

CUT & GLUE SORT

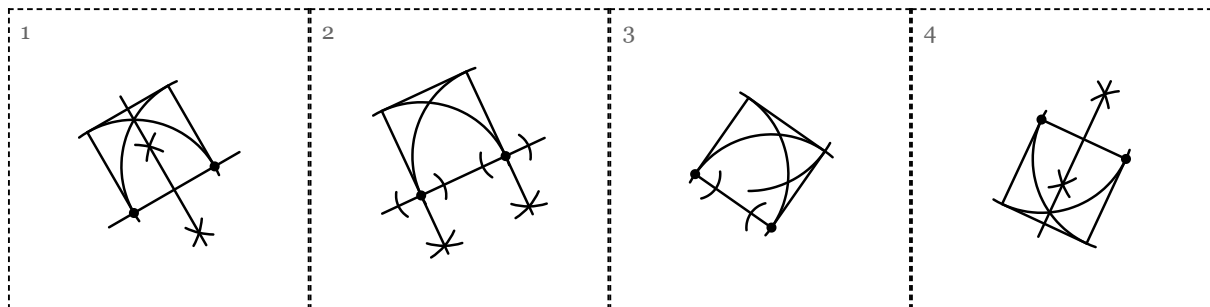


CONSTRUCTING AN EQUILATERAL TRIANGLE AND A SQUARE

Square on a Segment: Where Are the Right Angles?

A square · a right angle in the middle · or four equal sides and nothing more

FREE



1. **Hand out pages 3 and 4**, one of each per student, with scissors, glue and a compass.
2. **Say this once:** *“Every piece looks square. That is not the question. The question is what the marks prove. A square needs its right angles at the corners, not four equal sides.”*
3. **Every row gets 4.** A row with more or fewer has a piece in the wrong place. (This is on your page only, not the student's.)

Student sheets pages 3 and 4, one of each per student.

Answers page 5.

Rows 2 and 3 are the two most common wrong squares. In row 2, the student builds the perpendicular bisector of the segment, the construction students know best. That puts the right angle at the middle of the side, not at a corner. In row 3, the student copies the length of the segment three times with the compass. That gives four equal sides but no right angle, so the figure may be a rhombus that only looks square. For each wrong piece, ask the class: *what did this person think a square was?*

The third row is the hard one: four equal sides are not enough. Every piece is drawn exactly square, so a student cannot sort by looking. On some pieces the segment is never extended past its dots. Many students feel that extending the segment is not allowed. It is allowed, and the right angle at a dot needs it. Guessing does not work: every simple guessing rule, such as counting the arcs, gets at most nine of the twelve pieces right.



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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What did they prove?

A square, a right angle in the wrong place, or only the sides

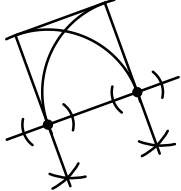
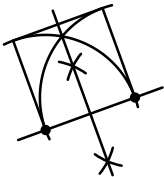
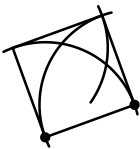
Name _____

Period _____

Date _____

Cut out the twelve pieces on the next page. Each is somebody's finished square on the segment between the two dots, with every mark left on. **Every one looks square, so looking decides nothing.**

What do the marks prove? Row 1: a right angle built at each dot, with the line carried past the dot, arcs on either side, and a crossing on the side. The segment's length was also carried up both sides. Row 2: a right angle is built, but at the middle of the segment. Row 3: four sides carried with the compass, and no right angle built anywhere. Glue each piece into its row.

 1 • Correct: a square	 2 • Wrong: right angle in the middle	 3 • Wrong: not yet a square
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1 • Correct: a square — *a right angle built at each dot, and the length carried up both sides*

2 • Wrong: right angle in the middle — *a right angle is built, but at the middle of the segment, not at a corner*

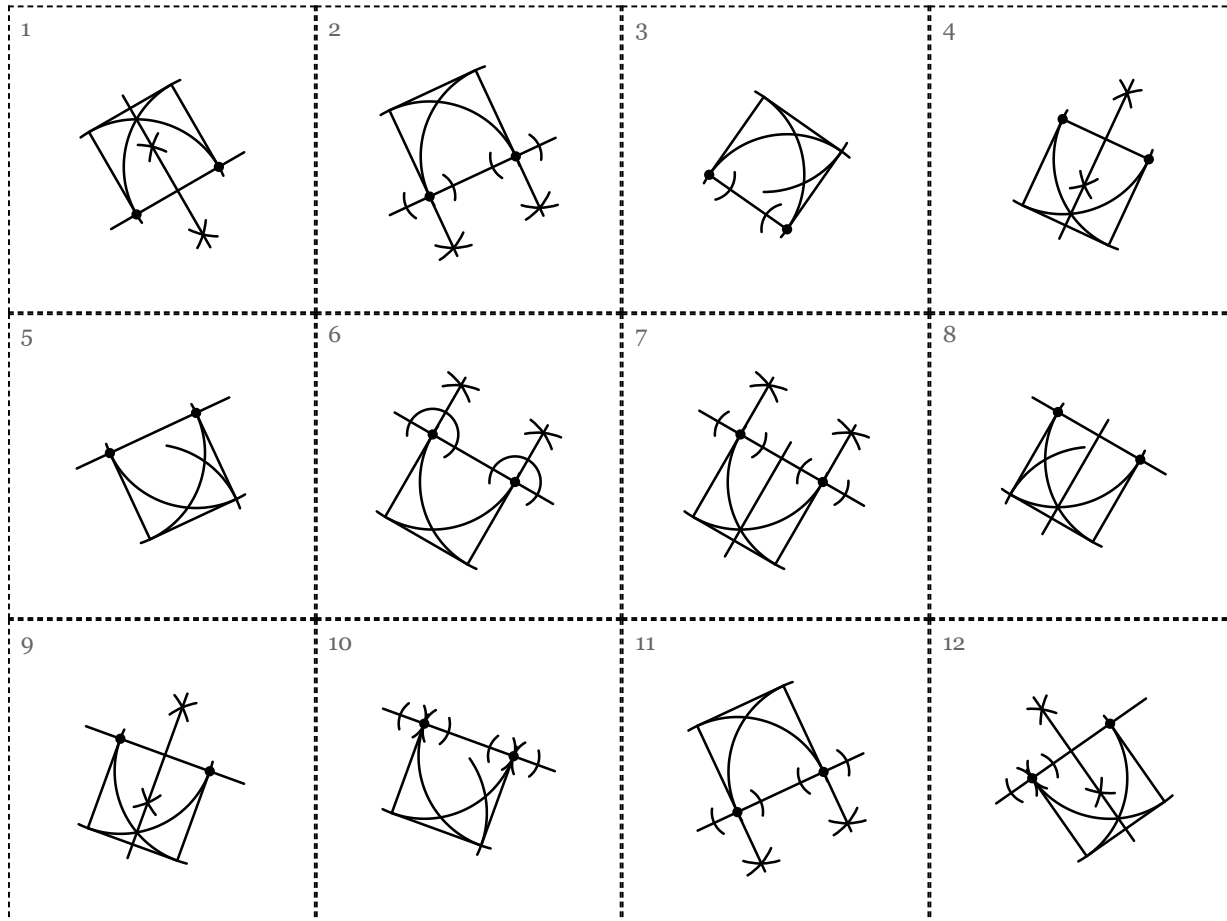
3 • Wrong: not yet a square — *four sides carried equal, and no right angle built anywhere*

The twelve pieces

Cut along the dotted lines

This lesson. The triangle: **one setting, taken from the given segment, used for both circles and never reopened.** The square: the same setting for carrying the length, and the rule from two lessons ago for the two perpendiculars at the ends. The line must be carried past each end first.

Last lesson: it had no rule of its own. **Every rule so far** is one question: two circles about the ends of a segment meet at two points, one, or none. It depends on the two openings and the gap.



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Cut & Glue Sort — answers

For the teacher

Correct: a square	2 — A right angle is built at each dot. The length of the segment is copied up both sides.	6 — The same. The first arc at each dot is drawn in one piece.	7 — The same, with an extra line drawn up the middle as a check.	11 — The same, with the square on the other side of the segment.
Wrong: right angle in the middle	1 — The perpendicular bisector of the segment is built. The sides at the dots are drawn by eye.	4 — The same. The segment is not extended past its dots.	9 — The same, turned around on the page.	12 — The perpendicular bisector is built. A perpendicular is tried at one dot, but its arcs meet only at the dot.
Wrong: not yet a square	3 — The segment is not extended. One arc at each dot crosses it once. Then three arcs of its length are drawn.	5 — Three arcs of the segment's length. The segment is extended, but no right angle is built.	8 — Three arcs of the segment's length, and a line up the middle drawn by eye.	10 — A perpendicular is tried at each dot, but the arcs meet only at the dot. Then three arcs of its length are drawn.

No piece depends on sharp eyes. Two arcs either have the same compass opening or differ by at least 3 mm. A crossing of two arcs is either on a line or at least 2.5 mm away from it. Every piece is drawn exactly square.