method
   b. material and labor take off method
   c. cubic foot method
   d. approximate guess method

141) Which of the following is not company overhead?
   a. labor wages
   b. utilities wages
   c. utilities
   d. advertising
   e. telephone bill

142) How much is saved when a 1.5% discount is taken on a $23,678 invoice?
   a. $3.55
   b. $35.17
   c. $355.17
   d. $3551.70

143) The Fair Labor Standards Act, which establishes minimum wage, child labor conditions and overtime pay applies to all employers who have _______ or more employees.
   a. one
   b. five
   c. eight
   d. ten

144) According to the Fair Labor Standards Act, an employee that works 40 hours for the week plus takes an 8 hour vacation day_____.
   a. will be paid time and one-half for 8 hours
   b. will be paid straight time for all 48 hours
   c. will be paid overtime for all 48 hours
   d. cannot be paid for vacation time

145) When you increase your price, which of the following increase.
   a. profit
   b. cost
   c. overhead
   d. labor
146) A contract bond protects .
   a. the contractor
   b. the employees
   c. the sub-contractors
   d. the owner

147) Detailed and precise descriptions of the work to be performed are called_____.
   a. specifications
   b. rules for bidding
   c. obligation sheet
   d. general conditions

148) Which of the following is not considered when applying for a bond?
   a. past performance
   b. contractors financial condition
   c. contractor's experience
   d. owner's financial condition

149) A company has $278,000 in assets and $1,92,000 in liabilities; what is the owners?
   a. $470,000
   b. $376,000
   c. $86,000
   d. $76,000

150) When using a cash basis for accounting, ______.
   a. you may change to an accrual basis if there is a tax advantage
   b. you may write off bad debts
   c. you may not know what has actually been earned
   d. you will know what has been collected and what has been paid
Answer Key

1. a Table 604.5
2. c 307.2.1
3. c 40 foot rule 916.2, Table 710.1(2),
4. d 708.4
5. c 605.14.3
6. b 31 2.9.1
7. a 705.5.3
8. a or b Table 706.3 (Some codes differ, check footnote)
9. b 202 definitions
10.c Table 308.5
11.c
12.a Some codes differ, check 202 definition building drain
13.b Table 604.3
14.c 202 definitions
15.b 607.4
16.d 910.2
17.c 708.7 exception 1
18.c 202 definitions
19.d 312.7
20.a 709.4
21.b 912.2.2
22.a Table 706.3
23.a 310.4 exception 2, Some codes differ, read section
24.c 609.2
25.d 305.1
26.c 31 4.2.3
27.b Table 702.3
28.d 314.2.2 this section deleted in some codes
29.a 604.3.1 ICC/ANSI Accessibility code
30.a Table 916.1
31. b  Table 606.5.4
32. b  904.2
33. d  802.2
34. c  Table 710.1(1), 40 foot rule 916.2
35. a  Table 916.5.1
36. b  403.6.1
37. d  202 def tempered water
38. d  608.3.1
39. b  312.1.1.1
40. a  304.2
41. d  1003.3.4
42. b  Table 709.1 and Table 912.3
43. d  605.21.3
44. b  307.3.3.3.2
45. c  Table 710.1(2)
46. a  202 def grease trap, 50 GPM requirement removed in 2009 code
47. a  Table 604.3
48. b  Table 604.4 see footnote a
49. c  Section 202 (see Chapter 2 – Definitions)
50. b  Section 402.4
51. c  Section 605.9
52. c  Sections 303.1 and 302.2
53. b  Section 608.15.4.2, exception 1
54. c  Section 608.15.4
55. d  Table 608.15.1
56. d  Section 708.7
57. b  Section 307.4
58. d  Section 71.2.4.2, exception 2
59. d  708.3.3
60. c  Table 604.4
61. c  Section 307.2.3.1, exception 1 and 307.3.2.1.2
62. a  608.13.2
63. a  604.8.2 ICC/ANSI
64. b 410.1  
65. a 312.4  
66. c 312.2 (some codes allow 3 feet) for residences  
67. d 307.2.2  
68. a 71 2.3.4  
69. b Table 710.1(1)  
70. b 402.3  
71. d 607.8 ICC/ANSI  
72. b 912.2 Accessibility Code  
73. d Table 308.5  
74. c Table 605.4  
75. a 413.2  
76. c Table 605.3  
77. c 312.6  
78. b 502.2  
79. b 1003.6  
80. c Table 308.5  
81. a 904.1  
82. c 604.2 ICC/ANSI. Accessibility code  
83. c 202 def grease trap, Only defined in 2006 and earlier codes  
84. b Add 1/2 pipe size when over 40 feet  
85. d 909.1  
86. a 1003.4.2.1  
87. c 305.8  
88. c Table 709.1 and Table 912.3  
89. d 71 3.7.2  
90. d Section 802  
91. c 701.9 (some codes do not allow drainage pipes above food prep)  
92. b 908.2  
93. c 409.2  
94. b 712.2 (exception ?)  
95. d 202 Definition leader  
96. d 417.3
97. d 604.3
98. a 609.3 ICC/ANSI, Accessibility Code
99. d 604.5.1 ICC/ANSI, Accessibility Code
100. c Table 604.10.1
101. a 405.3.1d
102. a Table 706.3, not restricted by footnotes
103. d 303.3
104. b Table 916.1
105. a 605.16.2
106. b 604.8.1
107. c 403.6
108. a 404.3
109. c vol=LXWXH
110. a Figure 503.6.6
111. a study vent tables
112. d 411.1.2 Note 2003 code says 3"
113. a 406.1.1 and 406.1.2 exception
114. c Table 403.9.2
115. c 503.10.8
116. c 60 square inches/.60 = 100
117. b Section 101
118. b 404.9
119. c 304.12
120. d Definition – boiler, low pressure
121. a
122. b 404.13
123. c Definition – registered design professional
124. d 307.2
125. c 503.6.9.1
126. c 503.6.7
127. c
128. c
129. b
130. b
131. a 230000/850000=27
132. a
133. a
134. a
135. b NYS plumbing contractor law
136. d
137. d NYS plumbing contractor law
138. b .15x$897,200
139. d
140. b
141. a
142. c
143. a
144. b
145. a
146. d
147. a
148. d
149. c
150. c