

CUT & GLUE SORT

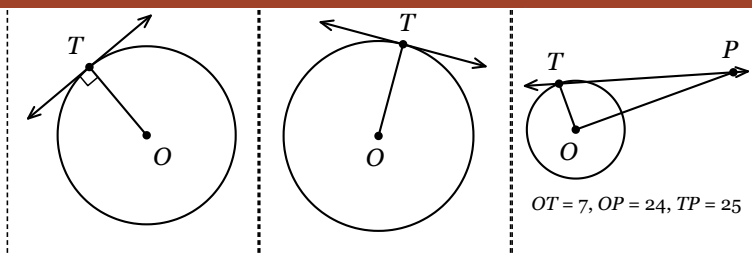


TANGENT LINES AND THE RADIUS

Is the Line Tangent? Prove It or Say You Cannot Tell

Twelve circles · tangent, not tangent, or cannot tell · three rows

FREE



Row 1. Tangent. The marks or the numbers prove that the line is tangent.

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Row 2. Not tangent. The marks or the numbers prove that the line is not tangent.

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Row 3. Cannot tell. Nothing on the piece proves it either way. The line only looks tangent.

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1. **Hand out pages 3 and 4**, one of each per student, with scissors and glue. No calculator is needed.
2. **Say this once:** *“A line is tangent only when the marks or the numbers prove it. Look for a right angle between the line and the radius at the point where they meet. If nothing proves it, the answer is cannot tell.”*
3. **Check a sheet in ten seconds:** every row gets four pieces.

Student sheets pages 3 and 4, one of each per student. Page 3 has the three rows. Page 4 has the pieces and a box with the two statements of the lesson.

Answers page 5.

This sheet never decides tangency from the look of the drawing. A line through a point T of the circle is tangent exactly when it is perpendicular to the radius OT. A line is also tangent when its distance from the center equals the radius. Three lengths OT, TP and OP decide the angle at T by the converse of the Pythagorean theorem, but only if the longest side is OP. 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.

Pieces 3, 4 and 8 are drawn to scale and look tangent, but they are not. Their numbers decide them. On piece 3, the numbers fit $a^2 + b^2 = c^2$ ($49 + 576 = 625$), but the longest side is TP, so the right angle is at O and not at T. On piece 4, the numbers fit no right triangle ($144 + 256 = 400$, but $441 \neq 21^2$). On piece 8, the distance from O to the line, 19, is less than the radius, 20, so the line crosses the circle twice. Students who trust the picture, or who stop when the numbers seem to work, put these in row 1.

Row 3 holds pieces that look tangent with nothing to prove it: no marks, only two of the three sides, or a right angle against a chord when the center is not shown. Guessing does not work: a simple guessing rule, such as “a small square means tangent,” places at most six pieces correctly.



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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Cut & Glue Sort — is the line tangent?

Tangent lines and the radius

Name _____

Period _____

Date _____

Each piece on the next page is a circle and a line. **Is the line tangent to the circle? Decide from the marks and the numbers, not from the look of the line.** Glue each piece in its row.

Row 1. Tangent. The marks or the numbers prove that the line is tangent.

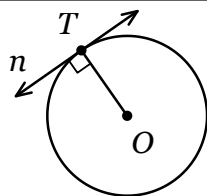
Row 2. Not tangent. The marks or the numbers prove that the line is not tangent.

Row 3. Cannot tell. Nothing on the piece proves it either way. The line only looks tangent.

Cut & Glue Sort — the pieces

Cut along the dashed lines

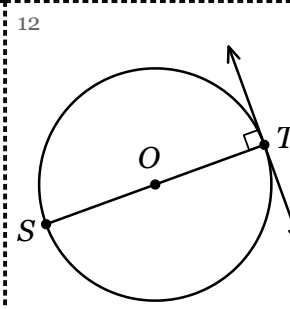
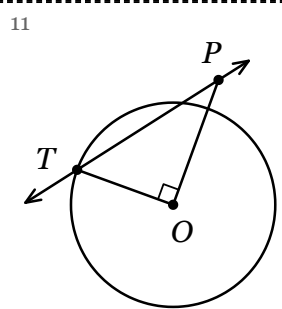
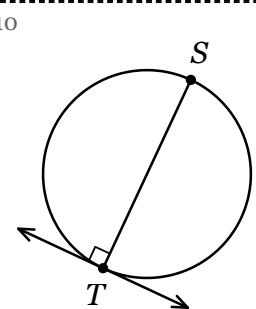
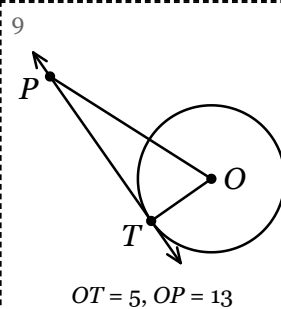
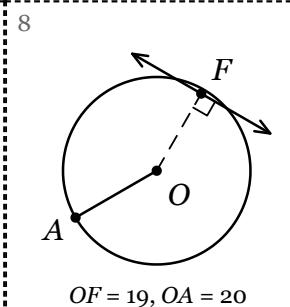
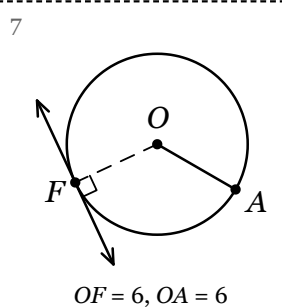
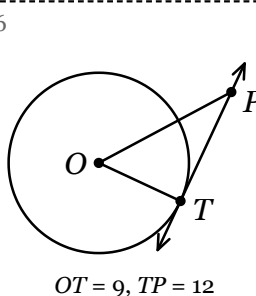
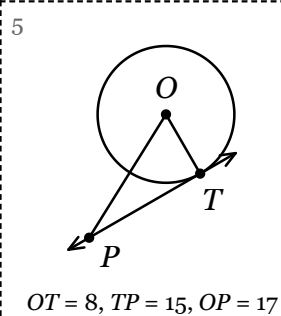
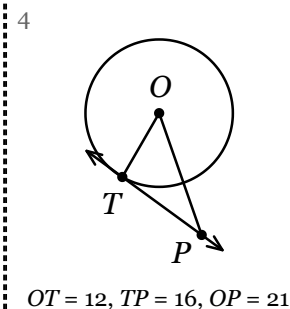
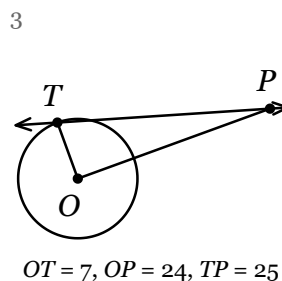
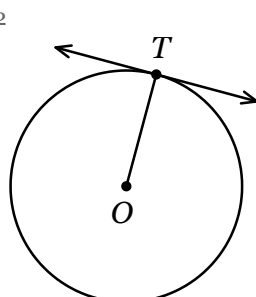
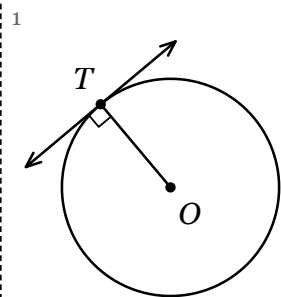
Cut out the twelve pieces. Glue each one in its row on the other sheet. A dot marked O is the center. A small square means a right angle. A dashed segment with a small square shows the distance from O to the line.



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.



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Every piece is listed by the number printed on its corner, with the reason. Each row holds four pieces.

1 Tangent. The marks or the numbers prove that the line is tangent.

- 1.** The radius OT is drawn, and a small square at T shows that OT and the line meet at a right angle. *Why:* The line is perpendicular to the radius OT at T, a point of the circle, so it is tangent there.
- 5.** OT = 8, TP = 15 and OP = 17. No angle is marked. *Why:* $8^2 + 15^2 = 64 + 225 = 289 = 17^2$. OP is the longest side, so the right angle is at T, between the radius and the line. The line is tangent.
- 7.** A dashed segment from O meets the line at F at a right angle, and OF = 6. The radius OA = 6. *Why:* The dashed segment OF is perpendicular to the line, so the distance from O to the line is 6. That is the radius, 6, so the line touches the circle at one point, F, and is tangent there.
- 12.** TS is a diameter through O. A small square at T shows that TS and the line meet at a right angle. *Why:* TS is a diameter, so it lies along the radius to T. The line is perpendicular to it at T, so it is tangent there.

2 Not tangent. The marks or the numbers prove that the line is not tangent.

- 3.** OT = 7, OP = 24 and TP = 25. No angle is marked. *Why:* $7^2 + 24^2 = 49 + 576 = 625 = 25^2$, so the triangle has a right angle. But TP = 25 is the longest side, so the right angle is at O, not at T. The line is not perpendicular to the radius, so it is not tangent.
- 4.** OT = 12, TP = 16 and OP = 21. No angle is marked. *Why:* $12^2 + 16^2 = 144 + 256 = 400$, but $21^2 = 441$. The angle at T is not a right angle, so the line is not perpendicular to the radius and is not tangent.
- 8.** A dashed segment from O meets the line at F at a right angle, and OF = 19. The radius OA = 20. *Why:* The distance from O to the line is 19, less than the radius 20, so the line crosses the circle at two points.
- 11.** The radius OT and the segment OP are drawn, P on the line. A small square at O shows that OT and OP meet at a right angle. *Why:* The right angle of triangle OTP is at O. A triangle has only one right angle, so the angle at T is not 90° . The line is not perpendicular to the radius OT, so it is not tangent.

3 Cannot tell. Nothing on the piece proves it either way. The line only looks tangent.

- 2.** The radius OT is drawn. Nothing is marked and no number is printed. *Why:* The line looks tangent, but no right angle is marked and no number is printed. A drawing alone does not prove tangency.
- 6.** OT = 9 and TP = 12. OP is drawn with no number. No angle is marked. *Why:* Two sides of triangle OTP do not fix the angle at T. Without the third side or a right-angle mark, nothing proves that OT is perpendicular to the line.
- 9.** OT = 5 and OP = 13. TP is not labeled. No angle is marked. *Why:* Two sides of triangle OTP do not fix the angle at T. Without the third side or a right-angle mark, nothing proves that OT is perpendicular to the line.
- 10.** The center is not marked. A chord TS is drawn, and a small square at T shows that TS and the line meet at a right angle. *Why:* The square shows that TS is perpendicular to the line. But the center is not marked, so nothing shows that TS is a diameter. The line is tangent only if it is perpendicular to the radius, so this cannot be told.

To check a piece with a student, ask: “Where does the line meet the circle? Is there a right angle there, between the line and the radius? Do the numbers prove it, with the longest side across from that corner?”