Getting Ready to Teach Unit 8

Learning Path in the Common Core Standards

Unit 8 broadens students' understanding of plane geometric figures including points, lines, line segments, rays, angles, and polygons. Students learn how to measure angles using a protractor and sort and classify angles and triangles.

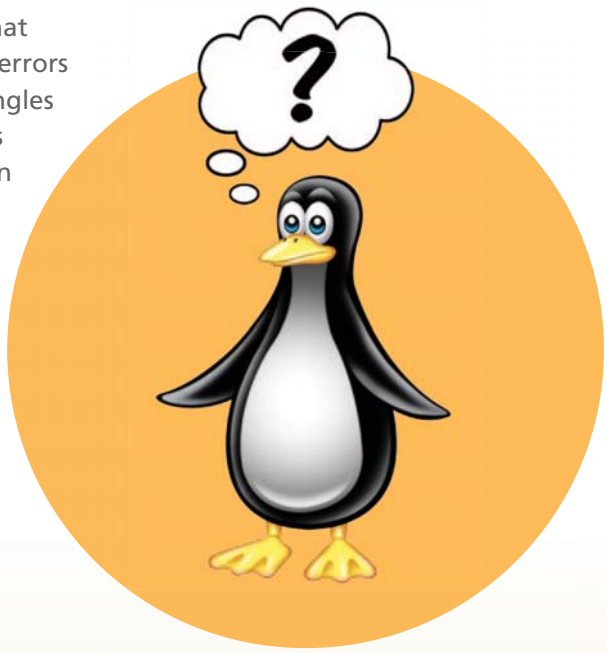
Students also apply their understanding of geometric properties, such as parallel and perpendicular lines and congruence, to identify certain types of quadrilaterals and to explore the relationships among quadrilaterals. Students also explore the relationships between triangles and rectangles and the properties of line symmetry.

Help Students Avoid Common Errors

Math Expressions gives students opportunities to analyze and correct errors, explaining why the reasoning was flawed.

In this unit, we use Puzzled Penguin to show typical errors that students make. Students enjoy explaining Puzzled Penguin's errors and teaching Puzzled Penguin the correct way to measure angles and analyze geometric figures. The following common errors are presented to the students as letters from Puzzled Penguin and as problems in the Teacher Edition that were solved incorrectly by Puzzled Penguin.

- **Lesson 2:** Using one letter to name an angle when several angles share that vertex
- **Lesson 5:** Incorrectly solving an equation to find an unknown angle measure
- **Lesson 9:** Drawing a line that is not perpendicular to the opposite side of the triangle
- **Lesson 11:** Drawing a line that results in shapes which are the same size and shape, but which are not also mirror images



In addition to Puzzled Penguin, there are other suggestions listed in the Teacher Edition to help you watch for situations that may lead to common errors. As a part of the Unit Test Teacher Edition pages, you will find a common error and prescription listed for each test item.

***Math Expressions* VOCABULARY**

As you teach the unit, emphasize understanding of these terms.

- angle
- degree
- diagonal
- line symmetry

See the Teacher Glossary.

Angles

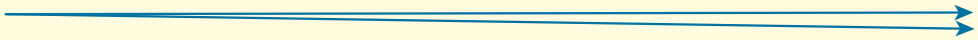
Lessons 1 2 3

Plane Figures In Lesson 1, students identify, explore the properties of, and draw plane figures including lines, line segments, rays, points, and angles. For example, students use the definition of a line to reason that although the lines below are drawn to different lengths, they are really the same length because all lines go on forever in both directions.

Allowing students to explore and compare the properties of these figures, as well as giving them an opportunity to draw them, is beneficial because it helps conceptualize what can often be abstract definitions of plane figures.

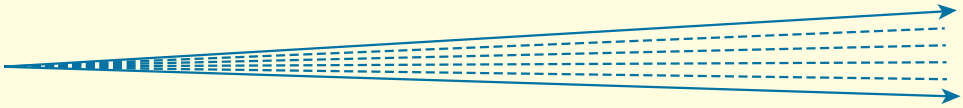
Classifying Angles In Lesson 1, students classify angles as acute, obtuse, or right by comparing angles to a right angle. The lesson presents the size of an angle as the amount of rotation, or turn, from one side of the angle to the other side. This informal exploration provides the foundation students will use as they move on to formalizing their knowledge of angles when they use a protractor to measure angles and compare the measurement to 90°.

Degrees Lesson 2 presents the concept of the degree as the unit of measurement used to measure the size of an angle. In the images below, students can see an angle with the measure of 1 degree, or 1°, and that five of these angles create an angle with the measure of 5°.



The measure of an angle is the total number of 1-degree angles that fit inside it.

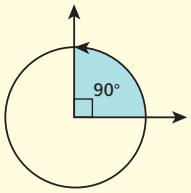
This angle measures 5 degrees.



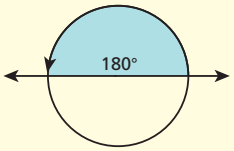
Images like the ones above are beneficial for students because they help them visualize the degree as a measurement unit. Additionally, they can more easily see that $5 \cdot 1° = 5°$.

Angles and Circles Lesson 2 also presents angles in the context of circles. An angle is shown as an interior angle of a circle with its vertex at the center of the circle. Students see, for example, that a right angle has a measure of 90° and that a 90° turn traces one quarter of a circle. In this way, students see that a 360° angle traces a complete circle and each degree is $\frac{1}{360}$ of the way around the circle.

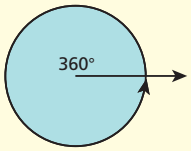
A **right angle** has a measure of 90°. A 90° turn traces one quarter of a circle.



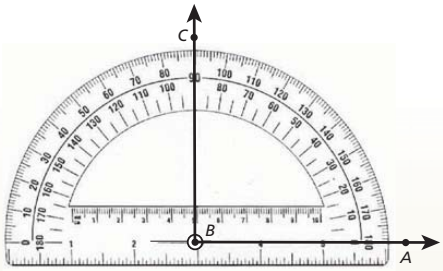
A **straight angle** measures 180°. A 180° turn traces one half of a circle.



The angle below measures 360°. A 360° turn traces a complete circle.



Measuring Angles In Lesson 2, students use a protractor to measure angles. To use a protractor accurately, students need to align the vertex of the angle carefully with the center mark on the protractor and align one ray with the zero line. Most protractors are labeled clockwise and counterclockwise. Students should choose the appropriate scale depending on the orientation of the angle.



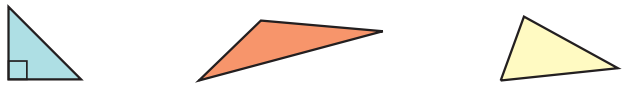
In Lesson 3, students apply their understanding of circles and using a protractor to drawing interior angles of given sizes in circles.

Students connect to their understanding of fractions as they express angle measures as fractions of 360°. For example, they describe a 60° angle as being $\frac{60}{360} = \frac{1}{6}$ of the circle or as an angle that makes 60 1-degree turns. Since each of those turns is $\frac{1}{360}$ of the circle, a 60° turn is $6 \cdot \frac{1}{360} = \frac{60}{360} = \frac{1}{6}$ of the circle.

Triangles

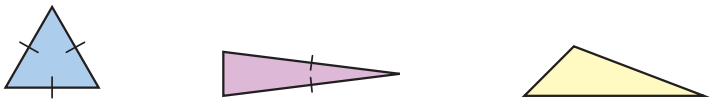
Lessons 4 5 6

Classifying Triangles In Lesson 4, students learn to identify the angles in a triangle as obtuse, right, or acute. They use these observations to classify triangles by angles as obtuse triangles, right triangles, or acute triangles.



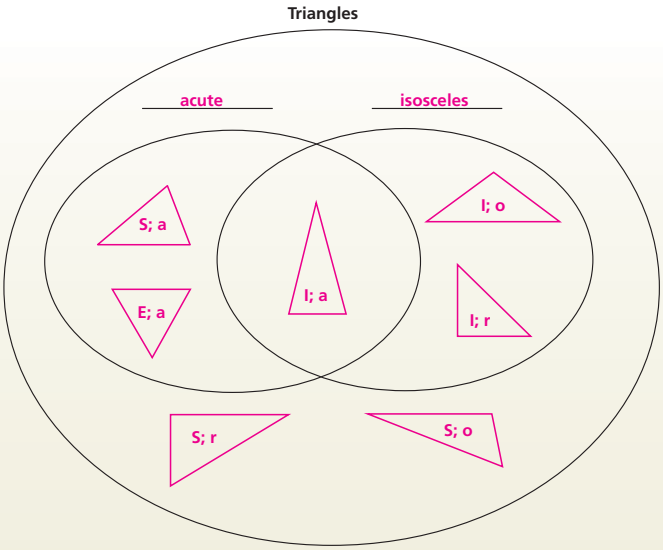
right obtuse acute

Students also attend to the sides of a triangle to identify the sides as equal or not equal. They use the observations of the congruency of the sides to classify the triangles by sides as equilateral, isosceles, or scalene.

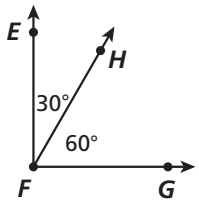


equilateral isosceles scalene

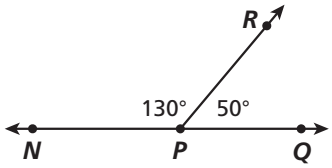
As students gain experience in identifying the attributes of the angles and sides in triangles, they begin to realize that triangles can be classified in different ways. For example, if an acute triangle has 0 equal sides, it is also scalene. If a right triangle has 2 equal sides, it is also isosceles. During this exploration, students also realize that some combinations of classifications are not possible. For example, an equilateral triangle cannot also be right or obtuse and a right triangle cannot have an obtuse angle.



Angle Measure Sums and Differences In Lesson 5, students learn how to add angle measures of two adjacent angles. This concept lays the foundation that students will need when they learn about angle pairs, such as complementary and supplementary angles, in future grades. For example, students see that a 30° and a 60° angle make a right angle and that a 130° and a 50° angle make a straight angle.

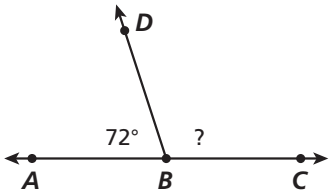


right angle



straight angle

Students apply this understanding of adding angles to subtracting angles to find unknown angle measures.



For example, in the diagram above, if students know that the measure of angle *ABC* is 180°, they can write and solve an equation to find the unknown angle measure.

$$180° - 72° = x \text{ or } 72° + x = 180°$$

Solving equations involving angles is beneficial because it helps students connect their algebraic and geometric understandings.

Triangles and Quadrilaterals

Lessons 7 8 9 10 11

Quadrilaterals In Unit 8, students explore the attributes of quadrilaterals. Exploration of quadrilaterals is the context through which students learn about special line and line segment pairs: parallel lines and perpendicular lines.

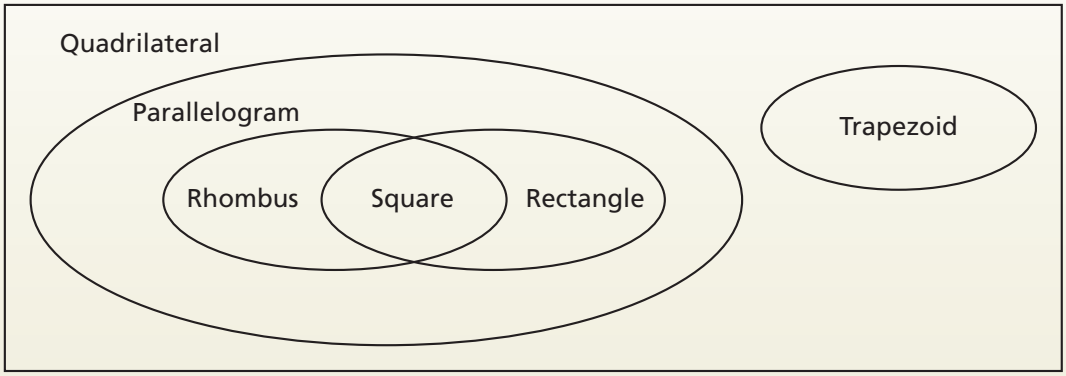
parallel line segments perpendicular lines

Students also learn to identify adjacent sides and opposite sides of figures. Students apply this understanding to identify and classify quadrilaterals, such as parallelograms, trapezoids, rhombuses, rectangles, and squares.

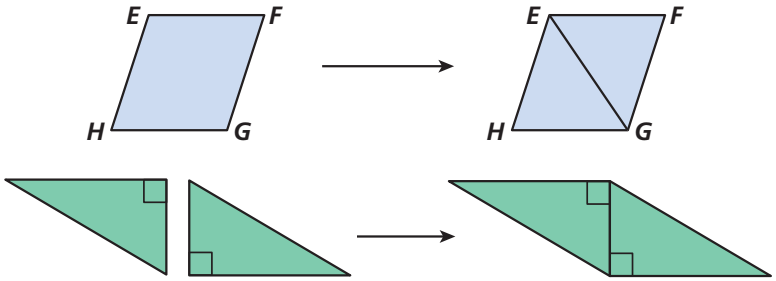
parallelogram trapezoid rhombus rectangle square

Presenting students with this specialized vocabulary and having them apply it to identifying quadrilaterals is beneficial because it gives students a meaningful context through which they not only learn these ideas, but apply them as well.

Students deepen their knowledge as they explore the relationships among quadrilaterals. The category diagram below is presented as a way to represent these relationships. A category diagram is a beneficial tool because it helps students to organize their thinking.



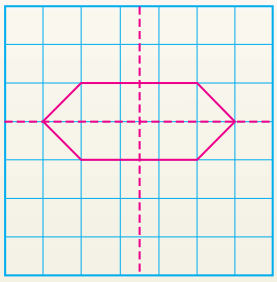
Relating Triangles and Quadrilaterals In Lesson 9, students use the concept of a diagonal to explore the relationship between triangles and quadrilaterals. Students see that a diagonal divides a quadrilateral into two triangles which have the same size and shape. This concept forms the basis for the formulas for the areas of triangles and parallelograms. Students see that a quadrilateral can be decomposed into two triangles with the same size and shape and that two triangles with the same size and shape can be composed into a quadrilateral.

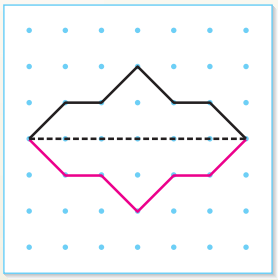


Students also learn how to draw perpendicular lines in triangles. This skill prepares students to identify the altitude, or height, of a figure without right angles.

Polygons Lesson 10 introduces the idea of a polygon. Polygons are closed figures with straight sides, and triangles and quadrilaterals are types of polygons. Students sort triangles and quadrilaterals by angles and by sides; for example, as polygons with right angles and as polygons with perpendicular sides. Students learn that polygons can be sorted in more than one way.

Line Symmetry To expand students' exploration of the properties of geometric figures, Lesson 11 presents line symmetry. Students see that a line of symmetry divides a figure in half so that, if the figure is folded along the line, the two halves will match exactly. Students determine if a figure has line symmetry, and if so, identify the line or lines of symmetry. Students are asked not only to draw lines of symmetry, but also to draw the other half of symmetric figures. This constructing helps solidify their understanding of symmetry. Using graph paper further enables students to visualize symmetry in figures.





Problem Solving

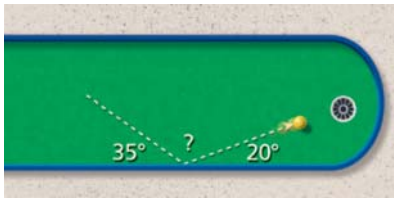
Lessons 2 6 7

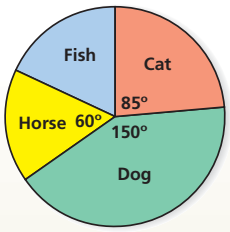
Problem Solving Plan In *Math Expressions* a research-based problem-solving approach that focuses on problem types is used.

- Interpret the problem
- Represent the situation
- Solve the problem
- Check that the answer makes sense.

Maps In Lessons 2 and 7, students apply their understanding of geometric figures to solving problems involving maps. Students solve problems involving roads represented as line segments, including parallel and perpendicular line segments, and turns represented as angles.

Adding and Subtracting Angle Measures In Lesson 6, students apply their understanding of angle measures by adding and subtracting angle measures to solve real life problems. For example, they analyze the angles in bridges and the way balls rebound in miniature golf games to solve problems. Students also apply their understanding of angle measures to help them interpret a circle graph.





Focus on Mathematical Practices

Lesson 12

The standards for Mathematical Practice are included in every lesson of this unit. However, there is an additional lesson that focuses on all eight Mathematical Practices. In this lesson, students use what they know about geometry to solve problems involving different types of flag designs.