Chapter 9

Big Idea
Understanding angles, triangles, and polygons can help me describe the world.

Learning Goals
- I can identify angles in the environment.
- I can estimate angle measures using 45°, 90°, and 180° as reference angles.
- I can measure angles in degrees.
- I can classify angles according to their measure.
- I can draw and label angles when the measure is given.
- I can show that the sum of interior angles is 180° in a triangle and 360° in a quadrilateral.
- I can construct acute, equilateral, isosceles, obtuse, right, and scalene triangles in different orientations.
- I can compare acute, equilateral, isosceles, obtuse, right, and scalene triangles in different orientations.
- I can describe the sides and angles of regular and irregular polygons.
- I can compare the sides and angles of regular and irregular polygons.

Essential Question
How can I use angles, triangles, and polygons to describe the world?

Important Words
- angle
- acute angle or acute triangle
- equilateral triangle
- irregular polygon
- isosceles triangle
- obtuse angle or obtuse triangle
- reflex angle
- regular polygon
- right angle or right triangle
- scalene triangle
- straight angle
Draw, build, measure, describe, and classify angles using non-standard units.

Example:

Explain how to draw an acute angle.

Jessie’s strategy:
I know an acute angle will be smaller than a right angle.
I drew a corner and divided it into three parts. I then traced two of the rays to draw an acute angle. I used an arc to show the angle I drew. Because this angle is smaller than a right angle, I know it is an acute angle.

Alejandro’s strategy:
I know the corner of a square pattern block is a right angle and an acute angle is smaller than that. I chose a triangle pattern block and traced one corner to make an acute angle.

Esther’s strategy:
I put one pencil horizontally. Then I put another pencil perpendicular to it. I know that in an acute angle the pencils will be closer together. I moved the vertical pencil toward the horizontal pencil to make an acute angle. Then I traced it.
1. A small beige pattern block, like the one shown below, can be used as a non-standard unit to measure an angle.

![Pattern block](image)

An angle is formed when two lines meet at the same endpoint.

Estimate the size of each angle in small beige pattern blocks.

a. 

b. 

c. 

d. 

e. 

f. 

2. Measure each angle in question 1 using small beige pattern blocks. Compare each measurement to your estimate.
3. Use a ruler and the strategy of your choice to draw an example of each of the following types of angles.
   
a. acute angle
b. right angle
c. obtuse angle

4. Classify each angle as an acute angle, a right angle, an obtuse angle, a straight angle, or a reflex angle.
   
a. 
   b. 
   c. 
   d. 
   e. 
   f. 

An acute angle is smaller than a right angle.

A right angle is made by two perpendicular lines.

An obtuse angle is larger than a right angle.

A straight angle looks like a straight line.

A reflex angle is larger than a straight angle.
5. Measure each angle using two different non-standard units.

- List the non-standard units you used.
- Explain how you measured each angle.
- Compare the two non-standard units you used.
- Compare the three angles above.

6. Classify each angle in question 5 as an acute, right, obtuse, straight, or reflex angle.

7. Compare the two angles below. What do you notice?

8. When is it important to know the size of an angle?
Angle Assistance

Draw, build, measure, describe, and classify angles using non-standard units to solve problems in real-life situations, such as sports, sharing, and construction.

**Example:**

Find examples of acute, right, obtuse, straight, and reflex angles in your classroom.

Grace’s strategy:

I know that a corner is a right angle, so the corner of my desk is a right angle.

I know that an acute angle is smaller than a right angle, like the angle between the legs on the art easel.

I know that an obtuse angle is larger than a right angle, like the angle in the big corner of the trapezoid tables.

A straight angle is any straight line, like the side of the whiteboard.

A reflex angle is larger than a straight angle. I see one around the outside of my desk.
1. Look around your classroom, school, or playground to find an example of each type of angle Grace identified in the example.

2. Identify an acute, right, obtuse, straight, and reflex angle in the picture below.

3. Antonio is a break-dancer. Describe any angles you see in the pictures of Antonio break-dancing.
   
   a.  
   b.  
   c.  

4. Hailee practices yoga. Describe any angles you see in the pictures of Hailee’s yoga poses.
   
   a.  
   b.  
   c.  
   d.  

5. Mrs. Krejci was sharing hexagonal tarts with her class. She could cut them in halves, in thirds, or in sixths, as shown below. What types of angles are represented by each way of sharing the tarts?

![Hexagonal Tarts Diagram]

6. Mr. Plaza is an architectural engineer. When he is designing a new house he needs to decide which type of roof system to use.

![Roof Systems Diagram]

   a. Trace each roof system and label examples of acute, right, and obtuse angles in the roof systems.
   
   b. What type of angle is most common in these roof systems? Why might this be?
   
   c. What shape is most common in the roof systems? Why might this be?
   
   d. Why might Mr. Plaza choose one roof system instead of another?

7. What types of angles are most common in your life? in nature? Why do you think that is?

I can classify angles according to their measure.
I can measure angles in degrees.
I can draw and label angles when the measure is given.
Accepting Angles

Draw, build, measure, describe, and classify angles.

**Example:**

Draw an angle of 80° and classify it as an acute, right, obtuse, straight, or reflex angle.

Mark’s strategy:

I know that 80° is less than 90°, so I know that the angle is acute.

I drew a line, then used a protractor to measure 80° from my line. I marked a point and then I drew the angle.

1. Charly drew an angle, as shown below, that he said was 80°.

   ![80° angle diagram]

   **a.** Explain to Charly how you can tell his angle is not 80°.

   **b.** What do you think he did wrong when he was drawing the angle?

   **c.** How can you use what you know about types of angles to help you draw a specific angle?
2. Estimate the size of each angle in degrees.
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 
   h. 

3. Measure each angle in question 2. Compare each measurement to your estimate.

4. Use a ruler to draw an example of each of the following types of angles.
   a. acute angle  
   b. right angle  
   c. obtuse angle  
   d. straight angle  
   e. reflex angle  

5. Use a protractor to measure each angle you drew for question 4.
6. Draw and label each angle.
   a. 35°  b. 70°  c. 90°  d. 100°
   e. 140°  f. 180°  g. 210°  h. 295°

7. Classify each angle you drew for question 6 as an acute, right, obtuse, straight, or reflex angle.

8. Measure each interior angle in the polygons below.
   a.  
   b.  

9. Describe and measure an acute, right, obtuse, straight, and reflex angle in the picture below.

10. Explain how knowing the type of angle helps to estimate the measure of the angle.

11. Create your own design, like the one in question 9, that uses different kinds of angles. Exchange designs with a partner and measure the angles in each other’s designs.

   I can identify angles in the environment.
   I can estimate angle measures using 45°, 90°, and 180° as reference angles.
   I can measure angles in degrees.
   I can classify angles according to their measure.
   I can draw and label angles when the measure is given.
Draw, build, measure, and classify angles to solve problems from real-life contexts, such as building, sharing, and designing.

**Example:**

Alexandria wants to cut her circular birthday cake so everyone receives a piece of the same size. What will the angle at the point of each piece be if she needs six pieces?

Becky’s strategy:

I drew a picture of a circle and drew a line to divide it in half using my ruler. Then I drew to split each half of the cake into three equal pieces.

I used my protractor to measure the angles in the middle of each piece. They are all about 60°.

Jamal’s strategy:

I found fraction circle pieces that are sixths. I measured the angle at the vertex of each piece. Each piece should be 60° in the middle.

1. Sam is cutting pie for dessert. What will the angle at the vertex of each piece be:
   a. if he shares the pie equally between two people?
   b. if he shares the pie equally between three people?
   c. if he shares the pie equally between four people?
   d. if he shares the pie equally between eight people?

2. Describe the type of angles in each piece for question 1. Explain what happens to the angle as more people share the pie.
3. Jenna is tiling a wall at a new school using the design shown below.

![Image of tiles](image)

a. Measure the angles in the blue tiles.
b. Measure the angles in the yellow tiles.
c. Explain why you think the angles are different in each colour of tile.

4. Jamal is studying carpentry and wants to build a cabinet. The plans for the doors he would like to build are shown below.

![Image of cabinet doors](image)

a. Measure the angles in the plan for the cabinet doors.
b. Describe the types of angles found in the plan for the cabinet doors.
c. Design an alternate plan for the cabinet doors that uses more right angles.
d. Why might Jamal want a design with more right angles?
5. Samson is learning to race the Giant Slalom. He is studying footage of ski racers from the Olympics and he notices that the racers change body position as they go through each section of the course.

![Skiers](image)

a. Estimate the angle of the skier’s body to the ground as he goes down the course.

b. Explain why the angle might change.

c. Explain when you think the racer was going the fastest.

6. Give an example of where you might find each of the following angles in real life.

   a. 90°
   b. 45°
   c. 10°
   d. 130°

7. Manuella is building an obstacle course that will be 50 metres long and have three corners. The first corner will be 85°, the second corner will be 135°, and the third corner will be 20°.

   a. Draw what the obstacle course might look like.
   b. Explain why there could be different ways to build this obstacle course.
   c. Describe the angle at each corner.

8. What strategies do you use to make estimating angles easier?

9. Describe a real-life situation where you might need to measure or know an angle.

   I can identify angles in the environment.
   I can estimate angle measures using 45°, 90°, and 180° as reference angles.
   I can measure angles in degrees.
   I can classify angles according to their measure.
   I can draw and label angles when the measure is given.
Pretty Polygons

Draw, build, measure, describe, and classify angles and sides in polygons.

**Example:**

Draw a polygon that:
- has five sides.
- has four angles that are less than or equal to 90°.
- has one reflex angle.
- has two parallel sides.

Betty’s polygon:
I knew that if I made a rectangle to begin with, I would have angles that were 90°, but a rectangle only has four sides, so I added another side which gave me my reflex angle.

Carter’s polygon:
I thought of an open envelope that has five sides, but no reflex angle. So I thought that if I just pushed the top down, it would give me a reflex angle.

1. Use the polygons Betty and Carter drew in the example above to:
   a. explain how both polygons match the description.
   b. draw another polygon that matches the description.
2. Estimate and then measure the marked angles in the following polygons. Classify each angle you measure.

   a. 
   b. 
   c. 
   d. 

3. Classify each shape below as a polygon or a non-polygon.

   a. 
   b. 
   c. 
   d.
4. Measure the sides of the following polygons. Explain whether each shape is regular or irregular.

A regular polygon has sides that are all equal and angles that are all equal. An irregular polygon has some sides that are different lengths and some angles that are different sizes.

a. 

b. 

c. 

d. 

5. Explain whether you can tell that a polygon is regular just by looking at it.

6. Measure the angles in the following regular polygons.

a. What do you notice about the angles in each shape?

b. What makes these shapes regular?
7. Draw and label the following polygons:
   a. an irregular 5-sided polygon with at least one acute angle
   b. a regular 4-sided polygon

8. Compare the polygons in each pair.
   a. 
      ![Octagon and Triangle](image)
   b. 
      ![Parallelogram and Rectangle](image)
   c. 
      ![Pentagon and Trapezoid](image)
   d. 
      ![Trapezoid and Triangle](image)
9. Find the sum of the interior angles in each of the following polygons.

a. 

b. 

c. 

d. 

10. What do you notice about the sum of the interior angles in a quadrilateral?

11. Explain whether you think regular or irregular shapes are more common in real life.

12. Explore whether it is possible to draw a quadrilateral with angles that do not add to 360°.
Draw, build, measure, describe, and classify angles and sides in polygons to solve problems from real-life contexts, such as street signs, buildings, puzzles, and scrapbooking.

**Example:**

Sidda noticed that the street signs around Grande Prairie are polygons. She drew and described each polygon.

The yield sign is a triangle because it has three sides. I measured all the sides and they are equal. I measured the angles and they are equal too. It is a regular triangle.

There are eight sides on the stop sign. I know that a polygon with eight sides is an octagon. I measured all the sides and all the angles and they are equal, so it is a regular octagon.

I can see that the street sign is a rectangle. All the angles are 90°, but the rectangle is irregular because not all of the sides are equal.

The school sign has five sides, so it is a pentagon. It has some right angles and some obtuse angles and the sides are not all equal, so it is an irregular pentagon.

The crosswalk sign is a square that has been rotated 45°. A square has four equal sides and four equal angles, so it is a regular quadrilateral.
1. Marcus is doing a puzzle with a friend. All the puzzle pieces are polygons. One of the puzzle pieces is shown below. What might some other puzzle pieces that attach to this piece look like?

[Diagram of a polygon puzzle piece]

2. The city of Mathmonton is thinking about designing new stop signs. Design a new stop sign based on the following criteria:
   - It must have at least four sides.
   - At least two of the sides must be parallel.
   - It must have at least two right angles.
   - It must be easy to draw.

3. Eunice is making a scrapbook to celebrate the end of elementary school. She designed the layout shown here.

   [Diagram of a scrapbook layout]

   a. What polygons will she have to cut to create her layout?
   b. What angles will her polygons have?
4. The GlassUs Window Company is designing new decorative windows for front doors. One window design is shown below.

![Window Design](image)

a. What types of polygons do you see in the design?
b. What types of angles do you see in the design?

5. Frieda used each set of points below to make a polygon. Plot the points and describe each polygon.

   a. (1, 3), (3, 3), (3, 6), (1, 8)
   b. (4, 2), (9, 2), (7, 6), (6, 6), (6, 5)

6. Jackson is making a jewelry box for his mom for Mother’s Day.

   a. Choose a polygon for the top of the box.
   b. Draw the top of the box and label the angles.
   c. Draw a design for the top of the box using at least one irregular polygon and at least one regular polygon.
7. Bob says the puzzle piece shown is a polygon. Sue says it is a non-polygon. Who is right? How do you know?

8. Use the clues below to draw the mystery polygon:
   - I am an irregular polygon.
   - I have more than five sides.
   - One of my angles is acute.
   - One of my angles is obtuse.

9. Explain whether the riddle in question 8 could describe more than one shape.

10. Reuben started to draw a quadrilateral by plotting the points (1, 2), (1, 5), and (4, 2). Plot a fourth point to make the quadrilateral:
   a. a square.
   b. a trapezoid.
   c. a kite.

11. Write your own riddle about a mystery polygon. Exchange riddles with a partner and try to solve each other’s riddles. Discuss the strategies you used to find the polygons.

12. Where do you see polygons in real life?
Measure and describe the angles and sides in a triangle. Draw, build, describe, and classify triangles according to their sides and their angles.

**Example:**

Draw a triangle that:

- has at least one acute angle
- is a right triangle
- is a scalene triangle

**Robert’s strategy:**

I know that an acute angle is less than 90°, so that means one of the angles in the triangle has to be less than 90°. I started by drawing that acute angle.

Then I added a right angle.

I measured all the sides to make sure they were different lengths. My triangle matches all the instructions.

**Joanna’s strategy:**

I drew a right angle first because that is easiest for me to draw. I know that the sides have to be different lengths, so I drew one side a lot longer than the other.

I drew a line to complete the triangle and checked to make sure I had at least one acute angle.

Then I measured, just to be sure that all the side lengths were different.
1. Draw triangles that show each of the following characteristics:
   a. three equal sides
   b. two equal sides
   c. no sides equal
   d. an angle greater than 90°
   e. all angles less than 90°
   f. three equal angles
   g. two equal angles

2. Classify each triangle from question 1 as an **acute triangle**, an **obtuse triangle**, or a **right triangle**.

3. Classify each triangle from question 1 as a **scalene triangle**, an **isosceles triangle**, or an **equilateral triangle**.

4. Draw a triangle that has one angle equal to:
   a. 120°
   b. 90°
   c. 70°

5. Estimate, then measure, each angle in the following triangles.
6. Draw a triangle that is:
   a. an acute triangle.  
   b. an obtuse triangle.  
   c. an isosceles triangle.  
   d. a right triangle.  
   e. a scalene triangle.  
   f. an equilateral triangle.

7. Classify each triangle according to the lengths of the sides and the measure of the angles.

   a. 
   b. 
   c. 
   d. 

8. Preston drew a triangle using each set of points below. Plot each set of points and describe the triangles he drew.
   a. (1, 1), (4, 1), (1, 4)
   b. (5, 1), (7, 3), (4, 3)
   c. (1, 7), (4, 4), (7, 4)

9. Compare the triangles in each pair.

   a. 
   b. 
   c. 
   d.
10. Find the sum of the interior angles in each triangle.

a. 

b. 

c. 

11. Draw three triangles and find the sum of the angles in each triangle.

12. Draw a triangle with interior angles that add up to more than 180°.

13. What do your answers for questions 10, 11, and 12 tell you about the interior angles in a triangle?

14. Can an acute triangle also be a scalene triangle? an isosceles triangle? an obtuse triangle? Why or why not?

15. Can an equilateral triangle also be an obtuse triangle? an acute triangle? a right triangle? Why or why not?
Draw, build, describe, and classify triangles according to their sides and their angles to solve problems from real-life contexts, such as houses, playgrounds, art, food, and design.

Example:

The window design in a front door is made up of triangles as shown.

What types of triangles are in the window? Are any of the sides congruent?

Juhn’s strategy:

I used my ruler to measure the sides of the triangles.

On two of the triangles, three of the sides are the same length. These triangles are equilateral. I labelled them E.

On three of the triangles, two of the sides are the same length. These triangles are isosceles. I labelled them I.

The shared sides are congruent because they are the same length. I labelled them with two tic marks.

The short sides of the two outside isosceles triangles are congruent because they are the same length. I labelled them with three tic marks.
1. Maheret noticed that the tops of the houses in her neighbourhood look like triangles. She drew some of the houses below. Measure to classify each triangle according to the measure of the sides and the angles.

a. 

b. 

c. 

d. 

2. Madz is completing an art project. The guidelines say he must:
   - use eight triangles.
   - represent an everyday object.
   - use at least four different types of triangles.

   Draw what his project might look like.

3. Janelle works for a roofing company. She is working on a house that is 12 metres wide and which has a roof that is 10 metres long. The angle at the peak of the roof is 70º, as shown in the diagram.

   a. What kind of triangle is formed by the roof?

   b. What are the angles of the corners labeled $a$ in the diagram?
4. Marian was folding paper for her annual spring party. What shape will each piece of paper be when it is folded along the dotted line?

   a. 
   b. 
   c. 

5. Lana designs windows for the GlassUs Window Company. The window she is designing must be a rectangle that is made up of four triangles.

   a. What could the window look like?
   b. What angles are in each of the triangles?
   c. What types of triangles could be in the window?

6. Jane was at the playground and noticed that the climbing structure she was on was made up of a bunch of triangles as shown.

   a. What type of triangle is the entire structure? How do you know?
   b. Are the smaller triangles the same kind of triangle as the entire structure?

7. What types of triangles do you see in real life? Where?