

MYSTERY PICTURE

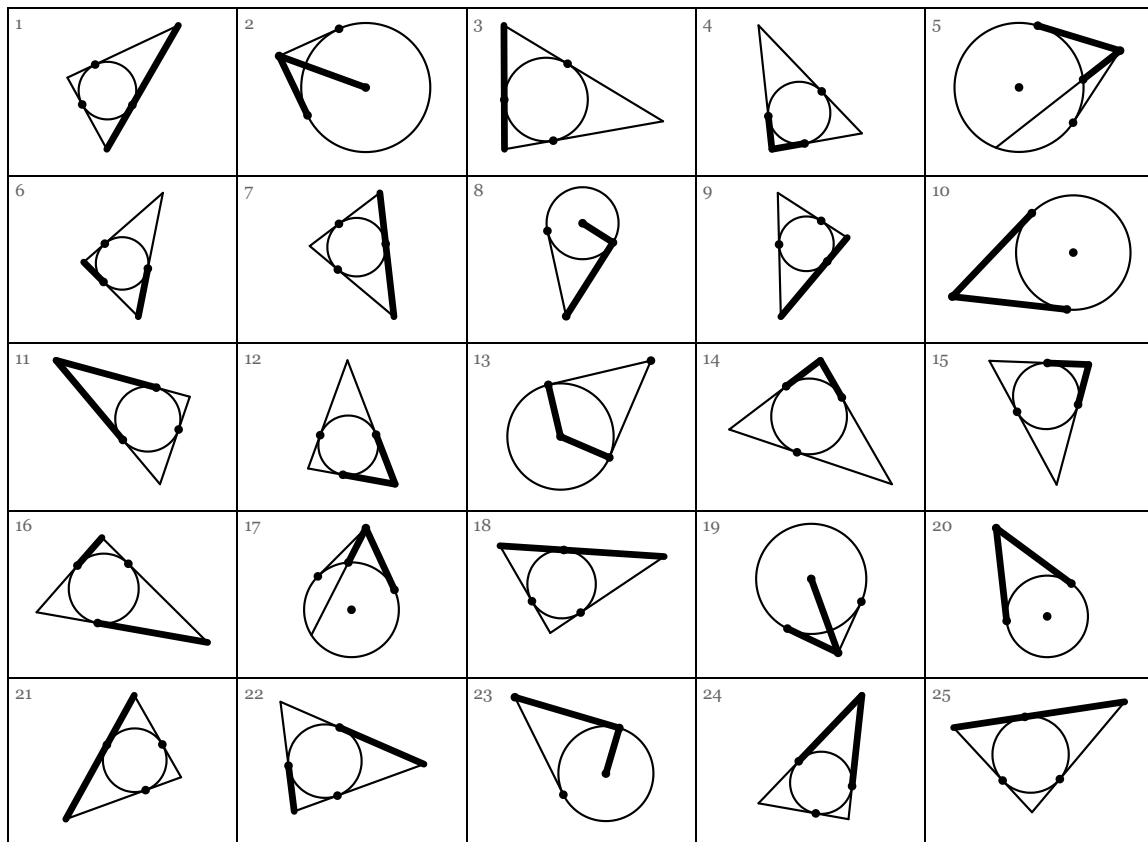


TANGENT SEGMENTS AND INSCRIBED AND CIRCUMSCRIBED CIRCLES

Tangent Segments: Must They Be Equal?

25 squares · two pieces from one corner · nothing to measure · a picture appears

FREE



1. **Give each student page 3** and a pencil. Nothing is measured or computed.
2. **Say this once:** *“In each square two segments are thick. Must they be equal? Two tangent segments from one point are always equal. Two radii of one circle are equal too. If they must be equal, fill the square with slanted lines. If not, leave it white.”*
3. **Let them work.** The picture shows when they are right. Nothing else is needed.

Student sheet page 3, one per student. A box at the bottom shows both rules with pictures.
Answers pages 4–5, for you.

Sixteen squares show a triangle with its inscribed circle, with the three points of tangency marked as dots. Each side is tangent to the circle, so the two pieces from one corner are tangent segments from one point and are equal. The other nine squares show a circle with its center and a point outside it, with the two tangent segments from that point. Nine squares are filled: the two pieces from one corner, the two tangent segments from the point, and once two radii.

Most white squares are pairs that look like two equal tangent segments. In thirteen of them the two thick segments touch, just as two tangent segments from one point do. On a triangle they are the two pieces of one side, which meet at a point of tangency and belong to two different corners. This is the most common mistake with this lesson. On a circle they are a tangent segment with the segment to the center, with a radius, or with part of a line that crosses the circle. Every triangle is scalene, so a white pair never looks equal.

If part of a student’s picture looks wrong, the mistake is in that square. Ask: *“Which corner does each thick piece start from?”* Guessing does not work. Every simple guessing rule, such as filling every square where the two thick segments touch, gets at least nine squares wrong. This sheet calls a circle inscribed in a triangle when it is inside the triangle and each side is tangent to it. Some textbooks use other definitions, so tell the class which ones this sheet uses.



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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Mystery Picture — must they be equal?

Tangent segments

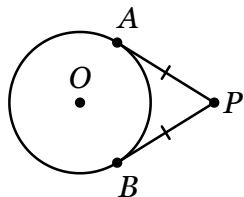
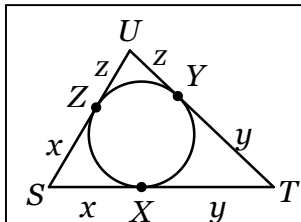
Name _____

Period _____

Date _____

In each square, two segments are thick. Must the two thick segments be equal? Do not measure. **If they must be equal, fill the square with slanted lines. If not, leave it white.** A picture appears. If part of it is missing, check that square again. The box at the bottom helps.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25



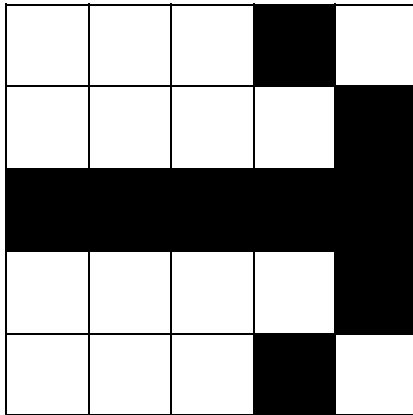
Two tangent segments from one point are equal. The two pieces from S are both x . $PA = PB$.
Two radii of one circle are equal.
 Nothing else on this sheet must be equal.



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Mystery Picture — answers

For the teacher



The finished picture is **a right arrow**. Nine squares are filled.

The letters below name the points so the table can say which segments are thick. They are not printed on the sheet. On a triangle STU, the circle touches ST at X, TU at Y and US at Z. On a circle, O is the center, P the point outside, and A and B the points of tangency. Q is where a line from P that crosses the circle first meets it. The table goes on over the page.

	The square	Answer	Why
1	A triangle with its inscribed circle. The thick pieces are SX and TX.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from S and one from T, two different corners.
2	A circle with center O and a point P outside it. The thick segments are PA and OP.	white	OP goes to the center. It is the longest side of the right triangle O, A, P, so it is longer than the tangent segment.
3	A triangle with its inscribed circle. The thick pieces are TY and UY.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from T and one from U, two different corners.
4	A triangle with its inscribed circle. The thick pieces are SX and SZ.	fill	Both run from the corner S. Two tangent segments from one point are equal.
5	A circle with center O and a point P outside it. The thick segments are PA and PQ.	white	PQ runs along a line that crosses the circle, so it is not a tangent segment.
6	A triangle with its inscribed circle. The thick pieces are SX and TY.	white	One runs from S and one from T, two different corners. Nothing makes them equal.
7	A triangle with its inscribed circle. The thick pieces are UZ and SZ.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from U and one from S, two different corners.
8	A circle with center O and a point P outside it. The thick segments are OA and PA.	white	One is a radius and one is a tangent segment. Nothing makes them equal.
9	A triangle with its inscribed circle. The thick pieces are SX and TX.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from S and one from T, two different corners.
10	A circle with center O and a point P outside it. The thick segments are PA and PB.	fill	They are the two tangent segments from P, so they are equal.
11	A triangle with its inscribed circle. The thick pieces are TX and TY.	fill	Both run from the corner T. Two tangent segments from one point are equal.
12	A triangle with its inscribed circle. The thick pieces are UY and UZ.	fill	Both run from the corner U. Two tangent segments from one point are equal.

Mystery Picture — answers, squares 13 to 25

For the teacher

	The square	Answer	Why
13	A circle with center O and a point P outside it. The thick segments are OA and OB.	fill	Both are radii of the circle.
14	A triangle with its inscribed circle. The thick pieces are SX and SZ.	fill	Both run from the corner S. Two tangent segments from one point are equal.
15	A triangle with its inscribed circle. The thick pieces are TX and TY.	fill	Both run from the corner T. Two tangent segments from one point are equal.
16	A triangle with its inscribed circle. The thick pieces are TX and UZ.	white	One runs from T and one from U, two different corners. Nothing makes them equal.
17	A circle with center O and a point P outside it. The thick segments are PB and PQ.	white	PQ runs along a line that crosses the circle, so it is not a tangent segment.
18	A triangle with its inscribed circle. The thick pieces are TY and UY.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from T and one from U, two different corners.
19	A circle with center O and a point P outside it. The thick segments are PB and OP.	white	OP goes to the center. It is the longest side of the right triangle O, B, P, so it is longer than the tangent segment.
20	A circle with center O and a point P outside it. The thick segments are PA and PB.	fill	They are the two tangent segments from P, so they are equal.
21	A triangle with its inscribed circle. The thick pieces are UZ and SZ.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from U and one from S, two different corners.
22	A triangle with its inscribed circle. The thick pieces are TY and SZ.	white	One runs from T and one from S, two different corners. Nothing makes them equal.
23	A circle with center O and a point P outside it. The thick segments are OB and PB.	white	One is a radius and one is a tangent segment. Nothing makes them equal.
24	A triangle with its inscribed circle. The thick pieces are UY and UZ.	fill	Both run from the corner U. Two tangent segments from one point are equal.
25	A triangle with its inscribed circle. The thick pieces are TY and UY.	white	They are the two pieces of one side, and they meet at the point of tangency. One runs from T and one from U, two different corners.