LESSON 2.9

Use Theorems About Angles

CAREER SPOTLIGHT: Carpenter

Occupation Description

Carpenters construct, repair, and install building frameworks and structures made from wood and other materials.

Carpenters have many different tasks. Some carpenters insulate office buildings; others install drywall or kitchen cabinets in homes. Still others focus on production or commercial work to help construct tall buildings or bridges. These carpenters also erect shoring and scaffolding for buildings.

Education

Carpenters typically need a high school diploma and learn on the job or through apprenticeships. Certain high school courses, such as mathematics and mechanical drawing, may be useful. Some vocational-technical schools offer associate's degrees in carpentry. The programs vary in length and teach basics and specialties in carpentry.

Potential Employers

The largest employers of carpenters are as follows:

Self-employed workers	27%
Residential building construction	22%
Nonresidential building construction	13%
Building finishing contractors	12%
Foundation, structure, and building exterior contractors	10%

Watch a video about carpenters:
https://cdn.careeronestop.org/OccVids/OccupationVideos/47-2031.00.mp4

Career Cluster
Architecture & Construction

Career Pathway
Construction

Career Outlook

- Salary Projections:
  Low-End Salary, $30,170
  Median Salary, $48,330
  High-End Salary, $84,690
- Jobs in 2018: 1,006,500
- Job Projections for 2028: 1,086,600 (increase of 8%)

Geometry Concept

- Apply theorems about angles.

Is this a good career for me?

Carpenters:

- Follow blueprints and building plans to meet the needs of clients.
- Measure, cut, and shape wood, plastic, and other materials.
- Construct and install building frameworks, including walls, floors, and doorframes.
- Instruct and direct laborers and other construction helpers.
- Install structures and fixtures, such as windows and molding.
- Inspect and replace damaged framework or other structures and fixtures.

Photo credit: Pikselstock/Shutterstock.com

Lesson Objective

In this lesson, you will look at how a carpenter applies theorems about angles to carpentry tasks such as framing buildings and building furniture.

Definitions

Angles that have the same angle measure are **congruent angles**.

A **linear pair** are two adjacent angles formed by intersecting lines.

Vertical angles are opposite angles formed by intersecting lines.

A pair of angles are **complementary** if the sum of the angle measures is 90°.

A pair of angles are **supplementary** if the sum of the angle measures is 180°.

Theorems

Linear Pair Postulate: Two angles that form a linear pair are supplementary.

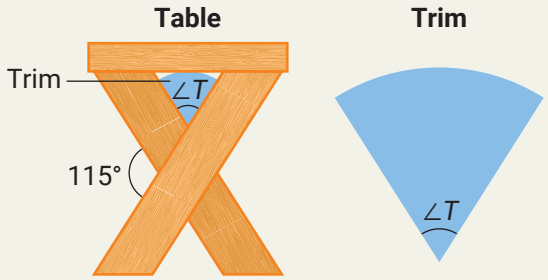
Vertical Angles Theorem: Vertical angles are congruent.

Congruent Complements Theorem: If two angles are complements to the same angle (or congruent angles), then the two angles are congruent.

Congruent Supplements Theorem: If two angles are supplements to the same angle (or congruent angles), then the two angles are congruent.

1 Step Into the Career: Linear Pair Postulate

A carpenter is building coffee tables with crossed legs and decorative trim. One version is shown. What is the angle measure that the carpenter should cut the bottom angle of the trim, $\angle T$, so that it fits with no gaps?



Devise a Plan

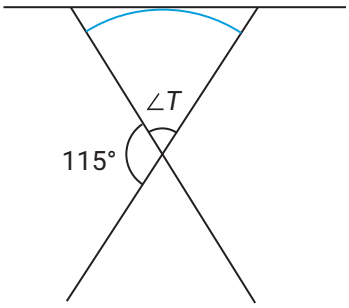
Step 1: Model the table legs with a pair of intersecting lines.

Step 2: Identify the type of angles formed by the 115° angle and $\angle T$.

Step 3: Write an equation to describe the connection between the 115° angle and $\angle T$.

Step 4: Solve for $m\angle T$.

Walk Through the Solution



Step 1: Model the table legs with a pair of intersecting lines, as shown.

Step 2: The 115° angle and $\angle T$ are adjacent angles formed by intersecting lines. They are a linear pair.

Step 3: By the Linear Pair Postulate, the angles are supplementary. The sum of the measures of the 115° angle and $\angle T$ is 180°.

$$115° + m\angle T = 180°$$

Step 4: Solve for $m\angle T$.

$$115° + m\angle T = 180°$$

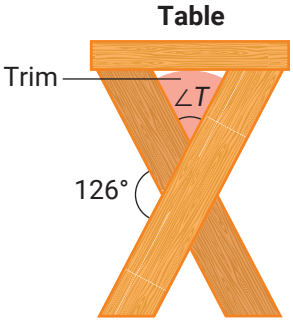
$$m\angle T = 180° - 115°$$

$$m\angle T = 65°$$

The carpenter should cut the trim piece so that $m\angle T$ is 65°.

On the Job: Apply The Linear Pair Postulate

1. A carpenter building coffee tables has decorative trim cut to various angles.



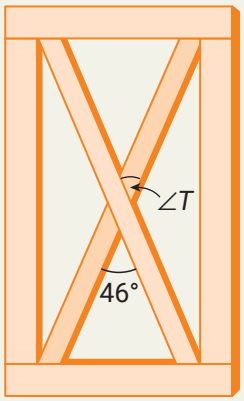
a. Will decorative trim cut with an angle of 57° fit the table shown?

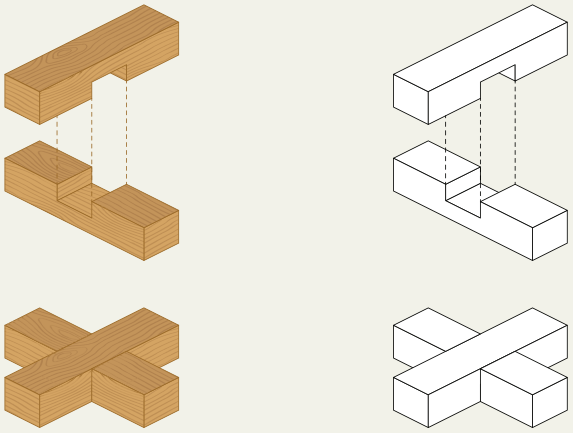
b. If the trim cut to an angle of 57° does not fit the table shown, what angle measure should the carpenter cut the angle of the trim, $\angle T$, so that it fits with no gaps?

2 Step Into the Career: Vertical Angles Theorem

A carpenter is building a shelving unit with additional support on each side provided by two boards that are connected with edge cross lap joints, as shown.

What is the measure of $\angle T$ that the carpenter should cut the notch in the board?





In edge cross lap joints, matching notches are cut in the two boards so that they fit together snugly.

Devise a Plan

Step 1: Model the two boards with a pair of intersecting lines.

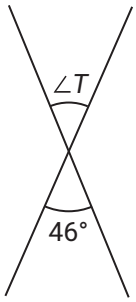
Step 2: Identify the type of angles formed by the 46° angle and $\angle T$.

Step 3: Identify the relationship between the 46° angle and $\angle T$.

Step 4: Find the measure of $\angle T$.

Walk Through the Solution

Step 1: Model the two boards with a pair of intersecting lines as shown.



Step 2: The 46° angle and $\angle T$ are opposite angles formed by intersecting lines. They are vertical angles.

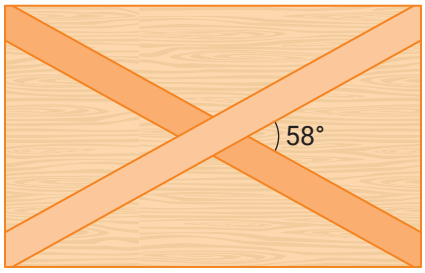
Step 3: By the Vertical Angles Theorem, vertical angles formed by intersecting lines are congruent.

Step 4: Since $\angle T$ and the 46° angle are congruent angles, $m\angle T = 46°$ by the definition of congruent angles.

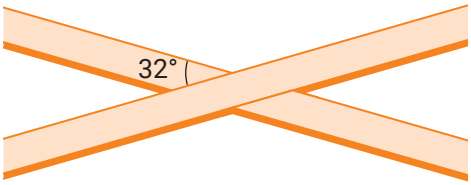
The carpenter should cut the notch with a 46° angle.

On the Job: Apply The Vertical Angles Theorem

2. A carpenter's apprentice has cut notches into several boards for edge cross lap joints to go on the sides of the box shown.



a. If the apprentice cut the boards using the angle shown at the right, do the boards work for the box?

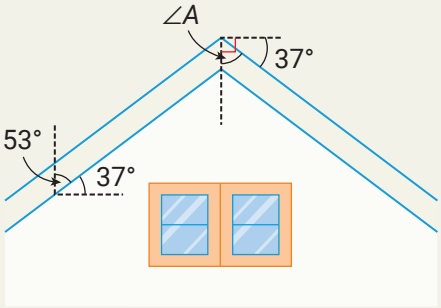


b. If the boards that the apprentice cut do not fit on sides of the box, what angle measure should have been used for the notches?

c. Can you identify the error that the apprentice made when calculating the angle that should be used?

3 Step Into the Career: Congruent Complements Theorem

A carpenter is framing the roof of a house where the pitch of the roof is 37°, as shown. What angle measure should be used for $\angle A$?



Devise a Plan

There are two 37° angles, a 53° angle, and $\angle A$ involved.

Step 1: Identify the relationship between the 37° angle and the 53° angle.

Step 2: Identify the relationship between the 37° angle and $\angle A$.

Step 3: Identify the relationship between the 53° angle and $\angle A$.

Step 4: Find $m\angle A$.

Walk Through the Solution

Step 1: Since 37 + 53 = 90, the 37° angle and the 53° angle form a right angle. They are complementary angles.

Step 2: The diagram shows that $\angle A$ and the 37° angle form a right angle, so they are complementary angles.

Step 3: From Steps 1 and 2, $\angle A$ and the 53° angle are both complements of 37° angles. By the Congruent Complements Theorem, two angles that are complements of the same angle (or congruent angles) are congruent.

Step 4: Since $\angle A$ is congruent to the 53° angle, $m\angle A$ is 53°.

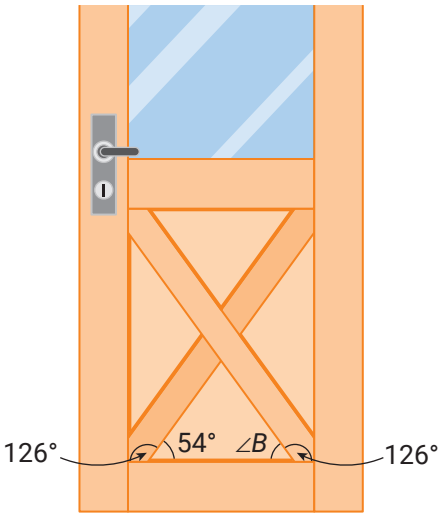
On the Job: Apply The Congruent Supplements Theorem

3. A carpenter is repairing a wooden door and needs to replace a triangular panel. What angle measure should be used for $\angle B$?

a. What is the relationship between a 54° angle and a 126° angle?

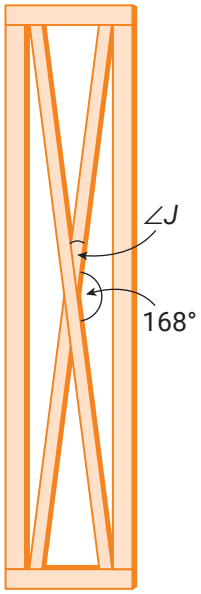
b. What is the relationship between $\angle B$ and the adjacent 126° angle?

c. What is $m\angle B$?



Career Spotlight: Practice

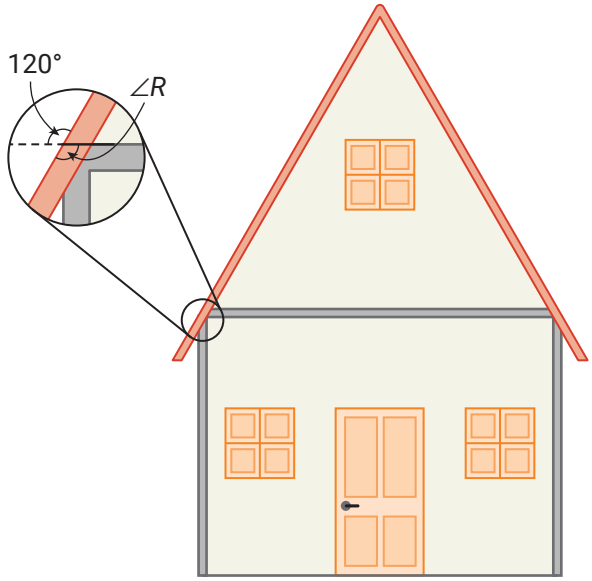
4. A carpenter is using an edge cross lap joint to create an X-shaped brace for the side of a bookcase. What angle measure should the carpenter use for $\angle J$ so that the boards fit together with no gaps?



5. A carpenter needs rafter ties to frame a very steep roof. The outside line of the roof makes a 120° angle with a horizontal line. What is the measure of $\angle R$?

QUICK TIP

Rafter ties are horizontal pieces that connect two sides of a roof.



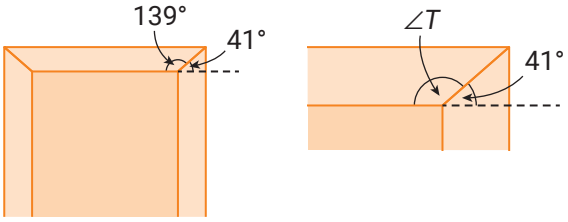
Devise a Plan

Step 1: Determine the relationship between the 120° angle and $\angle R$.

Step 2: _____?_____.

Step 3: _____?_____.

6. A carpenter needs to replace the trim above a doorway where the top trim and the side trim are different widths. The angles measured are shown.



a. What is the relationship between the 139° angle and the 41° angle shown on the left?

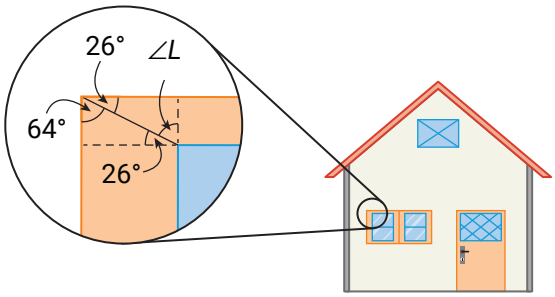
b. What is the relationship between the 41° angle and $\angle T$ shown on the right?

c. What relationship can you find between the 139° angle and $\angle T$?

d. What is $m\angle T$?

Career Spotlight: Check

7. A carpenter is working on a house. For the shutters on the lower window, the side frame needs to be wider than the top frame so that the shutters can be supported by the side frame.



Select the answer from each box that makes the sentence true.

The 26° angle and the 64° angle are

a. supplementary angles
b. complementary angles
c. a linear pair

. ∠*L* and the 26° angle are

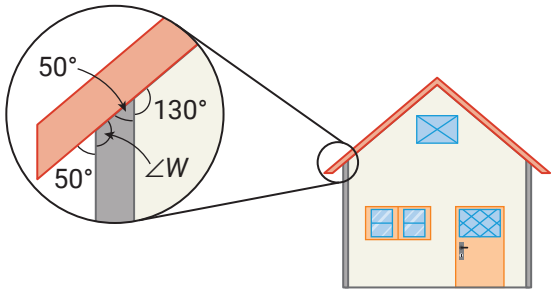
a. supplementary angles
b. complementary angles
c. a linear pair

. The measure of ∠*L* is

a. 26°
b. 64°
c. 116°

.

8. A carpenter is working on a house. The roof and the outer walls meet to form several angles.



What is $m\angle W$, and what theorem could you use to determine this?

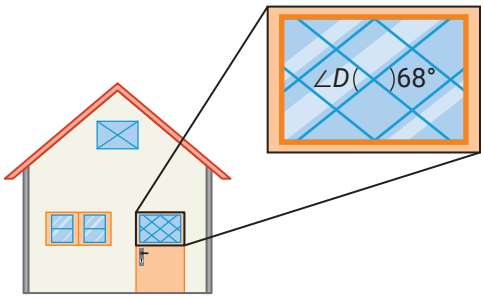
A. $m\angle W = 50°$, Congruent Supplements Theorem

B. $m\angle W = 130°$, Congruent Complements Theorem

C. $m\angle W = 50°$, Congruent Complements Theorem

D. $m\angle W = 130°$, Congruent Supplements Theorem

9. A carpenter is working on a house. The window in the door features framing that creates many angles.



Select all the statements that are true.

a. $m\angle D = 112°$

b. $\angle D$ and the angle labeled 68° are supplementary angles.

c. $m\angle D = 68°$

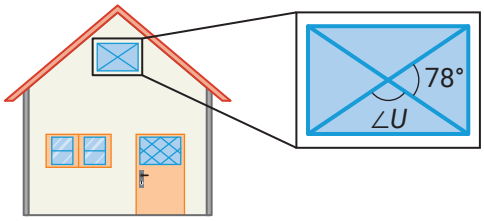
d. $\angle D$ and the angle labeled 68° are complementary angles.

e. $\angle D$ and the angle labeled 68° are vertical angles.

f. $m\angle D = 22°$

g. $\angle D$ and the angle labeled 68° are a linear pair of angles.

10. A carpenter is working on a house. The upper window has a frame that creates angles.



Select all the statements that are true.

a. $m\angle U = 102°$

b. $\angle U$ and the angle labeled 78° are supplementary angles.

c. $m\angle U = 78°$

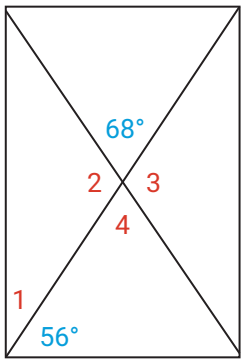
d. $\angle U$ and the angle labeled 78° are complementary angles.

e. $\angle U$ and the angle labeled 78° are vertical angles.

f. $m\angle U = 12°$

g. $\angle U$ and the angle labeled 78° are a linear pair of angles.

11. A carpenter is building a door with an X panel like the one shown. The panel is modeled by the diagram. The panel is a rectangle, so the corners are right angles. Use the diagram to find the measures of the numbered angles.



Match each angle with the correct angle measure.

	34°	56°	68°	112°
∠1	☐	☐	☐	☐
∠2	☐	☐	☐	☐
∠3	☐	☐	☐	☐
∠4	☐	☐	☐	☐