Walls support the roof of a structure and also enclose the structure. What kinds of tools do you think are used in framing walls?

Writing Activity: Research and Summarize
Contact the U.S. Forest Products Laboratory or similar organization and research new wood-based wall framing materials they are developing. Write a two-paragraph summary of your findings.
Before You Read Preview
Wall framing can begin once the floor system is complete and the subfloor is in place. Choose a content vocabulary or academic vocabulary word that is new to you. When you find it in the text, write down the definition.

Content Vocabulary
- sheathing
- stud
- plate
- header
- rough sill
- cripple stud
- trimmer stud
- rough opening (RO)
- corner post
- temporary bracing
- soffit

Academic Vocabulary
You will find these words in your reading and on your tests. Use the academic vocabulary glossary to look up their definitions if necessary.
- primary
- dimensions

Graphic Organizer
As you read, use a chart like the one shown to organize the components of wall framing. Add rows as necessary.

<table>
<thead>
<tr>
<th>component</th>
<th>purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Go to glencoe.com for this book’s OLC for a downloadable version of this graphic organizer.

Academic Standards
- **English Language Arts**
  Use written language to communicate effectively (NCTE 4)

- **Mathematics**
  - **Number and Operations:** Compute fluently and make reasonable estimates (NCTM)
  - **Measurement:** Apply appropriate techniques, tools, and formulas to determine measurements (NCTM)
  - **Geometry:** Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships (NCTM)

- **Science**
  - **Physical Science:** Motions and forces (NSES)

Industry Standards
- Wall and Ceiling Framing
- Wood Framing Layout and Construction
- Engineered Structural Components

NCTE National Council of Teachers of English
NCTM National Council of Teachers of Mathematics
NSES National Science Education Standards
Wall-Framing Basics
How does a bearing wall differ from a non-bearing wall?

The framing and sheathing for the first floor of a house create a flat and level platform on which to build the walls. Carpenters can then lay out, assemble, and erect the walls. This work must be done properly. Mistakes at this stage will make it more difficult to complete the rest of the house. For example, cabinets will not fit well if walls are not plumb.

After the walls are framed, sheathing must be attached to them. Sheathing consists of rigid 4’×8’ or larger panels that are attached to the outside surface of the exterior wall framing. Sheathing adds great stiffness and strength to the walls. This is important because the walls of a house will provide a framework for attaching interior and exterior coverings such as siding and drywall. A wall that also supports weight from portions of the house above, such as the roof, is called a load-bearing wall, or simply, a bearing wall.

Exterior walls are nearly always load-bearing walls. Interior walls, also called partition walls or partitions, are sometimes load-bearing walls. If they carry only their own weight and the weight of wall coverings, they are not considered load-bearing.

When roof trusses span the entire width of a house, the exterior walls support the weight of both the roof and ceiling loads. Interior walls then serve mainly as room dividers. When a roof is framed using ceiling joists and rafters instead of roof trusses, however, interior walls usually carry some of the ceiling load, as shown in Figure 16-1. It is important for a carpenter to understand the difference between bearing walls and non-bearing walls. Each type of wall is framed differently.

The standards and specifications found in this chapter and the following chapters are based on the 2006 IRC. However, you should always follow the codes used in your area. Even if your town or state has adopted the 2006 IRC as its model code, variations in the code may be required to address local conditions.
Choosing Lumber

Wall-framing lumber should be stiff, free from warpage and twist, and have good nail-holding capability. Bottom plates should be made of preservative-treated lumber when installed on a concrete slab. The woods used for wall-framing members are, in general, the same species as those used for floor framing. Common species include Douglas fir and Southern yellow pine.

Lengths of general framing lumber are available in increments of 2’. However, wall studs are usually precut to a particular length. Standard precut studs are usually 92⅝” long for an 8’ wall, as shown in Figure 16-2.

There are many different types and grades of lumber. The building code considers finger-jointed lumber to be no different than solid-sawn lumber of the same species and grade. Wall studs (vertical members) should be at least No. 3, standard, or stud-grade lumber. Lumber used for wall plates is sometimes a higher grade or different species than that used for studs due to

**Figure 16-2 Precut Studs**

Determining Ceiling Height A standard precut stud is 92½” long.
the need for long, straight lengths. Wall
plates must be straight or else the wall will
not be straight. High-quality construction
may require kiln-dried (KD) lumber to
minimize problems associated with lumber
shrinkage.

Wall-Framing Members

The **primary** framing members for walls
are **studs** and **plates**. Other framing members,
including headers, sills, cripple studs, and
trimmer studs, are physically connected
to one or both of these framing members.
These elements are all shown in **Figure 16-3**
on the next page.

**Studs** A **stud** is a vertical framing member.
Conventional construction commonly uses
2×4 studs spaced 16" on center (OC). The
full-length stud on either side of an open-
ing is sometimes referred to as a **king stud**.
The use of 2×6 studs for exterior walls is
increasingly popular. The extra thickness of
the resulting wall allows space for additional
insulation. These 2×6 studs may be placed
16" or 24" OC. Some interior walls are also
framed with 2×8 or larger studs, particularly
those that will contain the main drainpipes
for plumbing fixtures (see **Figure 16-34** on
p. 458). However, most interior walls are
framed with 2×4 lumber. Spacing for interior-
wall studs is normally 16" OC.

The ends of studs must be cut square so
they bear evenly on the plates. Cutting may
be done with a circular saw, power miter
saw, or radial-arm saw. Precut studs require
no additional trimming.

**Plates** A **plate** is a horizontal framing mem-
ber used to tie together interior and exterior
wall framing. The width of the plates deter-
mines the thickness of the wall. In a 2×6
wall, for example, the plates would be made
from 2×6 lumber. Each wall has three plates:
a bottom plate and two top plates.

The bottom plate, also called the **sole plate**,
ties the bottom ends of the studs together.
It also provides a nailing surface for the
bottom edge of wall coverings and wall
sheathing. The bottom plate is secured to

the bottom of the studs with nails. It is also
nailed to the subfloor.

The top plate is nailed to the top ends
of the studs and ties them together. It also
provides a nailing surface for wall coverings
and sheathing. The top plate has the same
dimensions as the bottom plate.

The second top plate, called a **double plate**, is
nailed to the first top plate after the walls
have been erected. The second top plate has
four purposes:

- It adds strength and rigidity to the top of
  the wall.
- It supports the ends of joists and the
  bottom ends of rafters.
- It helps distribute structural loads that
do not fall directly over studs.
- It ties intersecting walls together.

The double plate can be omitted in some
cases, such as when an in-line framing
system is used (see Chapter 14). If the double
plate is omitted, intersecting walls must be
tied together with a steel plate.

**Headers** Wherever an opening in a wall is
wider than the stud spacing, parts or all
of some studs will have to be left out. This
occurs most frequently with windows and
doors. It is also present with fireplaces and
pass-throughs. To prevent the wall from being
weakened at this point, a header is installed.

A **header** or **lintel** is a wood beam placed
at the top of an opening. The header sup-
ports structural loads above the opening and
transfers them to framing on each side of the opening. Headers are sometimes made of solid lumber. They are also built up from two or more pieces of 2\times H11003 lumber laid on edge with spacer blocks to match the thickness of the wall. They are also made from engineered lumber, such as laminated-veneer lumber (LVL).

**Framing a Wall**  The following is a basic technique for wall framing that can be used to frame nearly any straight wall.

**Step 1** Cut the bottom plate and top plate to length. If the plates will require more than one piece, make sure the break falls where a stud can support the end of both pieces, usually at 16” OC.

**Step 2** Align the bottom plate with the top plate. Tack them together temporarily.

**Step 3** Lay out the location of the windows, partitions, studs, and other components on the edges of both plates simultaneously.

**Step 4** Spread the top and bottom plates apart.

**Step 5** Place the required number of precut studs between the plates.

**Step 6** Install cripple studs, headers, and other parts of the framing. Nail the bottom and top plates to the studs by driving nails through the plates and into the end of each stud. At this stage, some carpenters also install the double top plate. If this technique is chosen, spaces must be left where the double plate of intersecting walls will tie in.

**Step 7** Square the wall and brace the corners.

**Step 8** Install panel sheathing (plywood or oriented-strand board).

**Step 9** Tilt the wall into place.

**Step 10** Make sure the wall is plumb, then install temporary braces to prevent it from tipping over.

**Step 11** Repeat the process for adjacent walls. As walls are erected, the double top plate can be installed. It overlaps the top plate of intersecting walls to tie walls together.

*Figure 16-3 A Framed Wall*

Go to glencoe.com for this book’s OLC for additional step-by-step procedures, applications, and certification practice.
Rough Sill A **rough sill** is a horizontal member placed at the bottom of a window opening to support the window. It connects the upper ends of the cripple studs that are below the window. The rough sill does not need the same strength as a header because it supports only the window, not structural loads. It is made from lumber having the same dimensions as the studs. It may be a single piece of lumber (single sill) or two pieces (double sill) if extra strength is required. Note that a rough sill is a framing member, while a windowsill is a part of the window itself.

Cripple Studs A **cripple stud**, or **cripple**, is a stud that does not extend all the way from the bottom plate to the top plate of a wall because of an opening such as framing for a window. Cripple studs are installed above headers and below rough sills. They are located where a full-length precut stud would be placed if there were no opening.

Cripple studs provide a nailing surface for the sheathing (outside) and for wall covering (inside). To conserve lumber, they are often cut from stock that is too short for other purposes.

Trimmer Studs A **trimmer stud**, or simply **trimmer** or **jack stud**, supports a header over a window or door opening. A trimmer stud is shorter than a standard stud but longer than a cripple stud. It is cut to fit beneath the header. A trimmer stud transfers structural loads from the header to the bottom plate. For wide openings, additional trimmer studs may be needed. Check local building codes.

**Estimating Studs, Plates, and Headers**

Wall framing requires many individual pieces of lumber. At the design and planning stages, you may need to know only the approximate number of pieces necessary. Later, you will need a more accurate calculation.

For exterior walls with studs spaced at 16” OC, figure one stud for every lineal foot of wall. For example, if you are building a 16-foot long wall, buy 16 studs. This allows for the extra framing required around openings and at corner posts. To determine the number of studs needed for a partition, refer to the table “Partition Studs Needed” in the **Ready Reference Appendix**.

To determine the number of lineal feet of top and bottom plates for walls having double top plates, multiply the length of the wall by three. Add materials for such items as gable-end studs, corner braces, fireblocking, and wall blocking. Sometimes a builder may wish to get a rough idea of how much lumber will be required for a house. A rough estimate can be made as follows:

1. Figure the total length of the outside walls, and then double it. This will give you the approximate combined total length of all the walls, interior and exterior.

2. Multiply the total length of all walls by five. This will give you the approximate total lineal footage of plate material plus the additional miscellaneous framing for gables, bracing, and blocking.

The dimensions of each header will sometimes be found on the building plan. The length of a header is generally 3” longer than the rough opening width. This assumes that the header will be supported by one trimmer stud on each end. This is generally the case with openings less than 6’ wide. Headers over larger openings should be supported by two trimmers at each end. In that case, the length of the header will be 6” greater than the rough opening width. Make a list of headers and their dimensions for use as a cutting list during construction. Review the plans to identify any areas requiring special framing. Add this material to the estimate.

Framing lumber is usually sold by the lineal foot. To estimate total cost, multiply the number of lineal feet by the cost per lineal foot. Add to that the cost of the precut studs. Another way to do this would be to determine the total cost by multiplying the total number of board feet by the cost of one board foot of lumber.

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**Explain** What is a plate?
**Wall Sheathing**

**What is the purpose of wall sheathing?**

Wall sheathing is a panel product nailed to the outside surface of exterior walls, as shown in Figure 16-4.

Wall sheathing has several functions:

- It strengthens and braces wall framing, and adds great rigidity to a house.
- It forms a solid nailing base for the siding.
- It helps to seal a house by reducing air infiltration.
- It ties wall framing to floor framing. A solid connection here is especially important in areas prone to high winds and earthquakes.

The use of diagonal bracing, also called corner bracing or wind bracing, is another way to strengthen a wall. It can be used with or without sheathing. In one bracing system, the studs are notched to receive 1×4 pieces that are let into the notches. This is known as let-in bracing. Another system uses metal angle strips that are nailed to the outside edges of the studs.

In mild climates, plywood sheet siding is sometimes applied directly to the outside of the wall studs (see Chapter 23). In this case, it serves both as siding and as sheathing. No separate sheathing is required. In this case, grades, thicknesses, and types of plywood vary from standard sheathing requirements. For example, the plywood must be thicker and of a higher grade in order to maintain wall strength.

**Installing Sheathing**

The most common sheathings used in residential construction are square-edged 4×8 panels made of plywood or oriented-strand board (OSB). Panel thickness ranges from 3⁄16" to 1". Walls with stud spacing 16″ OC must have sheathing that is at least 5⁄16" thick, although ½" is more common. When finish
siding requires nailing between studs (as with wood shingles), the sheathing should be at least ⅜" thick.

Though OSB is different from plywood in terms of manufacture, it is considered the same by codes in terms of sheathing. Nailing and installation details for OSB sheathing are similar to those for plywood.

Walls that have been covered with sheathing provide a more solid support for the ceiling and roof members. That is why carpenters apply the sheathing as soon as possible. However, it may be applied at either of the following stages:

- Sheathing may be applied when the wall frame is lying on the subfloor, completely framed and squared. The advantage in applying the sheathing at this time is that it can be nailed in place while the wall sections are lying flat. This eliminates

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### Estimating Sheathing

#### Number of Sheets Needed

Using the following example will allow you to determine how many sheets of sheathing will be needed to cover the walls of a house. For example, a one-story house has four walls and a gable roof. (A gable is the triangle formed in a wall by the sloping ends of a roof.) Two of the walls are 8' high and 28' long. The other two walls are 8' high and 36' long. The bottom of each gable is 28' long. Make a sketch of this arrangement to help you understand the situation.

**Step 1** Multiply the height of each wall by its width to determine the total area of each wall.

\[
\begin{align*}
8' \times 28' &= 224 \text{ sq. ft.} \\
224 \text{ sq. ft.} \times 2 &= 448 \text{ sq. ft.} \\
8' \times 36' &= 288 \text{ sq. ft.} \\
288 \text{ sq. ft.} \times 2 &= 576 \text{ sq. ft.}
\end{align*}
\]

#### Sample Gable

---

**Step 2** For a house with a gable roof, find the area of one gable. To find the area of a gable, multiply the height of the gable by one-half its width at the bottom, as shown in the sample gable below. Multiply the result by the number of gables to determine the total gable area. (For ease in calculating this example, change 4' 8" to a decimal, or 4.66').

\[
\begin{align*}
4.66' \times 14' &= 65.24 \text{ sq. ft.} \\
65.24 \text{ sq. ft.} \times 2 &= 130.48 \text{ sq. ft.}
\end{align*}
\]

**Step 3** Add the total area of each wall and the gables to determine the total wall area of the house.

\[
448 + 576 + 130.48 = 1,154.48 \text{ sq. ft.}
\]

**Step 4** There are 32 square feet in a 4×8 sheet of plywood. Divide the total wall area by 32 and round off the result. This will give the number of plywood sheets required to sheathe the house.

\[
1,154.48 \div 32 = 36.08
\]

However, a waste factor of 10% should be added to allow for cut pieces that cannot be used.

\[
36.08 \times 10\% = 3.608.
\]

Rounded up, the house would require 40 sheets of sheathing.
the need for ladders or scaffolding. The disadvantage is the added weight that must be lifted when erecting the walls.

- Sheathing can also be added after the wall frame has been erected, plumbed, and braced, and the ceiling joists have been installed.

**Orientation and Fastening** Sheathing is usually applied vertically, using perimeter nailing with no additional blocking. If a panel does not extend to the top of the wall, its top edge should be nailed to blocking, as in Figure 16-4 on page 435. An alternative would be to use longer sheathing panels. Local building codes may require that sheathing be applied only vertically near the corners of a building. This provides additional rigidity to the structure. Plywood can also be applied horizontally, although the horizontal joints between panels should be supported by solid blocking as a base for nailing.

Building codes sometimes allow sheathing to be fastened by stapling. However, nailing is more common. The spacing and gauge of fasteners is important in creating a solid connection between sheathing and framing. Nailing and stapling requirements for plywood wall sheathing are listed in the **Ready Reference Appendix**. See the tables titled “Stapling Schedule” and “Plywood Wall Sheathing Application Details.”

Where earthquakes or high winds are a common hazard, nailing requirements are stringent. This is especially true around window and door openings. Extra nailing strengthens a sheathed wall to the point that it can be considered a shear wall, sometimes called a braced-wall. A shear wall resists severe forces that tend to separate the sheathing from the framing. To create a shear wall, the sheathing must be nailed to all studs, blocking, and sills 3” OC, using 8d common or galvanized box nails. Another way to create a shear wall is to use a prefabricated wall product made of a light-gauge steel panel and wood framing. The steel resists shear forces and is bolted to the foundation. Engineering requirements may also require a moment frame. This is a load-bearing assembly that resists bending or twisting forces.

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**Section 16.1 Assessment**

**After You Read: Self-Check**

1. What stud spacing is commonly used in conventional construction?
2. What is the purpose of a header?
3. What problems might occur if a carpenter did not install cripple studs under a window opening?
4. What are the most common sheathings for residential construction?

**Academic Integration: Mathematics**

5. Calculate Bulk Savings Professional builders may be offered a lower price per sheathing panel because they usually order in bulk. Contact a building supplier to find out the price of one 4×8 sheet of ½” OSB wall sheathing. Ask the supplier what sort of a discount you would get if you purchased 50 sheets at one time. Calculate the difference in price per sheet and compare this to the price for one sheet. Report your findings.

Go to glencoe.com for this book’s OLC to check your answers.
Responsibility for Layout

What is wall layout?

The most experienced carpenter, called the lead carpenter, is entrusted with reading the plans and translating them into a series of lines and symbols marked on the subfloor. These marks are called a layout. The layout shows other carpenters exactly where to install the walls. Wall layout involves two main steps:

- Marking the location of walls on the subfloor.
- Marking the location of studs, windows, and doors on the wall plates.

In layout, accuracy is more important than speed. The lead carpenter must thoroughly understand the building plans before layout begins. In addition, he or she must be aware of special framing requirements for work to be done by other skilled workers, such as plumbers and electricians. Before the layout is started, the subfloor must be swept clean. This makes it easier to snap chalk lines on the surface. All objects that might be in the way, such as sawhorses, must be removed.

The layout is often done by a carpenter and an apprentice. The carpenter is responsible for measuring and marking. The apprentice observes and learns while holding one end of a chalk line or tape measure. A carpenter doing the layout alone might use a nail or an awl to hold the end of the tape or chalk line.

In some parts of the country, it is common to build houses on a slab foundation instead of on foundation walls. All the wood-framed walls of such a house must be bolted directly to the foundation. However, the principles for laying out and assembling walls are essentially the same as described here.

Laying Out Wall Locations

The first step in wall framing is to lay out the location of two intersecting exterior walls. Carpenters usually start with two long walls that meet at a corner. Measurements taken from these two walls can then be used to locate other walls. Once the exterior walls have been located, layout proceeds to the interior walls.

Exterior Walls

The outside edge of an exterior wall’s bottom plate should be flush with the outside edge of the subfloor. To begin layout, measure 3½" in from the edge of the sheathing (or 5½" for a 2×6 wall) and snap a chalk line parallel to the edge. Repeat the process for the intersecting wall.

Check the two chalk lines to make sure they form a 90° angle. Good carpenters never assume that the floor framing is perfectly square. To check for squareness, measure from the chalk line intersection exactly 3' along one line and 4' along the other, as shown in Figure 16-5. If the diagonal measurement between these two points is exactly 5', the corner is square. This is an example of the 3-4-5 rule. Any multiples of these numbers that preserve the same ratio,
such as 9, 12, and 15, will work in the equation. The larger the triangle formed using the 3-4-5 rule, the more accurately the building will be checked for square.

If the corner is not square, adjust one of the layout lines until it is. After the first two layout lines are correct, locate and mark the position of the remaining exterior walls.

**Interior Walls** Consulting the plans, locate the position of interior walls by measuring from the chalk lines that indicate exterior walls. Pull a chalk line taut and snap it to indicate the exact location of one edge of each partition’s bottom plate. To prevent confusion, mark an X on the subfloor to show the side of the line on which the plate will be located. This is where new carpenters often make a mistake. If the X is marked on the wrong side of the layout line, the wall will be built 3½" from its correct position. Check partition walls during layout to ensure that they are square with intersecting walls.

It is important to identify special partitions as layout proceeds. Special partitions will contain plumbing drains or other features. They may have to be thicker than standard walls. This should be noted on the subfloor.

**Cutting the Plates**

After the layout for the exterior and interior walls has been snapped out on the subfloor or the slab, cut the top and bottom plates to fit the layout. Some carpenters use a tape measure to measure the length of plates. Others mark plates using the subfloor layout marks as guides.

Plates for the exterior walls are cut first. Before cutting, you must decide which exterior walls are by-walls and which are butt-walls. A by-wall runs from the outside edge of the subfloor at one end of the building to the outside edge of the subfloor at the opposite end, as shown in Figure 16-6. By-walls are framed first and then erected into position. A butt-wall fits between the by-walls. Butt-walls are framed after by-walls. The double plate (rafter plate) will later tie butt-walls and by-walls together. The top plates of a given wall will be the same length.

**Figure 16-5 Using the 3-4-5 Rule**

**Useful Geometry** If two legs of a triangle measure 3' and 4', they form a 90° angle if the diagonal between the ends of the legs measures exactly 5'.

**Figure 16-6 Wall Identification**

**First Decision** To begin layout of the plates, decide which walls will be by-walls and which will be butt-walls. Usually, the longest walls will be by-walls, then the shorter walls are butt-walls. Sometimes the butt-walls have butt-walls that attach to them. For example, hall walls would normally be by-walls with the bedroom walls being butt-walls. Then closet walls would be butt walls to the bedroom walls.
Cut the exterior plates to length, making sure that the ends of the plates for long walls break on 16" OC marks. Then stack the plates on the subfloor and align them with the chalk lines. After you have cut the exterior wall plates, cut the interior wall plates. Place these plates on the X side of the chalk lines.

**Laying Out the Plates**

Plate layout identifies the location of each stud in a wall, as well as the location of doors and windows. These locations are marked on the edges or the sides of the plates using a carpenter’s pencil. Start by tacking the top and bottom plates together with two or three 8d nails. This prevents them from shifting during layout. If the edges of the plates are marked, then the edges should face up, as shown in Figure 16-7. If the sides of the plates are marked, then the sides should face up.

The procedure for laying out the plates depends partly on how walls, windows, and doors are dimensioned on the plans. If they are dimensioned in reference to centerlines, use the procedure described under “Openings.” If another dimensioning system is used, adapt the technique in some way. For example, you might measure between the faces of the plates, instead of to the centerlines of the plates.

**Openings**

Refer to the building plans to find the distance from one corner of the building to the center of the first opening. Measure this distance and square a line across both plates at this point. Mark the line with a centerline symbol and an identification letter or number. This can be used for reference when cutting other parts for this opening.

Continue to lay out and mark openings on the remaining exterior wall plates. Use a letter or symbol to distinguish between door and window centerlines. When laying out plates on a slab foundation, pay attention to the location of foundation anchor bolts during the layout process. There should be an anchor bolt within 12" of the end of each section of plate.

As they mark centerlines, many carpenters also “detail” the openings: this means to mark the rough opening as well as the location of trimmer studs and king studs. The **rough opening (RO)** is the space into which a door or window will fit, as shown in Figure 16-8. It allows room for the door or window and its frame. It also provides space for leveling and plumbing the frame. Note in Figure 16-9 that the centerline of a door opening has been marked 7'-7" from the outside corner. The rough opening (RO) measures 34½". One-half the RO (17¼") is laid out on each side of the centerline. The thickness of the trimmer stud is laid out on each side of this. The header (37½" long) will rest on top of the trimmer studs and between the king studs (marked with an X).

Building plans include window and door **schedules**, which are charts that provide rough-opening sizes. Maximum spans for...
headers and estimates of material needed for studs are listed in the **Ready Reference Appendix**. Refer to the tables titled “Maximum Spans for Headers,” “Exterior Wall Studs, Including Corner Bracing,” and “Partition Studs, Including Top and Bottom Plates.”

When the rough opening size for windows is not provided, it can be obtained from the window manufacturer’s catalog. The rough opening sizes vary somewhat among manufacturers. Each catalog typically contains tables showing four width and height measurements for each window: masonry openings, rough openings, frame size, and glass size. Some may also list the sash size. Rough openings usually allow ½” on each side of the window or door and ½” at the top of the unit to allow adjustment of the unit for plumb and level installation.

After you mark a window or door centerline on the plates, measure from each side of the centerline a distance equal to one-half the rough opening, as shown in Figure 16-9. Square a line at this point. This line represents the inside face of the trimmer stud. Now mark the plate to locate the position of each king stud. The face of the king stud is 1½” away from the inside face of the trimmer stud.

**Wall Intersections** Mark the exterior plates to indicate the centerlines of all intersecting interior walls. Again, start from one corner of the building. Mark the place where the interior wall would intersect with a P, as in Figure 16-10 on page 442.

**Exterior Corner Posts** A **corner post** is an assembly of full-length studs at the corner of a building. An **exterior** corner post is one that...
forms an inside corner and an outside corner. The inside corner provides nailing surfaces for interior wall coverings. The outside corner provides nailing surfaces for sheathing.

(Sheathing is discussed in Section 16.1.)

Corner posts are usually built from three or more studs to provide greater strength. They may be made in several ways. Two of the more common methods are shown in Figure 16-11 and Figure 16-12. Whatever method you choose, remember to mark the arrangement of studs on the exterior wall plates.

**Partition Corner Posts** A partition corner post is a particular type of post required where a partition meets another wall. A partition corner post is sometimes called a channel, a partition-T, or a T-post. In the type shown in Figure 16-13, the regular spacing of the outside wall studs is interrupted by double studs where the partition ties in. The double studs are set 3” apart. This interval allows the partition’s end stud to lap the others just enough to permit nailing. It leaves most of the inner edges of the other studs clear to...
serve as nailing bases for inside wall covering. The variation in Figure 16-14 gives more nailing surface for the inside wall covering.

Many carpenters detail the arrangement of partition corner posts as they locate partition centerlines. This is sometimes done with the aid of a site-built jig made of two blocks of framing lumber nailed together.

**Stud Locations** Mark all the exterior plates and all the partition plates for the location of wall studs and cripple studs. There are various ways to do this. Tape measures marked with special symbols at intervals of 16” and 24” may be used. Some carpenters find it faster and easier to use a layout template, as shown in Figure 16-15. A layout template, or layout stick, is an aluminum bar with 1½” wide “fingers” that correspond to the particular stud spacing being used. The template is 4’ long, the standard width of wall sheathing. It has four fingers, each 1½” wide and spaced 16” OC, representing four stud markings.

When laying out stud locations, you should be thinking ahead. Remember that sheathing and wallboard come in standard 4’ widths. There must always be a stud where two panels will meet in a vertical joint. The panels are fastened to the studs at these joints.

**Begin the layout on the plates by measuring from the corner of a by-wall. Make a mark 15¼” from the end of the plate. This will be the location to the edge of the first stud. Mark an X on the side of the line where the stud will be. This will ensure the stud will not be placed on the wrong side of the layout line. From that point on, mark every 16” to indicate the edge of each stud on that wall, as shown in Figure 16-16 on page 444. Double-check the layout by measuring along the plate to see that a stud will always be located where there will be a vertical joint between 4’ wide sheathing panels.**

**Before laying out the studs on a butt-wall, check the plans to determine the thickness of the wall sheathing. The spacing of the butt-wall studs must account for the thickness of the intersecting by-wall and its sheathing. This is needed because the butt-wall sheathing will overlap the by-wall and its sheathing. Measure 15¼” in from the outside edge of the sheathing as shown in Figure 16-17 on page 444. This ensures that the edges of the sheathing on the butt-wall will be properly supported at 4’ intervals.**

**Where the stud layout is interrupted by a window or door opening, lay out cripple studs above and below the opening. Maintain the 16” or 24” OC spacing that you used for the full-length studs. Mark on the plates the position of each cripple stud. The position of a cripple stud is usually marked with a C, rather than an X.**
Figure 16-16 Layout of a By-Wall Account for the Sheathing Check the layout carefully to make sure sheathing will be properly supported.

Figure 16-17 Layout of a Butt-Wall Check the Plans The spacing depends on the thickness of the sheathing.

After You Read: Self-Check
1. What is the 3-4-5 rule used for?
2. What is plate layout?
3. Explain the difference between a by-wall and a butt-wall.
4. What is a rough opening?

Academic Integration: Mathematics
5. 3-4-5 Rule With a partner, use a 25' tape measure to measure the diagonals of at least four large rectangles in a structure to see whether they are square. Examples of measurable spaces might be the walls of a room or a rectangular deck. Start in one corner of the layout. Record the results of your investigation for each rectangle, providing the length of the diagonal and whether or not the structure is square.

Go to glencoe.com for this book's OLC to check your answers.
Knowing Procedures
When would you prefer to erect a wall before you sheathed it?

When plate layout is complete, the various parts of the wall framing can be cut to length, assembled on the subfloor, nailed together, and lifted into place, as shown in Figure 16-18. Several procedures can be used to assemble walls. Some carpenters prefer to tip framed walls into place and sheathe them later. Other carpenters install sheathing, windows, and sometimes siding on exterior walls before lifting them into place. In either case, the walls should be squared. A common technique is to sheathe the walls on the floor deck but install windows and siding after the walls have been erected.

Choosing a Strategy
The method chosen depends in part on the length and weight of the walls. Whichever method is used, the order in which the exterior walls are to be assembled and erected must first be determined. The by-walls are usually erected first. The butt-walls are erected next.

In areas of the country where severe weather or earthquakes are a risk, buildings require the use of metal straps and anchors to strengthen the connections between framing members. In some cases, steel straps must be used to tie wall framing to the roof framing. Be sure to follow local codes. For more information, see Chapter 17.

Preparing Components
In the most common method of assembling walls, the cripple studs, trimmer studs, and headers are precut to length on the job site. Then they are distributed to the area on the subfloor where they will be assembled.

Figure 16-18  Erecting a Wall
Team Effort  In this case, the sheathing will be applied after the wall is in place. This reduces the weight of the wall and makes it easier to tilt up.

Builder’s Tip
Making a Cut List  Experienced carpenters always try to save time on a project without sacrificing quality. One technique is to make a cut list. This is a written list showing the length and dimension of all components in a wall. With the list in hand, one carpenter can quickly cut all the pieces without having to go back and forth to make measurements.
Cutting is usually done with a circular saw. However, a radial-arm saw or power miter saw ensures square cuts. Such a saw is often easier to use when making repetitive cuts to a standard length.

**Using a Story Pole** The length of each wall component can be determined from the plans. Because the height of wall openings is standardized, carpenters often lay out a story pole. A story pole is a piece of framing lumber that represents the wall from the top of the subfloor to the bottom of a ceiling joist, as shown in Figure 16-19. It includes information about the location and size of the window headers, sills, and door headers. It also includes the heights of various openings above the subfloor.

**Trimmer Studs and Cripple Studs** Trimmer studs should be cut to fit snugly under the header so they will support it properly. If a header settles, cracks in the plaster or drywall may develop, and doors and windows may fit improperly. The trimmer studs also reinforce the door and window openings. In fact, it is very important for all framing members to fit against each other tightly. This will help to reduce shifts in framing that can result in cracked wall surfaces as well as poorly fitting doors and windows.

**Figure 16-19 A Story Pole**

**Dimension List** A story pole is an efficient method for laying out repetitive components of a wall.
Determine the lengths of the cripple studs by referring to the story pole. To determine how many are required, count the cripple-stud layout marks on the wall plates.

**Headers** The depth of a header (lintel) is determined by the length of the opening it must span. Longer openings require stronger, deeper headers. This information will be found in the building plans or local code requirements. Make sure that the header is long enough to bear on all of the trimmer studs.

Header lengths are obtained by measuring the top plate between layout marks for the king studs. In the case of the door opening shown in Figure 16-9 on page 441, the header length would be 37½". Window and door headers are sometimes cut from solid pieces of 4×6 or larger stock. Commonly, however, the header is built up from 2×6 or wider framing stock. Side by side, two 2× members are only 3" thick. A ½" thick plywood spacer must be sandwiched between the two pieces to give the header the full 3½" thickness of the wall. The members are nailed with 16d nails staggered on 16" centers.

Various types of headers can be assembled using solid lumber, as shown in Figure 16-20. Many builders today use engineered lumber as header material. These products are generally stronger and save time because they do not need to be assembled.

A header will normally be supported by the trimmer studs. In some cases, as in remodeling, headers may be supported by metal framing brackets, as in Figure 16-21. In states where high winds are a threat, codes may require that metal straps be used to connect headers/plates and studs.

Rather than cut one header at a time, it is faster to first number the openings (such as windows, doors, and fireplaces) for...
identification. Then you can make a cutting schedule for all headers. One person can cut these to length as another assembles them. Use 16d nails, two near each end. Stagger the others 16” apart along the length of the header. Do not forget to use ½” spacers between the 2× members. Place assembled headers at their locations on the subfloor in readiness for the assembly of the wall sections.

**Assembling Corner Posts**  Because corner posts are made from precut studs, cutting is not required. Corner posts are nailed together with 10d and 16d nails. They are then taken to the place on the subfloor where they will be used for assembly of the wall sections. The short pieces of 2×4s at the base of the corner posts in Figures 16-11 and 16-12 on page 442 are installed after the walls have been raised. They will provide places for nailing the ends of the baseboard. Baseboard is a type of finish trim installed at the base of a wall. In areas where energy efficiency is especially important, other corner-post assemblies can be used.

**Recall**  What is a story pole?

**Assembling & Raising Walls**

**Why is it important to align the edges of studs in a wall?**

There are different methods for assembling and raising exterior walls and interior walls.

**Assembling and Raising Exterior Walls**

Each wall section is assembled on the subfloor. Begin the assembly by separating the plates that were tacked together for layout. Lay the top plate on edge on the subfloor about 8’ from the bottom plate. Do not flip the top plate end-for-end as you move it. If the plate is flipped, the layout marks will not match those on the bottom plate. This is a common mistake.

Lay a full stud at each mark. Place the header so that the rough sill, cripple studs, and trimmer studs are in position. Place the preassembled exterior corners and partition corners at the marked locations. You can now nail the components together. The order of assembly depends on the preference of the carpenter. The following is one approach.

Beginning at one end of the top plate, drive two 16d nails through the plate into each stud at the correct location. Secure the bottom plate in the same way. Be careful to keep the edges of the framing members flush with each other. This is essential if sheathing is to fit correctly. If the wall contains a door or window, nail all those components into place. To keep the edges of studs and plates perfectly aligned during nailing, carpenters step on the intersection as they nail through the plate. This also keeps the wall from sliding if it is being hand nailed. This problem is eliminated with pneumatic nailing.

**Framing a Window Opening**  Once all the full-length studs are in place, gather the components surrounding the window opening, as shown in Figure 16-22.

- The cripple studs at A are toenailed with four 8d nails, two on each side.
- The full stud is nailed to the header at B with four 16d nails and to the trimmer at C with 10d nails 16” OC.
The full studs are toenailed to the bottom plate or nailed through the bottom plate.

The lower part of the double sill is nailed with two 10d nails into the ends of the cripples at D.

The upper part of the sill (E) is nailed to the lower with 10d nails 8" OC and staggered.

The ends of the sills are nailed through the trimmer studs with two 16d nails at each end (F).

**Framing a Door Opening** Assembly of a door opening such as the one shown in Figure 16-23 should proceed as follows.

- The cripple studs (A) are toenailed with four 8d nails, two on each side.
- The full studs (B) are nailed to the header with four 16d nails on each side and toenailed to the bottom plate with two 8d nails. The full stud (B) could be nailed from the bottom up through the plate, with two 16d nails, if the plate is attached before the wall is erected.
- The trimmer (C) is nailed with 16d nails staggered 16" OC.
- Two 10d nails are driven into the end of the bottom plate at D.

**General Details** Trimmer studs fit under a window or door header. They are nailed to a king stud with 16d nails, spaced 16" apart and staggered. Notice that the trimmer stud for a door may extend from the header to the bottom plate. The portion of the plate within the door opening will be cut out.

**Builder’s Tip**

**SPLIT-FREE NAILING** When securing the studs at the ends of a wall, slightly blunt each nail by tapping its point with a hammer. The nail will then be less likely to split the plate.
later, after the wall is erected so that finish flooring can be laid. If this portion of the plate is cut out earlier, the wall will be more difficult to erect.

Nail through the king studs and into the header with 16d nails. Once the header is secure, insert the cripple studs above it. Nail their tops as if they were studs. Toenail the bottom end of each cripple to the header with two 8d nails on each side.

When you have fully assembled the wall on the subfloor, square it. Do this by running a tape measure across diagonally opposite corners, as shown in Figure 16-24. If the diagonal measurements between all corners are the same, the wall is square. If the wall is not square, push the plates in opposite directions until it is.

As mentioned earlier, some carpenters apply sheathing at this point. Others apply it after the wall has been erected. If walls are framed and sheathed while flat on the subfloor, raising the completed wall can be awkward. This is because the sheathing makes it hard for carpenters to get a good grip on the wall.

To make walls easier to raise, use a prybar to lift the top end of the wall off the deck. Slip in scrap 2×4 blocks at numerous locations beneath this. When the crew is ready to raise the wall, they will find it easier to get a solid grip.

**Temporary Bracing**

Temporary bracing is bracing that has the following two purposes:

- It prevents walls from tipping as they are being erected.
- It holds walls in position after they have been plumbed and straightened.

Temporary bracing may consist of 2×4 or 2×6 members nailed to one face of a stud and to a 2×4 block nailed to the subfloor, as shown in Figure 16-25. The wall braces may also be nailed to wood stakes driven into the ground outside the perimeter of the foundation.

Take care not to let the ends of the temporary braces project above the top plate. Otherwise, the braces could interfere with ceiling and roof framing and would have to be removed. This would disturb the plumbed and straightened walls. Use enough nails to brace the wall securely, but do not drive the nails in all the way. Each nail head should project enough to allow easy withdrawal. Leave the temporary
bracing in place until the ceiling and roof framing have been completed, and sheathing has been applied to the outside walls.

**Raising the Wall** As a wall is lifted into position, align the bottom plate with the chalk lines made earlier. This is a job for several carpenters. One carpenter is needed at each end of the wall. One or more may be needed in between, depending on the length of the wall. Have temporary bracing ready for use as soon as the wall is partially upright. As an extra measure of safety, nail 2x4 cleats to the outside of the rim joist to prevent an exterior wall from slipping off the subfloor as it is lifted. (A rim joist is a joist at the edge of the floor system.) In some cases, hand-cranked lifts are used to tilt a heavy wall into position.

When the wall is upright, fasten the bottom plate to the floor framing with 16d nails spaced 16” apart and staggered when practical. You can now plumb and brace the wall.

**Plumbing the Wall** To plumb a wall means to make sure it is perpendicular to the subfloor. Either a carpenter’s level or a plumb bob may be used to plumb wall sections. As noted earlier, framed exterior walls may be raised into position with or without sheathing already applied. In either case, the walls must be plumbed and straightened. This is done after all the framed walls are in position and temporarily braced.

**Using a Plumb Bob** To plumb a corner post with a plumb bob, attach the plumb line (string) securely to the top of the post, as shown in Figure 16-26. Make sure the line is long enough to allow the plumb bob to hang near the bottom of the post. Use two blocks of wood identical in thickness as gauge blocks. Tack one block near the top of the post between the plumb line and the post. Insert the second block between the plumb line and the bottom of the post. If the entire face of the second block makes contact with the line, the post is plumb.

**Using a Carpenter’s Level** To plumb a corner with a carpenter’s level, do not place the level directly against a stud. The face or edge of the stud may be bowed. Instead, place an 8’ level against blocks nailed to the top and bottom plates. To increase accuracy when plumbing the corner, hold the level so that you can
look straight in at the bubble. If a long level is not available, place a shorter level against a 1×4 straightedge, as in Figure 16-27. The blocks can be attached to the framing or to the straightedge. While one carpenter reads the level, another should be ready to move the braces as needed and to secure them as soon as the correct position is found.

Plumb outside corners by checking them on two adjacent surfaces, then brace them to prevent the wall from shifting. After you have plumbed and braced all exterior walls, plumb and brace the intersecting interior walls. This will also plumb the exterior wall at the point of intersection.

**Straightening Walls** To straighten walls, fasten a string line to the outside top of one of the corner posts. Stretch the line to the outside top of the corner post at the opposite end of the building. Fasten the line to this post in the same manner as for the first post. Place a ¾" wood block under each end of the line to give clearance, as shown in Figure 16-28. Place additional temporary
braces at intervals close enough to hold the wall straight. When the wall is far enough away from the line to permit another ¾" block to slide between the line and the plate, nail the braces. This straightening procedure is sometimes called *lining the walls*. It is carried out for the entire perimeter of the building. Later, you should also straighten any long partitions in the same manner.

**Assembling and Raising Interior Walls**

After all the exterior walls are plumbed and braced, and the bottom plates securely nailed, assemble and erect the interior walls. Interior walls are easier to assemble than exterior walls because they usually do not require framing for windows. However, they do require framing for doors. Otherwise, they are assembled in the same manner as exterior walls. To determine the sizes of the various parts (such as headers, trimmer studs, and cripple studs), refer to the building plans and the story pole.

Careful planning of the order in which the interior walls are assembled and erected is very important. See the Step-by-Step Application on page 436.

**Recall** What safety precautions are important when raising walls?

**JOB SAFETY**

**RAISING WALLS** A wall that is being raised must be braced quickly to lessen the chance that it will topple. Carpenters often secure the tops of the braces to the studs before erecting the wall. A single nail at this point allows the brace to swing into position as the wall is being raised.

Go to [glencoe.com](http://glencoe.com) for this book’s OLC for more on job safety.

**Installing the Double Plate**

**Why is the double plate necessary?**

The double plate is nailed to the top plate after the exterior and interior walls have been erected. Use the same type and quality of material as for the top plate. Be sure to cut the pieces accurately to length. Cutting to length is sometimes done when the top and bottom plates are cut. However, it is most often done after the walls are erected because the double plates are a different length than the other two plates.

One of the main purposes of the double plate is to tie the walls together at the top. Therefore, it laps over the joint formed at a corner of intersecting exterior walls, as shown in **Figure 16-29**. It also laps the joint formed by intersecting partitions, as shown in **Figure 16-30** on page 454. On a long wall, joints in the double plate should be at least 4' from any joint in the top plate. Fasten the double plate with 10d nails spaced 16" OC and staggered. Nail end laps between adjoining plates with two 16d nails on each lap (see bold arrow in **Figure 16-30**).

**Figure 16-29** on page 454 shows the order of assembly for assembling and erecting interior walls.
Assembling and Erecting Interior Walls  The following is a general procedure.

**Step 1**  Raise, fasten, and temporarily brace the longest center partition (1). Work should then proceed from the center wall out to the exterior walls, and from one end of the building to the other. Complete operations in one area before moving to the next area.

**Step 2**  Note that partition 1, though interrupted by openings, is considered to be one piece. Erect and plumb partition 2 next. Note that it helps support partition 1 and connects it to the previously plumbed exterior wall. Partition 3 comes next, then 4, 5, and 6, etc.

**Step 3**  Continue erecting partitions that are at right angles to each other, all the way to the back of the building. This sequence is better than erecting two parallel partitions (such as 2 and 4) and then working in a confined area to erect the connecting partition (3).

Go to glencoe.com for this book’s OLC for additional step-by-step procedures, applications, and certification practice.
Dealing with Special Conditions

When is special framing called for?

Special framing adds strength and quality to the construction. Its requirements are not always noted on the building plans. However, the carpenter should be familiar with them. Special framing details are required in various situations:

- For unusual architectural features.
- To provide openings for plumbing vents and fixtures.
- To provide openings for heating ducts.
- To add support for heavy items.
- To add blocking that supports the edges of interior wall coverings.
- To provide extra strength to houses built in earthquake or hurricane zones.
- In some cases, for fire safety.

A building must be enclosed quickly to protect it from the weather. However, special framing can be time-consuming. Therefore, it may not always be installed as the walls are being framed and erected. Instead, a builder may concentrate on sheathing the walls first and getting the house closed in. The builder may then install special framing as fill-in work during slack periods in later construction stages.

Unusual Walls

Most walls can be framed using standard precut studs and other components. In some situations, however, wall framing must be handled differently.

Gable Walls

Walls that angle upward to meet the underside of the roof framing are called gable walls or rake walls. The spacing of the studs is the same as for surrounding walls, but precut studs cannot be used. Instead, each stud in the gable wall must
be cut to a specific length. Its top end must be cut at an angle that matches the roof pitch (slope). The bottom plate of a gable wall is similar to that in a standard wall. The top plate slopes to follow the roof angle.

Gable walls are sometimes built and erected along with the rest of the wall framing. In other cases, the roof framing is installed first and the gable-wall framing is added afterwards. If the roof framing consists of trusses, the truss manufacturer supplies the gable-wall framing.

The cuts involved in building a gable wall are directly related to the slope of the roof. For this reason, gable-wall construction is discussed in Chapter 18.

**Bay Windows** Bay windows project outward from a wall or roof and have special framing requirements. The floor framing is provided during an earlier stage. The projecting walls of the bay may be framed and erected as if they were standard walls. Sometimes, however, an angled bay may call for framing that has been beveled with a circular saw or table saw. Note also that a bay window may require two headers. One header is over the opening in the main wall and one is over the window itself. See Figures 15-27 and 15-28 in Chapter 15 for details of bay window floor framing.

There are various ways to frame a bay window, depending on its size, roof type, and the type of windows. The bay window in **Figure 16-32** is one example. The ceiling

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**Figure 16-32 Bay Window Framing Like a Small House** Bay window framing has many of the same elements found elsewhere in the house framing.
joists in the framing of this bay window are set on top of the window headers. The top of a bay window should be kept in line with the other windows and doors in the room. Therefore, the wall header will not be a standard header height. It will have to be raised so that its bottom is in line with the bottom of the bay ceiling joists, as shown.

**Shear Walls** A *shear wall* has been engineered to withstand unusual stresses. These walls are installed in order to make the structure of a house more rigid. They are often used in areas where earthquakes and severe storms are common. Such a wall may also be a feature of houses with unusual designs.

Shear walls may require extra nailing, hold-downs and/or special anchor bolts. Wider studs may be needed to accommodate close nailing patterns. Shear walls may also call for the use of construction adhesives and/or sheathing on both sides of the wall. The requirements for a shear wall are specified by an architect or engineer and detailed on the plans. The carpenter must not deviate from those specifications.

**Radius Walls** Some modern architectural designs include curved walls, called *radius walls*. The dimensions of the curve are detailed on the plans. The studs may be the same dimensions as in surrounding walls. However, the curved plates are cut from plywood instead of lumber. The ends of blocking must be cut to an angle. The ability to build such unusual walls is the mark of an experienced framing carpenter.

**Reading Check**

**Summarize** How is a bay window like a miniature house?

**Other Special Conditions**

Carpenters often encounter special framing requirements that relate to providing framing for the work of other tradespeople. It is important for the carpenters to understand these requirements while performing their own trade.

**Plumbing Needs** Plumbing vents are usually installed in a 2\(\times\)6 or thicker wall, as shown in Figure 16-33. This is sometimes called a *plumbing wall*. It provides the needed wall thickness for the bell (large end) of a 4" cast-iron soil pipe, which is larger than the thickness of a 2\(\times\)4 stud wall.

In some cases, builders stagger wall studs in a way that reduces sound transmission through the wall. Fiberglass batt insulation or sound-deadening batts are then added to form a continuous, unbroken layer, as shown in Figure 16-33. This is sometimes called a *plumbing wall*. It provides the needed wall thickness for the bell (large end) of a 4" cast-iron soil pipe, which is larger than the thickness of a 2\(\times\)4 stud wall.

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**Figure 16-33 Framing a Plumbing Wall**

**Thick Wall** To create a thick wall, **A**, 2\(\times\)4 studs can be installed sideways on a 2\(\times\)6 plate, or **B**, 2\(\times\)6 studs can be installed as studs.
in Figure 16-34. To further reduce sound transmission, the wall can be covered with sound-resistant drywall (see Chapter 32, “Wall & Ceiling Surfaces”). This type of construction is sometimes called a sound wall. It helps to muffle the sound of water rushing through drain pipes.

Some plumbing fixtures may require extra backing prior to installation. This extra backing is sometimes called blocking. Backing is usually made from short lengths of 2× lumber but in some cases ¾” plywood can be used. This framing is sometimes noted on the plans and if so, it should be installed by the carpenter. Blocking can also be installed by the plumber. See Figure 16-35 in the Step-By-Step Application below for this procedure.

**Step-by-Step Application**

**Blocking for Plumbing Fixtures** Blocking helps to support plumbing fixtures. It should be installed shortly after the walls are framed.

**Step 1** Determine the height of the fixture and mark the location.

**Step 2** Nail a block on the side of the stud. Set it back from the edge a distance equal to the thickness of the backing material.

**Step 3** Cut the backing to fit between the studs and nail it in place. The backing material can also be notched into the studs at the correct height and face-nailed with 10d nails.

Go to glencoe.com for this book’s OLC for additional step-by-step procedures, applications, and certification practice.
One use of blocking might be that where a bathtub is enclosed by walls, support for its edges must be provided. (See Figure, 15-29 page 415.) Backing must also be provided for the shower-arm fitting and for any grab rails that will be installed in the tub area.

Sometimes a hatch will be built on the back of the shower wall. This provides access to the tub drain and overflow riser. Suitable backing should be installed to support the edges of the hatch. Wall-mounted sinks and toilets require special blocking to ensure a secure attachment to the wall.

**Cabinets** Special support and blocking must be provided for inset cabinets that are to fit between studs and be flush with the wall covering. These cabinets are usually designed to be fastened directly to the faces of the studs or to blocking. Backing for nailing the wall covering must be provided at the top and bottom of the cabinets.

Bathroom vanities, kitchen cabinets, and other cabinets must be securely fastened to the wall. A good framing job includes special blocking for this purpose. The location of the blocking can be determined by studying the building plans. One method of blocking for an upper cabinet is shown in Figure 16-36. In some cases it is advisable to install an extra full-length stud or even a 2×6 flat in the wall. This is especially true in kitchens where upper and lower cabinets will be installed.

To install the blocking:

1. Mark on the studs the top and bottom of the cabinets (1).
2. Blocks for attaching the cabinet backing are then fastened between the studs (2). These blocks must be back from the edge of the studs a distance equal to the thickness of the cabinet backing.
3. Mark the position of the cabinet backing onto the blocks (3).
4. Fasten the cabinet backing to the blocks at the location marks (4).

There are other ways to provide support for cabinets. Some carpenters inset ¾” plywood panels into the framing in the area of the cabinetry. Others inset continuous strips of 2× lumber where the top and bottom of the cabinets will be.

**Drywall Blocking** Drywall must be nailed or screwed around the entire perimeter of each sheet. This means that the edges of drywall must fall on solid wood. Though the carpenter does not install the drywall, he or she should know what type of support it needs. Added blocking or even whole studs that support drywall is much easier to install while the framing is being assembled. However, blocking requirements are not typically noted on plans.

**Trim Blocking** The installation of baseboard, chair rail, crown, and other moldings is made easier if blocking is provided for nailing at the ends. Without it, the nails must be driven very near the ends of the molding and usually at a slight angle to reach the corner posts. This often results in splitting the ends of the molding. Blocking, such as
that shown in Figure 16-12 on page 442, will minimize this problem. These small blocks are made from scrap framing stock that would otherwise be discarded. Trim carpenters appreciate this detail but do not often encounter it. Trim backing is often left out at the framing stage unless specifically noted on the plans.

**Heating Ducts** Heating ducts require openings in the ceiling, floor, or wall similar to Figure 16-37. Backing must therefore be provided for fastening the wall-covering material. An opening in the wall larger than the distance between studs requires cutting off one or more studs. It also requires a header to support the bottom end of the shortened stud and serve as a nailing surface for the wall covering.

**Soffits** A **soffit**, sometimes called a **bulkhead**, is a lowered portion of the ceiling. It sometimes contains lighting. More commonly it is used where upper cabinets do not extend to the ceiling, as shown in Figure 16-38. A soffit is usually about 2” deeper than the cabinets, so that molding may be installed at the cabinet top. Some carpenters will assemble a soffit from framing lumber and lift it into place as a unit. Others may install it in place. Whatever the method, the soffit must be level and securely attached to the surrounding framing. This makes cabinet installation easier.

The bottom of the soffit is usually about 84” from the finished floor. It is assembled from 2×2 and 2×4 lumber nailed together with 16d and 10d nails. It should be fastened directly to the wall and ceiling framing. After the wall covering has been applied and painted,
the cabinets are attached to the wall and to the bottom of the soffit. A piece of cove or quarter-round molding may be used to close the joint between the cabinet and the soffit.

**Chases**  A chase is a framed passageway that contains drainage pipes, wiring, or other features that must be concealed. In this respect, it is similar to a soffit. A chase may be vertical or horizontal. It typically does not carry structural loads.

**Fireblocking**

Building codes may require fireblocking in walls that are over 10' high. Fireblocking is meant to slow the passage of flames through wall cavities. It also strengthens the walls. It is made from short lengths of 2× framing lumber installed crosswise between studs. The blocking must be the same width as the surrounding framing and should fit snugly. The blocking can be staggered to make end nailing easier. In standard-height walls, the top and bottom plates are considered sufficient fireblocking.

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**Estimate Sheathing**  A one-story house has four walls and two gables. Two of the walls are 38' long. The other two walls are 50' long. The walls are 10' high. Each gable has a height of 12'. The gables are above the shorter walls. How many sheets of 4’×8’ wall sheathing will be needed? Round to the nearest whole number.

**Starting Hint**  To find the area of a gable, multiply the height of the gable by one-half its width at the bottom. Multiply the result by the number of gables to determine the total gable area.

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**Section 16.4**  **Assessment**

**After You Read: Self-Check**

1. What is a shear wall? When might it be used?
2. Name three types of special framing that might be required in a bathroom.
3. What is the purpose of a cabinet soffit?
4. What is the purpose of fireblocking?

**Academic Integration: Science**

5. **Continuous Blocking**  In cabinet blocking, blocking must be installed between studs in continuous runs. This means that some will have to be toenailed to the studs. To avoid this, some carpenters alternate 2×4 blocks with 2×6 blocks (or 2×6 blocks with 2×8 blocks). First, the narrower blocks are installed in every other stud bay and end-nailed through the studs. Then the wider blocks are installed in the remaining stud bays. The extra width of the second set of blocks allows them to be end-nailed as well. Why is end-nailing used rather than toenailing?

Go to glencoe.com for this book’s OLC to check your answers.
Chapter Summary
Exterior walls are nearly always load-bearing walls. Wall framing members include studs, plates, headers, cripple studs, sills, and trimmer studs. Sheathing may be applied before or after a wall is raised. The spacing and gauge of sheathing fasteners is important for establishing a solid connection.

Wall framing begins with laying out the location of two intersecting exterior walls. Plate layout identifies the location of each stud in a wall, as well as the location of doors and windows.

A story pole is useful as a quick layout reference. Exterior walls are set up, plumbed, and braced before interior walls.

Special framing adds strength and quality to a structure. Special framing is often done after the building is enclosed.

Review Content Vocabulary and Academic Vocabulary
1. Use each of these content vocabulary and academic vocabulary words in a sentence or diagram.

Content Vocabulary
- sheathing (p. 430)
- stud (p. 432)
- plate (p. 432)
- header (p. 432)
- rough sill (p. 434)
- cripple stud (p. 434)
- trimmer stud (p. 434)
- rough opening (RO) (p. 440)
- corner post (p. 441)
- temporary bracing (p. 450)
- soffit (p. 460)

Academic Vocabulary
- primary (p. 432)
- dimensions (p. 457)

Speak Like a Pro
Technical Terms
2. Work with a classmate to define the following terms used in the chapter: load-bearing wall (p. 430), bearing wall (p. 430), partition walls or partitions (p. 430), sole plate (p. 432), double plate (p. 432), lintel (p. 432), trimmer or jack stud (p. 434), by-wall (p. 439), butt-wall (p. 439), schedules (p. 440), partition corner post (p. 442), channel (p. 442), partition-T (p. 442), T-post (p. 442), layout template (p. 442), layout stick (p. 443), baseboard (p. 447), lining the walls (p. 453), shear wall (p. 457), sound wall (p. 458), bulkhead (p. 460).

Review Key Concepts
3. List the components of a framed wall.
4. Summarize how to apply sheathing.
5. Demonstrate how to estimate sheathing materials.
6. List the two main steps in wall layout.
7. Explain how to frame a window.
8. Describe two situations in which special framing might be used.
Critical Thinking

9. Synthesize What special framing techniques, if any, might be required in your local area because of climate or weather? Explain.

Academic and Workplace Applications

10. Measuring Diagonals Find the length of the diagonal of a rectangular floor that measures 24' by 36'. Draw a sketch to help you. Round your answer to the nearest tenth.

A diagonal separates a rectangle into two congruent (identical) right triangles. The lengths of the sides of a right triangle are related according to the Pythagorean theorem, which states that the sum of the square of the altitude and the square of the base of a right triangle equals the square of the hypotenuse. To square a number means to multiply it by itself.

Step 1: Find the sum of the squares of 24' and 36'.

Step 2: Use a calculator to find the square root of that sum.

11. 3-4-5 Rule The 3-4-5 rule relies on proportions, or ratios, to work. The 3-4-5 rule states that if two legs of a triangle measure 3' and 4', they form a 90° angle if the diagonal between the ends of the legs measures exactly 5'. Multiples of these numbers that preserve the 3:4:5 ratio (such as 9, 12, and 15) will also work in a 3-4-5 equation:

\[ 3 \times 3 = 9, \quad 3 \times 4 = 12, \quad 3 \times 5 = 15. \]

Use the 3-4-5 rule to fill in the missing number in the following proportional measurements where the two legs of a right triangle are 21' and the diagonal is 35':

\[ 21 - ? - 35 \]

12. Career Skills: Communicating Information Imagine that you work for a construction company that builds 20 houses each year. You are responsible for quality control. Create a one-page checklist that will help the builders review each set of plans for the special framing requirements. Include a paragraph that summarizes how the checklist will be used.

Short Answer

Directions Answer each question below with a complete sentence.

13. What are the primary wall-framing members?

14. What is a bearing wall?

15. What are three things good wall-framing lumber should be?