

# ANSWER MAZE

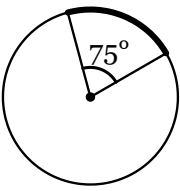
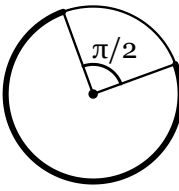


## ARC LENGTH AND RADIAN MEASURE

### Arc Length: How Far Around?

Degrees and radians · radius or diameter · one page · 10–15 minutes · nothing to prepare

FREE

|                                                                                     |                                                                                                                                                                                                                                                          |                                                                                      |                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>3</b> The diameter is 16 cm.</p> <p>Find the length of the heavy arc.</p> <p><b>Arc = 20.9 cm → go to box 4</b></p> <p><b>Arc = 10.5 cm → go to box 7</b></p> <p><i>Hint: Read the words beside the box number. Which length do they give?</i></p> |  | <p><b>7</b> The radius is 3 cm.</p> <p>Find the length of the heavy arc.</p> <p><b>Arc = 14.1 cm → go to box 1</b></p> <p><b>Arc = 4.7 cm → go to box 6</b></p> <p><i>Hint: Put a finger on the heavy arc. Which side of the center holds the mark?</i></p> |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1. **Hand out page 3**, one per student, and a calculator with a  $\pi$  key. Nothing else is needed.
2. **Say this once:** *“Start at box 3. Find the radius first. Find the angle of the heavy arc. Use the  $\pi$  key and round once, at the end, to the nearest tenth. Write every box number in the row at the bottom as you go.”*
3. **Check a sheet quickly.** A student with no mistakes writes **3 7 1 5 8 2**: six boxes, then out.

**Student sheet**    page 3, one per student, and scrap paper for working.  
**Answers**            page 4.

**Every box shows a circle** with two radii, the arc between them drawn heavy, and the angle at the center marked. The words give the radius or the diameter. The arc length is a fraction of the whole way around: the heavy arc's angle  $\div 360^\circ$ , times  $2\pi \times \text{radius}$ . In three boxes the angle is in radians, such as  $\pi/3$ . The student changes it to degrees with  $\pi \text{ radians} = 180^\circ$ , which is on the sheet. This sheet uses these words: the *radian measure* of an angle is its arc length  $\div$  the radius, and the *length* of an arc is a distance, in cm. Some textbooks use other definitions, so tell the class which ones this sheet uses.

**Every wrong answer comes from one of two mistakes.** In the first, the student uses the diameter as the radius and gets twice the length. These wrong answers send the student to box 4. In the second, the student uses the angle of the other arc, without taking it from  $360^\circ$ . These wrong answers send the student to box 6. Boxes 4 and 6 ask the same kind of question again, and both of their answers lead back to the route.

**The row at the bottom is the check.** A clean run is six numbers. Each wrong answer adds at least one more. Guessing does not get a student out: every simple guessing rule, such as always taking the larger number, goes wrong within the first two boxes.



**This is the free lesson this activity came from.** The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.  
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# Answer Maze — how long is the heavy arc?

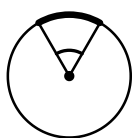
Start at box 3

Name \_\_\_\_\_

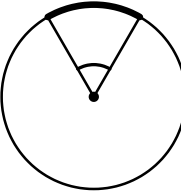
Period \_\_\_\_\_

Date \_\_\_\_\_

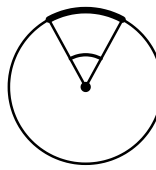
Start at box 3. Find the length of the heavy arc. **Use the  $\pi$  key on your calculator. Round once, at the end, to the nearest tenth of a cm.** Pick one answer and go to the box it names. Write each box number in the row at the bottom as you go.



radius 2 cm, 60°



radius 3 cm, 60°



1 radian

The whole circle is 360°. The whole way around is  $2\pi \times \text{radius}$ . We use this today. Why it is true comes later in the course.

An arc is a fraction of the circle. Its fraction is its angle  $\div 360^\circ$ .

**Radian measure** of an angle = arc length  $\div$  radius. It has no unit.  $\pi$  radians = 180°.

The diameter is twice the radius.

**1 The diameter is 14 cm.**

Find the length of the heavy arc.

**Arc = 14.7 cm → go to box 4**

**Arc = 7.3 cm → go to box 5**

*Hint: Find the radius first. What does a diameter go across?*

**2 The radius is 7 cm.**

Find the length of the heavy arc.

**Arc = 34.2 cm → you are out**

**Arc = 9.8 cm → go to box 6**

*Hint: Which angle belongs to the heavy arc? The two angles share the whole turn.*

**3 The diameter is 16 cm.**

Find the length of the heavy arc.

**Arc = 20.9 cm → go to box 4**

**Arc = 10.5 cm → go to box 7**

*Hint: Read the words beside the box number. Which length do they give?*

**4 The diameter is 10 cm.**

Find the length of the heavy arc.

**Arc = 22.7 cm → go to box 3**

**Arc = 11.3 cm → go to box 7**

*Hint: Read the length in the words. Is it the radius of the circle?*

**5 The radius is 5 cm.**

Find the length of the heavy arc.

**Arc = 9.6 cm → go to box 8**

**Arc = 21.8 cm → go to box 6**

*Hint: Trace the heavy arc with a pencil. Where is the angle mark?*

**6 The radius is 6 cm.**

Find the length of the heavy arc.

**Arc = 9.4 cm → go to box 1**

**Arc = 28.3 cm → go to box 7**

*Hint: Look at the angle mark and the heavy arc. Which side is each one on?*

**7 The radius is 3 cm.**

Find the length of the heavy arc.

**Arc = 14.1 cm → go to box 1**

**Arc = 4.7 cm → go to box 6**

*Hint: Put a finger on the heavy arc. Which side of the center holds the mark?*

**8 The diameter is 22 cm.**

Find the length of the heavy arc.

**Arc = 53.8 cm → go to box 4**

**Arc = 26.9 cm → go to box 2**

*Hint: Check the words: radius or diameter? The radius goes into the whole way around.*

Write every box number here, in order.

|  |  |  |  |  |  |  |  |  |  |
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|--|--|--|--|--|--|--|--|--|--|



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The route, in order. Boxes 4 and 6 are not on it. A student reaches them only by a wrong answer. They are the last two rows of the table. Every length is found with the calculator's  $\pi$  and rounded only at the end, to the nearest tenth of a cm.

**3 → 7 → 1 → 5 → 8 → 2 → out**

|   | The box's question                                                                                                                                              | Right answer, and why                                                                                                                                                                                                                                                                                           | Wrong answer, and why a student picks it                                                                                                   |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>Box 3</b><br>The diameter is 16 cm. The angle at the center is marked $75^\circ$ . Find the length of the heavy arc.                                         | <b>10.5 cm.</b> The radius is half the diameter, 8 cm. The heavy arc turns $75^\circ$ . It is $75/360 = 5/24$ of the circle. The whole way around is $2\pi \times 8 = 16\pi$ cm, so the arc is $5/24 \times 16\pi = 10\pi/3 \approx 10.5$ cm.                                                                   | "20.9 cm" goes to box 4. The diameter 16 is used as the radius: $5/24 \times 2\pi \times 16 = 20\pi/3 \approx 20.9$ cm, twice the length.  |
| 2 | <b>Box 7</b><br>The radius is 3 cm. The angle at the center is marked $\pi/2$ (radians), on the other side of the heavy arc. Find the length of the heavy arc.  | <b>14.1 cm.</b> The mark at the center, $\pi/2$ radians, which is $90^\circ$ , is on the other side. The heavy arc turns $360^\circ - 90^\circ = 270^\circ$ . It is $270/360 = 3/4$ of the circle. The whole way around is $2\pi \times 3 = 6\pi$ cm, so the arc is $3/4 \times 6\pi = 9\pi/2 \approx 14.1$ cm. | "4.7 cm" goes to box 6. The $90^\circ$ at the center belongs to the other arc: $1/4 \times 6\pi = 3\pi/2 \approx 4.7$ cm.                  |
| 3 | <b>Box 1</b><br>The diameter is 14 cm. The angle at the center is marked $\pi/3$ (radians). Find the length of the heavy arc.                                   | <b>7.3 cm.</b> The radius is half the diameter, 7 cm. The heavy arc turns $\pi/3$ radians, which is $60^\circ$ . It is $60/360 = 1/6$ of the circle. The whole way around is $2\pi \times 7 = 14\pi$ cm, so the arc is $1/6 \times 14\pi = 7\pi/3 \approx 7.3$ cm.                                              | "14.7 cm" goes to box 4. The diameter 14 is used as the radius: $1/6 \times 2\pi \times 14 = 14\pi/3 \approx 14.7$ cm, twice the length.   |
| 4 | <b>Box 5</b><br>The radius is 5 cm. The angle at the center is marked $250^\circ$ , on the other side of the heavy arc. Find the length of the heavy arc.       | <b>9.6 cm.</b> The mark at the center, $250^\circ$ , is on the other side. The heavy arc turns $360^\circ - 250^\circ = 110^\circ$ . It is $110/360 = 11/36$ of the circle. The whole way around is $2\pi \times 5 = 10\pi$ cm, so the arc is $11/36 \times 10\pi = 55\pi/18 \approx 9.6$ cm.                   | "21.8 cm" goes to box 6. The $250^\circ$ at the center belongs to the other arc: $25/36 \times 10\pi = 125\pi/18 \approx 21.8$ cm.         |
| 5 | <b>Box 8</b><br>The diameter is 22 cm. The angle at the center is marked $140^\circ$ . Find the length of the heavy arc.                                        | <b>26.9 cm.</b> The radius is half the diameter, 11 cm. The heavy arc turns $140^\circ$ . It is $140/360 = 7/18$ of the circle. The whole way around is $2\pi \times 11 = 22\pi$ cm, so the arc is $7/18 \times 22\pi = 77\pi/9 \approx 26.9$ cm.                                                               | "53.8 cm" goes to box 4. The diameter 22 is used as the radius: $7/18 \times 2\pi \times 22 = 154\pi/9 \approx 53.8$ cm, twice the length. |
| 6 | <b>Box 2</b><br>The radius is 7 cm. The angle at the center is marked $80^\circ$ , on the other side of the heavy arc. Find the length of the heavy arc.        | <b>34.2 cm.</b> The mark at the center, $80^\circ$ , is on the other side. The heavy arc turns $360^\circ - 80^\circ = 280^\circ$ . It is $280/360 = 7/9$ of the circle. The whole way around is $2\pi \times 7 = 14\pi$ cm, so the arc is $7/9 \times 14\pi = 98\pi/9 \approx 34.2$ cm.                        | "9.8 cm" goes to box 6. The $80^\circ$ at the center belongs to the other arc: $2/9 \times 14\pi = 28\pi/9 \approx 9.8$ cm.                |
|   | <b>Box 4</b><br>The diameter is 10 cm. The angle at the center is marked $130^\circ$ . Find the length of the heavy arc.                                        | <b>11.3 cm.</b> The radius is half the diameter, 5 cm. The heavy arc turns $130^\circ$ . It is $130/360 = 13/36$ of the circle. The whole way around is $2\pi \times 5 = 10\pi$ cm, so the arc is $13/36 \times 10\pi = 65\pi/18 \approx 11.3$ cm.                                                              | "22.7 cm" goes to box 3. The diameter 10 is used as the radius: $13/36 \times 2\pi \times 10 = 65\pi/9 \approx 22.7$ cm, twice the length. |
|   | <b>Box 6</b><br>The radius is 6 cm. The angle at the center is marked $3\pi/2$ (radians), on the other side of the heavy arc. Find the length of the heavy arc. | <b>9.4 cm.</b> The mark at the center, $3\pi/2$ radians, which is $270^\circ$ , is on the other side. The heavy arc turns $360^\circ - 270^\circ = 90^\circ$ . It is $90/360 = 1/4$ of the circle. The whole way around is $2\pi \times 6 = 12\pi$ cm, so the arc is $1/4 \times 12\pi = 3\pi \approx 9.4$ cm.  | "28.3 cm" goes to box 7. The $270^\circ$ at the center belongs to the other arc: $3/4 \times 12\pi = 9\pi \approx 28.3$ cm.                |

**How to check any box.** Find the radius: half the diameter, if the words give the diameter. Find the angle of the heavy arc: if the mark at the center is on the other side, take it from  $360^\circ$ . An angle in radians changes to degrees with  $\pi$  radians =  $180^\circ$ . Then the arc is that angle  $\div 360^\circ$ , times  $2\pi \times$  radius.

A student can find the last four boxes of the route by following the arrows backward from "you are out." So ask a student with a clean row to explain one box.