CENGAGE

BUILDING CONTRACTOR'S LICENSING

Exam Guide

SIXTH EDITION

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Exam Guide

SIXTH EDITION

By Chris Prince

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SVP, Higher Education Product Management: Erin Joyner

VP, Product Management, Learning Experiences: Thais Alencar

Product Director: Jason Fremder

Product Manager: Lauren Whalen

Product Assistant: Bridget Duffy

Senior Content Manager: Jenn Alverson

Digital Delivery Quality Partner: Elizabeth Cranston

Director, Product Marketing: Neena Bali

Production Service: Lumina Datamatics Ltd.

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Cengage
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INTRODUCTION

Congratulations! If you are reading this book, it is likely that you are pursuing a new opportunity. Whether you are preparing to take an exam in order to start your own contracting business, to enhance the qualifications of an existing company, or to qualify the company for which you now work, you are taking deliberate measures to improve an existing situation. So sit back, relax, and rest assured that the time you spend with this book will significantly improve your chances of passing the exam that you are about to take.

TIME FOR TEST MODE!

Preparing for and taking an exam requires a specific mind-set. It requires planning for the upcoming event and making a conscious effort to control anxiety. For most, the thought of taking an exam will cause a feeling of butterflies churning in the stomach. For some, it will lead to more severe symptoms such as headaches and nausea. Don't fear; controlled test anxiety is good. It creates a sense of urgency to succeed. Identify your level of anxiety, and control it.

How do you rate your level of anxiety? For some, perhaps the last test-taking ordeal was a high school final exam twenty years or so ago. The memory of this experience, coupled with the pressure of living up to the expectations of family, a boss, or coworkers can be overwhelming. When children are aware that a parent will soon be taking an exam, they are likely to reciprocate the pressure applied to do well in school. Bosses often assume that the exam will be a breeze for such a competent employee, and many times, a spouse's support is mistaken for unrealistic expectation. Peer pressure is not necessary. Do what you can to minimize it.

Keep the fact that you are taking the exam a secret! Maybe everyone notices your study efforts, but there is no need to announce the test date. Make your plans by scheduling the exam, and if you must explain, say that you have an appointment. The pressures felt from the need to please and live up to the expectations of everyone around you can lead to undue stress and is not necessary. If no one knows your plans, the only pressure you will feel to succeed is your own. This pressure is healthy and probably necessary. Rather than dealing with the pressure of others, imagine the feeling when you announce your accomplishment after the fact. Work toward this goal, and visualize success. Think positive.

Another way to eliminate stress may be to think of your first test date as a practice run. In the worst-case scenario, passing the exam will take two attempts. It is not the end of the world if you do not pass on the first attempt. Most states and municipalities allow you to take the exam as many times as necessary without penalty. Before using this suggestion, make sure that your exam does not limit the number of times it can be taken during a certain amount of time. (We will explain later how to check this.)

Notes

Next, avoid becoming irritated that the exam is required. Forget the fact that you know your trade and feel that you should not be required to pass an exam to prove yourself. Look at the experience as an opportunity. The knowledge gained from preparing for the exam will far outweigh the effort. Without a doubt, you will gain information that will improve your efficiency and trade expertise, and could even save you money.

Remember the old carpenter's advice to measure twice and cut once? Similarly, when it comes to test-taking, it is critical to be precise, careful, and methodical as you prepare for exam day. Apply this philosophy as you take the practice exams in this book—read the questions twice and choose the answers carefully. The exams are typically administered in a multiple-choice format, and it is not uncommon for at least two of the choices to appear to be correct, depending on how the question is read. Remember, there is only one correct answer, and one word in the question can change its entire meaning. Be careful.

After you have switched to test mode, it is time to prepare for the exam.

PREPARING FOR THE EXAM

The first step of preparation is to identify the exam required to accomplish your goal. If you are taking a state-required exam to become a licensed contractor, you can begin by visiting www.becomealicensedcontractor.com. Select your state, choose General Contracting under the listing of test types, and the test requirements will be found. The site will likely lead you to the candidate information bulletin provided by the approved testing company.

The candidate information bulletin is the test-taker's rule book. It provides specific information, including the addresses of testing centers, identification requirements, security procedures, and anything else necessary for taking the exam. In preparing for the exam, it is important to identify the answers to the following questions when using the candidate information bulletin.

1. **What are the approved references?** This is, by far, the most important piece of information to know prior to your exam-preparation mission. Most general contracting exams are based on either the *International Residential Code*® or the *International Building Code*® and several additional references. After identifying the approved reference materials, eliminate the study exams in this book that are not included in your exam. Do not spend valuable time studying information that is not included on your exam.

2. **Are the approved references allowed in the examination center?** In most cases, books are allowed in the examination room for use throughout the exam. While this would seem to make the exam extremely easy, if you are not familiar with how to use the books, it might as well be a closed-book exam.
3. **Is tabbing and highlighting of the books allowed?** Typically, if the approved references are allowed to be taken into the exam room, they are allowed to be highlighted and tabbed prior to test day. Many rules allow you to underline but prohibit you from making notes in the reference materials. The candidate information bulletin will specifically call for permanent tabs. Permanent tabs are those that cannot be easily removed. Post-it tabs are generally not allowed. If any of the rules are broken, your reference materials may be banned from the test site.
4. **What is the time frame for taking the exam?** The time frame is important because you will want to simulate the time allowed as you work through the study exams throughout this book. Simply divide the allotted time in minutes by the number of questions on the exam to determine the time allotment per question. You can now easily multiply the number of questions in a particular section of this book by the average time allowed per question to set the time frame for working through the practice exams. In the beginning, you will want to allot additional time until you become familiar with the reference materials.
5. **What is the content outline of the exam?** It is important to pay attention to the breakdown of the exam in order to allot your study time. If only 5 out of 80 questions pertain to OSHA, you should spend less time studying this subject and concentrate more on the areas representing the largest portion of the exam.

USING THIS EXAM GUIDE

Before using this guide, make sure that you have highlighters and tabs readily available. Begin with identifying the table of contents, the index, and the glossary of each reference book. Place a tab on each of these sections for easy access. The table of contents divides the book into chapters or subjects and will be used frequently. The index is an alphabetical listing of key words found throughout the book and should be your starting point for finding an answer to a specific question. If the answer is not found using the index, identify the chapter according to the subject of the question by using the table of contents. The glossary is an alphabetized listing of terms that serves as a useful source for answering questions quickly. A glossary may or may not be found in the approved references.

Notes

Notes

Each section of this exam guide is based on a particular subject. As you answer each of the questions from the study exam, highlight the answers. This will help you to become familiar with the book and will strengthen your ability to quickly reference important code items. Remember, the purpose of each practice exam is not to test your trade knowledge; it is to provide an exercise of how to navigate and use the approved reference(s). If you feel that you know the answer to a question, you should verify the answer using the applicable book. Pay close attention to the tables that are referenced as well as the subject matter of each chapter.

When it comes to tabbing your reference materials, be careful not to overdo it. Placing too many tabs will be more of a hindrance than a useful tool. Remember, when using tabs, the more tabs you use, the longer it will take to read through each one. Using the index will likely save you time in your search for specific information. It is highly recommended that you tab the chapters, table of contents, index, and useful tables.

Going into the exam, make sure that you are familiar with the subject matter of each book. It is very important for you to understand the layout of each book approved as a reference. This is accomplished through the process of answering the questions in this guide.

Prior to exam day, remove the index from approved reference books that are bound with a three-ring binder, staple it together, and place it in the front pocket of the binder. This will allow easy access to the index by being able to place it on the testing table beside the reference book rather than requiring you to flip back and forth between the index and the body of the book.

On average, exams allow about 3 minutes per question. When you begin using the study exams in this book, allow yourself 8 to 10 minutes per question. As you become more familiar with the reference materials, decrease this time allotment to about 5 minutes. By the time you complete the final exams, allow yourself only the time allotted on your exam.

It is important to devise a time-management strategy that works for you immediately. By test day, your goal is to have a plan of action of how to work through the exam. As you are preparing for the exam, keep in mind that the clock will be working against you. Decide the maximum amount of time that you will spend on one question before moving on to the next. You do not want to run out of time.

WHAT TO BRING TO THE EXAM

Notes

Prior to test day, make sure you get a good night's rest and arrive armed with the following items:

Candidate information bulletin. Many times, the proctor of the exam is inexperienced. If you are told that tabs are not allowed, you need to be able to defend yourself by referring to the bulletin (the rule book).

Bottle of water. The clock does not stop during the exam. There are no "hold" buttons. If you need a sip of water and have to run to the water fountain or bathroom, the timer will continue to count down. Although you have little choice when it comes to a bathroom break, at least be prepared for the dry mouth syndrome.

Magnifying glass. Many of the documents and diagrams used throughout the exam are difficult to read. Save the frustration and headache-causing eyestrain, and use a magnifying glass.

Two pencils and a pencil sharpener. Arrive with at least two pencils and a pencil sharpener, especially if you are taking the exam using the old-fashioned pencil-and-paper format. Tests are still administered this way in several states and municipalities.

Two calculators. Remember Murphy's law—if it can go wrong it probably will on test day. Have a contingency plan for everything. If you insist on using your favorite calculator, and it happens to be one that you are not sure is allowed, such as a construction master, make sure that you have a backup.

A great attitude. Make every attempt to remain calm, cool, and collected. This is easier to maintain if you have had adequate rest the night before the exam. Do not cram and stay up until midnight. This will work against your tolerance level for aggravation. Remember, frustration will only create tension and make everything more difficult.

Make sure that you also understand the requirements for identification, payment methods, and proper exam registration documentation.

LET THE TEST BEGIN

The moment you sit in the "hot seat" to begin the exam, let the strategy unravel. Have a plan and stick with it. A few recommendations:

1. **Switch to test mode.** Many times, the rules of thumb and assumptions you make in the field will not work in the test world. While your background and experience can be an attribute, do not allow it to get in the way on test day. Make no assumptions. If you are not 100% sure of an answer, try to verify it at some point. Be deliberate to focus and concentrate on each question.

Notes

2. **Arrange your work area neatly.** Stack your books to one side and, if possible, stand them upright so that they are easily accessible. Decide for yourself that at least for this day, you will be the most organized and careful person in the world.

3. **Download the memory.** That's right, download the information you are having trouble remembering. Transfer the formulas and anything else you have been repeating since you walked into the test site from your brain to the scratch sheet of paper provided by the proctor.

4. **Become familiar with the construction drawings and/or diagram booklet before you start the clock.** If your test is being administered by computer, you are in control of when the countdown begins. Take advantage of the control, but be careful not to push it. The proctor is only a few steps away and may prod you to begin the test if you wait too long.

5. **Answer the easy questions first.** Nothing will boost your confidence more than to run through a good portion of the exam answering questions based on information you recall from your studies. In contrast, your confidence level can diminish rapidly if you become distracted by a difficult question.

6. **"Mark" any questions answered that you doubt.** If the test is computer based, you have the option to mark questions to review later. If you run out of time, the computer accepts the selected answer and does not penalize you for marking the question. By marking questions, if you have additional time after answering all questions, you can verify the answers you selected.

7. **Leave the difficult questions unanswered, and come back to these last.** As you skip questions, make a note on the scratch paper, associating the question number with a specific book. This will allow you to categorize each of the unanswered questions by book, saving valuable time and unnecessary frustration. After reading the last question, you will be allowed to revisit unanswered questions or marked questions. You can choose to go to the first of these in the group or to a specific question number.

8. **Do not run out of time.** Pay attention to the clock. Do not leave any question unanswered. Before you run out of time, select a choice for each question. Questions left unanswered will be counted against you. If you have to guess on a number of questions, improve your odds by selecting the same choice on each question. For example, select all As or all Cs, but your goal is to manage your time and not have to guess on any of the questions.

PART ONE
Math Concepts

Understanding basic math concepts can be crucial for the portion of the exam, which is based on print reading.

If your candidate information bulletin does not list math or plan reading as subjects to be covered, this chapter may not be as important to you as some of the others. However, it will prove beneficial for shifting your thought process to test mode. Working through the exercises will stimulate your brain. This chapter can be thought of as the “warm up” recommended for most athletes prior to an intense workout.

While many contractors probably dread math, it is crucial to running a successful business. What many exam candidates come to realize is that math is not nearly as bad as what they have come to expect. In fact, most people are better at math than they think.

The following chapter covers basic math concepts that are crucial to the contracting business and, more importantly, for now at least, crucial to passing an exam. While it is impossible to cover every type of question that may appear on an exam, a strong knowledge of the proper steps to performing similar math calculations will get you through any exam.

Concepts covered in this chapter include:

- Math rules
- Rounding
- Converting inches to feet
- Square feet to estimate brick, block, and drywall
- Cubic yards to estimate concrete and dirt
- Framing math
- Roofing math

Notes

THE DREADED MATH

When it comes to math portions of the exam, there are several important and critical rules. It is in your best interest to convince yourself that for this one day, you are going to take a methodical approach and deliberately follow each of the rules that follow.

MATH RULES

1. **Always use a calculator.** This is probably the most critical rule when it comes to performing math operations on the exam. Never perform mental calculations. Once you arrive at an answer, do the calculation again to check your answer. Repeat your calculations until you are certain the answer is correct.
2. **Use scratch paper to write down each step of the math.** Professionals who use math on a daily basis—accountants, engineers, and the like—are sometimes the most difficult math students. Why? Because they simply refuse to use scratch paper to write each step of the equation as they work through it. They are also reluctant to use a calculator for what they believe to be simple math. You do not want to fail this exam by one or two points; it hurts worse to make a grade of 69 than it does to make a grade of 30. The point is, don't get in a hurry and miscalculate. Always write your problem out as you solve it. Always perform math operations, at least twice, with a calculator.
3. **Always multiply "like" numbers.** In other words, do not mix feet and inches. If you multiply 10 feet by 8 feet 6 inches, the answer is not 86 feet, it is 85 feet. You cannot simply multiply 10 by 8.6—you must first convert the 6 inches to feet (to be reviewed later).
4. **When converting inches to feet, round to the nearest hundredth.** Yes, this is an exception to Rule 3. The reason we round to the nearest hundredth when converting inches to feet is because it puts your answer in the correct range of the choices provided and allows you to write it down more easily. You would not want to write 0.3333333333333 when it would be much simpler to write 0.33 (to be reviewed later).
5. **Never round until you get to the end.** This simply means that you should never round any of your numbers until you solve the equation. When necessary, round based on the choices provided to a question or to the directions provided in the question. The only **exception** to this rule is when converting inches to feet (Rule 4).

Example:

Rounding up to the next whole yard, how many cubic yards of concrete will be needed to pour a 4-inch-deep drive that measures 20 feet $\times$ 100 feet?

a. 24
b. 24.44
c. 25
d. 25.5

Solution:

$$CY = \frac{L \times W \times D}{27}$$

$$CY = \frac{100 \times 20 \times .33}{27}$$

$$CY = 24.44$$

Explanation:

The question clearly states "round to the next whole yard." Although the exact answer is one of the choices, 25 (choice c) is the correct answer. Notice that 4 inches was converted to feet allowing the multiplication of "like" numbers. Before solving the equation, 0.33 was rounded. This is acceptable and will put you in the proper range of the correct answer for your exam.

6. **Draw it out.** If you have to sketch apples and stick people, do it. Remember, you do not want to fail this test by one question. It is critical that you use your scratch paper to draw as you solve the equation to answer the question.

MATH REVIEW

Rounding

Let's look at the concept of rounding. The numbers to the right of the digit, or point, begin with the tenth place. The second number is the hundredth place, and the third number is the thousandth place.

To round a number, begin by identifying the rounding digit, and look to its right side. If the digit to the right of your rounding digit is 4 or less, do not change it. All digits (numbers) to the right side of the rounding digit will be dropped.

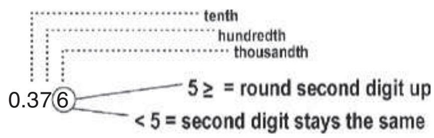
Example: 0.3333 rounded to the nearest hundredth will be 0.33

What if the number to the right of your rounding digit is not 4 or less? If the digit is 5, 6, 7, 8, or 9, your rounding digit is increased by one number. All digits to the right side of the rounding digit will then be dropped.

Example: 0.6777 rounded to the nearest hundredth will be 0.68

Notes

Rounding to the nearest 100th



Notes

For exam purposes, rounding is used most commonly when converting inches to feet (next lesson) for the purpose of multiplying and/or dividing like numbers. Since each of these steps will be written on a sheet of scratch paper, rounding to the nearest hundredth will save valuable time and will lead you to choose the correct answer.

If you do not round to the nearest hundredth, you will still arrive at the correct answer, but you are more likely to make a mistake.

Converting Inches to Feet

Converting inches to feet is necessary for multiplying like numbers and will frequently be the first step required to solve a math-related question. Begin to understand this concept by stating to yourself "There are 12 inches in 1 foot." Think about it. If someone asks how many feet are in 36 inches, your reply will be almost instant. This may be handy on test day.

Begin to think of inches in terms of fractions. To do this, 36 inches would be placed over 12 inches ($^{36}/_{12}$).

To convert a fraction to a decimal, you simply take the top number (numerator) and divide by the bottom number (denominator). Thirty-six inches divided by 12 equals 3. Apply this to any number presented as inches, and you can quickly convert it to feet.

Four inches converted to feet would simply be 4 divided by 12 ($^{4}/_{12}$). This equals 0.3333333333. Rounding to the nearest hundredth, 4 inches is equal to 0.33 feet.

Practice:

1. Rounding to the nearest hundredth, 14 inches is equal to ____ feet.
   a. 1.4
   b. 1.2
   c. 1.17
   d. 1.166

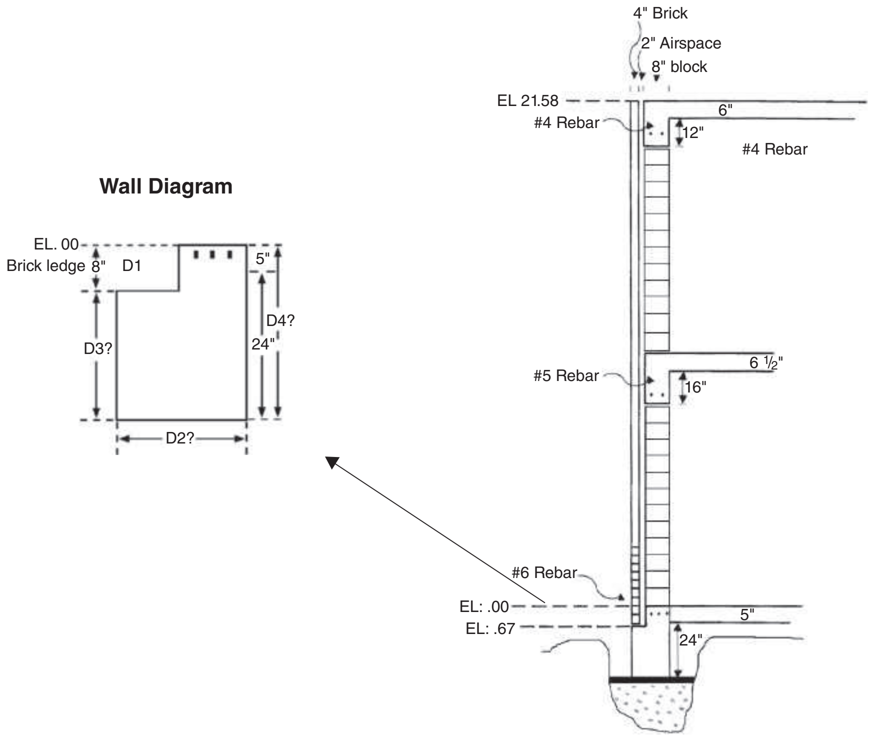
2. Rounding to the nearest hundredth, 8 inches is equal to ____ feet.
   a. 0.8
   b. 0.67
   c. 0.6666
   d. $^{8}/_{10}$

3. Rounding to the nearest hundredth, 3 inches is equal to ____ feet.
   a. 0.25
   b. 0.33
   c. 0.4
   d. 0.5

Answers/Solutions found in Part 18 of this book.

Notes

Applying the Concepts of Rounding and Converting Inches to Feet



The drawing shown represents the cross section of a two-story building. A cross section shows a view of the internal construction of an object or structure. It represents how it looks when cut on a plane.

The footing, slab, brick ledge, and building height can be determined from the drawing. A footing is a base or bottom of a foundation, pier, wall, or column that can be manually formed (stem wall) and supported by an earth-formed footing.

This particular footing will support a 4-inch brick and an 8-inch block separated by 2 inches of air space. All heights for this building will be relative to the slab level and will be represented by an elevation number.

Notes

An elevation is the height above an established reference point, such as the slab level in the drawing. The elevation at the top of the slab is identified as 0. The level portion of the footing that will support the brick is identified as −0.67'. This indicates the brick ledge is 67 hundredths of a foot lower than the floor level.

Answer the following questions based on the Wall Diagram on page 11.

1. Calculate the depth of the brick ledge. (D1)

   a. 0.6 ft.
   b. 0.67 ft.
   c. 0.8 ft.
   d. 0.85 ft.

2. What is the width of the footing? (D2)

   a. 1.2 ft.
   b. 1.17 ft.
   c. 1.4 ft.
   d. 1.25 ft.

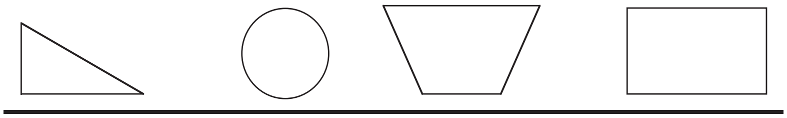
3. What is the outside height of the footing? (D3)

   a. 2.1 ft.
   b. 1.2 ft.
   c. 1.75 ft.
   d. 1.9 ft.

4. What is the inside dimension, from grade to the top of the slab, for the footing? (D4)

   a. 2.9 ft.
   b. 2.42 ft.
   c. 2.35 ft.
   d. 2.25 ft.

Calculate Square Feet

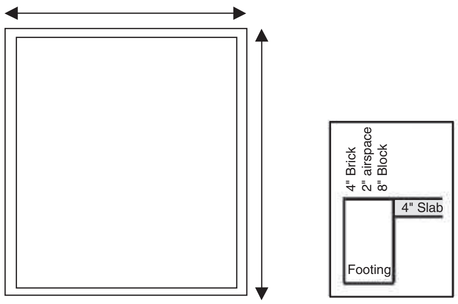


$\frac{L \times W}{2}$ πR^2 $\frac{B + C}{2} \times H$ $L \times W$ (or H)

A majority of building components, including drywall, bundles of shingles, roof sheathing, brick, and block, are estimated by determining the square feet of the area first. Think of square feet as the foundation, or the starting point, for any take-off. If you understand how to properly calculate square feet, you can correctly answer many of the questions on the exam.

As discussed previously, you should be precise with your calculations. For example: If you are answering a question such as how many square feet of concrete slab will be installed, first determine the precise dimensions of the slab. Do not simply take the outside dimensions that have been provided. Read the details to determine where the slab is poured. Is it to the inside of the building, or does the building sit on top of the slab?

Example:



What is square footage of the 4-inch slab if the building dimension is 31 feet 6 inches × 20 feet?

a. 632 sq. ft.

b. 630 sq. ft.

c. 583 sq. ft.

d. 515 sq. ft.

Explanation:

The width of the footing must be subtracted from the overall dimensions of the building because the detail specifies that the slab is poured to the inside. The width is 14 inch, which converts to 1.17 feet.

20' − 1.17 − 1.17 = 17.66 (subtract the thickness twice)
31.5 − 1.17 − 1.17 = 29.16 (subtract the thickness twice)
17.66 × 29.16 = 514.9656 (answer is (d))

Notes

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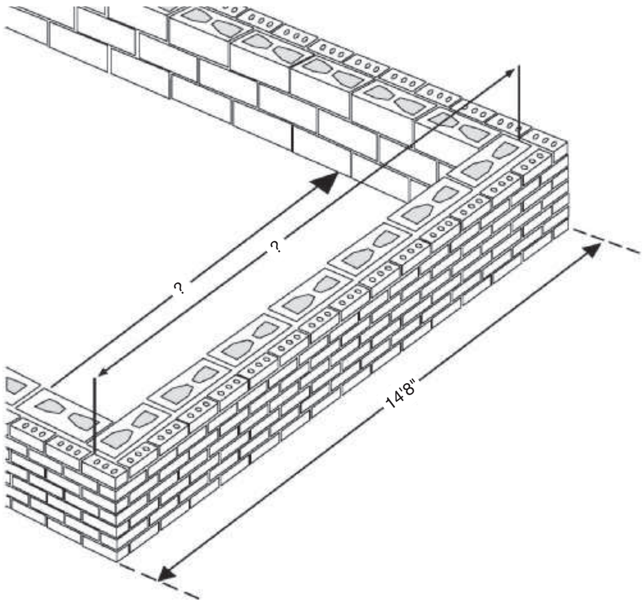
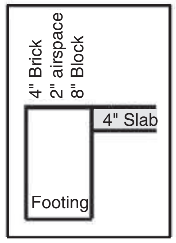




5. Based on the information provided, what is the dimension when measured on the inside of the structure?

   a. 14.67'

   b. 12.67'

   c. 13.5'

   d. 12.33'

6. If the construction of this building did not include brick and the dimensions of the interior remain the same as determined in Question #5, what is the measurement of the structure?

   a. 12.67'

   b. 13.67'

   c. 13.5'

   d. 11.67'

7. If this building were rectangular and measured 14 feet 6 inches in width and 23 feet in length, what is the inside dimension lengthwise?

   a. 22.67'

   b. 22'

   c. 21.83'

   d. 20.66'

Using Area (Square Feet) to Estimate Sheathing, Drywall, Brick, and Block

To estimate quantities of flat material, simply divide the area to be covered by the square feet of the material to be installed. For example, if the square feet of the interior walls for a structure totals 3,200, and 4' × 12' × ½" gypsum is being installed, divide 3,200 by 48 to determine that 67 boards must be ordered.

An obvious question at this point might be "Do I deduct for openings?" Do not deduct for openings when calculating gypsum/drywall. Do, however, deduct for openings when calculating brick or block.

1. How many sheets of 4' × 8' × ⅝" gypsum board will be needed for the interior of a garage with room dimensions of 24' × 30' with 8' ceilings? Note: The gypsum is to be installed on the walls and ceiling. Disregard openings.

   a. 23

   b. 27

   c. 50

   d. 69

2. After adjustments have been made to account for the pitch, a roof is determined to be 2,875 square feet. How many 4' × 8' pieces of sheathing will be installed?

   a. 90

   b. 60

   c. 120

   d. 52

Notes

Notes

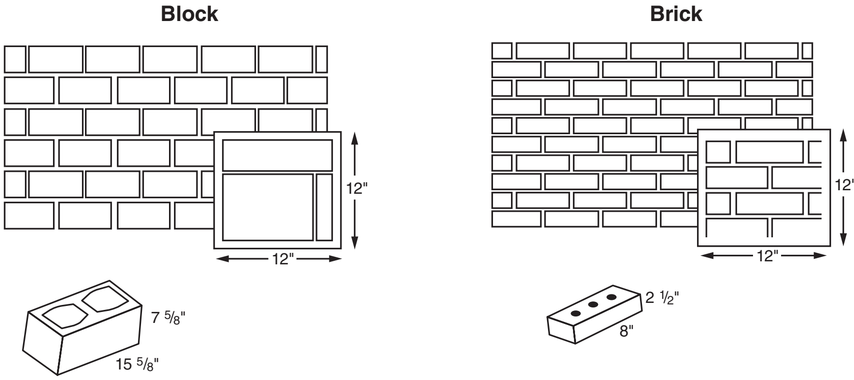
3. Half-inch gypsum board is to be installed on the 8' walls of a room with dimensions of 12' × 14'. Specifications call for 4' × 8' × ⅝" gypsum board to be installed on the ceiling. The room has an opening of 6' on one side with two windows, each 4' × 6' facing the front of the structure. How many 4 × 8 sheets of ½" gypsum must be ordered?

   a. 13

   b. 9

   c. 5

   d. 4



Estimating brick and block is similar to estimating gypsum or sheathing. Begin by determining the face area of the material to be installed. For example, if an 8" × 16" nominal block (7⅝" × 15⅝" plus the mortar joint) is to be used, the face area of the block is 128 square inches. To convert this to a multiplier, you can follow one of several methods.

First, you can divide 144 square inches by 128 square inches to determine that it will take 1.125 blocks per square foot. The area (square feet) multiplied by 1.125 determines the number of 8" × 16" blocks needed.

You can also divide 128 square inches by 144 square inches to determine that one block will cover 0.8888 square feet. The area (square feet) divided by 0.8888 will determine the number of 8" × 16" blocks needed. Either way will result in the same answer.

Many contractors take the length of a wall and divide by 1.33 to determine the number of blocks required on each course. They will then take the height of the wall and divide by 0.67 (height of an 8-inch block) to determine the number of courses required. By multiplying the number of courses by the number of blocks on each course, the total quantity needed for the structure can be determined.

For test purposes, it is recommended that you follow one of the first two methods. Begin by determining the total area in square footage and multiplying/dividing by the appropriate factor.

Example:

How many blocks are needed for a wall that is 21 feet tall and 38 feet long?

a. 898

b. 600

c. 917

d. 1,191

Explanation:

Determine the area of the structure by multiplying the height times the length: 21' × 38' = 798 square feet. The area divided by 0.8888 will determine the quantity of block needed: 798 ÷ 0.8888 = 898 blocks. The area multiplied by 1.125 will also determine the quantity of block needed: 798 × 1.125 = 898 blocks. The answer is (a).

To estimate the quantity of brick needed for a structure, follow the same steps. However, we will look at only one way to determine the correct answer. Begin this task by determining the number of bricks needed for each square foot of area. Next, determine the area, and multiply the area by the multiplier to arrive at the correct answer.

If a brick is 2½" × 8", the face area of the unit is 20 square inches. The square inches of a square foot (144) divided by 20 equals 7.2 bricks. If the area to be constructed with a brick veneer is 1,000 square feet, multiply the area by 7.2 to determine that 7,200 bricks should be ordered for this project.

At this point, you may be thinking of waste. Factors will be provided on your exam to determine the allotted waste. If the waste factor on this project (question) is specified as 15%, simply add this amount to the total: 15% of 7,200 is 1,080; 7,200 plus 1,080 is 8,280. If this were a question on the exam, the correct answer would be 8,280 bricks.

4. Disregarding waste and loss due to overlapping at the corners, how many standard 8" × 16" blocks would be needed for a 20' × 32' building that is 18' tall?

   a. 1,872

   b. 2,106

   c. 2,489

   d. 2,725

Notes

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5. Based on a waste factor of 10%, how many bricks will be needed for a 10' × 20' wall? The brick is 7" × 2¾".

   a. 1,295

   b. 1,485

   c. 1,646

   d. 1,760

6. A wall is 32' long, 8' high, and will be constructed out of 8" × 8" × 16" concrete masonry units (CMUs) with a brick veneer. Total square feet of openings is 28, and the brick is 2½" × 8". How many of each is required?

   a. 1,642 bricks, 257 blocks

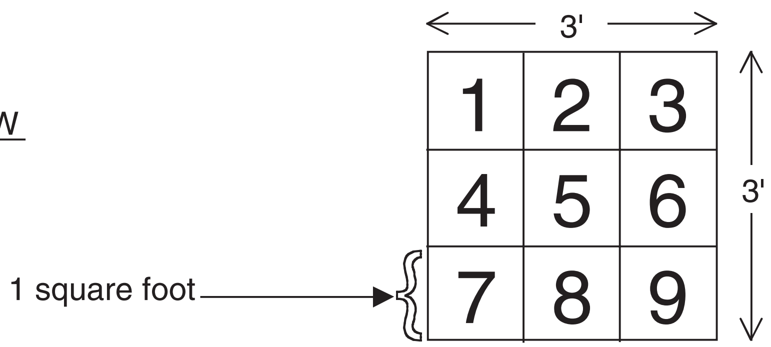
   b. 1,487 bricks, 228 blocks

   c. 1,287 bricks, 188 blocks

   d. 1,189 bricks, 171 blocks

Calculate square yards

$$\frac{L \times W}{9}$$



To calculate square yards, divide the area (square feet) by 9. There are 9 square feet in 1 square yard. It is highly recommended you always write the formula down before you begin to solve the equation. Write the formula down first, and carefully insert each number from the question into the formula.

It is not uncommon for an exam question to include too much information. In the testing profession, this information is referred to as a distracter. By paying attention to the formula, the distracter is less likely to cause a mistake in your calculations.

Example:

How many square yards of asphalt will be installed for a driveway that is 12 feet wide and 42 feet long? The depth of the asphalt is 2 inches.

a. 85.68 sq. yd.

b. 56 sq. yd.

c. 112 sq. yd.

d. 3.17 sq. yd.

Explanation:

Choices are provided for nearly any mistake made using the 2 inch depth. The proper way to calculate the square yards for this question is to calculate 12×42 and divide by 9. $12 \times 42 \div 9 = 56$. The answer is (b).

1. Calculate the square yards for a 20' $\times$ 45' area:

   a. 900 sq. yd.

   b. 33.33 sq. yd.

   c. 100 sq. yd.

   d. 75 sq. yd.

2. How many square yards of carpet must be ordered for a room that is 20' wide by 30' long? (This carpet only comes in a 12' roll.)

   a. 70 sq. yd.

   b. 80 sq. yd.

   c. 90 sq. yd.

   d. 100 sq. yd.

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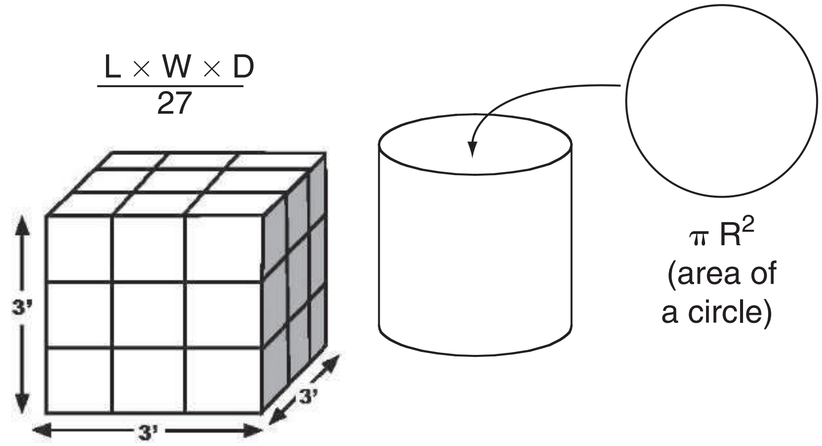
Calculate cubic yards



The formula to calculate cubic yards is length (in feet), times width (in feet), times depth (in feet), divided by 27. It is necessary to divide by 27 because there are 27 cubic feet in 1 cubic yard.

Cubic yards will often be referred to as volume. If an exam question directs you to calculate the volume of a building component, it is most likely asking for the cubic yards. However, if the choices are provided in cubic feet, do not divide by 27 (CF = L × W × D). Concrete, sand, and dirt are most commonly estimated in volume of cubic yards.

To calculate the cubic yards of a cylinder, begin by computing the area of the base. Multiply the base by the height of the cylinder and divide the total by 27.

Example:

Calculate the cubic yards of concrete needed for a 6-foot column that is 30 feet tall.

a. 20.93 cu. yd.

b. 31.4 cu. yd.

c. 565.2 cu. yd.

d. 847.8 cu. yd.

Explanation:

Begin with the formula L × W × D ÷ 27. L × W is the area of the column base computed by πR^2. R = half of the diameter, which will be 3, square the 3 to get 9. Pi × 9 equals the area, so 3.14 × 9 gives the area to be 28.26. 28.26 is the L × W portion of the CY formula. Now, multiply this by the depth of 30 feet to determine that this column has 847.8 cubic feet. Divide the cubic feet by 27 to determine the cubic yards: 847.8 ÷ 27 = 31.4. The answer is (b). (Note π is symbol for pi, which always equals 3.14.)

Example:

How many cubic yards of concrete should be ordered for a 4"-deep drive that is 14' wide and 65' long?

a. 8.43 cu. yd.

b. 11.12 cu. yd.

c. 300.3 cu. yd.

d. 364.7 cu. yd.

Explanation:

Begin with the formula $L \times W \times D \div 27$. The length is 65, the width is 14, and the depth is 0.33 (4 divided by 12): $65 \times 14 \times 0.33 \div 27 = 11.122$. The answer is (b).

1. How many cubic yards of concrete will be needed for a slab to be poured for a parking garage if the surface area is 875 square feet and the average slab depth is 6 inches?

   a. 10.80 cu. yd.

   b. 16.20 cu. yd.

   c. 19.44 cu. yd.

   d. 437.5 cu. yd.

2. Calculate the volume for a 32' tall holding tank that is 18' in diameter.

   a. 254.34

   b. 8,138.88

   c. 301.44

   d. 354.64

3. Two hundred linear feet of footing will be poured with an average width of 14". The average depth of the footing is 16". Concrete must be ordered by the whole yard and costs $65 per unit. What is the cost of the concrete for the footings?

   a. $715.00

   b. $749.45

   c. $780.00

   d. $2,022.93

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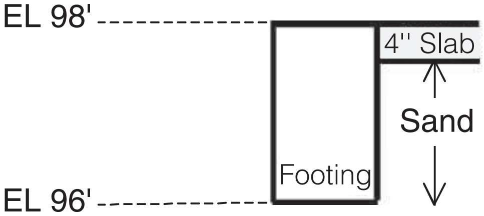
4. Based on this detail, calculate the cubic yards of sand needed to place between the slab and grade. The interior dimensions of the structure are 14' × 29'.

   a. 678 cu. yd.
   b. 25.11 cu. yd.
   c. 19.99 cu. yd.
   d. 18.65 cu. yd.



Calculating cubic yards is simple, especially when you are asked to calculate concrete. If the question is in reference to cubic yards of dirt, the swell and compaction factors need to be considered.

Swell is defined as the volume growth in soil after it is excavated. If you excavate, the soil will expand as it loosens. You cannot predict the number of dump trucks necessary to haul the excavated material away based solely on the dimensions of the area to be excavated. The volume of soil at its natural state, or bank cubic yards, will exceed the area excavated because it is no longer compacted.

The percentage of swell, or loose soil, depends on the soil type. This will be specified on the exam unless one of your approved reference books includes a chart with the information. If you are asked to calculate the cubic yards of dirt to be excavated from an area and are provided with a swell factor, simply increase the volume of the area to be excavated by the percentage provided.

Compaction rates can also be specified. When an excavation is to be backfilled, the fill must often be mechanically compacted. The compaction factors, or the difference between the fill in the truck and the final in-place compacted quantity, must be considered. If the compaction factor is 15%, divide the volume of the excavation by the reciprocal of the compaction factor. For example, if the open excavation represents 9 cubic yards and the compaction factor is 15%, divide 9 by 0.85. The volume to be delivered to fill the excavation after compaction is 10.58 cubic yards.

Example:

Based on a swell factor of 20%, how many cubic yards of dirt will be hauled away from a 12' × 22' excavation measuring 6' in depth?

   a. 1,900.8 cu. yd.
   b. 58.67 cu. yd.
   c. 73.33 cu. yd.
   d. 70.39 cu. yd.

Explanation:

Begin with the formula L × W × D ÷ 27. The length is 12, the width is 22, and the depth is 6. 12 × 22 × 6 ÷ 27 = 58.67 plus 20% = 70.399. The answer is (d).

Example:

Based on a compaction loss of 10%, how much fill is needed for an open excavation with a volume of 21 cubic yards?

a. 23.1 cu. yd.

b. 30 cu. yd.

c. 23.33 cu. yd.

d. 26.25 cu. yd.

Explanation:

21 ÷ 0.90 = 23.33. The answer is (c).

1. Based on Drawing #1, determine the quantity of soil to be hauled away from this site if it needs to be excavated 3' deep. Include an average of 2' around the entire structure. The swell factor is 15%, and the grade is considered to be level.

   a. 244.3 cu. yd.

   b. 265.5 cu. yd.

   c. 277.3 cu. yd.

   d. 280.6 cu. yd.

2. Soil with a 20% swell factor will be removed from a 4,000-square-foot excavation that is 7 feet deep. A dump truck will haul 20 cubic yards. How many dump trucks will be needed for this project?

   a. 52

   b. 63

   c. 67

   d. 71

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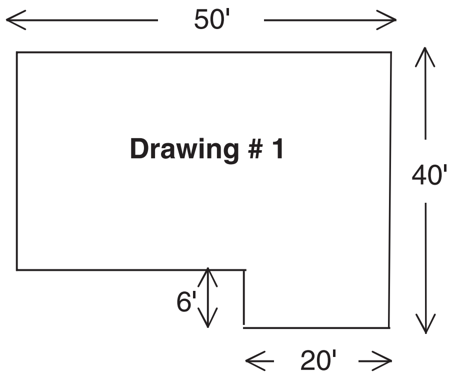

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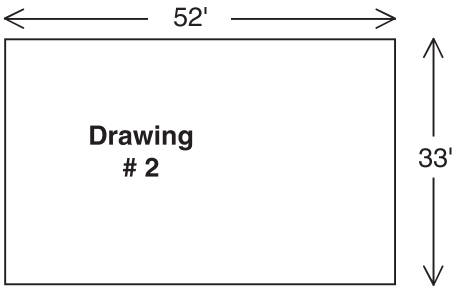
3. Considering a 10% loss of compaction, how many cubic yards of dirt will be needed to backfill an area that is 14' × 72' with a depth of 4'?

   a. 149.33 cu. yd.

   b. 164.266 cu. yd.

   c. 165.925 cu. yd.

   d. 167.854 cu. yd.



4. Based on Drawing #2, this area has been excavated 5' from the exterior of each wall. The entire area is 2' too low and must be backfilled with engineered soil that has a loss of compaction rated at 15%. How many cubic yards should be ordered?

   a. 232.33 cu. yd.

   b. 245.55 cu. yd.

   c. 254.32 cu. yd.

   d. 257.31 cu. yd.

FLOOR FRAMING TERMINOLOGY

Decking Material that forms the floor surface, usually attached directly over the floor joists.

Girder A larger beam of wood or steel used as the main support for concentrated loads at points along its span.

Floor joists Parallel framing members to support floors. These are the main framing members that support the floor span. Joists are usually made of engineered wood I-beams or at least 2 × 8 lumber.

Joist hangers Brackets designed to hold joist ends.

Ledger strip A strip of lumber nailed to a beam, girder, or joist on which the floor joist rests for support.

On center The allotted spacing between studs, joists, and rafters. This measurement is taken from the center of one member to the center of the adjacent member. On-center spacing is dictated by code and affects the joist size.

Span Distance between the structural supports in floors, ceilings, and roofs.

WALL FRAMING TERMINOLOGY

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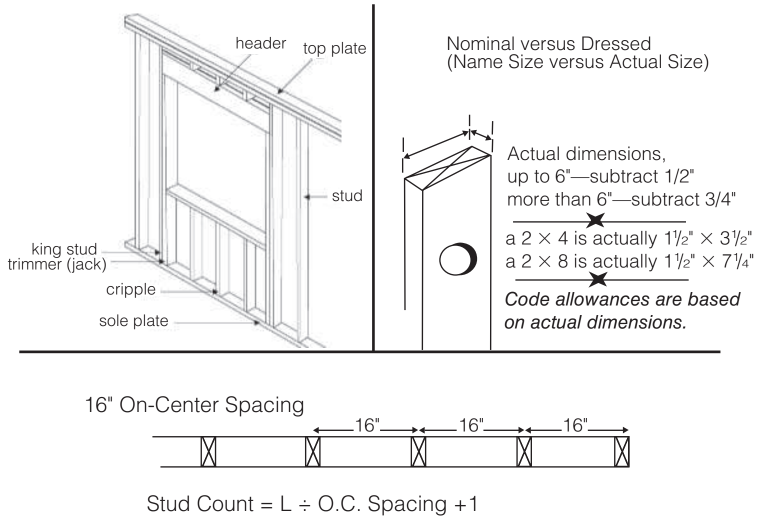

Bottom (sole) plate The bottom horizontal structural member of a stud-framed wall. The bottom plate is fastened to the floor (foundation or subfloor) with foundation bolts or proper nails.

Cripple stud The short studs placed above or below an opening. Cripples attach the header to the top plate and the sill to the sole plate.

Header A beam placed perpendicular to the wall studs above openings. The header is sized based on the span and the weight to be supported by the member.

Rough opening The framed opening to accommodate future installation of a door, window, or open passageway. Measurements for placing such components are made to the center of the rough opening.

Stud A 2" × 4" or 2" × 6" vertical framing member used to construct walls and partitions.

Top plate The top horizontal framing member that caps the framed wall and makes the connection for the ceiling joists and/or rafters. Top plates are usually doubled on exterior and bearing walls and can be single members for interior nonbearing partitions.

Trimmer stud The vertical member, sometimes referred to as a jack, that supports a header.

King stud The vertical framing members on the outside of the jack or trimmer stud.

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WALL FRAMING MATH

Let’s begin this topic with a review of the terminology used for estimating lumber. As reviewed previously, square *feet* is the area determined by multiplying length times width. For estimating lumber, it is how much surface a milled wood product will cover.

Another common unit of measuring for construction is linear feet. This unit of measurement is one dimensional. It is the measurement of the framing member’s length or an aggregate measurement of the entire wall length. It is common to begin a take-off (estimate) by determining the total linear feet of walls to be constructed.

Board feet, a less common unit of measurement for construction, is three dimensional and measures the volume of wood when sawn before it is kiln-dried. It is important to note that wood shrinks, more in width than in length, so the proper volume of lumber must be available before the desired finish product is planed. To estimate the quantity of board feet, multiply the quantity (number of pieces) by the nominal size of the member (in inches) by the length of the member (in feet) and divide by 12. Yes, you will break the rule of always multiplying “like numbers.” This is the proper way to estimate board feet.

Nominal size is the size of the lumber before it is planed or finished. It is the “name size.” The actual dimension of the framing members is not the same as the name size. The actual size of the framing members is reduced by ½" for nominal sizes up to 6" and ¾" for members above 6". For example, a 2 × 4 is actually 1½" × 3½". A 2 × 8 is actually 1½" × 7¼". Understanding this distinction is important to properly apply the building code and is critical to accurately performing math operations on the exam.

On-center spacing is an important concept to understand when estimating framing materials. If 16" on center is specified, the member will straddle the 16" incremental point across the span. The first two members are not center to center. Initially, the tape is pulled from a corner, and marks are made at the first 16-inch point and from each one that follows. Proper centering is important for the purpose of sheathing installation.

Dimensions on a set of plans are provided based on center to center of the framing. Construction materials often vary slightly in size, making it impossible to indicate actual edges of structural members. This method of measurement ensures that the plan (construction document) dimensions are achieved. If a window is to be placed, measurements are made to the center of the rough opening. The jack is installed by measuring a distance in each direction away from the center point that is equal to half of the rough opening. The size of the rough opening is always as wide as the specified component size plus 2 to 3 inches. The additional space provides for shimming the component to be installed so that it is level and plumb.

The quantity of members necessary for proper construction, such as studs, is calculated by taking the linear feet of the span and dividing it by the on-center spacing. This results in the number of spaces between the units; therefore, one additional unit must be added for the beginning (first) member. For example, if 2 × 4 studs are to be installed 16" on center in a 32' wall, the quantity of studs are calculated by taking 384" (32' × 12 to convert to "like" numbers) and dividing by 16. The result is 24. There are 24 spaces between each of the studs; add 1 and you have identified the number of studs to be installed in the wall. This same method applies to calculating the necessary number of joists or rafters.

If this 32' wall is 8' tall including a single sole plate, a double top plate, and no openings, the linear feet of lumber can easily be calculated. Begin by subtracting the thickness of the plates from the height of the wall. Since 2 × 4s are being installed, the thickness of each plate is 1½" (nominal vs. actual size). Three plates at 1½" each totals 4½". Subtract 4½" from 96" to determine that each stud will be 91½" in length.

If 25 studs are to be installed for this 32' wall, 25 × 91.5 gives us a total of 2287.5". Add the length of the plates—three plates at 32' long for a total of 96'. Now, divide 2287.5" by 12 to convert to feet. The total linear feet of lumber of studs is 190.62½. Add 96' for the plates; there are 286.62½ linear feet of lumber in this wall.

While the linear feet of lumber is rarely used in the real world, understanding the concept is critical to accurate estimating. More importantly, at this point, the concept is common on exams.

To calculate the board feet of lumber for this wall, begin by multiplying 25 × 2 × 4 × 8 and dividing by 12. This equals 133.33. This is the total number of board feet in the studs. Next, multiply 3 (the number of plates) by 2 × 4 × 32 and divide by 12. This equals 64. Add the two totals, 133.33 and 64; the total board feet for this wall is 197.33. When calculating board feet, you do not deduct for the material that will be cut, as we did when calculating the linear feet.

To "lay out a house" for the framer, it is necessary and critical to have a thorough understanding of plan reading and the ability to

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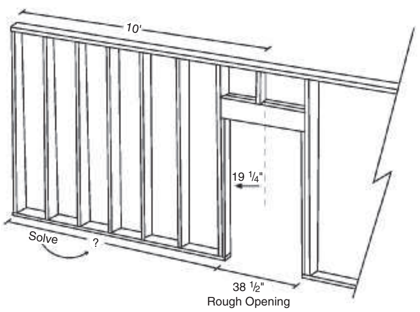
work a calculator. For exam purposes, the understanding is even more critical because you will have to visualize and sketch the exercise. For example, in the real world, it would be simple to locate the position of a 3' door to be installed 10' from the edge of the room. The plans would indicate that the 10' is the center of the 3' door. An experienced carpenter would simply pull the measuring tape from the edge of the room and mark the 10' point. The carpenter would then add 2½" to the size of the door and divide the total by 2. This would provide the second and third pencil marks to be made. Half of 38½" is 19¼". The carpenter would measure 19¼" to the right of the 10' mark and 19¼" to the left of the 10' mark. These marks would indicate where the edge of the trimmer stud (jack) should be installed. The following examples indicate how this question may be presented on an exam.

Example:

The center of the rough opening for a 3' door is indicated on the plans as being 10' from the edge of the room. What is the measurement from the edge of the room to the first beginning point of the rough opening?

a. 100.75"
b. 99.25"
c. 98.75"
d. 97.25"



Explanation:

Begin by sketching the information as it is described. Make a dimension line from the left to right indicating 10' to the center of an opening. The opening is 38.5 inches—the 3' for the door plus 2½" for the rough opening. Divide the rough opening by 2. Draw the dimension line, indicating 19.25". Subtract 19.25" from 120": $120 - 19.25 = 100.75$". This is the measurement from the edge of the room to where the rough opening begins. The answer is (a).

Example:

The center of the rough opening for a 3' door is indicated on the plans as being 10' from the edge of the room. What is the measurement from the edge of the room to the first right edge of the first trimmer?

a. 100.75"

b. 99.25"

c. 98.75"

d. 97.25"

Explanation:

Begin by sketching the information as it is described. Make a dimension line from the left to right indicating 10' to the center of an opening. The question is asking for the measurement to the right edge of the first trimmer. The header rests on the trimmer; therefore, the measurement to be identified will also indicate the measurement to the beginning of the header. The measurement of the header is 3" larger than the rough opening. This is determined by adding the width of each trimmer used to hold the header in place. Each trimmer is 1½" for a total of 3". The header is 41½". Divide 41.5 by 2 to determine half of the header. Subtract 20.75 from 120". The measurement from the left to the first right edge of the trimmer is 99.25". The answer is (b).

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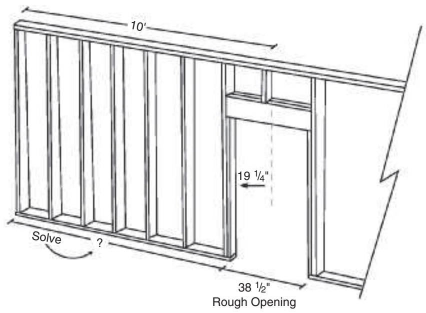

1. How many studs will be needed for a wall that is 25' long if studs are placed 16" on center?

   a. 18

   b. 19

   c. 20

   d. 21

2. Calculate the board feet of lumber in 18 floor joists. The 2 × 10 floor joists are 16' long.

   a. 27

   b. 480

   c. 1,280

   d. 5,760

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3. What is the measurement to the beginning of the rough opening for a 3' door? The door will be placed with the center located 9' from the edge of the room.

   a. 86.75"

   b. 87.25"

   c. 88.75"

   d. 89.25"

4. How many floor joists will be needed for a 24' span if spaced 16" on center?

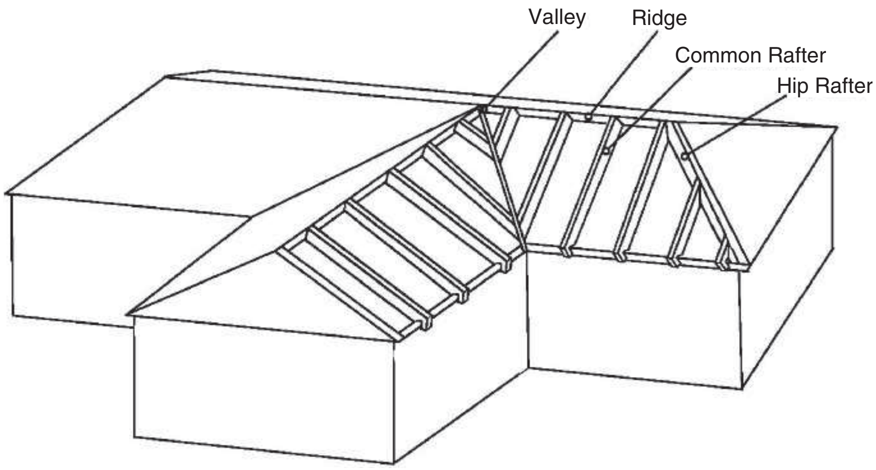
   a. 18

   b. 19

   c. 20

   d. 24

ROOF FRAMING TERMINOLOGY



Ridgeboard The highest horizontal roof member, which serves to align the rafters and tie them together at the upper end. The ridgeboard is at least one size larger than the rafters. For example, if 2×8, one size larger is 2×10.

Common rafter A structural member that extends from the top plate to the ridge in a perpendicular orientation. Rafters often extend beyond the roof plate to form the overhang, also called the eaves, which protect the sides of the structure.

Bird's mouth The notch, or cutout, of the rafter, which allows it to rest properly on the top plate.

Hip rafter A roof member that extends diagonally from the corner of the plate to the ridge.

Valley rafter A roof member that extends from the plate to the ridge along the lines where two roofs intersect.

Jack and hip rafters These types of rafters do not extend the entire distance from the ridge to the top plate of a wall.

Cripple jack A rafter fitted between a hip rafter and a valley rafter; a cripple jack does not touch the ridgeboard or top plate.

ROOF TYPES

Gable roof Perhaps the most common, a gable roof has two slopes that meet at the center of the building. It is simple, economical, and can be used on virtually any structure.

Hip roof A hip roof has four sides or slopes running toward the center of the building. Rafters at the corners extend diagonally to meet at the ridge. Additional rafters are framed into these rafters.

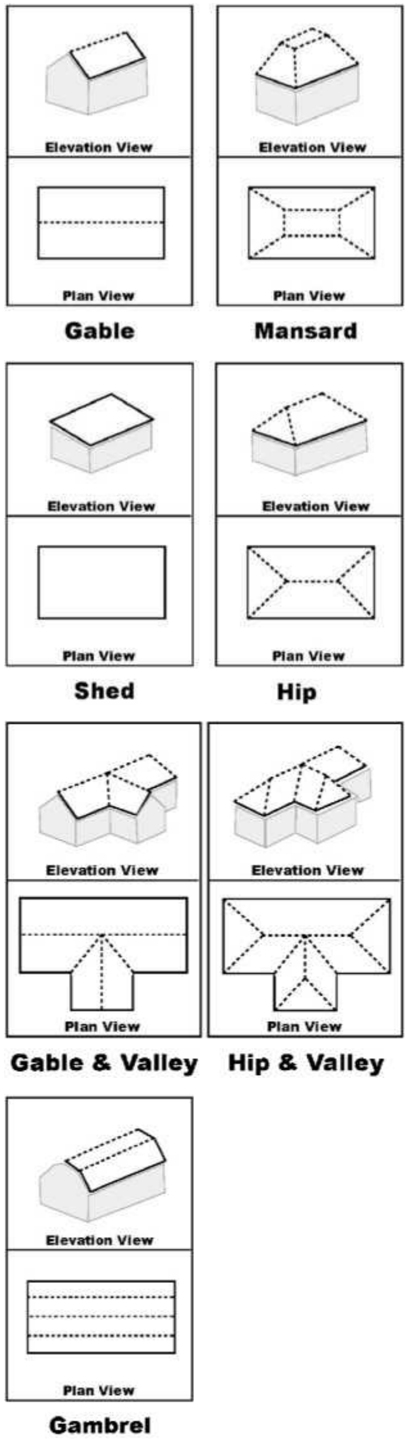
Gable and Valley roof A roof on which two gable roofs intersect.

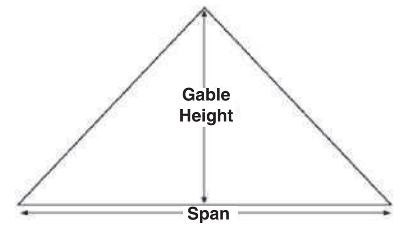
Hip and Valley roof A roof on which two hip roofs intersect.

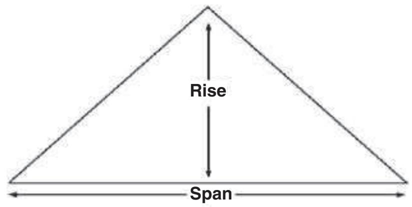
Mansard roof A roof that has four sloping sides, each of which has a double slope. As compared with a gable roof, this design provides more available space in the per level of the building.

Gambrel roofing A variation on the gable roof in which each side has a break near the ridge. This style of roof will provide more available space on the upper level.

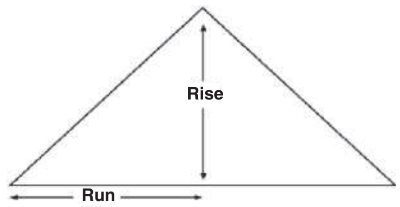
Shed roof Also referred to as a lean-to roof, the shed roof is a flat, sloped construction. It is common on high-ceiling contemporary construction and is often used on additions.







Pitch = $\frac{\text{Rise}}{\text{Span}}$



Slope = $\frac{\text{Rise}}{\text{Run}}$

ROOFING MATH

To begin the discussion of roofing math, there are several terms that must be clearly understood. It is important to understand that the term *span* refers to the horizontal distance from the outside of one exterior wall to the outside of the opposite wall. *Run* is the horizontal distance from the outside of the top plate to the center line of the ridgeboard, usually equal to half the span.

Rise is the total height of the rafter from the top plate to the ridge. The rise is typically stated in inches per foot of run.

Pitch is the angle or degree of slope of the roof in relation to the span. It is a ratio of gable height over the full span of the roof. Pitch is expressed as a fraction. For example, if the total rise is 6' and the span is 24', the pitch would be 6 in 24, which reduces to a ¼ pitch.

Slope is expressed as the relationship of rise to run. It is stated as a unit of rise to horizontal units of 12. A roof that has a rise of 5" for each foot of run is said to have a 5 in 12 slope.

It is common for a seasoned contractor to refer to a 5 in 12 slope as a 5⁄12 pitch. No one corrects the contractor and asks, "are you sure you don't mean a 5 in 12 slope?" Notice, the only words that change between the two statements are *pitch* and *slope*. These terms are used interchangeably, and both uses are accepted as correct. In fact, it is so common that even the codebooks refer to a slope as a pitch. Let's look at some examples to make sure that this concept is understood.

If a building is 24 feet wide and has a gable height of 8 feet, by placing the height over the building span, the pitch will be 8 over 24. This fraction reduces to ⅓.

If you have forgotten how to reduce a fraction, simply divide the numerator (top number of the fraction) and the denominator (bottom number) by their greatest common factor or divisor. If you have properly reduced the fraction, only the number 1 can be divided evenly into both the final numerator and denominator.

The slope of this roof would be 8 in 12 because a slope is expressed in a ratio of rise over run. Half of the 24' span would be a 12' run. The rise of 8 and the run of 12 is expressed in a ratio format of 8 in 12.

Let's try another example: If the building is 32' wide with a gable height of 8', by placing the numbers in a ratio of gable height over the span of the building, you will have 8 over 32. Now, reduce the fraction by taking the greatest common factor and dividing it into the numerator and the denominator. The greatest common factor is 8, and 8 will go into 8 one time, and 8 will go into 32 four times, with the result being that this roof has a one-fourth pitch.

If you need to determine the slope of this roof, converting the ¼ pitch to a slope is a little more difficult. Roof slopes are always provided with a ratio of the specified units of rise to 12 units of horizontal run. The run is always indicated in units of 12. This is because we measure in units of 12". When asked, a contractor usually provides measurements in feet. Rarely will the contractor say "the building is 480" wide."

So, what is the slope of a roof 32' wide with an 8' gable height? Many would quickly say 8 over 16. Yes, but this would not be one of the choices on the exam. The choices would be in a ratio of rise to run with the run being 12. So, let's set it up to solve for *x* (or the correct unit of rise).

Place *x* over 12, and beside it put 8 over 16. We will now cross multiply and divide by the reciprocal to solve for *x*: $12 \times 8 = 96$. Divide 96 by 16, which equals 6. The slope of this roof is 6 in 12.

Step 1: $\frac{x}{12} \quad \frac{8}{16}$

Step 2: $\frac{x}{12} \nearrow \frac{8}{16}$

(cross multiply)
$12 \times 8 = 96$

Step 3: Divide by reciprocal:
$96 \div 16 = 6$

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Example:

Determine the slope of a roof in units of vertical rise to 12 units of horizontal run when the span of the roof is 30' and the height of the gable is 10'. By placing the rise over the run, you have 10 over 15. However, we need it in units of rise to units of horizontal run. Again, we will solve

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for x over 12 and beside it write the fraction 10 over 15. We will cross multiply, so 12 times 10 will equal 120. Now, divide by the reciprocal of 15 to get 8. The slope of this roof is 8 in 12.

Step 1: $\frac{x}{12}$ $\frac{10}{15}$

Step 2: $\frac{x}{12} \nearrow \frac{10}{15}$

(cross multiply)

$12 \times 10 = 120$

Step 3: Divide by reciprocal:

$120 \div 15 = 8$

If provided a pitch in its reduced fraction such as ⅓, follow the same steps. The slope will be 1 over 1.5. (If 3 equals the span, run is half, hence the 1.5.) To convert this to a slope, place x over 12 beside the fraction 1 over 1.5. Cross multiply 12 times 1, and divide by the reciprocal of 1.5. The result is 8. A roof with a ⅓ pitch will have an 8 in 12 slope.

Step 1: $\frac{x}{12}$ $\frac{1}{1.5}$

Step 2: $\frac{x}{12} \nearrow \frac{1}{1.5}$

(cross multiply)

$12 \times 1 = 12$

Step 3: Divide by reciprocal:

$12 \div 1.5 = 8$

Questions on this topic generally use whole numbers and reduced pitches. It may be to your advantage to make a chart with three columns. The first column will be labeled "slope," the second column will be labeled "pitch," and the third column will be labeled "reduced pitch." First, fill in the slopes beginning with 2 in 12. Continue down to 8 in 12. In the second column, convert the pitch to a slope by multiplying 12 by 2 and placing the vertical rise on top (see example). You have converted the run to a span and now have a ratio of rise over span. In the last column, reduce each of the fractions.

A typical exam question is "What is the vertical rise of a roof that has a ⅓ pitch?" Using your chart, locate the ⅓ pitch, follow it to the column labeled "slope," and identify the vertical rise to be 8.

Run

Rise

$\frac{\text{Rise}}{2 \times \text{Run}}$

Slope	Pitch	Reduced Pitch
2:12	2/24	1/12
3:12	3/24	1/8
4:12		
5:12		
6:12		
7:12		
8:12		
9:12		
10:12		

Example:

What is the slope of a gable roof with a 36' span? The height of the gable is 12'.

a. 2:12

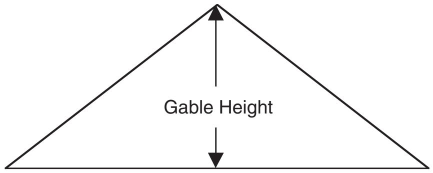
b. 4:12

c. 5:12

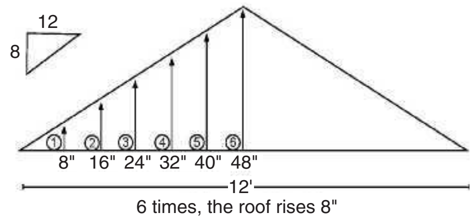
d. 8:12

Explanation:

Place *x* over 12, and beside it write 12 over 36. Cross multiply: 12 × 12 = 144. Divide by 18 (half of the 36' span) = 8. The answer is (d).



Determining the gable height of a structure is simple as long as the roof slope and span are provided. If the span of a building is 12' and the slope is 8 in 12, take half of the span and multiply it by 8". This formula is confusing to some people because it seems to be multiplying feet by inches (breaking the rule to always multiply "like numbers"). Do not think of the 6 as feet. Consider the 6 to be units and tell yourself that for each of the 6 units (units in 12-inch increments), the roof rises 8". (See diagram below.)



For a building with a span of 24' and a roof sloped 4 in 12, first determine the measurement to the ridge. If the building is 24' wide, the ridge will be located in the center. Half of 24 is 12. Now, multiply 12 by the vertical rise for a total of 48 inches. Divide 48 by 12, and the gable height is determined to be 4 feet.

Understanding this concept allows you to easily calculate the area (square feet) of the gable. Once it is calculated, the area can be multiplied or divided by the appropriate factor to estimate siding, brick, sheathing, and similar building components.

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If you need to estimate the quantity of brick (based on a factor of 7) to be installed in the gable area of a building that is 30' wide with an 8 in 12 slope roof, begin by converting the 30' span to a run. Divide 30 by 2. The run of the building is 15'. Next, multiply 15 by the vertical rise of 8. This equals 120. The height of the gable is 120" or 10'. Determine the area of the gable by taking the length of the run and multiplying it by the height of the gable. The area of the gable is 150 square feet. Since the actual area is only half of the rectangle that you calculated, it will account for each portion of the gable area. Take the square feet of the gable, and multiply it by 7 to determine that 1,050 bricks will be needed for this area.

Example:

Calculate the square feet of a gable for a building that is 28' wide and built with a 4:12 slope.

a. 32.69 sq. ft.

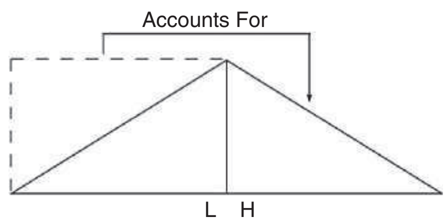
b. 65.38 sq. ft.

c. 78.36 sq. ft.

d. 95.25 sq. ft.

Explanation:

Identify the center point of the span, which is the highest point of the gable: $28 \div 2 = 14$. This roof rises 4" for each foot. Multiply 14 by 4 to determine the gable height: $14 \times 4 = 56$. Convert 56 inches to feet: $56 \div 12 = 4.67'$. Multiply 14 by 4.67 for a total of 65.38 square feet. If calculating the area of a triangle, divide by 2. It is not necessary to divide by 2 in this case because you have two triangles, one on each side of the ridge. The answer is (b).



1. What is the gable height for a building that is 28' wide? The roof slope is 6 in 12.

   a. 7 ft.

   b. 8 ft.

   c. 9 ft.

   d. 10 ft.

2. What is the slope of a roof with a ¼ pitch?

   a. 4:12

   b. 5:12

   c. 6:12

   d. 8:12

3. What is the run of a roof that has a 29' span?

   a. 13 ft.

   b. 13.5 ft.

   c. 14 ft.

   d. 14.5 ft.

4. Calculate the area of a gable if the slope of the roof is 8:12. The width of the building is 32'.

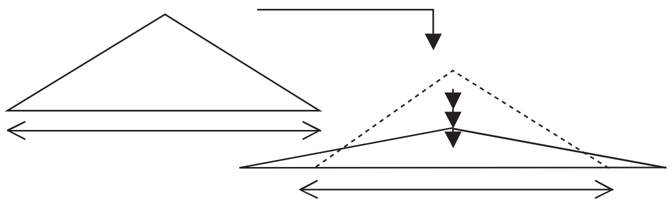
   a. 256.00

   b. 170.72

   c. 225.80

   d. 154.75

$C = \sqrt{a^2+b^2}$



The next concept is critical for many areas of roofing math, including estimating rafter lengths, bundles of shingles, and rolls of felt. For explanatory purposes, suppose we are working with a gable roof that is 24' wide with a 4 in 12 slope. Imagine that the ridgeboard is hinged to allow the roof to lay flat. If this roof were laid flat, it would not be 24' wide. Obviously, it would be wider. The question is, how much wider?

To determine the measurement of a building if we could lay it flat, we must apply the Pythagorean theorem. This theory states that when we have a right triangle, one that is formed with a 90-degree angle at the base, we can determine the hypotenuse as long as we

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know the two remaining measurements. Speaking in construction terms rather than mathematical jargon like triangles and hypotenuses, the right triangle is one half of our 24' wide building. The hypotenuse is the rafter on the building that connects the base to the ridge.

The formula states that *C*, the rafter, is equal to the square root of *A* squared plus *B* squared. *A* is the run of the building, and *B* is the rise of the building. In this case, *A* is 12, and *B* is 4. Plug the numbers into the formula. Begin by multiplying 12 by 12. This equals 144. Next, multiply 4 by 4. This equals 16. Add the two together; 144 plus 16 equals 160. Find the square root symbol $\sqrt{}$ on your calculator, and press it. The numbers returned are 12.6491. This tells us the length of the rafter for this building. Double this number, and the dimension of the roof is 25.2982. If we were answering a question on the exam, it would likely have asked for the rafter length to be ordered. Since lumber is ordered in 2' increments, the correct choice for this question is 14'.

The 24' wide building with a sloped roof of 4 in 12 is the most simple of this type of mathematical operation. If the width of the building is 30' and the slope remains 4 in 12, another step must be included in solving the equation. It is important to realize why this is so. In the example of the 24'-wide building, the height of the gable happened to be the same as the rise in the 4 in 12 slope. If the building were 30' wide with a 4 in 12 slope, the gable height would be different. The *B* in the formula stated in the Pythagorean theorem as we used it represents the gable height. So, if the building is 30' wide, begin by calculating the height of the gable. The center point of the building (peak of the gable) is 15'. If the slope is 4 in 12, we must multiply 15 by 4. This tells us that the height of the gable is 60". To convert 60" to feet, divide by 12. The height of the gable is 5'.

We can now calculate the length of the rafter (hypotenuse) of the building (half of which represents a right triangle). *A* is 15'. Fifteen squared equals 225. *B* is 5'. Five squared equals 25. Add 225 and 25, for a total of 250. Enter 250 in the calculator, and press the square root symbol $\sqrt{}$. The calculator returns 15.8113. The material to be ordered for the rafters in this building will be 16' in length.

Example:

A gable roof is built with an 8:12 slope. The building is 32' wide. If the two rafters that meet at the ridge are laid end to end, what is the total linear feet?

a. 19.23 linear feet

b. 34.25 linear feet

c. 36.84 linear feet

d. 38.46 linear feet

Explanation:

First, determine the gable height, take half of 32, which identifies the location of the highest point of the gable, and multiply 16 by 8 (this roof rises 8" for each foot): $16 \times 8 = 128$". Convert to feet: $128 \div 12 = 10.67$' (gable height). Now, plug the numbers into the Pythagorean theorem. $A = 16$, $B = 10.67$, $16 \times 16 = 256$, $10.67 \times 10.67 = 113.85$. Add these together: $256 + 113.85 = 369.85$. Press the square root symbol to get 19.23. $19.23 \times 2 = 38.46$. The two rafters end to end are 38.46'.

If the roof multiplier for a 4 in 12 slope roof had been available for the 30' wide building, the calculation would have been much simpler. If we were calculating the area of the roof, we would have multiplied the 30' by the multiplier. If we were calculating the length of a rafter, we would have divided the 30 by 2 to determine the run and multiplied the run by the factor, which would give us the rafter length. The step for determining the gable height would have been eliminated.

The roof multiplier for a 4 in 12 slope roof is 1.054. How is this calculated? Simply, plug the numbers into the Pythagorean theorem, and divide the answer by 12. This indicates the degree that the rafter (hypotenuse) rises per foot of run.

Let's calculate the roof factor for a 6 in 12 sloped roof. Plug the numbers into the formula for the Pythagorean theorem, *C* equals the square root of *A* squared plus *B* squared. Twelve squared equals 144; 6 squared equals 36; 144 plus 36 equals 180. Press the square root symbol $\sqrt{\ }$ on the calculator, and 13.4164 is returned. Finally, divide this by 12. Carry the factor out to the third digit. The roof multiplier, or factor, is 1.118.

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It is not uncommon for the exam to provide the roof multiplier in the instructions for the related math question. Of course, if you do not realize how to use the factor, it does you no good. If the factor is not provided, it can be easily calculated.

Calculate the factors for each of the slopes and fill in the table:

Slope	Equation	Multiplier
2:12	$2 \times 2 = 4$, $12 \times 12 = 144$, $4 + 144 = 148$, press $\sqrt{}$ $= 12.1655$, divide by $12 = 1.013$.	**1.013**
3:12		
4:12		
5:12		
6:12		
8:12		

5. Calculate the length of a common rafter for a 20' × 50' gable roof. The roof slope is 4:12, and the building has a 1' overhang.

   a. 10 ft.

   b. 12 ft.

   c. 13 ft.

   d. 22 ft.

6. If 6:12 gable roof is 30' wide with a 1' overhang, what is the measurement to use in calculating the roof area?

   a. 33.54

   b. 34.658

   c. 35.776

   d. 36.516

7. Using the Pythagorean theorem, what is the rafter length for a building that is 27' wide and measures 6' at the gable height?

   a. 12.56 ft.

   b. 14.77 ft.

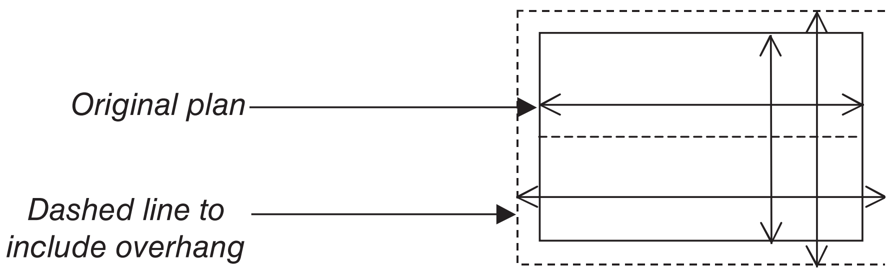
   c. 15.23 ft.

   d. 16.85 ft.

Roof area can easily be calculated using the multiplier, allowing us to compute the bundles of shingles, rolls of felt, or pieces of sheathing needed for the roof. You can simply calculate the square feet of the home and increase it by the roof multiplier. You may be asking, “What if it is a hip roof as opposed to a gable roof?” Believe it or not, it matters so little that it is acceptable practice to estimate both using this method.

Can you simply take the square feet provided as square feet for the roof area? You could, but if the structure has an overhang, it has not been calculated in the finished square feet. The overhang is the portion of the roof that extends beyond the wall of the building. There is no standard overhang. In fact, overhangs vary based on different roof pitches, architectural styles, and personal preferences. A structure can have multiple overhangs and be different for gable ends than what is specified for the eaves.

The simple way to begin calculating the area of the roof is to sketch the plan view of the structure. This is simply a two-dimensional sketch of the footprint of the building as if you were looking down on top of it. Next, you should place a dotted line around the perimeter of your sketch to illustrate the overhang. The area of the roof should be calculated using the new dimensions. This will provide the area of the roof if it were flat. Once this calculation is achieved, you simply multiply this number by the roof multiplier to account for the rise created by the pitch.



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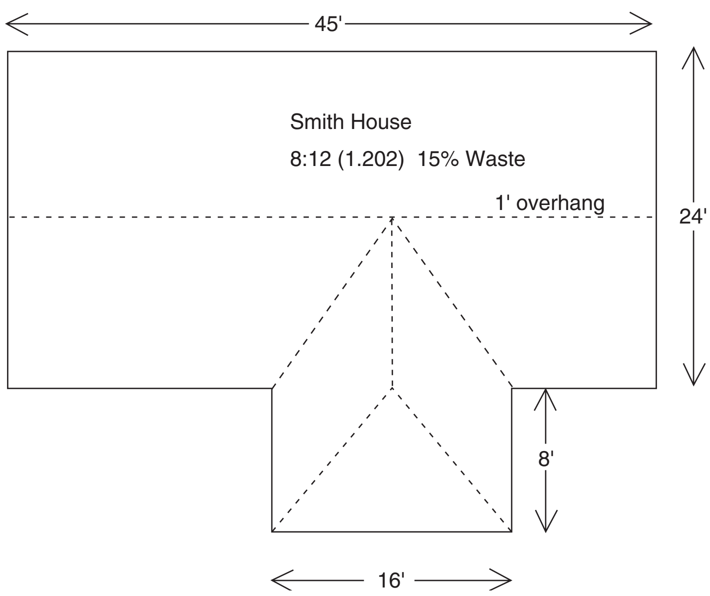
Let's try a simple roof. Calculate the roof area of a building that is 30' wide, 45' long, with a roof slope of 5:12. The overhang for the building is 1'. Begin by sketching the 30 × 45-foot rectangle. Next, draw a dotted line around the perimeter sketch to indicate the overhang. Now, draw a dimension line to connect the dashed lines on each side, and write the new dimensions to include the original measure plus the overhang.

The new dimension will be 30' plus 1' of overhang on each end, for a total of 32'. The dimension line going in the opposite direction will be 45' plus 1' of overhang on each end, for a total of 47'. Multiply 47 by 32 to determine the square feet of the flat area of this structure including the overhangs. Forty-seven feet times 32' equals 1,504 square feet. Finally, multiply the 1,504 square feet by 1.083. This is the multiplier for a 5 in 12 sloped roof. The total square feet of the roof for this building is 1,628 square feet.

Let's try another example. Calculate the area of a hip roof that is 75' in length, 27' in width, and has an 18" overhang. The slope of the roof is 6 in 12. Sketch the footprint of the building. Next, draw a dashed line around the perimeter of the building sketch to indicate the overhang. Add dimension lines to connect the dashed lines that are parallel to one another. The new dimensions will be 78' × 30'. Multiply 78 × 30; the area of the roof is 2,340 square feet. Multiply 2,340 square feet × 1.118, the multiplier for a 6:12 slope, to determine that the total area of the roof is 2,616 square feet.



Now, one that is a little more difficult (Smith House on page 42). The building in the diagram provides all of the information necessary for calculating the area of the roof. It provides the roof slope as well as the roof multiplier. The waste factor for this plan is indicated, and the overhang is noted. Follow these steps:

In Step 1, the dashed line is added to indicate the overhang. In Step 2, the new dimension lines were added to show the overhang. Step 3 divided the plan into manageable sections. The larger of the two sections measures 47' × 26'. The smaller section is 18' × 8'. Notice that the 8-foot dimension line for the small section stays the same because of the one foot included in the larger section (indicated by the heavy line).

The larger section is 1,222 square feet, and the smaller section is 144 square feet. Added together, the total for the roof area is 1,366 square feet. To account for the pitch, multiply 1,366 × 1.202, which equals 1,641.93. Add 15% to consider the waste. The total area of roofing for this plan is 1888.22 square feet.

If you were asked to calculate the bundles of 15-lb, three-tab shingles for this plan, you would divide the total area by 100. This is to convert the roof area to squares. There is 100 square feet per roofing square. Shingles are packaged such that three bundles will cover 100 square feet. By multiplying the squares by 3, you determine that this plan will require 57 bundles of shingles (1,888.22 ÷ 100 = 18.88 × 3 = 56.64, which rounds to 57 bundles).

Questions on the exam typically include the roof multiplier, considerations for waste, the number of bundles required per square, yield for felt, and a statement to disregard starter shingles and ridge caps.

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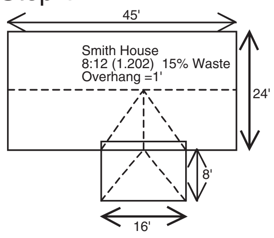
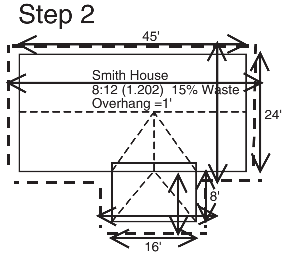
Step 1



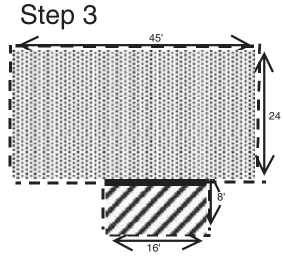
Sketch dash line to indicate overhang.

Step 2



Add dimension lines to include overhang.

Step 3



Divide the plan into sections.

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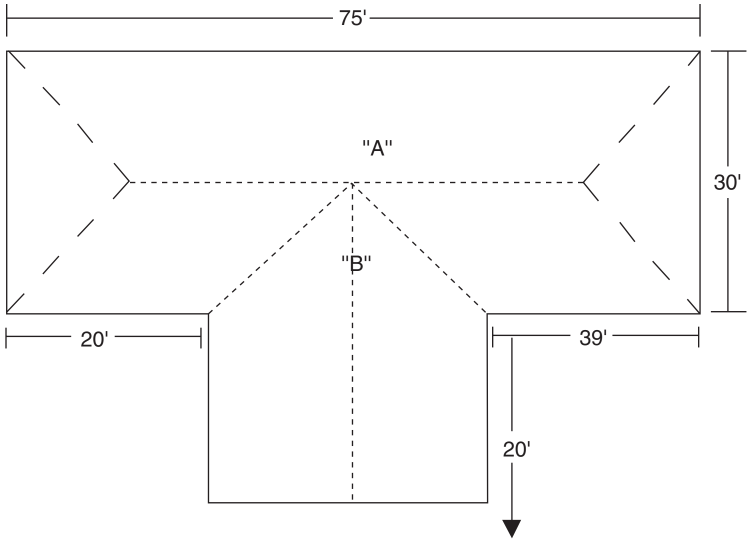

8. Calculate the square feet of this building. Note: Roof slope is 4:12, overhang is 1', waste factor is 10%.

   a. 2,570 sq. ft.

   b. 2,824 sq. ft.

   c. 2,976 sq. ft.

   d. 3,274 sq. ft.

9. What is the length of the common rafters to be ordered for section *B* if the roof slope is 6:12? Note: The overhang is 18".

   a. 9 ft.

   b. 10 ft.

   c. 11 ft.

   d. 12 ft.

10. Three-tab, 15-lb shingles are to be used for this residential building (3 bundles per square). The slope of the roof is 5:12, and the overhang is 1'. Waste should be based on 5%. How many bundles are needed?

    a. 72

    b. 81

    c. 91

    d. 97

PART TWO
Administration

Questions are based on the Building Code.

The following code quiz is based on topics that concern the building administration. Exam candidates preparing for an exam based on the *International Residential Code*® and the *International Building Code*® will find the answers in Chapter 1.

The code quizzes are written to familiarize you, the exam candidate, with the reference book. If you feel that you know the answer to the question, the correct answer is less important than your ability to identify the corresponding code location. Remember, these quizzes are representative of the subject matter covered on exams but do not represent actual questions. Do not attempt to memorize the answers. It is much more effective to understand how to locate the subject matter in the approved references.

Questions in this quiz cover the following subject matter:

- Permits
- Certificates of occupancy
- Demolition
- Temporary permits
- Building officials
- Construction documents

Study Tip

Plans or Blueprints will be referred to as Construction Documents in your Code Book.

1. Which of the following statements is true regarding site plans submitted for demolition projects?

   a. Site plans are not required for structures to be removed.
   b. Site plans must show the construction to be demolished.
   c. Site plans must show the size and location of existing construction that will remain.
   d. Both b and c

2. A permit that has been issued is deemed void if work does not begin within ___ days of issuance.

   a. 30
   b. 60
   c. 90
   d. 180

3. In addition to one set of approved plans being retained by the building official, an approved copy must always be available:

   a. at the job site.
   b. at the contractor's office.
   c. when the inspector requests to see a copy.
   d. at the county clerk's office.

4. The building permit must be:

   a. displayed in the contractor's office.
   b. posted on the job site.
   c. provided to the inspector when requested.
   d. posted in the building official's office.

5. Which of the following construction projects would *not* require a building permit?

   a. A 400-square-foot, two-story building
   b. A one-story, 200-square-foot home attached to an existing two-car garage
   c. A one-story detached accessory structure with 120 square feet
   d. None of the above

6. Who has the authority to approve the use of temporary power?

   a. Electrical contractor
   b. General contractor
   c. Home owner
   d. Building official

7. Which of the following is not found on a Certificate of Occupancy?

   a. If an automatic sprinkler is provided
   b. Name and address of the owner
   c. Name of the building official
   d. Contractor's license number

8. Which of the following must be included on a stop work order?

   a. Contractor's name and license number
   b. Name of person doing the work
   c. Conditions under which work will be permitted to resume
   d. Number of days the order will be in place

Study Tip

Any topic that is related to Administrative Issues from an Inspector's perspective will be discussed in Chapter 1 of your Code Book.

Study Tip

As you locate answers to each of the questions in your Code Book, make sure to highlight them as you go.

9. One set of approved construction documents must be retained by the building official for not less than how many days from the date of the completion?

   a. 90

   b. 180

   c. 30

   d. 120

10. One set of approved construction documents shall be retained for not less than 180 days by which of the following?

    a. Contractor

    b. Home owner

    c. Building official

    d. None of the above

PART THREE

Design and Planning

Questions are based on the Building Code.

The following code quiz is based on topics primarily affecting the design of a building. Exam candidates preparing for an exam based on the *International Residential Code®* will find the answers in Chapter 3. Candidates using the *International Building Code®* will find the answers in various chapters.

As stated previously, the code quizzes are written to familiarize you with the reference book. Do not attempt to rely on your field knowledge to pass the exam. It is imperative for you to become familiar with using the Code Book. These quizzes will prepare you for the exam in the most efficient manner. Take the time to locate the answer to each question using the Code Book.

Questions in this quiz cover the following subject matter:

- Ceiling heights
- Lighting and ventilation
- Means of egress
- Rescue opening
- Guardrails
- Stairs
- Sanitation
- Live loads/Dead loads