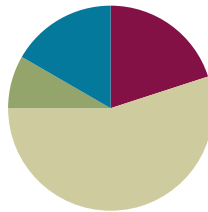


## Lesson 8

Objective: Identify and measure angles as turns and recognize them in various contexts.

### Suggested Lesson Structure

■ Fluency Practice	(12 minutes)
■ Application Problem	(5 minutes)
■ Concept Development	(33 minutes)
■ Student Debrief	(10 minutes)
<b>Total Time</b>	<b>(60 minutes)</b>



### Fluency Practice (12 minutes)

- Count by  $90^\circ$  **4.MD.7** (2 minutes)
- Break Apart 90, 180, and 360 **4.MD.7** (4 minutes)
- Physiometry **4.G.1** (2 minutes)
- Sketch Angles **4.MD.6** (4 minutes)

### Count by $90^\circ$ (2 minutes)

Note: This fluency activity prepares students for Lesson 8. If students struggle to connect counting groups of 9, groups of 9 tens, and groups of 90, write the counting progressions on the board.

9	18	27	36
9 tens	18 tens	27 tens	36 tens
90	180	270	360
$90^\circ$	$180^\circ$	$270^\circ$	$360^\circ$

Direct students to count forward and backward:

- Nines to 36
- 9 tens to 36 tens
- 90 to 360
- $90^\circ$  to  $360^\circ$

**Break Apart 90, 180, and 360 (4 minutes)**

Materials: (S) Personal white board

Note: This fluency activity prepares students for unknown angle problems in Lessons 10–11.

T: (Project a number bond with a whole of 90. Fill in 20 for one of the parts.) On your personal white boards, write the number bond, filling in the unknown part.

S: (Draw a number bond with a whole of 90 and with 20 and 70 as parts.)

Continue breaking apart 90 with the following possible sequence: 60, 40, 50, and 45.

T: (Project a number bond with a whole of 180. Fill in 70 for one of the parts.) On your boards, write the number bond, filling in the unknown part.

S: (Draw a number bond with a whole of 180 and with 70 and 110 as parts.)

Continue to break apart 180 with the following possible sequence: 90, 130, 40, and 135.

T: (Project a number bond with a whole of 360. Fill in 50 for one of the parts.) On your boards, write the number bond, filling in the unknown part.

S: (Draw a number bond with a whole of 360 and with 50 and 310 as parts.)

Continue to break apart 360 with the following possible sequence: 200, 190, 180, 90, 120, and 45.

**Physiometry (2 minutes)**

Note: Kinesthetic memory is strong memory. This fluency activity reviews terms from Lessons 1–7.

T: Stand up.

S: (Stand up.)

T: Show me an acute angle.

S: (Make an acute angle with arms.)

T: Show me an obtuse angle.

S: (Make an obtuse angle with arms.)

T: Show me a right angle.

S: (Make a right angle with arms.)

T: Show me an angle that measures approximately  $100^\circ$ .

S: (Move arms further apart, increasing the space between their arms, so that it is approximately  $100^\circ$ .)

T: Show me an angle that measures approximately  $150^\circ$ .

S: (Move arms further apart to approximately  $150^\circ$ .)

Continue with the following possible sequence:  $90^\circ$ ,  $80^\circ$ ,  $30^\circ$ ,  $20^\circ$ ,  $120^\circ$ ,  $40^\circ$ ,  $110^\circ$ , and  $180^\circ$ .

T: What's another name for a  $180^\circ$  angle?

S: A straight angle.

T: (Point to one of the classroom's side walls.) Point to the walls that run perpendicular to the wall I'm pointing to.

S: (Point to the front and back wall.)

- T: (Point to the front wall.)
- S: (Point to the side walls.)

Continue pointing to the other side wall and back wall.

- T: (Point to the back wall.) Point to the wall that runs parallel to the wall I'm pointing to.
- S: (Point to the front wall.)

Continue pointing to one side wall, the back wall, and the other side wall.

### Sketch Angles (4 minutes)

Materials: (S) Personal white board

Note: This fluency activity reviews terms from Lesson 7.

- T: On your personal white boards, show me  $\angle ABC$  that measures about  $90^\circ$ .
- S: (Sketch  $\angle ABC$  that measures approximately  $90^\circ$ .)
- T: What do we call an angle that measures  $90^\circ$ ?
- S: Right angle.
- T: On your boards, show me  $\angle DEF$  that measures about  $80^\circ$ .
- S: (Sketch  $\angle DEF$  that measures approximately  $80^\circ$ .)
- T: What type of angle did you draw?
- S: Acute.

Continue with the following possible sequence:  $10^\circ$ ,  $150^\circ$ ,  $50^\circ$ ,  $120^\circ$ , and  $45^\circ$ .



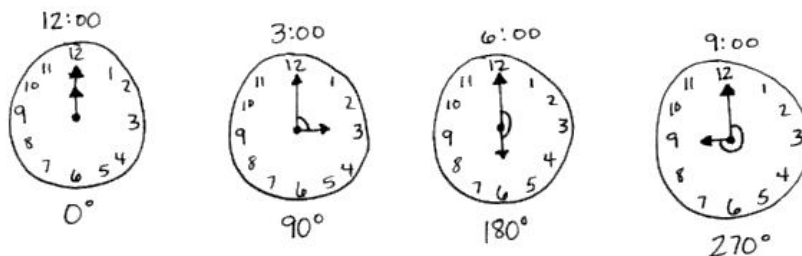
#### NOTES ON MULTIPLE MEANS OF ACTION AND EXPRESSION:

If students do not recognize that the middle letter of the angle (for example,  $B$  of  $\angle ABC$ ) denotes the vertex, then quickly review. Then, guide students to set a goal for the Sketch Angles Fluency Practice. An appropriate goal may be to consistently label the vertex as the middle letter of the angle.

Additionally, some students may benefit from sketching a  $90^\circ$  angle as a reference point for each angle.

### Application Problem (5 minutes)

Draw a series of clocks that show 12:00, 3:00, 6:00, and 9:00. Use an arc to identify an angle and estimate the angle created by both hands on the clock.



Note: This Application Problem reviews the sketching of angles from Lesson 7 and leads up to the Concept Development of today's lesson, where students further explore angle measure on a circle. Some students may identify 3:00 as a  $270^\circ$  angle and 9:00 as a  $90^\circ$  angle. Confirm with the arcs whether the estimated measurements are accurate.

### Concept Development (33 minutes)

Materials: (T) Analog clock (S) Clock (Template)

#### Problem 1: Explore angle measure as turning in relation to the hour hand on a clock.

- T: Use your straightedge to draw a line segment that starts at the tick mark representing the hour of 12 and ends at the tick mark representing the hour of 6. Fold along the line that you just drew. What fractional units have you just created?
- S: Halves!
- T: Next, fold your clock in half again. Unfold and trace along the second fold. What is the new fractional unit you have created?
- S: Fourths.  $\rightarrow$  Quarters.
- T: At 12:00, the hour hand points at the 12. Point at the 12. At 3:00, the hour hand points at the 3. Use your finger to trace along the edge of the circle from the 12 to the 3 to represent the movement of the hour hand. What fraction of the arc is that?
- S: One fourth.
- T: How many degrees did you just move?
- S:  $90^\circ$ .
- T: At 6:00, the hour hand points at the 6. Trace along the edge of the circle from the 3 to the 6. How many degrees did you just move?
- S:  $90^\circ$ .
- T: At 9:00, the hour hand points at the 9. Trace along the edge of the circle from the 6 to the 9. How many degrees did you just move?
- S:  $90^\circ$ .
- T: Point to the 9, and trace another quarter of the way around the clock. Where does your finger stop?
- S: At the 12.
- T: Talk to your partner about the total number of degrees and the number of quarter turns we just made.
- S: One quarter of the way around the clock plus one quarter plus one quarter plus one quarter. That's  $90^\circ + 90^\circ + 90^\circ + 90^\circ$ .  $360^\circ$ .  $\rightarrow$  Four quarter-turns.  $\rightarrow 4 \times 90 = 360$ .  $\rightarrow 4 \times 9$  tens, 36 tens, or  $360^\circ$ .
- T: Talk to your partner about moving from the 12 to the 6 along the arc.
- S: That would be halfway around the clock.  $\rightarrow 180^\circ$  because  $90 + 90 = 180$ .
- T: How about from the 12 to the 9?
- S: That's three quarter-turns.  $\rightarrow 270^\circ$  because  $90 + 90 + 90 = 270$ .

**Problem 2: Explore angle measure as turning in relation to the room.**

- T: Everyone, stand up and face the front of the room. Let's represent turns by using our bodies. Stay where you are. If you can, show me a complete turn.
- S: (Attempt to do so.)
- T: How many degrees did you turn?
- S: 360. A full turn is  $360^\circ$ .  $\rightarrow$  It's just like what we showed on the clock.
- T: Face the front of the room again. This time, make a half-turn. Where are you facing?
- S: The back of the room.
- T: How many degrees did you turn when you made a half-turn?
- S:  $180^\circ$ .  $\rightarrow 180^\circ$  is half of  $360^\circ$ .  $\rightarrow 90^\circ + 90^\circ = 180^\circ$ .
- T: What is another turn that we can show?
- S: We can show a quarter-turn. That would be  $90^\circ$ .
- T: Everyone, face the front of the room again. Show me where you will face when you make a quarter-turn.
- T: Why are people facing in different directions?
- S: I turned to the left.  $\rightarrow$  I turned to the right.
- T: Who is correct? The students who turned to the left or right? Take a moment to discuss with your neighbor.
- S: We are both correct.  $\rightarrow$  We both made a quarter-turn. We just turned in different directions.  $\rightarrow$  Whether you turn to the left or right, you are still turning  $90^\circ$ . No one said which way, just that it had to be a quarter-turn.
- T: Face the front of the room. Make two quarter-turns in the same direction.
- S: We are all facing the back of the room!  $\rightarrow$  Two quarter-turns is the same as a half-turn. Some of us started off going to the left, and some started off going to the right, but we all ended up facing the back of the classroom.
- T: We can say that we all did a 180. We were facing one direction, and then we were facing the opposite direction.

**Problem 3: Recognize turning angles in various contexts.**

- T: When a skateboarder does a 180, what does she do?
- S: She spins around to face the other way.
- T: When a car loses control on an icy road and does a 360, what does the car do?
- S: It spins all the way around in a circle.
- T: Turn your pencil a quarter-turn.
- S: (Do so.)
- T: With your partner, come up with an example of something that might turn. Identify the turn using degrees or turns, and then be prepared to report back to the class.
- S: My mom turned up the heat on the stove, so she moved the knob a quarter-turn.  $\rightarrow$  To find the library, walk down to the end of this hall and turn  $90^\circ$  to the right.  $\rightarrow$  The earth does a 360 every day.  $\rightarrow$  When the plug didn't fit into the iPad to charge it, I flipped the charger a half-turn.

### Problem Set (10 minutes)

Students should do their personal best to complete the Problem Set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students should solve these problems using the RDW approach used for Application Problems.

### Student Debrief (10 minutes)

**Lesson Objective:** Identify and measure angles as turns and recognize them in various contexts.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson.

Any combination of the questions below may be used to lead the discussion.

- Why was there confusion with turning  $90^\circ$ , but not with turning  $180^\circ$  or  $360^\circ$ ? How can the terms clockwise and counterclockwise be used in Problem 7?
- Why is there more than one answer for Problem 7?
- Does it matter in Problem 8 if you turned  $180^\circ$  to the right or  $180^\circ$  to the left? Explain.
- What do you notice about the terms used to tell time? (All of the benchmark angles have terms, i.e., half past, quarter of, quarter past.)
- Stand face-to-face with your partner. Ask your partner to turn to the left. Why does it appear to you that she turned to the right? In each problem in this lesson, when someone turns to the right or left, it is from his or her perspective. What does this mean?



#### NOTES ON MULTIPLE MEANS OF ACTION AND EXPRESSION:

Scaffold the Problem Set with the following options:

- Put a dot in the center of the circle to assist with drawing in Problem 5.
- Guide students to count by  $90^\circ$  or fourths up to the desired turn.
- Clarify for English language learners that *quarters* and *fourths* are interchangeable terms.
- For Problem 7, encourage students to actually turn the Problem Set paper and count the quarter-turns to make the picture upright.

**Exit Ticket (3 minutes)**

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help with assessing students’ understanding of the concepts that were presented in today’s lesson and planning more effectively for future lessons. The questions may be read aloud to the students.

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5. John turned the knob of the shower 270° to the right. Draw a picture showing the position of the knob after he turned it.

6. Barb used her scissors to cut out a coupon from the newspaper. How many quarter turns does she need to turn her scissors in order to stay on the lines?

Barb needs to make four quarter-turns.

7. How many quarter turns does the picture need to be rotated in order for it to be upright?

The picture needs to be rotated one quarter-turn to the left or three quarter-turns to the right.

8. Meredith faced north. She turned 90° to the right and then 180° more. In which direction is she now facing?

Meredith is now facing west.

4•8.55

COMMON CORE Lesson 8: Identify and measure angles as turns and recognize them in various contexts. 8/5/13 engage<sup>ny</sup> X.X.2

Name \_\_\_\_\_

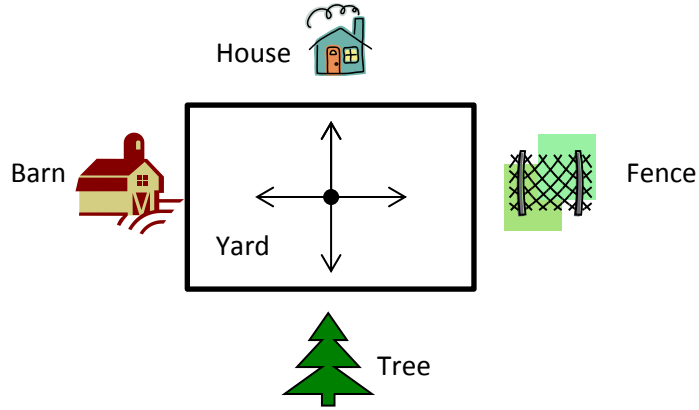
Date \_\_\_\_\_

1. Joe, Steve, and Bob stood in the middle of the yard and faced the house. Joe turned  $90^\circ$  to the right. Steve turned  $180^\circ$  to the right. Bob turned  $270^\circ$  to the right. Name the object that each boy is now facing.

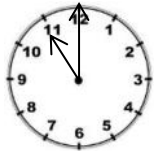
Joe \_\_\_\_\_

Steve \_\_\_\_\_

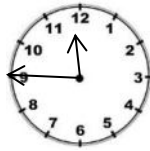
Bob \_\_\_\_\_



2. Monique looked at the clock at the beginning of class and at the end of class. How many degrees did the minute hand turn from the beginning of class until the end?



Beginning



End

3. The skater jumped into the air and did a 360. What does that mean?

4. Mr. Martin drove away from his house without his wallet. He did a 180. Where is he heading now?



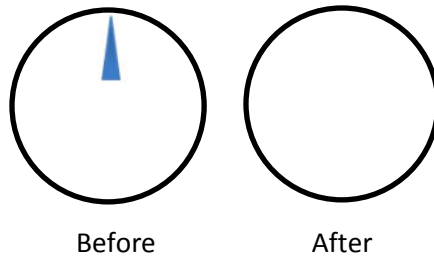
House



Store



5. John turned the knob of the shower 270° to the right. Draw a picture showing the position of the knob after he turned it.



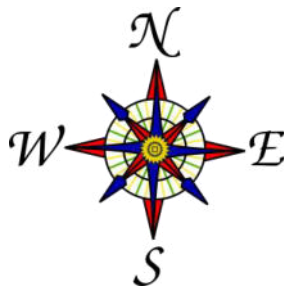
6. Barb used her scissors to cut out a coupon from the newspaper. How many quarter-turns does she need to turn the paper in order to stay on the lines?



7. How many quarter-turns does the picture need to be rotated in order for it to be upright?



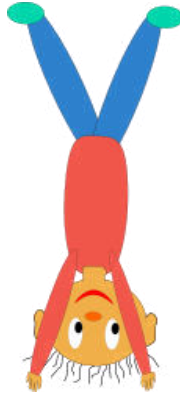
8. Meredith faced north. She turned 90° to the right, and then 180° more. In which direction is she now facing?




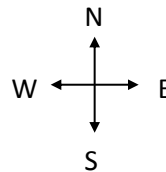
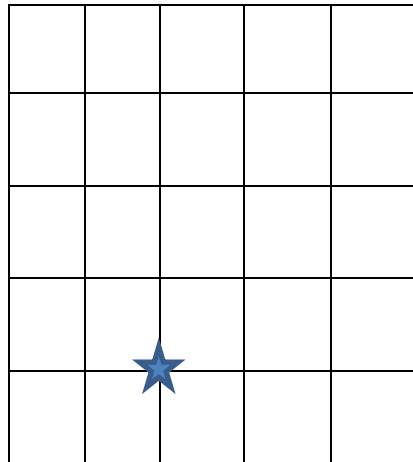
Name \_\_\_\_\_

Date \_\_\_\_\_

- Marty was doing a handstand. Describe how many degrees his body will turn to be upright again.



- Jeffrey started riding his bike at the . He travelled north for 3 blocks, then turned  $90^\circ$  to the right and rode for 2 blocks. In which direction was he headed? Sketch his route on the grid below. Each square unit represents 1 block.



Name \_\_\_\_\_

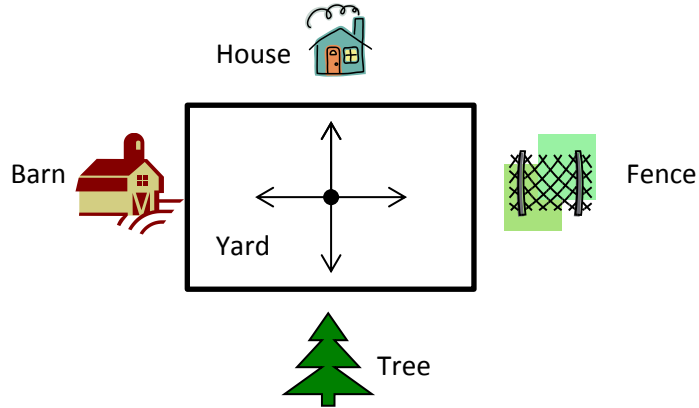
Date \_\_\_\_\_

1. Jill, Shyan, and Barb stood in the middle of the yard and faced the barn. Jill turned  $90^\circ$  to the right. Shyan turned  $180^\circ$  to the left. Barb turned  $270^\circ$  to the left. Name the object that each girl is now facing.

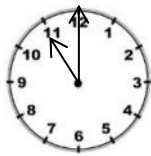
Jill \_\_\_\_\_

Shyan \_\_\_\_\_

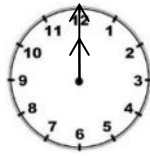
Barb \_\_\_\_\_



2. Allison looked at the clock at the beginning of class and at the end of class. How many degrees did the minute hand turn from the beginning of class until the end?



Beginning

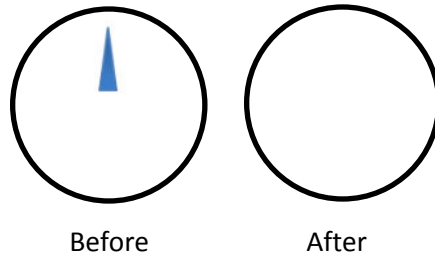


End

3. The snowboarder went off a jump and did a  $180^\circ$ . In which direction was the snowboarder facing when he landed? How do you know?

4. As she drove down the icy road, Mrs. Campbell slammed on her brakes. Her car did a  $360^\circ$ . Explain what happened to Mrs. Campbell's car.

5. Jonah turned the knob of the stove two quarter-turns. Draw a picture showing the position of the knob after he turned it.



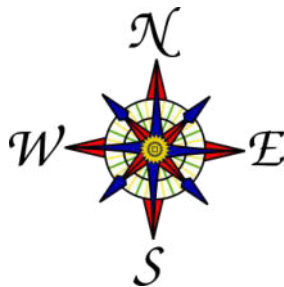
6. Betsy used her scissors to cut out a coupon from the newspaper. How many total quarter-turns will she need to rotate the paper in order to cut out the entire coupon?

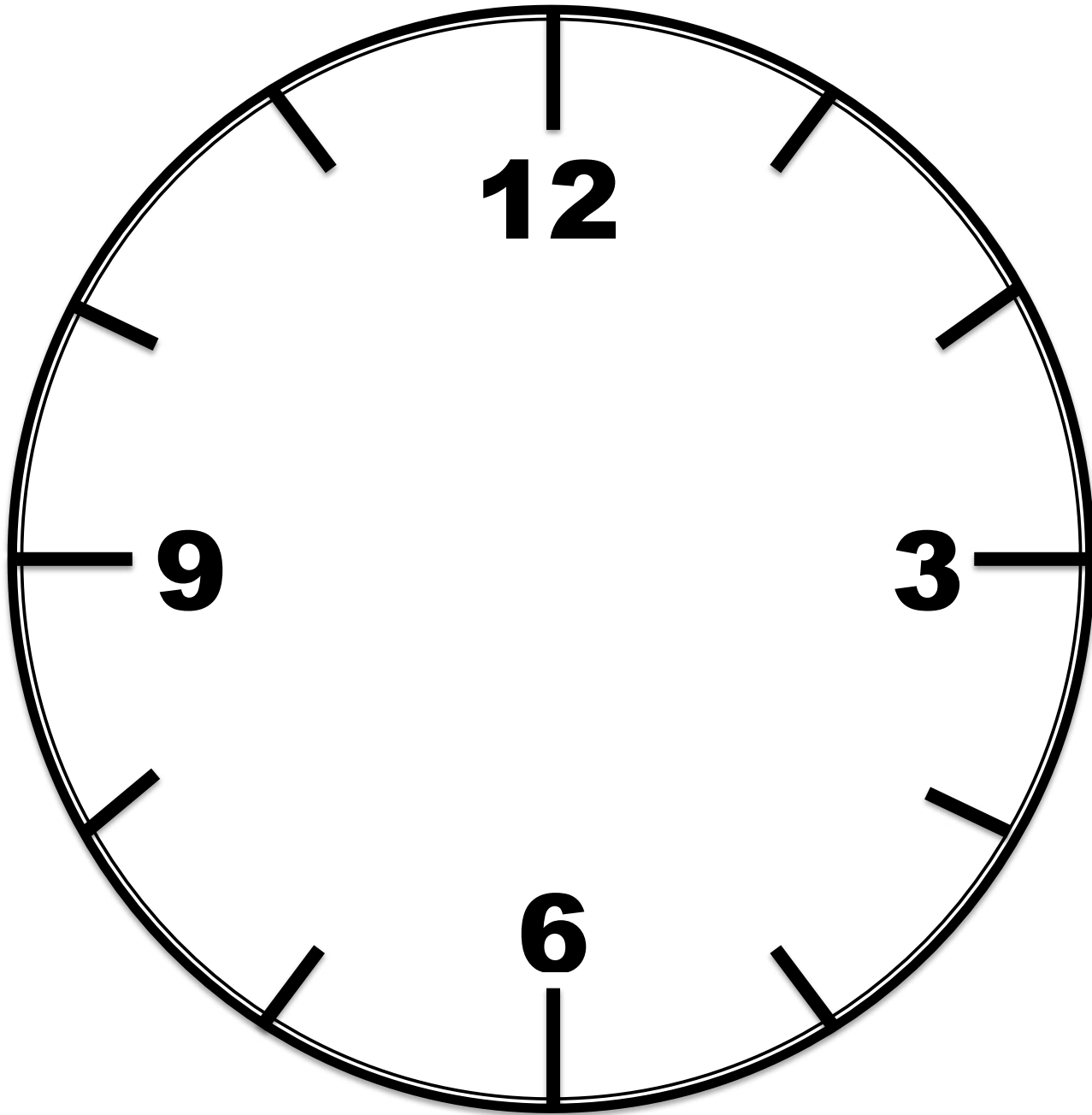


7. How many quarter-turns does the picture need to be rotated in order for it to be upright?



8. David faced north. He turned  $180^\circ$  to the right, and then  $270^\circ$  to the left. In which direction is he now facing?





\_\_\_\_\_

clock