MORE SUPER SCIENCE

with SIMPLE STUFF!

Susan R. Popelka

Good Year Books

Dedication

To my mom, Dorothy Huberty, my sister, Lynn Johnson, my high school English teacher, Mrs. Muelmanns, and my college physics teacher, Mr. Bergsten.

Acknowledgments

Many people helped me with this book. I would like to thank my family, Carl, Erin, Mike, and Gail Popelka, who encouraged me and waited patiently for their turn on the computer while I did yet one more rewrite. I would not have been able to finish the book without the daily question, *Are you done with your book yet?*

For the past ten years I have been teaching hands-on science workshops to elementary teachers. I wrote this book because those teachers asked me to write it. The activities in the book are their favorites, and they have tried and tested all of them. I owe them a heartfelt thank you for teaching me as I was teaching them.

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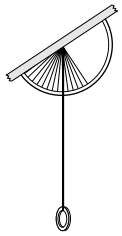


Science An astrolabe is an instrument that measures the angular distance between two objects.

Stuff Cardboard; protractor; straw; string (12 inches); washer; tape

What to Do

The astrolabe made in this activity is used in several other activities in this book.

1. Draw a line down the middle of the piece of cardboard. Place the flat edge of a protractor on this line, and mark the angles in steps of 10°. Mark the angle corresponding to 90° as 0°, the angle corresponding to 80° as 10°, the angle corresponding to 70° as 20°, and so on. Draw lines to each of the marked angles; label these lines with the corresponding angle measures.
2. Cut the half-circle out of the cardboard.
3. Tie a washer to one end of a piece of string. Tape the other end of the piece of string to the middle of the cardboard, where the angle marked as 0° begins.
4. Tape a straw on top of the straight edge of the cardboard. You have now created an astrolabe.
5. Look through the straw as you move the astrolabe up and down, from vertical to horizontal. Notice that the string passes over the lines you marked on the cardboard.
6. Make sure that when you change the position of the astrolabe, you don't move it right or left or tilt it. Also, make sure that the string with the washer hangs straight down.
7. Take the astrolabe outside. Look through the straw at the tops of several objects that you know are about the same distance from you, and measure the angle.
8. Look at distant trees through the straw, and measure the angle of the top of the trees. Look at nearby trees, and measure the angle.

What's Going On Here

When the straw is held horizontally, the string hangs straight down, passing over the line corresponding to 0°. When the straw is held vertically, the string still hangs straight down, but this time it passes over the line corresponding to 90°. If the straw is held at some position between horizontal and vertical, the string will pass over a line between 0° and 90°. The closer the straw is to being vertical, the closer the angle will be to 90°; the closer the straw is to being horizontal, the closer the angle will be to 0°. Navigators use astrolabes to determine the position of their ships or aircraft. In the Northern Hemisphere, the angle between the horizon and the North Star is the latitude.

Try It!

★ Try measuring the angle of the North Star at night and comparing it to your latitude. Measure the angle of the North Star several nights and at different times of night.

★ Try measuring the angle of another star in the night sky at different times of night.

ANGLES AND ASTROLABS

What You Want to Know

How does the angle change as you look at objects that are about the same height but are at different distances from you? How does the angle change when you look at objects that are the same distance from you but have different heights?

What You Think Will Happen

When you look at the top of an object through your astrolabe, the angle will be larger when

a. you look at an object that is closer to you.

b. you look at a taller object.

c. both (a) and (b).

d. neither (a) nor (b).

What Happened

Record the angle shown on your astrolabe when you looked at objects that were about the same distance from you.

Object	Angle on astrolabe

Record the angle shown on your astrolabe when you looked at objects that are about the same height but were at various distances from you.

Distance	Angle on astrolabe
Nearby	
Not too far away	
Far away	
Very far away	

What It Means

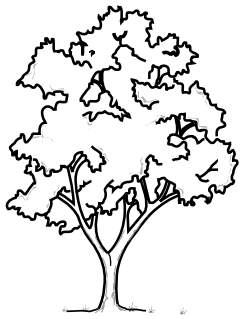
What do your observations tell you about how the angle on your astrolabe depends on the height of an object?

What do your observations tell you about how the angle on your astrolabe depends on the distance to an object?

HOW HIGH IS THAT TREE?

Science You can use the astrolabe from the previous activity to measure the height of a building or tree.

Stuff Measuring tape; yardstick or meter stick; astrolabe from "Angles and Astrolabes"



What to Do

1. Go outdoors and find a tree (or a flagpole, tall building, or light pole).
2. Measure a distance on the ground at least 30 feet away from the tree. Stand at that distance.
3. Look through the straw of the astrolabe, and line it up with the top of the tree. Make sure that the string is hanging straight down and is not caught on your hand or on the cardboard.
4. Have your partner record the angle that the string lines up with on the astrolabe. If it is between two numbers, estimate what the number is. For example, if it is midway between 10° and 20°, call it 15°.
5. Now all you need to do is multiply some numbers together to get the height of the tree.
   Use this equation to determine the height of the tree: $\mathbf{H = tan\ (A) \times D + L}$. In this equation "H" is the height of the tree, "A" is the angle on the astrolabe to the top of the thing, "D" is the distance you are from the thing, "tan" is the abbreviation for tangent, and "L" is the distance from the ground to the eyes of the person holding the astrolabe.
6. Repeat steps 1 through 5 for two other high objects.

What's Going On Here

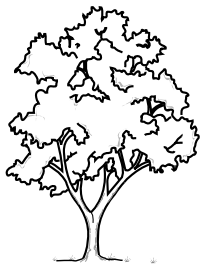
When you look through the straw at the top of the tree, the string hangs straight down and indicates the angle above the ground that corresponds to the top of the tree. To determine the height of the tree, first multiply the tangent of the angle by the distance from the astrolabe to the tree. Tangents are listed on the next page. They also can be found using a calculator. Just enter the angle measure that you read from the astrolabe, and press the "tan" key on your calculator. On some calculators you may have to press the "tan" key first and then the angle. After you have multiplied the tangent of the angle by the distance to the tree, you need to add the distance from the ground to the astrolabe, or, in other words, from the ground to the person's eyes.

Try It!

- ★ Try measuring the heights of different things indoors—for example, the height of the gymnasium ceiling at your school.
- ★ Try measuring the height of your house.

Name Date

HOW HIGH IS THAT TREE?



What You Want to Know

How can you use an astrolabe to measure the height of things?

What You Think Will Happen

What do you think is the height of the different objects you are going to measure?

Object _____ Height _____ Object _____ Height _____

Object _____ Height _____ Object _____ Height _____

What Happened

1. In the column labeled "A," record the angle measure shown on your astrolabe when you looked at the top of the object.
2. Look in the table below to find out what "tan (A)" is equal to, and put that number in the table.
3. In the column labeled "D," record the distance from where you were standing to the object.
4. In the column labeled "L," record the distance from the ground to your eyes.
5. Multiply the number in the "tan (A)" column by the number in the "D" column. Add the number in the "L" column to it, and write that number in the column labeled "H." That is the height of the thing you are measuring.

Thing	A	tan (A)	D	L	H

Angle	Tangent	Angle	Tangent	Angle	Tangent
0	0.000	30	.577	60	1.732
5	.087	35	.700	65	2.145
10	.176	40	.839	70	2.747
15	.268	45	1.000	75	3.732
20	.364	50	1.192	80	5.671
25	.466	55	1.428	85	11.430

What It Means

Do the heights of the different objects you measured make sense? Explain your answer. _____