

SCAVENGER HUNT



INDIRECT MEASUREMENT WITH SIMILAR TRIANGLES

How Tall Is It, Without a Ladder?

Shadows and mirrors · draw the two triangles · the cards check the answers

FREE

ANSWER

30 m

At 4 p.m. the sun shines on level ground. Maya is 1.6 m tall. Her shadow is 2.4 m long. At the same moment, the shadow of the oak tree is 12 m long.

Draw the two triangles. How tall is the oak tree?

Heights go with heights. Shadows go with shadows.

R

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Scavenger Hunt — how to run it

a full class period

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 H D J E A P C*.
2. **Say this once:** *“First draw the two triangles in the box on your sheet. Heights go with heights. Shadows go with shadows. In a mirror, use the height of the eyes. Then find the height, and walk to the card with that number at the top.”*
3. **Each group writes one line per card.** Eight right answers bring the group back to its first card.

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 three set-ups as plain drawings with no numbers.
Answers	pages 12–13, for you only. Do not put them up in the room.

No card has a drawing. Each card tells a scene in words: a person and a tall object in the sun, or a person who sees the top of a tall object in a mirror on the ground. The student draws the two triangles first. The two triangles are similar because both objects stand straight up and the sun’s rays are parallel, or because a flat mirror makes equal angles on its two sides.

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. On a sun card, a group that puts the person’s shadow where the height belongs gets the number at the top of another card. On a mirror card, a group that uses the person’s full height instead of the height of the eyes does the same. Every card prints both of those heights. The card that the wrong answer leads to sends the group to the card it got wrong.

The check is the length of the group’s list. A clean run is **eight lines**. 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. A group that arrived by a right answer skips it. If a group keeps coming back to the same cards, do not give the answer. Ask: *“Point to the two heights in your drawing. Which one starts at the eye?”*



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

9 m

A mirror lies flat on level ground. Omar sees the top of the clock tower in it. The mirror is 10 m from the base of the clock tower. It is 1 m from his feet. Omar is 1.7 m tall. His eyes are 1.6 m above the ground.

Draw the two triangles. How tall is the clock tower?

The eyes are a little lower than the top of the head.

A

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ANSWER

44 m

Zoe is 1.7 m tall. Her eyes are 1.6 m above the ground. A mirror lies flat on level ground. Zoe sees the top of the climbing wall in it. The mirror is 2.5 m from her feet. It is 25 m from the base of the climbing wall.

Draw the two triangles. How tall is the climbing wall?

Point to the eye in the drawing. The line to the mirror starts at that point.

B

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ANSWER

11 m

A mirror lies flat on level ground. Rosa sees the top of the radio tower in it. The mirror is 2.5 m from her feet. It is 50 m from the base of the radio tower. Her eyes are 1.5 m above the ground. Rosa is 1.6 m tall.

Draw the two triangles. How tall is the radio tower?

Each triangle has one corner at the mirror. Find the other two.

C

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ANSWER

14 m

At noon the shadow of the bell tower is 10 m long. The ground is level and the sun shines. At the same moment, Sam's shadow is 0.8 m long. Sam is 1.6 m tall.

Draw the two triangles. How tall is the bell tower?

Draw the two triangles apart. Turn them the same way.

D

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ANSWER

26 m

At 2 p.m. the sun shines on level ground. Ava's shadow is 1 m long. At the same moment, the shadow of the pine tree is 6 m long. Ava is 1.5 m tall.

Draw the two triangles. How tall is the pine tree?

Each shadow belongs to one object. Keep each shadow with its own object.

E

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ANSWER

28 m

At noon the sun shines on level ground. Dan's shadow is 0.9 m long. At the same moment, the shadow of the old chimney is 10 m long. Dan is 1.8 m tall.

Draw the two triangles. How tall is the old chimney?

A tall object has a long shadow. Does the answer fit that?

F

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ANSWER

18 m

A mirror lies flat on level ground. Ella sees the top of the stadium tower in it. The mirror is 24 m from the base of the stadium tower. It is 1.2 m from her feet. Ella is 1.6 m tall. Her eyes are 1.5 m above the ground.

Draw the two triangles. How tall is the stadium tower?

Use the height of the eyes. The top of the head is not in the triangle.

G

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ANSWER

8 m

Leo is 1.5 m tall. His eyes are 1.4 m above the ground. A mirror lies flat on level ground. Leo sees the top of the flagpole in it. The mirror is 2.5 m from his feet. It is 25 m from the base of the flagpole.

Draw the two triangles. How tall is the flagpole?

The line of sight starts at the eyes, not at the top of the head.

H

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ANSWER

20 m

A mirror lies flat on level ground. Nina sees the top of the water tower in it. The mirror is 2 m from her feet. It is 40 m from the base of the water tower. Her eyes are 1.3 m above the ground. Nina is 1.4 m tall.

Draw the two triangles. How tall is the water tower?

The distance to the feet goes with the distance to the base.

J

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ANSWER

32 m

At 6 p.m. the sun shines on level ground. The short post's shadow is 2.4 m long. At the same moment, the shadow of the office building is 22 m long. The short post is 1.2 m tall.

Draw the two triangles. How tall is the office building?

Say the three corners of each triangle out loud.

K

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ANSWER

17 m

At 10 a.m. the sun shines on level ground. Luis is 1.8 m tall. His shadow is 1.2 m long. At the same moment, the shadow of the palm tree is 6 m long.

Draw the two triangles. How tall is the palm tree?

Divide each shadow by its own height. The two answers should match.

L

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ANSWER

4 m

Mia is 1.4 m tall. Her eyes are 1.3 m above the ground. A mirror lies flat on level ground. Mia sees the top of the grain tower in it. The mirror is 1.2 m from her feet. It is 24 m from the base of the grain tower.

Draw the two triangles. How tall is the grain tower?

Two heights are given for the person. Only one is in the triangle.

M

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ANSWER

5 m

A mirror lies flat on level ground. Kai sees the top of the church tower in it. The mirror is 1 m from his feet. It is 10 m from the base of the church tower. His eyes are 1.4 m above the ground. Kai is 1.5 m tall.

Draw the two triangles. How tall is the church tower?

Which point does the line of sight start from?

N

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ANSWER

16 m

At 6 p.m. the sun shines on level ground. Ben is 1.5 m tall. His shadow is 3 m long. At the same moment, the shadow of the school building is 22 m long.

Draw the two triangles. How tall is the school building?

Which length is the height of the person? Which is the shadow?

P

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ANSWER

15 m

At 3 p.m. the shadow of the house is 12 m long. The ground is level and the sun shines. At the same moment, the fence post's shadow is 1.8 m long. The fence post is 1.2 m tall.

Draw the two triangles. How tall is the house?

Put both heights on top. Put both shadows below them.

Q

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ANSWER

30 m

At 4 p.m. the sun shines on level ground. Maya is 1.6 m tall. Her shadow is 2.4 m long. At the same moment, the shadow of the oak tree is 12 m long.

Draw the two triangles. How tall is the oak tree?

Heights go with heights. Shadows go with shadows.

R

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Scavenger Hunt — where I went

Indirect measurement

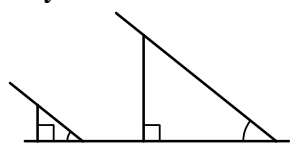
Name _____

Period _____

Date _____

Draw the two triangles first, on one line below. Write your answer with its unit. Then find the card with your answer at the top. 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.**

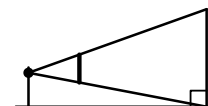
Three ways to make two similar triangles. The drawings are not to scale.



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.

Card letter	My two triangles	My answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

What does a shadow say to its tree at sunset?

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

4 = G 5 = E 8 = I 9 = M 11 = L 14 = O 15 = R 16 = N 17 = M 18 = L 20 = G 26 = E 28 = I 30 = R 32 = N
44 = O

4	5	8	9	11	14	15	16	17	18	20	26	28	30	32	44	



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Scavenger Hunt — answers

For the teacher

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

R (8 m) → H (14 m) → D (20 m) → J (26 m) → E (9 m) → A (16 m) → P (11 m) → C (30 m) → R

What does a shadow say to its tree at sunset? The answer is *I'M LONGER!* It is read along the boxes of the record sheet, which run from the smallest number to the largest.

Card	The question on the card	Answer, and why	The wrong answer it catches	Letter of its top
1 R	At 4 p.m. the sun shines on level ground. Maya is 1.6 m tall. Her shadow is 2.4 m long. At the same moment, the shadow of the oak tree is 12 m long. How tall is the oak tree?	8 m. Height goes with height and shadow with shadow: the height $\div$ 1.6 = $12 \div 2.4$. So the height is $1.6 \times 12 \div 2.4 = 8$ m.	18 m. A shadow is put where a height belongs: $2.4 \times 12 \div 1.6 = 18$.	R
2 H	Leo is 1.5 m tall. His eyes are 1.4 m above the ground. A mirror lies flat on level ground. Leo sees the top of the flagpole in it. The mirror is 2.5 m from his feet. It is 25 m from the base of the flagpole. How tall is the flagpole?	14 m. The line of sight starts at the eyes, so the eye height (1.4 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.4 \times 25 \div 2.5 = 14$ m.	15 m. The full height is used instead of the eye height: $1.5 \times 25 \div 2.5 = 15$.	I
3 D	At noon the shadow of the bell tower is 10 m long. The ground is level and the sun shines. At the same moment, Sam's shadow is 0.8 m long. Sam is 1.6 m tall. How tall is the bell tower?	20 m. Height goes with height and shadow with shadow: the height $\div$ 1.6 = $10 \div 0.8$. So the height is $1.6 \times 10 \div 0.8 = 20$ m.	5 m. A shadow is put where a height belongs: $0.8 \times 10 \div 1.6 = 5$.	O
4 J	A mirror lies flat on level ground. Nina sees the top of the water tower in it. The mirror is 2 m from her feet. It is 40 m from the base of the water tower. Her eyes are 1.3 m above the ground. Nina is 1.4 m tall. How tall is the water tower?	26 m. The line of sight starts at the eyes, so the eye height (1.3 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.3 \times 40 \div 2 = 26$ m.	28 m. The full height is used instead of the eye height: $1.4 \times 40 \div 2 = 28$.	G
5 E	At 2 p.m. the sun shines on level ground. Ava's shadow is 1 m long. At the same moment, the shadow of the pine tree is 6 m long. Ava is 1.5 m tall. How tall is the pine tree?	9 m. Height goes with height and shadow with shadow: the height $\div$ 1.5 = $6 \div 1$. So the height is $1.5 \times 6 \div 1 = 9$ m.	4 m. A shadow is put where a height belongs: $1 \times 6 \div 1.5 = 4$.	E
6 A	A mirror lies flat on level ground. Omar sees the top of the clock tower in it. The mirror is 10 m from the base of the clock tower. It is 1 m from his feet. Omar is 1.7 m tall. His eyes are 1.6 m above the ground. How tall is the clock tower?	16 m. The line of sight starts at the eyes, so the eye height (1.6 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.6 \times 10 \div 1 = 16$ m.	17 m. The full height is used instead of the eye height: $1.7 \times 10 \div 1 = 17$.	M
7 P	At 6 p.m. the sun shines on level ground. Ben is 1.5 m tall. His shadow is 3 m long. At the same moment, the shadow of the school building is 22 m long. How tall is the school building?	11 m. Height goes with height and shadow with shadow: the height $\div$ 1.5 = $22 \div 3$. So the height is $1.5 \times 22 \div 3 = 11$ m.	44 m. A shadow is put where a height belongs: $3 \times 22 \div 1.5 = 44$.	N
8 C	A mirror lies flat on level ground. Rosa sees the top of the radio tower in it. The mirror is 2.5 m from her feet. It is 50 m from the base of the radio tower. Her eyes are 1.5 m above the ground. Rosa is 1.6 m tall. How tall is the radio tower?	30 m. The line of sight starts at the eyes, so the eye height (1.5 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.5 \times 50 \div 2.5 = 30$ m.	32 m. The full height is used instead of the eye height: $1.6 \times 50 \div 2.5 = 32$.	L

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 to the card it got wrong and tries it again. If the group makes the same mistake here, 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	The wrong answer it catches	Letter of its top
G	A mirror lies flat on level ground. Ella sees the top of the stadium tower in it. The mirror is 24 m from the base of the stadium tower. It is 1.2 m from her feet. Ella is 1.6 m tall. Her eyes are 1.5 m above the ground. How tall is the stadium tower?	30 m. The line of sight starts at the eyes, so the eye height (1.5 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.5 \times 24 \div 1.2 = 30$ m.	32 m. The full height is used instead of the eye height: $1.6 \times 24 \div 1.2 = 32$.	L
Q	At 3 p.m. the shadow of the house is 12 m long. The ground is level and the sun shines. At the same moment, the fence post's shadow is 1.8 m long. The fence post is 1.2 m tall. How tall is the house?	8 m. Height goes with height and shadow with shadow: the height $\div 1.2 = 12 \div 1.8$. So the height is $1.2 \times 12 \div 1.8 = 8$ m.	18 m. A shadow is put where a height belongs: $1.8 \times 12 \div 1.2 = 18$.	R
N	A mirror lies flat on level ground. Kai sees the top of the church tower in it. The mirror is 1 m from his feet. It is 10 m from the base of the church tower. His eyes are 1.4 m above the ground. Kai is 1.5 m tall. How tall is the church tower?	14 m. The line of sight starts at the eyes, so the eye height (1.4 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.4 \times 10 \div 1 = 14$ m.	15 m. The full height is used instead of the eye height: $1.5 \times 10 \div 1 = 15$.	E
F	At noon the sun shines on level ground. Dan's shadow is 0.9 m long. At the same moment, the shadow of the old chimney is 10 m long. Dan is 1.8 m tall. How tall is the old chimney?	20 m. Height goes with height and shadow with shadow: the height $\div 1.8 = 10 \div 0.9$. So the height is $1.8 \times 10 \div 0.9 = 20$ m.	5 m. A shadow is put where a height belongs: $0.9 \times 10 \div 1.8 = 5$.	I
M	Mia is 1.4 m tall. Her eyes are 1.3 m above the ground. A mirror lies flat on level ground. Mia sees the top of the grain tower in it. The mirror is 1.2 m from her feet. It is 24 m from the base of the grain tower. How tall is the grain tower?	26 m. The line of sight starts at the eyes, so the eye height (1.3 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.3 \times 24 \div 1.2 = 26$ m.	28 m. The full height is used instead of the eye height: $1.4 \times 24 \div 1.2 = 28$.	G
L	At 10 a.m. the sun shines on level ground. Luis is 1.8 m tall. His shadow is 1.2 m long. At the same moment, the shadow of the palm tree is 6 m long. How tall is the palm tree?	9 m. Height goes with height and shadow with shadow: the height $\div 1.8 = 6 \div 1.2$. So the height is $1.8 \times 6 \div 1.2 = 9$ m.	4 m. A shadow is put where a height belongs: $1.2 \times 6 \div 1.8 = 4$.	M
B	Zoe is 1.7 m tall. Her eyes are 1.6 m above the ground. A mirror lies flat on level ground. Zoe sees the top of the climbing wall in it. The mirror is 2.5 m from her feet. It is 25 m from the base of the climbing wall. How tall is the climbing wall?	16 m. The line of sight starts at the eyes, so the eye height (1.6 m) goes with the height, and mirror to feet goes with mirror to base. So the height is $1.6 \times 25 \div 2.5 = 16$ m.	17 m. The full height is used instead of the eye height: $1.7 \times 25 \div 2.5 = 17$.	O
K	At 6 p.m. the sun shines on level ground. The short post's shadow is 2.4 m long. At the same moment, the shadow of the office building is 22 m long. The short post is 1.2 m tall. How tall is the office building?	11 m. Height goes with height and shadow with shadow: the height $\div 1.2 = 22 \div 2.4$. So the height is $1.2 \times 22 \div 2.4 = 11$ m.	44 m. A shadow is put where a height belongs: $2.4 \times 22 \div 1.2 = 44$.	N

Other mistakes lead to no card. A group might copy the tall object's shadow as its height, or add the difference of two lengths instead of using the ratio, or turn the mirror's ratio upside down. Its answer is then not the number at the top of any card.