

CUT & GLUE SORT



INDIRECT MEASUREMENT WITH SIMILAR TRIANGLES

Will This Plan Work?

Twelve measuring plans in words · shadows, mirrors and rulers · three rows

FREE

measures.

- his height
- from the mirror to his feet
- from the mirror to the tower's base

moment, she measures.

- the tree's shadow
- her height
- her shadow

straight up. She measures:

- her height
- her shadow
- the pole's shadow

Row 1. Correct: these three lengths give the height.

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Row 2. Wrong: the triangles are similar, but one length is measured from the wrong place.

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Row 3. Wrong: the two triangles are not similar, so no lengths will work.

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Cut & Glue Sort — how to run it

25 minutes, including the cutting

1. **Hand out pages 3 and 4**, one of each per student, with scissors and glue. Nothing else is needed.
2. **Say this once:** *“For each plan, first ask: are the two triangles similar here? If yes, ask: is each length measured from the right place?”*
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 the three set-ups as plain drawings.
Answers	page 5.

Each piece is a measuring plan in words. It describes a scene and lists the three lengths someone measures to find a height. The student decides whether the plan works. Row 1 holds plans that work. Row 2 holds plans in a good scene where one length is measured from the wrong place: the height to the top of the head instead of the eye height, a slanted line of sight instead of a distance straight along (the mirror to the eyes, the eye to the top of the flagpole), or a distance that starts at the wrong point.

The last row is the most important. Its plans measure the right three lengths, so they look correct. But the scene breaks the method. A nearby lamp sends its rays out from one point, so they are not parallel. A tree on a hill does not make a right angle with its shadow. The sun moves between two times of day. A tilted mirror does not make equal angles on its two sides. In each case the two triangles are not similar, and saying so is the whole answer.

A student who checks only the lengths and never the scene places at most eight pieces correctly. Ask that student: *“Where does the light come from? Do both objects stand straight up on level ground?”* Guessing rules place 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 — will the plan work?

Indirect measurement

Name _____

Period _____

Date _____

Each piece on the next page is a plan to find a height without climbing. It tells the scene and the three lengths someone measures. **Picture the two triangles. Decide which row the plan belongs in, and glue it there.**

Row 1. Correct: these three lengths give the height.

Row 2. Wrong: the triangles are similar, but one length is measured from the wrong place.

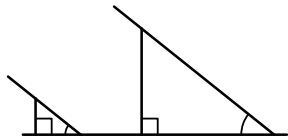
Row 3. Wrong: the two triangles are not similar, so no lengths will work.

Cut & Glue Sort — the plans

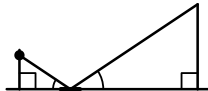
Cut along the dashed lines

Cut out the twelve pieces. Glue each one in its row on the other sheet.

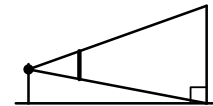
Three ways to make two similar triangles. The drawings are not to scale.



Sun: the rays are parallel. Both stand straight up.



Mirror: flat on the ground. The dot is the eye.



Ruler: held straight up. It just covers the post.

1 A mirror lies flat on level ground. Finn sees the top of a tower in it. He measures:

- his height
- from the mirror to his feet
- from the mirror to the tower's base

2 The sun shines on level ground. Ana and a tree stand straight up. At one moment, she measures:

- the tree's shadow
- her height
- her shadow

3 At night, one street lamp lights the level ground. Jen and a pole stand straight up. She measures:

- her height
- her shadow
- the pole's shadow

4 The sun shines. Eva stands on flat ground, but the tree stands on a steep hill. She measures:

- her height
- her shadow
- the tree's shadow

5 Cal holds a ruler straight up at arm's length. It just covers a post, top to bottom. He measures:

- from his eye to the post
- the ruler's length
- from his eye to the ruler

6 Kira holds a ruler straight up at arm's length. It just covers a flagpole, top to bottom. She measures:

- the ruler's length
- from her eye to the ruler
- from her eye to the top of the flagpole

7 A mirror lies flat on level ground between Ben and a tower. He sees the top of the tower in it. He measures:

- his eye height
- from the mirror to his feet
- from the mirror to the tower's base

8 A mirror rests on a stone, so it is tilted. Lin sees the top of a tower in it. She measures:

- from the mirror to her feet
- from the mirror to the tower's base
- her eye height

9 The sun shines on level ground. Ivan and a tree stand straight up. At one moment, he measures:

- his height
- his shadow
- the distance from him to the tree

10 A mirror lies flat on level ground between Hana and a chimney. She sees the top of the chimney in it. She measures:

- her eye height
- from the mirror to her eyes
- from the mirror to the chimney's base

11 On level ground in the sun, Gus measures his height and shadow at 9 a.m. He measures the tree's shadow at noon. The three lengths are:

- his height
- his shadow
- the tree's shadow

12 The sun shines on a level field. A post and a flagpole stand straight up. At one moment, Dee measures:

- the post's height
- the flagpole's shadow
- the post's shadow



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Each row holds four pieces. Every piece is printed again here, with the reason.

1 Correct: these three lengths give the height.

2. The sun shines on level ground. Ana and a tree stand straight up. At one moment, she measures: the tree's shadow; her height; her shadow. *Why:* The sun's rays are parallel, and both stand straight up on level ground, so the triangles are similar. Height goes with height and shadow with shadow.

5. Cal holds a ruler straight up at arm's length. It just covers a post, top to bottom. He measures: from his eye to the post; the ruler's length; from his eye to the ruler. *Why:* The ruler and the post both stand straight up, so the two triangles that meet at the eye are similar. The ruler goes with the post, and the eye to the ruler goes with the eye to the post.

7. A mirror lies flat on level ground between Ben and a tower. He sees the top of the tower in it. He measures: his eye height; from the mirror to his feet; from the mirror to the tower's base. *Why:* A flat mirror makes equal angles on its two sides, and both stand straight up, so the triangles are similar. The plan uses the eye height and the two distances along the ground.

12. The sun shines on a level field. A post and a flagpole stand straight up. At one moment, Dee measures: the post's height; the flagpole's shadow; the post's shadow. *Why:* The sun's rays are parallel, and both stand straight up on level ground, so the triangles are similar. Height goes with height and shadow with shadow.

2 Wrong: the triangles are similar, but one length is measured from the wrong place.

1. A mirror lies flat on level ground. Finn sees the top of a tower in it. He measures: his height; from the mirror to his feet; from the mirror to the tower's base. *Why:* The line of sight starts at the eye. The plan needs his eye height, not his height.

6. Kira holds a ruler straight up at arm's length. It just covers a flagpole, top to bottom. She measures: the ruler's length; from her eye to the ruler; from her eye to the top of the flagpole. *Why:* The plan needs the distance from her eye to the flagpole, straight out, to go with the distance from her eye to the ruler. The distance from her eye to the top of the flagpole is a slanted line of sight. It would go with the line from her eye to the top of the ruler, which was not measured.

9. The sun shines on level ground. Ivan and a tree stand straight up. At one moment, he measures: his height; his shadow; the distance from him to the tree. *Why:* The plan needs the tree's shadow. The distance from him to the tree is not a side of either triangle.

10. A mirror lies flat on level ground between Hana and a chimney. She sees the top of the chimney in it. She measures: her eye height; from the mirror to her eyes; from the mirror to the chimney's base. *Why:* The plan needs the distance along the ground, from the mirror to her feet. The distance from the mirror to her eyes is a slanted line.

3 Wrong: the two triangles are not similar, so no lengths will work.

3. At night, one street lamp lights the level ground. Jen and a pole stand straight up. She measures: her height; her shadow; the pole's shadow. *Why:* A lamp is close, so its rays spread out from one point. The rays meet the ground at different angles at the two shadow tips, so the triangles are not similar.

4. The sun shines. Eva stands on flat ground, but the tree stands on a steep hill. She measures: her height; her shadow; the tree's shadow. *Why:* The tree's shadow falls on the hill, so the angle between the tree and its shadow is not a right angle. The triangles are not similar.

8. A mirror rests on a stone, so it is tilted. Lin sees the top of a tower in it. She measures: from the mirror to her feet; from the mirror to the tower's base; her eye height. *Why:* A tilted mirror does not make equal angles with the ground on its two sides, so the triangles are not similar.

11. On level ground in the sun, Gus measures his height and shadow at 9 a.m. He measures the tree's shadow at noon. The three lengths are: his height; his shadow; the tree's shadow. *Why:* The sun moves between 9 a.m. and noon, so its rays meet the ground at a different angle. The triangles are not similar.

To check a piece with a student, ask two questions. First: are the two triangles similar in this scene? If no, it goes in row 3. If yes, ask: is each length measured from the right place (the eye, the feet, the base)? If yes, it goes in row 1. If no, it goes in row 2.