

SCAVENGER HUNT



TANGENT LINES AND THE RADIUS

Tangent Lines and the Radius

The right angle at the point of tangency · radius or diameter · the cards check the answers

FREE

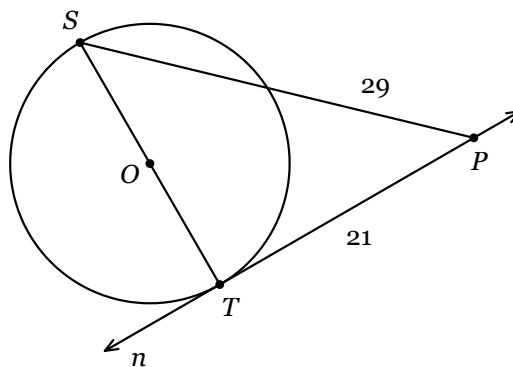
ANSWER

61°

Line n is tangent to the circle at T . O is the center, and ST is a diameter.

Find the radius of the circle.

The radius runs from the center to the circle. The diameter goes all the way across.



F

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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: *F A H C N R E K*.
2. **Say this once:** “*On every card, line n is tangent to the circle at T . First draw the right angle at T , between the radius and the line. Every answer is a whole number. Then walk to the card with your 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 right angle between a tangent line and the radius.
Answers	pages 12–13, for you only. Do not put them up in the room.

Every card shows a circle drawn to scale, with its center O and a line n tangent to it at T . The radius OT and the line n meet at a right angle. No card marks that right angle, so the students must put it there themselves. That is the habit this lesson builds. Eight cards ask for the radius or the diameter, using the Pythagorean theorem in the right triangle. Eight cards ask for an angle of that triangle. The two acute angles add to 90° , because the third angle is the right angle at T .

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. There are two mistakes. In the first, the student gives the diameter when the card asks for the radius, or the radius when it asks for the diameter. In the second, the student forgets the right angle at T and takes the two other angles to add to 180° . Each of these lands on a card off the ring. 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. Every card has a line in italics under its question. It tells a group that arrived by a wrong answer what to check. A group that arrived by a right answer skips it. Guessing does not work: no single rule, such as taking the difference of the two numbers, gets more than four of the cards. If a group keeps coming back to the same cards, ask: “*Where is the right angle? Does the card ask for the radius or the diameter?*”



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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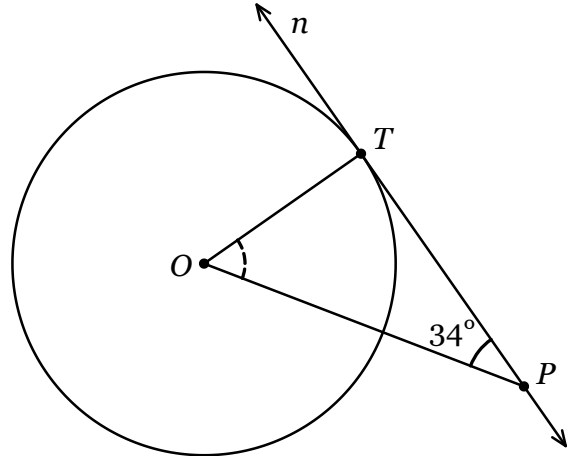
ANSWER

10

Line n is tangent to the circle at T . O is the center.

Find the measure of angle TOP .

The radius and the tangent line meet at 90° . Put that angle in the triangle first.



A

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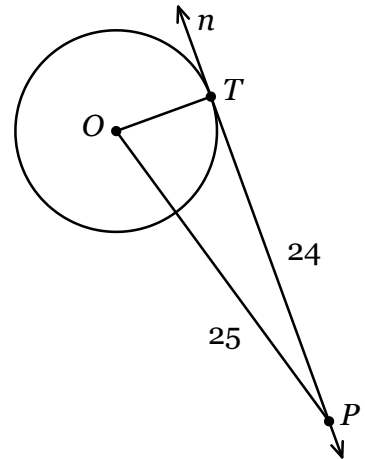
ANSWER

121°

Line n is tangent to the circle at T . O is the center.

Find the diameter of the circle.

Put 90° at T first. Then the angles at O and P add to 90 , so solve with 90 .



B

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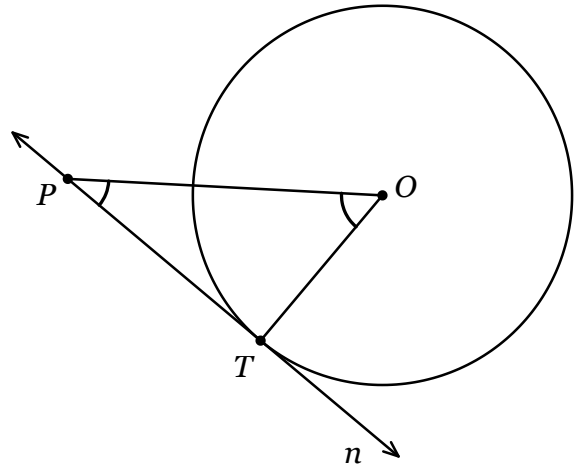
ANSWER

42

Line n is tangent to the circle at T . O is the center. Angle $OPT = (2x + 5)^\circ$ and angle $TOP = (3x + 5)^\circ$.

Find the measure of angle TOP .

A triangle has three angles. Which one sits at the point of tangency?



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C

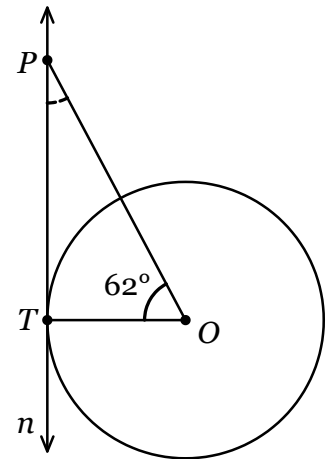
ANSWER

7

Line n is tangent to the circle at T . O is the center.

Find the measure of angle OPT .

OT is one radius. The diameter is twice OT , through the center and out again.



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D

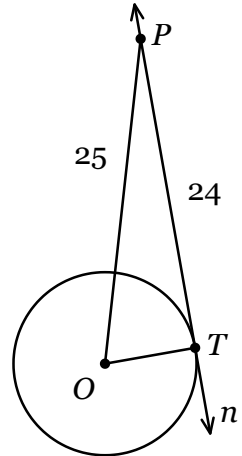
ANSWER

28°

Line n is tangent to the circle at T . O is the center.

Find the diameter of the circle.

Put a finger on the center. Which segment is one radius?



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E

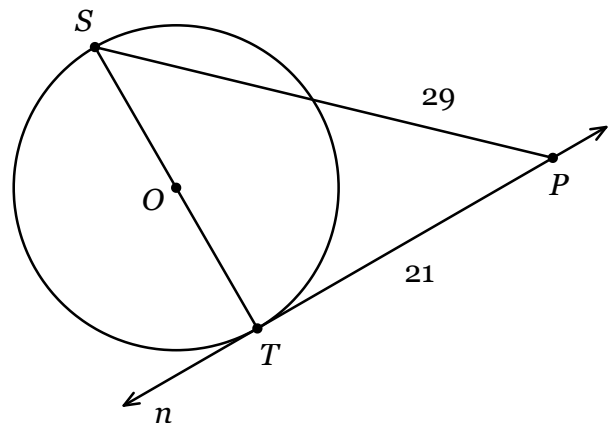
ANSWER

61°

Line n is tangent to the circle at T . O is the center, and ST is a diameter.

Find the radius of the circle.

The radius runs from the center to the circle. The diameter goes all the way across.



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F

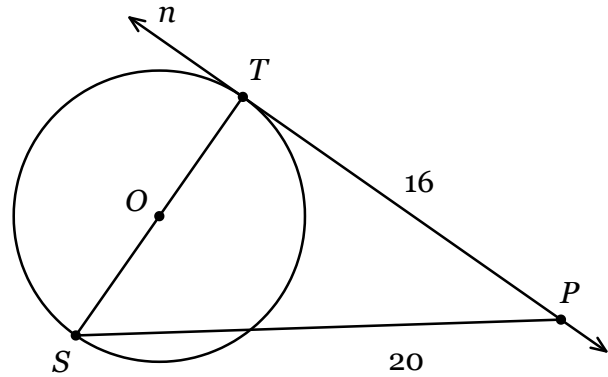
ANSWER

118°

Line n is tangent to the circle at T . O is the center, and ST is a diameter.

Find the radius of the circle.

*The right angle at T takes 90° of the triangle's 180° .
The other two share the rest.*



G

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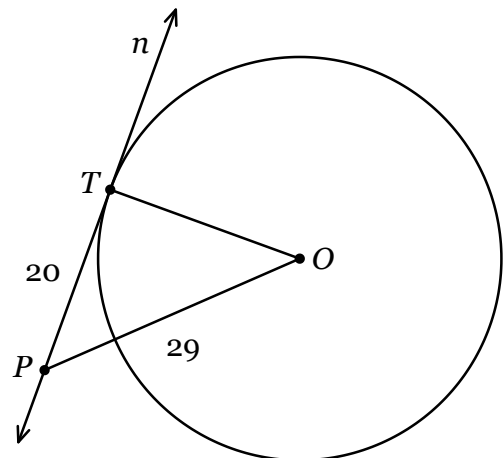
ANSWER

56°

Line n is tangent to the circle at T . O is the center.

Find the diameter of the circle.

Read the question again. Does it ask for the radius or the diameter?



H

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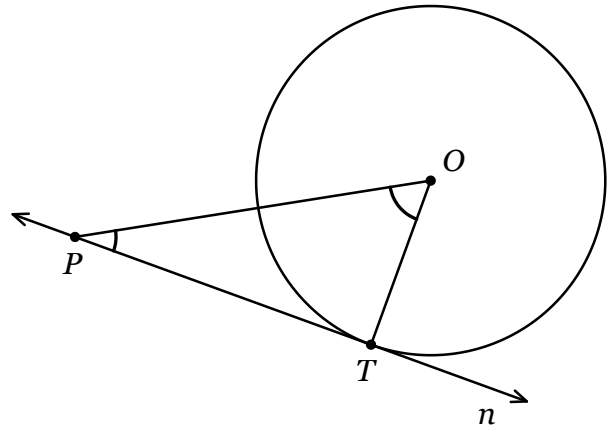
ANSWER

20

Line n is tangent to the circle at T . O is the center. Angle $OPT = (2x + 3)^\circ$ and angle $TOP = (4x + 9)^\circ$.

Find the measure of angle TOP .

A radius is half of a diameter. Is your length one radius or the whole diameter?



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J

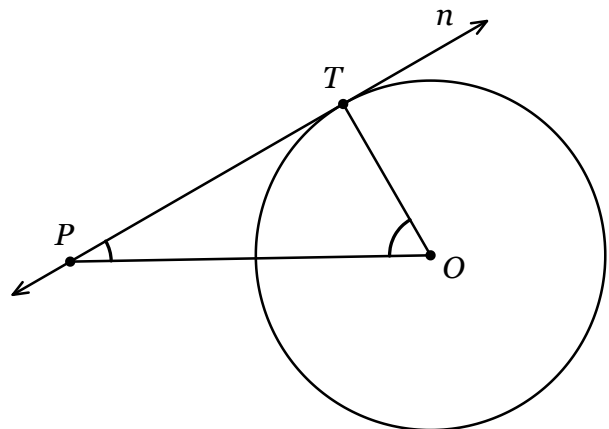
ANSWER

14

Line n is tangent to the circle at T . O is the center. Angle $OPT = (2x + 3)^\circ$ and angle $TOP = (4x + 9)^\circ$.

Find the measure of angle TOP .

*Find the point where the line touches the circle.
What angle is at that point?*



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K

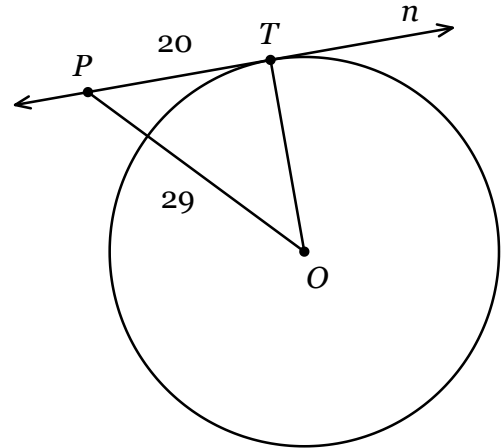
ANSWER

107°

Line n is tangent to the circle at T . O is the center.

Find the diameter of the circle.

*With 90° at T , the two angle expressions add to 90 , not 180 .
Solve for x again.*



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L

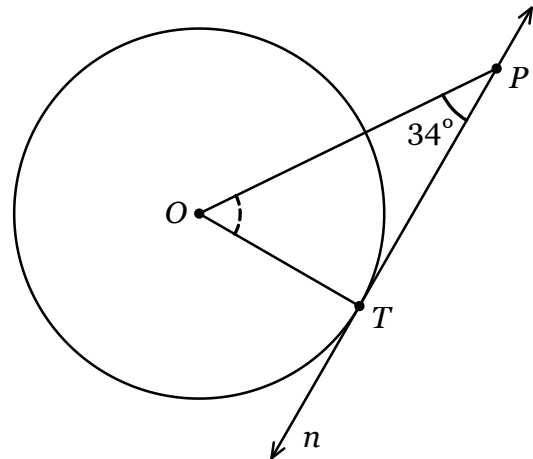
ANSWER

21

Line n is tangent to the circle at T . O is the center.

Find the measure of angle TOP .

A diameter is two radii end to end. Does the card ask for one radius or two?



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M

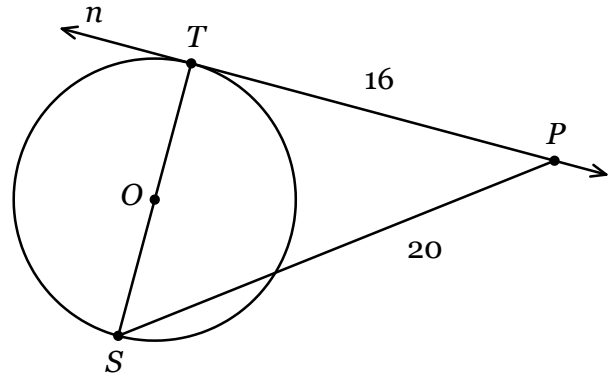
ANSWER

53°

Line n is tangent to the circle at T . O is the center, and ST is a diameter.

Find the radius of the circle.

A diameter is two radii long. Which length does this card ask for?



N

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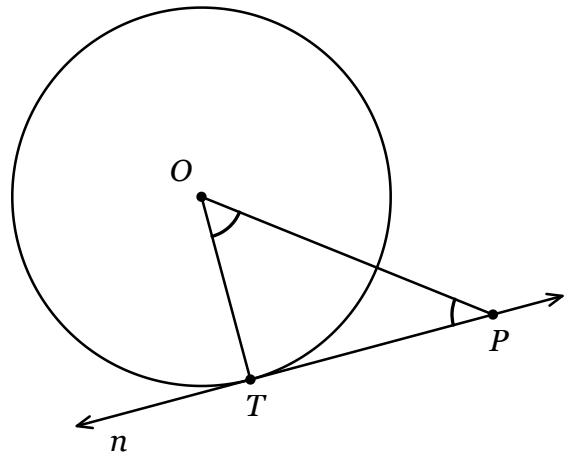
ANSWER

12

Line n is tangent to the circle at T . O is the center. Angle $OPT = (2x + 5)^\circ$ and angle $TOP = (3x + 5)^\circ$.

Find the measure of angle TOP .

A diameter goes across through O . The radius is half of it, from O to the circle.



P

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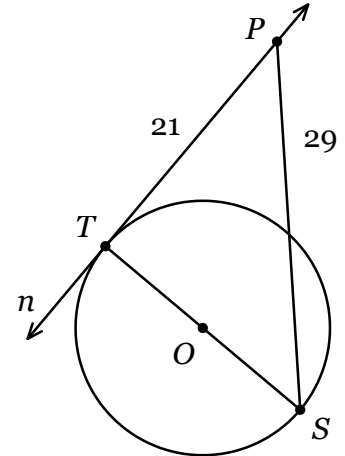
ANSWER

146°

Line n is tangent to the circle at T . O is the center, and ST is a diameter.

Find the radius of the circle.

The angles at O and P add to 90° , since T holds 90° . Is each one under 90° ?



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Q

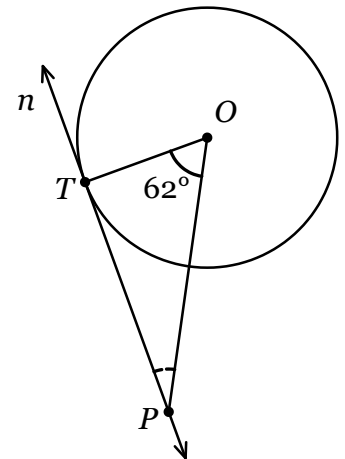
ANSWER

6

Line n is tangent to the circle at T . O is the center.

Find the measure of angle OPT .

An angle at O or at P of this triangle is always less than 90° .



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R

Scavenger Hunt — where I went

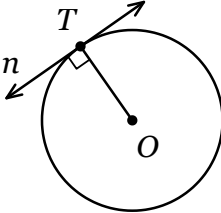
Tangent lines and the radius

Name _____

Period _____

Date _____

On every card, line n is tangent to the circle at T , and O is the center. First draw the radius to T and mark the right angle. **Every answer is a whole number. A length has no unit, and an angle is in degrees.** 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.**



A tangent line touches the circle at exactly one point, the point of tangency.

Tangent → right angle: a tangent line is perpendicular to the radius drawn to the point of tangency.

Right angle → tangent: a line through a point of the circle that is perpendicular to the radius there is a tangent line.

Card letter	Your work	Answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

What does a radius say each time it meets a tangent line?

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.**

6 = A 7 = T 10 = L 12 = H 14 = L 20 = G 21 = I 28° = R 42 = I 53° = G 56° = H 61° = T 107° = L 118° = R
121° = A 146° = L

6	7	10	12	14	20	21	28°	42	53°	56°	61°	107°	118°	121°	146°	



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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.

F (10) → A (56°) → H (42) → C (53°) → N (6) → R (28°) → E (14) → K (61°) → F

What does a radius say each time it meets a tangent line? The answer is *ALL RIGHT!* It is read along the boxes of the record sheet, which run from the smallest number to the largest. On every card the radius OT and the tangent line meet at a right angle at T . This sheet calls a tangent a line that touches the circle at exactly one point. Some textbooks use other definitions, so tell the class which ones this sheet uses.

Card	What the card shows	Answer, and why	The common wrong answer on this card, and why	Letter of its top
1 F	ST is a diameter and line n is tangent at T . $SP = 29$ and $TP = 21$. Find the radius.	10. The tangent is perpendicular to the diameter at T , so triangle STP has its right angle at T . $ST^2 = 29^2 - 21^2 = 841 - 441 = 400$, so $ST = 20$. The radius is half of the diameter: 10.	20. 20 is the whole diameter ST . The question asks for the radius, which is half of it.	T
2 A	Line n is tangent at T . Angle $OPT = 34^\circ$. Find angle TOP .	56°. The radius OT is perpendicular to the tangent, so the angle at T is 90° . The angles of triangle OTP add to 180° , so angle $TOP = 180^\circ - 90^\circ - 34^\circ = 56^\circ$.	146°. 146° leaves out the right angle at T : $180^\circ - 34^\circ = 146^\circ$. An angle of 146° cannot sit in a triangle beside a right angle.	L
3 H	Line n is tangent at T . $OP = 29$ and $TP = 20$. Find the diameter.	42. The radius OT is perpendicular to the tangent at T , so triangle OTP has its right angle at T . $OT^2 = 29^2 - 20^2 = 841 - 400 = 441$, so the radius is 21. The diameter is twice the radius: 42.	21. 21 is the radius OT . The question asks for the diameter, which is twice as long.	H
4 C	Line n is tangent at T . Angle $OPT = (2x + 5)^\circ$ and angle $TOP = (3x + 5)^\circ$. Find angle TOP .	53°. The angle at T is 90° , so the other two add to 90° : $5x + 10 = 90$, so $x = 16$. Angle $TOP = 3 \times 16 + 5 = 53^\circ$.	107°. Setting the two angles' sum to 180° leaves out the right angle at T : $5x + 10 = 180$ gives $x = 34$ and $3 \times 34 + 5 = 107^\circ$, which is more than 90° .	I
5 N	ST is a diameter and line n is tangent at T . $SP = 20$ and $TP = 16$. Find the radius.	6. The tangent is perpendicular to the diameter at T , so triangle STP has its right angle at T . $ST^2 = 20^2 - 16^2 = 400 - 256 = 144$, so $ST = 12$. The radius is half of the diameter: 6.	12. 12 is the whole diameter ST . The question asks for the radius, which is half of it.	G
6 R	Line n is tangent at T . Angle $TOP = 62^\circ$. Find angle OPT .	28°. The radius OT is perpendicular to the tangent, so the angle at T is 90° . The angles of triangle OTP add to 180° , so angle $OPT = 180^\circ - 90^\circ - 62^\circ = 28^\circ$.	118°. 118° leaves out the right angle at T : $180^\circ - 62^\circ = 118^\circ$. An angle of 118° cannot sit in a triangle beside a right angle.	A
7 E	Line n is tangent at T . $OP = 25$ and $TP = 24$. Find the diameter.	14. The radius OT is perpendicular to the tangent at T , so triangle OTP has its right angle at T . $OT^2 = 25^2 - 24^2 = 625 - 576 = 49$, so the radius is 7. The diameter is twice the radius: 14.	7. 7 is the radius OT . The question asks for the diameter, which is twice as long.	R
8 K	Line n is tangent at T . Angle $OPT = (2x + 3)^\circ$ and angle $TOP = (4x + 9)^\circ$. Find angle TOP .	61°. The angle at T is 90° , so the other two add to 90° : $6x + 12 = 90$, so $x = 13$. Angle $TOP = 4 \times 13 + 9 = 61^\circ$.	121°. Setting the two angles' sum to 180° leaves out the right angle at T : $6x + 12 = 180$ gives $x = 28$ and $4 \times 28 + 9 = 121^\circ$, which is more than 90° .	L

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	Answer, and why	The common wrong answer on this card, and why	Letter of its top
J	Line n is tangent at T . Angle $OPT = (2x + 3)^\circ$ and angle $TOP = (4x + 9)^\circ$. Find angle TOP .	61° . The angle at T is 90° , so the other two add to 90° : $6x + 12 = 90$, so $x = 13$. Angle $TOP = 4 \times 13 + 9 = 61^\circ$.	121°. Setting the two angles' sum to 180° leaves out the right angle at T : $6x + 12 = 180$ gives $x = 28$ and $4 \times 28 + 9 = 121^\circ$, which is more than 90° .	G
Q	ST is a diameter and line n is tangent at T . $SP = 29$ and $TP = 21$. Find the radius.	10 . The tangent is perpendicular to the diameter at T , so triangle STP has its right angle at T . $ST^2 = 29^2 - 21^2 = 841 - 441 = 400$, so $ST = 20$. The radius is half of the diameter: 10.	20. 20 is the whole diameter ST . The question asks for the radius, which is half of it.	L
M	Line n is tangent at T . Angle $OPT = 34^\circ$. Find angle TOP .	56° . The radius OT is perpendicular to the tangent, so the angle at T is 90° . The angles of triangle OTP add to 180° , so angle $TOP = 180^\circ - 90^\circ - 34^\circ = 56^\circ$.	146°. 146° leaves out the right angle at T : $180^\circ - 34^\circ = 146^\circ$. An angle of 146° cannot sit in a triangle beside a right angle.	I
L	Line n is tangent at T . $OP = 29$ and $TP = 20$. Find the diameter.	42 . The radius OT is perpendicular to the tangent at T , so triangle OTP has its right angle at T . $OT^2 = 29^2 - 20^2 = 841 - 400 = 441$, so the radius is 21. The diameter is twice the radius: 42.	21. 21 is the radius OT . The question asks for the diameter, which is twice as long.	L
P	Line n is tangent at T . Angle $OPT = (2x + 5)^\circ$ and angle $TOP = (3x + 5)^\circ$. Find angle TOP .	53° . The angle at T is 90° , so the other two add to 90° : $5x + 10 = 90$, so $x = 16$. Angle $TOP = 3 \times 16 + 5 = 53^\circ$.	107°. Setting the two angles' sum to 180° leaves out the right angle at T : $5x + 10 = 180$ gives $x = 34$ and $3 \times 34 + 5 = 107^\circ$, which is more than 90° .	H
G	ST is a diameter and line n is tangent at T . $SP = 20$ and $TP = 16$. Find the radius.	6 . The tangent is perpendicular to the diameter at T , so triangle STP has its right angle at T . $ST^2 = 20^2 - 16^2 = 400 - 256 = 144$, so $ST = 12$. The radius is half of the diameter: 6.	12. 12 is the whole diameter ST . The question asks for the radius, which is half of it.	R
D	Line n is tangent at T . Angle $TOP = 62^\circ$. Find angle OPT .	28° . The radius OT is perpendicular to the tangent, so the angle at T is 90° . The angles of triangle OTP add to 180° , so angle $OPT = 180^\circ - 90^\circ - 62^\circ = 28^\circ$.	118°. 118° leaves out the right angle at T : $180^\circ - 62^\circ = 118^\circ$. An angle of 118° cannot sit in a triangle beside a right angle.	T
B	Line n is tangent at T . $OP = 25$ and $TP = 24$. Find the diameter.	14 . The radius OT is perpendicular to the tangent at T , so triangle OTP has its right angle at T . $OT^2 = 25^2 - 24^2 = 625 - 576 = 49$, so the radius is 7. The diameter is twice the radius: 14.	7. 7 is the radius OT . The question asks for the diameter, which is twice as long.	A

Other mistakes lead to no card. A group might add the squares where it should subtract them, subtract the two lengths without squaring them, copy the printed angle, give 90° , or give the value of x in place of the angle. Its answer is then not the number at the top of any card, and most of these are not whole numbers.