

MYSTERY PICTURE

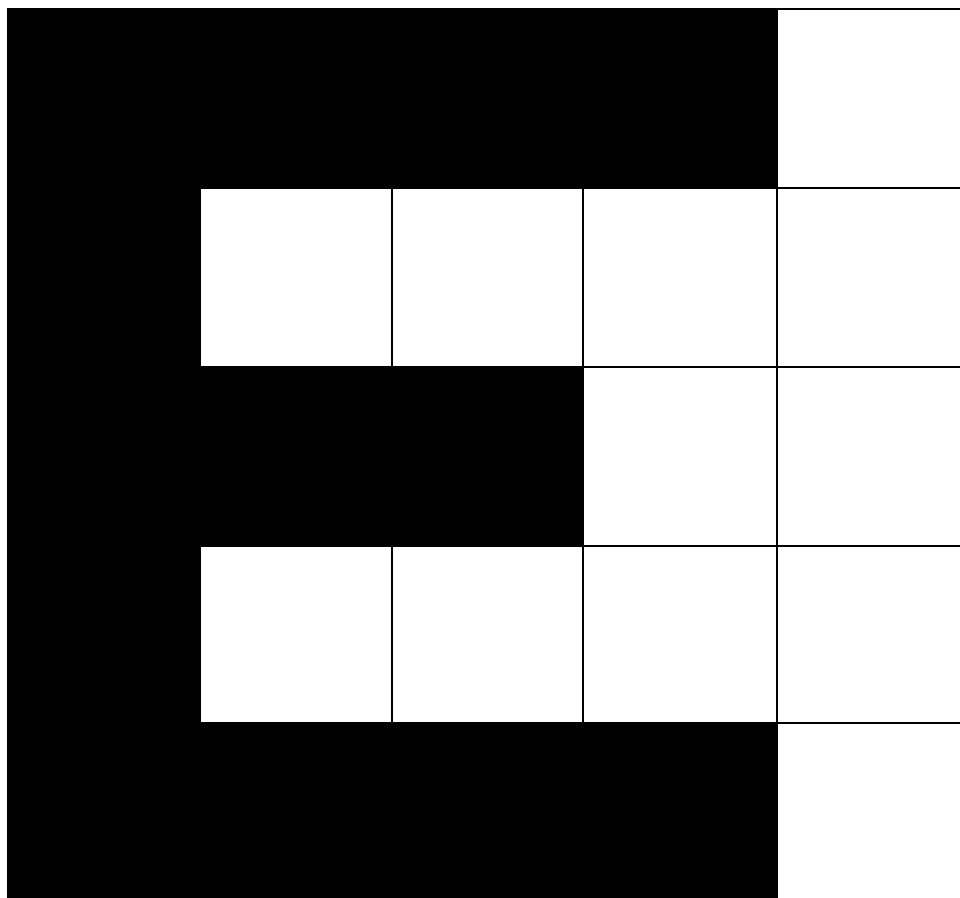


ANGLE BISECTORS AND THE INCENTER

Is This Point the Incenter?

25 triangles · read the marks, not the looks

FREE



1. **Hand out page 3**, one per student. Pencils. Nothing else is needed.
2. **Say this once:** *“The incenter is the same distance from the three sides. A distance to a side is measured along a segment perpendicular to the side. Look for the small squares, the ticks and the arcs before you decide.”*
3. **When a student finishes, look at the picture.** If it is not the letter E, a square is wrong. The student finds it and checks it again.

Student sheet	page 3, one per student. It shows the incenter and the circumcenter as two small marked drawings.
Answers	page 4: the finished picture and the reason for every square.

This sheet practices one skill: reading the marks to name the point. The incenter is the point the same distance from the three *sides*. That distance is measured along a segment that is perpendicular to the side, so the marks must show a small square at each side and the same ticks on all three segments. The incenter is also where the angle bisectors meet. So lines from two or three corners, each cutting its angle into two parts with the same arcs, also show the incenter.

The white squares hold the mistakes students make. The same ticks on the segments to the three *corners* show the circumcenter, not the incenter (four squares). Lines that are perpendicular to the sides at their middles are perpendicular bisectors, so they show the circumcenter too (two squares). In two squares the three segments to the sides have the same ticks but are not perpendicular to the sides. A slanted segment is not a distance. In one square the segments are perpendicular to the sides, but one has different ticks. In three squares only one corner is cut in half, which is not enough.

The incenter is always inside the triangle. Two filled squares have an obtuse triangle, and the incenter is still inside. The circumcenter of an obtuse triangle is outside it.

Thirteen squares are filled and twelve are white. Guessing does not work. Every simple guessing rule, such as filling every square with a small square in it, gets at least nine squares wrong.



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

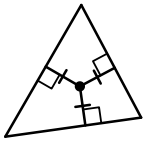
Is the dot the incenter?

Name _____

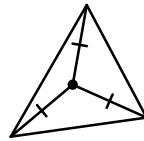
Period _____

Date _____

Each square shows a triangle with a dot and some marks. Do the marks show that the dot is the incenter? If yes, fill the square with slanted lines. If no, leave it white. Trust the marks, not how the drawing looks.



The **incenter**: the same distance from the three **sides**. It is where the angle bisectors meet.



The **circumcenter**: the same distance from the three **corners**. It is where the perpendicular bisectors meet.

A small square marks a right angle. Segments with the same number of ticks are equal. Angles with the same number of arcs are equal. A distance to a side is measured along a segment that is perpendicular to the side.

When you finish, look at the picture. If part of it is missing, or one square does not fit, check that square again.

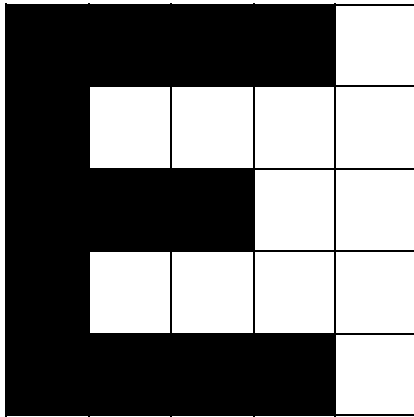
1 	2 	3 	4 	5
6 	7 	8 	9 	10
11 	12 	13 	14 	15
16 	17 	18 	19 	20
21 	22 	23 	24 	25



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Mystery Picture — answers

For the teacher



The finished picture is **the letter E**: a bar down the left side, bars along the top and the bottom, and a shorter bar in the middle.

A square is filled when the marks show the incenter: three segments perpendicular to the sides with the same ticks, or lines from at least two corners that each cut their angle into two equal parts. Every other square is white.

To check a square with a student, ask: “Where are the small squares? Where are the ticks: on segments to the sides, or to the corners?”

1–5	1 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter.	2 · FILL Each line from a corner cuts its angle into two parts with the same arcs. The three angle bisectors meet at the incenter.	3 · FILL Two lines from corners cut their angles into equal parts (same arcs). Two angle bisectors are enough: they cross at the incenter.	4 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter. The triangle is obtuse, and the incenter is still inside.	5 · white The ticks are on the segments to the corners. The dot is the same distance from the corners: the circumcenter.
6–10	6 · FILL Each line from a corner cuts its angle into two parts with the same arcs. The three angle bisectors meet at the incenter. The triangle is obtuse, and the incenter is still inside.	7 · white One corner is cut into equal parts, but the other has two different arcs. One angle bisector is not enough.	8 · white Each line is perpendicular to a side at its middle (the halves have the same ticks). These are perpendicular bisectors: the circumcenter.	9 · white The segments are perpendicular to the sides, but one has two ticks and the others one. The distances are not all equal.	10 · white The ticks are on the segments to the corners: the circumcenter. It is outside, and the incenter never is.
11–15	11 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter.	12 · FILL Two lines from corners cut their angles into equal parts (same arcs). Two angle bisectors are enough: they cross at the incenter.	13 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter.	14 · white The segments to the sides have the same ticks, but none is perpendicular to its side. A slanted segment is not a distance.	15 · white One corner is cut into equal parts, but the other has two different arcs. One angle bisector is not enough.
16–20	16 · FILL Each line from a corner cuts its angle into two parts with the same arcs. The three angle bisectors meet at the incenter.	17 · white The ticks are on the segments to the corners. The dot is the same distance from the corners: the circumcenter.	18 · white Each line is perpendicular to a side at its middle (the halves have the same ticks). These are perpendicular bisectors: the circumcenter.	19 · white One corner is cut into equal parts, but the other has two different arcs. One angle bisector is not enough.	20 · white The segments to the sides have the same ticks, but none is perpendicular to its side. A slanted segment is not a distance.
21–25	21 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter.	22 · FILL Two lines from corners cut their angles into equal parts (same arcs). Two angle bisectors are enough: they cross at the incenter.	23 · FILL Each line from a corner cuts its angle into two parts with the same arcs. The three angle bisectors meet at the incenter.	24 · FILL Three segments are perpendicular to the sides and have the same ticks. The dot is the same distance from the three sides: the incenter.	25 · white The ticks are on the segments to the corners: the circumcenter. It is outside, and the incenter never is.