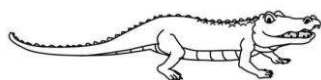


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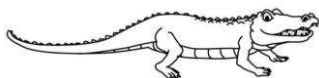
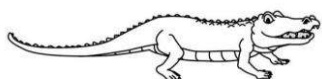


Table of Contents with Benchmarks

Geometric Reasoning	10
Prove and apply geometric theorems to solve problems.	
MA.912.GR.1.1	13
Prove relationships and theorems about lines and angles. Solve mathematical and real-world problems involving postulates, relationships and theorems of lines and angles.	
MA.912.GR.1.2	21
Prove triangle congruence or similarity using Side-Side-Side, Side-Angle-Side, Angle-Side-Angle, Angle-Angle-Side, Angle-Angle and Hypotenuse-Leg.	
MA.912.GR.1.3	32
Prove relationships and theorems about triangles. Solve mathematical and real-world problems involving postulates, relationships and theorems of triangles.	
MA.912.GR.1.4	44
Prove relationships and theorems about parallelograms. Solve mathematical and real-world problems involving postulates, relationships and theorems of parallelograms.	
MA.912.GR.1.5	52
Prove relationships and theorems about trapezoids. Solve mathematical and real-world problems involving postulates, relationships and theorems of trapezoids.	
MA.912.GR.1.6	57
Solve mathematical and real-world problems involving congruence or similarity in two-dimensional figures.	
Apply properties of transformations to describe congruence or similarity.	
MA.912.GR.2.1	65
Given a preimage and image, describe the transformation and represent the transformation algebraically using coordinates.	
MA.912.GR.2.2	74
Identify transformations that do or do not preserve distance.	



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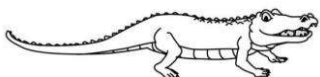
MA.912.GR.2.3	77
Identify a sequence of transformations that will map a given figure onto itself or onto another congruent or similar figure.	
MA.912.GR.2.5	82
Given a geometric figure and a sequence of transformations, draw the transformed figure on a coordinate plane.	
MA.912.GR.2.6	87
Apply rigid transformations to map one figure onto another to justify that the two figures are congruent.	
MA.912.GR.2.8	92
Apply an appropriate transformation to map one figure onto another to justify that the two figures are similar.	

Use coordinate geometry to solve problems or prove relationships.

MA.912.GR.3.1	98
Determine the weighted average of two or more points on a line.	
MA.912.GR.3.2	101
Given a mathematical context, use coordinate geometry to classify or justify definitions, properties and theorems involving circles, triangles or quadrilaterals.	
MA.912.GR.3.3	109
Use coordinate geometry to solve mathematical and real-world geometric problems involving lines, circles, triangles and quadrilaterals.	
MA.912.GR.3.4	120
Use coordinate geometry to solve mathematical and real-world problems on the coordinate plane involving perimeter or area of polygons.	

Use geometric measurement and dimensions to solve problems.

MA.912.GR.4.1	128
Identify the shapes of two-dimensional cross-sections of three-dimensional figures.	
MA.912.GR.4.2	133
Identify three-dimensional objects generated by rotations of two-dimensional figures.	



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MA.912.GR.4.3 138

Extend previous understanding of scale drawings and scale factors to determine how dilations affect the area of two-dimensional figures and the surface area or volume of three-dimensional figures.

MA.912.GR.4.4 144

Solve mathematical and real-world problems involving area of two-dimensional figures.

MA.912.GR.4.5 152

Solve mathematical and real-world problems involving the volume of three-dimensional figures limited to cylinders, pyramids, prisms, cones and spheres.

MA.912.GR.4.6 162

Solve mathematical and real-world problems involving the surface area of three-dimensional figures limited to cylinders, pyramids, prisms, cones and spheres.

Make formal geometric constructions with a variety of tools and methods.

MA.912.GR.5.1 167

Construct a copy of a segment or an angle.

MA.912.GR.5.2 173

Construct the bisector of a segment or an angle, including the perpendicular bisector of a line segment.

MA.912.GR.5.3 178

Construct the inscribed and circumscribed circles of a triangle.

Use properties and theorems related to circles.

MA.912.GR.6.1 184

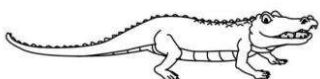
Solve mathematical and real-world problems involving the length of a secant, tangent, segment or chord in a given circle.

MA.912.GR.6.2 190

Solve mathematical and real-world problems involving the measures of arcs and related angles.

MA.912.GR.6.3 199

Solve mathematical problems involving triangles and quadrilaterals inscribed in a circle.



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MA.912.GR.6.4	208
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Solve mathematical and real-world problems involving the arc length and area of a sector in a given circle.

Apply geometric and algebraic representations of conic sections.

MA.912.GR.7.2	213
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Given a mathematical or real-world context, derive and create the equation of a circle using key features.

MA.912.GR.7.3	220
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Graph and solve mathematical and real-world problems that are modeled with an equation of a circle. Determine and interpret key features in terms of the context.

Trigonometry	224
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Define and use trigonometric ratios, identities or functions to solve problems.

MA.912.T.1.1	225
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Define trigonometric ratios for acute angles in right triangles.

MA.912.T.1.2	232
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Solve mathematical and real-world problems involving right triangles using trigonometric ratios and the Pythagorean Theorem.

Logic and Discrete Theory	240
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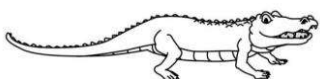
Develop an understanding of the fundamentals of propositional logic, arguments and methods of proof.

MA.912.LT.4.3	241
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Identify and accurately interpret “if...then”, “if and only if”, “all” and “not” statements. Find the converse, inverse and contrapositive of a statement.

MA.912.LT.4.10	246
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Judge the validity of arguments and give counterexamples to disprove statements.



Arc and Angle Measures

Use properties and theorems related to circles.

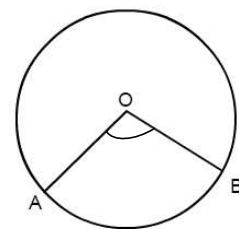
Solve mathematical and real-world problems involving the measures of arcs and related angles.

Central Angle

An angle whose vertex is the center of the circle and whose sides are radii of the circle is called a central angle.

In the figure, $\angle AOB$ is a central angle. The measure of a central angle is equal to the measure of the arc it intercepts.

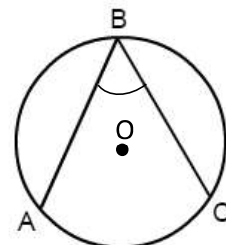
$$m\angle AOB = m\widehat{AB}$$



Inscribed Angle

An inscribed angle of a circle is an angle made by any two chords of the circle and whose vertex is a point on the circle.

Inscribed angle $\angle ABC$ is shown in circle O.



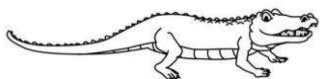
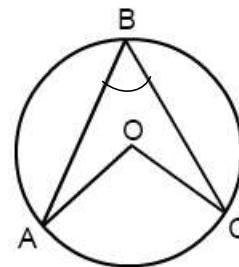
Inscribed Angle Theorem

The inscribed angle theorem states that an inscribed angle is equal to one half the measure of its intercepted arc.

$$m\angle ABC = \frac{1}{2} m\widehat{AC}$$

Additionally, if a central angle is equal to its intercepted arc, then an inscribed angle, intersecting the same arc as the central angle, will be equal to half the measure of the central angle.

$$m\angle ABC = \frac{1}{2} (m\angle AOC)$$

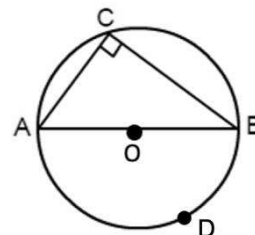


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Geometric Reasoning – MA.912.GR.6.2

Inscribed Angle on Diameter

When an inscribed angle intercepts a semicircle, the inscribed angle is a right angle.

$$m\angle ACB = \frac{1}{2}(m\widehat{ADB}) = \frac{1}{2}(180^\circ) = 90^\circ$$



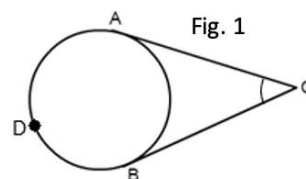
Exterior Angles of a Circle

An exterior angle of a circle is an angle formed by two tangents, a tangent and a secant, or two secants that intersect outside a circle.

The exterior angle of a circle is equal to half the difference of the measures of the intercepted arcs.

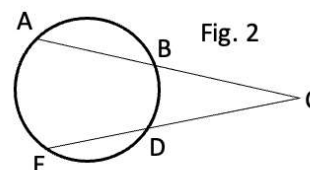
In figure 1, $\angle ACB$ is the exterior angle between the two tangents \overline{AC} and \overline{BC} . The intercepted arcs are \widehat{ADB} and \widehat{AB} .

$$m\angle ACB = \frac{1}{2}(m\widehat{ADB} - m\widehat{AB})$$



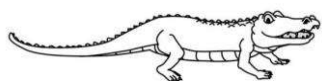
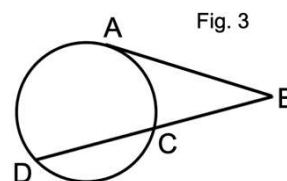
In figure 2, $\angle ACE$ is the exterior angle between the two secants \overline{AC} and \overline{EC} . The intercepted arcs are \widehat{AE} and \widehat{BD} .

$$m\angle ACE = \frac{1}{2}(m\widehat{AE} - m\widehat{BD})$$



In figure 3, $\angle ABD$ is the exterior angle between tangent \overline{AB} and secant \overline{BD} . The intercepted arcs are \widehat{AD} and \widehat{AC} .

$$m\angle ABD = \frac{1}{2}(m\widehat{AD} - m\widehat{AC})$$

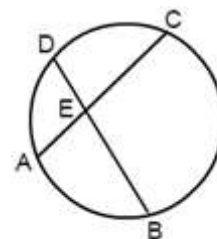


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Geometric Reasoning – MA.912.GR.6.2

Angles formed inside the circle by two intersecting chords

When two chords intersect inside a circle, four angles are formed. In the figure, we can see chords \overline{AC} and \overline{BD} are intersecting inside the circle at point E . Two pairs of vertical angles are formed at point E .

Each angle measure is equal to half the sum of the measures of the intercepted arcs.



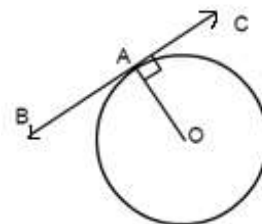
$$m\angle DEA = m\angle BEC = \frac{1}{2}(m\widehat{AD} + m\widehat{BC})$$

$$m\angle DEC = m\angle AEB = \frac{1}{2}(m\widehat{DC} + m\widehat{AB})$$

Radius and Tangent of a Circle

The radius of a circle is always perpendicular to a tangent line at the point of tangency.

In the figure, the radius \overline{OA} is perpendicular to the tangent \overleftrightarrow{BC} at point A .



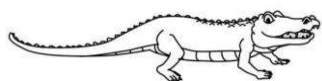
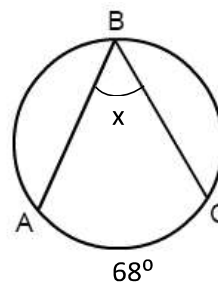
Example 1:

Find $m\angle ABC$, represented by x , if $m\widehat{AC} = 68^\circ$.

Solution:

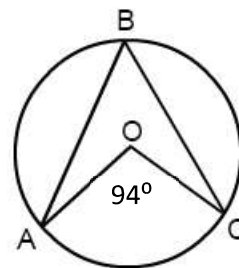
$\angle ABC$ is an inscribed angle. An inscribed angle is equal to half the measure of the intercepted arc.

$$\begin{aligned} m\angle ABC &= \frac{1}{2}(m\widehat{AC}) \\ &= \frac{1}{2}(68^\circ) \\ &= 34^\circ \end{aligned}$$



Example 2:

If $m\angle AOC = 94^\circ$, find $m\angle ABC$ and $m\widehat{AC}$.



Solution:

$\angle ABC$ is an inscribed angle and $\angle AOC$ is a central angle. If an inscribed angle and a central angle intersect the same arc, then the measure of the inscribed angle is equal to half the measure of the central angle.

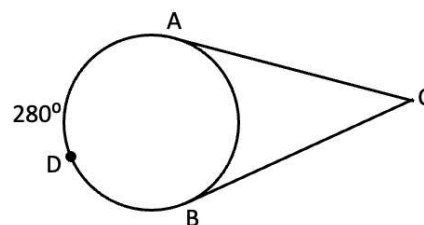
$$\begin{aligned} m\angle ABC &= \frac{1}{2}(m\angle AOC) \\ &= \frac{1}{2}(94^\circ) \\ &= 47^\circ \end{aligned}$$

The measure of the arc intercepted by the central angle is always equal to the measure of the central angle.

$$m\widehat{AC} = m\angle AOC = 94^\circ$$

Example 3:

In the given figure, find $m\angle ACB$.

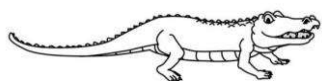


Solution:

$\angle ACB$ is an exterior angle. The measure of an exterior angle of a circle is equal to half the difference of the measures of its intercepted arcs.

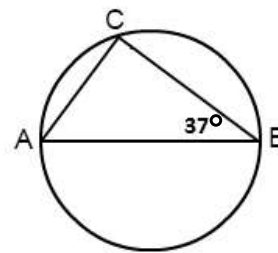
$$m\widehat{AB} = 360^\circ - 280^\circ = 80^\circ$$

$$\begin{aligned} m\angle ACB &= \frac{1}{2}(m\widehat{ADB} - m\widehat{AB}) \\ &= \frac{1}{2}(280^\circ - 80^\circ) \\ &= \frac{1}{2}(200^\circ) = 100^\circ \end{aligned}$$



Example 4:

Find $m\angle BAC$, if $m\angle ABC = 37^\circ$ and \overline{AB} is a diameter of the circle.



Solution:

An inscribed angle intercepting the diameter of the circle is a right angle, so $m\angle ACB = 90^\circ$

Consider the $\triangle ACB$.

$$m\angle ACB + m\angle ABC + m\angle BAC = 180^\circ$$

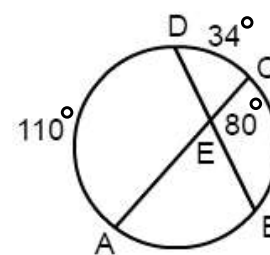
$$90^\circ + 37^\circ + m\angle BAC = 180^\circ$$

$$127^\circ + m\angle BAC = 180^\circ$$

$$m\angle BAC = 53^\circ$$

Example 5:

In the figure, $\widehat{AD} = 110^\circ$, $m\angle BEC = 80^\circ$, $m\widehat{DC} = 34^\circ$. Find $m\widehat{BC}$ and $m\widehat{AB}$.



Solution:

The measure of an interior angle made by two intersecting chords is equal to half the sum of the measures of its intercepted arcs.

$$m\angle BEC = \frac{1}{2}(m\widehat{AD} + m\widehat{BC})$$

$$80^\circ = \frac{1}{2}(110^\circ + m\widehat{BC})$$

$$160^\circ = 110^\circ + m\widehat{BC}$$

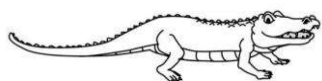
$$m\widehat{BC} = 50^\circ$$

$$m\widehat{AB} + m\widehat{BC} + m\widehat{CD} + m\widehat{DA} = 360^\circ$$

$$m\widehat{AB} + 50^\circ + 34^\circ + 110^\circ = 360^\circ$$

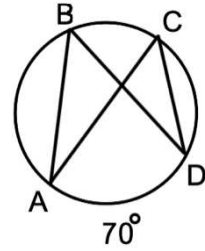
$$m\widehat{AB} + 194 = 360^\circ$$

$$m\widehat{AB} = 166^\circ$$



Example 6:

In the figure, $\widehat{AD} = 70^\circ$. Find $m\angle ABD$ and $m\angle ACD$.

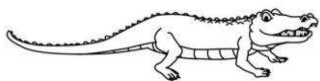


Solution:

$\angle ABD$ and $\angle ACD$ are both inscribed angles with the same intercepted arc, \widehat{AD} . The measure of an inscribed angle is equal to half the measure of its intercepted arc.

$$m\angle ABD = m\angle ACD = \frac{1}{2}(70^\circ) = 35^\circ$$

Note: Inscribed angles that intercept the same arc will always be congruent.

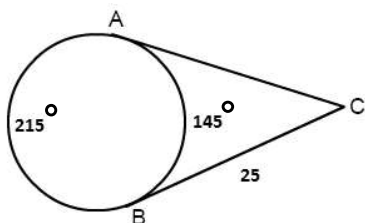


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Geometric Reasoning – MA.912.GR.6.2

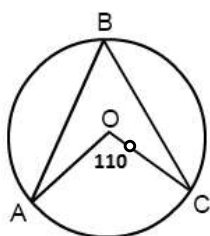
Now Try These:

For 1 – 2, Equation Editor

1. Use the figure below. Write and solve an equation to find $m\angle ACB$.

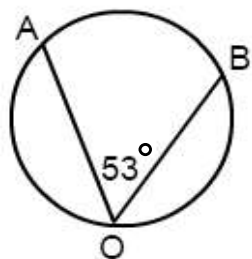


2. If $m\angle AOC = 110^\circ$, what is the $m\angle ABC$ in the diagram below?



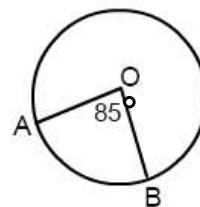
For 3 – 4, GRID

3. In the given figure, the measure of inscribed angle AOB is 53° . Draw another inscribed angle in the same circle congruent to $\angle AOB$.



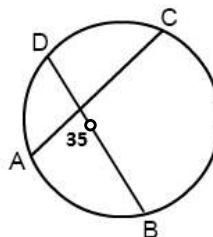
4. $\angle AOB$ is a central angle and $m\angle AOB = 85^\circ$.

Use circle O to draw an inscribed angle whose measure is half the measure of $\angle AOB$.



For 5 – 6, Multiple Choice

5. Based on the figure below, which statement is correct?



- A. $35^\circ = \frac{1}{2}(m\widehat{AD} + m\widehat{BC})$
 B. $35^\circ = \frac{1}{2}(m\widehat{AB} - m\widehat{DC})$
 C. $35^\circ = \frac{1}{2}(m\widehat{AB} + m\widehat{DC})$
 D. $35^\circ = \frac{1}{2}(m\widehat{AD} - m\widehat{BC})$
6. If x represents the measure of an inscribed angle of a circle and y represents the measure of the arc intercepted by the inscribed angle, then which of the following statements is true?
- A. $x = y$
 B. $x = y/2$
 C. $y = x/2$
 D. $x = 2y$

