nesec NASA Earth Science Education Collaborative

Trees: Connecting Science, History, and Community

Trees provide a versatile and engaging theme for library programs. Whether your audience is families, children, youth, or adults, tree-themed activities provide affordable, fun, and meaningful programming. Libraries of all sizes and locations can leverage tree-related topics to easily branch into iREAD 2026: *Plant a Seed, Read.*

NASA's Moon Trees

Did you know there are Moon Trees here on Earth? While these trees did not grow on the moon, they are connected to NASA's mission of exploration and discovery as far back as Apollo and as recently as the Artemis I test flight.

On January 31, 1971, NASA launched the Apollo 14 spacecraft. Astronaut Stuart (Stu) Roosa, the command module pilot and a former USDA Forest Service smoke jumper, brought along hundreds of tree seeds in his personal kit (Photo right courtesy NASA). Once returned from lunar orbit, the seeds were germinated and grown into seedlings by the USDA Forest Service. They were eventually planted across the United States, many as part of 1976 bicentennial celebrations. For a time, the locations of many of the trees were a mystery. Thanks to an inquiry from a third-grade teacher in 1996, NASA planetary scientist and lunar historian Dr. David Williams launched a campaign to locate the Apollo Moon Trees, leading to the Apollo 14 Moon Tree database and historical archive describing Moon Tree milestones.

Fast forward to the Artemis I launch on November 16, 2022, where trees are again an important part of a space mission. As a tribute to Apollo 14 and in celebration of the future of space exploration, NASA partnered with the USDA Forest Service to fly nearly 2,000 tree seeds of five different species aboard the Orion.

An open call by NASA in Fall 2023 resulted in more than 1,000 applications from libraries, schools, museums, universities, and community organizations to serve as Artemis I Moon Tree Stewards. These Moon Tree Steward organizations are doing more than cultivating the trees. They are preserving important science history artifacts

for generations to come, nurturing community connections, sparking curiosity about space, and fostering a deeper understanding of NASA's missions.

Is there a Moon Tree Steward organization near you? Find their locations at: https://www.nasa.gov/learning-resources/artemis-i-moon-tree-stewards/

Photo courtesy Myrtle Creek Public Library, Oregon, Moon Tree ceremonial planting. June 22, 2024.

NASA advances scientific understanding of the Earth

Did you know that NASA also studies Earth? In addition to looking up, NASA uses the unique perspective of space to look down and learn more about Planet Earth and its interconnected systems. Data from a variety of platforms in space, the atmosphere, in the ocean, or on the Earth's surface are used to understand and monitor the changing planet, study its interconnected ecosystems, and manage resources such as forests and trees. For example:

- The NASA/U.S. Geological Survey Landsat program provides the longest, continuous record of Earth's land surfaces with over 50 years of observations. Landsat applications include forest management, wildland fire impacts, agriculture and food security, and water resource management.
- Instruments like the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) and the Global Ecosystems Dynamics Investigation (GEDI) use lidar technology to measure forest height and canopy structure. The data are crucial to understand forest ecosystems, estimate biomass, and calculate carbon storage.

Trees programming: rooted in community

Imagine if you could fly above the treetops. Think of all the amazing varieties of trees and forests that you could see. Would you spot a mighty redwood soaring high into the

sky, snow-covered pines and spruces with hard, needle-like leaves, or a weeping willow with its long, delicate, drooping branches swaying with the breeze? Perhaps you'd see a Joshua tree with its sharp, dagger-like leaves, astonishingly thriving in the dry, hot desert. Or you might spot fascinating banyan trees that grow aerial roots, meaning that when a branch gets too heavy for the tree to support, the roots will touch the ground and grow another trunk. And, of course, you could also spy the national tree of the United States—the oak—or your official state tree.

In addition to their diversity and beauty, trees have cultural connections. They add depth and meaning to stories and literature (e.g., in *To Kill a Mockingbird*, the oak tree is a place of refuge and protection); they represent the history of a place (e.g., Emancipation Oak in Virginia and Banyan Tree Drive in Hawaii); symbolize connectedness (e.g., as a gathering spot, shared memories, and social bonds); and improve quality of life by providing beautiful spaces to live, work, and play.

Trees also help create a healthy environment in communities by:

- Absorbing carbon dioxide
- Providing oxygen for people and animals
- Filtering air and improving air quality
- Lowering surrounding air temperature by providing shade and transpiration of water
- Providing shelter and protection for people, animals, and other plants
- Producing food for people and many animals

Following are three library-friendly activities—full activities also attached—that will help you start planning programs to investigate and learn about trees in your community. They are fun, educational, and evergreen, meaning you can use them anytime!

1. **Be a Tree Detective**
   Trees provide all kinds of clues to their identity, such as their overall shape, their bark, leaves or needles, flowers, fruits and seeds, and leaf buds. Their location can also be a clue. The learner will pick a mystery tree and use their detective skills to gather clues.

2. **Stories Trees Tell**
   Learn how dendrochronology, or the study of data from tree ring growth, can help us to understand more about a tree's story—its age along with environmental events and trauma it has encountered over the course of its lifetime. Tell your story like a tree by creating tree ring stories: each ring represents one year and includes significant events.

3. **How Tall Is Your Tree? Measuring Tree Height with Different Tools**
   Learn how to measure tree height using a variety of scientific tools including a

measuring tape, a paper clinometer (template attached), and the GLOBE Observer mobile app. Observing tree height allows NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere. Tracking how trees are changing over time can help estimate the number of trees that make up an area.

Following is a link to a video demonstrating how to build and use the paper clinometer: https://youtu.be/Ky6KhGLw1AU?si=ZTb67UhQe1DJB4PH

Photo courtesy the Los Angeles Public Library (LAPL). Participants in the LAPL Neighborhood Science Program (https://www.lapl.org/neisci) are shown learning about trees and how to estimate tree height with a DIY Clinometer.

Books

Trees can be found throughout fiction and nonfiction. Following are links to some of our favorite books for children, teens and adults.

Books for Kids
https://search.worldcat.org/lists/830feb49-d2b2-46e6-b340-d13391cb9524

Books for Adults
https://search.worldcat.org/lists/76e3a65c-fb48-4b55-a493-97db84d4b9ab

References

Apollo 14's Moon Tree Database
https://nssdc.gsfc.nasa.gov/planetary/lunar/moon_tree.html

Landsat Science, https://landsat.gsfc.nasa.gov

Moon Trees Stand as Living Testaments to First Voyages to Moon (2021). *https://www.nasa.gov/history/moon-trees-stand-as-living-testaments-to-first-voyages-to-moon/*

Moon Trees: Past, Present, & Future (2024). This short documentary film (21:17) explores the incredible story of Moon Trees, and how they have inspired multiple generations to reach for the Moon. https://youtu.be/fMep6Hmb7YA?si=9J3h51-Kf0MBhS8-

NASA, USDA Forest Service Fly Next Generation of Moon Tree Seeds on Artemis I (2022). https://www.nasa.gov/learning-resources/nasa-usda-forest-service-fly-next-generation-of-moon-tree-seeds-on-artemis-i/

NASA Earth Science Applied Sciences, https://appliedsciences.nasa.gov

Acknowledgments

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Be a Tree Detective
How to Identify Trees

The learner will use their senses to explore a tree by looking for specific indicators of the tree's identity. They will take note of the tree's **habitat** and the overall shape of the tree. Then they will explore parts of the tree, including bark, leaves or needles, flowers, fruits, **seed pods** and cones. They will collect information about their tree by taking pictures or sketching items. They may also choose to collect tree parts that are on the ground (not from the living tree) such as nuts, leaves, or flowers. The learner will learn how to use a field guide to identify their tree.

Needles

Scales

Leaves

Purpose

The learners will become tree detectives looking for clues to a tree's identity. Trees provide all kinds of clues, such as their overall shape, their bark, leaves or needles, flowers, fruits and seeds, and leaf buds. Their location can also be a clue. The learner will pick a mystery tree and use their detective skills to gather clues. Using **deductive reasoning**, they will solve the mystery of their tree's identity! It may only take one or two clues to identify a tree, or it may take many. Sometimes, you may need to conduct additional investigations to solve a puzzling one. The identity is in the details!

Time

1 hour

Materials

- ☐ Tree identification guide for trees in your region
- ☐ (Optional) An age-appropriate book that introduces detective skills
- ☐ A detective kit, which may include:
    - Magnifying glass
    - Sketchbook and colored pencils
    - Camera or phone for taking pictures
    - Evidence collection bag
- ☐ “My Tree Clues” worksheet (included below)

Safety Tips

- Appropriate footwear is essential when walking through natural areas.
- Younger learners should always be accompanied by an adult when collecting clues.
- Make sure your tree is safe to explore, meaning there are no poisonous plants or stinging insects present.
- If the learner wants to collect items from their tree, please only take items that have fallen off the tree, not parts of the live tree.

Smooth bark

Furrowed bark

Warty bark

What to Do

1. Begin with a detective story, if you wish. You may also choose to explore your tree guide. Take note of the words used to describe the tree features in the guide.
2. The learners can pick a tree to find the identity of individually or with a group.
3. They will begin by observing the area around the tree. Trees grow in habitats where they can thrive. Is it in the woods or in an open area? Is it in or near water? Does the tree look healthy?
4. Look at the tree. The learner may take pictures of these components, sketch them, or collect them if they have fallen off the tree.

a. **Size and shape:** From a distance, is it a tall tree or a short one? What is the **canopy** shaped like? Canopies may be broadly spreading or more compact. The tree may look like a familiar shape, like a vase, column, umbrella, or cone.
b. **Bark:** What is the texture of the bark? Is it smooth, furrowed, peeling, shiny, or warty? What colors do you see on the bark? If you'd like, do a rubbing of the bark by holding a piece of paper against the tree and using the long side of a crayon to make an impression of the bark's pattern.
c. **Leaves:** What color are the leaves? What shape are they? Does the tree have broad leaves, needles, scales, or buds? Is the tree **evergreen**, meaning it stays green all year, or **deciduous**, meaning it drops its leaves in the winter? While most trees with needles or scales are evergreen and most trees with broad leaves are deciduous, there are some exceptions. If it is winter and your tree has dropped its leaves, you will need to look at the **leaf buds**. A leaf bud is the part of a tree that will eventually develop into a leaf.
    i. **For broad leaves:** Are the edges smooth, **toothed**, or **lobed**?
    ii. **For needles or scales:** It's often helpful to measure the length of needles or scales. If the tree has needles that grow in bunches, how many are in each bunch? Is the needle flat or can you roll it between your fingers?
    iii. **For leaf buds:** What does the bud look and feel like? Is it pointy or scaley? Are the buds in clusters? What color are they?
d. **Leaf arrangement:** Do the leaves come off the branch opposite each other or alternatively, or do all the leaves come off the branch at one point?
e. **Flowers, fruits, and seeds:** Explore the branches and the surrounding ground for flowers, fruits, and seeds. What shape and color are they?

5. Bring your evidence (pictures, sketches, tree parts) to one place. Use your tree guide to identify your tree. Most guides are split up into sections based on prominent features of trees.
6. Share your clues with a friend, parent, teacher, or counselor and tell them the identity of your tree.

Examples of Seed Pods

Examples of Leaf Buds

Questions for Review

1. What helped you most in figuring out the identity of your tree?
2. What did you learn about your tree?
3. If you could not identify your tree, what further information do you need?

Key Words

Canopy: the branches and leaves of a tree

Conifers: a tree that bears cones and needle-like or scale-like leaves; usually evergreen

Deciduous: a tree that sheds its leaves each year

Deductive reasoning: using facts to come to a conclusion

Evergreens: a plant or tree that has green leaves throughout the year

Furrowed: deep lines or grooves

Habitat: the natural home of an animal or plant

Leaf buds: a small bump on a tree that will become a leaf

Lobed: a curved or rounded part that sticks out

Prominent: noticeable

Scales: small, flat pieces that layer on top on each other

Seed pods: the case that holds the tree's seeds, such as pinecones or nuts

Toothed: having multiple parts that stick out, shaped like teeth or small triangles

Warty: having hard, rough lumps

Extension

There are field guides for many different things found in nature. In addition to trees, learners can explore and identify plants, flowers, rocks, and animals by looking at their individual features.

Acknowledgments

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My Tree Clues

Find a tree and collect clues that will help you identify the species.

Habitat

Describe where the tree lives. Is it in a forest? A meadow? Is it growing in or near water?

Shape

Sketch or photograph the shape of your tree.

Describe the shape in one word (for example: umbrella, cone, column).

Bark

Sketch, photograph, or do a rubbing of the bark.

Describe the texture in one word (for example: smooth, ridged, papery).

Leaves

Find a leaf to sketch or photograph. Optionally, use a ruler to measure your leaf.

Leaf Arrangement

Circle one:

Flowers, Fruits, and Seeds

Does the tree have flowers, fruits, or seeds (for example: nuts, acorns, pods, cones)? Sketch or photograph what you find.

Stories Trees Tell

Learning the Language of Our Tall Forest Friends

Participants learn about tree ring growth, how this data helps understand more about a tree, then write their own tree ring stories, with each ring representing one year in their life.

Time

30 minutes

Purpose

The purpose of this activity is to understand how **dendrochronology**, or the study of data from tree ring growth, can help us to understand more about a tree's age along with trauma and environmental events it has encountered over the course of its lifetime.

Have the participants write their own tree ring stories, with each ring representing one year of their life. They can include indentations in their layers to show certain events that occurred that they feel were of major importance during that year of their life.

Materials

- ☐ Tree stump, "tree cookie", or a printout of the cross section of a tree
- ☐ Paper or journal
- ☐ Colored pencils
- ☐ Optional: sample pictures of tree cookies

Safety Tips

If you are cutting a "tree cookie" from a fallen tree trunk or tree limb, please be sure to use protective equipment, have close adult supervision and permission to cut from the fallen tree.

Overview

There is so much that we can learn from a tree simply by taking a look inside of it. Here are just a few of the things we can learn about a tree's story from examining the "tree cookie" - a cross-section of a tree trunk or branch, used to study the tree's growth and history.

- ☐ **Age of tree:** We can count the circles, or **growth rings**, to determine the tree's age. Each year, the tree grows a new layer that consists of **early wood** (the lighter portion of the ring indicating more growth in spring months) and **later wood** (the darker portion of the ring indicating less growth in winter months). The tiny ring in the center of the "tree cookie" taken from the trunk of the tree represents its first year and is approximately the same size as the seed from which the tree grew.
- ☐ **Climate:** We can look at the width of the rings to determine which years experienced an abundance of rainfall evident by wider rings versus those that may have resulted during a drought or extremely cold winter shown by narrow rings.
- ☐ **Trauma:** Scars may indicate a loss of a tree limb, fire, or some other trauma occurring during that particular year of the tree's life.
- ☐ **Disease:** Wavy lines or extremely narrow lines on a tree can indicate insect infestation or a disease.

What to Do

Now that you know how a tree tells its story, take a few minutes to draw a "tree cookie" that tells your story. Questions you might consider:

- ☐ How old am I? (or how many rings should I draw?)
- ☐ Do I have any scars that tell about my story?
- ☐ Which years did I grow a lot?
- ☐ Which years did I grow a little?
- ☐ Have I ever been really sick?
- ☐ Did I lose a lot of teeth during certain years?

Feel free to be creative and include any special events, trips, and favorite moments as you tell your story like a tree! Use the link below to learn more about creating your very own tree story.

In this video (**https://youtu.be/s47PTR9enKc)**, Will Phelps (12 years old), a Camp Discovery alumnus, demonstrates how you can represent your life and all its important events just like a tree!

Questions for Review

1. How can we tell how old a tree is?

2. What do wavy lines suggest about a tree?
3. What can we learn about the climate from looking inside a tree?
4. If a tree encountered a forest fire during its fourth year, what would we expect to find on the fourth growth ring?

Key Words

Growth rings: The increment of wood added to a tree during a single growth period.

Dendrochronology: The study of data from tree ring growth.

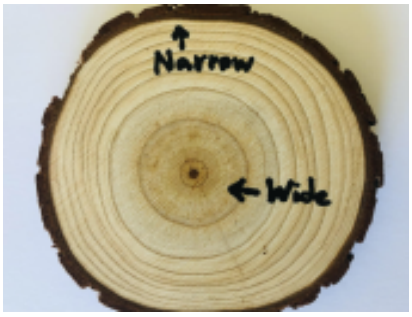
Early wood: The wood formed at the beginning of a growing season, which is typically light in appearance.

Late wood: The wood formed at the end of the growing season that is typically darker and more dense than early wood.

Extensions

Older participants can interpret a picture of a “tree cookie” by determining the tree’s age, the climate throughout its lifetime, trauma it has endured, and its rate of growth. The level of detail and depth of this activity can be customized based on the abilities of the participants.

Younger participants can utilize pictures of “tree cookies” to understand the concepts of counting the rings to determine a tree’s age and identifying the difference between a narrow ring and a wide ring as it relates to a tree’s growth.



Acknowledgments

This resource was created by the NASA Earth Science Education Collaborative (NASA award NNX16AE28A).

How Tall Is Your Tree?
Measuring Tree Height with Different Tools

Participants will investigate and record data about trees by learning how to measure tree height. They will learn how to measure trees using a variety of scientific tools, including a measuring tape, a ***clinometer,*** *and the GLOBE Observer app.*

Purpose

The purpose of this activity is to learn how to collect tree height measurements, which provide information to assist in studying the health of trees, forests, and our planet.

Time

45-60 minutes

Materials

- ☐ Build a Clinometer (attached) and materials (string, washer/weight, straw, tape)
- ☐ Paper or journal
- ☐ Colored pencils
- ☐ Measuring tapes (one per pair of students)
- ☐ Smartphone or tablet
  - Download the free GLOBE Observer app from the App Store or Google Play
- ☐ (Optional) Tree identification guide that has good photos and vivid descriptions. For example:
  - *Nature Guide: Trees* by Tony Russell
  - *Ultimate Explorer Field Guide: Trees* by Patricia Daniels
  - *The Tree Book for Kids and Their Grown Ups* by Gina Ingoglia

Safety

- Locate an area with level ground where you have a clear view of the base and **canopy** of each tree you plan to measure.
- Look for trees with a safe walking path to their base. You may wish to mark the trees with colored ribbon.
- Clear any tripping hazards, look for wasp nests, wear tick protection and appropriate shoes.

Background

Trees cool and moisten our air and fill it with oxygen, thereby helping balance Earth's **carbon** budget. Forests are considered one of the world's largest banks for all of the carbon emitted into the atmosphere through natural processes and human activities. Tree height is the most widely used indicator of an **ecosystem**'s ability to grow trees. Observing tree height allows NASA scientists to understand the gain or loss of **biomass** which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere. Tracking how trees are changing over time can help us estimate the number of trees that make up an area.

What to Do

1. Determine if you wish to measure trees using a clinometer and/or the GLOBE Observer app. You may want to take measurements of the same trees using both the clinometer and the GLOBE Observer app and compare your findings.
2. Watch the GLOBE Observer Trees Introduction video.
3. Construct clinometers and/or download the GLOBE Observer app.
4. As a warm-up, have each learner use a measuring tape to measure the circumference of their wrist. This may be done with a partner. Have them repeat this 10 times and calculate the average circumference. Have the learners do the same for the circumference of their waist.
5. Have learners make the prediction of how many times larger the circumference of a tree will be than their waist.
6. Measure trees and record data using the data table below. Consider having learners work in pairs and have both pairs measure the same trees multiple times to ensure accuracy.
7. Discuss other observations noted during this activity, such as the types of trees measured and their physical features.
8. Analyze your data table, noticing any patterns or unexpected results.

Questions for Review

1. What can measuring tree height tell us about our local ecosystem?
2. You can determine how precise tree height can be measured by making repeated measurements of the same tree – either by one person, or by several people. How many measurements do you think should be made in order to know if you have a precise measurement? Why?
3. What are the tools for measuring trees and the possible errors between them?

Key Words

Biomass: the total mass of living material above ground measured across a particular area

Biometry: the measuring of living things

Canopy: the branches and leaves of a tree

Carbon: a chemical element found in nature and the atmosphere

Circumference: the distance around something

Clinometer: a tool for measuring the angle or elevation of slopes

Ecosystem: a community of living organisms and nonliving organisms in an environment interacting as a system

Extension Activity

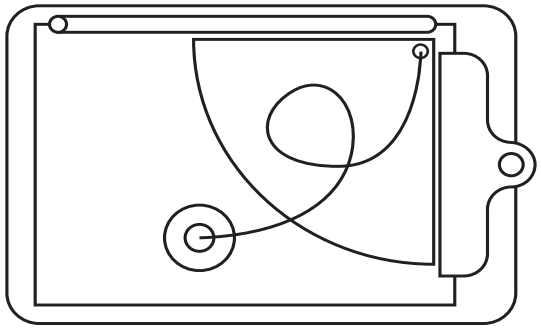
Have each group member predict how tall they are and then measure their height. Make a prediction of how many times taller the tree they measured is than they are.

For a family challenge, estimate how tall the whole family's combined heights would be and compare that to a tree.

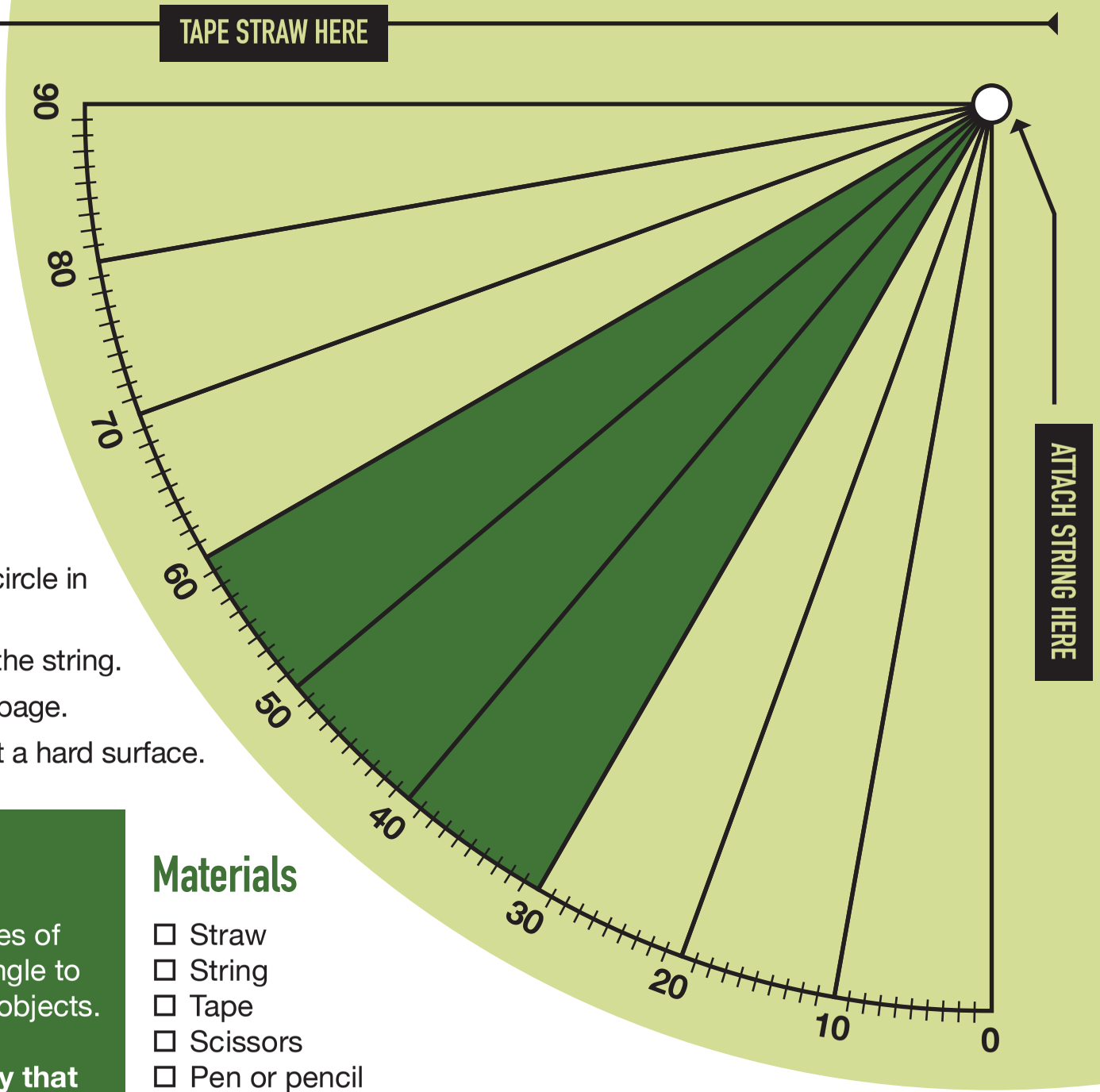
Acknowledgments

This resource was adapted by the NASA Earth Science Education Collaborative (NASA award NNX16AE28A) for iREAD 2026. It is based on the GLOBE Observer Tree Height Comparisons activity.

Build a Clinometer



1. Pull a knotted string through the circle in the upper right corner.
2. Attach a weight to the bottom of the string.
3. Tape your straw to the top of the page.
4. Clip to a clipboard or hold against a hard surface.



What is a clinometer?

A clinometer is tool for measuring angles of slope or elevation. You will need this angle to calculate the height of trees and other objects.

Measuring tree height is just one way that scientists study the health of forests. Give it a try using this paper clinometer.

Materials

- ☐ Straw
- ☐ String
- ☐ Tape
- ☐ Scissors
- ☐ Pen or pencil
- ☐ Hard surface (clipboard, book, cardboard)
- ☐ Weight (beads, paper clip, metal washer)

Calculate the Height of a Tree

1. Find a tree on level ground that is at least 15 feet (5 meters) tall. Stand where you can clearly see the base and the top.
2. Look at the top of the tree through the drinking straw.
3. Use the clinometer to measure the angle at which you are looking at the tree. It helps to have a friend tell you where the string crosses the arc.
4. Measure the distance to the tree using a tape measure or your pace length.

You can also measure trees with the GLOBE Observer app - no tape measure or clinometer required!

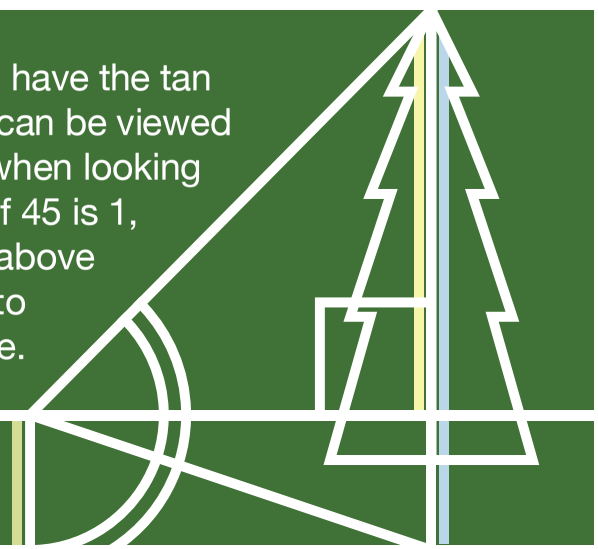
Download on the App Store

GET IT ON Google Play

What is a tangent?

The tangent (tan) of an angle is a trigonomic function used to calculate the legs of a right triangle. When measuring a straight tree on level ground, the tree trunk and ground form a right triangle.

If your calculator doesn't have the tan function, find a tree that can be viewed from a 45 degree angle when looking at the top. The tangent of 45 is 1, so the height of the tree above your eye height is equal to the distance from the tree.



Which measurement system do you prefer?

Imperial (Feet and Inches) *or* Metric (Meters and Centimeters)

Circle or highlight the units you plan on using. Remember, you can use either system, but it's important to only use one.

Your Height (in. / cm) **- 4 in. = / - 10 cm =** **Eye Height** (in. / cm)

This is an estimate. You can also measure your eye height with the tape measure.

Distance from Tree (in. / cm) **x tan** ( ) **=** **Vertical Leg** (in. / cm)

Vertical Leg (in. / cm) **+** **Eye Height** (in. / cm) **=** **Tree Height** (in. / cm)

Tree Height (in. / cm) **÷ 12 = / ÷ 100 =** **Tree Height** (ft. / m)

You can use the same process to measure anything taller than you on level ground.