Unit 5
Completing the Structure

In this Unit:

Hands-On Math Project Preview

Assembling Resources

After completing this unit, you will you will find a local organization, such as Rebuilding Together, that builds or repairs homes for low-income members of the community. You will also identify the dimensions and materials needed for a rectangular storage shed that could be part of one of the organization's building projects:

Project Checklist

As you read the chapters in this unit, use this checklist to prepare go the unit project:

- ✓ Examine the amount of labor involved in applying vinyl siding.
- ✓ Identify the methods for estimating exterior siding.
- ✓ Think about how the steps in building a shed would be similar building a house.

Go to glencoe.com for this book's OLC. Find the WebQuest activity for Unit 5 called "Construction Specialties."

Construction Careers Glazier

Profile A glazier is responsible for selecting, cutting, installing, replacing, and removing all types of glass. Residential glazing involves replacing glass in home windows, and installing glass mirrors, shower doors, and bathtub enclosures.

Academic Skills and Abilities

- mathematics
- blueprint reading
- geometry
- interpersonal skills
- organization and planning skills

Career Path

- apprenticeship programs
- on-the-job training
- trade and technical school courses
- certification

Go to **glencoe.com** for this book's OLC to find more information about carpentry and construction careers.

Explore the Photo

Different Materials At this stage of construction, the frame has been completed. *What materials other than wood might be used in the next stage?*

CHAPTER 20

Windows & Skylights

Chapter Objectives

After completing this chapter, you will be able to:

- **Describe** the basic types of windows.
- **Identify** the ways in which windows are made energy efficient.
- **Use** a window schedule and a manufacturer's size table.
- **Show** how to install a standard double-glazed or casement window.
- **Calculate** an estimate for the cost of a window.

Discuss the Photo

Work with Others The individuals in the photo can be seen working together to lift the window into the framing. *How is working as a team beneficial to these individuals?*

Writing Activity: Brainstorming

Windows may be installed for a variety of reasons. Different types of houses in various climates make use of very different window styles. Brainstorm the many functions that windows serve. List your ideas.

Olaf Doering/Alamy

Chapter 20 Reading Guide

Before You Read Preview

Windows let light and air into a house and are also an important part of its architectural design. Before reading this chapter, take a few minutes to examine the windows at school and in your home. After you have read the chapter, write one or two sentences describing your findings.

Content Vocabulary

- glazing
- sash
- muntin
- window schedule
- unit dimension
- mullion strips

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.

- sufficient
- technology
- function

Graphic Organizer

As you read, use a chart like the one shown to compare the features of different types of windows.

Type of Window	Sash	Hardware
double-hung	upper and lower	metal sash locks
casement	side-hinged	rotary opener, hinge assembly, sash lock

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

Academic Standards

Mathematics

Problem Solving: Monitor and reflect on the process of mathematical problem solving (NCTM)

Measurement: Apply appropriate techniques, tools, and formulas to determine measurements (NCTM)

English Language Arts

Use written language to communicate effectively (NCTE 4)

Use different writing process elements to communicate effectively (NCTE 5)

Science

Science and Technology: Abilities of technological design (NSES)

Earth and Space Science: Geochemical cycles (NSES)

Physical Science: Interactions of energy and matter (NSES)

Industry Standards

Window Installation

NCTE National Council of Teachers of English
NCTM National Council of Teachers of Mathematics
NSES National Science Education Standards

Section 20.1

Types of Windows & Skylights

Windows

What is glazing?

Windows let light and air into a house. They are also an important part of its architectural design, as shown in **Figure 20-1**. However, 20 to 30 percent of the heat lost from some houses is through the windows. This loss is due to air leaking around the window or by heat being radiated through the glass. In hot climates, cool indoor air can be lost in a similar fashion. As heating and cooling costs have climbed, manufacturers have greatly improved the energy efficiency of windows.

Windows should suit the style of the house. Different rooms within the house, however, will require different sizes and types of windows. For example, bedrooms and living rooms will often require larger windows to allow more light and ventilation. In a bathroom, however, smaller windows will provide greater privacy. Convenient window operation is another important consideration when selecting windows.

Design Requirements

The building code requires that the total area of window glass in a room should be not less than 8 percent of the floor area. This ensures **sufficient** natural light. The total window area that can be opened for ventilation should be not less than 4 percent of the floor area, unless mechanical air conditioning and ventilation are provided. Bathrooms must have no less than 3 sq. ft. of glazing, unless the room is ventilated with a fan. In the kitchen, windows should provide good ventilation of cooking odors.

Figure 20-1 Windows and Style

Many Shapes The style, size, and shape of windows heavily influence the style of the house. *How many different window sizes and shapes do you see in the photo?*

Windows serve an additional and often overlooked purpose. They provide a way for rescuers to enter a room in an emergency. Windows also allow emergency exit from the room, particularly during a fire. According to building codes, every bedroom must have at least one window (or exterior door) that is suitable for *egress*, or emergency escape. It must have the following characteristics:

- Sill height no more than 44" above the floor.
- Height of opening no less than 24".
- Width of opening no less than 20".
- Unblocked open area no less than 5.7 sq. ft., except those on grade floor openings. These must have an open area of no less than 5.0 sq. ft.

(Note: A window with the minimum opening height and the minimum opening width will have an unblocked open area of only 3.3 sq. ft. This will not meet code. However, a window with the minimum opening height that is also 48" wide would have an unblocked open area of 8 sq. ft. That would be acceptable.)

Recall *What is one advantage of installing smaller windows in a bathroom?*

Types of Windows

The basic parts of a window are the glazing, the sash, and the frame, as shown in **Figure 20-2**. **Glazing** refers to the glass portions of a window. The glass within each section of window is also called a *pane* or a *lite*. The **sash** is the part that holds the glazing. The *frame* is the fixed part of the assembly that receives the sash. It consists of a *sill*, *side jambs*, and a *head jamb*.

At one time, the sash and the frame of a window were supplied separately. Today, windows are factory assembled as complete units, sometimes with the exterior casing in place. A completely assembled window unit is sometimes called a *prehung window*. The carpenter installs this entire unit at once instead of installing the frame and sash separately.

There are six major types of windows: *double-hung*, *casement*, *stationary*, *awning*, *hopper*, and *horizontal-sliding* windows. The types that open are shown in **Figure 20-3** on page 578.

Most windows can be fitted with screens to keep insects out when the window is open. Screens used with double-hung, sliding, and hopper windows are installed on the outside of the window. For casement and awning windows that open out, the screen is installed on the inside.

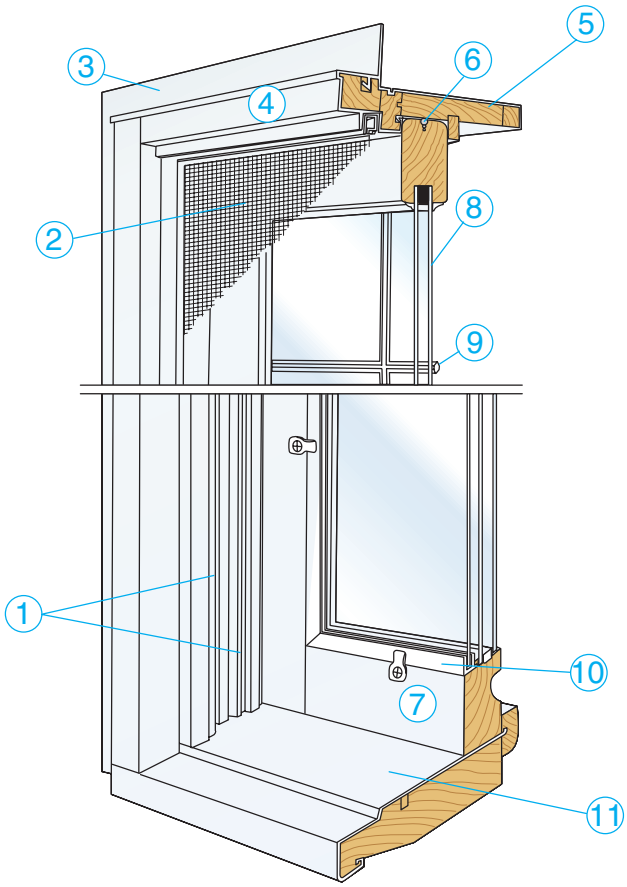


Figure 20-2 Parts of a Window Unit
Window System Parts of an assembled double-hung window: **1.** Tracks **2.** Screen **3.** Mounting flange **4.** Exterior casing **5.** Head jamb **6.** Weatherstripping **7.** Sash **8.** Glazing **9.** Muntins **10.** Removable storm panel **11.** Sill

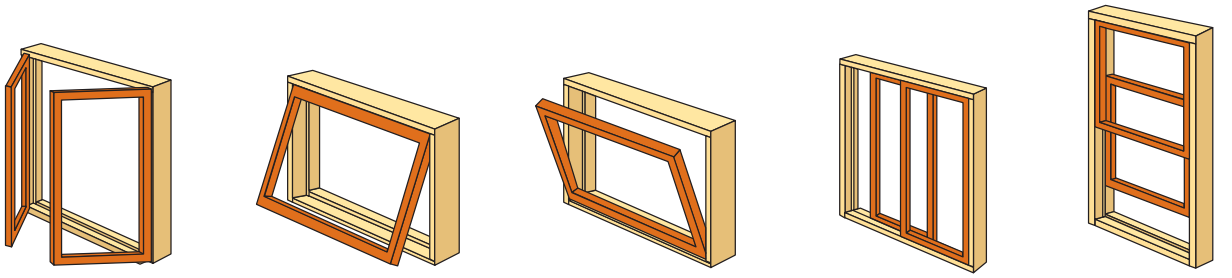


Figure 20-3 Basic Window Styles
Windows That Open There are five basic window styles. Stationary windows do not open and are not shown here.

Double-Hung Windows The *double-hung* window consists of an upper and a lower sash that slide up and down in channels in the side jambs. A *jamb* is an exposed upright member on each side and at the top of the frame. Each sash has springs or balances that hold it in any position. Some types allow the sash to be removed or pivoted away for easy cleaning, painting, or repair. A *single-hung* window is a variation, where the upper sash is fixed in place, and only the lower sash slides up and down. Only half of a double-hung or single-hung window can be opened at one time.

A sash may have muntins. A **muntin** is a vertical or horizontal piece that holds a pane of glass. When glass was first used in houses, only small panes were available. Muntins were used to hold a group of panes together to form a single window. Modern glass **technology** makes very large panes possible. However, muntins are often part of a window's design because they create a traditional appearance. Sometimes the muntins are purely decorative. For example, some manufacturers sell preassembled muntin grids that snap in place over a single lite. Although these are not true muntins, they make it look as if the glass were divided into six or more portions. Grids simplify painting and other maintenance. A window in which the muntins actually hold individual panes is called a *true divided lite* window.

Hardware for a double-hung window includes one or two metal sash locks. When engaged, these locks prevent the sash from being opened from the outside. They also draw the sash together at the meeting rails to reduce air infiltration.

Casement Windows Casement windows have a side-hinged sash that swings inward or outward. An outward-swinging sash does not get in the way of furniture. Also, wind tends to push an outward-swinging sash against the weatherstripping, making a stronger seal. One advantage of the casement window over the double-hung type is that the entire window area can be opened for ventilation. Hardware consists of a rotary opener, a hinge assembly, and a sash lock.

Stationary Windows Stationary windows, also called *fixed-glass windows*, are sometimes

REGIONAL CONCERNS

Storm-Protected Windows Codes in areas with severe storms often require the installation of storm-resistant windows in new construction. These windows have reinforced glazing, reinforced frames, and strengthened locking mechanisms. These features reduce damage caused by wind-borne debris. They also reduce the chance that high winds will pull the window unit out of the framing. Folding or rolling shutters can be installed over the windows to increase protection from damage.

Go to **glencoe.com** for this book's OLC for more information about regional concerns.

Figure 20-4 Fixed and Awning Windows
Two Types of Windows The top row consists of stationary windows. The bottom row consists of stationary windows above smaller awning windows.

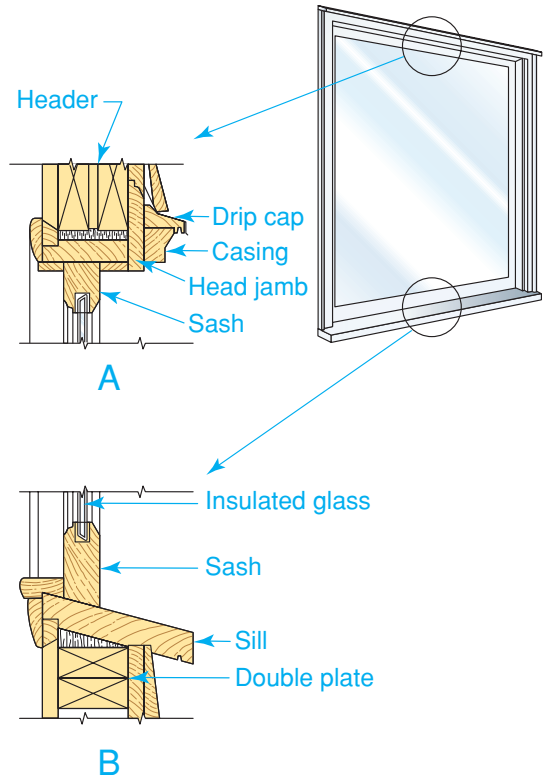


Figure 20-5 Parts of a Stationary Window
Simple Construction This cross section shows the **A.** head jamb area and **B.** the sill area, as well as some of the wall framing.

used alone, but they are more commonly combined with other window types, as shown in **Figure 20-4**. They consist of a single pane of insulated glass fastened permanently into the frame and cannot be opened. Stationary windows can be installed with a sash, as shown in **Figure 20-5**, or without. When they are installed without a sash, the glass is set directly into the frame members and held in place with stops.

Glass block is a type of stationary window, although technically it is not a window at all. Glass block is typically sold by glass manufacturers, not window companies. It is installed by masons, not carpenters, because the individual units are held in place with mortar. However, assemblies of glass block, called *panels*, are often used to serve the same purposes as a window, as shown in **Figure 20-6**. They can be used to admit light in places where transparency and ventilation are not required. It is difficult to break glass block, so the material is also used where security is important.

Figure 20-6 Glass Block
Strong and Private Glass blocks can be used to admit light where ventilation is not required.

Joe Mallon

Awning and Hopper Windows The sash of an *awning* window swings outward at the bottom, as shown in **Figure 20-7**. Awning windows are sometimes grouped in pairs. A *hopper* window is similar to an awning window, except that the sash swings inward at the top. Both types provide protection from rain while open. They are sometimes combined with stationary windows (see Figure 20-4). Hardware includes hinges, pivots, and sash-supporting arms.

Horizontal-Sliding Windows *Horizontal-sliding windows* resemble casement windows in appearance. However, the sashes (in pairs) slide horizontally in separate tracks, or *guides*, located on the sill and head jamb, as shown in **Figure 20-8**.

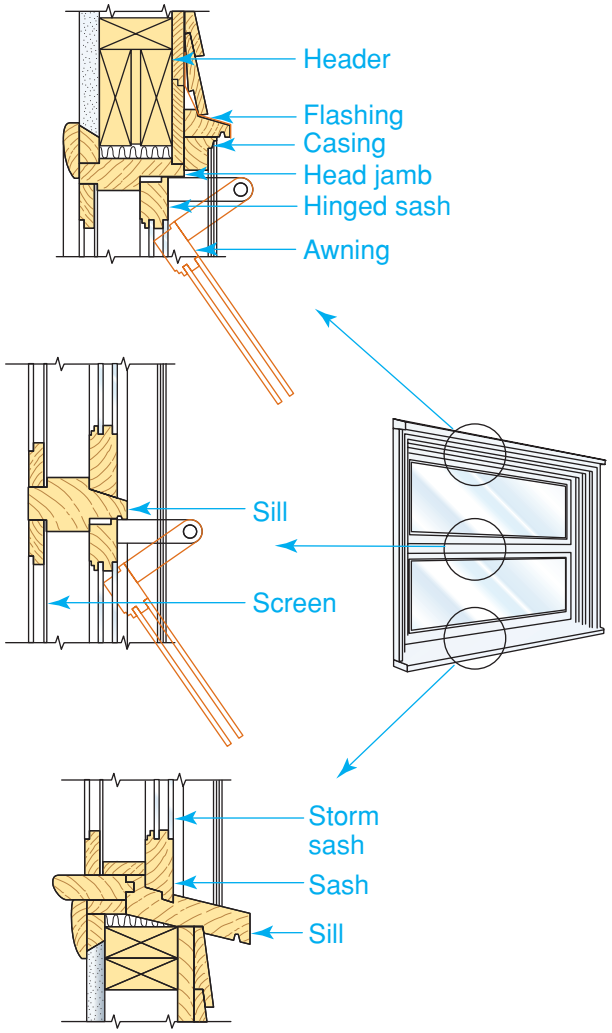


Figure 20-7 Double Awning Window
Good Ventilation Cross section of a double awning window. This features two awning windows combined into a single unit.

Frame & Sash Materials

What does cladding do?

Any of the basic types of windows can have sashes and frames made of wood, metal, vinyl, fiberglass, or wood composites. *Hybrid windows* are a combination of two or more materials.

Wood

Wood window frames and sashes should be made from a clear grade of all-heartwood stock. The wood should be decay-resistant or given a preservative treatment. Species commonly used include ponderosa and other pines, cedar, cypress, and spruce. All

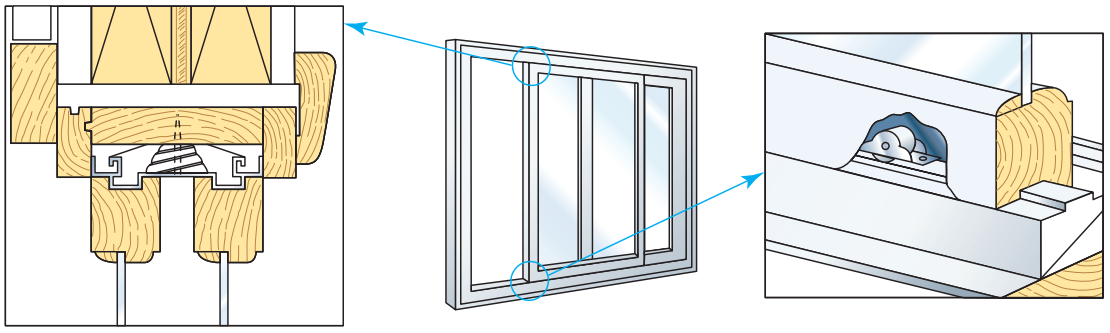


Figure 20-8 Sliding Window
Horizontal Slider The track at the top of the sash is spring loaded. This provides a weathertight seal and also permits lifting the sash out of the window frame. Along the sill, the sash travels on a nylon roller for easy operation.

wood components should also be treated with a water-repellent preservative at the factory.

The wood parts of a *clad-wood window* are covered, or clad, with vinyl or aluminum, as shown in **Figure 20-9**. The wood provides strength, and the cladding protects the wood. This type of wood window never needs painting.

Metal

Metal window frames and sashes are usually made of steel or aluminum. They are generally lighter and less costly than windows made of other materials. Frames and sashes are narrower than those of wood windows. This allows a larger glass area for a given rough opening. Unlike wood windows, metal windows are not subject to insect attack. They are available with a baked-on or anodized finish. Painting is not required.

Aluminum windows are uncommon where winters are cold. This is because heat loss through metal frames and sashes is much greater than through similar wood units. A related problem is that moisture-laden air inside a house can condense on metal surfaces exposed to cold outside air. Windows that have a thermal break reduce these problems. A *thermal break* is a material such as rubber or dense foam insulation that slows the transmission of heat and cold. The most energy-efficient metal windows have two-piece frames separated by a thermal break.

Most metal windows have a nailing flange on all sides. This makes them easy to install. Manufacturer's instructions should be followed carefully. However, the techniques generally follow those required for other flanged windows (see Step-by-Step Application on page 589).

Vinyl, Fiberglass, and Composites

Windows with structural PVC (polyvinyl chloride, or vinyl) sashes and frames are easy to maintain, and they resist heat loss. This material used for windows is sometimes referred to as *uPVC* (unplasticized PVC). This means it does not contain plasticizers, which are thought to be environmentally harmful.

The window in **Figure 20-10** is one example of a PVC unit. The vinyl is colored all the way through, so it does not need painting. It also resists attack by insects. Vinyl window frames have hollow channels beneath the surface. In *insulated vinyl* windows, these cavities are filled with foam insulation for greater energy efficiency.

Window frames can also be made of fiberglass, which is a polyester-based material reinforced with very thin glass strands. Fiberglass window frames can be

Figure 20-9 Clad-Wood Window
Protective Layer A cutaway of a clad-wood window.

Figure 20-10 Structural uPVC Window
uPVC A cutaway view of a structural uPVC window.

Joe Mallon

hollow or insulated, much like vinyl frames, though fiberglass is stiffer and stronger.

Another material used for windows consists of polymers (plastics) mixed with wood particles. This mixture is made into various shapes under pressure. Composites have properties similar to those of solid wood, but are more resistant to decay.

Reading Check

Synthesize *In areas prone to termites, which frame and sash material would be best?*

Energy Efficiency

The energy efficiency of a window depends on more than one component. For example, a window with the most energy-efficient glazing would still be inefficient if faulty weatherstripping allowed heat loss around the sash.

Ratings When choosing windows, compare independent ratings of overall performance. The most accurate ratings consider glazing, weatherstripping, materials, and construction. The National Fenestration Rating Council (NFRC) has developed a window rating system that considers solar heat gain, R-value (a measure of resistance to heat transfer), and air leakage, as shown in **Figure 20-11**. The rating numbers indicate the percentage of heating or cooling energy the window saves compared to an inefficient window with single glazing and an aluminum frame. The higher the number, the greater the savings.

Heat transfer through windows is expressed in U-values, or U-factors. U-values are like the R-values for insulation, except they are reversed. A lower U-value indicates less heat loss or gain and greater insulating performance. Another useful efficiency rating is called the *solar-heat-gain coefficient*, or SHGC. It expresses the amount of solar heat that passes through a window. Its scale goes from 0 (zero), for none, to 1, for 100 percent of available solar heat. Numbers in between are given in decimals, such as 0.55. *Visible transmittance (VT)* is a number that indicates how easy a window is to see through and how well it admits daylight. For example, tinted glass may be rated as 15 percent VT and clear glass as 90 percent VT.

Glazing Most windows installed in new houses contain insulating glass. Sometimes called *double-glazed windows*, they are made with two or more sheets of glass separated

Science: Condensation

Chemical Reactions One problem with using aluminum as a window framing material is its tendency to permit condensation. Explain how moisture-laden air inside a house can lead to condensation on metal window materials such as aluminum.

Starting Hint Condensation is the change of water vapor into liquid water. What would cause this change?

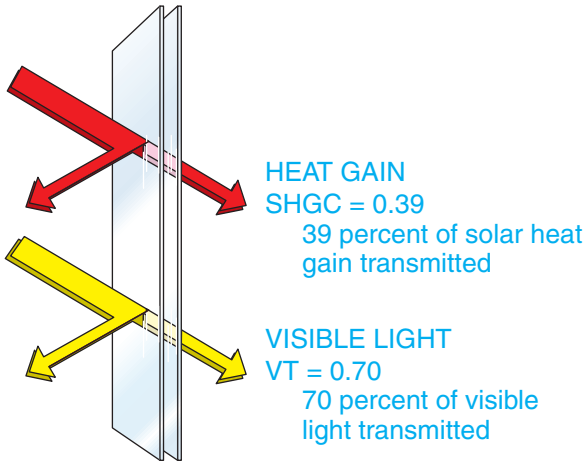


Figure 20-11 High Efficiency Glazing
Managing Heat Transfer Efficiency rating for one type of high-efficiency window glazing. SHGC stands for solar heat gain coefficient, and VT stands for visible light transmittance.

by an air space (see **Figure 20-12**). The edges are sealed to trap the air between the sheets, which provides the insulation. This type of window has more resistance to heat loss than one with a single sheet of glass. Insulating glass is used in both stationary and movable-sash windows.

In very cold climates, windows may even be triple glazed. The added airspace improves the energy efficiency of the window. Because triple-glazing can be expensive, it is important to balance its cost against the energy savings it delivers.

The type of glass used also affects energy performance. The following are available:

Low-e Glazing Many window manufacturers offer low-emissivity, or *low-e*, glazing. *Low-emissivity* means that the glass radiates less heat to the outdoors than regular glass. For one common type, a special coating is applied directly to one of the glass surfaces facing the airspace. This coating reduces energy flow through the glazing by as much as 50 percent. Low-e glass can be useful in both warm and cool climates.

Heat-Absorbing Glazing This type of glass contains special tints (dyes) that enable it to absorb large amounts of solar energy. This is particularly helpful in cool climates.

Gas-Filled Glazing Energy efficiency is improved if the air between double-glazed panes is replaced with a denser gas that insulates better. Colorless gases such as argon and krypton are sometimes used.

Figure 20-12 Insulating Glass Window
Double Glazed A cross section of an insulating glass window.

Low-Conductance Spacers

In the 1960s and 1970s, manufacturers used aluminum spacers to separate the two panes of double-glazed windows. Because aluminum is a good conductor of heat, these windows were not very efficient. Modern double-glazed windows use materials such as silicone foam or thermoplastics. These materials are sometimes referred to as *warm edge spacers.* They conduct less heat and improve the overall efficiency of a window.

Weatherstripping

The main purpose of weatherstripping around a window is to prevent air from leaking between the sash and the frame. Weatherstripping is made of various flexible materials, including foam and fibrous pile. Over time, weatherstripping can lose its effectiveness due to wear. Worn or damaged weatherstripping should be replaced. Weatherstripping should not be painted or stained.

Reading Check

Discuss *What advantage do double-glazed windows offer?*

Skylights

What might make a skylight more energy efficient?

A skylight is essentially a window that is placed in a flat or pitched roof. The purpose of a skylight is primarily to admit natural light into a room, but some skylights can be opened for ventilation.

Skylights come in two basic types: fixed and ventilating. *Fixed skylights* cannot be opened. They are generally less expensive

Doug Wilson

and easier to install. *Ventilating skylights* swing open on hinges. They can allow heated air to escape the house in hot weather. They can also funnel cooling breezes inside. Some units can be fitted with adjustable blinds or shades that can be used to control the amount of light admitted. A ventilating skylight is shown in **Figure 20-13**.

The glazing in a skylight can be either flat glass or plastic that is flat or domed. A skylight with flat glazing is sometimes called a *roof window*. Skylights should be double glazed to reduce heat loss. Some skylights include triple glazing or high-performance glazing with a low-e coating.

Tunnel Skylights In recent years, a new type of skylight has become available. Unlike skylights that offer natural light and ventilation as well a view of the sky, these units, called *tunnel skylights*, have one purpose only: to bring natural light into a room without reducing energy efficiency.

Build It Green The outside portion of a tunnel skylight consists of a clear dome located on the roof, as shown in **Figure 20-14**. The dome is connected to a sealed tubular shaft that passes through the roof system and attic. At the other end of the shaft is a light diffuser mounted flush with the room ceiling. When sunlight enters the dome it is channeled downwards by light-reflecting surfaces on the inside of the shaft. The light is then spread into the room by the diffuser. This type of skylight is energy efficient because the shaft is sealed. Also, by bringing natural daylight into an otherwise dark room, lights do not need to be turned on.

Figure 20-13 Ventilating Skylight
Light and Air This skylight can be opened and closed from below with a telescoping hand crank.

Figure 20-14 Tunnel Skylight
Easy Installation A tunnel skylight captures light and channels it to a room below.

Section 20.1 Assessment

After You Read: Self-Check

1. Why is it important for every bedroom to have at least one window or an exterior door?
2. Name the six basic types of windows.
3. What is a hybrid window?
4. What is the purpose of a tunnel skylight?

Academic Integration: English Language Arts

5. **Persuasive Paragraph** Double- and triple-glazed windows have greatly improved the energy efficiency of modern homes. They have also provided greater flexibility in how homeowners choose to try to regulate indoor temperatures and humidity levels. Write a paragraph to try to persuade homeowners to install double- or triple-glazed windows in their home.

Go to glencoe.com for this book's OLC to check your answers.

Section 20.2 Installing Windows & Skylights

Sizing Windows

How does the work of a framing carpenter affect window installation?

A **window schedule** is a portion of the building plans that contains descriptions of the windows and the sizes for the glass, the sash, and sometimes the rough opening. The location of each window in a house is found by matching the number of the window in the schedule with the corresponding number on the house plan, as shown in **Figure 20-15** on page 586.

The width of a window's jambs must be the same dimension as the thickness of the wall, including the exterior sheathing and the interior finished wall covering. Window jambs are made of nominal 1" or thicker lumber. The sills are made from nominal 2" lumber and are sloped for good drainage. The sash is normally 1¾" thick.

Rough-Opening Sizes

The *rough opening* is the space left in the wall framing to receive a window. It is always larger than the window itself to allow for shimming and ease of installation. Information about the rough-opening sizes for all windows in a house is needed when the walls are framed.

When the dimensions of a window are specified, the width is the first dimension given and the height is the second. The number of lites and the window style may follow or precede these dimensions. For example, consider this specification: 28½" × 24", 2 lites D.H. This means that the glass itself is 28½" wide and 24" high and that there are two pieces of glass in a double-hung unit. Often the term *lite* is abbreviated L.T.

The rough-opening size of a wood window can be figured if the glass size is known. The rough opening should be about

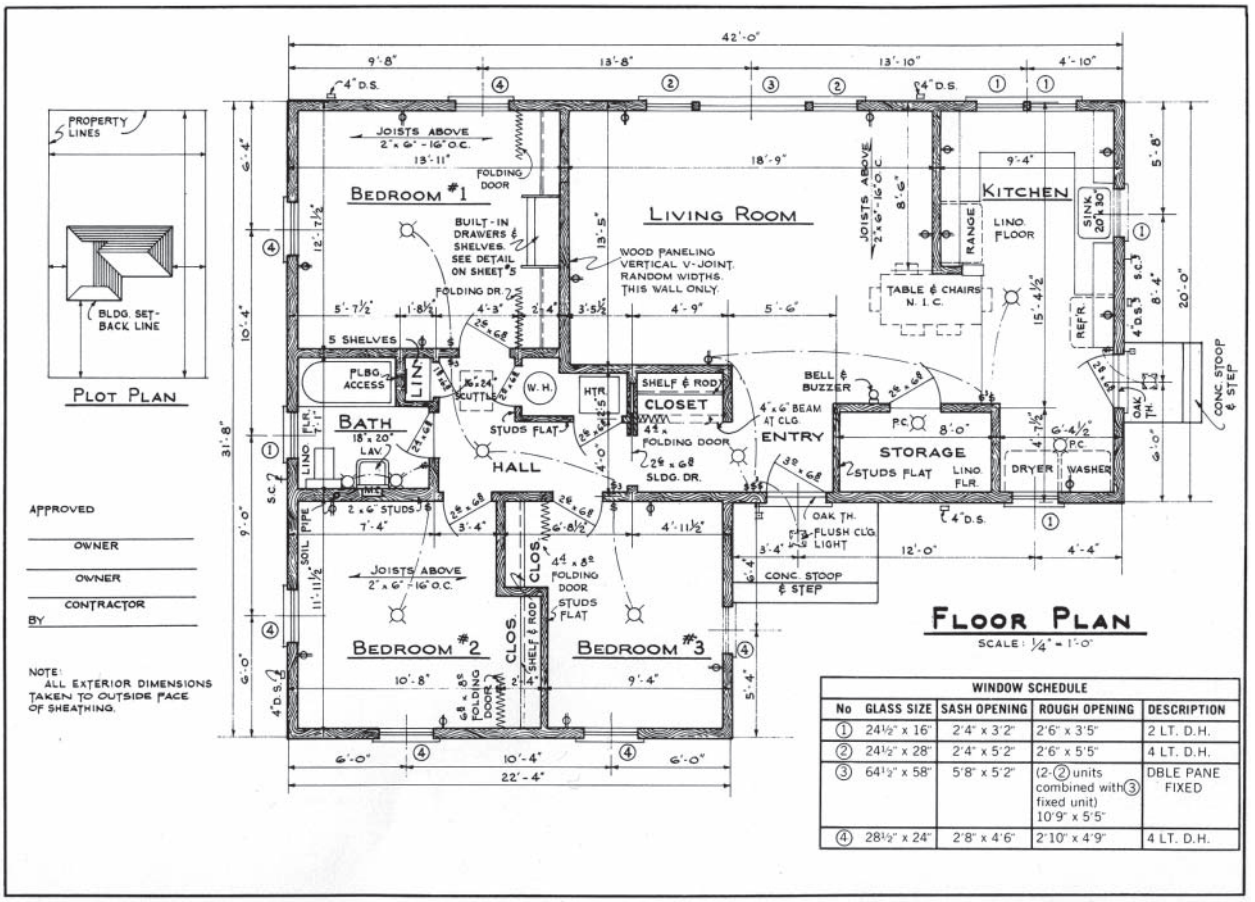


Figure 20-15 Planning for Windows

Determining Locations A house plan, including a basic window schedule. The letters D.H. stand for *double hung.*

6" wider and 10" higher than the window glass size. To figure the rough-opening width for our example, add 6" to the glass width: 28½" + 6" = 34½", or 2'-10½". To obtain the rough-opening height, add the upper and lower glass heights. Then add 10": 24" + 24" + 10" = 58", or 4'-10". These allowances are fairly standard. They provide room for plumbing, squaring, and normal adjustments to the window position. However, when the window manufacturer is known, always use its recommended rough-opening sizes because these will be more precise.

If the rough-opening size is not on the plans, it can be obtained from the window manufacturer's catalog. Sizes vary somewhat among manufacturers. Each catalog contains tables showing four width and height measurements for each window: masonry opening, rough opening, frame size, and glass size. Some may also list the sash size. Refer to **Figure 20-16**. Note the headings in the top left corner:

- *Masonry* refers to the masonry opening. This is the size of the opening that should be used if the house is built using brick or stone.
- *Rough* refers to the rough opening. This is the size that should be used in wood-frame houses with wood, vinyl, or metal siding.
- *Frame* refers to the frame size. This is the measurement of the window from edge to edge, excluding exterior casings. In some cases, the unit dimension may be listed instead of the frame size. The **unit dimension** is the overall size of the window, including casings.

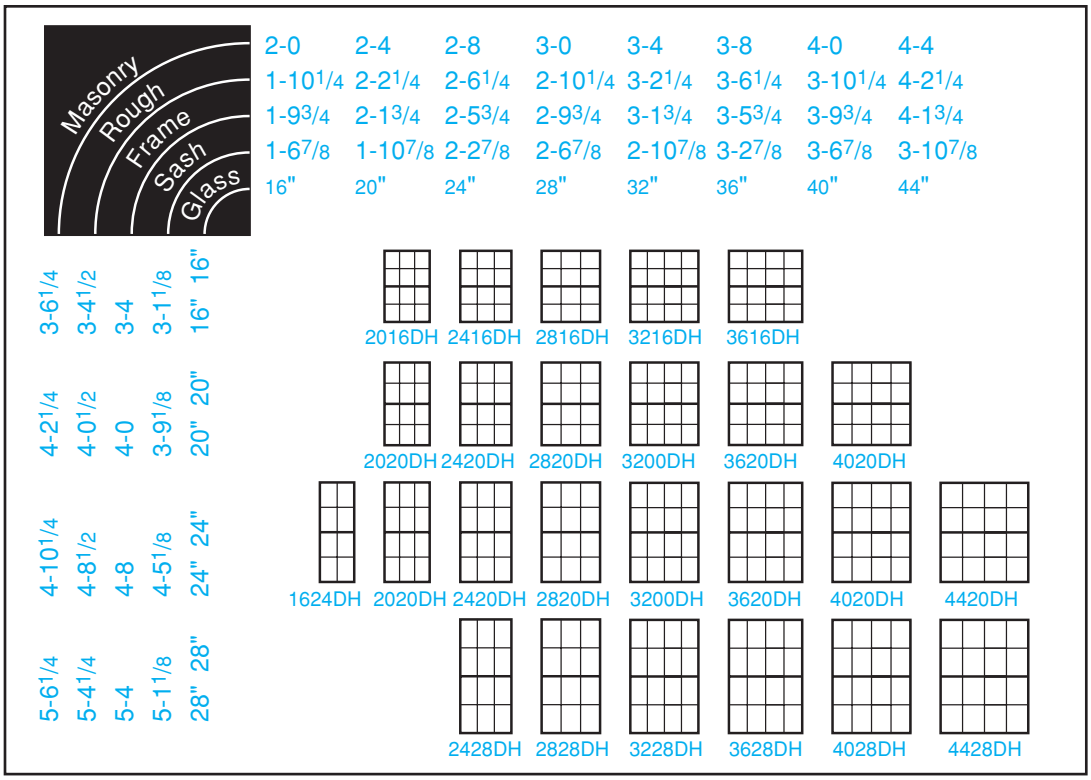


Figure 20-16 Window Size Table
Key Framing Data An example of a manufacturer's size table for double-hung windows.

- *Sash* refers to the actual dimensions of the sash.
- *Glass* refers to the dimensions of the glass, both visible and covered, in a single sash.

Combination Windows

Many times, windows of various styles and sizes are combined to make up a larger unit for a particular room and use. These combined units are separated only by vertical wood pieces called **mullion strips**. Windows grouped in this way are sometimes referred to as *mulled windows.*

The rough opening for a combined unit is smaller than the rough openings for the individual units added together. For example, refer to the house plan in Figure 20-15. Note that the window schedule on the plan calls for a combination window unit in the living room. This unit consists of two No. 2 and one No. 3 window units. It would be important to consult the manufacturer's catalog to find the rough opening for this combined unit.

Installing Windows

Why must windows be plumb?

Careful installation is necessary for a window to function properly. It is also important because an improperly installed window can allow water to seep into the framing. This would eventually cause the framing to rot.

Before installation, apply a coat of primer to all wood portions of the window (including both sides of the jambs). This will increase durability. Do not apply primer to wood portions that will be varnished or similarly sealed later.

Windows are put in after the exterior walls have been sheathed but before the wood, vinyl, or metal siding has been installed. Many windows have an installation flange, often called a *nailing flange,* that makes installation easier. This is shown in **Figure 20-17** on page 588. The flange is either part of the window unit or made of

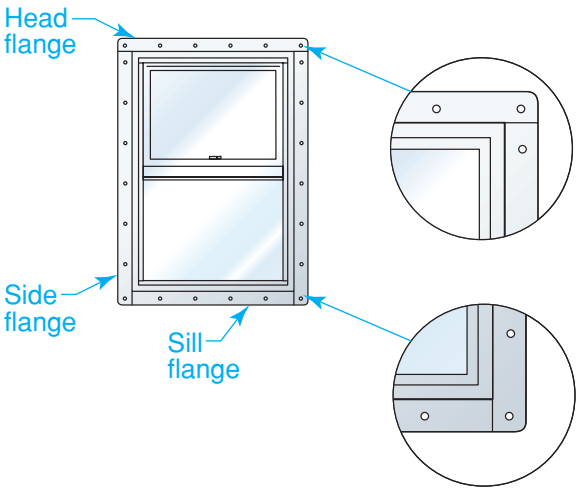


Figure 20-17 Window Installation Flange
Makes Mounting Easy Individual installation flanges on a double-hung window.

separate pieces inserted into grooves in the outer face of the jamb. See page 589 for steps in installing a window.

Standard Windows

Most window frames are installed in the same general way, regardless of style or manufacturer. However, you should always refer to the manufacturer's instructions for recommendations. For example, some manufacturers recommend that the sash be removed from the frame to prevent breakage and to allow for easier handling. Others specify not only that the sash be left in the frame but also that diagonal braces and, in some cases, reinforcing blocks, be left in place. This ensures that the frame remains square and in proper alignment during installation. If the sash is to be left in during installation, make sure the locks are engaged.

Another difference concerns the method for adding flashing to a window. The traditional technique is to use 8" wide splines of 15 lb. building paper. The bottom spline is installed first, then the sides, then the top piece. These are overlapped and stapled around the opening before the window is installed. However, many builders are now using strips of flexible, self-adhesive flashing instead. These strips are made of either butyl rubber or modified bitumen (*rubberized asphalt*). Check with the window supplier to see which method is recommended.

Once windows have been installed, they are surrounded with wood *trim* on the outside of the house and wood *casing* on the inside. For more on this subject see Chapter 26, "Molding & Trim."

Builder's Tip

BRICK MOLDING During the manufacture of some windows, thick wood molding is permanently attached to the outer edges of the jambs. This molding is called *brick mold* or *brick molding*. Depending on the type of window, brick mold sometimes serves as a nailing flange, particularly on wood frame windows. Casing nails may be driven through the brick mold and into the sheathing. Later, siding will be installed so that it butts up to the outer edges of the brick mold.

Windows in Masonry Walls

Window manufacturers specify methods for installing their windows into masonry walls, such as those of brick veneer. A common method is to replace the installation flanges on the windows with metal jamb clips, as shown in **Figure 20-18**. The clips are screwed to the

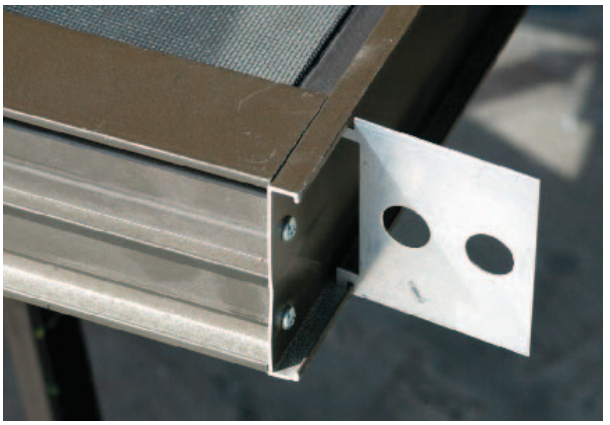


Figure 20-18 Jamb Clips
Masonry Connection Metal jamb clips allow windows to be installed in a masonry wall.

Tim Fuller

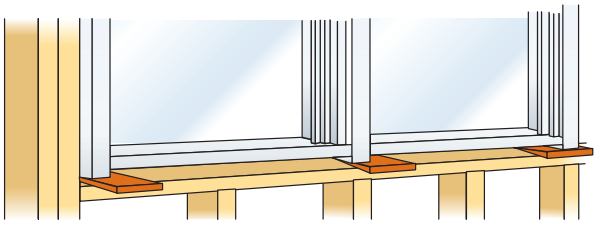
Step-by-Step Application

Installing a Flanged Window Window installation is a two- or three-person job. One installer works inside the house, while the others work outside. Always follow the window manufacturer's installation instructions, otherwise the manufacturer's warranty may be void. The following method assumes that housewrap (see Chapter 16) has already been installed over the sheathing.

Step 1 Prepare the window. Inspect the sash and frame for damage. If nailing flanges are separate pieces, insert them into their grooves on the window. Tap them into place with a wood block and hammer. The head flange should overlap the side flanges. The side flanges should overlap the sill flange.

Step 2 Cut the housewrap so the window can be placed in the rough opening. There should be a horizontal cut at the head jamb. Then slip the top flange of the window under the resulting flap. If there is no housewrap in place, some builders staple lengths of felt paper (9" to 12" wide) to the sheathing around the opening. These are called splines. The upper splines must overlap those that are lower. This helps to drain any moisture that might later get behind the siding.

Step 3 Insert the window. Large or heavy windows should be lifted by at least two people. Place the frame in the opening from the outside, allowing the subsill to rest in the rough opening. Hold the window in place against the sheathing. Center it from side to side in the opening.



Step 4 Level the window sill by inserting blocks or tapered shims beneath it from inside the house. Place the shims or blocks under the legs near the corners of the window and at the center, as shown in the figure below. Check the window for plumb.

Step 5 When the window is plumb and level, nail through a flange at one corner, using a 1¾" roofing nail. Check the window again to be sure it is plumb and level. Check it for squareness by measuring diagonally across the corners. If the two measurements are the same, the window is square. If the window is not square, shim the side jambs as needed. Then recheck plumb and level. Measure across the window at the top, bottom, and center. Measurements should be equal.

Step 6 Nail each corner of the installation flange to secure the window. Check the window for easy operation. Then nail the entire perimeter of the installation flange. Space roofing nails every 6" to 8" or as recommended by the manufacturer. Remove any remaining packing on the window unit.

Step 7 From inside, fill gaps between the jamb and the framing with expanding foam sealant. Do not use too much insulation or the jambs will bow inward, and the window will not open properly.

Go to **glencoe.com** for this book's OLC for additional step-by-step procedures, applications, and certification practice.

window jambs. They are then nailed into furring strips or connected directly to masonry fasteners. There should be at least ½" clearance from the top of the masonry to the bottom of the sill, as shown in **Figure 20-19** on page 590.

Basement Windows

Basement window units are made of wood, plastic, or metal. In most cases, the sash is removed from the frame. The frame is set into the concrete forms for a poured wall. The wall is poured with the window frame in place. If the windows are to be set into a concrete block wall, special blocks are placed around the frame that accommodate the various frame types. The windowsills are usually installed after the basement floor framing is constructed.

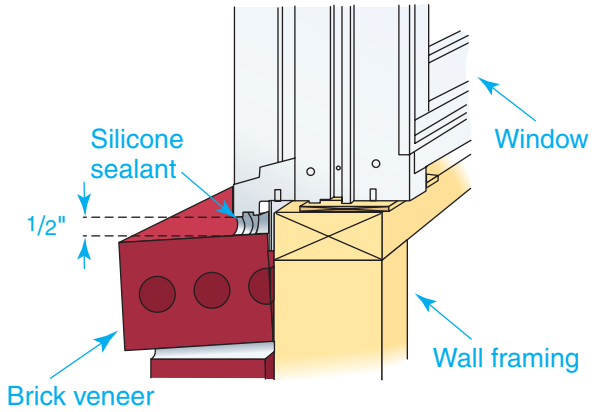


Figure 20-19 Installation Clearance
Gap Sealant Window installation in brick-veneer construction.

Installing Skylights

Why are skylights more likely to leak than windows?

Some skylights are complete units, ready to set into the roof. Others must rest on a lumber curb that lifts them above the level of the roof, as shown in **Figure 20-20**.

Because skylights are often high in a ceiling, they can be fitted with small motors that open and close them. The motors are controlled electronically from below. Rough wiring is put in before finished wall and ceiling surfaces are installed. Skylights without motors can be opened and closed with long poles or cranks.

Skylight Flashing Because skylights are located on roofs, they require a heavier duty flashing to prevent leaks than windows do (see **Figure 20-21**). Great care must be taken to ensure this flashing is installed properly. The most durable flashing is made of copper, but aluminum flashing is more commonly used because it is much less expensive.

There are two methods of installing skylight flashing. *Step flashing* consists of small pieces of L-shaped metal that are interwoven with the roof shingles, as shown in **Figure 20-22**. The other option is *pan flashing*, where a one-piece metal assembly called a *pan* fits over the skylight curb, as in **Figure 20-23**. The pan must be fabricated by a sheet metal shop for a specific size of skylight. After pan flashing is in place, the roof shingles are installed. It is also possible to install a skylight in a tile roof. In such cases, flexible lead step flashing is often used.

Estimating Costs

The cost of an individual window unit depends on its quality, style, glass type, frame material, and any factory-applied finish. To determine an accurate cost, a complete list

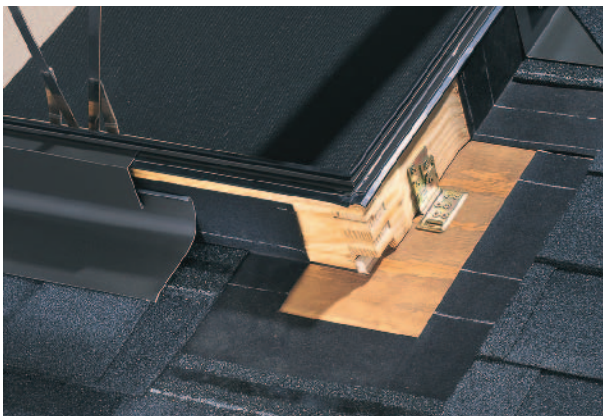


Figure 20-20 Curb-Type Skylight
Properly Flashed Some skylights rest on a wood curb. The curb may be supplied by the skylight manufacturer, as shown here, or it may be constructed on site from 2×6 lumber.

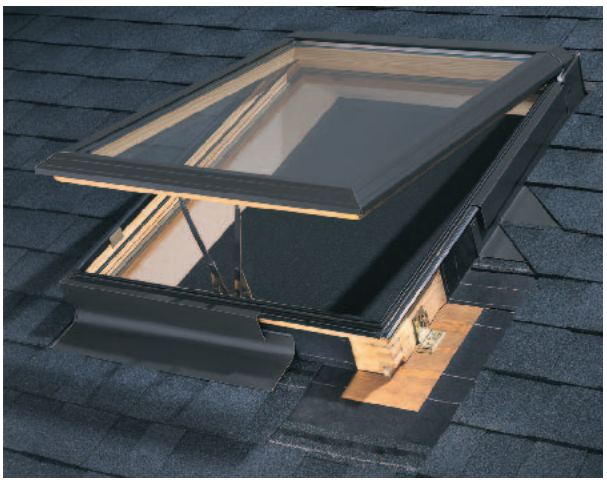


Figure 20-21 Skylight Flashing
Ventilating Skylight Note that the flashing extends over the shingles below the skylight.

Courtesy of Velux Corp.

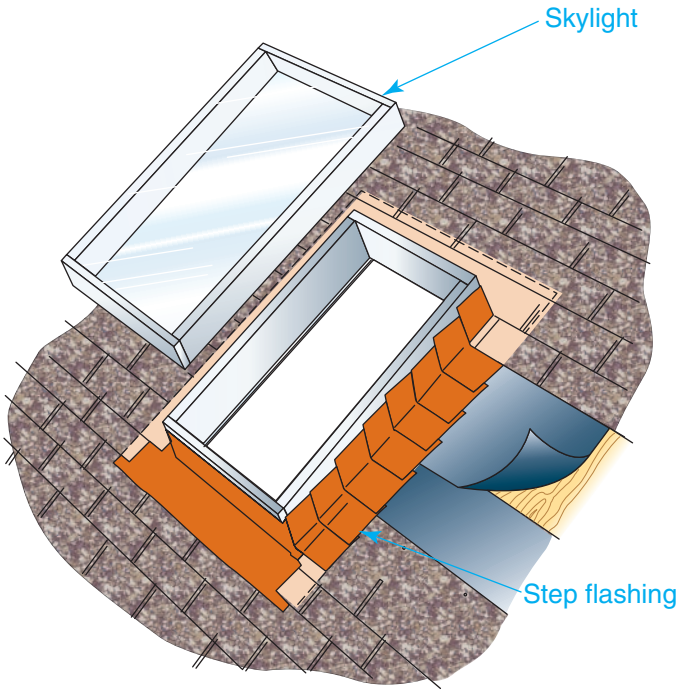


Figure 20-22 Step Flashing
Many Pieces Like shingles, each piece of step flashing overlaps another to shed water.

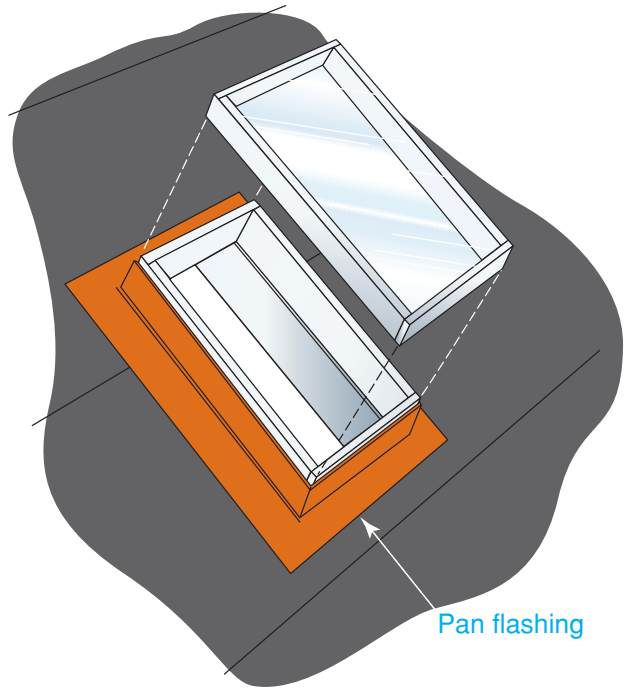


Figure 20-23 Pan Flashing
One Piece Seams in pan flashing should be soldered to prevent leakage.

of the windows should be submitted to the supplier for pricing.

The labor required for installing and setting windows depends on their size and style. The approximate time can be estimated as follows based on window glass size:

- Up to 10 sq. ft. of glass area: 1 hr.
- Up to 20 sq. ft. of glass area: 1½ hrs.
- Over 20 sq. ft. of glass area: 2 hrs.

These estimates include only the preparation of the opening and the actual installation of the window unit. They do not include installation of interior trim.

Section 20.2 Assessment

After You Read: Self-Check

1. Name two places where you can find dimensions for the rough opening of a window.
2. Describe the two types of installation flange.
3. Describe the traditional technique for adding flashing to a window.
4. Describe the difference between step flashing and pan flashing for skylights.

Academic Integration: Mathematics

5. **Problem Solving** Reno's Replacement Window Co. charges $50 per hour to install replacement windows. Figure the labor cost of installing four windows with a glass size of 30" by 48" windows, four windows with a glass size of 36" by 48", and two windows with a glass size of 72" by 48".

Go to glencoe.com for this book's OLC to check your answers.

CHAPTER 20

Review and Assessment

Chapter Summary

Section 20.1

A single house has various types and sizes of windows. The six basic types include double-hung, casement, stationary, awning, hopper, and horizontal-sliding windows. The energy efficiency of a window depends on glazing, weatherstripping, materials, construction, and other features.

Section 20.2

A window schedule gives important specifications. Window installation requires two or more people. The care with which a window and its flashing are installed has a large impact on its ability to prevent air and water leaks.

Review Content Vocabulary and Academic Vocabulary

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

Content Vocabulary

- glazing (p. 577)
- sash (p. 577)
- muntin (p. 578)
- window schedule (p. 585)
- unit dimension (p. 586)
- mullion strips (p. 587)

Academic Vocabulary

- sufficient (p. 576)
- technology (p. 578)

Speak Like a Pro

Technical Terms

2. Work with a classmate to define the following terms used in the chapter: *egress* (p. 577), *lite* (p. 577), *frame* (p. 577), *prehung window* (p. 577), *double-hung* (p. 578), *jamb* (p. 578), *single-hung* (p. 578), *true divided lite* (p. 578), *fixed-glass windows* (p. 578), *glass block* (p. 579), *panels* (p. 579), *awning* (p. 580), *hopper* (p. 580), *guides* (p. 580), *hybrid windows* (p. 580), *thermal break* (p. 581), *solar-heat-gain coefficient* (p. 582), *visual transmittance (VT)* (p. 582), *double-glazed windows* (p. 582), *low-emissivity* (p. 583), *warm edge spacers* (p. 583), *roof window* (p. 584), *rough opening* (p. 585), *nailing flange* (p. 587).

Review Key Concepts

3. List the types of windows used in residential construction.

4. Explain how windows are made energy efficient.

5. Describe how a window schedule and a manufacturer's size table are read.

6. Demonstrate how a standard double-glazed or casement window is installed.

7. Show how window costs are estimated.

Critical Thinking

8. Analyze With safety in mind, state which of the five basic window styles would be the least accessible for rescuers. Explain your reasoning.

9. Explain Which type of window material would you not recommend to an individual installing windows in cold climates? Explain your recommendation.

Academic and Workplace Applications

STEM Mathematics

10. Window Measurements The only window in a second-floor bedroom has a height of 24 inches. If building codes require an unblocked open area of 5.7 square feet, what is the minimum width of the window? Express your answer in inches. Round up to the nearest whole inch.

Math Concept Computing with measurements should be done using equivalent units of measure.

Step 1: To convert 5.7 square feet to square inches, multiply by the number of square inches in one square foot.

Step 2: Divide the total area in inches by the height of the window.

Step 3: Round up the quotient to the nearest whole inch.

STEM Technology

11. Energy Efficiency It is estimated that 20 to 30 percent of the heat lost from some houses is through the windows. This loss is due to air leaking around the window or by heat being radiated through the glass. As heating and cooling costs have climbed, manufacturers have greatly improved the energy efficiency of windows. Double- and triple-glazed windows are one example of technological advances that have lead to more efficient windows. Research the technological advances that have made double-glazed windows more efficient. Write a paragraph summarizing your findings.

21st Century Skills

12. Collaboration Working in groups of 3 or 4, use the diagram your instructor has handed out to label the parts of an assembled double-hung window. Discuss the diagram with your team members and correct any errors. Finally, elect a representative from your team to present your diagram to the class.

Standardized TEST Practice

CERTIFICATION PREP

Multiple Choice

Directions Choose the phrase or word that best answers the following questions.

13. Which type of window has a side-hinged sash that swings inward or outward?

a. stationary window
b. double-hung window
c. casement window
d. hopper window

14. Generally, the total area of window glass in a room should be no less than what percent of the floor area?

a. 10
b. 8
c. 3
d. 15

15. What term is used to describe a short vertical or horizontal piece of wood used to hold a pane of glass?

a. mullion strip
b. screen
c. sash
d. muntin

TEST-TAKING TIP

When answering multiple-choice questions, ask yourself if each option is true or false. This may help you find the best answer.

*These questions will help you practice for national certification assessment.