

MYSTERY PICTURE

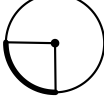
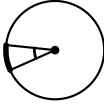
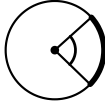
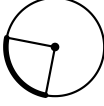
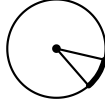
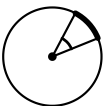
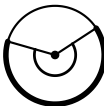
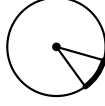


ARC LENGTH AND RADIAN MEASURE

One Radian: Longer Than the Radius?

25 arcs · degrees, radians, lengths · no calculator · a picture appears

FREE

1  The angle is 75° .	2  The angle is 2 radians.	3  The arc is 8 cm long. The diameter is 10 cm.	4  The angle is $2\pi/3$ radians.	5  The angle is 130° .
6  The angle is 25° .	7  The angle is 0.5 radians.	8  The angle is $\pi/6$ radians.	9  The arc is 9 cm long. The radius is 6 cm.	10  The angle is 1.5 radians.
11  The arc is 3 cm long. The radius is 6 cm.	12  The angle is 45° .	13  The arc is 2π cm long. The radius is 4 cm.	14  The angle is 100° .	15  The arc is π cm long. The radius is 5 cm.
16  The angle is 0.7 radians.	17  The angle is $3\pi/4$ radians.	18  The angle is 4 radians.	19  The angle is $\pi/4$ radians.	20  The arc is 4 cm long. The diameter is 12 cm.
21  The arc is 9 cm long. The diameter is 14 cm.	22  The angle is 160° .	23  The angle is $\pi/2$ radians.	24  The angle is 210° .	25  The angle is 2.6 radians.

1. **Give each student page 3** and a pencil. No calculator is needed.
2. **Say this once:** *“One radian is the angle whose arc is as long as the radius. It is about 57° . In each square, is the heavy arc longer than the radius? If yes, fill the square with slanted lines. If no, leave it white.”*
3. **Let them work.** The picture shows when they are right. Nothing else is needed.

Student sheet page 3, one per student. A box at the top shows a 60° arc on two circles, and one radian.
Answers pages 4–5, for you.

Each square shows a circle with an arc drawn heavy, and words that give the angle or the arc's length. The radian measure of an angle is its arc length $\div$ the radius. So the arc is longer than the radius exactly when the angle is more than 1 radian, which is about 57° . Some textbooks use other definitions, so tell the class which ones this sheet uses. Sixteen squares are filled.

The squares give the angle in different ways. An angle in degrees is compared with 57° . An angle in radians is compared with 1. An angle such as $\pi/4$ radians needs π , a little more than 3: $\pi/4$ is less than 1 and $\pi/2$ is more. Where the words give the arc and the radius, the student compares them. Where they give the diameter, the student halves it first: on two filled squares the arc is shorter than the diameter but longer than the radius. An arc of 2π cm is about 6.3 cm, not 2 cm. Every square is drawn true, so the heavy arc turns the angle the words give.

If part of a student's picture looks wrong, the mistake is in that square. Ask: *“How many radii long is this arc? More than one, or less?”* Guessing does not work. Every simple guessing rule, such as filling every square that shows a degree sign, gets at least seven squares wrong.



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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Mystery Picture — longer than the radius?

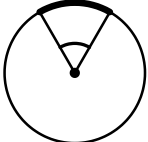
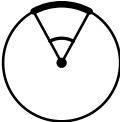
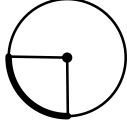
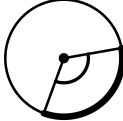
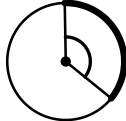
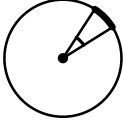
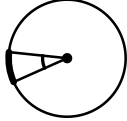
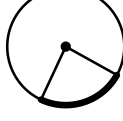
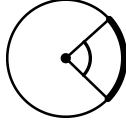
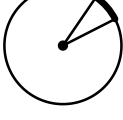
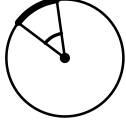
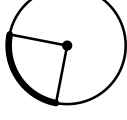
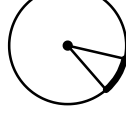
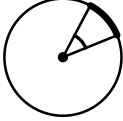
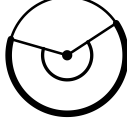
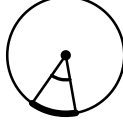
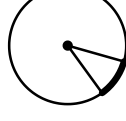
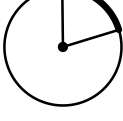
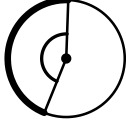
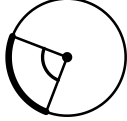
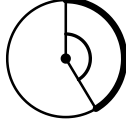
Radian measure

Name _____

Period _____

Date _____

Each square has a circle with a heavy arc. The words give the angle or the arc. **Is the heavy arc longer than the radius?** If yes, fill the square with slanted lines. If no, leave it white. No calculator is needed. **1 radian is about 57° .** A picture appears. If part of it is missing, check that square again.

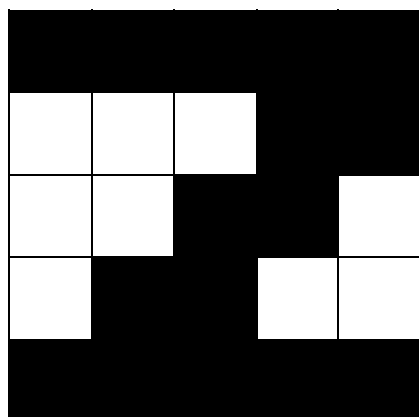
 radius 2 cm, 60°			 radius 3 cm, 60°			 1 radian			Radian measure of an angle = arc length $\div$ radius. It has no unit. π radians = 180°. 1 radian is about 57°. An arc longer than the radius has an angle of more than 1 radian. The diameter is twice the radius.					
1		The angle is 75° .	2		The angle is 2 radians.	3		The arc is 8 cm long. The diameter is 10 cm.	4		The angle is $2\pi/3$ radians.	5		The angle is 130° .
6		The angle is 25° .	7		The angle is 0.5 radians.	8		The angle is $\pi/6$ radians.	9		The arc is 9 cm long. The radius is 6 cm.	10		The angle is 1.5 radians.
11		The arc is 3 cm long. The radius is 6 cm.	12		The angle is 45° .	13		The arc is 2π cm long. The radius is 4 cm.	14		The angle is 100° .	15		The arc is π cm long. The radius is 5 cm.
16		The angle is 0.7 radians.	17		The angle is $3\pi/4$ radians.	18		The angle is 4 radians.	19		The angle is $\pi/4$ radians.	20		The arc is 4 cm long. The diameter is 12 cm.
21		The arc is 9 cm long. The diameter is 14 cm.	22		The angle is 160° .	23		The angle is $\pi/2$ radians.	24		The angle is 210° .	25		The angle is 2.6 radians.



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Mystery Picture — answers

For the teacher



The finished picture is **the letter Z**. Sixteen squares are filled.

A square is filled when its heavy arc is longer than the radius: an angle of more than 1 radian, about 57° . The table gives the reason for every square. It goes on over the page.

	The square says	Answer	Why
1	The angle is 75° .	fill	75° is more than one radian, about 57° , so the arc is longer than the radius.
2	The angle is 2 radians.	fill	2 radians is more than 1 radian, so the arc is longer than the radius (the arc is 2 radii long).
3	The arc is 8 cm long. The diameter is 10 cm.	fill	The radius is half the diameter, 5 cm. The arc, 8 cm, is longer than 5 cm. A student who compares the arc with the diameter, 10 cm, leaves it white by mistake.
4	The angle is $2\pi/3$ radians.	fill	$2\pi/3$ is about 2.09, more than 1, so the arc is longer than the radius.
5	The angle is 130° .	fill	130° is more than one radian, about 57° , so the arc is longer than the radius.
6	The angle is 25° .	white	25° is less than one radian, about 57° , so the arc is shorter than the radius.
7	The angle is 0.5 radians.	white	0.5 radians is less than 1 radian, so the arc is shorter than the radius (the arc is 0.5 radii long).
8	The angle is $\pi/6$ radians.	white	$\pi/6$ is about 0.52, less than 1, so the arc is shorter than the radius.
9	The arc is 9 cm long. The radius is 6 cm.	fill	The arc, 9 cm, is longer than the radius, 6 cm.
10	The angle is 1.5 radians.	fill	1.5 radians is more than 1 radian, so the arc is longer than the radius (the arc is 1.5 radii long).
11	The arc is 3 cm long. The radius is 6 cm.	white	The arc, 3 cm, is shorter than the radius, 6 cm.
12	The angle is 45° .	white	45° is less than one radian, about 57° , so the arc is shorter than the radius.

Mystery Picture — answers, squares 13 to 25

For the teacher

	The square says	Answer	Why
13	The arc is 2π cm long. The radius is 4 cm.	fill	2π cm is about 6.3 cm, longer than the radius, 4 cm.
14	The angle is 100° .	fill	100° is more than one radian, about 57° , so the arc is longer than the radius.
15	The arc is π cm long. The radius is 5 cm.	white	π cm is about 3.1 cm, shorter than the radius, 5 cm.
16	The angle is 0.7 radians.	white	0.7 radians is less than 1 radian, so the arc is shorter than the radius (the arc is 0.7 radii long).
17	The angle is $3\pi/4$ radians.	fill	$3\pi/4$ is about 2.36, more than 1, so the arc is longer than the radius.
18	The angle is 4 radians.	fill	4 radians is more than 1 radian, so the arc is longer than the radius (the arc is 4 radii long).
19	The angle is $\pi/4$ radians.	white	$\pi/4$ is about 0.79, less than 1, so the arc is shorter than the radius.
20	The arc is 4 cm long. The diameter is 12 cm.	white	The radius is half the diameter, 6 cm. The arc, 4 cm, is shorter than 6 cm.
21	The arc is 9 cm long. The diameter is 14 cm.	fill	The radius is half the diameter, 7 cm. The arc, 9 cm, is longer than 7 cm. A student who compares the arc with the diameter, 14 cm, leaves it white by mistake.
22	The angle is 160° .	fill	160° is more than one radian, about 57° , so the arc is longer than the radius.
23	The angle is $\pi/2$ radians.	fill	$\pi/2$ is about 1.57, more than 1, so the arc is longer than the radius.
24	The angle is 210° .	fill	210° is more than one radian, about 57° , so the arc is longer than the radius.
25	The angle is 2.6 radians.	fill	2.6 radians is more than 1 radian, so the arc is longer than the radius (the arc is 2.6 radii long).