

SCAVENGER HUNT



ANGLES FORMED BY CHORDS, SECANTS AND TANGENTS

Angles from Chords, Secants & Tangents

Inside, on, or outside the circle? · the cards check the answers

FREE

ANSWER

73°

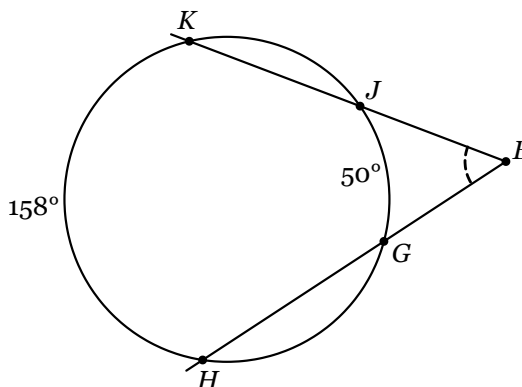
EH and *EK* are secants.

Find $m\angle HEK$.

Write it in whole degrees, like 37° .

Outside the circle, the angle is less than half the far arc. Check yours.

A



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1. **Tape the 16 cards around the room**, in any order. Each card has a large letter in its bottom left corner. Start each group at a *different* one of these eight cards: *Q A N H B F J M*.
2. **Say this once:** *“First say where the vertex is: inside, on, or outside the circle. Inside, take half the sum of the two arcs. On the circle, take half the arc inside the angle. Outside, take half the difference of the two arcs inside the angle: (far arc – near arc) ÷ 2. The far arc is the one farther from the vertex. Write your answer in whole degrees, like 37°. Then walk to the card with that answer at the top.”*
3. **Each group writes one line per card.** Eight right answers bring the group back to its first card.

16 cards	pages 3–10, one copy. There are two cards on each sheet. Cut the whole stack once.
Record sheet	page 11, one per student. It shows the three places a vertex can be, with the rule for each.
Answers	pages 12–13, for you only. Do not put them up in the room.

Every card shows a circle, two lines, one marked angle and two arc measures. On six cards two chords cross inside the circle. On four, a tangent and a chord meet on it. On six, secants or tangents meet outside it, and the two arcs are the far arc and the near arc.

This sheet calls a line a secant when it cuts the circle at two points, and a tangent when it touches the circle at exactly one point. The arcs an angle intercepts are the arcs inside the angle. For two chords crossing inside the circle, the rule also uses the arc inside the vertical angle. Some textbooks use other definitions, so tell the class which ones this sheet uses.

Eight of the sixteen cards make the ring. A group reaches the other eight only by a wrong answer, but all the cards look the same. Three mistakes lead there: forgetting to halve, using half the difference where half the sum belongs (or the reverse), and using the arc on the wrong side of the chord. That card sends the group back to the card it got wrong.

The check is the length of the group’s list. A clean run is **eight lines**. Each wrong answer adds two. The line in italics under each card’s question tells a group that arrived by a wrong answer what to check. Guessing does not work: no simple rule, such as always halving the larger number, gets more than two of the cards. If a group is stuck, ask: *“Where is the vertex? Which arcs are inside the angle?”*



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ANSWER

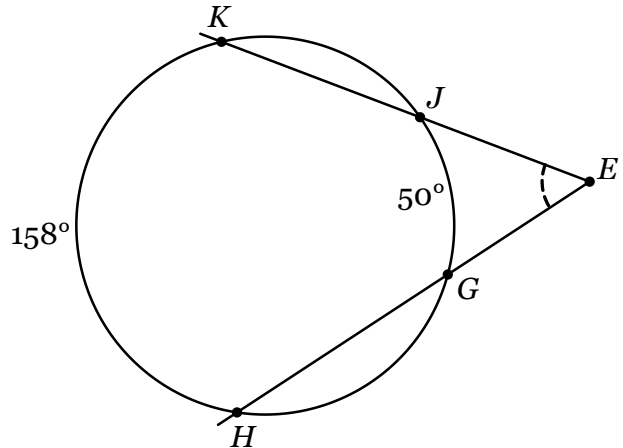
73°

EH and EK are secants.

Find $m\angle HEK$.

Write it in whole degrees, like 37° .

Outside the circle, the angle is less than half the far arc. Check yours.



A

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ANSWER

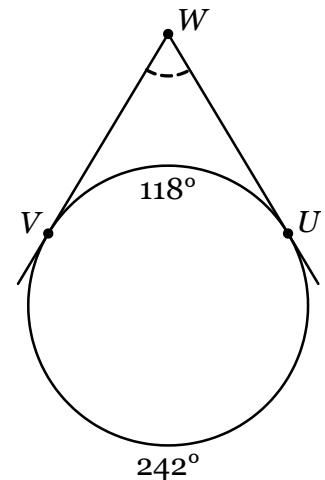
95°

WU and WV are tangent to the circle.

Find $m\angle UWV$.

Write it in whole degrees, like 37° .

Two tangents from one point make two arcs. The two arcs make 360° .



B

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ANSWER

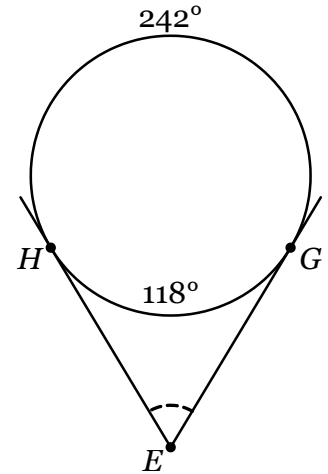
150°

EG and EH are tangent to the circle.

Find $m\angle GEH$.

Write it in whole degrees, like 37° .

A vertex outside the circle uses the difference of the arcs, never the sum.



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C

ANSWER

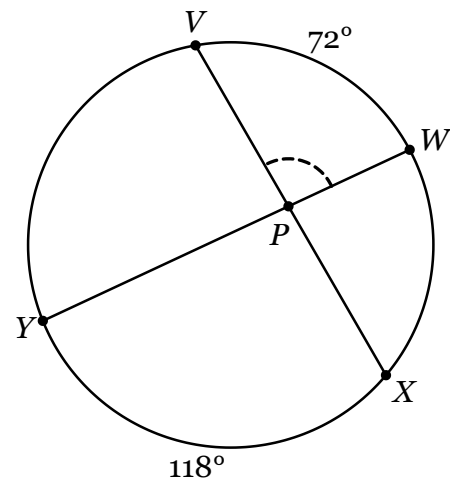
124°

Chords VX and WY cross at P .

Find $m\angle VPW$.

Write it in whole degrees, like 37° .

Far arc minus near arc, and then half of it. Both steps count.



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D

ANSWER

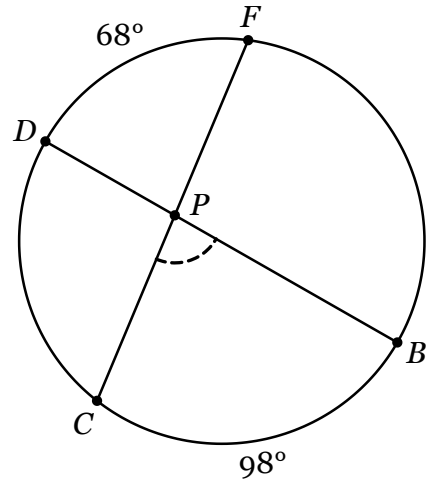
146°

Chords BD and CF cross at P .

Find $m\angle BPC$.

Write it in whole degrees, like 37° .

Add the two arcs, then halve. Is the answer less than 180° ?



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E

ANSWER

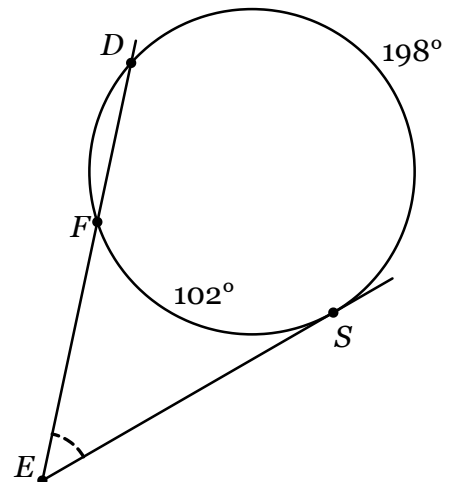
62°

ES is tangent at S . ED is a secant.

Find $m\angle SED$.

Write it in whole degrees, like 37° .

Put a finger on the vertex. Then find the arcs between its two sides.



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F

ANSWER

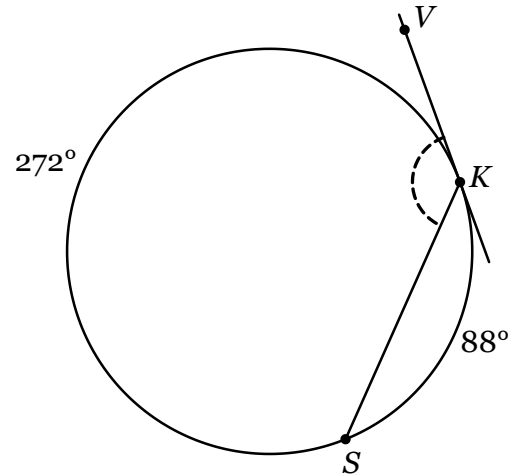
15°

Line VK is tangent to the circle at K .

Find $m\angle VKS$.

Write it in whole degrees, like 37° .

Inside the circle, the answer is bigger than half of either arc.



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G

ANSWER

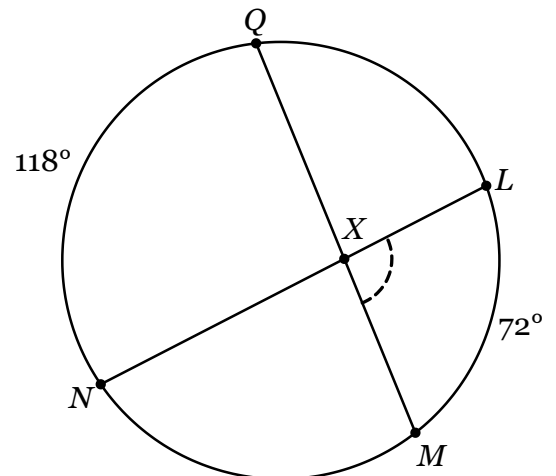
58°

Chords LN and MQ cross at X .

Find $m\angle LXM$.

Write it in whole degrees, like 37° .

Every rule here ends the same way. Halve at the end.



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H

ANSWER

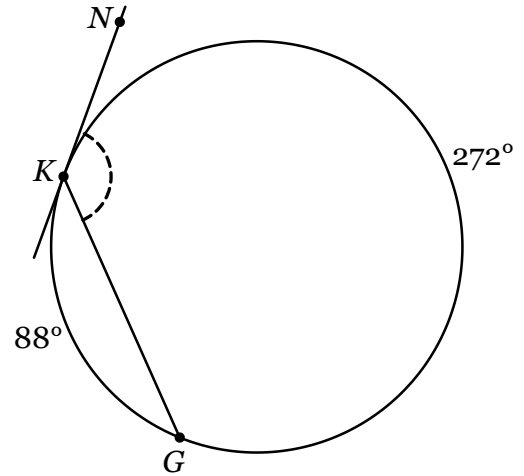
48°

Line NK is tangent to the circle at K .

Find $m\angle NKG$.

Write it in whole degrees, like 37° .

Look at both numbers before any adding or subtracting.



J

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ANSWER

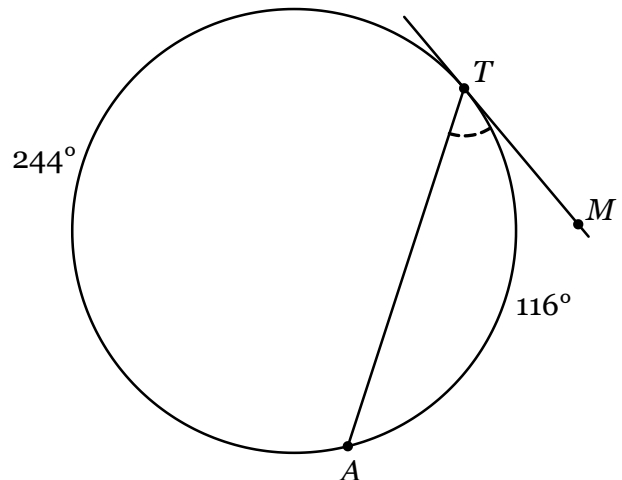
23°

Line MT is tangent to the circle at T .

Find $m\angle MTA$.

Write it in whole degrees, like 37° .

Inside the circle, add the two arcs. Then halve the sum.



K

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ANSWER

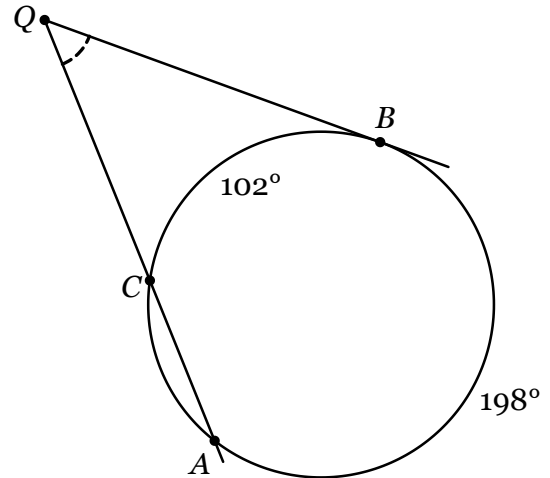
44°

QB is tangent at B . QA is a secant.

Find $m\angle BQA$.

Write it in whole degrees, like 37°.

Which arc lies inside the angle? Trace it from one side to the other.



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L

ANSWER

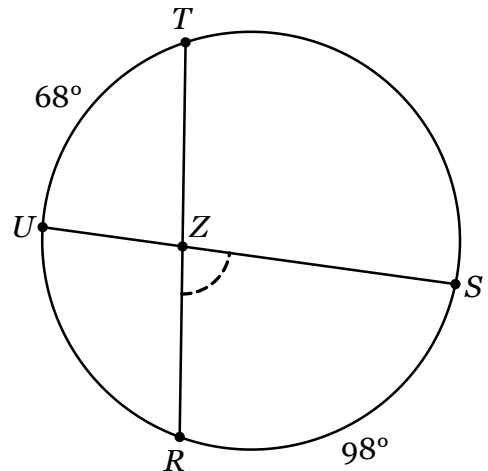
136°

Chords RT and SU cross at Z .

Find $m\angle RZS$.

Write it in whole degrees, like 37°.

Say the rule out loud: half the sum, half the arc, or half the difference?



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M

ANSWER

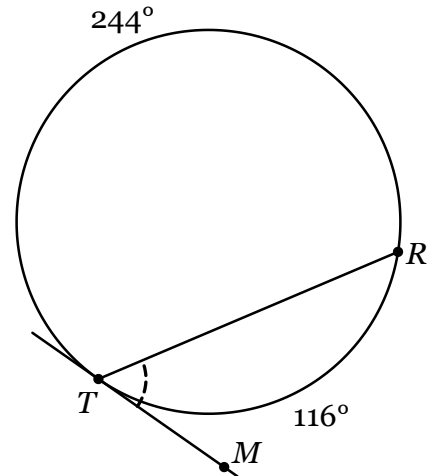
54°

Line MT is tangent to the circle at T .

Find $m\angle MTR$.

Write it in whole degrees, like 37° .

Is the angle obtuse? Then the arc inside it is more than 180° .



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N

ANSWER

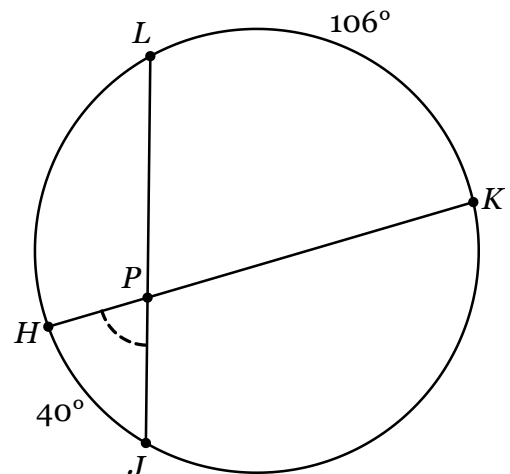
104°

Chords HK and JL cross at P .

Find $m\angle HPJ$.

Write it in whole degrees, like 37° .

Outside the circle, take the near arc from the far arc. Then halve.



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P

ANSWER

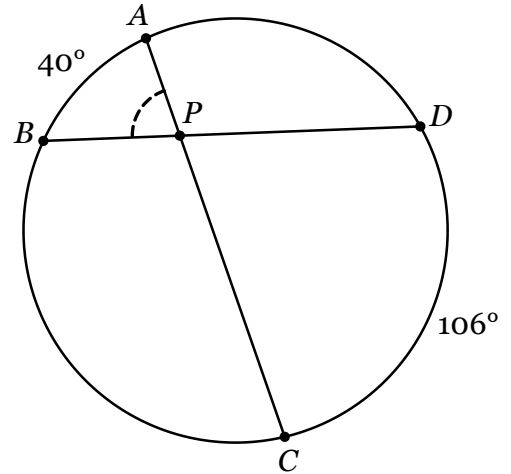
83°

Chords AC and BD cross at P .

Find $m\angle APB$.

Write it in whole degrees, like 37° .

Find the vertex first. Is it inside, on, or outside the circle?



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Q

ANSWER

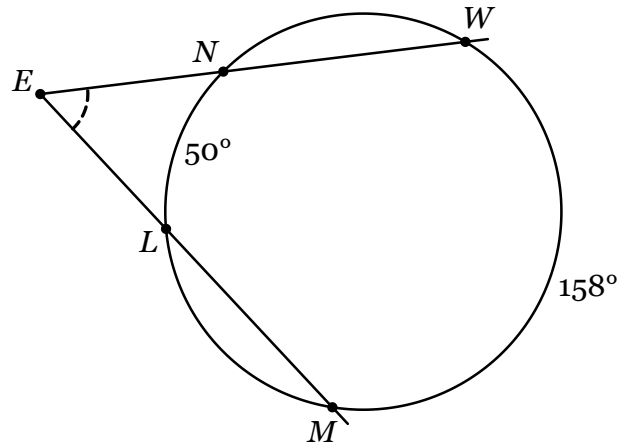
116°

EM and EW are secants.

Find $m\angle MEW$.

Write it in whole degrees, like 37° .

On the circle, the angle is half of the arc inside it.



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R

Scavenger Hunt — where I went

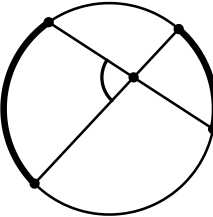
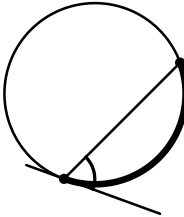
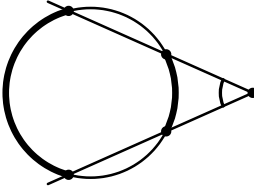
Angles from chords, secants and tangents

Name _____

Period _____

Date _____

For each card, first write where the vertex is: inside, on, or outside the circle. Then find the angle. **Write it in whole degrees, like 37° .** Then find the card with your answer at the top. A clean run is eight lines. Each card has a line in *italics* under its question. **If you are on a card because you went wrong, its line says what to check. If you were right, skip it.**

 Vertex inside: the angle is half the SUM of the arc inside it and the arc across from it.	 Vertex on the circle (a tangent and a chord): the angle is half the arc inside it.	 Vertex outside: the angle is half the DIFFERENCE, far arc minus near arc.
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Card letter	Where is the vertex: inside, on, or outside?	The angle, in degrees
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Which part of a football game do these angles like best?

Every number stands for a letter. Write the letter for each answer in the box above its number. Read the boxes you filled, left to right. **If they do not spell the answer, one of your answers is wrong.**

$15^\circ = M$ $23^\circ = E$ $44^\circ = F$ $48^\circ = H$ $54^\circ = A$ $58^\circ = L$ $62^\circ = F$ $73^\circ = T$ $83^\circ = I$ $95^\circ = M$ $104^\circ = L$ $116^\circ = T$ $124^\circ = H$
 $136^\circ = E$ $146^\circ = I$ $150^\circ = A$

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15° 23° 44° 48° 54° 58° 62° 73° 83° 95° 104° 116° 124° 136° 146° 150°



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Scavenger Hunt — answers

For the teacher

The ring in order, with the answer found on each card. A group may begin anywhere on it. Wherever it begins, eight right answers bring it back to that card.

Q (73°) → A (54°) → N (58°) → H (95°) → B (62°) → F (48°) → J (136°) → M (83°) → Q

Which part of a football game do these angles like best? The answer is *HALF TIME!* It is read along the boxes of the record sheet, which run from the smallest number to the largest.

Card	What the card shows and asks	Answer, and why	The common wrong answer on this card, and why	Letter of its top
1 Q	Chords AC and BD cross at P . Find $m\angle APB$. (vertex inside)	73° . The vertex P is inside the circle. Arc AB is inside the angle, and arc CD is inside the angle across from it. Half their sum: $(40^\circ + 106^\circ) \div 2 = 73^\circ$.	146°. 146° is the sum of the two arcs, not halved. Inside the circle the angle is half the sum: 73°.	I
2 A	EH and EK are secants. Find $m\angle HEK$. (vertex outside)	54° . The vertex E is outside the circle. The far arc is 158° and the near arc is 50°. Half their difference: $(158^\circ - 50^\circ) \div 2 = 54^\circ$.	104°. 104° is half the sum of the arcs. That rule is for a vertex inside the circle. Outside, take half the difference: 54°.	T
3 N	Line MT is tangent to the circle at T . Find $m\angle MTR$. (vertex on the circle)	58° . The vertex T is on the circle. The arc inside $\angle MTR$ is the short arc from T to R , 116°. Half of it is 58°.	116°. 116° is the arc itself. On the circle the angle is half of the arc inside it: 58°.	A
4 H	Chords LN and MQ cross at X . Find $m\angle LXM$. (vertex inside)	95° . The vertex X is inside the circle. Arc LM is inside the angle, and arc NQ is inside the angle across from it. Half their sum: $(72^\circ + 118^\circ) \div 2 = 95^\circ$.	23°. 23° is half the difference of the arcs. That rule is for a vertex outside the circle. Inside, take half the sum: 95°.	L
5 B	WU and WV are tangent to the circle. Find $m\angle UWV$. (vertex outside)	62° . The vertex W is outside the circle. The far arc is 242° and the near arc is 118°. Half their difference: $(242^\circ - 118^\circ) \div 2 = 62^\circ$. The two arcs of two tangents make 360°.	124°. 124° is the difference of the arcs, not halved. Outside the circle the angle is half the difference: 62°.	M
6 F	ES is tangent at S . ED is a secant. Find $m\angle SED$. (vertex outside)	48° . The vertex E is outside the circle. The far arc is 198° and the near arc is 102°. Half their difference: $(198^\circ - 102^\circ) \div 2 = 48^\circ$.	150°. 150° is half the sum of the arcs. That rule is for a vertex inside the circle. Outside, take half the difference: 48°.	F
7 J	Line NK is tangent to the circle at K . Find $m\angle NKG$. (vertex on the circle)	136° . The vertex K is on the circle. The arc inside $\angle NKG$ is the long arc from K to G , 272°. Half of it is 136°. The angle is obtuse, so its arc is more than 180°.	44°. 44° is half of the other arc, 88°, on the far side of the chord. The angle opens onto the 272° arc, so it is 136°.	H
8 M	Chords RT and SU cross at Z . Find $m\angle RZS$. (vertex inside)	83° . The vertex Z is inside the circle. Arc RS is inside the angle, and arc TU is inside the angle across from it. Half their sum: $(98^\circ + 68^\circ) \div 2 = 83^\circ$.	15°. 15° is half the difference of the arcs. That rule is for a vertex outside the circle. Inside, take half the sum: 83°.	E

Scavenger Hunt — the cards off the ring

For the teacher

A group reaches these eight cards only by a wrong answer. The number at the top of each one is the wrong answer from one ring card. Its right answer is the number at the top of that ring card, so the group goes to the card it got wrong and tries it again. If the group makes the same mistake here, it goes to another card off the ring. So a second wrong answer never moves a group forward.

Card	What the card shows and asks	Answer, and why	The common wrong answer on this card, and why	Letter of its top
E	Chords BD and CF cross at P . Find $m\angle BPC$. (vertex inside)	83° . The vertex P is inside the circle. Arc BC is inside the angle, and arc DF is inside the angle across from it. Half their sum: $(98^\circ + 68^\circ) \div 2 = 83^\circ$.	15°. 15° is half the difference of the arcs. That rule is for a vertex outside the circle. Inside, take half the sum: 83°.	I
P	Chords HK and JL cross at P . Find $m\angle HPJ$. (vertex inside)	73° . The vertex P is inside the circle. Arc HJ is inside the angle, and arc KL is inside the angle across from it. Half their sum: $(40^\circ + 106^\circ) \div 2 = 73^\circ$.	146°. 146° is the sum of the two arcs, not halved. Inside the circle the angle is half the sum: 73°.	L
R	EM and EW are secants. Find $m\angle MEW$. (vertex outside)	54° . The vertex E is outside the circle. The far arc is 158° and the near arc is 50°. Half their difference: $(158^\circ - 50^\circ) \div 2 = 54^\circ$.	104°. 104° is half the sum of the arcs. That rule is for a vertex inside the circle. Outside, take half the difference: 54°.	T
K	Line MT is tangent to the circle at T . Find $m\angle MTA$. (vertex on the circle)	58° . The vertex T is on the circle. The arc inside $\angle MTA$ is the short arc from T to A , 116°. Half of it is 58°.	116°. 116° is the arc itself. On the circle the angle is half of the arc inside it: 58°.	E
D	Chords VX and WY cross at P . Find $m\angle VPW$. (vertex inside)	95° . The vertex P is inside the circle. Arc VW is inside the angle, and arc XY is inside the angle across from it. Half their sum: $(72^\circ + 118^\circ) \div 2 = 95^\circ$.	23°. 23° is half the difference of the arcs. That rule is for a vertex outside the circle. Inside, take half the sum: 95°.	H
C	EG and EH are tangent to the circle. Find $m\angle GEH$. (vertex outside)	62° . The vertex E is outside the circle. The far arc is 242° and the near arc is 118°. Half their difference: $(242^\circ - 118^\circ) \div 2 = 62^\circ$. The two arcs of two tangents make 360°.	124°. 124° is the difference of the arcs, not halved. Outside the circle the angle is half the difference: 62°.	A
L	QB is tangent at B . QA is a secant. Find $m\angle BQA$. (vertex outside)	48° . The vertex Q is outside the circle. The far arc is 198° and the near arc is 102°. Half their difference: $(198^\circ - 102^\circ) \div 2 = 48^\circ$.	150°. 150° is half the sum of the arcs. That rule is for a vertex inside the circle. Outside, take half the difference: 48°.	F
G	Line VK is tangent to the circle at K . Find $m\angle VKS$. (vertex on the circle)	136° . The vertex K is on the circle. The arc inside $\angle VKS$ is the long arc from K to S , 272°. Half of it is 136°. The angle is obtuse, so its arc is more than 180°.	44°. 44° is half of the other arc, 88°, on the far side of the chord. The angle opens onto the 272° arc, so it is 136°.	M

Other mistakes lead to no card. A group might make a different slip: forgetting to halve, adding the far and near arcs, halving one arc only, halving the other arc only, giving the other angle at the vertex (180° minus the answer), using half the sum where half the difference belongs (or the reverse), giving the arc on the other side of the chord, halving the arc on the other side of the chord. Its answer is then not the number at the top of any card, and the group knows to check its work.