

MYSTERY PICTURE

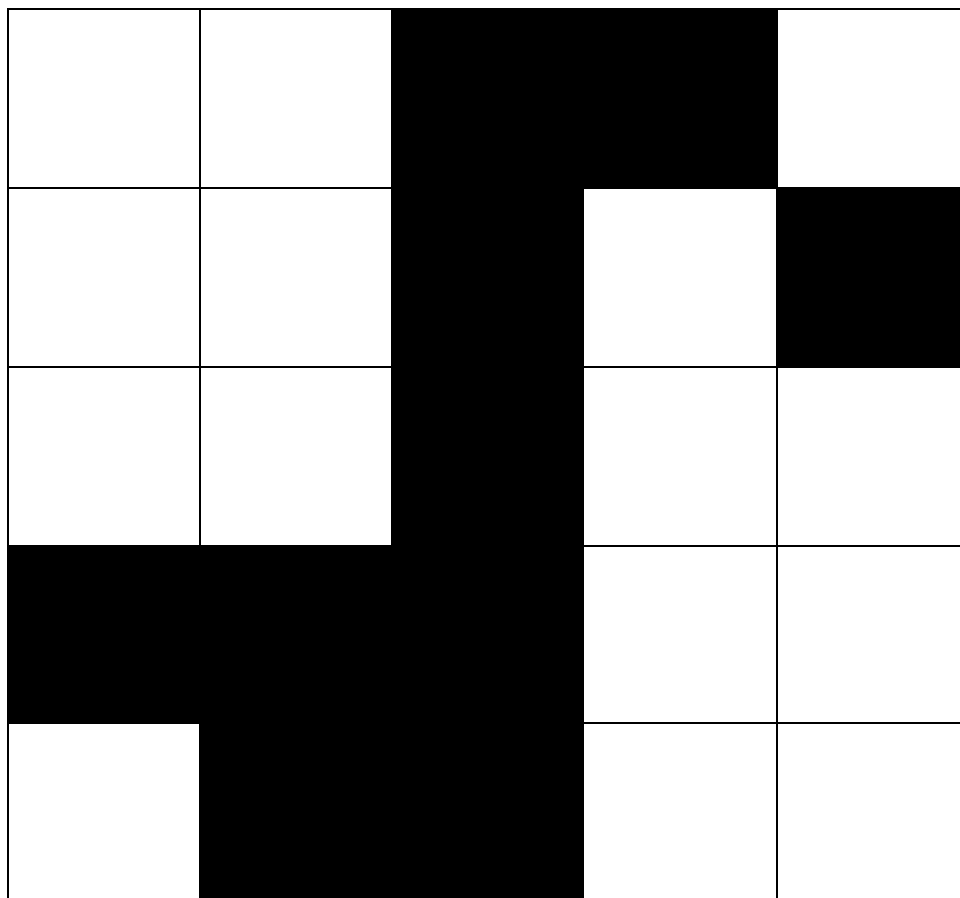


COMPLEMENTARY, SUPPLEMENTARY AND VERTICAL ANGLES

Vertical Angles: Must They Be Equal?

25 squares · no numbers · a wrong square breaks the picture

FREE



1. **Hand out page 3.** That is the whole preparation.
2. **Say this once:** *“Two angles must be equal only if the figure makes them equal. They can be the opposite angles of two straight lines. Or a little square can make both of them right angles. Looking equal does not count.”*
3. **Fill a square with slanted lines if its two marked angles must be equal. Leave it white if they need not be.** A picture appears. 10 of the 25 are filled.

Student sheet page 3, one per student. It shows the three cases as small pictures.
Answers page 4: the finished picture and the reason for every square.

Many white squares look as if they should be filled. That is on purpose. Three have a single ray across from an angle of the crossing. The two angles look opposite, but the ray has no ray opposite it, so they are not vertical angles. Three are made of four rays that do not form two straight lines. Their opposite angles are drawn within a few degrees of equal. Two are a linear pair on lines that cross at 86° or 94° , with no little square. The angles look like right angles, but they need not be. Two have three lines through one point. The marked angles are across the point, but they are not made by the same two lines.

The filled squares are not all alike. Three carry a little square. On two of those, the two equal angles sit *side by side*. They are equal because the square makes both of them right angles. Compare them with the white squares drawn at 86° or 94° . Together they show the main rule of the lesson. *You may assume vertical angles from a diagram. You may not assume that two lines are perpendicular.* Two straight lines that cross always make vertical angles, so the drawing is enough for them. A right angle is an extra fact, so it must be marked with a little square.

Guessing does not work. Every simple guessing rule, such as filling every square whose two arcs look the same size, gets at least five squares wrong. The picture then comes out wrong, and the student can see it. **Do not let students measure.** The question is what the figure makes true, not what the drawing looks like.

“Vertical” is also an everyday word, and that confuses students. Say once, out loud: vertical angles are *opposite* angles. They open left and right as often as up and down. The figures are drawn at 21 different tilts, and no line on the sheet is horizontal.



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

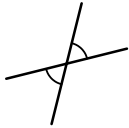
The figure decides, not the look. Do not measure.

Name _____

Period _____

Date _____

Must the two marked angles be equal? If yes, fill it with slanted lines. If no, leave it white. Only two LINES make vertical angles, and only a little square makes a right angle. **A picture appears. If it is not right, one square is wrong.**



Vertical angles
two lines · EQUAL



Linear pair
one straight line · ADD TO 180°



Four rays, not two lines
not vertical · no rule

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

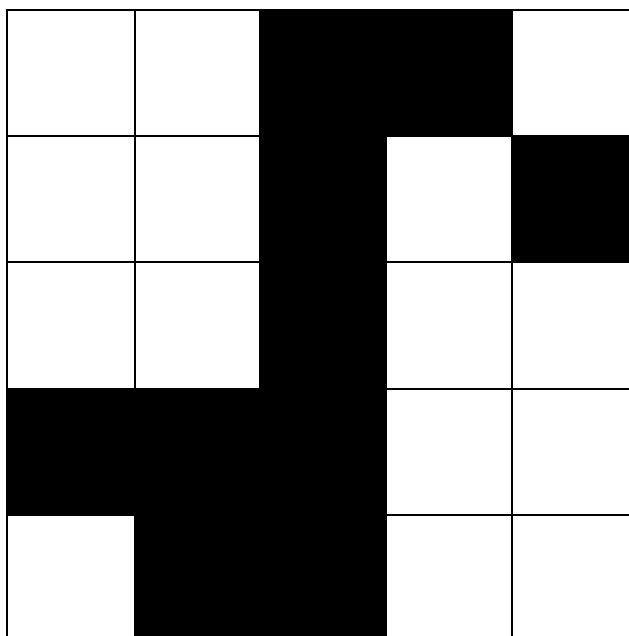


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Mystery Picture — answers

For the teacher

The finished picture is **a musical note**: the stem up the middle, the flag curling off to the right at the top, the round head at the bottom left. Read the table left to right, as on the student's sheet. The squares are numbered there.



1–5	white the ray has no opposite ray, so not vertical	white four rays, not two straight lines	FILL two lines cross, so the angles are vertical	FILL vertical angles; the extra ray changes nothing	white no square, so they need not be 90°
6–10	white a linear pair, so they add to 180°	white side by side, and nothing makes them equal	FILL three lines, and the angles are vertical	white not made by the same two lines	FILL the square makes both right angles
11–15	white the ray has no opposite ray, so not vertical	white four rays, not two straight lines	FILL two lines cross, so the angles are vertical	white no square, so they need not be 90°	white a linear pair, so they add to 180°
16–20	FILL vertical angles; the extra ray changes nothing	FILL three lines, and the angles are vertical	FILL the square makes both right angles	white side by side, and nothing makes them equal	white not made by the same two lines
21–25	white the ray has no opposite ray, so not vertical	FILL two lines cross, so the angles are vertical	FILL the square makes both right angles	white four rays, not two straight lines	white side by side, and nothing makes them equal

On every white square, the two marked angles are drawn at least a few degrees apart. So the drawing never disagrees with this key. But on seven of the white squares, the difference is too small to see.