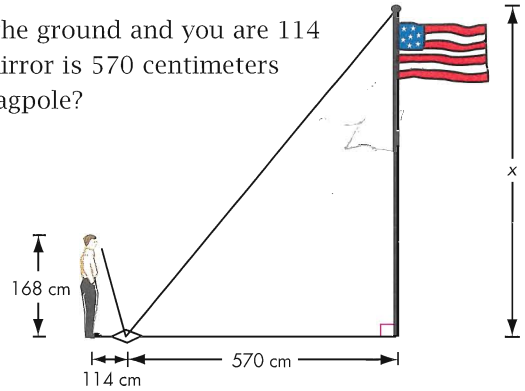
Example B

Your eye is 168 centimeters above the ground and you are 114 centimeters from the mirror. The mirror is 570 centimeters from the flagpole. How tall is the flagpole?

$$\frac{168}{114} = \frac{x}{570}$$
$$114x = (168)(570)$$
$$x = \frac{(168)(570)}{114}$$
$$x = 840$$

The flagpole is about 840 centimeters tall.



In this chapter's Project: The Shadow Knows, you will get a chance to use the indirect methods just described to determine the heights of objects you're unable to measure directly. For now, though, just practice on the problems in Exercise Set 12.4.

Exercise Set 12.4

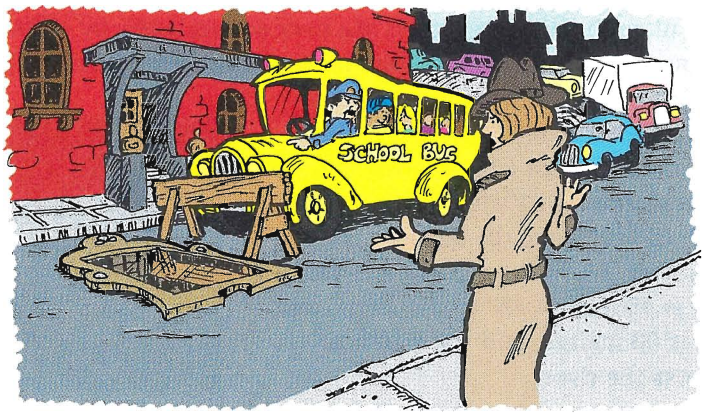
1. If a 4-meter flagpole casts a 6-meter shadow at the same time that a nearby building casts a 24-meter shadow, how tall is the building?

2.* If five-foot-tall Madeleine casts an 84-inch shadow, then how tall is her friend if at the same time his shadow is one foot shorter than hers?

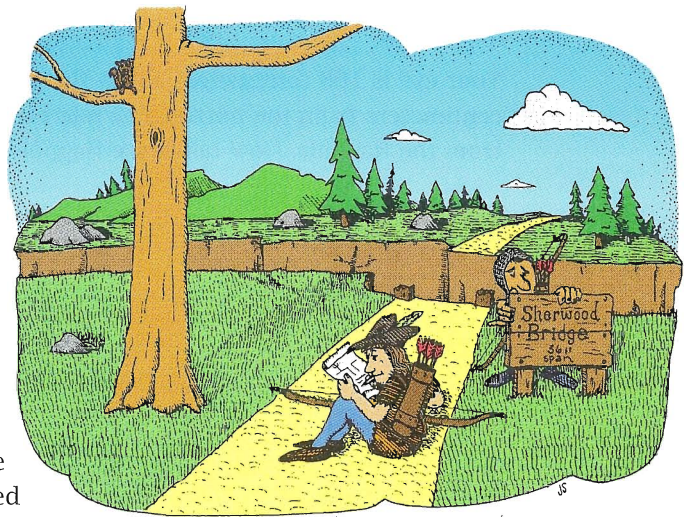
3. A rope from the tip of a flagpole reaches all the way down to the end of the flagpole shadow, a distance of 10 meters. The length of the shadow is 6 meters. How tall is the nearby football goal post if it has a shadow of 4 meters?

4.* Juanita, who is 1.82 meters tall, wants to find the height of a tree in her back yard. From the tree's base, she walks 12.20 meters along the tree's shadow until her head is in a position where the tip of her shadow exactly overlaps the end of the treetop's shadow. She is now 6.10 meters from the end of the shadows. How tall is the tree?

5. One overcast day, private eye Samantha Diamond needed to calculate the height of a window in a nearby building. Because there were no shadows cast, she decided to use mirrors. Sam positioned a mirror on the ground between herself and the building so that when she looked into the mirror while standing upright, she saw into the window. The mirror was 1.22 meters from her feet and 7.32 meters from the base of the building. Sam's eye was 1.82 meters above the ground. How high up on the building was the window located?

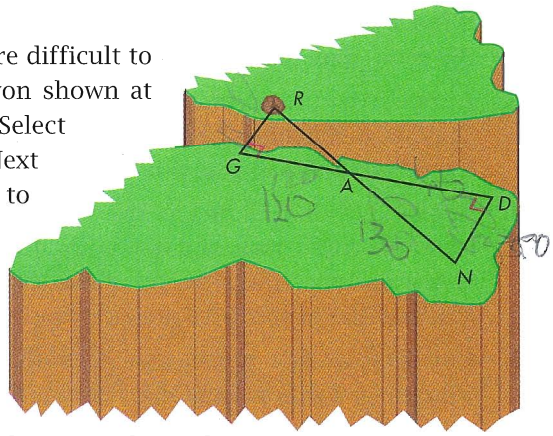


6.* Late one afternoon, while being chased by the Sheriff of Nottingham into an unfamiliar part of Sherwood Forest, Robin Hood and Little John found themselves trapped between a wide chasm and the approaching sheriff. A bridge had once spanned the chasm but was now collapsed. Fortunately, the bridge's sign was still standing. It gave Robin the information necessary to plan his escape: The chasm was 36 feet across. A large tree grew near the chasm, the only tree within 50 yards. Robin quickly paced off the distance from the cliff edge to the tree and found that it was 24 feet. He noticed that the shadow cast by the tree stretched directly across the chasm and that the tip of the shadow just reached the opposite edge of the chasm. Robin hastily measured the shadow created by his 55-inch frame and found it to be 77 inches. Using this information, Robin calculated the height of the tree. What was the height of the tree to the nearest foot? If Robin and Little John were to chop down the tree, would it be long enough to reach across the chasm? Was Robin Hood able to elude the Sheriff of Nottingham?

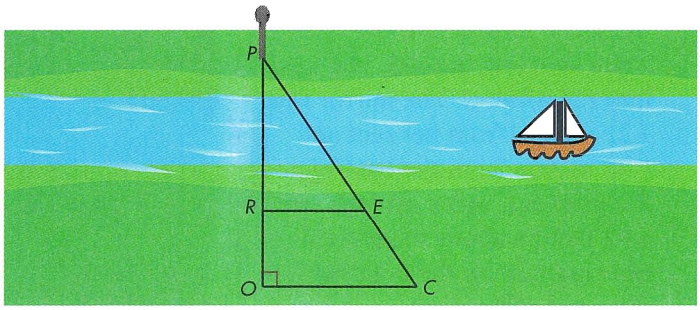


The adventures of Robin Hood

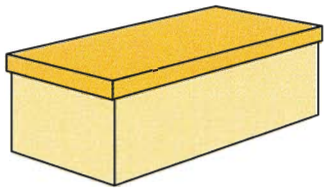
7.* Similar triangles can also be used to find distances that are difficult to measure directly. Calculate the distance across the canyon shown at right by sighting a rock on the opposite side at point R. Select points G and D so that $\overline{GD}$ is perpendicular to $\overline{RG}$. Next measure a convenient distance ND (with $\overline{ND}$ perpendicular to $\overline{DG}$), then locate point A, the intersection of $\overline{RN}$ and $\overline{GD}$. Because $\angle D$ and $\angle G$ are congruent and $\angle DAN$ and $\angle GAR$ are congruent, then $\Delta DAN \sim \Delta GAR$. The distance across the canyon can be determined because the triangles are similar. If GA is 120 meters, DA is 60 meters, and ND is 50 meters, find GR, the distance across the canyon.



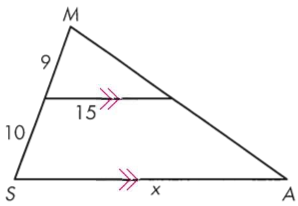
8.* Calculate the distance across the river shown below by sighting a pole on the opposite bank at point P. Align points R and O on the near bank so that points P, R, and O are collinear. Next measure a convenient distance OC with $\overline{OC} \perp \overline{PO}$, then locate point E by sighting the intersection of $\overline{CP}$ with $\overline{RE}$ ($\overline{RE} \perp \overline{PO}$). You can calculate the distance across the river, PR, because $\Delta PRE \sim \Delta POC$. If RO is 45 meters, OC is 90 meters, and RE is 60 meters, find the distance across the river.



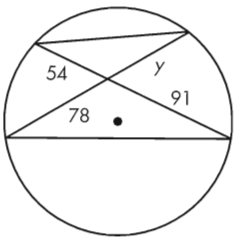
9.* A pinhole box camera is a very simple device. Place unexposed film at one end of a box (a shoe box will work nicely) and make a pinhole at the opposite end. When you let light in through the pinhole, an inverted image is produced on the film. Suppose you are taking a picture of a painting 30 cm wide by 45 cm high with a pinhole box camera that has a depth of 20 cm. How far from the front of the box should you place the object if you wish to make an image that is 2 cm by 3 cm? Draw a diagram showing the box camera, the film, and the painting to be photographed.



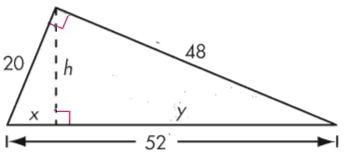
10.* Find x.

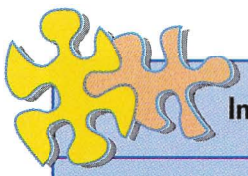


11.* Find y.



12.* Find x, y, and h.





Improving Algebra Skills—*Algebraic Magic Squares III*

A magic square is an arrangement of numbers in a square array such that the numbers in every row and every column have the same total.

In some magic squares, the two diagonals have the same totals as the rows and the columns. For example, in the magic square at top right, the sum of each row is 21, of each column is 21, and of each diagonal is 21.

In an algebraic magic square the algebraic sums in all rows and columns have the same totals.

6	11	4
5	7	9
10	3	8

In the algebraic magic square at right, the sums in the diagonals are equal to the sums in the rows and the columns. Find the value of x.

$8 - x$	15	14	$11 - x$
12	$x - 1$	x	9
8	$x + 3$	$x + 4$	5
$2x - 1$	3	2	$2x + 2$