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Circles: Arc Lengths and Areas of a Sector

An **arc** is an unbroken part of a circle consisting of all points on a circle located between two endpoints. There are three classifications of arcs: the *minor arc*, the *major arc*, and the *semicircle*. **Arc length** is the distance along an arc measured in linear units. It is calculated by multiplying the circumference (2πr) by the angle of the arc divided by the total number of possible angles in a circle.

$$L = 2\pi r\ (^{m^\circ}/_{360^\circ}) \qquad \text{Circumference}\left(\frac{\text{Angle measure of the arc}}{\text{Total degrees in a circle}}\right)$$

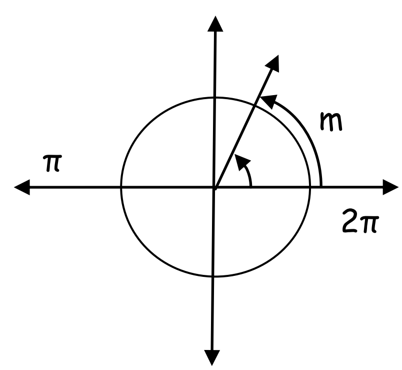
A **sector** is a region bound by two radii of the circle and their intercepted arc. We can use the following formula to find the **area of a sector**:

$$A = \pi r^2\ (^{m^\circ}/_{360^\circ}) \qquad \text{Area of circle}\left(\frac{\text{Angle measure of the arc}}{\text{Total degrees in a circle}}\right)$$

Did you notice the similarities between the two formulas? Both use the proportion of angle measures in order to derive the desired information. A similar system was established using **radians**.

Radians determine a sector's area in proportion to the rest of a circle. In a circle with radius r and center at the origin, one radian is the measure of an angle in standard position whose terminal side intercepts an arc with length m.

Radians are angle measurements separate from degrees, so that 360° converts to 2π radians and 180° converts to π radians.



We can use this proportion to convert radian angle measure to degrees and vice-versa.

Degrees to Radians:
Multiply degree measure by $\dfrac{\pi \text{ radians}}{180^\circ}$

Radians to Degrees:
Multiply radian measure by $\dfrac{180^\circ}{\pi \text{ radians}}$

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Practice. Calculate the arc length using the given information.

1. r = 6
   m = 60

2. r = 10
   m = 30

3. r = 3
   m = 90

4. r = 15
   m = 12

Practice. Calculate the area of the sector using the given information.

5. r = 7
   m = 60

6. r = 29
   m = 18

7. r = 19
   m = 120

8. r = 28
   m = 180

Practice. Convert from radians to degrees, or degrees to radians.

9. 120°

10. $\frac{\pi}{3}$

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Answer Key

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1. 6.28
2. 5.23
3, 4.71
4. 3.14
5. 25.64
6. 132.04
7. 377.85
8. 1230.88
9. $^{2\pi}/_{3}$
10. 60°