Unit 7, Lesson 8

The Size of An Angle, in Degrees

Standards

Building On	**4.NBT.A.1**
Addressing	**4.MD.C.5.a, 4.MD.C.7**
Building Toward	**4.MD.C.5, 4.MD.C.6, 4.MD.C.7**

Instructional Routines

- What Do You Know about _____?

Goals

- Comprehend (in spoken and written language) the meaning of the term “degree.”
- Use parts of a circle (halves, fourths) and benchmark angle measurements (such as 90°, 180°, 270°, 360°) to estimate the size of an angle, in degrees.

Student Facing Learning Goals

Let’s describe the size of an angle, using degrees.

Lesson Purpose

The purpose of this lesson is for students to understand that angles can be measured in degrees and to use benchmark angle measurements to make sense of the new unit.

Narrative

Previously, students used the hands of an analog clock to describe and compare the sizes of angles. In this lesson, students learn about degrees as a unit for measuring angles.

In the first activity, students are introduced to 360 degrees as the measurement of a full rotation of a ray about a fixed point. They use this to interpret and describe other benchmark angle measurements (90°, 180°, 270°). They then use these benchmarks to estimate and sketch new angles with given measurements in degrees.

Next, students use these reference angles to create an angle measurement tool from paper. They partition the straight angle of a semicircle into smaller angles by folding. In doing so, they draw from their experience with the clock, where each hour or each minute can be thought of as equal-size parts around the center point of the clock.

Throughout the lesson, listen for the way students make connections to their work with clocks, and to their understanding of fractions of a circle, as they reason about how to estimate and sketch angles in degrees, using an understanding that a full rotation is 360 degrees.

Required Materials

Materials to Gather

- Paper: Activity 2
- Rulers or straightedges: Activity 2

Materials to Copy

- Making a Measuring Tool Template (1 copy for every 3 students): Activity 2

Lesson Timeline

Warm-up	10 min
Activity 1	15 min
Activity 2	20 min
Synthesis Estimate	10 min
Cool-down	5 min

Teacher Reflection Questions

How did students connect the angles they created in the second activity to the fractions of a circle? How can you help students make connections between degrees and a fraction of a circle in upcoming lessons?

Warm-up

10 min

What Do You Know about 360?

Standards

Building On	**4.NBT.A.1**
Building Toward	**4.MD.C.5, 4.MD.C.7**

Instructional Routines

- What Do You Know about ____?

The purpose of this *Warm-up* is to invite students to think about 360 in terms of related numbers—as a result of addition, subtraction, multiplication, or division. The reasoning done here will be helpful when students compose angles into a sum of 360° or decompose a 360° angle into smaller angles, particularly benchmark angles such as 30°, 60°, 90°, and 180°.

Student Task Statement

What do you know about 360?

Student Response

Sample responses:

- It is 40 less than 400, and 60 more than 300.
- It is 10 times 36, twice 180, and half of 720.
- It is a multiple of 10, 20, 30, 40, 60, 90, 120, 180.
- It is 2×180, 3×120, 4×90, 6×60, 9×40, 10×36, 12×30, 15×24, 18×20.

Launch

- Display the number.
- "What do you know about 360?"

Activity

- 1 minute: quiet think time
- Record responses.
- If no students mentioned different ways to express 360, ask: "How could we express the number 360?" and "What do you know about the factors of 360?"

Activity Synthesis

- Draw students' attention to the factors of 360. "What are the factors of 360? How many are there?"
- "The number 360 and its factors are important when describing angles. Let's find out why they show up again and again as we look at a new way to describe and measure the size of an angle."

Activity 1

15 min

A Full Turn

Standards

Addressing **4.MD.C.5.a, 4.MD.C.7**

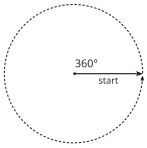
In previous activities, students used the features of a clock to describe and compare angles. This activity introduces students to the **degree** as a unit of measure.

Because one degree is much more abstract than one inch or one square-inch tile, students are first introduced to 360 degrees as a full rotation of a ray around its starting point. Students use this information to reason about other angle measurements. They may use their understanding of fractions of a circle to determine the sizes (MP7).

In the *Activity Synthesis*, students describe angle measurement as additive. Students will continue to build this understanding and reason about the size of 1 degree in subsequent lesson activities.

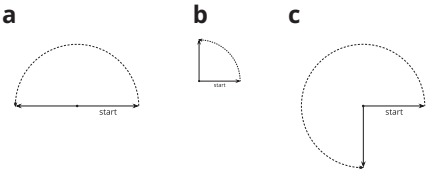
Student Task Statement

A ray that turns all the way around its starting point has made a full turn.



We say that the ray has turned 360 **degrees**.

1. How many degrees has the ray turned from where it started?



2. Sketch 2 angles:
   a. an angle where a ray has turned 50°
   b. an angle where a ray has turned 130°

Student Response

1. a. 180 degrees
   b. 90 degrees
   c. 270 degrees
2. Students' sketches need not be precise, but should show reasonable estimates of an angle that is between 40 degrees and 60 degrees for the 50-degree angle and between 120 degrees and 140 degrees for 130-degree angle.

Launch

- Groups of 2
- "Just like length and area can be measured in standard units, angles have standard units."
- "One standard unit for measuring the size of an angle is **degree**."
- Display the image of the ray turning 360 degrees and read the opening *Task Statement*.

Activity

- "Use this information to determine how many degrees each ray has turned from where it started. Then sketch some angles that are about the size given in degrees."
- 3–4 minutes: independent work time
- "Compare your thinking with your partner. Explain how you made your estimates."
- 2–3 minutes: partner discussion
- Monitor for students who:
  - Describe the 180-degree turn as half a full turn or turning half a circle.
  - Describe the 90-degree angle as half of half a turn or as a turning a fourth of the way around the circle.
  - Use their estimate for the 90-degree angle to estimate the 270-degree angle, by adding ($90 + 90 + 90$ or $180 + 90$) or by subtracting ($360 - 90$).

Activity Synthesis

- Invite previously identified students to share how they estimated the turn of each ray in degrees.
- "How were your methods the same? How were they different?" (We all used the first diagram to figure out how much of a turn. Some of us used one measure to find the next measure. Some of us thought about addition and some thought about division).
- Consider displaying the equation $90 + 90 + 90 = 270$ and discussing:
  - "How does this match a way to estimate the third angle?"
  - "What's another equation we could use to describe that angle?"
- "An angle that measures 90 degrees is called a **right angle**."
- "Where have you seen right angles before?" (Corners of squares or rectangles. Corners of paper. The angle made by the hands of a clock when it is 3 o'clock or 9 o'clock.)

Activity 2

20 min

Make a Measuring Tool

Standards

Addressing	**4.MD.C.5.a, 4.MD.C.7**
Building Toward	**4.MD.C.6**

In this activity, students construct a protractor-like tool that shows some benchmark angles. They do so by decomposing given angles—120° and 180°—and then looking for other ways to compose or decompose the subsequent angles identified along the way.

The activity serves several goals. The first is to familiarize students with the structure of a protractor, using tactile processes (folding paper and aligning lines or edges). The second goal is to develop students' intuition for thinking of a larger angle as composed of smaller angles, preparing them to see (in future lessons) that a 1° angle is $\frac{1}{360}$ of a full turn. A final goal is to motivate the need for a tool that can measure angles more precisely.

Some students may use a square corner of a sheet of paper to find a 90° angle on their semicircle and others may choose to fold their semicircle in half. Expect most students to fold their paper to find all subsequent angles.

Required Materials

Materials to Gather

- Paper: Activity 2

Materials to Copy

- Making a Measuring Tool Template (1 copy for every

- Rulers or straightedges: Activity 2

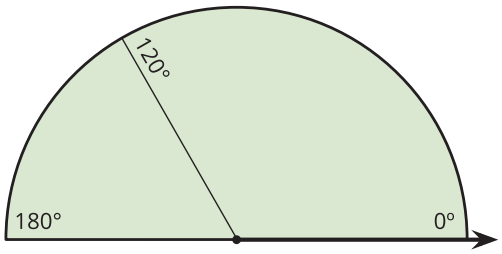
3 students): Activity 2

Required Preparation

- Create a paper half circle from the blackline master for each student.

Student Task Statement

Your teacher will give you a sheet of paper in the shape of half a circle. It shows a 120° angle and a 180° angle from the ray on the bottom right.

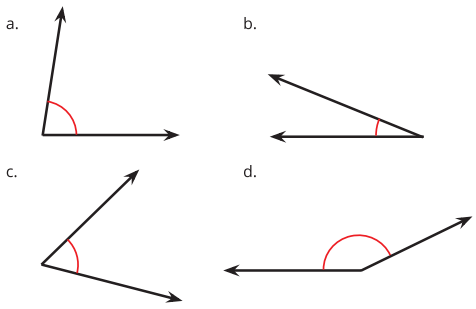


On the half-a-circle paper:

1. Draw a line segment to show a 90° angle from the same ray. Label it with the measurement. Be as precise as possible.
2. Draw line segments to show the following angles (measured from the same ray). Label the measurement on each segment.

   60° 45° 30° 150° 135°
3. Can you find a 1° angle from that same ray? Explain or show how you know.
4. You just made a measuring tool!

   How is it used to estimate the size of an angle? Discuss your ideas with your group. Then use your tool to estimate the sizes of at least 2 angles.



Launch

- Groups of 2–4
- Give each student one paper half circle and access to rulers or straightedges.
- "Your sheet of paper is in the shape of half a circle. It shows a ray on the bottom right and two angles (120° and 180°) measured from the ray."
- "We see the 120° label. Where is the 120° angle? Where are the two rays that make this angle?"
- 1 minute: quiet think time for the first problem
- 1 minute: group discussion
- "Where do you think the second ray of a 90° angle would be?" (Between 0° and 120°, but closer to 120°.)

Activity

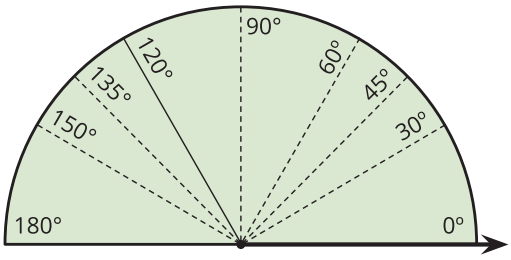
- 5–7 minutes: independent work time
- As students work on the last problem, monitor their ideas for using their tool to estimate angle measurements.

Activity Synthesis

- "How did you find a 90° angle?" (I folded the semicircle into halves.)
- "How did you find all the other angles?" (For 60°, fold to line up the thick ray with the 120° segment, splitting 120 into two. For 45°, fold to line up the ray with the 90° segment, splitting 90 into two. Repeat in a similar fashion to find the others.)
- Invite students to share how they might find a 1° angle in their half circle. Highlight explanations that involve finding some fraction of smaller and smaller angles.
- Solicit some estimates of the angle measurements in the last problem. Record and display them for comparison later, when the same four angles are measured, using a protractor.
- Students likely will notice that their tool is imprecise

Student Response

1. See image.
2. See image.



3. Sample responses:
   a. Split 30° into three equal parts to get 10° each. Split the 10° into two parts of 5° each. Break each 5° angle into five parts of 1°.
   b. It can't really be done—not precisely, anyway. The angle is too small to find by folding.
4. Sample responses:
   a. 80°
   b. 25°
   c. 60°
   d. 155°

Advancing Student Thinking

If students create angles by estimating the locations of the lines, consider asking:

- "How did you decide where to create the angles?"
- "Do you think the angle you need to create is smaller or larger than those that you have drawn already? How might folding help you create more precise angles during this task?"

Lesson Synthesis

"In earlier lessons, we used clocks to help us compare angles and talk about their sizes. Today we learned that angles can be measured in degrees and that some angles are helpful for estimating the sizes of other angles."

"What did you learn about 360°?" (It's the measurement of the angle made by a ray that makes a full turn around a point.)

"How would you describe a 180° angle?" (It's half of a full turn. The two rays make a straight line or point in opposite directions.)

"How would you describe a 90° angle?" (It's a half of a half turn. It's the size of an angle made when a ray makes a fourth of a full turn around a point. It is called a **right angle**. It's the size of the angle at the corner of a piece of paper.)

Suggested Centers

- Compare (1–5), Stage 6: Fractions (Supporting)
- Target Measurements (2–5), Stage 4: Degrees (Addressing)

Cool-down

5 min

Estimate Angle Size in Degrees

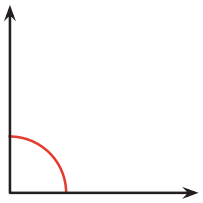
Standards

Addressing **4.MD.C.5.a**

Student Task Statement

Use the tool you created to estimate the size of each angle in degrees.

a



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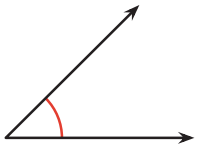

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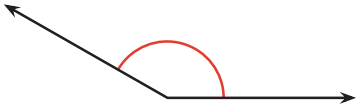

Student Response

1. 90 degrees
2. 45 degrees
3. 150 degrees

Responding to Student Thinking

Students find angle measurements that are more than 5 degrees greater than or less than 90°, 45°, or 150°.

Next Day Supports
Launch Activity 1, with a discussion about this *Cool-down*.