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1. 010510b, P.I. G.G.51

A small fragment of something brittle, such as pottery, is called a shard. The accompanying diagram represents the outline of a shard from a small round plate that was found at an archaeological dig.

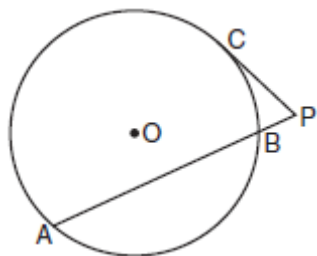


If \overline{BC} is a tangent to \widehat{AB} at B and $m\angle ABC = 45$, what is the measure of \widehat{AB} , the outside edge of the shard?

[A] 225° [B] 45° [C] 135° [D] 90°

2. 080925b, P.I. G.G.51

In the accompanying diagram of circle O , \overline{PC} is a tangent, \overline{PBA} is a secant, $m\widehat{AB} = 132$, and $m\widehat{CB} = 46$. Find $m\angle P$.

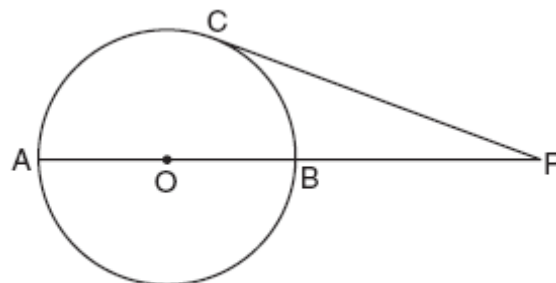


3. 060132b, P.I. G.G.51

Point P lies outside circle O , which has a diameter of \overline{AOC} . The angle formed by tangent \overline{PA} and secant \overline{PBC} measures 30° . Sketch the conditions given above and find the number of degrees in the measure of minor arc CB .

4. 010721b, P.I. G.G.51

In the accompanying diagram of circle O , diameter \overline{AOB} is extended through B to external point P , tangent \overline{PC} is drawn to point C on the circle, and $m\widehat{AC} : m\widehat{BC} = 7 : 2$. Find $m\angle CPA$.

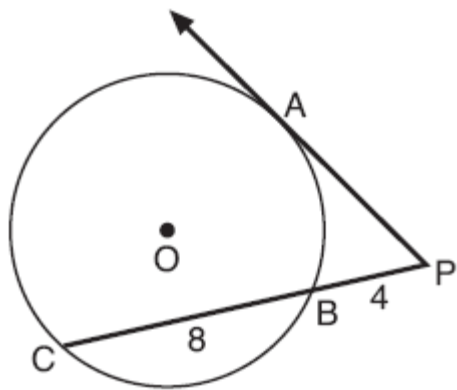


(Not drawn to scale)

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5. 080719b, P.I. G.G.53

In the accompanying diagram, \overline{PA} is tangent to circle O at A , \overline{PBC} is a secant, $PB = 4$, and $BC = 8$.

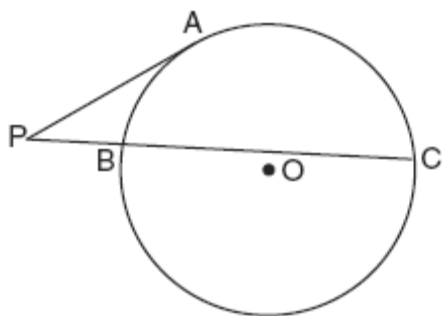


What is the length of \overline{PA} ?

- [A] 4 [B] $4\sqrt{2}$ [C] $4\sqrt{3}$ [D] $4\sqrt{6}$

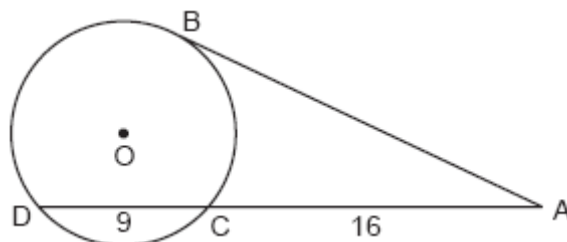
6. 010623b, P.I. G.G.53

In the accompanying diagram, \overline{PA} is tangent to circle O at A , secant \overline{PBC} is drawn, $PB = 4$, and $BC = 12$. Find PA .



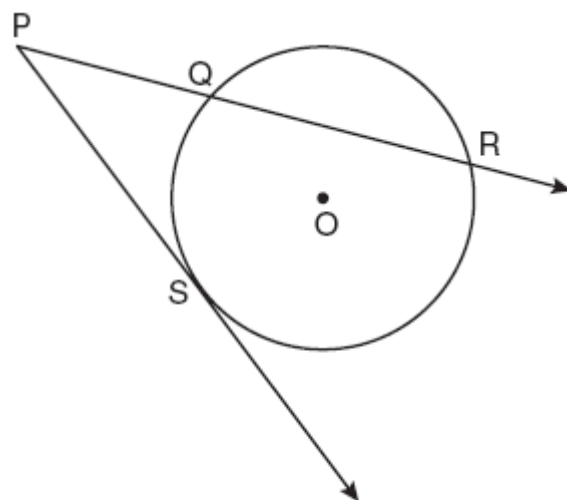
7. 010821b, P.I. G.G.53

In the accompanying diagram, \overline{AB} is tangent to circle O at B . If $AC = 16$ and $CD = 9$, what is the length of \overline{AB} ?



8. fall0817ge, P.I. G.G.53

In the diagram below, \overline{PS} is a tangent to circle O at point S , \overline{PQR} is a secant, $PS = x$, $PQ = 3$, and $PR = x + 18$.



(Not drawn to scale)

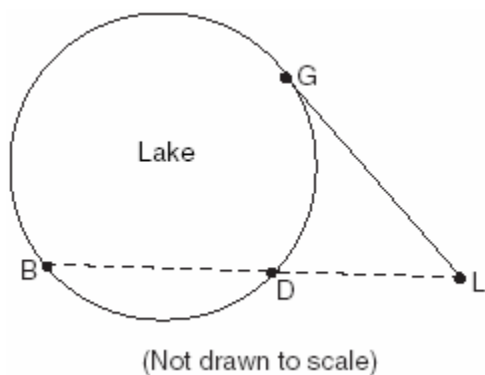
What is the length of \overline{PS} ?

- [A] 6 [B] 27 [C] 3 [D] 9

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9. 080103b, P.I. G.G.53

In the accompanying diagram, cabins B and G are located on the shore of a circular lake, and cabin L is located near the lake. Point D is a dock on the lake shore and is collinear with cabins B and L . The road between cabins G and L is 8 miles long and is tangent to the lake. The path between cabin L and dock D is 4 miles long.

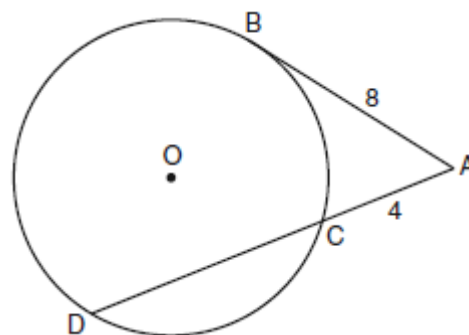


What is the length, in miles, of \overline{BD} ?

- [A] 24 [B] 12 [C] 4 [D] 8

10. 060916ge, P.I. G.G.53

In the diagram below, tangent \overline{AB} and secant \overline{ACD} are drawn to circle O from an external point A , $AB = 8$, and $AC = 4$.



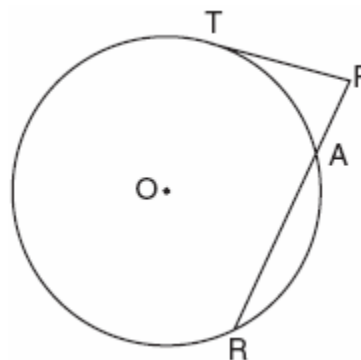
What is the length of \overline{CD} ?

- [A] 10 [B] 16 [C] 13 [D] 12

11. 060433b, P.I. G.G.53

The accompanying diagram shows a circular machine part that has rods \overline{PT} and \overline{PAR} attached at points T , A , and R , which are located on the circle;

$m\widehat{TA} : m\widehat{AR} : m\widehat{RT} = 1 : 3 : 5$; $RA = 12$ centimeters; and $PA = 5$ centimeters.

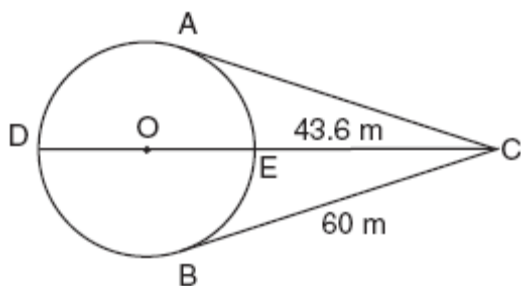


Find the measure of $\angle P$, in degrees, and find the length of rod \overline{PT} , to the nearest tenth of a centimeter.

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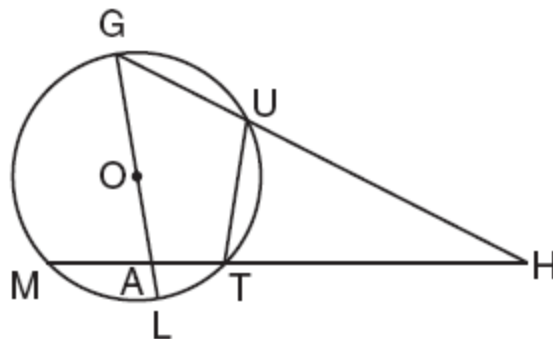
12. 060534b, P.I. G.G.53

An architect is designing a park with an entrance represented by point C and a circular garden with center O , as shown in the accompanying diagram. The architect plans to connect three points on the circumference of the garden, A , B , and D , to the park entrance, C , with walkways so that walkways \overline{CA} and \overline{CB} are tangent to the garden, walkway \overline{DOEC} is a path through the center of the garden, $m\widehat{ADB}:m\widehat{AEB}=3:2$, $BC = 60$ meters, and $EC = 43.6$ meters. Find the measure of the angle between walkways \overline{CA} and \overline{CB} . Find the diameter of the circular garden, to the nearest meter.



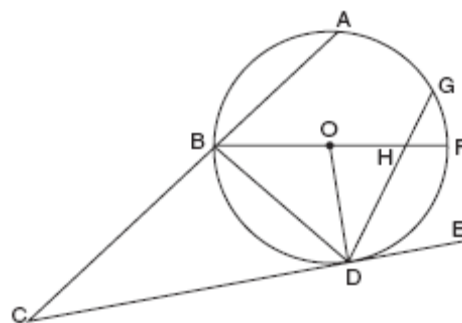
13. 080333b, P.I. G.G.51

Given circle O with diameter \overline{GOAL} ; secants \overline{HUG} and \overline{HTAM} intersect at point H ; $m\widehat{GM}:m\widehat{ML}:m\widehat{LT}=7:3:2$; and chord $\overline{GU} \cong$ chord \overline{UT} . Find the ratio of $m\angle UGL$ to $m\angle H$.



14. 080633b, P.I. G.G.51

In the accompanying diagram, circle O has radius \overline{OD} , diameter \overline{BOHF} , secant \overline{CBA} , and chords \overline{DHG} and \overline{BD} ; \overline{CE} is tangent to circle O at D ; $m\widehat{DF} = 80$; and $m\widehat{BA}:m\widehat{AG}:m\widehat{GF}=3:2:1$. Find $m\widehat{GF}$, and $m\angle BHD$, $m\angle BDG$, $m\angle GDE$, $m\angle C$, and $m\angle BOD$.



[1] D _____

[2] 68, and appropriate work is shown.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] 68, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[2] incorrect procedure.

[4] 60° , and an appropriate sketch is drawn, and appropriate work is shown.

[3] A correct sketch is shown, and $m\widehat{AB}$ is correct.

or [3] A correct sketch is shown, but one computational error is made, leading to an incorrect $m\widehat{AB}$, but $m\widehat{CB}$ is appropriate,

based on the incorrect $m\widehat{AB}$.

[2] A correct sketch is shown, but an incorrect procedure is used to find either the correct or incorrect $m\widehat{AB}$, but $m\widehat{CB}$ is appropriate,

based on the incorrect $m\widehat{AB}$.

or [2] An incorrect sketch is shown, but an appropriate $m\widehat{CB}$ is found, based on the incorrect sketch.

[1] Only a correct sketch is shown.

or [1] 60° , but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[3] incorrect procedure.

[2] 50, and appropriate work is shown, such as $m\widehat{AC} = 140$, $m\widehat{BC} = 40$, and

$$m\angle CPA = \frac{1}{2}(140 - 40).$$

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] $m\widehat{AC}$ and $m\widehat{BC}$ are found correctly, but no further correct work is shown.

or [1] 50, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[4] incorrect procedure.

[5] C _____

[2] 8, and appropriate work is shown, such as $(PA)^2 = 4 \times 16 = 64$.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as failing to reject the negative root.

or [1] 8, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[6] incorrect procedure.

[2] 20, and appropriate work is shown.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] A correct equation is written, but no further correct work is shown.

or [1] 20, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[7] incorrect procedure.

[8] D _____

[9] B _____

[10] D _____

[6] 80 and 9.2, and appropriate work is shown.

[5] Appropriate work is shown, but one computational or rounding error is made.

[4] Appropriate work is shown, but two or more computational or rounding errors are made.

or [4] Appropriate work is shown, but one conceptual error is made in solving for one of the values.

or [4] 80, and appropriate work is shown, but the length of \overline{PT} is not found or is found incorrectly.

or [4] The measure of all three arcs and the length of \overline{PT} are found correctly, but the measure of $\angle P$ is not found or is found incorrectly.

[3] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

[2] Appropriate work is shown, but one conceptual error is made in solving for each value.

or [2] 80 and 9.2, but no work is shown.

or [2] 9.2, and appropriate work is shown, but no further correct work is shown.

or [2] The measures of all three arcs are found correctly, but no further correct work is shown.

[1] 80 or 9.2, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[11] incorrect procedure.

[6] $m\angle ACB = 36$ and $DOE = 39$, and appropriate work is shown. [If trigonometry is used to find that $m\angle ACB = 35.98138002$, allow full credit for the full display of the calculator or any correctly rounded response.]

[5] Appropriate work is shown, but one computational or rounding error is made.

[4] Appropriate work is shown, but two or more computational or rounding errors are made.

[3] Appropriate work is shown, but one conceptual error is made.

or [3] $m\angle ACB = 36$, and appropriate work is shown, but no further correct work is shown.

or [3] $DOE = 39$, and appropriate work is shown, but no further correct work is shown.

[2] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

or [2] $m\angle ACB = 36$ and $DOE = 39$, but no work is shown.

[1] The measures of the arcs are found correctly, but no further correct work is shown.

or [1] $m\angle ACB = 36$ or $DOE = 39$, but no work is shown.

[0] 36 and 39, but no work is shown and the answers are not labeled.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[12] obviously incorrect procedure.

- [6] $\frac{2}{1}$ or 2:1 or an equivalent ratio, and appropriate work is shown.
- [5] Appropriate work is shown, but one computational error is made, but an appropriate ratio is found.
- or [5] Appropriate work is shown, but the answer is not written as a ratio.
- or [5] Appropriate work is shown, but the ratio is reversed or is simplified incorrectly.
- [4] Appropriate work is shown, but two or more computational errors are made, but an appropriate ratio is found.
- or [4] Correct measures are found for all the arcs and the angles, and appropriate work is shown, but no ratio is found.
- or [4] Correct measures are found for all the arcs, but the measure of one angle is found incorrectly, but an appropriate ratio is found.
- [3] One conceptual error is made, but appropriate work is shown, and an appropriate ratio is found.
- or [3] Correct measures are found for all the arcs, but the measures of both angles are found incorrectly, but an appropriate ratio is found.
- [2] Correct measures are found for all the arcs, but no further correct work is shown.
- [1] Only the value of x is found correctly, and appropriate work is shown.
- or [1] $\frac{2}{1}$ or 2:1 or an equivalent ratio, but no work is shown.
- [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [13]

- [6] $m\widehat{GF} = 30$, $m\angle BHD = 65$, $m\angle BDG = 75$, $m\angle GDE = 55$, $m\angle C = 35$, and $m\angle BOD = 100$, and appropriate work is shown.
- [5] $m\widehat{GF}$ is determined correctly, but $m\widehat{BD}$ is determined incorrectly, but all five of the angle measures are determined appropriately.
- or [5] $m\widehat{GF}$ is determined incorrectly, but all five of the angle measures are determined appropriately, based on the incorrect arc measure.
- or [5] $m\widehat{GF}$ is determined correctly, but only four of the angle measures are determined correctly.
- [4] $m\widehat{GF}$ is determined incorrectly, and only four of the angle measures are determined appropriately, based on the incorrect arc measure.
- or [4] $m\widehat{GF}$ is determined correctly, but only three of the angle measures are determined correctly.
- [3] $m\widehat{GF}$ is determined incorrectly, and only three of the angle measures are determined appropriately, based on the incorrect arc measure.
- or [3] $m\widehat{GF}$ is determined correctly, but only two of the angle measures are determined correctly.
- [2] $m\widehat{GF}$ is determined incorrectly, and only two of the angle measures are determined appropriately, based on the incorrect arc measure.
- or [2] $m\widehat{GF}$ is determined correctly, but only one angle measure is determined correctly.
- [1] $m\widehat{GF}$ is determined incorrectly, and only one angle measure is determined appropriately.
- or [1] $m\widehat{GF}$ is determined correctly, but no further correct work is shown.
- [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [14]