Construction Blueprint Reading Unit # 107

Construction Blueprint Reading II

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Chapter 1

HVAC System Blueprints

Objectives:

At the end of this chapter, students will be able to:

1). Comprehend the major components of a commercial HVAC system.
2). Understand the basic HVAC systems and how they function in commercial applications.
3). Compare mechanical drawings with architectural drawings and recognize the impacts on the drywall-lathing scope of work.

Introduction

The main purpose of commercial HVAC (heating, ventilating and air conditioning) systems is to provide the people inside buildings with a comfortable and safe working environment by providing “conditioned” air. Movement of conditioned air includes having the air clean, odor free and within a certain temperature and humidity range. A range or comfort zone between 68 degrees to 79 degrees, with 30 cubic feet per minute of air movement, is considered as acceptable design criteria for commercial buildings.

Normal body temperature is 98.6 °F. Food and other items we eat or take into our bodies is converted into energy in the form of heat that maintains the body's temperature, so this heat must be dissipated or taken away. With a body temperature of 98.6 °F, it is well noted that a comfort heating system does not warm us up. All it does is adjust inside conditions so the rate of body heat dissipation makes a person feel comfortable.

If heat is dissipated too fast, occupants feel cool; too slow, they feel hot and perspire. When air temperature and humidity are so high the body cannot rid itself of the heat fast enough, steps must be taken to cool and dry the air for comfort.

Components of HVAC Systems

The volume of air required to heat, cool and provide good indoor air quality is calculated based on the heating, cooling and ventilation loads. The air volume to be moved through the HVAC system is calculated in units of cubic feet per minute or cfm by the mechanical engineers, under the supervision of the project architect. The diagram below shows the major components of a HVAC system found in many commercial buildings. Following is a brief description of how the components work together as a system.

Once the air volume is calculated, the "conditioned" air is supplied by the ductwork and delivered through diffusers to the work area. The air then circulates and flows through the return air duct back to the air handler unit. At this point, some of the returned air is exhausted to the outside and an amount equal to the exhausted air is made up with clean fresh air and mixed with the circulated air. Dampers control the intake and exhaust functions and the return and supply fans move the air through the filters, over the coils and back to the conditioned space and the process starts over again. The air passes over both heating and cooling coils with the desired coil providing either heating or cooling. Air balancers, located in the ductwork, "balance" the amount of airflow in individual rooms. Each diffuser is measured for airflow and compared with the calculations of the engineers. Airflow can then be increased or decreased at the diffusers by opening or closing a damper to balance the system. Circulated air replaces the conditioned air lost through the walls, roof, windows and doors, maintaining the interior environment at the desired temperature.

One very important process HVAC systems provide, which is often overlooked, is ventilation of the workspace. Humans exhale carbon dioxide as they breathe, which is a contaminant. Another contaminant could be cigarette smoke. Obviously, a buildup of contaminants would not be healthy; therefore buildings especially with fixed windows require ventilation. Ventilation is the process of supplying outside air to buildings in the proper amount to offset the contaminants and odors produced by people and equipment providing a healthy work environment.

Component Definitions

BLOWERS vs. FANS: Blowers and fans both produce air movement. Centrifugal blowers (sometime called a squirrel cage) can produce higher air pressures that make them suitable for duct systems. Axial fans (resemble a propeller) are less expensive and are usually used when you have little resistance to airflow.

BTU (BRITISH THERMAL UNIT): Energy; the amount of heat required to raise one pound of water by one degree.

BUILDING ENVELOPE: The imaginary shape of a building indicating its maximum volume; a transition space where the interaction between outdoor forces and indoor conditions can be watched.

COMPRESSOR: The pump in a mechanical refrigeration system that compresses the refrigerant vapor into a smaller volume, thereby raising the pressure of the refrigerant and consequently its boiling temperature.

CONDENSATE: The liquid formed by condensation of a vapor: in steam heating, water condensed from steam; in air conditioning, water extracted from air as by condensation on the cooling coil of a refrigeration machine.

DAMPER: A device used to vary the volume of air passing through an air outlet, inlet, or duct.

DIFFUSER: The outlet for the air in the ductwork or air delivery system.

DUCTWORK: The ductwork or duct system used to deliver conditioned air to the respective areas to be conditioned. The system is designed to deliver the correct amount of air to each area.

DUCT RUNOUTS: The end of the ductwork, as in diffuser locations where air leaves the duct.

EXFILTRATION: The outward flow of air through a wall, joints, etc.

EXTENDED PLENUM: This is a trunk duct of constant size (usually at the

discharge of a fan, fan coil unit, mixing box, constant volume box, etc.) extended as a plenum to serve multiple and/or branch ducts (see Semi-Extended Plenum).

EXTRACTOR: A device located at the tee of two ducts that is used to direct air-flow. It is used mainly to divert air to branch takeoffs.

FAN: Is an air pump that causes airflow by creating a pressure difference.

HEAT EXCHANGER: A device specifically designed to transfer heat between two physically separated fluids.

INFILTRATION: The seepage or flow of air into a room or space through cracks around windows, under doors, etc.

INTERNAL HEAT GAIN: Heat generated from within the space being considered from sources such as people, lights, motors, etc.

PLENUM: A compartment, area or duct used to gather air.

THERMOSTAT: An automatic control device actuated by temperature.

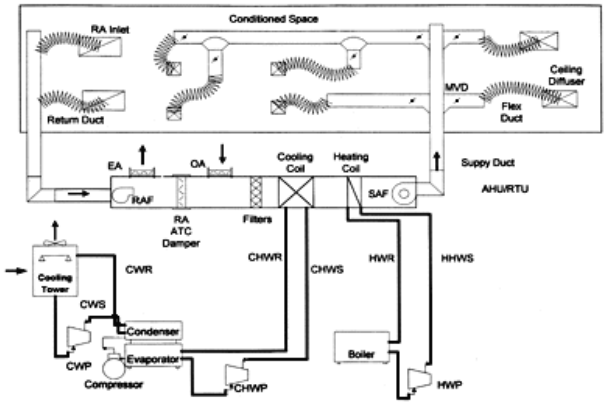
TRUNK DUCT: The main duct from which branch ducts extend.

VAV BOX: Sometimes referred to as a VAV terminal. This box has controlled dampers inside that vary the volume of air sent to the controlled space.

VENTILATION: Bringing in outside air by use of a mechanical system.

ZONE: The specific section of a building controlled by a single thermostat. Buildings may be divided into many zones.

HVAC System Components



System Components:

CWP- Condenser Water Pump
CWS- Condenser Water Supply
CWR- Condenser Water Return
CHWP- Chilled Water Pump
CHWS- Chilled Water Supply
CHWR- Chilled Water Return
HWP- Hot Water Pump
HWR- Hot Water Return
RA Inlet- Return Air Inlet
RAF- Return Air Fan
EA- Exhaust Air
OA- Outside Air
AHU- Air Handler Unit
RTU- Roof Top Unit
MVD- Manual Volume Dampers
SAF- Supply Air Fan

Types of HVAC Systems

There are three basic types of HVAC systems used in commercial construction today. They are: air and water, all water or all air. Water systems are also called hydronic systems. Hydronic is a term used for heating and cooling with liquids.

The all air systems provide heated or cooled air to the conditioned space through a ductwork system. In the typical system, cooling and heating is accomplished with the air passing over a refrigerant coil (cooling) or a heat exchanger (heat).

The basic air-water system is similar to the all-air system with air flowing over chilled water coils instead of refrigerant coils for cooling and hot water coils for heating. The previous example shown above would be considered an air-water system.

All-water systems accomplish space cooling by circulating chilled water from a central refrigerant system through cooling coils in air handling units located in the conditioned space. The same air-handling units provide heat for the conditioned space by circulating heated water from a boiler through the unit.

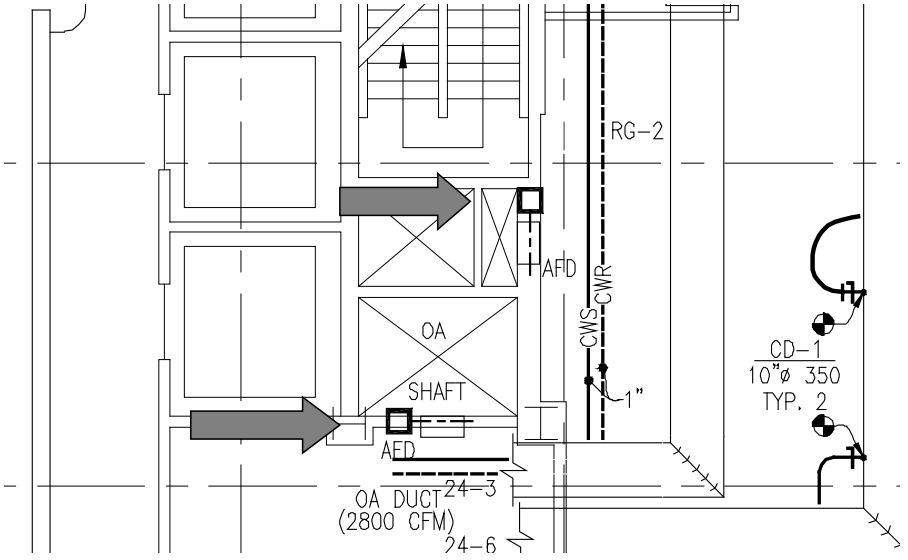
HVAC Drawings and Architectural Drawings

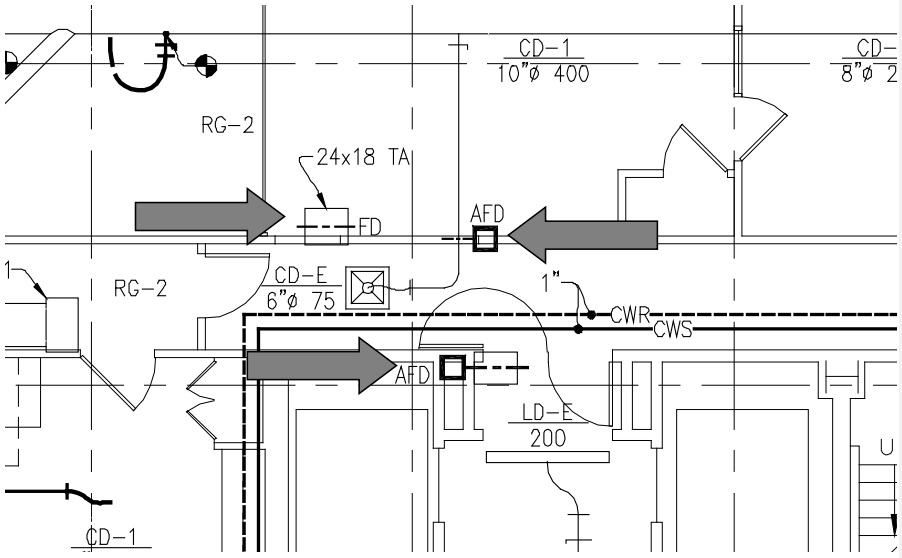
As apprentices, you will be introduced to shaftwall installation along with hanging gypsum wallboard. You probably have installed coreboard, possibly not realizing its purpose. Maybe you have rocked the roof of a building with gypsum wallboard, creating a return air plenum between the t-bar and the roof. Or you have framed and wrapped for fire damper penetrations in a rated wall. All of this work will be located in the mechanical or architectural drawings and is coordinated between the drywall/lathing and HVAC foremen.

Some of the work we do framing walls or hanging gypsum wallboard relates to the other trades such as HVAC or the UBC- Uniform Building Code. We are not going to teach you how to read HVAC drawings in detail, but how to recognize the basic features such as ducts and their direction of installation, fire dampers, shafts and plenums. Coordinating the drywall/lathing work with the HVAC subcontractor is very important to having your job run smoothly.

The drawings on the following page are excerpts from mechanical drawings showing automatic fire dampers “AFD” or fire dampers “FD” located in the shafts and walls. As you can see, locating the fire dampers is easy, but at what height are they to be framed and what are the opening sizes? You may want to use the mechanical drawings to locate the dampers affecting the partitions you will be building and then coordinate the opening sizes and mounting heights with the HVAC foreman.

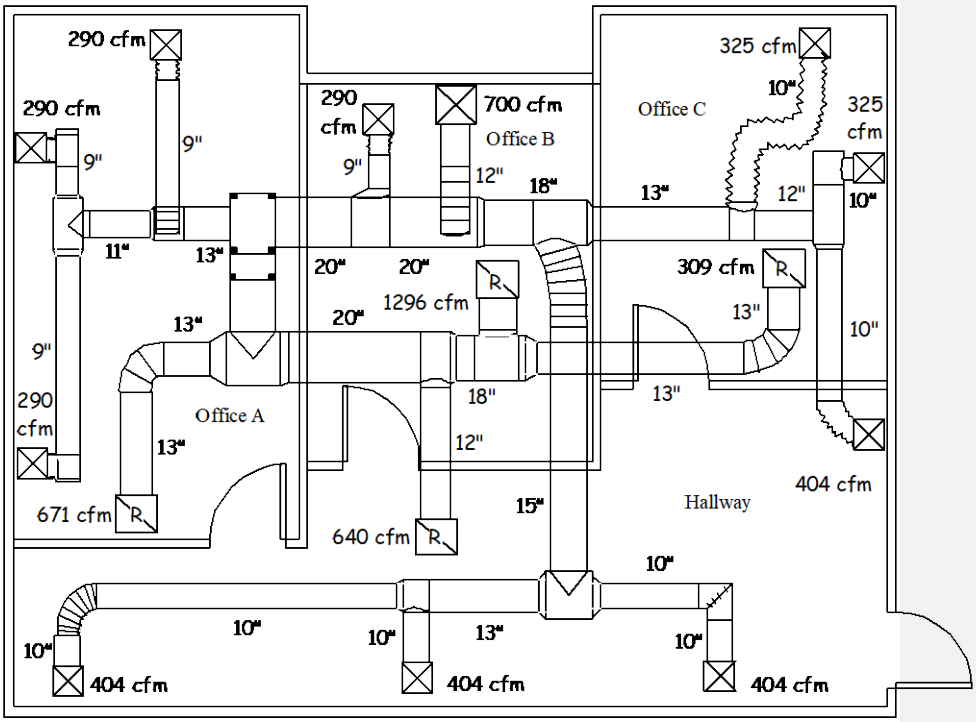
Fire Dampers as Shown on Mechanical Drawings

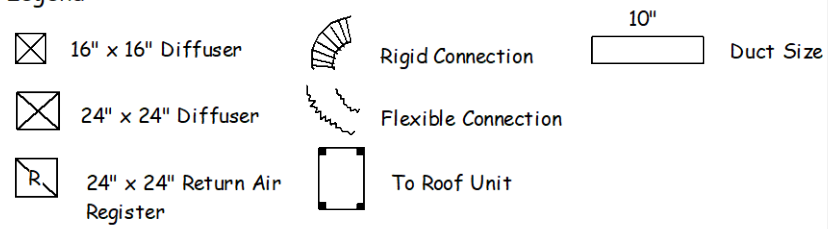




The following drawing is a simple job and a typical HVAC ducting plan.

HVAC Ducting Plan





As you can see the duct layout is superimposed over the wall layout, which is typical on most HVAC duct plans. Notice how the ductwork goes from larger to smaller in size, thereby maintaining the required volume of air

movement at the diffuser. The diffusers show the cubic feet per minute of required airflow as calculated by the engineers along with the size of the ductwork supplying that particular diffuser. Rigid or flexible pipe connects each diffuser to the ductwork.

Looking at the duct plan on the previous page, how many areas would concern you if this were your job? Suppose you have full height rated walls to build and the HVAC subcontractor ran his ducts before you rocked. Could it be rocked then? In addition to those areas, ductwork penetrates the walls seven times, so there might be seven damper sizes to frame and wrap with rock. We will assume the ceilings are t-bar or there could be fifteen more penetrations to frame. Again, you are not going to know the size to frame the damper or diffuser openings, even if the size is shown on the drawings. The best thing to do is have the HVAC foreman layout the locations, RO sizes and height dimensions prior to the framing. So when the framers come through, it is written in the bottom track or on the floor and it gets framed.

The mechanical duct plan(s) should show registers or diffusers impacting your hard ceilings if the architectural reflected ceiling does not. Again, make sure the HVAC ducting is not being installed directly above any full height partitions hampering your ability to frame the partitions. Look at the mechanical plans for direction of the duct installation in relation to your wall framing for potential conflicts or problems. The same goes for draftstops, if you can install the draftstops before the mechanical subcontractor installs his ductwork, it will save a lot of time and labor. By looking at the HVAC drawings, you should have an understanding of how the mechanical work will affect your work and what areas call for coordination with the HVAC subcontractor.

Chapter 1

HVAC Study Guide

Directions:
Answer the following questions using the bubble answer sheet.

1). The duct layout drawing is usually shown superimposed over the wall layout.
A). True
B). False

2). Hydronic is a term used for heating and cooling with liquids.
A). True
B). False

3). The all air systems provide heated or cooled air to the conditioned space through a ductwork system.
A). True
B). False

4). One very important process HVAC systems provide, which is often overlooked, is contamination of the workspace.
A). True
B). False

5). The air volume to be moved through the HVAC system is calculated in units of cubic yards per minute.
A). True
B). False

6). The volume of air required to heat, cool and provide good indoor air quality is calculated based on the heating, cooling and ventilation loads.
A). True
B). False

7). Ventilation is the process of supplying outside air to buildings in the proper amount to offset the contaminants and odors produced by people and equipment providing a healthy work environment.
A). True B). False

8). Dampers control the intake and exhaust functions in an HVAC system.
A). True
B). False

9). Ductwork goes from larger to smaller in size, thereby maintaining the required volume of air movement at the diffuser.
A). True
B). False

10). All-water systems accomplish space cooling by circulating chilled water from a central refrigerant system through cooling coils.
A). True
B). False

Chapter 1

HVAC Exercise #1

Directions: Name: _____

Match the following definitions to the choices given below.

A). Duct Runout
B). Damper
C). Exfiltration
D). Thermostat
E). Fan
F). Plenum
G). Diffuser
H). BTU
I). Ductwork
J). Infiltration
K). Zone
L). Ventilation

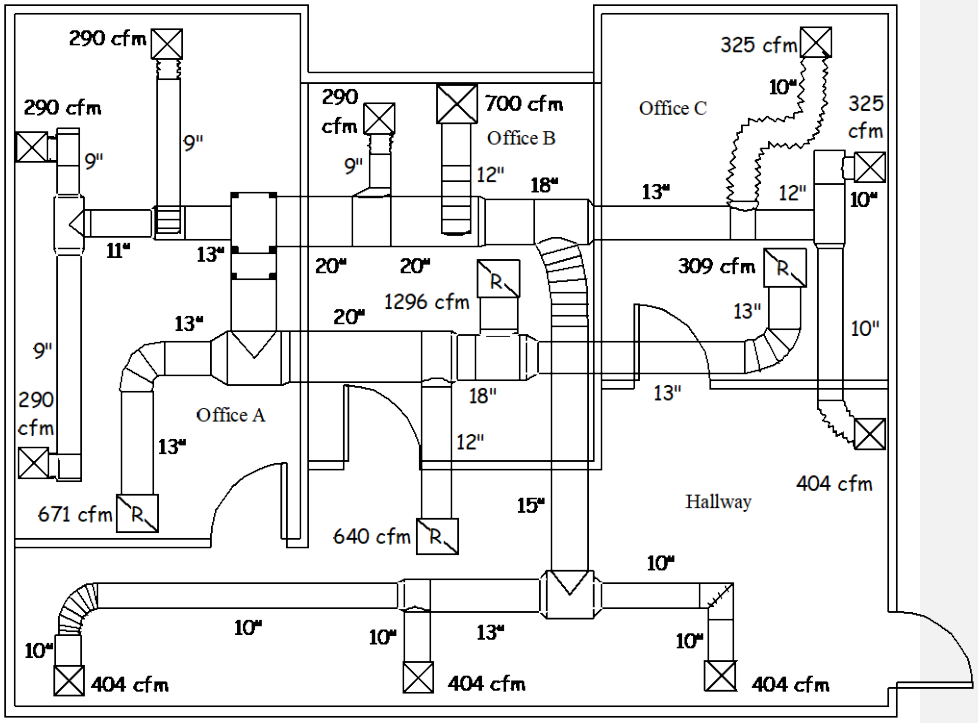
1). _____ Bringing in outside air by use of a mechanical system.
2). _____ An air pump that causes airflow by creating a pressure difference.
3). _____ An automatic control device actuated by temperature.
4). _____ A device used to vary the volume of air passing through an air outlet, inlet, or duct.
5). _____ The outward flow of air through a wall, joints, etc.
6). _____ A compartment, area or duct used to gather air.
7). _____ The specific section of a building controlled by a single thermostat.
8). _____ The seepage or flow of air into a room or space through cracks around windows, under doors, etc.
9). _____ The amount of heat required to raise one pound of water by one degree.
10). _____ The system used to deliver conditioned air to the respective areas to be conditioned. The system is designed to deliver the correct amount of air to each area.
11). _____ The outlet for the air in the ductwork or air delivery system.
12). _____ The end of the ductwork, as in diffuser locations where air leaves the duct.

Chapter ?

HVAC Exercise #2

Directions: Name: _____

Answer the following questions using the HVAC drawing below and the answer bubble sheet.



Legend:

- 16" x 16" Diffuser
- 24" x 24" Diffuser
- 24" x 24" Return Air Register
- Rigid Connection
- Flexible Connection
- To Roof Unit
- 10" Duct Size

1). Which room has the ductwork returning to the roof?
A). Office A
B). Office B
C). Office C
D). Hallway

2). How many return air registers are located in each room?
A). 1
B). 2
C). 3
D). 4

3). What is the total “cfm” for the supply air in Office B?
A). 1296
B). 990
C). 870
D). 640

4). What size duct serves the return air register in the Hallway?
A). 9”
B). 10”
C). 12”
D). 20”

5). What is the total “cfm” for the supply air in the Hallway?
A). 990
B). 870
C). 1616
D). 640

6). What is the largest size duct serving Office C?
A). 20”
B). 13”
C). 12”
D). 9”

7). What is the total “cfm” for the supply air in the Office A?
A). 870
B). 990
C). 1616
D). 640

8). How many 16” x 16” supply diffusers are there?
A). 8
B). 9
C). 10
D). 12

9). How many 24” x 24” supply diffusers are there?
A). 1
B). 2
C). 3
D). 5

10). What size duct serves the 24” x 24” supply diffuser in Office B?
A). 9”
B). 10”
C). 12”
D). 13”

11). If each supply and return duct penetrating a wall required a fire damper, how many fire dampers would you need to frame for?
A). 4
B). 5
C). 6
D). 7

12). What size duct serves the return air register in Office C?
A). 9”
B). 10”
C). 12”
D). 13”

Chapter 2

Electrical System Blueprints

Objectives:

At the end of this chapter, students will be able to:

1). Understand basic electrical terms, symbols and diagrams when reading electrical blueprints.
2). Realize how electricity is distributed in a commercial building.
3). Know how to research electrical drawings for information relating to the drywall and lathing trades.

Introduction

Electrical drawings used in commercial construction will range from simple line drawings showing outlets, light fixtures and switching on a single drawing to complex drawings having a multiple sheets for the outlets, light fixtures and switching. Multifaceted electrical prints contain schedules for light fixtures, panels and equipment, further providing information needed for construction.

Electrical blueprints contain many drawings similar to the architectural blueprints, for instance you will usually find a reflected ceiling plan, although it may be called a lighting plan. The power plan showing telephone outlets and receptacles is overlaid on the floor plan. Obviously, all the sheet notes will pertain to the electrical construction instead of architectural construction. Because you are already familiar with similar drawings, understanding electrical drawings will become easier once you learn a few electrical terms, symbols and what information is important to the drywall/lather.

Electrical System for Buildings

Electricity enters a building through the service entrance. The electricity travels the way of conductors from the utility pole, service head and mast, through the meter to the service equipment. Commercial buildings sometimes

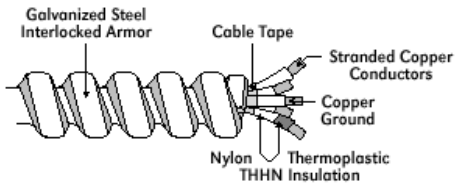
require the use of feeder circuits, which distributes a large block of power from the service equipment to a sub-feeder panel or a branch circuit panel as shown above.

From the distribution panel, circuits complete the intended path of electricity, to the mechanisms (lights, receptacles, etc.) and back to the source. An electric current flows along a conductor, approximately the speed of light, 186,000 miles per second.

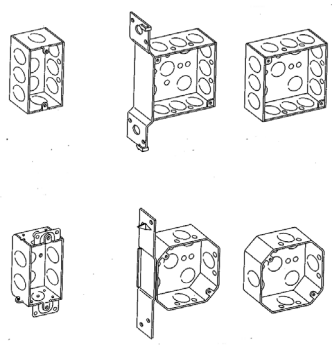
The wire or conductors must be run in conduit called pipe or EMT (electrical metallic tubing). Popular today is a product called MC (metal clad) cable where the wire is factory installed in the conduit and the cable is flexible, which eliminates the need of bending pipe. Conduit or MC cable attaches to metal boxes as shown below, so electrical connections can be made as called for on the drawings.

Any roughed in electrical or plumbing work will need to be inspected prior to installing any wallboard. Most cities will required these inspections before the framing inspection, so it would be your responsibility to verify these inspections prior to calling for the framing inspection.

MC Cable



Metal Boxes



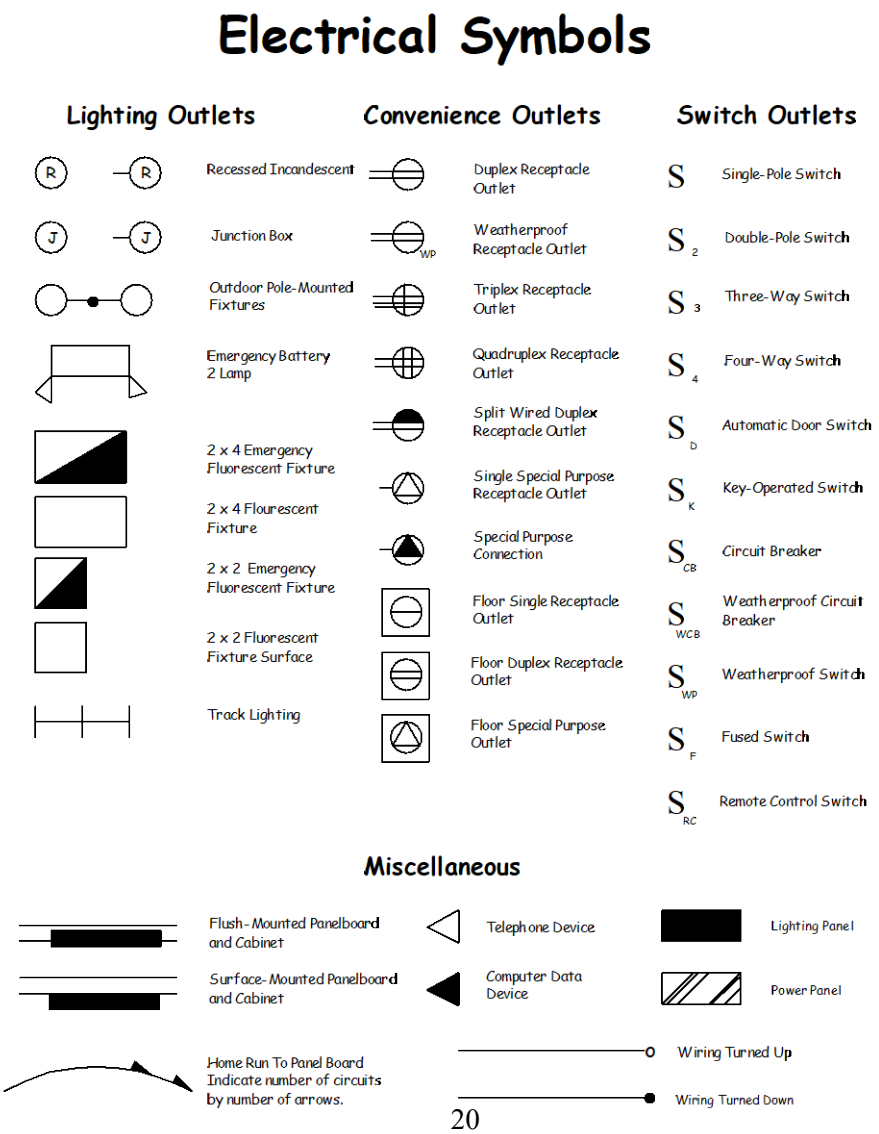
Electrical Terms

Following are some of the most common terms used in electrical construction:

Ampere -- The practical unit of electric current flow. If a one ohm resistance is connected to a one volt source, one ampere will flow.
AWG -- American Wire Gage. This term refers to the U.S. standard for wire size.
Circuit -- A complete path over which an electric current can flow.
Circuit Breaker – A switching device that automatically opens a circuit when the circuit has been overloaded.
Conductor – A wire or material used to carry the flow of electricity.
Conduit-A tubular raceway for data or power cables. Metallic conduit is common, although non-metallic forms may also be used.
Convenience Receptacle—An outlet where current is taken from a circuit to serve electrical devices.
Current -- The movement of electrons through a conductor; measured in amperes, milliamperes, and microamperes.
Distribution Panel—The insulated panel or box which receives current from the source and distributes it through branch circuits to various points in the building.
Feeder -- A circuit, such as conductors in conduit or a busway run, which carries a large block of power from the service equipment to a sub-feeder panel or a branch circuit panel or to some point at which the block power is broken into smaller circuits.
Ground -- A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.
Ground Fault Circuit Interrupter -- A device intended for the protection of personal that functions to de-energize a circuit.
NEC- National Electrical Code.
Service Entrance—The conductors from the utility pole, service head and mast, which bring the electrical current to the building through the meter to the distribution panel.
Transformer -- An apparatus used for changing the voltage and current of an alternating circuit.
Unit of Current -- The practical unit of current is the ampere, which is the current produced by a pressure of one volt in a circuit having a resistance of one ohm.
Voltage--The electromagnetic force, which causes current to flow through a conductor (wire).

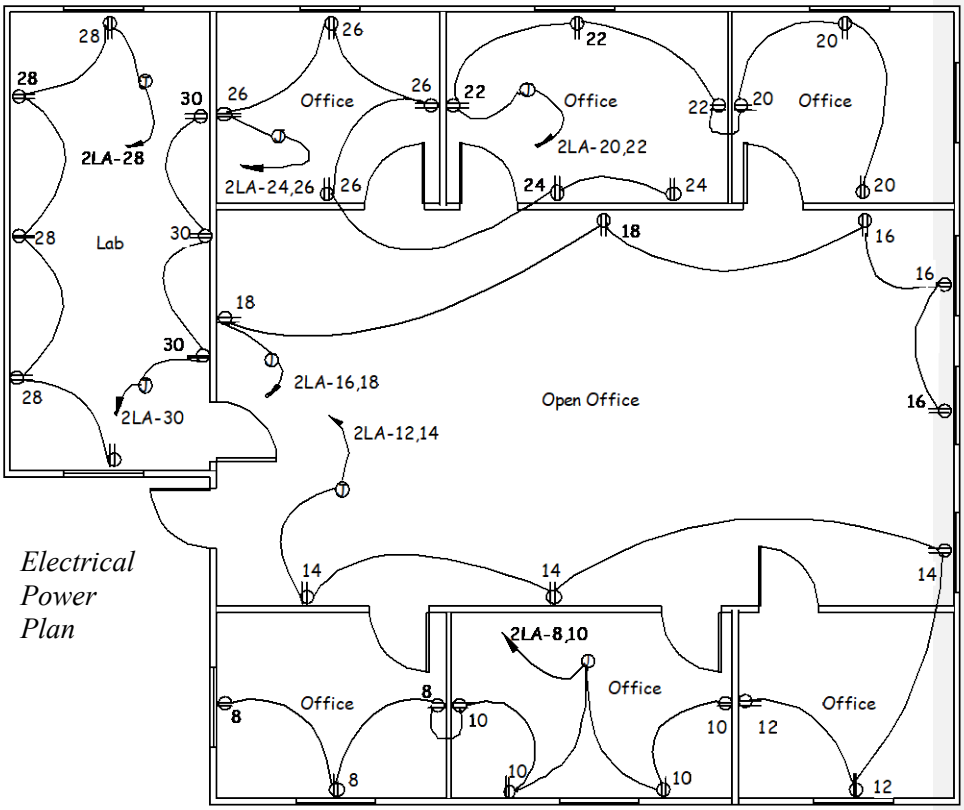
Electrical Symbols

Electrical drawings will contain many different symbols and to read electrical drawings effectively, you will need to interpret these symbols properly. Most architects will provide a symbol legend explaining the symbols used in that particular set of blueprints. These symbols are standard symbols and are common to all drawings. Once you become familiar with them, you will recognize them in each set of drawings you use.



Electrical Plans

Drywall/Lathers should have a basic understanding of the electrical drawings and be able to identify the receptacles, switches, distribution panel(s) and most importantly the lighting fixtures. On the drawing below, note how the outlets are grouped together and connected by single line. This line is really conduit, placed where the electrician deems it appropriate or practical. The line or circuit then connects to a junction box and is directed back to the distribution panel. When a run of conduit goes to the distribution panel, it is called a "home run", you may have heard this term used before. Each conduit run is a single circuit as designated by the single arrowhead, going to panel "2LA" as shown in the drawing below. If two circuits were contained in one conduit, there would be two arrowheads. All of the receptacles are identified on the drawing with a number and each circuit breaker will be labeled with the corresponding receptacle numbers at the distribution panel.

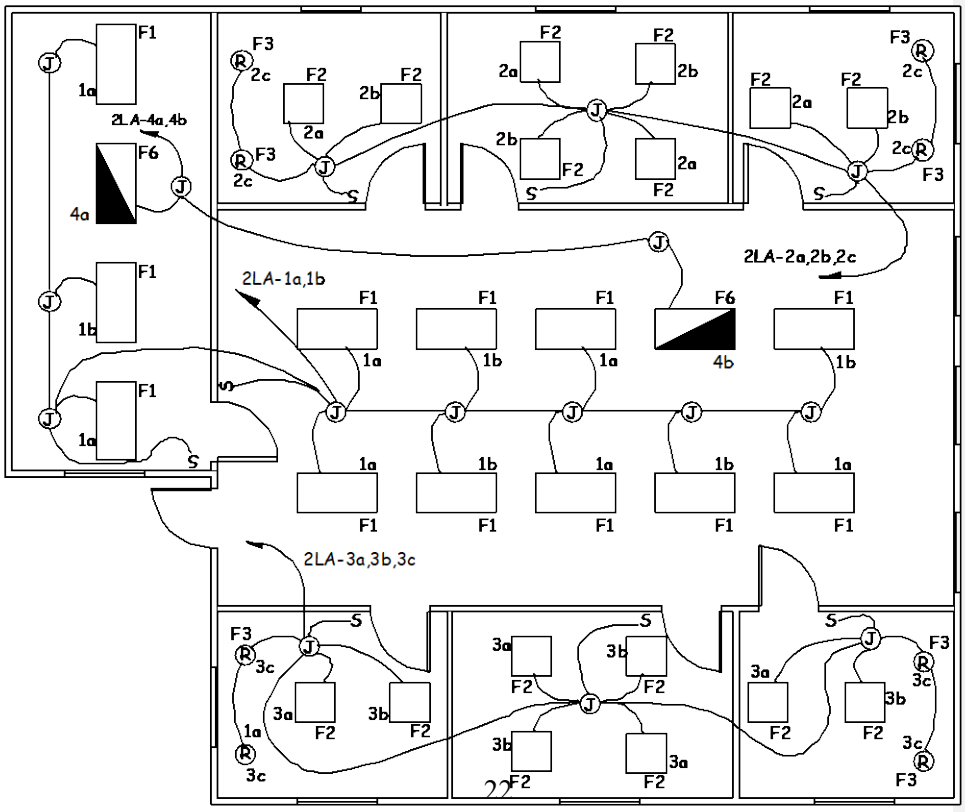


Electrical Power Plan

On the lighting plan shown below, you have circuits going back to the distribution panel similar to the power plan. Note how each light fixture has identification, such as F1, F2 or F3.

If the plans specify gypsum board ceilings, you would need to know how these lights are going to mount in the ceilings along with the layout of the light fixtures. To find how a light fixture will mount, locate a lighting schedule, sometimes called a fixture schedule, in the electrical blueprints. The fixtures will be listed in the schedule as they are found on the drawing, so you will need to cross-reference between the schedule and the drawing. The lighting schedule will list all the fixtures used on the project along with information about mounting, manufacturer, voltage and any remarks about the fixture. The electrical lighting plan may also show a dimensioned layout for the light fixtures or the architectural reflected ceiling plan will have layout information. Although the schedule has the mounting or attachment information for the fixture, you will need to verify the actual rough opening or backing dimensions with the electrical contractor.

Electrical Lighting Plan



An example of a fixture schedule for the previous lighting plan is shown below. The architect will list the “mark” or identification number of the fixture as well as the manufacture, catalog number, voltage and the type of mount. Depending on how many fixtures there are on the job, the fixture schedule could contain a few fixtures or many fixtures with multiple schedules.

Lighting Fixture Schedule

Fixture Schedule					
Mark	Manufacture	Voltage	Mount	Cat. No.	Remarks
F1	Lowell	120-277	Surface	GT-46	
F2	Lowell	120-277	Surface	KH-03	
F3	Lowell	120	Recess	TR-11	Insulation Rated
F4	Lowell	120-277	Pendant	DS-65	
F5	Lowell	120	Surface	LK-34	Wall Bracket
F6	Lowell	120-277	Surface	NN-84	Emergency
F7	Lowell	120-277	Surface	LK-36	6'-0" AFF
F8	Cooper	208	Pole	12309	See Site Plan

Chapter 2

Study Guide

Directions:
Answer the following questions using the bubble answer sheet.

1). Multifaceted electrical prints contain _____ for light fixtures, panels and equipment, further providing information needed for construction.
A). Directions
B). Schedules
C). Plot plans
D). None of the above

2). If the plans specify gypsum board ceilings, you would need to know how the lights are going to _____ in the ceilings.
A). Mount
B). Layout
C). Both A & B
D). None of the above

3). When a run of conduit goes to the distribution panel, it is called a _____.
A). Return
B). Feeder
C). Home run
D). Branch circuit

4). Electricity enters a building through the _____ _____.
A). Service entrance
B). Underground vault
C). Distribution panel
D). Branch circuit

5). An electric current flows along a conductor, approximately the speed of light, 186,000 miles per second.
A). True
B). False

6). Commercial buildings sometimes require the use of _____ _____, which distributes a large block of power from the service equipment to a sub-feeder panel or a branch circuit panel.
A). Feeder circuits
B). Service entrances
C). Circuit breakers
D). None of the above

7). Wire or conductors must be run in conduit called pipe or EMT (electrical metallic tubing).
A). True
B). False

8). From the distribution panel, _____ complete the intend~~ed~~ path of electricity, to the mechanisms (lights, receptacles, etc.) and back to the source.
A). Outlets
B). Circuit breakers
C). Circuits
D). None of the above

9). Most architects will provide a symbol _____ explaining the symbols used in that particular set of blueprints.
A). Diagram
B). Schedule
C). Legend
D). None of the above

10). Conduit or MC cable attaches to metal _____, so electrical connections can be made as called for on the drawings.
A). Raceways
B). Boxes
C). Outlets
D). None of the above

Chapter 2

Electrical Exercise #1

Directions:

Match the following definitions to the choices given below.

A. Circuit	G. Conductor
B. Current	H. Distribution Panel
C. NEC	I. Circuit Breaker
D. Transformer	J. AWG
E. Voltage	K. Service Entrance
F. Ampere	L. Ground Fault Circuit Interrupter

1). _____ The practical unit of electric current flow. If a one ohm resistance is connected to a one volt source, one ampere will flow.
2). _____ The insulated panel or box which receives current from the source and distributes it through branch circuits to various points in the building.
3). _____ National Electrical Code.
4). _____ A complete path over which an electric current can flow.
5). _____ The electromagnetic force, which causes current to flow through a conductor (wire).
6). _____ An apparatus used for changing the voltage and current of an alternating circuit.
7). _____ The movement of electrons through a conductor; measured in amperes, milliamperes, and microamperes.
8). _____ American Wire Gage. This term refers to the U.S. standard for wire size.
9). _____ A wire or material used to carry the flow of electricity.
10). _____ A switching device that automatically opens a circuit when the circuit has been overloaded.
11). _____ The conductors from the utility pole, service head and mast, which bring the electrical current to the building through the meter to the distribution panel.
12). _____ A device intended for the protection of personal that functions to de-energize a circuit.

Chapter 2

Electrical Exercise #2

Directions: Name: _____

Match the symbols to the correct explanation.

A). 

B). 

C). 

D). 

E). 

F). 

G). 

H). 

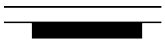
I). 

J). 

K). 

L). 

M). 

N). 

O).

P).

1). _____ Single Pole Switch

2). _____ Wiring Turned Down

3). _____ Flush Mounted Panel

4). _____ Weatherproof Receptacle

5). _____ Special Purpose Connection

6). _____ Computer Data Device

7). _____ Surface Mounted Panel

8). _____ Weatherproof Circuit Breaker

9). _____ 2 x 4 Fluorescent Fixture

10). _____ Telephone Device

11). _____ Junction Box

12). _____ 2 x 2 Emergency Fixture

13). _____ Double Pole Switch

14). _____ Floor Duplex Receptacle

15). _____ Wiring Turned Up

16). _____ Duplex Receptacle

Chapter 3

Plumbing System Blueprints

Objectives:

At the end of this chapter, students will be able to:

1). Become familiar with plumbing drawings and symbols.
2). Realize how disability codes affect the bathroom core construction.
3). Understand how a plumbing system functions.

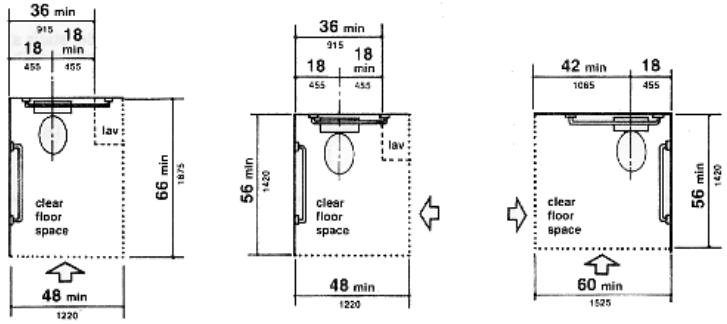
Introduction

The bathroom core is one of the most important areas on a job for a drywall/lather to recognize because of the amount of work involved with various trades. Walls need to be built to comply with ADA (Americans with Disabilities Act) codes. Proper clearances between finished wall surface and a toilet fixture or a clear unobstructed turning radius for a wheelchair must be addressed; therefore we will discuss some of the ADA requirements later in this chapter. Being able to recognize the meaning of different plumbing fixture and valve symbols is helpful when reading both architectural and plumbing drawings.

Symbols and ADA Requirements

The plumbing symbols most commonly used are shown in the following charts. The plan view symbols are drawn as if you are looking down on the fixture. They will have shapes as to what you might expect the fixture to look like from above. A toilet, sometimes called a water closet, needs to be framed 18" from any finished surface of a sidewall or obstruction to meet ADA requirements as the toilet symbol shows in the drawing below.

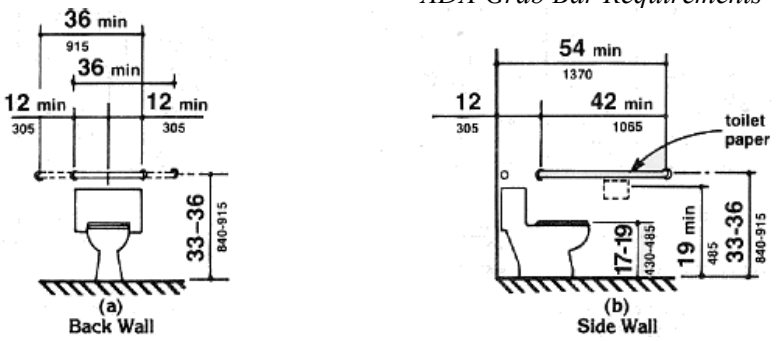
ADA Water Closet Requirements



The plumber requires 12” finished clearance from the back wall to properly set the toilet fixture. These measurements are to the center of the waste line and from the finished wall surfaces.

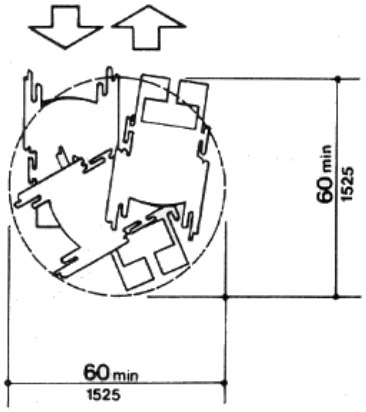
Grab bar backing is shown in the drawing below. Backing needs to be set at the required dimensions to meet ADA codes and to make sure the grab bar will not interfere with removing or replacing the toilet lid. A 36-inch minimum length grab bar is required behind the water closet mounted at a height between 33 and 36 inches. The grab bar must extend a minimum of 12 inches beyond the center of the water closet toward the sidewall and a minimum of 24 inches toward the open side for either a left or right side approach. Be sure you install the backing to accommodate these requirements. The toilet paper dispenser shall be mounted at a minimum height of 19 inches.

ADA Grab Bar Requirements

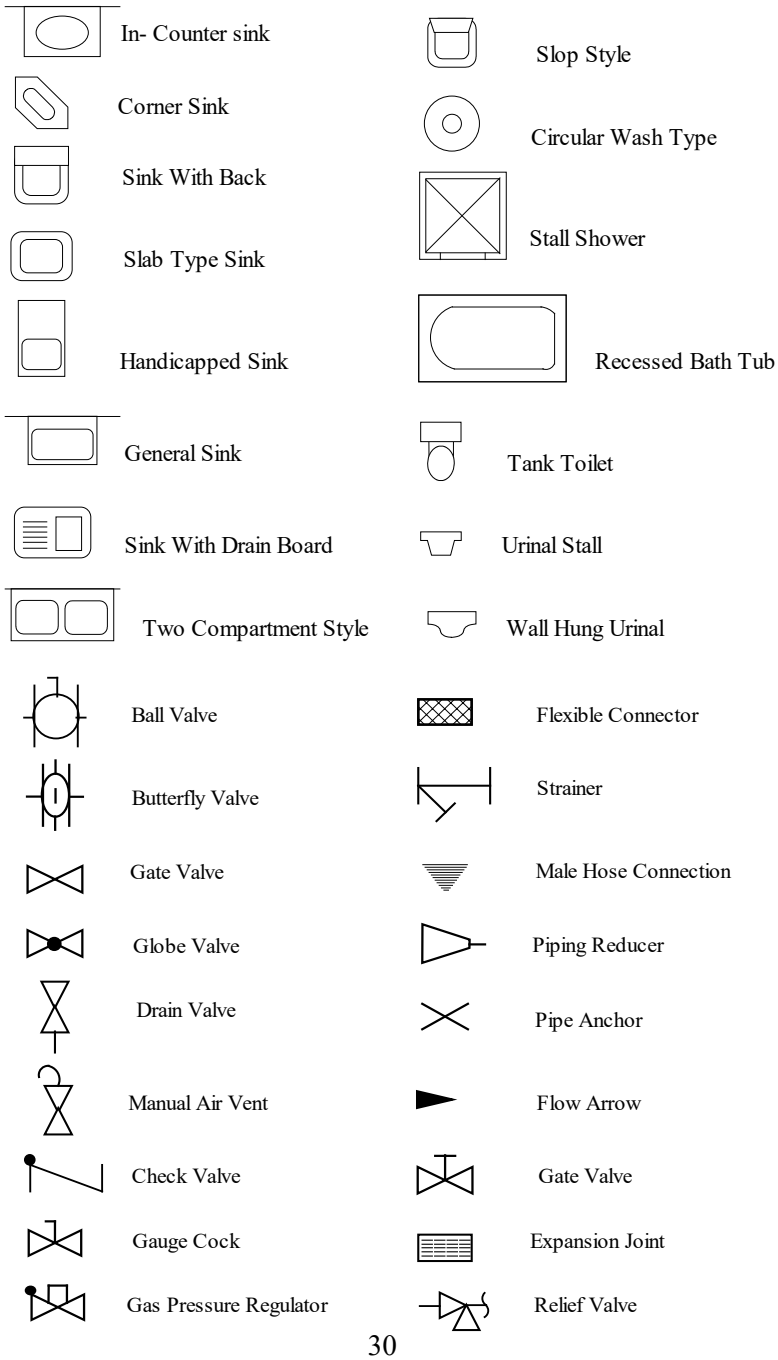


Another important dimension to maintain in the bathroom core is a clear turning radius for wheelchair access. ADA requires a minimum of 60” or 5’-0” as shown in the drawing below. You will often see the turning radius on the enlarged bathroom floor plan showing the critical area requiring the clear dimension.

ADA Wheelchair Turning Radius



Common Plumbing Fixture and Valve Symbols



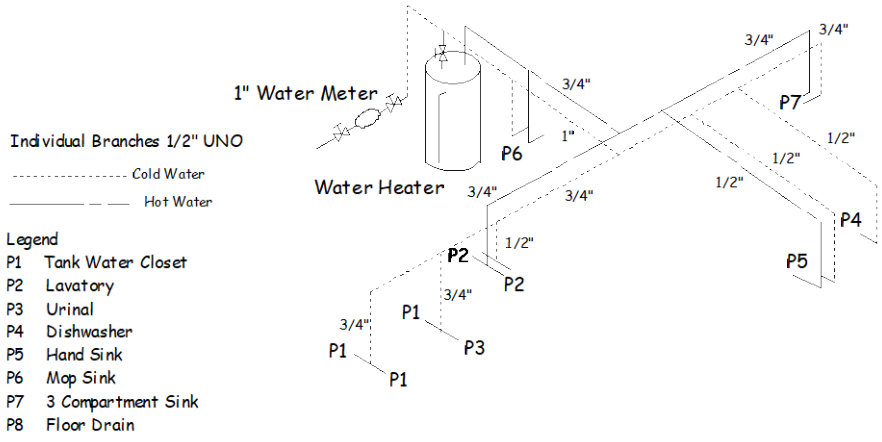
Plumbing Systems

Water enters a building from the city water main and on through the water meter sometimes with a regulator to regulate the water supply pressure. Water pressure is fuel for the plumbing system. Distributing, manipulating, and preserving water pressure is the plumber's responsibility. The plumber and the plumbing designer rely on the internal diameter of the water delivery pipes to control water pressure. The smaller the pipe diameter, the lower the pressure and the greater the velocity of the water moving through it.

At this point, the water supply is split to the different areas through out the building by means of distribution pipes and control valves. The main water supply lines installed in the building are typically 2" or 4" in diameter, with the distribution lines sized down to the diameter of ½". The distribution drawing should list the size pipe to be used to each individual fixture. Both the distribution and waste system drawings are generally drawn in an isometric style as shown below.

In this case, the water enters the building through a 1" water meter, with gate valves on each side of the meter, and onto the water heater. The cold water is then sent to other parts of the building, supplying the fixtures listed on the drawing and defined by the legend. Both hot and cold water supplies are needed at sink fixtures P2, P5, P6 and P7, whereas fixtures P1, P3 and P4 require only cold water.

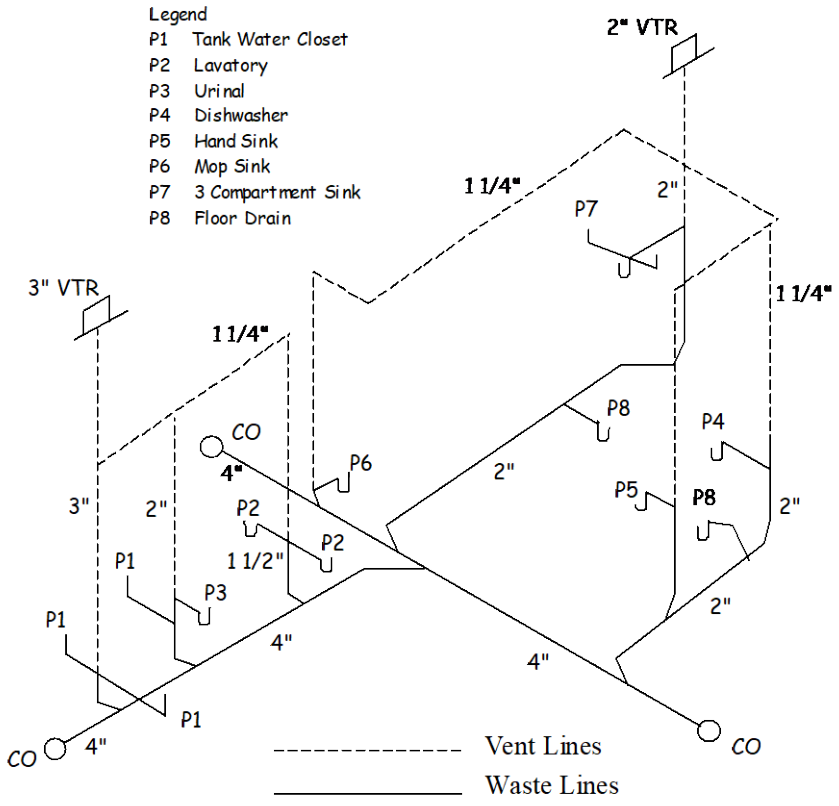
Isometric Water Distribution Drawing



Plumbers rely on gravity to drive the drainage and waste removal portion of the plumbing system. The drainage and waste system is referred to as the "DWV" (drainage, waste, and vent) system. Waste lines are larger than supply lines to allow for the proper removal of waste from the building.

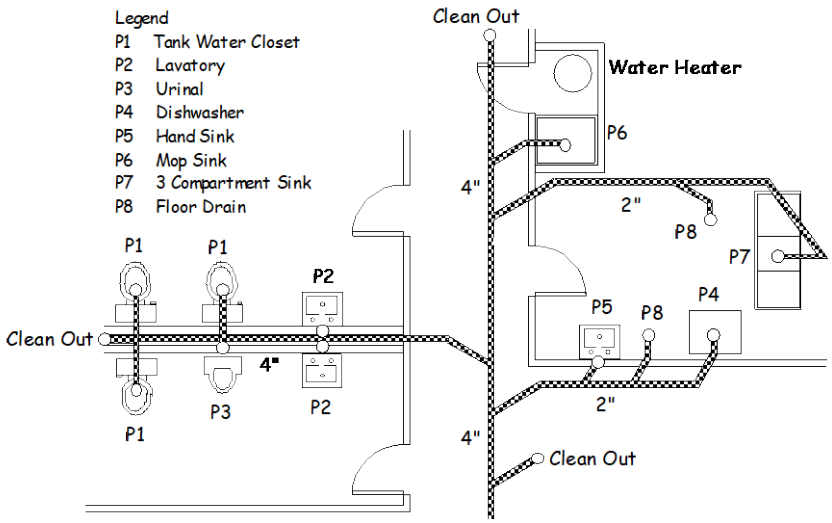
Wastewater exits the building through the wastewater system. The first step in this system is the trap at each fixture. A trap is designed to retain a small amount of water so that sewer gas cannot come up through the pipes and enter into the building. Once water has flowed through the trap, wastewater will pass through a "T" with one branch of the "T" going up and the other going down. The branch that goes up will make its way up through the roof to let in air to compensate for any vacuum that the water going down the pipe creates. Think of what happens when you hold your finger over the end of a straw that is full of water, when you release your finger the vacuum is broken and the water flows out.

Isometric DWV Drawing



As the wastewater flows out and into the main sewer system, the water will pass a number of clean outs. These clean outs typically consist of a type of "T" with the stem of the "T" at a 45 degree angle (called a sanitary "T"). There is a cap that covers the stem. The purpose of these clean-outs is to provide access for drain cleaning equipment if there is a clog in the wastewater system.

Plan View DWV Drawing



Plumbing Codes

Plumbing systems installed in commercial buildings are governed by local, state and federal codes. Pipes are sized in increasingly smaller diameter as it branches away from the supply lines, mainly to reduce the water pressure from the city main at the toilets, sinks and other fixtures. Codes will specify the type of pipe to use for supply and waste lines, along with the internal pipe size and where the plumber installs shutoff valves, clean outs, what kinds of fittings to use. The amount of slope or drop drainpipes require to function properly is also stipulated. Code will also specify how leak tests are to be performed for both supply and waste lines.

Conclusion

The plumbing drawings can be used as a reference when building partitions or during layout, but you will rely on the architectural drawings and what you see when framing. If you come across a gate valve, ball valve or a cleanout that will be located behind the wall surface, you will need to frame for an access panel.

Examples of a Gate Valve, Ball Valve and Cleanout with Cover

The height of the grab bar backing should be checked to make sure it works with the plumbing fixtures being installed and complies with the ADA codes. The underground plumbing may not be in the exact location as called for on the blueprints and you my need to adjust the wall layout to maintain the proper clearances. If adjusting the layout does not affect any critical dimensions, it is much easier to adjust the layout than have the plumber dig up and relocate the plumbing. Get documentation from the general contractor approving any deviation from the construction blueprints. You should also have the plumbing foreman stipulate any openings or backing requirements he may need.

Chapter 3

Study Guide

Directions:
Answer the following questions using the bubble answer sheet.

1). A toilet, sometimes called a water closet, needs to be set _____ from any finished sidewall or obstruction to meet ADA requirements.
A). 12”
B). 16”
C). 18”
D). 24”

2). The plumber requires _____ clearance from the finished back wall to properly set the toilet fixture.
A). 12”
B). 16”
C). 18”
D). 24”

3). As wastewater flows out and into the main sewer system, the water will pass a number of _____ _____.
A). Gate valves
B). Clean outs
C). Relief valves
D). None of the above

4). The purpose of these clean-outs is to provide access for drain cleaning equipment if there is a clog in the wastewater system.
A). True
B). False

5). Pipes are sized in increasingly _____ diameter as it branches away from the supply lines, mainly to reduce the water pressure from the city main at the toilets, sinks and other fixtures.
A). Smaller
B). Larger

6). A trap is designed to retain a small amount of water so that _____ _____ cannot come up through the pipes and enter into the building.
A). Hot water
B). Cold water
C). Sewer gas
D). None of the above

7). Plumbers rely on gravity to drive the drainage and waste removal portion of the plumbing system.
A). True
B). False

8). A ___-inch minimum length grab bar is required behind the water closet mounted at a height between ____ and ____ inches.
A). 42, 36, 38
B). 40, 36, 38
C). 36, 36, 38
D). None of the above

9). A toilet paper dispenser shall be mounted at a minimum height of ____ inches.
A). 19
B). 22
C). 24
D). 30

10). Water pressure is fuel for the plumbing system.
A). True
B). False

11). Plumbing systems installed in commercial buildings are governed by local, state and federal _____.
A). Codes
B). Taxes
C). Specifications
D). None of the above

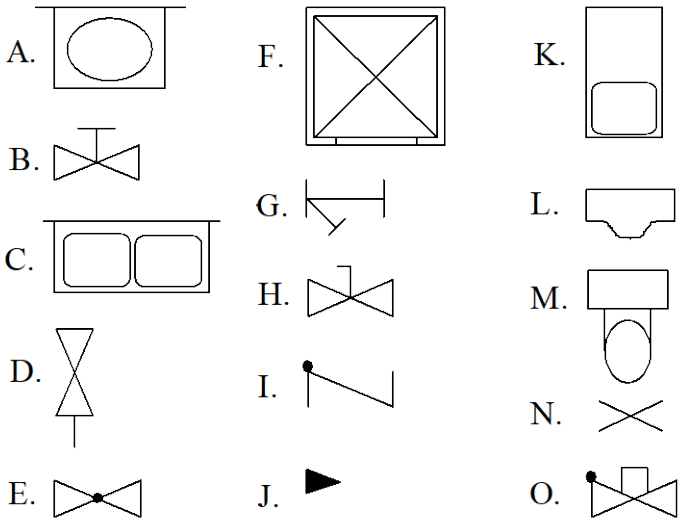
12). ADA requires at minimum of 60” or 5’-0” as a clear turning radius for wheelchair access.
A). True B). False

Chapter 3

Plumbing Exercise #1

Directions:

Match the symbols to the correct explanation.



1). _____ Strainer

2). _____ Gas Pressure Regulator

3). _____ In- Counter Sink

4). _____ Drain Valve

5). _____ Tank Toilet

6). _____ Flow Arrow

7). _____ Two Compartment Style

8). _____ Gauge Cock

9). _____ Handicapped Sink

10). _____ Check Valve

11). _____ Stall Shower

12). _____ Gate Valve

13). _____ Wall Hung Urinal

14). _____ Globe Valve

15). _____ Pipe Anchor

Chapter 3

Plumbing Exercise #2

Directions:

Use the isometric drainage, waste and venting drawing on page 32 to answer the following questions.

1). How many waste line cleanouts (CO) are shown?
A). 1
B). 2
C). 3
D). 4

2). What size vent line serves fixtures P1 and P3?
A). 1”
B). 2”
C). 3”
D). 4”

3). What size vent line serves fixture P5?
A). 1 ¼”
B). 2”
C). 3”
D). 4”

4). What size waste line serves fixtures P7 and P8?
A). 1”
B). 2”
C). 3”
D). 4”

5). How many floor drains are shown?
A). 1
B). 2
C). 3
D). 4

Use the isometric water distribution drawing on page 31 to answer the following questions.

6). What size is the incoming water line?
A). 1”
B). 2”
C). 3”
D). 4”

7). Fixture P1 requires both hot and cold water lines.
A). True
B). False

8). Fixture P5 requires both hot and cold water lines.
A). True
B). False

9). What size cold water line serves fixture P4?
A). ½”
B). ¾”
C). 1”
D). None of the above

10). How many gate valves are shown?
A). 1
B). 2
C). 3
D). 4

Chapter 4

Construction Specifications

Objectives:

At the end of this chapter, students will be able to:

1). Understand how specifications relate to the construction process.
2). Comprehend how specifications are organized.
3). Locate information contained in a set of specifications.

Introduction

Specifications are written documents defining the quality of work to be done and the materials to be used in construction. Together with the drawings, they describe the size, shape and physical location of the construction project, assuring its completion in a manner in which it was intended. Design professionals such as architects and engineers produce specifications that are used by builders, manufacturers, distributors and subcontractors to construct a building.

Organization

Specifications also provide information in a logical order as defined by The Construction Specifications Institute (CSI). Specifications are also known as "specs" and may not be the same for every construction project. If a project were an interior remodel, it probably would not have information about site construction. Specs are organized into sixteen "Divisions" established by CSI and basically follow the sequence of construction. The divisions are:

- **Division 00- Bidding and Contracting Requirements**
- **Division 01- General Requirements**
- **Division 02- Site Construction**
- **Division 03- Concrete**
- **Division 04- Masonry**
- **Division 05- Metals**
- **Division 06- Woods and Plastic**
- **Division 07- Thermal and Moisture Protection**

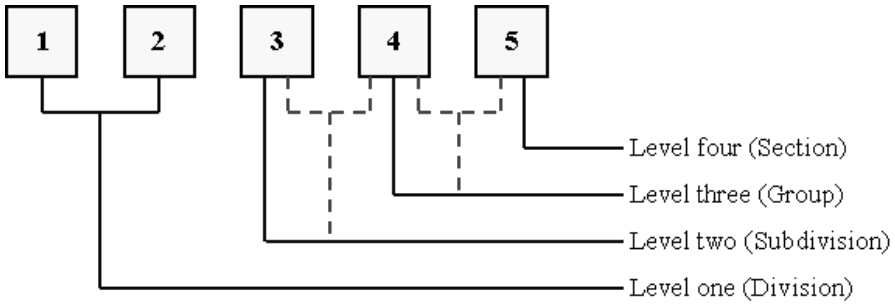
- **Division 08- Doors and Windows**
- **Division 09- Finishes**
- **Division 10- Specialties**
- **Division 11- Equipment**
- **Division 12- Furnishings**
- **Division 13- Special Construction**
- **Division 14- Conveying Systems**
- **Division 15- Mechanical**
- **Division 16- Electrical**

These divisions are further broken down into subdivisions or sections, which contain precise information for the particular trade involved. For example, Division 9- Finishes, has these major subdivisions:

09100 METAL SUPPORT SYSTEMS
09200 LATH AND PLASTER
09230 AGGREGATE COATINGS
09250 GYPSUM WALLBOARD
09300 TILE
09400 TERRAZZO
09500 ACOUSTICAL TREATMENT
09550 WOOD FLOORING
09600 STONE AND BRICK FLOORING
09650 RESILIENT FLOORING
09680 CARPETING
09700 SPECIAL FLOORING
09760 FLOOR TREATMENT
09800 SPECIAL COATINGS
09900 PAINTING
09950 WALL COVERING

The following numbering system was developed to easily locate a trade or topic within a set of specifications.

Hierarchy of Section Numbers



- The first two digits in section code always refer to divisions.
- The third number in the section code usually refers to related subdivisions.
- The fourth digit in section codes usually refers to groups of works/materials of a similar nature, like reinforcing steel, welded wire fabric and stressing tendons.
- The fifth digit in section codes always refers to items or individual sections like non-load bearing wall framing.

Purpose of Specifications

Specifications will indicate the quality of materials to be used, methods for application of a product, along with references to industry and workmanship standards. For example, the drawings may show concrete and the thickness; the specification would list the compressive strength of the concrete and size of the aggregate mixture in the concrete. Specifications will list the exact materials to use in the construction process, thereby making sure the owner receives what is expected, but also makes the contractors bidding the project bid apples to apples and oranges to oranges. Specifications are also written to settle any disputes between the owner, contractor and subcontractors regarding the construction project. Specifications also provide a consistent place to present information because of the standardized format.

Specifications will define the application to use when installing a product or material. For Gypsum Wallboard, Section 09250, Division 9, there will be a subsection on application. You probably will have installed plenty of

gypsum wallboard and know how it is applied, but the architect may want the gypsum wallboard stood up instead of railroaded. If you did not read the specification, you could be tearing a lot of railroaded gypsum wallboard off the walls. Reading all of the divisions and subdivisions is not necessary, but make **absolutely sure** you read the subdivisions pertaining to and relating to your scope of work.

Much of the information needed to construct a building is placed in the specifications instead of the blueprints, mainly to keep the drawings legible. Some architects will reference section or subsection numbers directly on the drawings themselves. Remember, if information is contained in the specs, it is as important as being on the drawings.

In essence, specifications indicate the following:

- Quality
- Materials
- Methods
- Standards
- Application

Non-technical and Technical Aspects

Other information contained in the specifications, between the owner and general contractor, are the contract document and general requirement provisions. This type of information would be found in Division 00- Bidding and Contracting Requirements and Division 01- General Requirements and is considered non-technical. Non-technical information is provided for items such as insurance, bid and performance bonds, taxes, utilities, permits and job supervision. The non-technical aspects are usually detailed and comprehensive, so there is no misunderstanding about who has what responsibilities.

The technical information is the divisions 2 through 16 themselves. Quality, materials, methods, standards and application are all technical aspects. The ability to specify results is often an overlooked technical aspect. If the architect did not indicate how something is to be installed or function, the contractor will usually do it according to the lowest possible

acceptable industry standard or local work rule. Therefore, quality control is another important technical aspect.

How To Read Specifications

Specifications can be fairly simple or complex depending on the job and there are times when smaller projects are constructed without a specification book. Specification books have their own page numbering system are organized into the divisions instead of chapters as you would find in an ordinary book.

When looking for specific information you will need to determine what division or subdivision would have the information. For example, if you where looking for what type of plaster finish is required, you would look in 09200- Lath and Plaster or if you needed to know what type of welding rod to use when framing, check 09100- Metal Support Systems.

One item to locate is the Table of Contents, which will show the major divisions, subdivisions or sections. Most of our work is considered a finish, so we will always be located in Division 9- Finishes, therefore you will become familiar with subdivisions: 09100- Metal Support Systems, 09200- Lath & Plaster and 09250- Gypsum Wallboard. The table of contents will refer to the subdivision number as the page number in the spec book. It may also show an additional number 09250-1 for page one, 09250-2 for page two, etc. for that particular subdivision.

Reading Specs

- Locate the table of contents and the division with the information needed
- Locate the subdivision number that would contain the precise information, for example 09250- Gypsum Board. Use this subdivision number as the page number.
- Find the section in the subdivision; quality, materials, methods, standards or application that applies to the information needed.
- **Read** all of the specification(s) that pertain to your work.

The Complete Construction Specification Institute of Divisions and Subdivisions:

DIVISION I - GENERAL REQUIREMENTS
01010 SUMMARY OF WORK
01020 ALLOWANCES
01030 SPECIAL PROJECT PROCEDURES
01040 COORDINATION
01050 FIELD ENGINEERING
01060 REGULATORY REQUIREMENTS
01070 ABBREVIATIONS AND SYMBOLS
01080 IDENTIFICATION SYSTEMS
01100 ALTERNATES/ALTERNATIVES
01150 MEASUREMENT AND PAYMENT
01200 PROJECT MEETINGS
01300 SUBMITTALS
01400 QUALITY CONTROL
01500 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
01600 MATERIAL AND EQUIPMENT
01650 STARTING OF SYSTEMS
01660 TESTING, ADJUSTING, AND BALANCING OF SYSTEMS
01700 CONTRACT CLOSEOUT
01800 MAINTENANCE MATERIALS

DIVISION 2 - SITEWORK
02010 SUBSURFACE INVESTIGATION
02050 DEMOLITION
02100 SITE PREPARATION
02150 UNDERPINNING
02200 EARTHWORK
02300 TUNNELLING
02350 PILES, CAISSONS AND COFFERDAMS
02400 DRAINAGE
02440 SITE IMPROVEMENTS
02480 LANDSCAPING
02500 PAVING AND SURFACING
02580 BRIDGES

02590 PONDS AND RESERVOIRS
02600 PIPED UTILITY MATERIALS AND METHODS
02700 PIPED UTILITIES
02800 POWER AND COMMUNICATION UTILITIES
02850 RAILROAD WORK
02880 MARINE WORK

DIVISION 3 - CONCRETE
03010 CONCRETE MATERIALS
03050 CONCRETING PROCEDURES
03100 CONCRETE FORMWORK
03150 FORMS
03180 FORM TIES AND ACCESSORIES
03200 CONCRETE REINFORCEMENT
03250 CONCRETE ACCESSORIES
03300 CAST-IN-PLACE CONCRETE
03350 SPECIAL CONCRETE FINISHES
03360 SPECIALLY PLACED CONCRETE
03370 CONCRETE CURING
03400 PRECAST CONCRETE
03500 CEMENTITIOUS DECKS
03600 GROUT
03700 CONCRETE RESTORATION AND CLEANING

DIVISION 4 - MASONRY
04050 MASONRY PROCEDURES
04100 MORTAR
04150 MASONRY ACCESSORIES
04200 UNIT MASONRY
04400 STONE
04500 MASONRY RESTORATION AND CLEANING
04550 REFRACTORIES
04600 CORROSION RESISTANT MASONRY
DIVISION 5 - METALS
05010 METAL MATERIALS AND METHODS
05050 METAL FASTENING

05100 STRUCTURAL METAL FRAMING
05200 METAL JOISTS
05300 METAL DECKING
05400 COLD-FORMED METAL FRAMING
05500 METAL FABRICATIONS
05700 ORNAMENTAL METAL
05800 EXPANSION CONTROL
05900 METAL FINISHES

DIVISION 6 - WOOD AND PLASTICS
06050 FASTENERS AND SUPPORTS
06100 ROUGH CARPENTRY
06130 HEAVY TIMBER CONSTRUCTION
06150 WOOD-METAL SYSTEMS
06170 PREFABRICATED STRUCTURAL WOOD
06200 FINISH CARPENTRY
06300 WOOD TREATMENT
06400 ARCHITECTURAL WOODWORK
06500 PREFABRICATED STRUCTURAL PLASTICS
06600 PLASTIC FABRICATIONS

DIVISION 7 - THERMAL AND MOISTURE PROTECTION
07100 WATERPROOFING
07150 DAMPPROOFING
07200 INSULATION
07250 FIREPROOFING
07300 SHINGLES AND ROOFING TILES
07400 PREFORMED ROOFING AND SIDING
07500 MEMBRANE ROOFING
07570 TRAFFIC TOPPING
07600 FLASHING AND SHEET METAL
07800 ROOF ACCESSORIES
07900 SEALANTS

DIVISION 8 - DOORS AND WINDOWS
08100 METAL DOORS AND FRAMES
08200 WOOD AND PLASTIC DOORS
08250 DOOR OPENING ASSEMBLIES
08300 SPECIAL DOORS
08400 ENTRANCES AND STOREFRONTS
08500 METAL WINDOWS
08600 WOOD AND PLASTIC WINDOWS
08650 SPECIAL WINDOWS
08700 HARDWARE
08800 GLAZING
08900 GLAZED CURTAIN WALLS

DIVISION 9 - FINISHES
09100 METAL SUPPORT SYSTEMS
09200 LATH AND PLASTER
09230 AGGREGATE COATINGS
09250 GYPSUM WALLBOARD
09300 TILE
09400 TERRAZZO
09500 ACOUSTICAL TREATMENT
09550 WOOD FLOORING
09600 STONE AND BRICK FLOORING
09650 RESILIENT FLOORING
09680 CARPETING
09700 SPECIAL FLOORING
09760 FLOOR TREATMENT
09800 SPECIAL COATINGS
09900 PAINTING
09950 WALL COVERING

DIVISION 10 - Specialties
10100 CHALKBOARDS AND TACKBOARDS
10150 COMPARTMENTS AND CUBICLES
10200 LOUVERS AND VENTS
10240 GRILLES AND SCREENS

10250 SERVICE WALL SYSTEMS
10260 WALL AND CORNER GUARDS
10270 ACCESS FLOORING
10280 SPECIALTY MODULES
10290 PEST CONTROL
10300 FIREPLACES AND STOVES
10340 PREFABRICATED STEEPLES, SPIRES. AND CUPOLAS
10350 FLAGPOLES
10400 IDENTIFYING DEVICES
10450 PEDESTRIAN CONTROL DEVICES
10500 LOCKERS
10520 FIRE EXTINGUISHERS. CABINETS, AND ACCESSORIES
10530 PROTECTIVE COVERS
10550 POSTAL SPECIALTIES
10600 PARTITIONS
10650 SCALES
10670 STORAGE SHELVING
10700 EXTERIOR SUN CONTROL DEVICES
10750 TELEPHONE ENCLOSURES
10800 TOILET AND BATH ACCESSORIES
10900 WARDROBE SPECIALTIES

DIVISION 11 - EQUIPMENT
11010 MAINTENANCE EQUIPMENT
11020 SECURITY AND VAULT EQUIPMENT
11030 CHECKROOM EQUIPMENT
11040 ECCLESIASTICAL EQUIPMENT
11050 LIBRARY EQUIPMENT
11060 THEATER AND STAGE EQUIPMENT
11070 MUSICAL EQUIPMENT
11080 REGISTRATION EQUIPMENT
11100 MERCANTILE EQUIPMENT
11110 COMMERCIAL LAUNDRY AND DRY CLEANING EQUIPMENT
11120 VENDING EQUIPMENT
11130 AUDIO-VISUAL EQUIPMENT
11140 SERVICE STAT10N EQUIPMENT
11150 PARKING EQUIPMENT
11160 LOADING DOCK EQUIPMENT

11170 WASTE HANDLING EQUIPMENT
11190 DETENTION EQUIPMENT
11200 WATER SUPPLY AND TREATMENT EQUIPMENT
11300 FLUID WASTE DISPOSAL AND TREATMENT EQUIPMENT
11400 FOOD SERVICE EQUIPMENT
11450 RESIDENTIAL EQUIPMENT
11460 UNIT KITCHENS
11470 DARKROOM EQUIPMENT
11480 ATHLETIC. RECREATIONAL, AND THERAPEUTIC EQUIPMENT
11500 INDUSTRIAL AND PROCESS EQUIPMENT
11600 LABORATORY EQUIPMENT
11650 PLANETARIUM AND OBSERVATORY EQUIPMENT
11700 MEDICAL EQUIPMENT
11780 MORTUARY EQUIPMENT
11800 TELECOMMUNICATION EQUIPMENT
11850 NAVIGATION EQUIPMENT

DIVISION 12 - FURNISHINGS
12100 ARTWORK
12300 MANUFACTURED CABINETS AND CASEWORK
12500 WINDOW TREATMENT
12550 FABRICS
12600 FURNITURE AND ACCESSORIES
12670 RUGS AND MATS
12700 MULTIPLE SEATING
12800 INTERIOR PLANTS AND PLANTINGS

DIVISION 13 - SPECIAL CONSTRUCTION
13010 AIR SUPPORTED STRUCTURES
13020 INTEGRATED ASSEMBLIES
13030 AUDIOMETRIC ROOMS
13040 CLEAN ROOMS
13050 HYPERBOLIC ROOMS
13060 INSULATED ROOMS
13070 INTEGRATED CEILINGS
13080 SOUND. VIBRATION. AND SEISMIC CONTROL
13090 RADIATION PROTECTION

13100 NUCLEAR REACTORS
13110 OBSERVATORIES
13120 PRE-ENGINEERED STRUCTURES
13130 SPECIAL PURPOSE ROOMS AND BUILDINGS
13140 VAULTS
13150 POOLS
13160 ICE RINKS
13170 KENNELS AND ANIMAL SHELTERS
13200 SEISMOGRAPHIC INSTRUMENTATION
13210 STRESS RECORDING INSTRUMENTATION
13220 SOLAR AND WIND INSTRUMENTATION
13410 LIQUID AND GAS STORAGE TANKS
13510 RESTORATION OF UNDERGROUND PIPELINES
13520 FILTER UNC)ERDRAINS AND MEDIA
13530 DIGESTION TANK COVERS AND APPURTENANCES
13540 OXYGENATION SYSTEMS
13550 THERMAL SLUDGE CONDITIONING SYSTEMS
13560 SITE CONSTRUCTED INCINERATORS
13600 UTILITY CONTROL SYSTEMS
13700 INDUSTRIAL AND PROCESS CONTROL SYSTEMS
13800 OIL AND GAS REFINING INSTALLATIONS AND CONTROL SYSTEMS
13900 TRANSPORTATION INSTRUMENTATION
13940 BUILDING AUTOMATION SYSTEMS
13970 FIRE SUPPRESSION AND SUPERVISORY SYSTEMS
13980 SOLAR ENERGY SYSTEMS
13990 WIND ENERGY SYSTEMS

DIVISION 14 - CONVEYING SYSTEMS
11140 SERVICE STATION EQUIPMENT
14100 DUMBWAITERS
14200 ELEVATORS
14300 HOISTS AND CRANES
14400 LIFTS
14500 MATERIAL HANDLING SYSTEMS
14600 TURNTABLES
14700 MOVING STAIRS AND WALKS
14800 POWERED SCAFFOLDING

14900 TRANSPORTATION SYSTEMS

DIVISION 15 - MECHANICAL
15050 BASIC MATERIALS AND METHODS
15200 NOISE, VIBRATION, AND SEISMIC CONTROL
15250 INSULATION
15300 SPECIAL PIPING SYSTEMS
15400 PLUMBING SYSTEMS
15450 PLUMBING FIXTURES AND TRIM
15500 FIRE PROTECTION
15600 POWER OR HEAT GENERATION
15650 REFRIGERATION
15700 LIQUID HEAT TRANSFER
15800 AIR DISTRIBUTION
15900 CONTROLS AND INSTRUMENTATION

DIVISION 16 - ELECTRICAL
16050 BASIC MATERIALS AND METHODS
16200 POWER GENERATION
16300 POWER TRANSMISSION
16400 SERVICE AND DISTRIBUTION
16500 LIGHTING
16600 SPECIAL SYSTEMS
16700 COMMUNICATIONS
16850 HEATING AND COOLING
16900 CONTROLS AND INSTRUMENTATION

Sample Specification for Drywall

DIVISION 9 / FINISHES
SECTION 09250 / GYPSUM DRYWALL CONSTRUCTION

1. GENERAL

1-01 DESCRIPTION

A. Applicable requirements of Conditions of the Contract and of Sections listed under General Requirements apply to Work of this Section.
B. Work Included:
1. Metal Stud Partition Systems.
2. Ceiling Suspension Systems.
3. Gypsum wallboard for walls and wall repairs, wood-furring metal furring, insulation, sealant, joint treatment and accessories.
4. Provide openings including plaster rings, etc., for mechanical and electrical pipes, fixtures, equipment, etc.
C. Related Work Within Other Sections:
1. Removal and Alterations..... Section 01035
2.Painting.....Section 09900
3. Mechanical and Electrical Work:..... Sections of Divisions 15 & 16

1-02 QUALITY ASSURANCE

A. For fire-rated assemblies, comply with fire-resistance ratings as indicated, and as required by governing authorities and codes. Provide materials, accessories and application procedures, which are UL-listed or tested in accordance with ASTM E119 for type of construction shown.
B. See Section 13090, "Radiation Protection," for material for installation by this Section.

1-03 SUBMITTALS

A. Manufacturer's Data: Submit two (2) copies of manufacturer's product specifications and installation instructions to the Contractor for review. Submit for each component of each system, including other data as may be required to show compliance with these specifications.

1-04 JOB CONDITIONS

A. Environmental Requirements: Maintain a uniform room temperature between 55° F and 70° F in cold weather one (1) week prior to and during application, and until completely dry or occupied. Provide adequate ventilation.
B. Protect all finished work during the process of drywall work; repair any damage done to such work in a manner satisfactory to Contractor.

2. PRODUCTS

2-01 MATERIALS

A. Materials are listed with specified manufacturer's name for purpose of description only. Materials shall be as manufactured by National Gypsum, U.S. Gypsum, Johns-Manville, Celotex, Flintkote, Fry or Bostwick.
B. Wall Framing: Metal studs, channel type, standard 20 gauge, roll-formed of galvanized steel, designed for screw attachment, in widths 3-5/8" as called for on drawings, complete with floor and ceiling runner channels, as manufactured by U.S. Gypsum Co. or National Gypsum Co.
C. Wall Furring:
1. Interior Wall-Furring Channels: 7/8" deep x 1-3/8" face width channels of cold-rolled galvanized steel.
D. Gypsum Board (ASTM C36):
1. Standard taper, (Type X) Fire Code "C" gypsum panel with rounded edges, 5/8".
2. Standard taper, rounded edge with integral lead-lined resistive gypsum panel, screw-attached with lead protective disks. See Section 13090, "Radiation Protection."
E. Joint Treatment: Durabond 90 Prefill and USG; ready-mixed, all-purpose and topping joint compound. Reinforcing tape shall be Perf-A-Tape reinforcing tape.
F. Fasteners: 1 1/8" screw U.S.G. Branch Hi-Lo, Type S, bugle head-to-metal framing; 1-1/2" screw, Type W bugle head-to-wood.
G. Accessories: Corner Reinforcement - Dur-A-Bead No. 103; Metal Trim - U.S.G. No. 401, 402, 200A, 200C, Nat. Gyp, #550 with vinyl bead;

Control Joint - U.S.G. No. 093, Drywall and Acoustic Terminal - Fry Reglet Corp. SCM 125. Use plastic "J" trim at heads, jambs and at repair areas as directed by Contractor.
H. Sealant: U.S.G. Acoustical Sealant.
I. Adhesive: Manufacturer's recommended adhesive for direct application to indicated substrate.
J. Insulation:
1. Batt/Blanket Insulation: Provide 3-1/2" (R-11) unfaced fiberglass batts at locations indicated on drawings, FS HH-1-521, Type I. [Furnish 6" batts to Installer of Section 09500, for installation above Computer Room ceiling.
2. Vapor Barrier: Provide 4-mil vapor barrier polyethylene sheet with taped edges and overlaps to accomplish a continuous vapor barrier.
3. Rigid Board: Insulation shall be Dow Chemical Styrofoam SM or U.S.G.; formular closed-cell extruded, expanded polystyrene plastic board insulation complying with FSHH-1-524, Type II, Class B, of thickness as indicated on drawings; K factor @ 40° + .185; R =5.4 for 1" thickness; R = 8.1 for 1-1/2" thickness; and R = 10.81 for 2" thickness, etc. Water absorption .02% by volume. Insulation shall bear manufacturer's label or stamp.

3. EXECUTION

3-01 INSPECTION

A. Examine and inspect materials to which gypsum board is to be applied. Remedy all defects prior to installation of drywall. Any defects in the finished installation due to misaligned framing or other causes will be the responsibility of the Work performed under this Section. Such defects shall be remedied as directed by Contractor.
B. Existing and New Building Areas: Do not store any materials or equipment on or within the structure in such a manner so as to overload the structure. All materials and equipment shall be stored so as to distribute their loads. Do not permit any part of the structure to be overloaded by work on the Project.

3-02 INSTALLATION

A. Metal Stud Installation:
1. Erection of steel studs shall be done in strict accordance with

manufacturer's recommendations to secure a sound and workmanlike manner. Use screw attachments from stud to floor and ceiling runners.
2. In accordance with manufacturer's recommendations.
3. Extend partition stud system through acoustical ceilings, and elsewhere as indicated to the structural support and substrate above ceiling. Space studs 16" o.c., except as indicated otherwise.
B. Wall-Furring:
1. Attach wall-furring channels to structure with mechanical anchors 24" o.c. vertically.
C. Insulation and Vapor Barrier:
1. Unless otherwise specifically directed by Contractor, install all building insulation in accordance with "Fiberglass Building Insulation Application Instructions," publication 3-BL-4992 of Owens-Corning Fiberglas Corp, current edition.
2. Install vapor barrier sheet to accomplish a continuous barrier with a minimum of taped joints taking care not to penetrate barrier during installation of same.
3. Butt rigid board insulation tightly together and stagger all vertical joints. Secure boards in place with metal Z-furring, adhesive and stick clips as recommended by manufacturer.
D. Drywall Installation:
1. Preparation:
a. Examine and inspect materials to which gypsum wallboard is to be applied. Report any defects to Contractor prior to commencing work. Commencement of work will indicate acceptance of existing conditions and acceptance of full responsibility for complete Work specified.
b. Defects due to misaligned framing or other causes will be the responsibility of this Section and shall be corrected without additional cost to Owner or Contractor.
2. Cutting: Gypsum wallboard shall be cut by scoring and breaking. If cut by sawing, work from the face side. Where board meets projecting surfaces, it shall be neatly scribed.
E. Installing Furring:
1. Space metal furring channels 24" o.c. and securely clip with furring channel clips or saddle tie with 2 strands of 16-gauge tie wire to existing surface. End splices shall be provided by nesting channels no less than 8" and securely tying with wire.

2. Furnish and install plaster rings where required for mechanical and electrical work.
F. Supplemental Framing: Provide supplemental framing, blocking and bracing wherever walls, partitions or ceilings are indicated to support fixtures, equipment, services, cabinets, heavy trim and furnishings, and similar work requiring attachment and support. Where type of support is not otherwise indicated, comply with manufacturer's supplementary recommendations and industry standards, considering weight of or loading resulting from the item supported.
G. Installing Gypsum Board:
1. Install gypsum board in a single layer or double layers attached to members with power-driven, self-tapping drywall screws in accordance with manufacturer's specifications. Provide1-hour and 2-hour UL installation techniques at rated enclosures if indicated on the drawings.
2. Use boards of maximum practicable lengths so that an absolute minimum number of end joints occur. Boards shall be brought into contact with each other but shall not be forced into place.
3. Locate wallboard joints at openings so that no end joint will align with edges of opening. End joints shall be staggered, and joints on opposite sides of partition shall not occur on the same stud or same height from floor.
4. Install gypsum board at right angles to furring channels and parallel on metal studs. Locate gypsum board butt joints over the center of furring members.
5. Install gypsum board with drywall screws 12" o.c. in the field of the board and 8" o.c. along vertical abutting edges, 3/8" in from all edges. Screws shall proceed from central portion of board toward ends and edges. Screws shall be driven home with the heads slightly below the surface of the board. Care shall be taken to avoid breaking the paper face.
H. Application of Accessories:
1. Vertical and horizontal exterior corners shall be reinforced with corner beads fastened with suitable fasteners not over 9" o.c. on both flanges along entire length of beads. Corner beads shall be in 1 piece for full length of corner (up to stock lengths).
2. Where board terminates against masonry or other dissimilar materials, apply metal trim over board edge and fasten with screws or staples spaced 12" o.c. Apply sealant between metal trim and wall surface. Use similar method for plastic trim. Use full-length pieces for metal and plastic trim.

3. At control joints, break wallboard behind joint and back by double studs. Attach control joint to board edge with staples spaced 6" o.c. on both flanges along entire length of joint. Locate control joints at 30' o.c. maximum at changes of wall construction or at both sides of door openings above jambs to ceiling.
4. Furnish and install plaster rings as required for Mechanical and Electrical Work.
I. Access Panels: Install access panels furnished by Mechanical/Electrical Contractors.
J. Finishing and Repairs to Existing Surfaces:
1. Finish all board joints and internal angles with taped joint system installed in accordance with manufacturer's recommendations. Spot exposed fasteners on board faces and finish corner beads, control joints and trim as required in accordance with manufacturer's recommendations for a smooth, flush surface.
2. Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required. Prefill open joints and rounded or beveled edges, if any, using type of compound recommended by manufacturer.
3. Apply joint tape at joints between gypsum boards except where trim accessories are indicated.
4. Apply joint compound in 3 coats (not including prefill of opening in base) and sand between last 2 coats and after last coat.
5. Partial Finishing: Omit 3rd coat and sanding on concealed drywall work, which is indicated for drywall finishing or which requires finishing to achieve fire-resistance rating, sound rating, or to act as air or smoke barrier.
6. Installer shall advise Contractor of required procedures for protecting gypsum drywall from damage and deterioration during remainder of construction period.
7. Section 09900 will apply a fine uniform finish (orange peel) drywall coating over exposed gypsum drywall surfaces. [Do all repairs, patching and fixing of existing plaster/drywall surfaces using acceptable drywall techniques to achieve a uniform repaired surface.]
8. Drywall finishing work will not be considered acceptable if corners or edges do not form true, level or plumb lines, or if joints, fastener heads, flanges of trim accessories, or defects are visible after application of field-applied decoration.

3-03 GUARANTEE

A. All work under this Section shall be guaranteed for a period of one (1) year against fastener popping, ridging and other faulty workmanship. Evidence of same shall be remedied at no cost to Owner.

END 09250-7 of 7

Office Building
SECTION 09100
METAL SUPPORT SYSTEMS
PART 1 GENERAL

1.01 SUMMARY
A. Section Includes: Formed metal stud framing, furring, suspension systems and accessories as shown on Drawings and as specified.

1.02 SUBMITTALS
A. Product Data: Submit data describing standard framing member materials and finish, product criteria, load charts, limitations, and installation instructions.
B. Certificates: Mill Certification shall be provided with shipment to verify chemical composition, yield strength, tensile strength, elongation and coating thickness. Include listing of applicable ASTM standards specified in this section and comparison of ASTM requirements to actual materials provided to jobsite.
C. Manufacturer's letter: Manufacturer shall provide letter stating that the material supplied to the specific project meets or exceed the performance standards listed in these specifications.

1.03 QUALITY ASSURANCE
A. Perform Work in accordance with ASTM C 754 requirements. B. Maximum deflection of all walls shall be L/360.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specification requirements: 1. American Studco Inc. 2. Gold Bond Building Products Div., National Gypsum. 3. Unimast, Inc. 4. Western 5. CEMCO 6. Dietrich Industries

2.02 FRAMING MATERIALS
A. Studs, Runners and Furring Channels: 1. ASTM C 645, electro-galvanized to meet ASTM A 591, manufactured from steel supplied in accordance with ASTM A 446, Grade A; ASTM A 525, G60 designation galvanized sheet steel. 2. Thickness: 25 (0.45mm) gauge for studs and

runners, and 25 gage (0.45mm) for channels. Furnish 20 gauge studs at single layer gypsum board receiving ceramic tile finish and for walls over 14 feet high. Adjust gauge as required for maximum deflection as described in Part 1.
B. Studs: C-shaped, non-load bearing rolled steel, punched for utility access, of size shown on Drawings.
C. Ceiling Runners: Cold or hot-rolled steel, meet ASTM C 754. Deflection track runner shall have 2½" legs.
D. Hanger and Tie Wire: Meet ASTM C 754.
E. Furring and Bracing Members: Of same gauge, material and finish as studs, thickness to suit purpose.
F. Clips, Brackets: Galvanized wire or sheet metal designed for attachment of furring members.
G. Fasteners: GA 203, self-drilling, self-tapping screws.
H. Anchorage Devices: Power driven, powder actuated, drilled expansion bolts or screws with sleeves as required for positive anchorage.
I. Acoustic Sealant: As specified in Section 09250.
J. Primer: FS TT-P-645, for touch-up of galvanized surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are ready to receive Work.
B. Verify field measurements are as shown on Drawings.
C. Verify that rough-in utilities are in proper location.
D. Beginning of installation means acceptance of substrate.

3.02 METAL STUD ERECTION

A. Install stud framing in accordance with ASTM C 754.
B. Align and secure top and bottom runners at 24 inches (600mm) o.c. Place two beads of acoustic sealant between runners and substrate where indicated on drawings.
C. Fit runners under and above openings; secure intermediate studs at spacing of wall studs.
D. Connect studs to tracks using fastener method.
E. Door Opening Framing: Install double studs at doorframe jambs. Install stud tracks on each side of opening, at frame head height, and between studs and adjacent studs.

F. Blocking: Nail wood blocking to studs. Bolt or screw steel channels to studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, and hardware.
G. Coordinate installation of bucks, anchors, blocking, electrical and mechanical Work placed in or behind partition framing.
H. Splice studs with 8 inch (200mm) nested lap, secure each stud flange with flush head screw.
I. Construct corners using minimum three studs.
J. Brace stud framing system and make rigid.
K. Coordinate erection of studs with requirements of door and window frame supports and attachments.
L. Align stud web openings.
M. Refer to Drawings for indication of partitions extending to ceiling only and for partitions extending through ceiling to structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Provide extended leg ceiling runners.
N. Coordinate placement of insulation in multiple stud spaces made inaccessible after stud framing erection.

3.03 WALL FURRING INSTALLATION
A. Erect wall furring for direct attachment to concrete, brick masonry and concrete walls.
B. Erect furring channels vertically. Secure in place on alternate channel flanges at maximum 24 inches (600mm).
C. Space furring channels maximum 16 inches (400mm) on center, not more than 4 inches (100mm) from floor and ceiling lines, and butting walls.
D. Install furring channels directly attached to concrete and brick masonry and concrete walls, as applicable in accordance with Manufacturer's instructions.
E. Erect freestanding metal stud framing tight to concrete, concrete and brick masonry walls, attached by adjustable furring brackets in accordance with Manufacturer's instructions.

3.04 ACOUSTICAL AND FIRE RATINGS
A. Install framing and furring as required for indicated acoustical and fire ratings.

3.05 CEILING FRAMING INSTALLATION
A. Install in accordance with ASTM C 754.

B. Coordinate location of hangers with other Work.
C. Install ceiling framing independent of walls, columns and above-ceiling work.
D. Reinforce openings in ceiling suspension system, which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 inches (600mm) beyond each end of openings.
E. Laterally brace entire suspension system.
F. No hanger support shall be allowed from roof deck.
G. At steel beams, joists or other steel construction wrap hangers around, inset through, or clip or bolt to the supports, so as to develop the full strength of the hangers.
H. At lights or other openings that interrupt the main runner or furring channels reinforce grillage with 3/4 inch (19mm) cold-rolled channels, wire tied atop and parallel to the main runner channels.
I. Do not bridge control and expansion joints with metal furring. Provide separate supports on each side of joint.
J. Fabricate and bend curved furring to required curves and radii in the shop.
K. Compression posts shall be installed on 96 square feet intervals, starting at 4’-0” from each wall.

3.06 CLEANING
A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition in accordance with Section 01500.
END OF SECTION

Chapter 4

Specifications Study Guide

Directions:
Answer the following questions using the bubble answer sheet.

1). Specifications are written documents defining the _____ of work to be done and the materials to be used in construction.
A) Scope
B) Type
C) Quality
D) None of the above

2). The general contractor of the construction project usually writes or produces the project specifications.
A) True
B) False

3). Specifications, together with the drawings, describe the size, shape and physical location of a construction project.
A) True
B) False

4). Division 04 would define what type of work?
A) Metals
B) Masonry
C) Finishes
D) Concrete

5). Division 09 would define what type of work?
A) Finishes
B) Electrical
C) Woods & Plastics
D) Furnishings

6). All of the divisions, as listed by the Construction Specification Institute, are used for every construction project.
A) True
B) False

7). Specifications are written to clarify responsibilities between the owner, general contractor and subcontractors.
A) True
B) False

8). Specifications should indicate the following aspect(s):
A) Quality
B) Materials
C) Application
D) All of the above

9). Information about insurance, permit and taxes would be considered _____ aspects of a construction project.
A) Technical
B) Non-technical

10). Information placed in a specification is **not** as important as being placed on the drawings.
A) True
B) False

11). Information about quality, materials to be used, standards to follow and application are considered _____ aspects of a construction project.
A) Technical
B) Non-technical

12). What is the subdivision or section number for "Gypsum Wallboard"?
A) 09250
B) 09100
C) 09700
D) 09900

13). Specification books refer to the subdivision number as the page number.
A) True
B) False

14). The _____ will list the major divisions, subdivisions or sections contained in the specification book.
A) Definitions C) Introduction
~~E)~~B) Table of Contents D) None of the above

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Chapter 4

Specification Exercise #1

Directions:
List the following subdivisions (section number) using the CSI master list found on pages 45-52. Use the bubble answer sheet for your answers.

1). What is the subdivision number for “Prefabricated Structural Wood”?
A) 01800
B) 02010
C) 06170
D) 06500

2). What is the subdivision number for “Abbreviations and Symbols”?
A) 01070
B) 05900
C) 15600
D) 11650

3). What subdivision would have information on “Flagpoles”?
A) 13060
B) 10350
C) 01800
D) 12700

4). What subdivision would have information on “Louvers and Vents”?
A) 03600
B) 13070
C) 10200
D) 15650

5). What is the subdivision number for “Elevators”?
A) 07800
B) 08250
C) 14200
D) 16600

6). What subdivision would have information on “Metal Support Systems”?
A) 09100
B) 10290
C) 12800
D) 03250

7). What subdivision would have information on “Gypsum Wallboard”?
A) 11120
B) 10800
C) 09250
D) 09950

8). What is the subdivision number for “”Lockers”?
A) 10500
B) 08800
C) 02150
D) 15700

9). What subdivision would have information on “Fireproofing”?
A) 13990
B) 07250
C) 01660
D) 06400

10). What subdivision would have information on “Lath & Plaster”?
A) 10260
B) 09200
C) 08900
D) 09500

11). How many subdivisions are shown under Division 9- Finishes?
A) 18
B) 3
C) 16
D) 7

12). How many major divisions are shown?
A) 11
B) 19
C) 15
D) 16

13). What subdivision would have information on “Metal Doors and Frames”

A) 08100
B) 16600
C) 11460
D) 15500

14). What is the subdivision number for “Structural Metal Framing”?

A) 02010
B) 05100
C) 03150
D) 14400

15). What subdivision would have information on “Liquid and Gas Storage Tanks”?

A) 11130
B) 13410
C) 14800
D) 12670

Chapter 4

Specification Exercise #2

Directions:
Use the "**SECTION 09250 / GYPSUM DRYWALL CONSTRUCTION"** found on pages 53-59 to answer the following questions. Use the bubble answer sheet for your answers.

1). "Radiation Protection" information can be found under what section?
A) 01035
B) 09900
C) 13090
D) None of the above

2). All work under this section shall be guaranteed for a period of (1) year against faulty workmanship.
A) True
B) False

3). Space metal furring channels _____and securely clip with furring channel clips or saddle.
A) 24" on center
B) 16" on center

4). What size batt or blanket insulation is to be used at locations indicated on the drawings?
A) 3 ½"
B) 2 ½"
C) 5 ½"
D) None of the above

5). Partition stud spacing should be _____ unless indicated otherwise.
A) 24" on center
B) 16" on center

6). Gypsum board can be railroaded on the metal stud walls.
A) True
B) False

7). Locate control joints at _____ maximum at changes of wall construction or at both sides of door openings above jambs to ceiling.
A) 40’-0” on center
B) 35’-0” on center
C) 30’-0” on center
D) 25’-0” on center

8). Apply joint compound in _____ coats (not including prefill of opening in base) and sand between last 2 coats and after last coat.
A) 2
B) 3
C) 4
D) None of the above

9). All gypsum board is to be installed with drywall screws 12" o.c. in the field of the board and 8" o.c. along vertical abutting edges, 3/8" in from all edges.
A) True
B) False

10). Gypsum wallboard shall be cut by scoring and breaking. If cut by sawing, work from the _____ side.
A) Back
B) Face

11). Manufacturer's Data: Submit ~~two~~ (_____) copies of manufacturer's product specifications and installation instructions to the Contractor for review.
A) 1
B) 2
C) 3
D) 4

12). Where board terminates against masonry or other dissimilar materials, apply _____.
A) Metal trim
B) Perforated tape
C) Wood backing
D) None of the above

13). Section 09250 is to apply the orange peel finish over the drywall.
A) True
B) False

14). What gauge tie wire is to be used for saddle ties when attaching furring channels to existing surfaces?
A) 16 gauge
B) 18 gauge
C) 9 gauge
D) 8 gauge

15). Vertical and horizontal exterior corners shall be reinforced with _____.
A) Fiberglass tape
B) Aluminum trim
C) Corner bead
D) Prefinished corners

16). Use boards of _____ practicable lengths so that an absolute _____ number of end joints occur.
A) Maximum/minimum
B) Minimum/maximum

17). Work in this section is related to work in “Removal and Alterations” section 01035.
A) True
B) False

18). Work in this section is related to work in “Metal Windows” section 08500.
A) True
B) False

19). Applicable requirements of Conditions of the Contract and of Sections listed under General Requirements apply to Work of this Section.
A) True
B) False

20). Work included under this section includes “Ceiling Suspension Systems”.

A) True

B) False

Chapter 4

Specification Exercise #3

Directions: Use **"Section 09100- Metal Support Systems"** pages 60-63 to answer the following questions. Use the bubble answer sheet for your answers.

1). Which manufacturer is not acceptable as a provider of metal studs?
A). Unimast
B). Western
C). Dietrich
D). Knorr

2). Wall furring channels are to be spaced at _____ on center, not more than _____ from floor and ceiling lines and abutting walls.
A). 24", 6"
B). 24", 8"
C). 16", 6"
D). 16", 4"

3). Installation of ceiling framing shall be _____ of walls, columns and above-ceiling work.
A). Attached
B). Independent
C). Requirements
D). None of the above

4). For quality assurance, work shall be performed in accordance to ASTM C _____ requirements.
A). 754
B). 525
C). 645
D). G60

5). The stud gauge shall be adjusted for a maximum deflection of _____.
A). L/120
B). L/240
C). L/360

D). None of the above

6). Beginning of stud installation means _____ of substrate.
A). Acceptance
B). Rejection
C). Completion
D). None of the above

7). Fasteners shall be self-drilling, self-tapping screws.
A). True
B). False

8). Hanger and tie wire shall comply with ASTM C _____.
A). 360
B). 591
C). 754
D). 645

9). Align and secure top and bottom runners at ____ inches (600mm) o.c. Place _____ beads of acoustic sealant between runners and substrate where indicated on drawings.
A). 16, 2
B). 16, 1
C). 24, 2
D). 24, 1

10). Leave work in clean condition in accordance with Section _____.
A). 09100
B). 09250
C). 01500
D). 05410

11). Placement of insulation in multiple stud spaces made inaccessible after stud framing erection should be coordinated.
A). True
B). False

12). Splice studs with ___ inch (200mm) nested lap, secure each stud flange with flush head screw.
A). 8
B). 10

13). Mill Certification shall be provided with _____ to verify chemical composition, yield strength, tensile strength, elongation and coating thickness.
A). Order
B). Shipment
C). Certification
D). None of the above

14). It is the responsibility of the framer to verify that rough-in utilities are in the proper location.
A). True
B). False

15). Corner construction shall use a minimum of _____ studs.
A). One
B). Two
C). Three
D). Five

16). _____ openings in ceiling suspension system, which interrupt main carrying channels or furring channels.
A). Brace
B). Reinforce
C). Separate
D). Fabricate

17). Walls framed over_____ in height require 20 gauge studs.
A). 12'-0"
B). 14'-0"
C). 16'-0"
D). None of the above

18). Acoustic sealant is specified in Section 09250.
A). True
B). False

Chapter 5

Estimating

Objectives:
At the end of this chapter, students will be able to:

1). Interpret various portions of a blueprint to determine the type of material required for building or ordering.
2). Relate surface area and lineal measurement with material estimation and takeoffs.
3). Calculate the footage of a particular construction assembly and determine the quantity of material needed for construction.

Introduction

Most of the time, the company estimator determines the materials required from the blueprints and walking the job. However, some companies require the job foreman to order their material and have the job stocked. In this chapter, you will learn how to figure the amount of material to order. Knowing how to estimate and with your ability to read blueprints, will make this process easy.

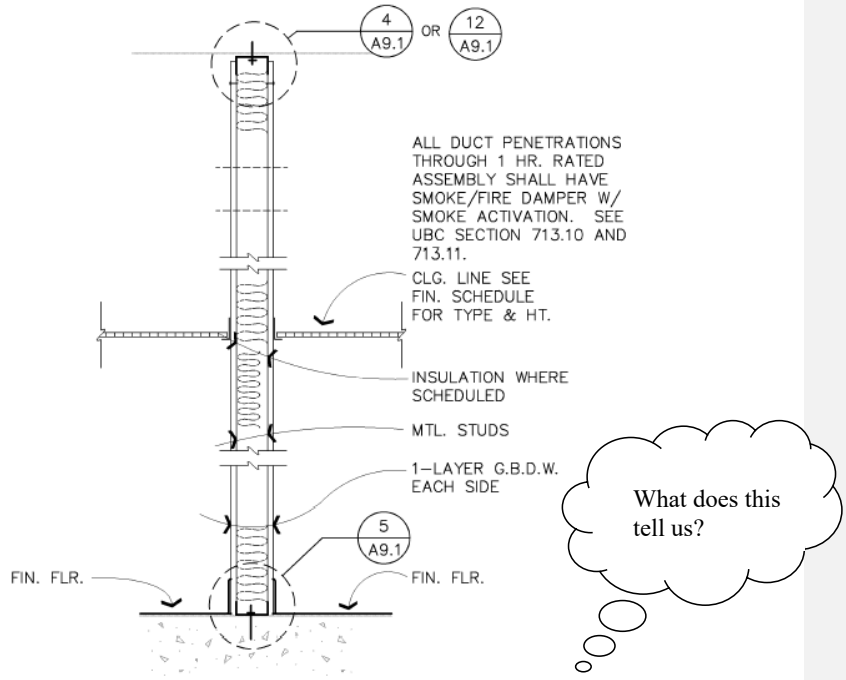
You will use what was learned from your previous blueprint reading class to gather information. The wall legend, section views, elevation views and details, all have important information about the materials used to build a project.

To know how many studs a partition requires we would need to know what on center the framing is, either 16 inch or 24 inch. The same goes for the gypsum wallboard, we would need to know how many layers are needed for each side of the wall and what height the gypsum wallboard will be installed, to correctly figure the amount of sheets. Some other variables needed are how high and how long is the partition. Correctly interpreting information is the basis for proper estimating.

Gathering Information

Where would you look in a set of blueprints to find information about framing a wall or how many layers of gypsum wallboard to install? One of

the first places to look should be the drawing index. As you know, this lists all of the different sheets or drawings contained in a set of blueprints. From here, the next step would be to find a wall legend or a drawing with partition types. You would want to research the section views or the details as referenced on the floor plan or elevations for information. Take a look below at an example of a partition type as found in the drawings and the information it shows:



C 1-HR. RATED WALL TO UNDERSIDE OF ROOF OR SECOND FLOOR W/ (1) LAYER TYPE 'X' 5/8" G.B.D.W. EA. SIDE OF 3-5/8" MTL. STUDS @ 16" O.C.

C1 SAME AS **C** EXCEPT PROVIDE SOUND INSULATION.

C2 SAME AS **C** EXCEPT PROVIDE (2) LAYERS 5/8" G.B.D.W. AT ONE SIDE

C3 SAME AS **C** EXCEPT WALL TO UNDERSIDE OF EXISTING TUNNEL LID. COMPLETE TUNNEL AS REQUIRED TO MAINTAIN ONE HOUR RATING.

C4 SAME AS **C** EXCEPT WALL WITH (2) LAYERS TYPE 'X' G.B.D.W. EA. SIDE OF 6" MTL STUDS AND SOUND INSULATION.

FOR PENETRATIONS AT RATED WALLS, REFER TO DETAILS 16/A9.1 AND 20/A9.1

For the type C partition, we would frame the wall using 3 5/8 studs at 16” on center and install 5/8-inch gypsum board full height on both sides of the stud. The other type partitions, C1 thru C4, are the same as type C, except for the additional work as noted. What we do not know is, what gauge are the studs and what type of flange will they have? Sometimes included in a set of blueprints, is a metal stud-sizing chart, which may be called an allowable span chart. Take a look at the chart on this page and we will review some important information contained in a sizing or allowable span chart.

Metal Stud Sizing

This shows what centers to frame the wall based on the height shown below

Section	L/120			L/240		
	5 psf			5 psf		
	12 in.	16 in.	24 in.	12 in.	16 in.	24 in.
158CC20				10'-0"	9'-1"	7'-11"
158CC18				10'-9"	9'-9"	8'-6"
158CC16				11'-6"	10'6"	9'-1"
158CC14				12'-3"	11'-2"	9'-9"
250CC20				13'-10"	12'-7"	11'-0"
250CC18				15'-0"	13'-7"	11'-10"
250CC16				16'-0"	14'-7"	12'-9"
250CC14				17'-2"	15'-7"	13'-7"
350CC20				17'-11"	16'-4"	14'-3"
350CC18				19'-5"	17'-8"	15'-5"
350CC16				20'-10"	18'-11"	16'-6"
350CC14				22'-4"	20'-3"	17'-9"
358CC20				18'-5"	16'-9"	14'-8"
358CC18				20'-0"	18'-2"	15'-10"
358CC16				21'-5"	19'-5"	17'-0"
358CC14				22'-11"	20'-10"	18'-3"
400CC20				19'-11"	18'-1"	15'-10"
400CC18				21'-7"	19'-7"	17'-1"
400CC16				23'-2"	21'-0"	18'-4"
400CC14				24'-10"	22'-7"	19'-8"
600CC20				27'-6"	25'-0"	21'-10"
600CC18				29'-10"	27'-1"	23'-8"
600CC16				32'-0"	29'-1"	25'-5"
600CC14				34'-4"	31'-3"	27'-3"
800CC20				34'-9"	31'-7"	27'-7"
800CC18				37'-9"	34'-3"	29'-11"
800CC16				40'-6"	36'-10"	32'-2"
800CC14				43'-7"	39'-7"	34'-7"

This is the stud size, gauge and flange size

This shows the maximum height a wall can be framed based on the stud spacing above

CODING EXAMPLE:

358 CC 18

- 18 — Gauge
- CC — Style and Flange Size
- 358 — Size: 3 5/8

Notes:

1. Heights based on properly attached sheathing on each flange over the entire lenght of the stud.
2. Lateral load multiplied by 0.75 for strenght determination per ANSI A4.4.
3. Heights for 14 and 16 gauge studs based on Fy = 50 KSI.
4. End Reaction=Load (psf)*spacing(in)*height from Table(ft)/24, check web crippling table for allowable reaction.
5. Height based on web punchouts a minimum of 1.5 times the web height from the edge of bearing.
6. Use larger stud size than in tables where so indicated in drawing.
7. Except for furred wall studs size shall be 3 5/8 inch.
8. Use L/120 for heights below 10 ft. and L/240 for heights over 10 ft.
9. See drawings for special conditions.
10. Reference ICBO ER No. 4943
11. Chart is for non-load bearing application only.

Read the Notes!!

The architect specifically notes all stud sizes, gauges and spacing to be verified with the stud chart. Take a look at the coding example, a 3 5/8" stud is written as 358, CC is the flange size style and 16 is the gauge and written as 358CC16. Let's say the plans called for a full height type C wall and the tallest point of your wall is 16'-0". What gauge stud do you use? Remember, partition type C calls for 3 5/8" framing, at 16" on center.

First, locate the stud size 358. Start with the 20-gauge stud and read across. At 12" on center framing, we could frame to a maximum height of 18'-5", at 16" on center: 16'-9" and at 24" on center: 14'-8". In this case, I would use the 20-gauge material at 16" on center, because 16'-0" does not exceed the allowable height of 16'-9".

Some other information given in the chart is the allowable deflection limits given as L/120 and L/240. Without going into the whole scientific explanation, this is the amount of flex allowed in the surface materials before damage occurs and 5 psf is the minimum lateral load applied.

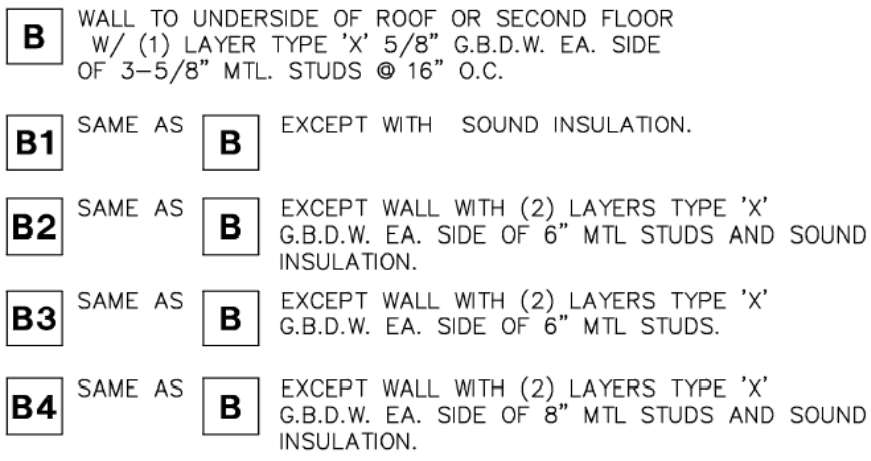
Most blueprints and metal framing specifications will not contain a stud-sizing chart, but all of the stud manufacturers have this information. The specification will refer you to the manufacturers technical literature. Your office should supply you with the manufacturers literature, which is normally required by City building inspectors during the framing inspection. Also found within this literature will be the different flange sizes and their respective coding, i.e. IC, CC, etc. An IC flange could measure 1 ¼" and a CC flange could measure 1 3/8" and so forth.

Blueprints typically list size, gauge and spacing of the framing members in the wall legend. Even though this information is shown on the blueprints, you should verify the allowable heights of the studs you are using on your job as a precaution. The last thing you would want to happen is to have a couple hundred feet of wall framed and it fails the framing inspection because of the walls being over spanned. You should notify the architect for clarification before proceeding. Knowing what material to use when constructing a wall or when ordering can be as easy as reading the wall legend. Other times a little more research is required. Keep in mind that these allowable heights are based on both sides of the stud being rocked full height and these charts would **not** apply to walls partially rocked on one or both sides.

Wall Legend

The wall legend is a listing of all the partition types used on the project and how each partition is identified on the drawings. The wall legend is usually found on the floor plan or there could be a sheet entirely dedicated to the partition types. For each partition, the architect provides a listing of important information about how to construct that particular partition. For example, the size and gauge of stud used for framing will be given along with what center to place the studs. It will list how many layers of gypsum board to install on each side of the stud and to what height to install the gypsum board. Any other items such as insulation, caulking, attachment of studs to track, backing, etc. could be listed. Many times the architect will further direct you to other details or cross sections concerning the partition from the wall legend. Below is an example of a partition legend where the architect uses a letter to identify the partition on the floor plan. The architect stipulated the drywall/lather check the metal stud sizing chart similar to the one we previously studied for the correct gauge of stud to use.

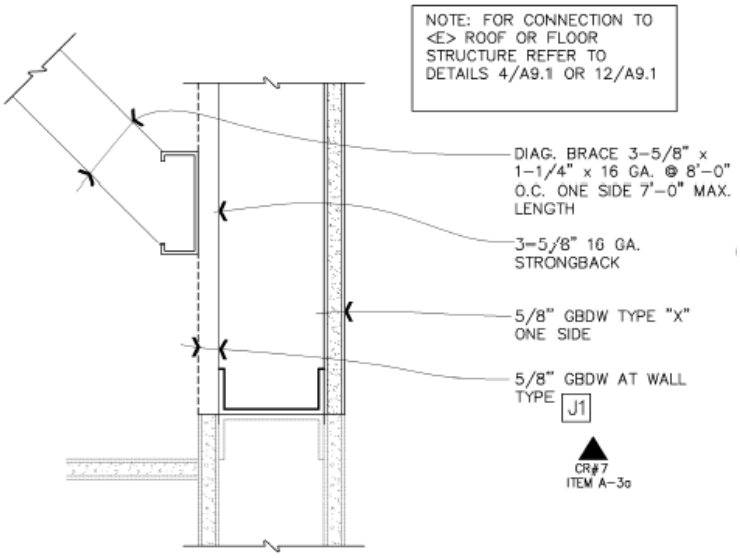
Partition Legend



The architect can convey exactly how the wall is to be constructed and clearly identifies the different types of material to use. In the above wall legend, particular attention should be paid to the stud sizes during layout.

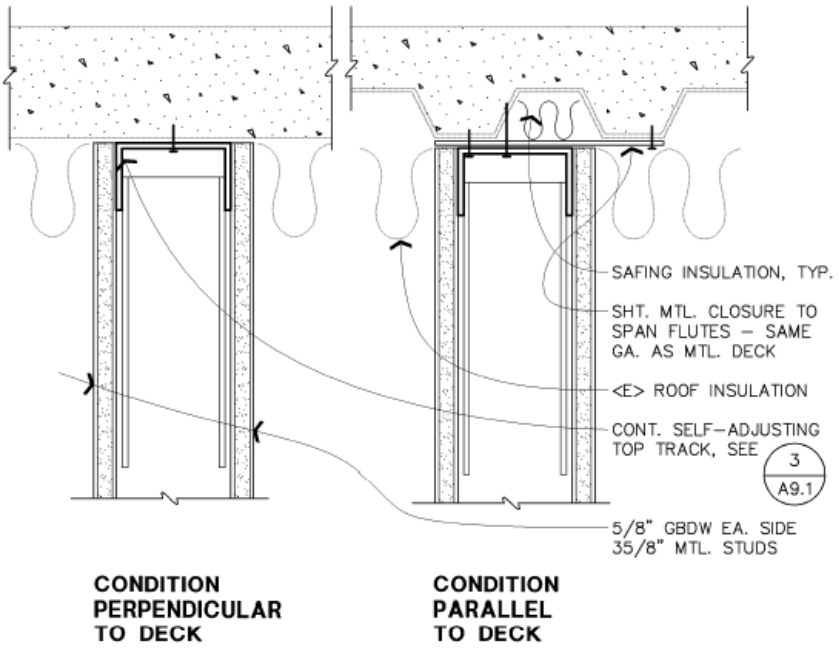
Details

Details will show the materials to use and methods of attachment when constructing a particular item. From Unit 106 we learned how to locate details when referenced on the drawings. The next step is to understand how to read details better and the importance of constructing an item as it is detailed.



G.B.D.W. PONY WALL EXT. @ EXISTING WALL 3"=1'-0" **11**

The detail above is referencing the bracing of a pony wall to be built above an existing partition. The wall legend contained in the blueprint shows the type of material used to construct the pony wall. Notice how the architect wants a 3 5/8 inch, 16 gauge strongback installed continuously down the entire pony wall, with a 3 5/8 inch 16 gauge stud brace at 8'-0" on center. The architect then refers to other details to use when attaching the brace to the roof or floor above. When the pony wall attaches to the second floor deck, detail 4/A9.1 is used and is shown below.



(1) HR. G.B.D.W. WALL @ SECOND FLOOR DECK 3"=1'–0" **4**

There are two conditions encountered when installing the top track as shown. The top track is installed perpendicular and parallel to the flutes in the metal decking. Depending upon the condition, you would need to install a metal closure above the top track when the pony wall runs parallel to the flutes in the deck, whereas the top track attaches directly to the deck when the pony wall runs perpendicular to the flutes. The detail also references the type of top track to use in detail 3/A9.1.

Details are important for a variety of factors. When the architect draws a detail, they are stipulating how something is to be built. The performance of a wall in a fire or earthquake for example, depends on how the wall was constructed. If the drywall/lather builds a wall exactly per the drawings and details, the architect is solely responsible for the walls performance.

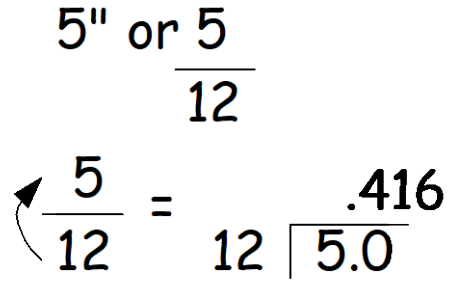
Unfortunately in today's litigious society, construction defects are some of the most common lawsuits. Understand the details and build the item exactly as it is drawn and you will not have any problems.

Practical Math

Drywall/Lathers use practical math every day on the jobsite, so it is important to review some of the basic applications you have previously studied in Unit 103. For instance, what is the decimal equivalent of ½" or ¼" or how do you convert 6.45' into feet and inches? Being able to accurately add or subtract dimensions gathered from the blueprints is essential to this trade.

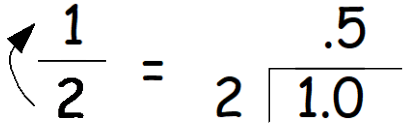
Changing Inches to Decimal Feet

To change whole inches (6") or a mixed number inch (6 ¾") to a decimal foot, you must first create a fraction. An inch is part of a foot or 12 inches; therefore place the inch (the numerator) over the number 12 (the denominator). Divide the denominator into the numerator for the decimal foot equivalent. For example, to change 5 inches into a decimal foot, divide 5 by 12. The answer is .42 rounded off to the nearest hundredth.



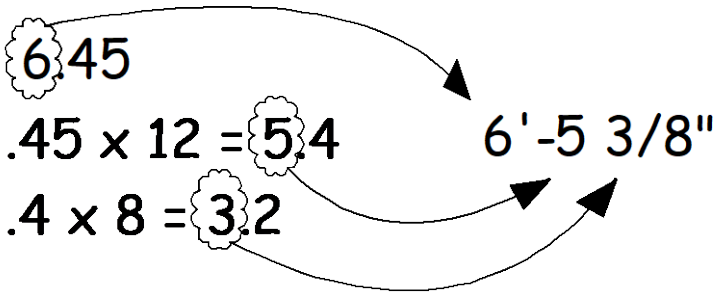
Changing Fractions to Decimals

To change a fraction to a decimal, divide the denominator into the numerator. For example, to change ½ into a decimal, divide 2 (the denominator) into 1 (the numerator). The answer is .5



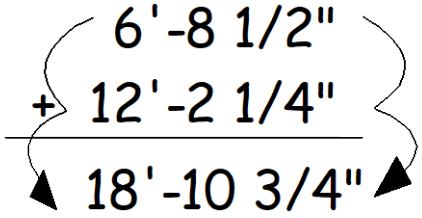
Changing Decimals to Feet and Inches

To change a decimal to feet and inches, multiply the decimal portion by 12. For example, to change the decimal 6.45 feet into feet and inches, the 6 is whole feet so it is not multiplied. Multiply .45 times 12 equaling 5.4 inches. The multiplier 12 is used because there are 12 inches in one foot. Now multiply the decimal portion by whatever fraction of an inch is needed, 1/8, 1/4, or 1/2. The 5 is whole inches and is not multiplied. Multiply .4 times 8 (for 1/8ths) equaling 3.2. The 3 is whole 1/8ths, so your answer is 6'-5 3/8".



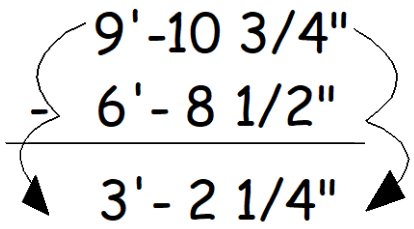
Addition of Feet and Inches

To add feet and inches together, it is important to add feet with feet and inches with inches. For example, to add 6'- 8 ½" to 12'- 2 ¼", add the fractions of inches ½" to ¼" = ¾", add the whole inches 8" + 2" = 10" and add the feet 6'+ 12' = 18' for an answer of 18'- 10 ¾".



Subtraction of Feet and Inches

To subtract feet and inches, it is important to subtract feet from feet and inches from inches. For example, to subtract 6'- 8 ½" from 9'- 10 ¾", subtract the fractions of inches ½" from ¾" = ¼" and subtract the whole inches 8" from 10" = 2" and subtract the feet 6' from 9'= 3'. The answer is 3'- 2 ¼".

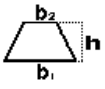


Surface Area

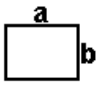
Area is measured in "square" units. The area of a figure is the number of squares required to cover it completely, like tiles on a floor. Area of a square = side times side. Since each side of a square is the same, it can simply be the length of one side squared. If a square has one side of 4 inches, the area would be 4 inches times 4 inches, or 16 square inches. (Square inches can also be written in^2.) Be sure to use the same units for all measurements. You cannot multiply feet times inches, it doesn't make a square measurement. Below are some common area formulas needed to determine the area of the various shapes.

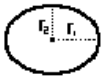
Area Formulas

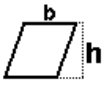
square = a^2 

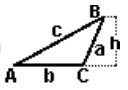
trapezoid = $h/2\ (b_1 + b_2)$ 

circle = *pi* r^2 

rectangle = ab 

ellipse = *pi* r_1 r_2 

parallelogram = bh 

triangle = $\frac{1}{2}(bh)$ 

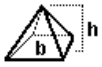
(pi or π= 3.141592...)

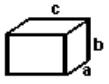
Volume

Volume is measured in "cubic" units. The volume of a figure is the number of cubes required to fill it completely, like blocks in a box. Volume of a cube = side times side times side. Since each side of a square is the same, it can simply be the length of one side cubed. If a square has one side of 4 inches, the area would be 4 inches times 4 inches times 4 inches, or 64 cubic inches. (Cubic inches can also be written in^3.) Below are some common volume formulas needed to determine the volume of the various shapes.

Volume Formulas

cube = a^3 

pyramid = (1/3) **b** h 

rectangular prism = a b c 

cone = 1/3 *pi* r^2 h 

cylinder = *pi* r^2 h 

sphere = (4/3) *pi* r^3 

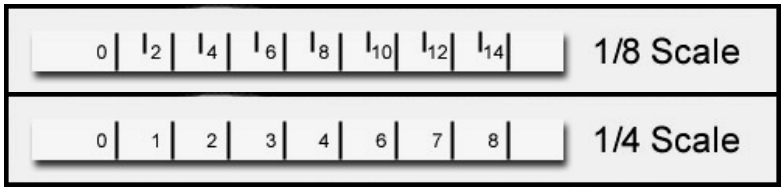
(pi or π= 3.141592...)

Lineal Measurement

The term lineal comes from the word linear, which means: of, relating to, or resembling a line; straight. When we measure a wall for length, the term lineal feet is often used to describe how long it is.

A quick way to find the total length of a wall is to use a “scale tape” or sometimes called a “takeoff tape”. The nice feature about a scale tape is the total lineal footage it gives you. There is not a need to add lengths of walls together to find a total. To accurately figure the lineal footage of partitions you must match the scale on the tape to the scale of the drawing. You can find most scale dimensions in the title block of drawing; however, the scale might be different on different pages. If you're not careful, your measurement can be off by as much as 100%.

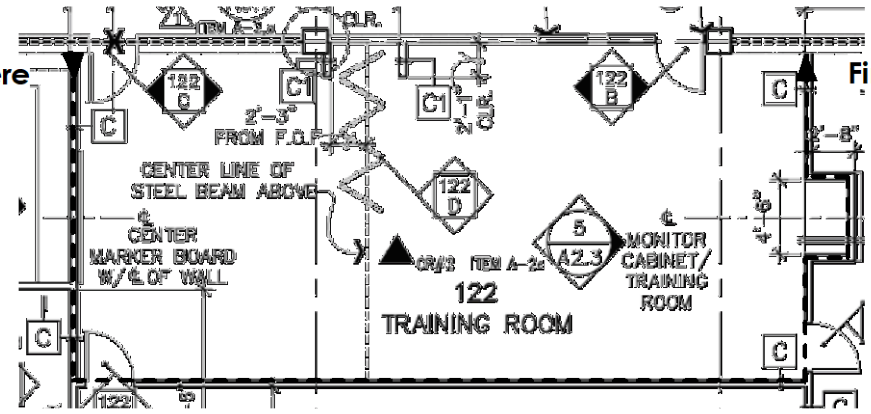
Examples of Scale Tapes



Tools used to measure lengths include an architectural ruler, a scaled measuring tape, a mechanical measuring device, or an electronic measuring wheel. The architectural rule is fine for a few quick measurements. Measuring tape for 1/8-in. and 1/4-in. scale drawings is popular; however, the electronic scale wheel is the most convenient and most accurate when working with drawings that have multiple scales.

When using a scale tape, take a look at the drawing and determine a logical place to start measuring. Confirm the fact all of the walls are the same type and in this case, type C walls. The scale tape should read 0 at your starting point, continue to measure the distance around the room until the entire wall or groups of walls has been measured. In most cases, do not stop at the door or window openings, measure through these items, because of the material above the opening; gypsum wallboard, studs, track, etc. You would read the number shown on the tape at the finish point, say 78’-0” lineal feet as an example.

Take off Example



Now all we need to know is the height of the roof and we could, without difficulty, figure how many sheets of rock are needed. A quick look at the partition type description tells us that 1 layer of gypsum board is to be applied full height on each side of this wall. If the roof measures 24'-0", the formula would look like:

78 x 24 x 2 = 3744 square feet

Which is the amount of rock to cover both sides. Let's use 4 x 10's to rock the wall, so divide 3744 by 40, which equals 93.6 sheets. Surface area of a wall is further explained in the next section.

Surface Area of a Wall

One aspect of a material takeoff involves the determination of surface area. The surface area of a wall is determined by multiplying the length of the wall times the height of the wall or:

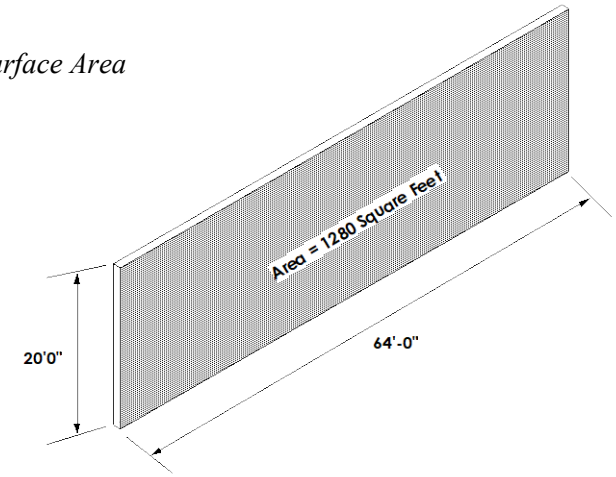
Area= Length x Height

- The area of a rectangle can be found by multiplying the length times the height.
- The rectangular wall below has a length of 64 feet and a height of 20 feet, its area is: 64 x 20 = 1280 square feet,

which is the number of square feet needed to cover the wall surface.

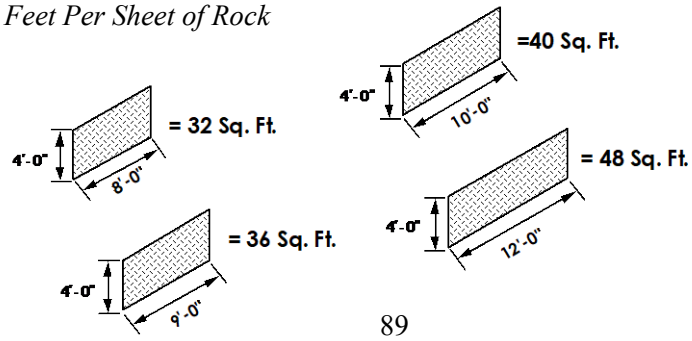
- Surface area is the area of a given surface. Roughly speaking, it is the "amount" of a surface (i.e., it is proportional to the amount of gypsum wallboard needed to cover it), and has units of distance squared.

Wall Surface Area



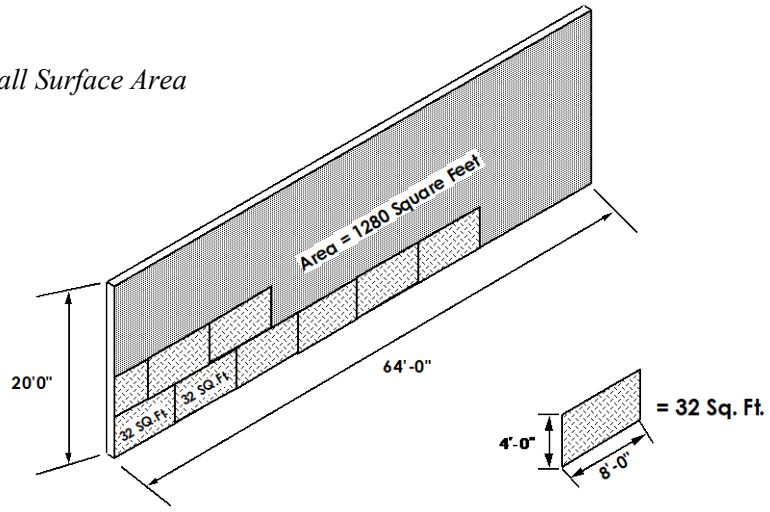
We know one side of this partition has 1280 square feet of surface area. How many sheets of rock would be needed to rock one side? The answer to that question would depend on the size of the gypsum wallboard. If we take 1280 square feet and divide by the square feet in one sheet of rock, this should give us the total number of sheets needed to rock one side of this wall. Notice how the square feet are different in each sheet of rock below, depending on the size of the sheet.

Square Feet Per Sheet of Rock



If we rock one side using 4’ x 8’ sheets, how many sheets are going to be needed? Divide 1280 square feet by 32 square feet, which equals 40 sheets. Continuing to rock the wall shown below will take 40 sheets and if both sides are rocked, 80 sheets are needed. Simply multiply the amount for one side by 2, because there are two sides to rock.

Wall Surface Area



The amount of gypsum wallboard required is 80 sheets exactly for both sides, if the rockers do not make any mistakes or the sheets are not forklift damaged, etc. Order a few more sheets; say 86 or 88. It cost quite a bit more to send a truck with a stocker/scrapper for 2 more sheets than the 6 or 8 extra you ordered to start with.

The same calculations work for ceilings as well as walls. The only difference is substituting width for height.

Area = Length x *Width*

Take an example of a corridor ceiling. The length of this corridor is 80 feet and the *width* of this corridor is 8 feet. Its area is: 80 x 8 = 640 square feet.

Length of walls and heights of roofs will never be exactly in 1 foot multiples, so what if you have a wall measuring 133’-4” long and 21’-8”

high. I would call it 134'-0" long and 22'-0" high. Make it easy to multiply, because those few inches will probably be cut from a full sheet anyway.

Figuring Studs and Track

It would be very time consuming to figure how many studs it would take to frame a wall at 24" on center if you divided the length by 2, then added for each door and window king stud, floater studs, backing studs and an additional stud each time the wall changed direction. Basically the same process applies for 16" on center framing, except you would not divide by 2.

Drywall estimators will use multipliers to solve this problem. To determine how many studs are required, if framed 24" on center without window or door openings, take the lineal footage of the wall and multiply by .50 and then add 1 stud to finish the wall. If you had a multiplier, which gave you 15% more studs for windows and door openings, you would have a multiplier equaling .65. And if the wall were framed 16" on center, 15% more studs would equal a multiplier of .86. Lets do a couple of examples:

Lineal Footage	**.65 X**	**.86 X**
100 LF	65 Studs	86 Studs
134 LF	87.1 Studs	115.24 Studs
245 LF	159.29 Studs	284.88 Studs
368 LF	239.2 Studs	316.48 Studs
1453 LF	944.45 Studs	1249.58 Studs

Your equation would look like this:
100 x .86 = 86

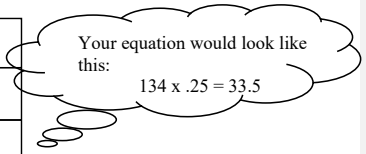
Your equation would look like this:
1453 x .65 = 944.45

If a wall requires more studs than the allowance, you will probably have a wall requiring fewer studs than the allowance, so these multipliers work well on the average. If you are ordering material, remember that studs and track come 10 pieces to a bundle, so round up or down depending how many studs

you are ordering. These same multipliers are used by many drywall estimators and have stood the test of time as the saying goes.

Track is also figured with a multiplier of the wall's lineal footage. If the top and bottom track are the same material, we know multiplying the length of the wall by 2 equals top and bottom, but what about track for window sills, headers and overlaps? Instead of counting window and door openings, use a multiplier of .25. Using a multiplier of .25 allows for 25% additional track, including the top and bottom tracks. The answer will equal the number of 10'-0" pieces of track needed.

Lineal Footage	**.25 X**
100 LF	25 Track
134 LF	33.5 Track
245 LF	61.25 Track



There are so many variables involved with drywall construction. Sometimes you may need to figure one stud per foot of wall for radius walls and bathroom chase walls. The architect may specify slotted top track or 16 gauge king studs. In these cases you will need to count these items individually or use different multipliers.

Points to Remember

- Gather the information on the materials specified; framing centers, how many layers, types of track, etc.
- Do an accurate takeoff of the lineal footages and verification of heights.
- Use the multipliers whenever possible:
  - **.65x** for 24" on center framing
  - **.86x** for 16" on center framing
  - **.25x** for track
- Area = Length x Height
- Multiply the wall square footage (area) by the number of layers, divide by the sheet size.
- Allow for a little extra board

Chapter 5
Estimating

Study Guide

Directions:

Answer the following questions using the bubble answer sheet.

1). Section views, elevation views, wall legends and details may contain information about building materials.
A) True
B) False

2). You must determine the on center framing for a partition when figuring the amount of studs required.
A) True
B) False

3). What does the "CC" represent in the following stud code: 358CC16?
A) Stud gauge
B) Stud size
C) Flange style & size
D) None of the above

4). What does the "16" represent in the following stud code: 358CC16?
A) Stud gauge
B) Stud size
C) Flange style & size
D) None of the above

5). Surface area is the area of a given surface and has units of distance squared.
A) True
B) False

6). When figuring surface area of a wall, the formula is: Area = ? x Height.
A) Radius
B) Square Feet
C) Length

D) None of the above

7). When determining the number of sheets of gypsum wallboard, a wall would require, you will need to determine the sheet size.
A) True
B) False

8). A scale tape will show the total lineal footage of what is measured.
A) True
B) False

9). In most cases, when measuring walls for materials, you should measure through door and window openings.
A) True
B) False

10). What multiplier determines how many studs are required for 24" on center framing:
A) .86x
B) .65x
C) .25x
D) None of the above

11). What multiplier determines how many studs are required for 16" on center framing:
A) .86x
B) .65x
C) .25x
D) None of the above

12). What multiplier is used to determine how many pieces of top and bottom track are required when the tracks are the same material? :
A) .86x
B) .65x
C) .25x
D) None of the above

13). Tools used to measure lengths on a set of blueprints include:
A) Architectural ruler
B) Scaled measuring tape
C) Electronic measuring wheel

D) All of the above

14). When using a scale tape to measure it is important to match the scale of the tape to the scale of the drawing.
A) True
B) False

Use the allowable span chart on page 78 to answer the following questions.

15). What is the maximum framing height allowed for a 600CC20 stud at 16” on center?
A) 27’-1”
B) 25’-0”
C) 15’-10”
D) 21’-10”

16). What is the maximum framing height allowed for a 358CC18 stud at 24” on center?
A) 20’-0”
B) 18’-2”
C) 15’-10”
D) 18’-3”

17). What is the maximum framing height allowed for a 400CC14 stud at 24” on center?
A) 19’-8”
B) 22’-7”
C) 25’-0”
D) 23’-2”

18). What is the maximum framing height allowed for a 158CC20 stud at 16” on center?
A) 7’-11”
B) 9’-1”
C) 9’-9”
D) 10’-0”

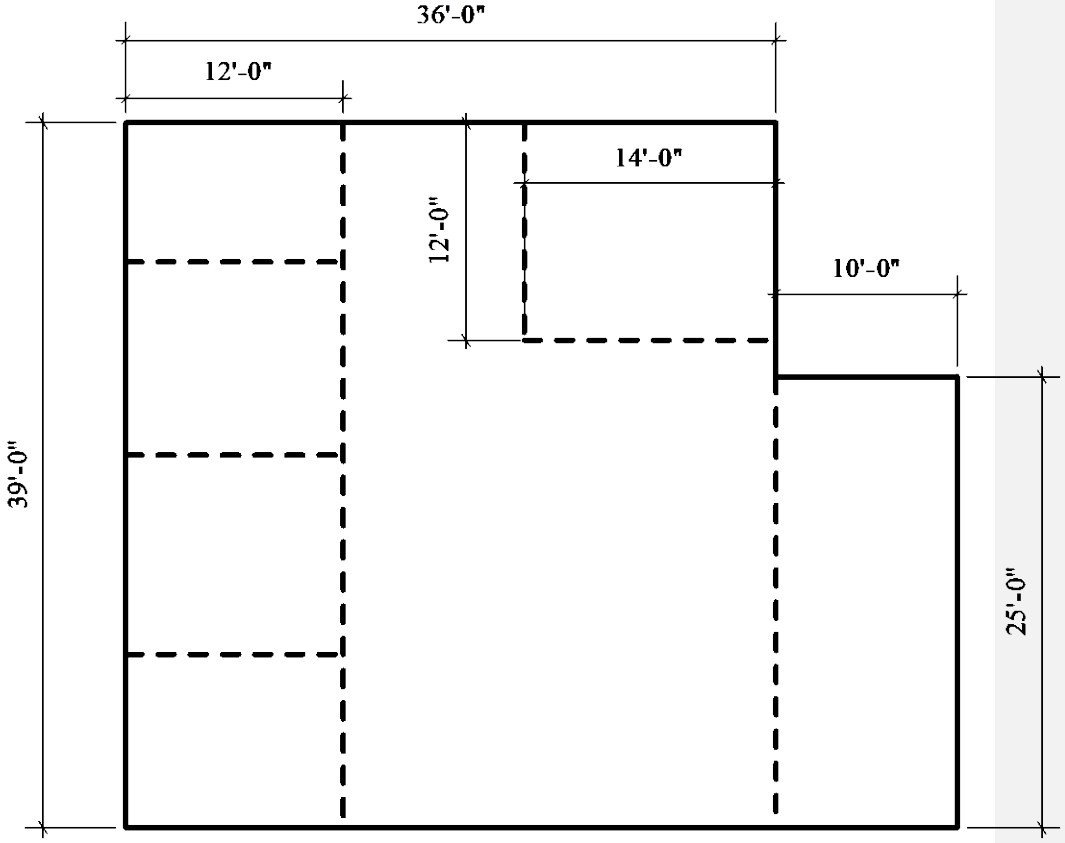
19). What is the maximum framing height allowed for a 250CC16 stud at 24” on center?

A) 11’-10”
B) 12’-9”
C) 13’-7”
D) 14’-7”

20). What is the maximum framing height allowed for a 800CC20 stud at 12” on center?

A) 27’-7”
B) 31’-7”
C) 32’-2”
D) 34’-9”

Take Off Exercise #1



Full height partition, 5/8 "x" each side , roof height 24'-0"

Interior partition to 10'-0", 5/8 "x" each side

Directions:

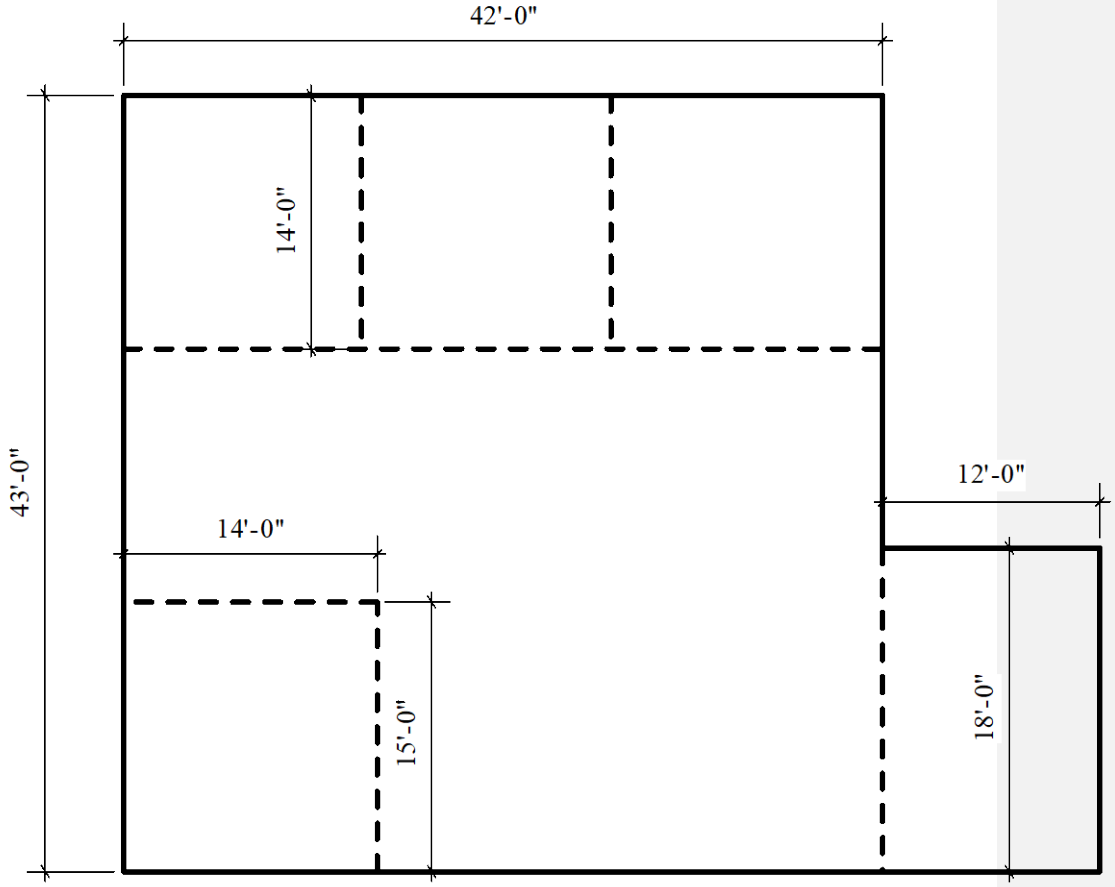
1).Find the total pieces of gypsum board to complete this job, using 4x8 sheets. Allow 10% waste.

2).Find the total pieces of stud and track to complete this job, breakdown each length of stud needed. All framing is 24" O.C. with 3 5/8" stud.

Answers:

24' Stud _____ 10' Stud _____ 10'Track _____ 4x8 Shts _____

Take Off Exercise #2



Full height partition, 5/8 "X" each side , roof height 24'-0"

Interior partition to 10'-0", 5/8 "x" each side

Directions:

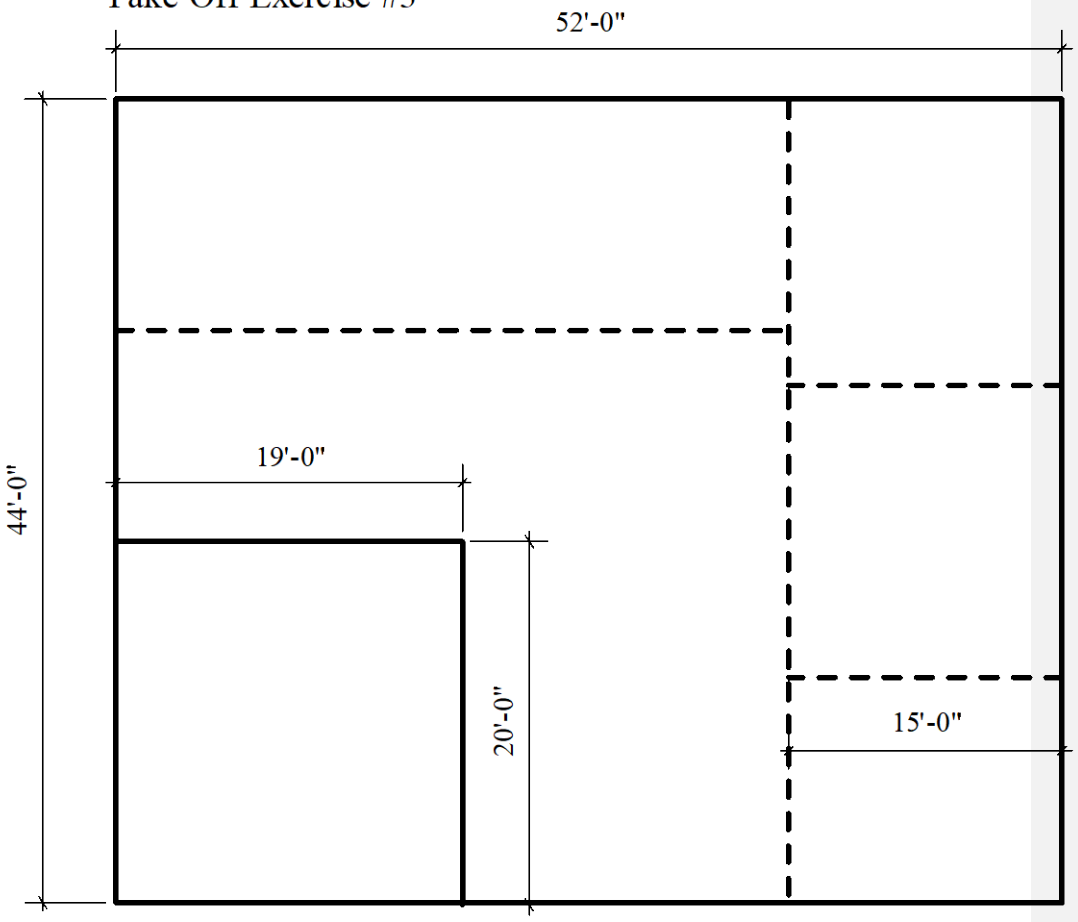
1). Find the total pieces of gypsum board to complete this job, using 4x8 sheets. Allow 10% waste.

2).Find the total pieces of stud and track to complete this job, breakdown each length of stud needed. All framing is 16" O.C. with 3 5/8" stud.

Answers:

24' Stud_____ 10' Stud_____ 10'Track_____ 4x8 Shts_____

Take Off Exercise #3



Full height partition, 5/8 "x" each side , roof height 22'-0"

Interior partition to 10'-0", 5/8 "x" each side

Directions:

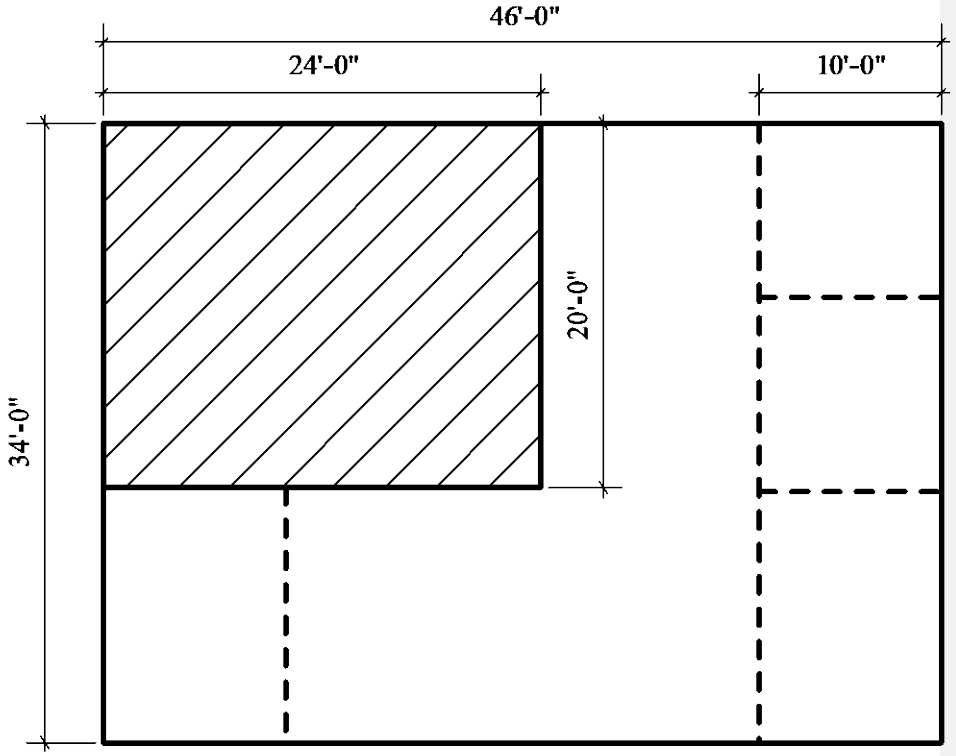
1). Find the total pieces of gypsum board to complete this job, using 4x10 sheets. Allow 10% waste.

2).Find the total pieces of stud and track to complete this job, breakdown each length of stud needed. All framing is 16" O.C. with 3 5/8" stud.

Answers:

22' Stud_____ 10' Stud_____ 10' Track_____ 4x10 Shts_____

Take Off Exercise #4



Gypsum board ceiling, 1 layer 5/8 "x"

Full height partition, 5/8 "X" each side , roof height 22'-0"

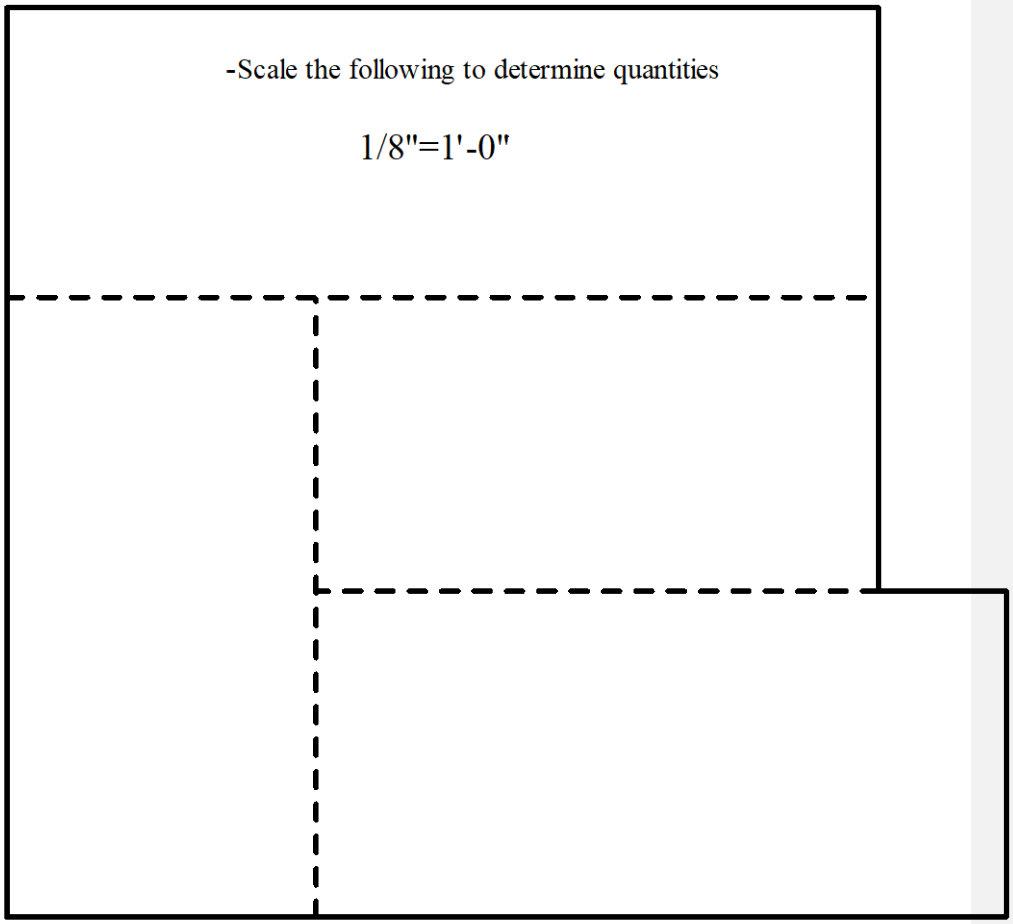
Interior partition to 9'-0", 5/8 "x" each side

Directions:
1). Find the total pieces of gypsum board to complete this job, using 4x12 sheets. Allow 10% waste.
2).Find the total pieces of stud and track to complete this job, breakdown each length of stud needed. All framing is 24" O.C. with 3 5/8" stud.

Answers:

22' Stud_____ 9' Stud_____ 10' Track_____ 4x12 Shts_____

Take Off Exercise #5



Full height partition, 5/8 "x" each side , roof height 26'-0"

Interior partition to 10'-0", 5/8 "x" each side

Directions:

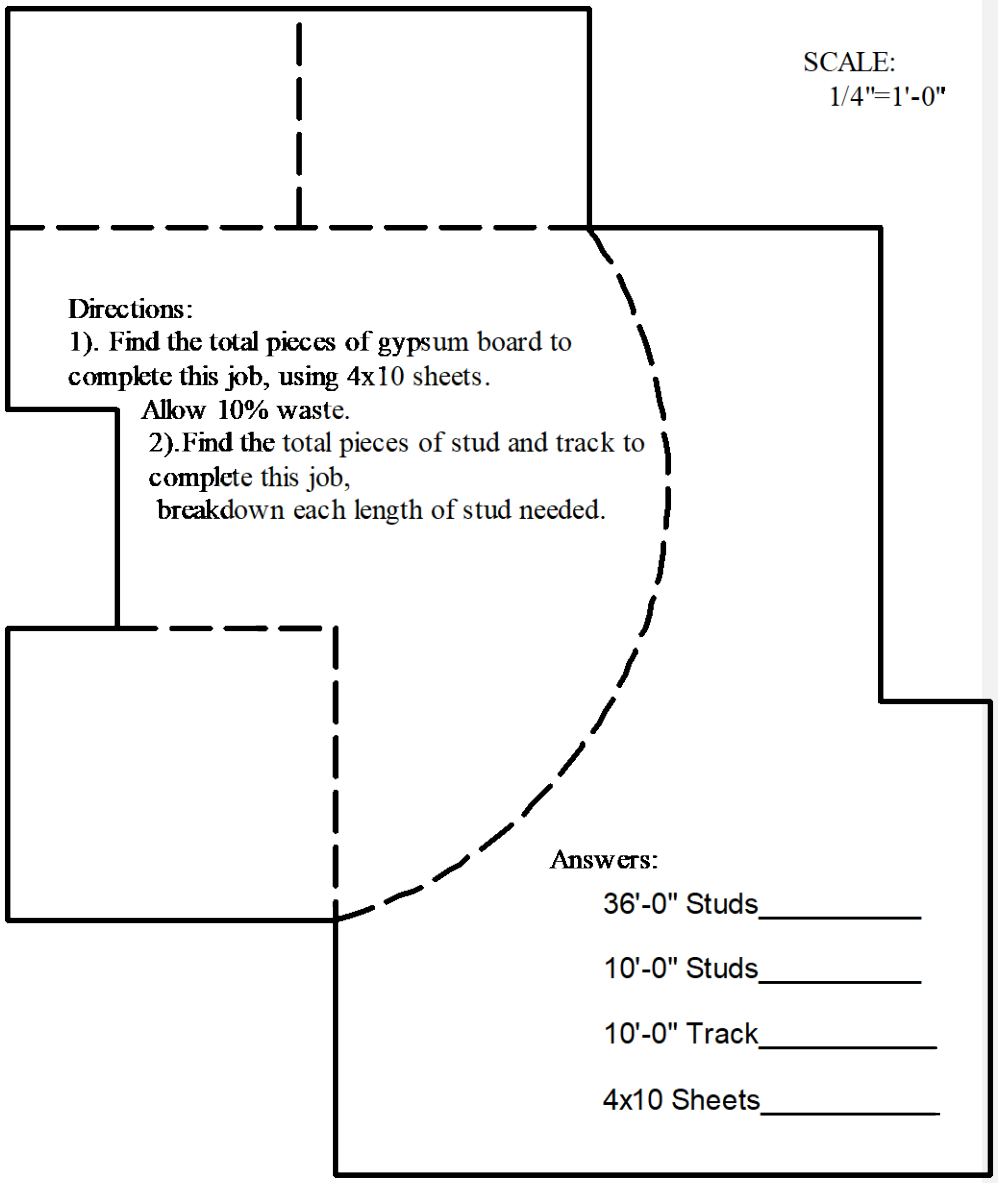
1). Find the total pieces of gypsum board to complete this job, using 4x12 sheets. Allow 10% waste.

2).Find the total pieces of stud and track to complete this job, breakdown each length of stud needed. All framing is 16" O.C. with 3 5/8" stud.

Answers:

26' Stud_____ 10' Stud_____ 10' Track_____ 4x12 Shts_____

Take Off Exercise #6



Full Height Partition, 36'-0" High, 5/8 "x" each side, Frame 24" O.C.

Under Grid Partition, 10'-0" High, 5/8 "x" each side, Frame 16" O.C.

Chapter 5

Practical Math Exercise #1

Directions:
Change the following fractions to decimals. Use the bubble answer sheet for your answers. **Round off your answer to the nearest hundredth**.

1). What is the fraction 1/8 written as a decimal?
A) 0.01
B) 0.13
C) 1.25
D) None of the above

2). What is the fraction 1/4 written as a decimal?
A) 0.02
B) 0.25
C) 2.5
D) None of the above

3). What is the fraction 1/2 written as a decimal?
A) 0.05
B) 5.0
C) .08
D) None of the above

4). What is the fraction 1/16 written as a decimal?
A) .06
B) .62
C) 6.25
D) None of the above

5). What is the fraction 3/8 written as a decimal?
A) .38
B) .03
C) .08
D) None of the above

6). What is the fraction 3/4 written as a decimal?
A) .75
B) .07
C) 7.5
D) None of the above

7). What is the fraction 5/8 written as a decimal?
A) .63
B) .06
C) 6.25
D) None of the above

8). What is the fraction 7/8 written as a decimal?
A) .08
B) .88
C) 8.75
D) None of the above

9). What is the mixed number fraction 6 7/8 written as a decimal?
A) .88
B) .08
C) 68.7
D) 6.88

10). What is 8 7/8 inches written as a decimal foot?
A) .74
B) 7.39
C) .07
D) None of the above

Chapter 5

Practical Math Exercise #2

Directions:
Add or subtract the following dimensions. Use the bubble answer sheet for your answers.

1). What is 65’- 4” added to 23’- 6”?
A) 98’- 10”
B) 78’- 2”
C) 88’- 10”
D) None of the above

2). What is 29’- 7” added to 45’- 2”?
A) 74’- 9”
B) 79’- 4”
C) 75’- 4”
D) None of the above

3). What is 34’- 8” added to 56’- 6”?
A) 91’- 2”
B) 90’- 4”
C) 92’- 1”
D) None of the above

4). What is 12’-9 ¾” added to 45’-7 ½”?
A) 55’- 5 ¼”
B) 56’- 6 ½”
C) 58’-5 ¼”
D) None of the above

5). What is 105’- 9 ½” added to 67’-11 ¾”?
A) 174’- 8 ½”
B) 173’- 8 ¼”
C) 173’- 9 ¼”
D) None of the above

6). What is 23’- 5” subtracted from 78’- 9”?
A) 55’- 4”
B) 54’- 5”
C) 45’- 4”
D) None of the above

7). What is 76’- 9” subtracted from 112’- 11”?
A) 32’- 6”
B) 36’-4”
C) 32’-2”
D) None of the above

8). What is 34’- 8” subtracted from 44’- 5”?
A) 10’- 9”
B) 8’- 9”
C) 9’- 9”
D) None of the above

9). What is 78’- 11¾” subtracted from 89’- 3”?
A) 10’- 3 ¼”
B) 11’- 9 ¼”
C) 9’- 3 ¼”
D) None of the above

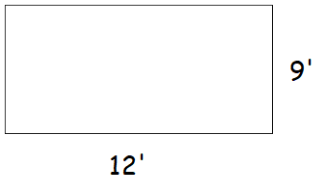
10). What is 16’-3 ½” subtracted from 32’- 11 ¾”?
A) 18’- 6 ¼”
B) 20’- 8 ¼”
C) 16’- 8 ¼”
D) None of the above

Chapter 5

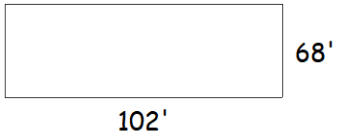
Practical Math Exercise #3

Directions:
Use the appropriate formula to find the area of the following figures. Utilize the bubble answer sheet for your answers. **Round off your figures *before* calculating and final answer to the nearest hundredth.**

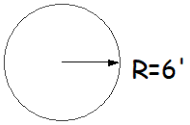
1). What is the area of the following rectangle?
A) 106 sq. ft.
B) 104 sq. ft.
C) 108 sq. ft.
D) 110 sq. ft.



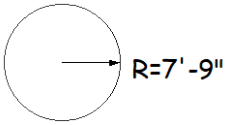
2). What is the area of the following rectangle?
A) 6936 sq. ft.
B) 9636 sq. ft.
C) 6863 sq. ft.
D) 4356 sq. ft.



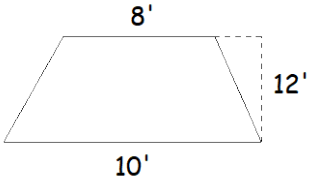
3). What is the area of the following circle?
A) 37.68 sq. ft.
B) 110.34 sq. ft.
C) 113.04 sq. ft.
D) 210.67 sq. ft.



4). What is the area of the following circle?
A) 188.6059 sq. ft.
B) 189.04 sq. ft.
C) 188.5960 sq. ft.
D) 188.63 sq. ft.

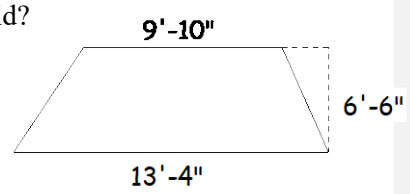


5). What is the area of the following trapezoid?
A) 98 sq. ft.
B) 110 sq. ft.
C) 108 sq. ft.
D) 216 sq. ft.



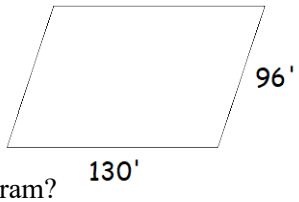
6). What is the area of the following trapezoid?

A) 72.57 sq. ft.
B) 73.27 sq. ft.
C) 75.27 sq. ft.
D) 77.27 sq. ft.



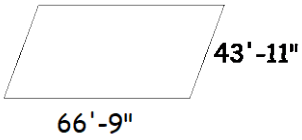
7). What is the area of the following parallelogram?

A) 12480 sq. ft.
B) 12580 sq. ft.
C) 14280 sq. ft.
D) 13560 sq. ft.



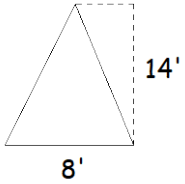
8). What is the area of the following parallelogram?

A) 2931.66 sq. ft.
B) 2932.45 sq. ft.
C) 2992.32 sq. ft.
D) 2994.33 sq. ft.



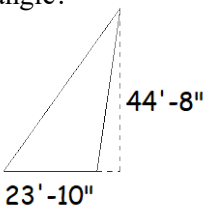
9). What is the area of the following triangle?

A) 46 sq. ft.
B) 56 sq. ft.
C) 66 sq. ft.
D) 76 sq. ft.



10). What is the area of the following triangle?

A) 532.24 sq. ft.
B) 542.24 sq. ft.
C) 542.42 sq. ft.
D) 544.23 sq. ft.

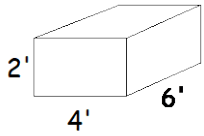


Chapter 5

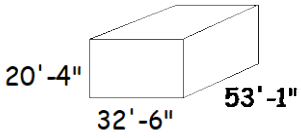
Practical Math Exercise #4

Directions:
Use the appropriate formula to find the volume of the following figures. Utilize the bubble answer sheet for your answers. **Round off your figures *before* calculating and final answer to the nearest hundredth.**

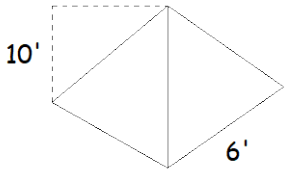
1). What is the volume of the following rectangular prism?
A) 38 cu. ft.
B) 48 cu. ft.
C) 58 cu. ft.
D) 68 cu. ft.



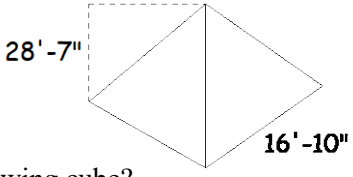
2). What is the volume of the following rectangular prism?
A) 35071.28 cu. ft.
B) 36071.28 cu. ft.
C) 35678.32 cu. ft.
D) 23498.21 cu. ft.



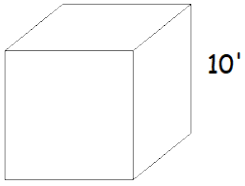
3). What is the volume of the following pyramid?
A) 110 cu. ft.
B) 120 cu. ft.
C) 130 cu. ft.
D) 135 cu. ft.



4). What is the volume of the following pyramid?
A) 2688.42 cu. ft.
B) 2678.43 cu. ft.
C) 2698.42 cu. ft.
D) 2765.23 cu. ft.

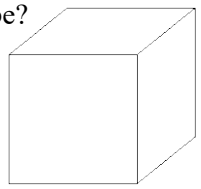


5). What is the volume of the following cube?
A) 1000 cu. ft.
B) 1010 cu. ft.
C) 1100 cu. ft.
D) 1110 cu. ft.



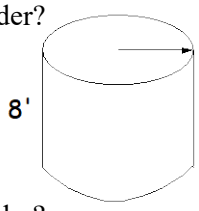
6). What is the volume of the following cube?

A) 34695.26 cu. ft.
B) 36495.26 cu. ft.
C) 36945.26 cu. ft.
D) 36789.26 cu. ft.



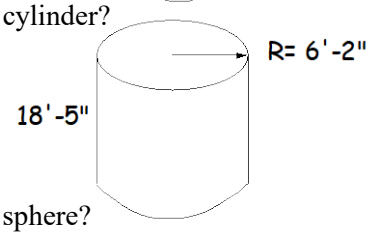
7). What is the volume of the following cylinder?

A) 401.92 cu. ft.
B) 404.92 cu. ft.
C) 456.56 cu. ft.
D) 456.90 cu. ft.



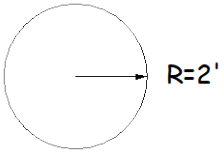
8). What is the volume of the following cylinder?

A) 2201.45 cu. ft.
B) 2202.67 cu. ft.
C) 2201.86 cu. ft.
D) 2204.45 cu. ft.



9). What is the volume of the following sphere?

A) 33.49 cu. ft.
B) 34.49 cu. ft.
C) 35.49 cu. ft.
D) 36.56 cu. ft.



10). What is the volume of the following sphere?

A) 1162.74 cu. ft.
B) 1172.74 cu. ft.
C) 1182.74 cu. ft.
D) 1192.74 cu. ft.