

SCAVENGER HUNT



GEOMETRIC MEAN AND THE ALTITUDE TO THE HYPOTENUSE

The Altitude Rule or a Leg Rule?

One right triangle on every card · find the length · the cards check the answers

FREE

ANSWER

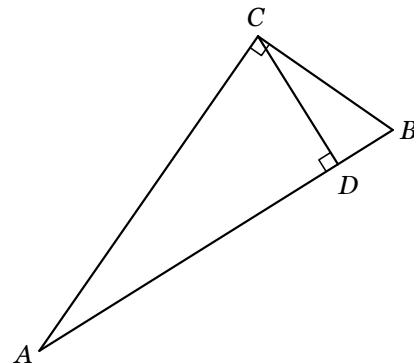
18

Right angle at C. CD is the altitude to AB.

AD = 49, DB = 9

How long is CD?

The altitude goes with the two pieces of the hypotenuse.



R

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1. **Tape the 16 cards around the room**, in any order. Each card has a large letter in its bottom left corner. Start each group at a *different* one of these eight cards: *R P E Q N K H B*.
2. **Say this once:** “Before any arithmetic, write which rule you need: the altitude rule or a leg rule. The record sheet shows both. Eight right answers bring you back to your first card.”
3. **Each group finds the length, then walks to the card with that number at the top.** Nothing else is needed.

16 cards	pages 3–10, one copy. There are two cards on each sheet. Cut the whole stack once.
Record sheet	page 11, one per student. It shows the two rules as two small drawings.
Answers	pages 12–13, for you only. Do not put them up in the room.

Every card shows one right triangle with the altitude from the right angle to the hypotenuse. The altitude cuts the hypotenuse into two pieces. The *altitude rule*: the altitude squared equals one piece times the other piece. The altitude is the *geometric mean* of the two pieces. The *leg rule*: a leg squared equals its own piece (the piece that touches the same end of the hypotenuse) times the whole hypotenuse.

There are four kinds of card, two of each on the ring. The two pieces given, the altitude asked: the common mistake takes the average of the two pieces. The altitude and one piece given, the other piece asked: the common mistake treats the altitude as the average of the two pieces. The two pieces given, a leg asked: the common mistake multiplies the two pieces, as if for the altitude, and never adds them to get the hypotenuse. A leg and the hypotenuse given, the leg's own piece asked: the common mistake gives the other piece.

Eight of the sixteen cards make the ring. A group reaches the other eight only by a wrong answer, but all the cards look the same. The common mistake on a ring card gives the number at the top of one of the other cards. That card's answer sends the group back to the card it got wrong. **A clean run is eight lines**, and each wrong answer adds two. Every card has a line in small type under the question. It tells a group that arrived by a wrong answer what to check. If a group keeps coming back to the same cards, ask: “Which segment is the altitude? Which piece touches this leg?”



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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ANSWER

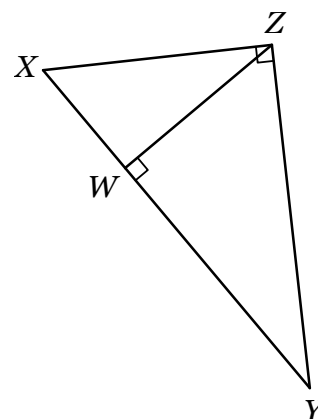
32

Right angle at Z. ZW is the altitude to YX.

$YW = 9$, $ZW = 6$

How long is WX?

Put a finger on the leg. Which piece does it touch?



A

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ANSWER

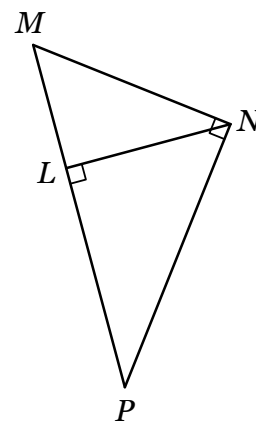
4

Right angle at N. NL is the altitude to MP.

$MN = 30$, $MP = 50$

How long is ML?

The square of a leg is its own piece times the hypotenuse.



B

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ANSWER

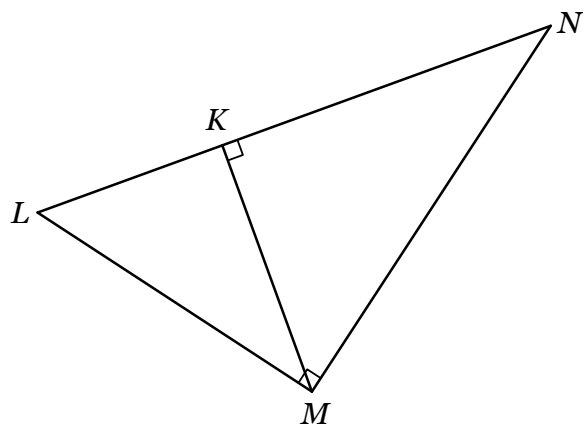
3

Right angle at M. MK is the altitude to LN.

LK = 18, KN = 32

How long is LM?

Write the altitude rule as piece times piece.



C

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ANSWER

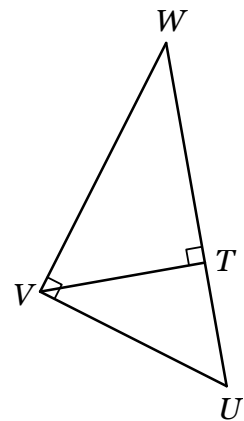
29

Right angle at V. VT is the altitude to UW.

UW = 50, UV = 30

How long is UT?

Multiply the two pieces, then take the square root.



D

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ANSWER

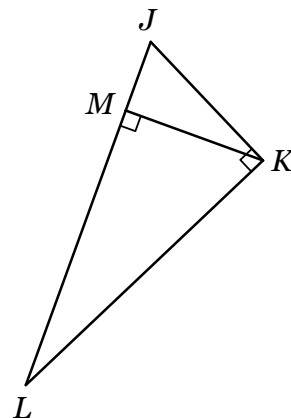
15

Right angle at K. KM is the altitude to JL.

KM = 28, JM = 14

How long is ML?

Which segment is unknown here: the altitude or a piece?



E

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ANSWER

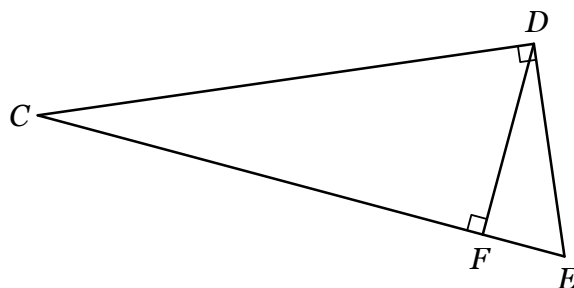
12

Right angle at D. DF is the altitude to CE.

CF = 49, FE = 9

How long is DF?

Does the rule use the whole hypotenuse or one piece of it?



F

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ANSWER

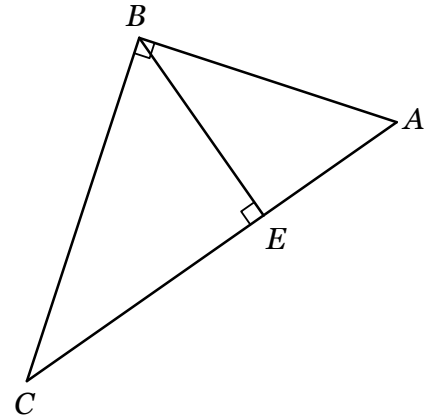
42

Right angle at B. BE is the altitude to AC.

EC = 16, AE = 9

How long is AB?

The altitude is never halfway between the two pieces.



G

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ANSWER

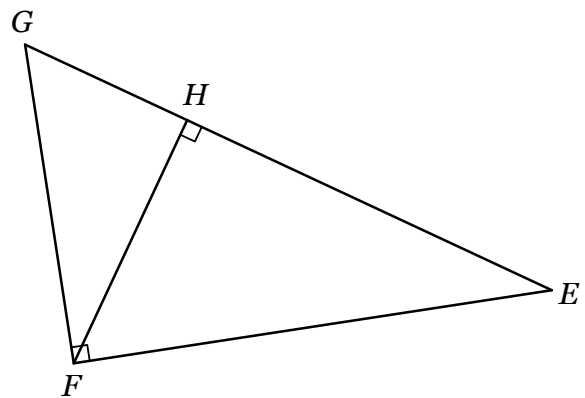
30

Right angle at F. FH is the altitude to EG.

EH = 9, FH = 6

How long is HG?

Divide the square of the altitude by the known piece.



H

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ANSWER

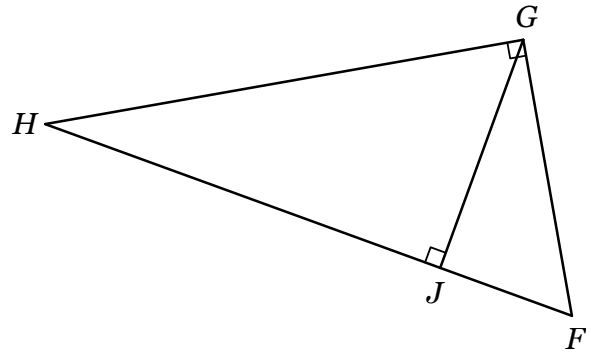
10

Right angle at G. GJ is the altitude to FH.

$FG = 22$, $FH = 44$

How long is FJ?

The geometric mean is less than the average of two numbers.



J

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ANSWER

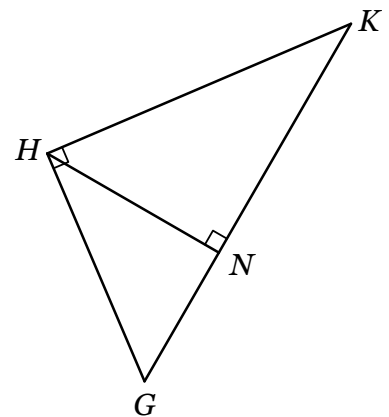
6

Right angle at H. HN is the altitude to GK.

$GN = 18$, $NK = 32$

How long is GH?

Add the two pieces first to get the whole hypotenuse.



K

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ANSWER

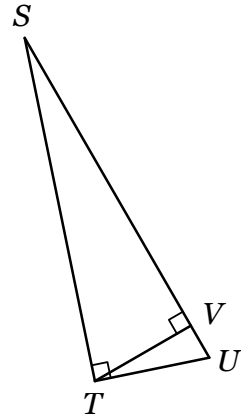
24

Right angle at T. TV is the altitude to SU.

$$VU = 2, SV = 18$$

How long is TV?

Is the hypotenuse one piece, or both pieces together?



L

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ANSWER

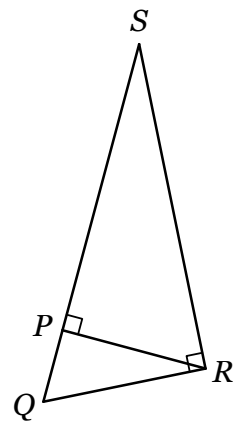
33

Right angle at R. RP is the altitude to QS.

$$RP = 28, QP = 14$$

How long is PS?

Which piece touches the end of the leg?



M

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ANSWER

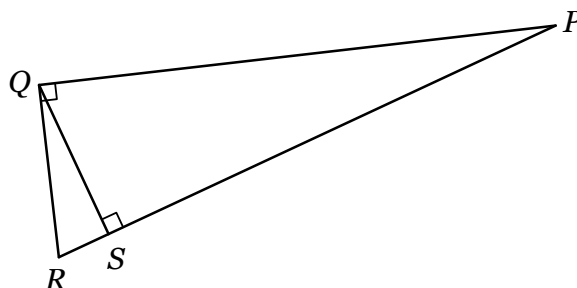
11

Right angle at Q. QS is the altitude to PR.

SR = 2, PS = 18

How long is QS?

Square the answer. It must equal one piece times the other.



N

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ANSWER

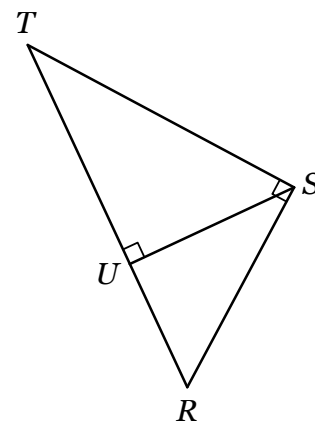
21

Right angle at S. SU is the altitude to RT.

UT = 16, RU = 9

How long is RS?

A leg goes with its own piece and the whole hypotenuse.



P

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ANSWER

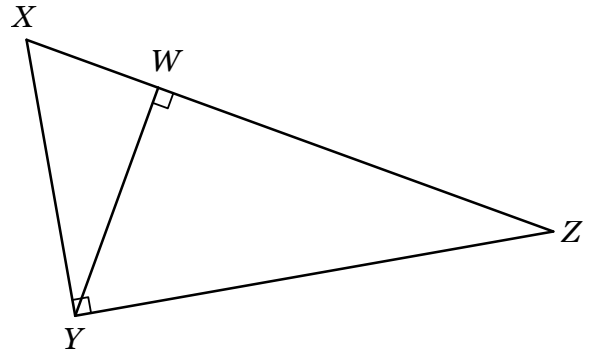
56

Right angle at Y. YW is the altitude to XZ.

$$XZ = 44, XY = 22$$

How long is XW?

Find the piece that shares an end with the leg.



Q

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ANSWER

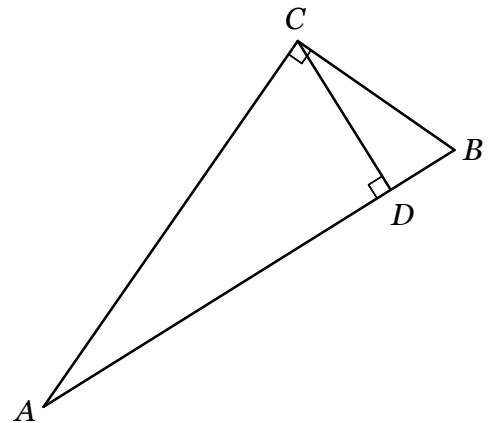
18

Right angle at C. CD is the altitude to AB.

$$AD = 49, DB = 9$$

How long is CD?

The altitude goes with the two pieces of the hypotenuse.



R

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Scavenger Hunt — where I went

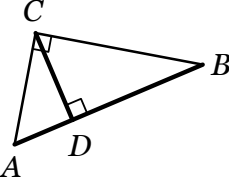
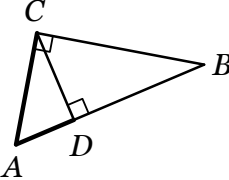
The altitude to the hypotenuse

Name _____

Period _____

Date _____

Do the card you are at. Fill in one line. Then find the card with your answer at the top. **Before any arithmetic, write which rule you need: the altitude rule or a leg rule.** A clean run is eight lines. Each card has a line in small type under the question. **If you are on a card because you went wrong, its line says what to check. If you were right, skip it.**

	Altitude rule. The altitude squared is one piece times the other piece. $CD^2 = AD \cdot DB$, so $\frac{AD}{CD} = \frac{CD}{DB}$		Leg rule. A leg squared is its own piece times the whole hypotenuse. $AC^2 = AD \cdot AB$, so $\frac{AD}{AC} = \frac{AC}{AB}$
The altitude CD goes from the right angle to the hypotenuse AB. It cuts AB into two pieces, AD and DB. $AD + DB = AB$. A leg's own piece is the piece that touches the same end of the hypotenuse: AD for the leg AC, DB for the leg BC.			

Card letter	The rule I need (the altitude rule or a leg rule)	My answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Why is the altitude not nice to the two pieces of the hypotenuse?

Every number stands for a letter. Write the letter for each of your answers in the box above that number. Leave the other boxes empty. Then read the boxes you filled, left to right. **If they do not spell the answer, one answer is wrong.**

3 = S 4 = I 6 = T 10 = A 11 = I 12 = N 15 = S 18 = M 21 = E 24 = E 29 = T 30 = A 32 = I 33 = M 42 = I
56 = N

3	4	6	10	11	12	15	18	21	24	29	30	32	33	42	56



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Scavenger Hunt — answers

For the teacher

The ring in order. A group may begin anywhere on it. Wherever it begins, eight right answers bring it back to that card.

R → P → E → Q → N → K → H → B → R

Why is the altitude not nice to the two pieces of the hypotenuse? The answer is *IT IS MEAN*. The ring's answers, in the order of the boxes on the record sheet (smallest number first), with their letters: **4 I • 6 T • 11 I • 15 S • 18 M • 21 E • 30 A • 56 N**.

Card	The question on the card	Answer, and why	Wrong answer from the common mistake	Joke letter for the number at its top
1 R	Right angle at C, altitude CD. AD = 49, DB = 9. How long is CD?	21 . CD is the altitude, and AD and DB are the two pieces. Altitude rule: $CD^2 = 49 \times 9 = 441$, so CD = 21.	29, from taking the average of the two pieces instead of the geometric mean	M
2 P	Right angle at S, altitude SU. UT = 16, RU = 9. How long is RS?	15 . RS is a leg, and its own piece is RU. The hypotenuse is $9 + 16 = 25$. Leg rule: $RS^2 = 9 \times 25 = 225$, so RS = 15.	12, from using the two pieces where the whole hypotenuse belongs (the altitude rule on a leg)	E
3 E	Right angle at K, altitude KM. KM = 28, JM = 14. How long is ML?	56 . KM is the altitude and JM one piece, so ML is the other piece. Altitude rule: $28^2 = 14 \times ML$, so $ML = 784 \div 14 = 56$.	42, from taking the altitude as the average of the two pieces	S
4 Q	Right angle at Y, altitude YW. XZ = 44, XY = 22. How long is XW?	11 . XY is a leg, and its own piece is XW (both touch X). Leg rule: $22^2 = XW \times 44$, so $XW = 484 \div 44 = 11$.	33, from pairing the leg with the piece that does not touch it	N
5 N	Right angle at Q, altitude QS. SR = 2, PS = 18. How long is QS?	6 . QS is the altitude, and PS and SR are the two pieces. Altitude rule: $QS^2 = 18 \times 2 = 36$, so QS = 6.	10, from taking the average of the two pieces instead of the geometric mean	I
6 K	Right angle at H, altitude HN. GN = 18, NK = 32. How long is GH?	30 . GH is a leg, and its own piece is GN. The hypotenuse is $18 + 32 = 50$. Leg rule: $GH^2 = 18 \times 50 = 900$, so GH = 30.	24, from using the two pieces where the whole hypotenuse belongs (the altitude rule on a leg)	T
7 H	Right angle at F, altitude FH. EH = 9, FH = 6. How long is HG?	4 . FH is the altitude and EH one piece, so HG is the other piece. Altitude rule: $6^2 = 9 \times HG$, so $HG = 36 \div 9 = 4$.	3, from taking the altitude as the average of the two pieces	A
8 B	Right angle at N, altitude NL. MN = 30, MP = 50. How long is ML?	18 . MN is a leg, and its own piece is ML (both touch M). Leg rule: $30^2 = ML \times 50$, so $ML = 900 \div 50 = 18$.	32, from pairing the leg with the piece that does not touch it	I

Each wrong answer in the table is the number at the top of a card off the ring. Those cards are on the next page.

Scavenger Hunt — the cards off the ring

For the teacher

A group reaches these eight cards only by a wrong answer. The number at the top of each one is the wrong answer from one ring card. Its right answer is the number at the top of that ring card, so the group goes back to the card it got wrong. If the group makes the same mistake again, it goes to another card off the ring. So a second wrong answer never moves a group forward.

Card	The question on the card	Answer, and why	Wrong answer from the common mistake	Joke letter for the number at its top
D	Right angle at V, altitude VT. UW = 50, UV = 30. How long is UT?	18. UV is a leg, and its own piece is UT (both touch U). Leg rule: $30^2 = UT \times 50$, so $UT = 900 \div 50 = 18$.	32, from pairing the leg with the piece that does not touch it	T
F	Right angle at D, altitude DF. CF = 49, FE = 9. How long is DF?	21. DF is the altitude, and CF and FE are the two pieces. Altitude rule: $DF^2 = 49 \times 9 = 441$, so $DF = 21$.	29, from taking the average of the two pieces instead of the geometric mean	N
G	Right angle at B, altitude BE. EC = 16, AE = 9. How long is AB?	15. AB is a leg, and its own piece is AE. The hypotenuse is $9 + 16 = 25$. Leg rule: $AB^2 = 9 \times 25 = 225$, so $AB = 15$.	12, from using the two pieces where the whole hypotenuse belongs (the altitude rule on a leg)	I
M	Right angle at R, altitude RP. RP = 28, QP = 14. How long is PS?	56. RP is the altitude and QP one piece, so PS is the other piece. Altitude rule: $28^2 = 14 \times PS$, so $PS = 784 \div 14 = 56$.	42, from taking the altitude as the average of the two pieces	M
J	Right angle at G, altitude GJ. FG = 22, FH = 44. How long is FJ?	11. FG is a leg, and its own piece is FJ (both touch F). Leg rule: $22^2 = FJ \times 44$, so $FJ = 484 \div 44 = 11$.	33, from pairing the leg with the piece that does not touch it	A
L	Right angle at T, altitude TV. VU = 2, SV = 18. How long is TV?	6. TV is the altitude, and SV and VU are the two pieces. Altitude rule: $TV^2 = 18 \times 2 = 36$, so $TV = 6$.	10, from taking the average of the two pieces instead of the geometric mean	E
C	Right angle at M, altitude MK. LK = 18, KN = 32. How long is LM?	30. LM is a leg, and its own piece is LK. The hypotenuse is $18 + 32 = 50$. Leg rule: $LM^2 = 18 \times 50 = 900$, so $LM = 30$.	24, from using the two pieces where the whole hypotenuse belongs (the altitude rule on a leg)	S
A	Right angle at Z, altitude ZW. YW = 9, ZW = 6. How long is WX?	4. ZW is the altitude and YW one piece, so WX is the other piece. Altitude rule: $6^2 = 9 \times WX$, so $WX = 36 \div 9 = 4$.	3, from taking the altitude as the average of the two pieces	I

Other mistakes lead to no card on the ring. A group might forget the square root, pair a leg with the far piece, or hand in the whole hypotenuse. Its answer is then not the number at the top of any ring card, and the group knows to check its work.

Guessing does not work. Every simple rule that uses only the two printed numbers, such as multiplying them and taking the square root, answers at most six of the sixteen cards correctly.