

MYSTERY PICTURE



SINE AND COSINE OF COMPLEMENTARY ANGLES

Is $\sin A = \cos B$?

25 lettered right triangles · no numbers · a picture appears

FREE

1 $\sin A = \cos B$	2 $\cos D = \sin E$	3 $\cos R = \sin P$	4 $\sin M = \cos L$	5 $\sin S = \sin U$
6 $\tan Z = \tan X$	7 $\sin G = \cos H$	8 $\cos V = \sin U$	9 $\sin M = \cos M$	10 $\sin E = \cos D$
11 $\cos R = \sin S$	12 $\cos X = \sin Y$	13 $\sin K = \cos J$	14 $\cos G = \sin F$	15 $\sin N = \cos Q$
16 $\sin B = \cos F$	17 $\tan S = \tan T$	18 $\cos K = \cos L$	19 $\cos E = \sin D$	20 $\sin H = \cos J$
21 $\sin W = \cos X$	22 $\cos T = \sin R$	23 $\cos Z = \sin W$	24 $\sin C = \cos A$	25 $\cos P = \sin R$

1. **Give each student page 3** and a pencil.
2. **Say this once:** *“Each square has a right triangle and one statement. Is the statement true? If yes, fill the square with slanted lines. If no, leave it white. If no right angle is marked, leave it white. Look at the letters: which angle is each ratio about?”*
3. **Let them work.** The picture shows when they are right. Nothing else is needed.

Student sheet page 3, one per student. A strip at the top shows why $\sin A = \cos B$ in a right triangle ABC.
Answers pages 4–5, for you.

No square has a number. The student decides from the letters alone. In a right triangle, the side opposite one acute angle is the side adjacent to the other acute angle, and the hypotenuse is the same for both. So the sine of one acute angle is the cosine of the other: the same side over the same hypotenuse. Fourteen squares are true and are filled.

Each white square is a common mistake. In two the statement uses two sines or two cosines. In two it uses two tangents: $\tan A$ and $\tan B$ are not equal, because one is the other turned upside down. In one it uses the sine and the cosine of one angle. In three it uses the right angle as if it were acute. In three no right angle is marked, although the triangle looks right and the statement would be true if it were.

If part of a student’s picture looks wrong, the mistake is in that square. Ask: *“Which letter is the right angle? Which side is opposite this angle?”* Guessing does not work: every simple guessing rule gets at least seven squares wrong. A student who fills every sine-and-cosine statement of two different letters, without checking for the right angle, gets six 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 statement true?

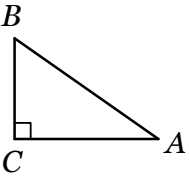
sine and cosine

Name _____

Period _____

Date _____

Each square has a triangle and one statement. **Is the statement true? If yes, fill the square with slanted lines. If no, leave it white. If no right angle is marked, leave it white.** A picture appears. If part of it is missing, or one square does not fit, check that square again.

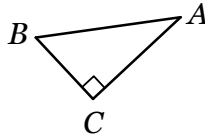
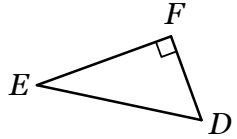
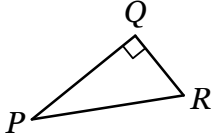
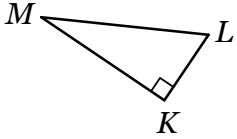
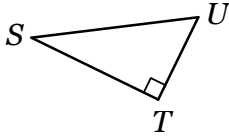
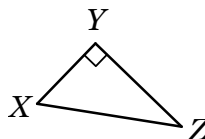
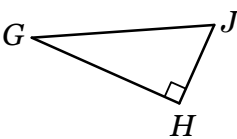
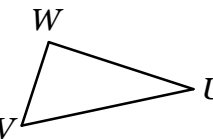
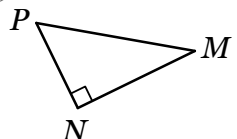
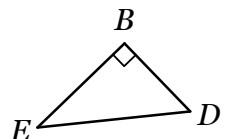
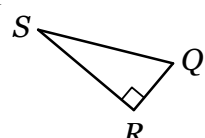
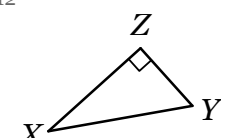
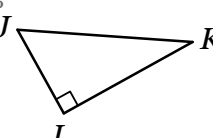
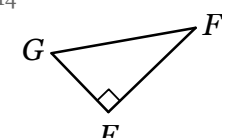
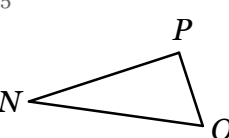
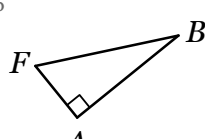
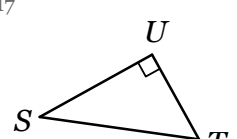
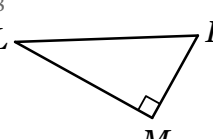
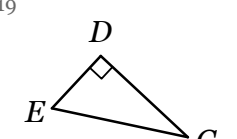
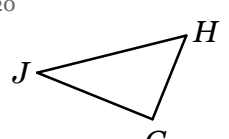
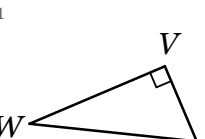
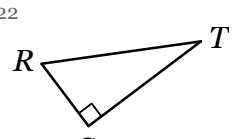
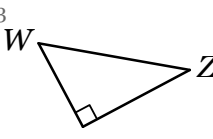
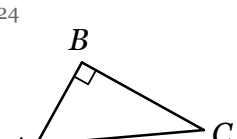
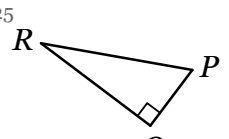


C is the right angle. A and B are the two acute angles, so $A + B = 90^\circ$.

$\sin = \text{opposite} \div \text{hypotenuse}$ $\cos = \text{adjacent} \div \text{hypotenuse}$ $\tan = \text{opposite} \div \text{adjacent}$

BC is opposite A and adjacent to B. So $\sin A = \frac{BC}{AB}$ and $\cos B = \frac{BC}{AB}$.

$\sin A = \cos B$ and $\cos A = \sin B$. The sine of one acute angle is the cosine of the other.

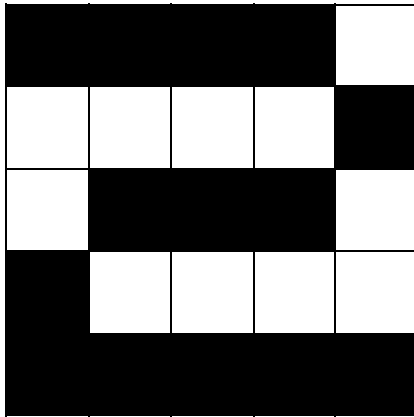
1  $\sin A = \cos B$	2  $\cos D = \sin E$	3  $\cos R = \sin P$	4  $\sin M = \cos L$	5  $\sin S = \sin U$
6  $\tan Z = \tan X$	7  $\sin G = \cos H$	8  $\cos V = \sin U$	9  $\sin M = \cos M$	10  $\sin E = \cos D$
11  $\cos R = \sin S$	12  $\cos X = \sin Y$	13  $\sin K = \cos J$	14  $\cos G = \sin F$	15  $\sin N = \cos Q$
16  $\sin B = \cos F$	17  $\tan S = \tan T$	18  $\cos K = \cos L$	19  $\cos E = \sin D$	20  $\sin H = \cos J$
21  $\sin W = \cos X$	22  $\cos T = \sin R$	23  $\cos Z = \sin W$	24  $\sin C = \cos A$	25  $\cos P = \sin R$



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Mystery Picture — answers

For the teacher



The finished picture is **the number 2**. Fourteen squares are filled.

To check a square, find the right angle first. A statement is true only when it is a sine and a cosine of the two other corners, two different letters. The table gives the reason for every square, and it goes on over the page.

	The square	Answer	Why
1	Right angle at C. $\sin A = \cos B$	fill (true)	A and B are the two acute angles. $\sin A = \frac{BC}{AB}$ and $\cos B = \frac{BC}{AB}$: the same side over the same hypotenuse.
2	Right angle at F. $\cos D = \sin E$	fill (true)	D and E are the two acute angles. $\cos D = \frac{DF}{DE}$ and $\sin E = \frac{DF}{DE}$: the same side over the same hypotenuse.
3	Right angle at Q. $\cos R = \sin P$	fill (true)	R and P are the two acute angles. $\cos R = \frac{QR}{PR}$ and $\sin P = \frac{QR}{PR}$: the same side over the same hypotenuse.
4	Right angle at K. $\sin M = \cos L$	fill (true)	M and L are the two acute angles. $\sin M = \frac{KL}{LM}$ and $\cos L = \frac{KL}{LM}$: the same side over the same hypotenuse.
5	Right angle at T. $\sin S = \sin U$	white (false)	$\sin S = \frac{TU}{SU}$ but $\sin U = \frac{ST}{SU}$. A different side is on top, so they are not equal. Only a sine and a cosine swap.
6	Right angle at Y. $\tan Z = \tan X$	white (false)	$\tan Z = \frac{XY}{YZ}$ and $\tan X = \frac{YZ}{XY}$. One is the other turned upside down, so they are not equal.
7	Right angle at H. $\sin G = \cos H$	white (false)	H is the right angle, not an acute angle. The rule pairs the two acute angles, G and J.
8	No right-angle mark. $\cos V = \sin U$	white (no right angle marked)	No right angle is marked. Without one there is no hypotenuse, so sine and cosine are not defined. The triangle only looks right.
9	Right angle at N. $\sin M = \cos M$	white (false)	Both ratios are of the same angle M: $\sin M = \frac{NP}{MP}$ and $\cos M = \frac{MN}{MP}$. The rule pairs two different angles.
10	Right angle at B. $\sin E = \cos D$	fill (true)	E and D are the two acute angles. $\sin E = \frac{BD}{DE}$ and $\cos D = \frac{BD}{DE}$: the same side over the same hypotenuse.
11	Right angle at R. $\cos R = \sin S$	white (false)	R is the right angle, not an acute angle. The rule pairs the two acute angles, Q and S.
12	Right angle at Z. $\cos X = \sin Y$	fill (true)	X and Y are the two acute angles. $\cos X = \frac{XZ}{XY}$ and $\sin Y = \frac{XZ}{XY}$: the same side over the same hypotenuse.

Mystery Picture — answers, squares 13 to 25

For the teacher

	The square	Answer	Why
13	Right angle at L. $\sin K = \cos J$	fill (true)	K and J are the two acute angles. $\sin K = \frac{JL}{JK}$ and $\cos J = \frac{JL}{JK}$: the same side over the same hypotenuse.
14	Right angle at E. $\cos G = \sin F$	fill (true)	G and F are the two acute angles. $\cos G = \frac{EG}{FG}$ and $\sin F = \frac{EG}{FG}$: the same side over the same hypotenuse.
15	No right-angle mark. $\sin N = \cos Q$	white (no right angle marked)	No right angle is marked. Without one there is no hypotenuse, so sine and cosine are not defined. The triangle only looks right.
16	Right angle at A. $\sin B = \cos F$	fill (true)	B and F are the two acute angles. $\sin B = \frac{AF}{BF}$ and $\cos F = \frac{AF}{BF}$: the same side over the same hypotenuse.
17	Right angle at U. $\tan S = \tan T$	white (false)	$\tan S = \frac{TU}{SU}$ and $\tan T = \frac{SU}{TU}$. One is the other turned upside down, so they are not equal.
18	Right angle at M. $\cos K = \cos L$	white (false)	$\cos K = \frac{KM}{KL}$ but $\cos L = \frac{LM}{KL}$. A different side is on top, so they are not equal. Only a sine and a cosine swap.
19	Right angle at D. $\cos E = \sin D$	white (false)	D is the right angle, not an acute angle. The rule pairs the two acute angles, C and E.
20	No right-angle mark. $\sin H = \cos J$	white (no right angle marked)	No right angle is marked. Without one there is no hypotenuse, so sine and cosine are not defined. The triangle only looks right.
21	Right angle at V. $\sin W = \cos X$	fill (true)	W and X are the two acute angles. $\sin W = \frac{VX}{WX}$ and $\cos X = \frac{VX}{WX}$: the same side over the same hypotenuse.
22	Right angle at S. $\cos T = \sin R$	fill (true)	T and R are the two acute angles. $\cos T = \frac{ST}{RT}$ and $\sin R = \frac{ST}{RT}$: the same side over the same hypotenuse.
23	Right angle at Y. $\cos Z = \sin W$	fill (true)	Z and W are the two acute angles. $\cos Z = \frac{YZ}{WZ}$ and $\sin W = \frac{YZ}{WZ}$: the same side over the same hypotenuse.
24	Right angle at B. $\sin C = \cos A$	fill (true)	C and A are the two acute angles. $\sin C = \frac{AB}{AC}$ and $\cos A = \frac{AB}{AC}$: the same side over the same hypotenuse.
25	Right angle at Q. $\cos P = \sin R$	fill (true)	P and R are the two acute angles. $\cos P = \frac{PQ}{PR}$ and $\sin R = \frac{PQ}{PR}$: the same side over the same hypotenuse.