

MYSTERY PICTURE

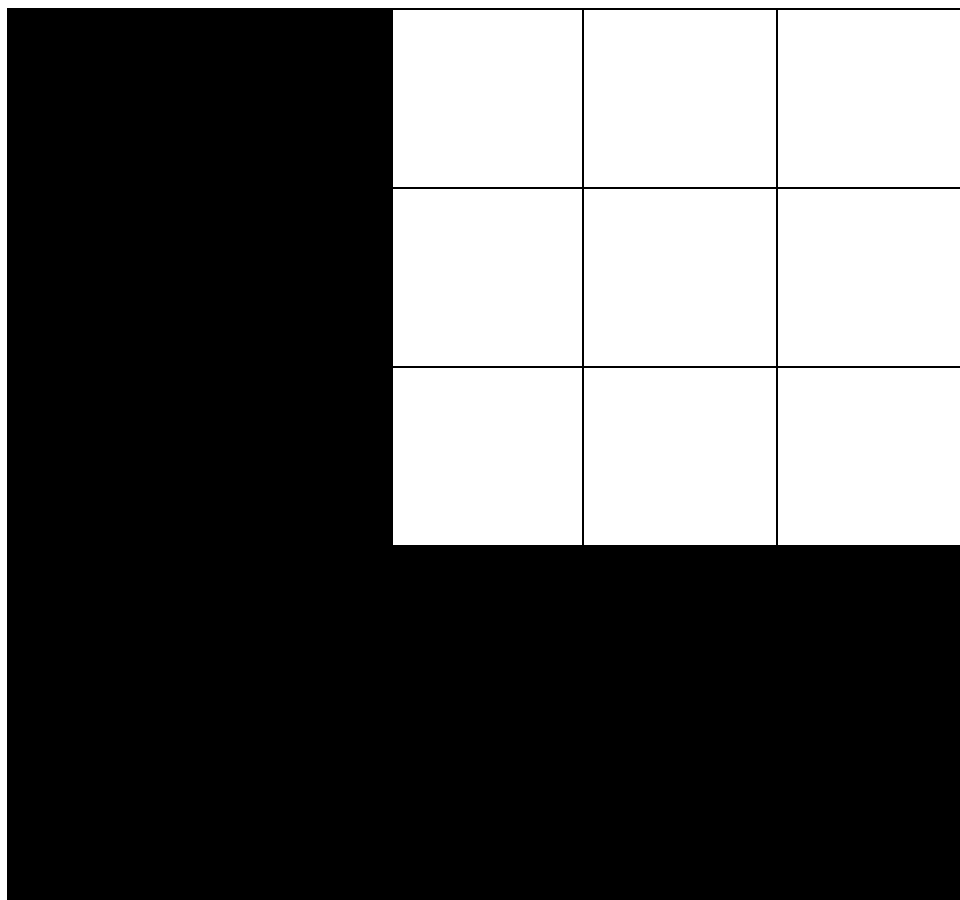


SINE, COSINE AND TANGENT RATIOS

Sine, Cosine or Tangent: Is It True?

25 equations · five lettered right triangles · true or not?

FREE



1. **Hand out page 3**, one per student. Pencils. Nothing else is needed.
2. **Say this once:** *“Find the triangle with the same letters. Put your finger on the angle the equation names. Then name the hypotenuse, the opposite leg and the adjacent leg. If the equation is true, fill the square with slanted lines. If not, leave it white.”*
3. **When a student finishes, look at the picture.** If it is not the letter L, a square is wrong. The student finds it and checks it again.

Student sheet	page 3, one per student. The five triangles and the three definitions, with the same triangle drawn twice, are printed at the top.
Answers	page 4: the finished picture and the reason for every square.

This sheet practices one question: which sides does each ratio use? For an acute angle of a right triangle, $\sin = \text{opposite leg} \div \text{hypotenuse}$, $\cos = \text{adjacent leg} \div \text{hypotenuse}$, and $\tan = \text{opposite leg} \div \text{adjacent leg}$. The leg opposite the angle does not touch it. The adjacent leg touches it. The hypotenuse touches it too, but it is never called the adjacent leg. There are no numbers on the sheet, so nobody can get a square right by arithmetic.

Each white square shows a common mistake. Five swap the opposite and adjacent legs, which gives the ratio of the other acute angle. Two use the hypotenuse as the adjacent leg in a tangent. One is a cosine written upside down. One writes a sine as $\text{opposite} \div \text{adjacent}$. In every one of the five triangles, the squares ask about both acute angles, so the two legs change roles inside one triangle.

Sixteen squares are filled and nine are white. No triangle has a level side. A student who calls the more upright leg “opposite” gets ten squares wrong. Guessing does not work either: every simple guessing rule, such as filling every square with the hypotenuse on the bottom, gets at least eight 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

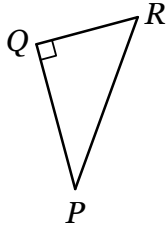
Is the equation true?

Name _____

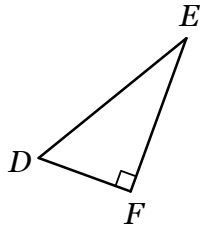
Period _____

Date _____

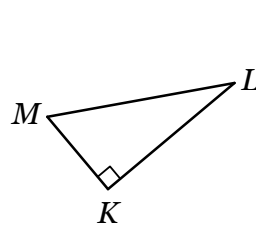
Each square is an equation about one of the five triangles. Its letters tell you which triangle. First find the angle it names. Is the equation true? If yes, fill the square with slanted lines. If no, leave it white. When you finish, look at the picture. If part of it is missing, or one square does not fit, check that square again.



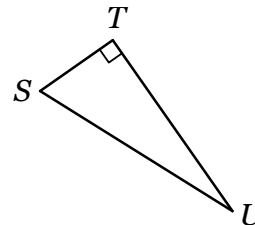
Triangle 1. Right angle at Q.



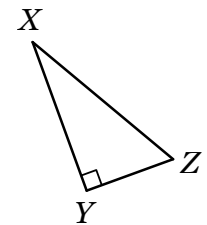
Triangle 2. Right angle at F.



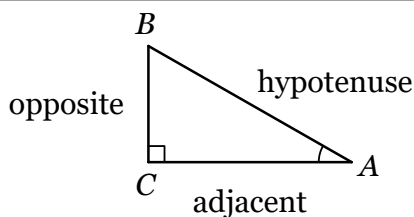
Triangle 3. Right angle at K.



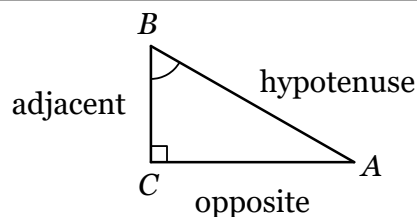
Triangle 4. Right angle at T.



Triangle 5. Right angle at Y.



The arc marks angle A.



The arc marks angle B.

$$\sin A = \frac{\text{leg opposite A}}{\text{hypotenuse}}$$

$$\cos A = \frac{\text{leg adjacent to A}}{\text{hypotenuse}}$$

$$\tan A = \frac{\text{leg opposite A}}{\text{leg adjacent to A}}$$

The **hypotenuse** is across from the right angle. The leg **opposite** an angle does not touch it. The leg **adjacent** to an angle touches it. The hypotenuse touches the angle too, but it is never the adjacent leg. When the angle moves, opposite and adjacent change places.

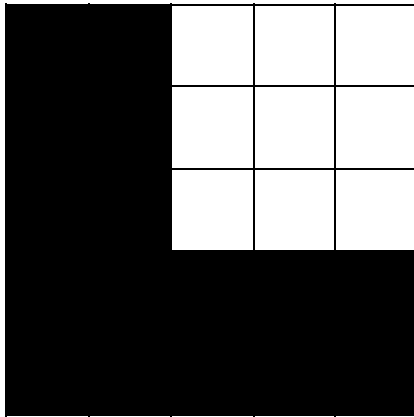
1 $\sin P = \frac{QR}{PR}$	2 $\cos E = \frac{EF}{DE}$	3 $\sin L = \frac{KL}{LM}$	4 $\tan U = \frac{ST}{SU}$	5 $\cos X = \frac{YZ}{XZ}$
6 $\tan M = \frac{KL}{KM}$	7 $\cos S = \frac{ST}{SU}$	8 $\sin R = \frac{PQ}{QR}$	9 $\cos D = \frac{DE}{DF}$	10 $\tan Z = \frac{YZ}{XY}$
11 $\tan X = \frac{YZ}{XY}$	12 $\cos R = \frac{QR}{PR}$	13 $\sin S = \frac{ST}{SU}$	14 $\tan L = \frac{KM}{LM}$	15 $\sin E = \frac{EF}{DE}$
16 $\sin D = \frac{EF}{DE}$	17 $\sin Z = \frac{XY}{XZ}$	18 $\cos L = \frac{KL}{LM}$	19 $\tan P = \frac{QR}{PQ}$	20 $\sin U = \frac{ST}{SU}$
21 $\cos U = \frac{TU}{SU}$	22 $\tan D = \frac{EF}{DF}$	23 $\cos Z = \frac{YZ}{XZ}$	24 $\tan R = \frac{PQ}{QR}$	25 $\sin M = \frac{KL}{LM}$



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Mystery Picture — answers

For the teacher



The finished picture is **the letter L**: a stem two squares thick and a foot two squares thick.

A square is filled when its fraction uses the right two sides for the angle it names. This sheet uses these definitions: $\sin = \text{opposite leg} \div \text{hypotenuse}$, $\cos = \text{adjacent leg} \div \text{hypotenuse}$, $\tan = \text{opposite leg} \div \text{adjacent leg}$. Some textbooks use other definitions, so tell the class which ones this sheet uses.

To check a square with a student, point at the angle and ask: “Which leg touches this angle? Which leg does not?”

1–5	1 · FILL $\sin P = QR/PR$ QR is the leg opposite P and PR is the hypotenuse. So $\sin P = QR/PR$ is true.	2 · FILL $\cos E = EF/DE$ EF is the leg adjacent to E and DE is the hypotenuse. So $\cos E = EF/DE$ is true.	3 · white $\sin L = KL/LM$ KL is the leg adjacent to L and LM is the hypotenuse. But $\sin L = KM/LM$. KL/LM is $\cos L$.	4 · white $\tan U = ST/SU$ ST is the leg opposite U and SU is the hypotenuse. But $\tan U = ST/TU$. ST/SU is $\sin U$.	5 · white $\cos X = YZ/XZ$ YZ is the leg opposite X and XZ is the hypotenuse. But $\cos X = XY/XZ$. YZ/XZ is $\sin X$.
6–10	6 · FILL $\tan M = KL/KM$ KL is the leg opposite M and KM is the leg adjacent to M. So $\tan M = KL/KM$ is true.	7 · FILL $\cos S = ST/SU$ ST is the leg adjacent to S and SU is the hypotenuse. So $\cos S = ST/SU$ is true.	8 · white $\sin R = PQ/QR$ PQ is the leg opposite R and QR is the leg adjacent to R. But $\sin R = PQ/PR$. PQ/QR is $\tan R$.	9 · white $\cos D = DE/DF$ DE is the leg adjacent to D. But $\cos D = DF/DE$. DE/DF is that fraction upside down, and it is more than 1.	10 · white $\tan Z = YZ/XY$ YZ is the leg opposite Z and XY is the leg adjacent to Z. But $\tan Z = XY/YZ$. YZ/XY is $\tan X$, the other acute angle.
11–15	11 · FILL $\tan X = YZ/XY$ YZ is the leg opposite X and XY is the leg adjacent to X. So $\tan X = YZ/XY$ is true.	12 · FILL $\cos R = QR/PR$ QR is the leg adjacent to R and PR is the hypotenuse. So $\cos R = QR/PR$ is true.	13 · white $\sin S = ST/SU$ ST is the leg adjacent to S and SU is the hypotenuse. But $\sin S = TU/SU$. ST/SU is $\cos S$.	14 · white $\tan L = KM/LM$ KM is the leg opposite L and LM is the hypotenuse. But $\tan L = KM/KL$. KM/LM is $\sin L$.	15 · white $\sin E = EF/DE$ EF is the leg adjacent to E and DE is the hypotenuse. But $\sin E = DF/DE$. EF/DE is $\cos E$.
16–20	16 · FILL $\sin D = EF/DE$ EF is the leg opposite D and DE is the hypotenuse. So $\sin D = EF/DE$ is true.	17 · FILL $\sin Z = XY/XZ$ XY is the leg opposite Z and XZ is the hypotenuse. So $\sin Z = XY/XZ$ is true.	18 · FILL $\cos L = KL/LM$ KL is the leg adjacent to L and LM is the hypotenuse. So $\cos L = KL/LM$ is true.	19 · FILL $\tan P = QR/PQ$ QR is the leg opposite P and PQ is the leg adjacent to P. So $\tan P = QR/PQ$ is true.	20 · FILL $\sin U = ST/SU$ ST is the leg opposite U and SU is the hypotenuse. So $\sin U = ST/SU$ is true.
21–25	21 · FILL $\cos U = TU/SU$ TU is the leg adjacent to U and SU is the hypotenuse. So $\cos U = TU/SU$ is true.	22 · FILL $\tan D = EF/DF$ EF is the leg opposite D and DF is the leg adjacent to D. So $\tan D = EF/DF$ is true.	23 · FILL $\cos Z = YZ/XZ$ YZ is the leg adjacent to Z and XZ is the hypotenuse. So $\cos Z = YZ/XZ$ is true.	24 · FILL $\tan R = PQ/QR$ PQ is the leg opposite R and QR is the leg adjacent to R. So $\tan R = PQ/QR$ is true.	25 · FILL $\sin M = KL/LM$ KL is the leg opposite M and LM is the hypotenuse. So $\sin M = KL/LM$ is true.