Southeast Area 4-H Newsletter

COLORADO STATE UNIVERSITY EXTENSION

September 2018

Important 4-H Dates

September

September 2nd - 4th - State 4-H Shooting Sports Weekend 2

September 4th - Extension Offices Closed

October

October 1st - New 4-H Year Begins

October 1st-7th - National 4-H Week

October 12th-14th - Minda Witt Memorial Open Boer Goat Show

October 19th - Photography Clinic

November

November 1st - National Western Stock Show Junior Livestock Entries Due

November 9th-11th - Dare to Be You 4-H Camp

December

December 1st - Catch-a-calf applications due

County Fair Dates

September 6th - 10th - Kiowa County Fair

September 21st-24th - Holly Gateway Fair

Southeast Area Office
411 North 10th Street
Rocky Ford, CO 81067
719-254-7608

Baca County
700 Colorado Street
Springfield, CO 81073
719-523-6971
coopext_baca@mail.colostate.edu

Cheyenne County
Box 395
Cheyenne Wells, CO 80810
719-767-5716
coopext_cheyenne@mail.colostate.edu

Kiowa County
Box 97
Eads, CO 81036
719-438-5321
coopext_kiowa@mail.colostate.edu

Prowers County
1001 South Main
Lamar, CO 81052
719-336-7734
coopext_prowers@mail.colostate.edu

Bent County
1499 Ambassador Thompson
Las Animas, CO 81054
719-456-0764
coopext_bent@mail.colostate.edu

Crowley County
613 Main Street, Courthouse Annex
Ordway, CO 81063
719-267-5243
coopext_crowley@mail.colostate.edu

Otero County
Box 190
Rocky Ford, CO 81067
719-254-7608
coopext_ otero@mail.colostate.edu

National 4-H Week
October 1-7, 2018

National 4-H week is October 1st through 7th, 2018. This is a great week to promote the 4-H program in your community, as well as thank the many individuals and businesses that support the local 4-Hers throughout the year. Check your county newsletter for specific county activities.

Minda Witt Memorial Open Boer Goat Show

Minda Witt was an important part of the southeastern Colorado Boer goat industry. Many of you have been impacted by Minda's knowledge and caring heart over the years. October 12th-14th there will be an open Boer goat show, held at the Prowers County Fairgrounds, in honor of Minda Witt. This show includes American Boer Goat Association (ABGA) registered purebred doe and buck classes, ABGA registered percentage doe classes, commercial (unregistered) doe and buck classes, as well as a junior market goat show. There will also be a Junior American Boer Goat Association show as well. All JABGA animals must be registered under youth under the age of 18 and youth must hold a JABGA membership in the current year. These shows are a great opportunity to get those stock show wethers out, show off your production herd or just come watch and learn. Check in Friday evening starting at 5:00 p.m at the Prowers County Fairgrounds Livestock Pavilion. Entries are $15 per head if post marked by September 30th. Entries post marked after September 30th will be $20 per head. Pen fee is five dollars per pen. Show starts at 9:00 a.m. Saturday morning, starting with commercial classes. ABGA and JABGA shows will follow. The junior show will be shown in conjunction with the open ABGA show. Jackpot market show will start at approximately 1:00 p.m. Weigh - in will be from 10:00 to 12:00. Saturday evening there will be a dinner and a clinic put on by show management. Sunday show starts at 9:00 with the same class order. For more information please contact Jennifer Seltzer at 970-656-3557.

Photography Clinic

Otero and Prowers Counties are teaming up to present a hands on photography clinic. This is open to any one enrolled in 4-H who is interested in the photography project and will be held on Friday, October 19 at the Bent County Extension office. We will start the morning at 9:00 a.m. with some classroom time. We will learn about the basics of photography and discuss the photography project requirements. We will then go out into the field and put our new skills to work. We ask that your children come with a packed lunch and an open mind for learning. If you would like to participate in this clinic please contact the Prowers or Otero extension offices no later than Friday, October 12th.

National Western Stock Show Junior Livestock Entries

Junior Livestock Exhibitors - entries for the junior livestock market shows at National Western are due November 1st. Entry information can be found at http://www.nationalwestern.com/livestock-shows/livestock-exhibitors. Please contact your local extension office for additional questions or help.

Catch-a-Calf Contest

Applications are currently being accepted for the 2019 National Western Stock Show Catch-a-Calf Program. The program is open to any 4-H member that is 12 and older by December 31st, 2018. Youth that sign up for the program will compete at a 2018 NWSS rodeo performance to catch a calf. Those that are successful will receive a calf in May 2019. They are responsible for all care and must purchase their own feed and equipment. The deadline to apply is December 1st, 2018. More information and an application can be found online at http://www.nationalwestern.com/livestock-shows/catch-a-calf-contest/.

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www.Colorado Farm Bureau.com

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719-254-3368

515 North Main Street
Rocky Ford, CO 81067

Bent County 4-H

September 2018 Newsletter

Vol 8, Issue 15, September 2018

What to Look For:

1. State Fair Results
2. 4-H T-Shirts
3. 4-H Ag Day at CSU
4. Project pick-up
5. Harvest Show
6. 4-H Robotics
7. Award Applications and information

State 4-H News

www.colorado4h.org
Project Resources
StateFairExhibitReq.pdf.

We're on FACEBOOK! Please **LIKE** our pages to stay up-to-date with all the upcoming events & share with your friends, let's get to 500 likes!

- Bent County Extension
- Bent County Fairgrounds

County News

Opportunities and Deadlines

September 17—Application Deadlines
September 19—4-H Council Meeting
September 22—4-H Ag Day at CSU Campus
September 21—Quilting Registration deadline
September 30—Bent County 4-H Banquet
October 2-4—Bent County Harvest Show
October 19—Photography Field Trip

Bent County 4-H T-Shirts

Western Prairie 4-H Club still has Bent County 4-H t-shirts at the Extension Office that need to be picked up and paid for. Please take care of this ASAP.

Record Books & Sale Checks

COMPLETED record books need to be turned in to the Extension Office in order to collect your check from the Market Sale. There are still a few checks here at the Extension Office. If you have not collected your premium money, please get that at the Extension Office, too. It is still here for you. :)

State Fair Results

If you are interested to see the State Fair results, they can be accessed at http://co4h.colostate.edu/ Not only are the general project results available, but the Shooting Sports results are posted, too.

Congratulations to our Bent County Archery team, Kree Wallace, Denton Willbanks, Bryce Dupree, and Pace Wallace at the state shoot!

Congratulations as well to Tyler Coulter for receiving State Fair Grand Champion in 4-H Filmmaking. This qualifies Tyler to go to National 4-H Congress as one of 32 Colorado delegate! Way to go!

BENT COUNTY SEPTEMBER 2018

State Fair Project Pick-up

State Fair Projects will be available for pick up after September 4, 2018 at the Extension Office. Please have all State Fair entries collected by September 25, 2018. After that time, projects left at the Extension Office may be purged. Please feel free to call the office and make arrangements if necessary, and we will do our best to accommodate you.

Calling All Outstanding 4-H Members

Attached to this newsletter is an application for outstanding Junior and Outstanding Senior 4-H members. Be recognized for your outstanding efforts in areas like your 4-H projects, community activities, leadership, and club /county efforts. I encourage you to submit your application to be in the running for the title of Outstanding 4-H Junior and Outstanding 4-H Senior and receive your award at the Bent County 4-H Banquet in September, 2018.

4-H Robotics

There have been a number of members who have expressed some sort of interest in 4-H robotics. I am working on getting a robotics team/club together. I am in the process of gathering the necessary documents to host an informational meeting There will be more information posted on Facebook and in the upcoming newsletters about 4-H robotics in Bent County, so if you are interested, keep looking for that!!

Join Colorado 4-H at CSU Ag Day - for tradition of feast, football and fun

CSU's famous Ag Day is about a month away and we would like you to be a part of the university's tradition of feast, football and fun. Activities will begin @ 9:00 AM with the football game time @ 1:00 PM

Ag Day is a giant tailgate barbecue featuring many of Colorado agricultural commodities such as beef, lamb, pork, potatoes and dairy. The 37th Annual Ag Day will take place on Saturday, Sept. 22, immediately before CSU's football game against Illinois State.

For the third year, Ag Day and Colorado 4-H will be celebrated together. Colorado 4-H will have an assortments of activities, involving STEM, Ag Education, and more!
For more information on Ag Day w/4-H, please visit the Colorado 4-H website. 4-H families and volunteers who desire additional discounted football tickets they can be purchased at: https://csurams.com/promocode/, using code "4-H".

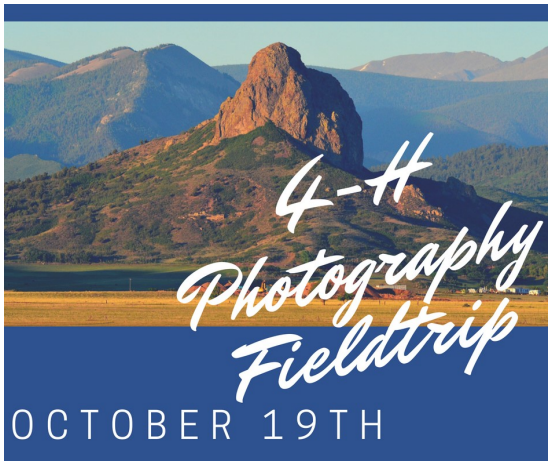
Bent County Harvest Show

The Bent County Harvest Show will be held at St. Mary's Hall in Las Animas. The 77th Harvest Show is an open class show in which youth and adults can submit entries. Books with classes and divisions are available at Bent County Business or can be collected at the Extension Office if you are interested in entering. The flyer for events is attached to this newsletter. Premiums will be paid to winners as indicated in the Harvest Show books. We look forward to seeing all of the amazing talent in Bent County submitted to the Harvest Show this year!

BENT COUNTY SEPTEMBER 2018

Photography Fieldtrip

Otero and Prowers Counties are teaming up to present a hands on photography clinic. This is open to any one enrolled in 4-H who is interested in the photography project. We will start the morning at 9:00 a.m. on October 19th at the Bent County Extension office with some classroom time. We will learn about the basics of photography and discuss the photography project requirements. We will then go out into the field and put our new skills to work. We ask that your children come with a packed lunch and an open mind for learning. If you would like to participate in this clinic please contact the Prowers or Otero extension offices no later than Friday, October 12th."



Get a jump start on your 2019 4-H projects with the 4-H Quilt Block of the Month! Participants will learn the basics of sewing quilt blocks with triangles and squares at the Kickoff Classes. Kickoff classes will be held from 4:00-6:00 pm on September 24th at the Otero County Extension Office and September 25th at the Crowley County Extension Office. Each month after the Kickoff, October-May, participants will pick up a new block to take home and sew. In June of 2019, a final class will be held to help youth finish their 9-block, lap quilts. The quilts can then be exhibited at the County Fair. Whether you are a quilting pro, would like to try a new project, or are new to 4-H altogether, give the 4-H Block of the Month a try!

There is no cost for the blocks, but participants will be responsible for buying the fabric and batting to finish their quilt. Each youth will have their choice of color combination: teal, black, and white; grey, red, and white; pink, black, and white; or yellow, grey, and white. Please call 719-469-0190 or email marlena.griesse@colostate.edu to register by September 21st.

BENT COUNTY SEPTEMBER 2018

4-H Council Officer Elections

Have you thought about taking the opportunity to serve your other 4-H members and be a leader to all of Bent County 4-H? Want to help make decisions that support all of our County clubs? Now is the time to think about building your leadership resume, and being an officer on the Bent County 4-H Council is a great opportunity to do just that! It is time once again to elect new officers for the upcoming 4-H year that begins in October. Elections will take place at the September 4-H Council meeting and inductions will take place at the upcoming 4-H Banquet on September 30, 2018. Applications are attached to this newsletter. Please read carefully the requirements for applicants to be sure you meet the criteria.

Applications need to be returned to the Extension Office by September 17, 2018. It can be e-mailed to sa.weber@colostate.edu, mailed to 1499 Amb Thompson Blvd Las Animas, CO 81054, left in the locked mailbox at the front of the Extension Office or dropped off to the Extension Office during business hours. I look forward to seeing your application for an opportunity to serve your 4-H clubs in Bent County!

Award Nominations

4-H members have the privilege of thanking and recognizing outstanding members and supporters of Bent County 4-H through award nominations for the Friend of 4-H Award, and Meritorious Service Award. If you know an individuals, please take time to fill out a nomination form to be voted on at the next Bent County 4-H Council Meeting on September 19, 2018. These individuals/businesses will be recognized at the Bent County 4-H Banquet in October. The award nomination application is attached to this newsletter.

To submit an application, it must be returned to the Extension Office by September 17, 2018. It can be e-mailed to sa.weber@colostate.edu, mailed to 1499 Amb Thompson Blvd Las Animas, CO 81054, left in the locked mailbox at the front of the Extension Office or dropped off to the Extension Office during business hours.

Bent County 4-H Council
Officer Application

Name _____

Address _____

_____

Club _____

Age on 12/31/18_____ Years of 4-H completed _____

I would like to be nominated for the following offices. I meet the listed requirements for those offices.

_____ **President** – Must have completed 3 years of 4-H
Must be 14 years old OR
Have parents' approval and commitment to bring member to meetings

_____ **Vice President** – Must have completed 3 years of 4-H
Must be 14 years old OR
Have parents' approval and commitment to bring member to meetings

_____ **Secretary** -- Must be 14 years old OR
Have parents' approval and commitment to bring member to meetings

_____ **Treasurer** -- Must be 14 years old OR
Have parents' approval and commitment to bring member to meetings

_____ **Reporter** -- Must have completed 1 year of 4-H

_____ **Parliamentarian** – Must have completed 1 year of 4-H

_____ **Senator** -- Must be 14 years old
Must have completed 3 years of 4-H
Must be willing to represent Bent County 4-H at 2 district and 2 state meetings each year

I give my permission for my child, _____, to hold council office, and will help them with transportation to meetings. (Required for members under 14).

_____ _____
Parent's signature Date

Due September 19 at the county council meeting.

Outstanding Member Application
Bent County 4-H

Due to the Extension Office September 17 at 5 p.m.

Name_____ **Age** on 12/31/17_____

Years of 4-H Completed (including current year) _____ **Birthdate** _____

Junior Division: Members who were 9-13 years of age on 12/31/17
Senior Division: Members who were 14-18 as of 12/31/17

Designate level of involvement by: L (local club), C (county), D (district), S (state), N (national).

Projects completed: list by year, starting with current year.

_____

_____

_____

_____

_____

_____

Leadership Experiences: include elected or appointed offices, committee membership or chair, or any roles that developed leadership skills

_____

_____

_____

_____

_____

_____

Community Service Activities:

_____

_____

_____

_____

_____

_____

Public Speaking Experiences: include demonstrations, talks, workshops, radio spots, etc.

_____

_____

_____

_____

_____

_____

4-H Contests, Activities and Events: any not listed above, including camps, workshops, exchanges, CWF, judging teams, etc.

_____

_____

_____

_____

_____

_____

4-H Promotion and Recruitment: include school visits, news articles, parade floats, display booths, etc.

_____

_____

_____

_____

_____

_____

4-H Awards and Recognition:

_____

_____

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_____

_____

_____

How has 4-H helped you "Make the Best Better"?

_____

_____

_____

_____

_____

_____

Submit <u>one</u> of the following with this application:

1. **Letter of recommendation by 4-H leader, parent or member.**
2. **One page essay about your involvement in 4-H.**

<u>Return to the Extension Office before September 17 at 5 p.m.</u>

Bent County Meritorious Service to 4-H Award & Friends of 4-H Award Nomination Form

NOMINATION DEADLINE: DUE SEPTEMBER 17, 2018
to the CSU Extension Office, 1499 Amb Thompson Blvd, Las Animas, CO 81054
or e-mail to sa.weber@colostate.edu

"To recognize a friend of 4-H (other than advisor or member) for their contributions (time, effort, monetary) to the success of the Bent County 4-H Program."

Nominee's Name: _____

Nominee's Address: _____
Street or P.O. Box City Zip Code

Nominator's Name: _____

Briefly describe why this friend of 4-H should be considered for this award. Tell what contributions this volunteer has made and how the Bent County 4-H program benefited.

Please submit any photographs, news clippings or other materials, which may assist the reviewing committee in evaluating the contributions to 4-H of this nominee.

Date: _____

Signature of Nominator: _____

77TH ANNUAL BENT COUNTY

Harvest Show

Tuesday
October 2nd

2:30PM - Superintendent's Meeting
3:00-6:00PM - All School Art Entries Due
3:00-7:00PM - Booth Set-up
3:00-7:00PM - Entries Accepted (All Divisions)

Wednesday
October 3rd

8:00-8:30AM - Cut Flowers & Baked Goods Entries Accepted Only
8:30AM - Judging In All Departments (Closed to the Public Until Complete)
3:00PM - Release Baked Goods & Frozen Foods
8:00PM - Exhibits Close

Thursday
October 4th

9:00AM - Exhibits Open
4:00PM - Awards Ceremony & Premiums Paid
4:15-5:00PM - Release Exhibits & Booth Clean-Up

St. Mary's Hall
774 Elm Ave Las Animas, CO

October 2-4, 2018

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH
COLORADO STATE UNIVERSITY EXTENSION

ST[EMpower]

CAREERS

Last year's STEM activities focused on exploring your interests and talents, and finding careers that use those gifts and knowledge. If you missed that series, they are located at http://tra.extension. colostate.edu/stem-resources/, activities 38-43 in the yellow sidebars.

This year, we will be exploring some amazing STEM careers that are related to the STEM activities. As you work through the activities, you may find them fascinating. If that is the case, then you may like to find out more about the career described in that issue.

Planting the seed for a career in forest stewardship

Do you love being outside and enjoy the shade of a mature tree on a hot day? Are you curious about the animals and plants that grow in the forest? If you answer yes to either of these questions, then maybe you are interested in learning more about a career in forest stewardship!

Trees are tough, and provide so many amazing

Welcome Fall Colors

and the science of Quaking Aspens

BACKGROUND

Quaking Aspen (*Populus tremuloides*) is the most wide-spread species of tree in North America, with Utah and Colorado home to the largest stands. Each individual aspen tree is part of a colony, united by a single root system. Most aspens grow as root saplings. This is called **vegetative reproduction**. Because of this, aspens are the largest organisms on Earth. A grove of aspen can be a single organism, or it can be several organisms. You tell the difference by examining the similarities and differences between them. Aspens can also produce seeds through **sexual reproduction**.

The largest and oldest known colony of aspen, Pando, is found in southern Utah in the Fishlake National Forest. It is over 100 acres in size, weighs more than 14 million pounds, and is aged at 80,000 years!

While the focus of this issue is our mystical Colorado aspens, fluttering leaves like butterfly wings and a riot of color in fall, the experiments can be conducted on any tree. You don't need to find a stand of aspen; you can use any **deciduous** tree near you.

Objectives—you will:

- **Have fun** exploring the science of trees
- Discover a career in forestry
- Conduct a series of experiments:
  - Transpiration
  - Photosynthesis
- Make a model of a leaf cross section
- Analyze the results of your experiments
- Estimate your "tree" by height, girth, mass, and surface area
- Describe your findings
- Apply what you learn: enjoy hiking; participate as a citizen scientist

DO:

ADOPT A TREE

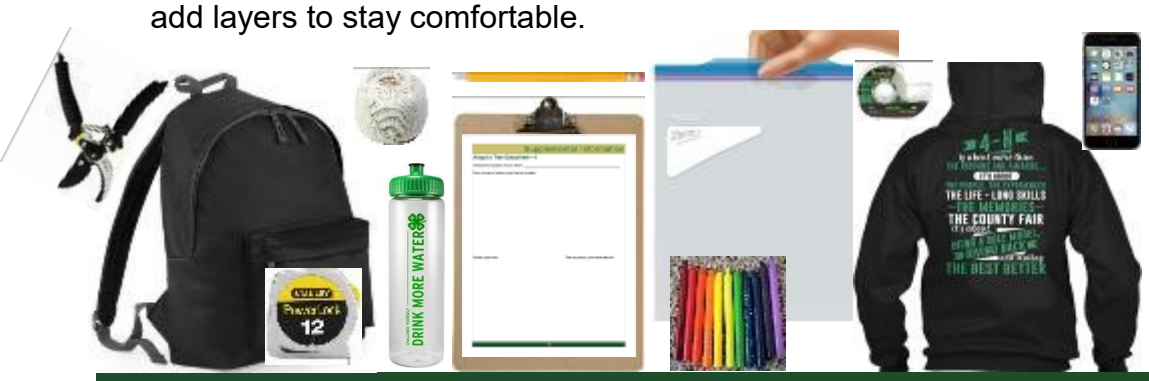
We start our journey in the science of trees by getting to know one tree better. For the purposes of these activities, you need to select a **deciduous** tree (one that loses its leaves in the fall).

Materials:

- Camera (check with your county extension 4-H agent to borrow one)
- Calculator (see camera note)
- Copy of the Adopt a Tree Datasheets (page 28-30)
- Crayons with their paper removed
- Tape
- Pencil
- Cotton string (cotton string does not stretch)
- Metal tape measurer
- Clipboard or homemade clipboard (cardboard with binder clip)
- Resource to ID tree:
  - iPhone, iPad, download free app LeafSnap http://leafsnap.com/
  - https://www.arborday.org/trees/whatTree/
  - Ask librarian at your county library
- Water bottle (with water)
- Backpack or sack (to carry all items)
- Large plastic bag (shopping bag or gallon size baggie)
- Sharp scissors or hand pruning shears

Directions:

- Gather your supplies in your backpack. Since you are headed outdoors, be sure to dress appropriately for the weather. Layered clothes are the best way to remain comfortable while out and about. As the temperature or your activity level changes, you can remove or add layers to stay comfortable.



resources that we use in our daily lives. The products derived from trees growing in a forest help produce the paper that this newsletter is printed on, the desk that you are sitting at, and the structure of the school that you are attending. Trees even help to filter the air you are breathing. Without trees, many of the things we use in our everyday life would not exist.

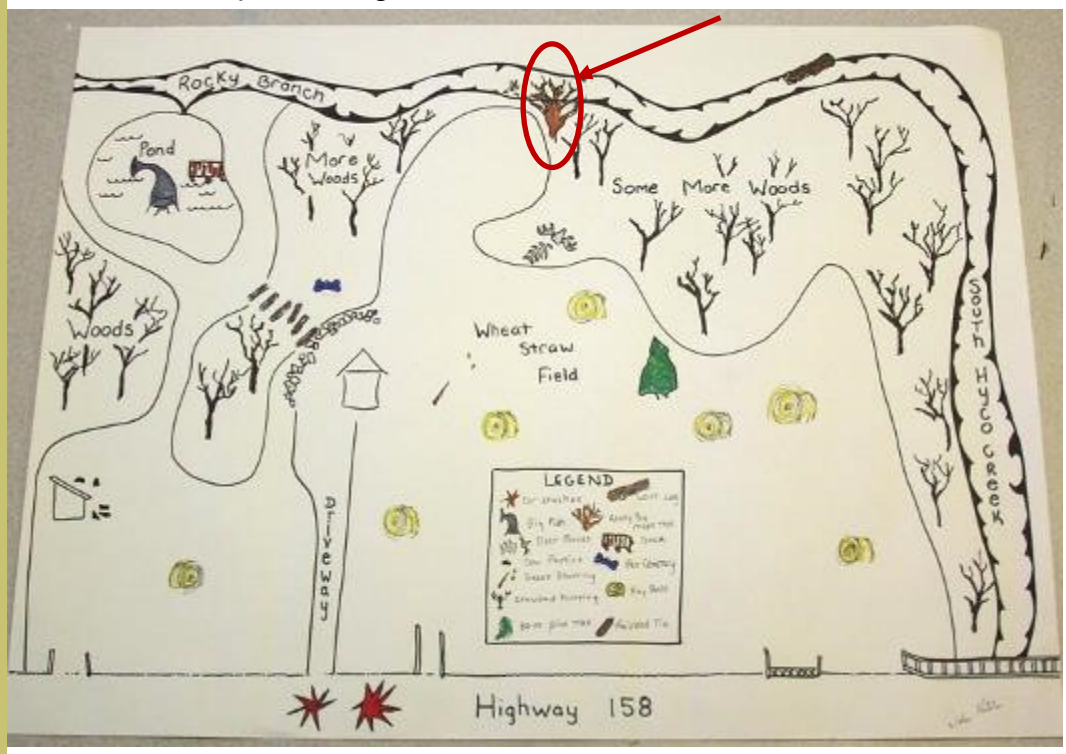
It all begins with proper and sustainable management of our forest resources. So, if you love trees and are interested in learning more about these miraculous plants, then you need to better understand the places they grow and the resources that are needed to raise trees that will produce valuable products. Just like other crops, trees need proper soil (DON'T call it dirt, that's the stuff on our pants!). So, you will need to study topics like soil science, geology, and meteorology. Trees are pollinated like flowers and other agricultural crops by birds and insects. Learning about wildlife and how to make sure they are healthy and learning how to provide them with a proper home is important. In order to properly understand the amount of material you have and the finances associated with forest management, you'll need to learn math and

economics so you can properly measure the trees and estimate how much money you can invest in the crop and how much you need to sell your timber for. Trees and forests are intricate systems and understanding how everything works together in a sustainable approach is very important.

All that education will really pay off when you are able to enjoy working in the forest every day! Your "office" will always have a window to the outside. You can spend time outdoors all year long and enjoy the different seasons and the conditions that exist in each one of those seasons. You will have the chance to see things that few people get to experience, like watching species of wildlife utilize the trees and their resources for food and habitat. Watching a moose nibble on the tips of willows on an early fall morning on your way to work is an amazing experience. You can be sure that no two days will ever be the same and you might have the chance to operate heavy equipment, run chainsaws, conduct fire operations, use ATVs and snowmobiles, and hike in the forest!

There are many jobs you can pursue in the forest industry depending on your interests and

- Scout around your home, neighborhood, school or park to find a **deciduous** tree (loses its leaves in the fall) that you will "adopt" for all these activities. Find a tree that is on fairly flat ground and separated from other trees. You can also adopt a **conifer** tree (tree with cones) in addition to your deciduous tree. Collect a sample of your tree by clipping a small branch with your scissors or shears. Place in the plastic bag.



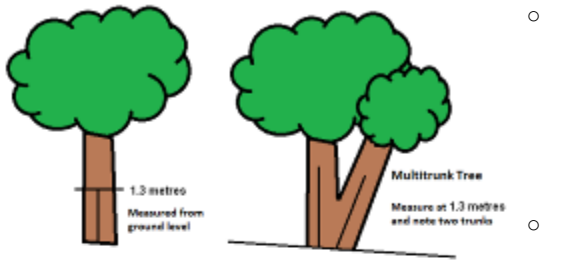
- **Adopt a Tree Datasheet—1**, draw a map from your home to the tree. Sketch your tree, and take some pictures. Be sure to include images of the entire tree, the bark, a single leaf (or a couple of leaves). When you return home, download and print your pictures to add to your datasheets. Determine the species of tree. You can use the iPad or iPhone app, Leafsnap (http://leafsnap.com/), the website https://www.arborday.org/trees/whatTree/, or find tree guide books at your county library. If still in doubt, go to your county extension office and ask the master gardeners to help identify your tree.

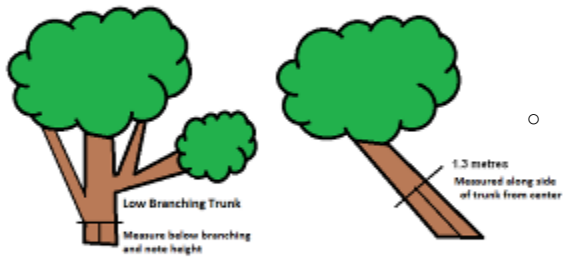

Supplemental Information
Adopt a Tree Datasheet—1

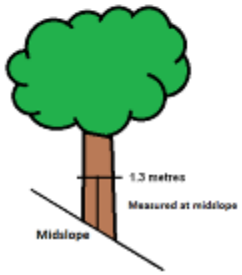
- **Adopt a Tree Datasheet—2**, place the paper on the bark of your tree. Use the crayon on the side and rub. Bark is one of the characteristics used to identify what the species is. Sketch a single leaf, and then make a rubbing of the leaf. Be sure to take a couple of pictures of the bark, both a close-up and further away.
- A leaf is another characteristic used to identify a species of tree. You can make your leaf and bark rubbings very beautiful!

- **Adopt a Tree Datasheet—3**, collect measurements of your tree to later determine the **girth** (**circumference**) height, **mass**, average crown spread, and the number of leaves on the tree in summer. The datasheet has abbreviated directions to help you remember.

- Girth (Circumference):

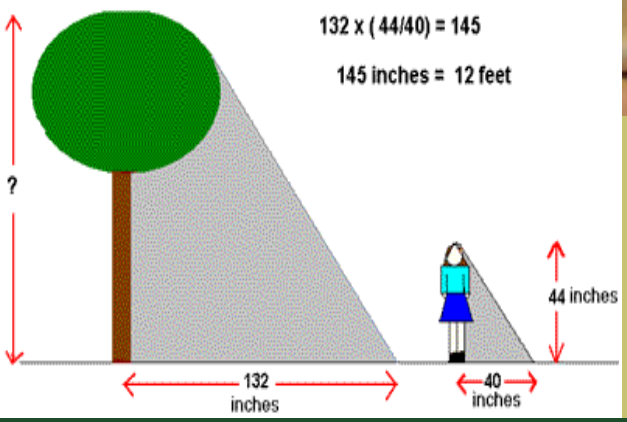






  - This measurement is the distance around the trunk of a tree measured perpendicular to the trunk 4.5 feet above ground level. Measure 4.5 feet with the metal tape measure.
  - Place the string at this measurement and tape to the bark. If you are working with a partner, it is much easier if your partner holds the string.
  - Continue walking around the tree, measuring 4.5 feet above the ground, the string hugging the tree's trunk. Continue until you are back where you started.
  - If your trunk is not perpendicular to the ground, measure the string perpendicular to the trunk, not the ground, at an average of 4.5 feet. That means some of the measurement will be higher, and some will be lower than 4.5 feet.
  - Cut the string where the two ends meet. Lay the string out and measure the length of the string.
  - Record the girth on your datasheet.

- Height:
  - On a sunny day measure the shadow of the tree. Start at the base of the tree, and walk in a straight line until you are at the tip of the tree's shadow. Record this on your datasheet.
  - If the tree's shadow is on a slope, try a different time of day, when the shadow casts in a different direction. This may help you avoid the slope.
  - Stand against a wall or your tree, and ask a friend to measure your height. Use the clipboard to level the top of your head. If you are working alone, you need to do this at



desires. Spending time studying topics in the environmental science area will prepare you for that career path and ensure you are able to follow your dreams of becoming a forest steward!

John Rizza
CSU Ext./USDA-NRCS
Small Acreage Specialist
Forest Steward

The following information about careers in Forestry & Natural resources is from: http://forestrycareers.org/careers.html

F&NR Starting Salary Ranges	
Bachelors Degree	$25k - $60k
Masters Degree	$35k - $80k
Doctoral Degree	$50k - $90k

Colorado State Forestry Service: https://csfs.colostate.edu/

Different positions in forestry:

- **Fish and Wildlife Management**: You will develop the biological and ecological background needed to manage and sustain healthy populations of fish and wildlife.

Professionals in this area work with government, industry and private organizations to insure fish and wildlife conservation objectives are met.

- **Parks, Recreation and Tourism**: Parks, recreation and tourism deal with the human dimensions of natural resource management, seeking to understand the various different ways in which people connect with, and relate to, nature; thus promoting a love and respect for the environment around us and the people within it. Graduates in this discipline work in a wide array of venues, from wilderness parks to the inner-city.

- **Management and Conservation**: Graduates

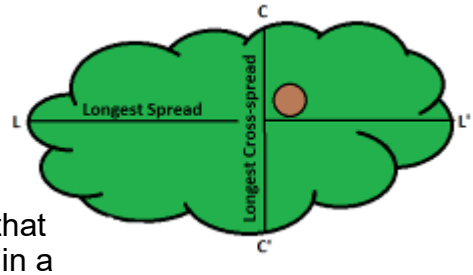
home and ask a parent to help you. Be sure you keep on your shoes! Record your measurement.

- Measure your shadow from your heel to the tip of your head shadow. If you are alone, place a rock on the end of the steel tape measure, and walk back. Stand up straight, and move around until the tip of your head shadow touch the rock and tape on the ground. Measure and record on your datasheet.

- Average leaf measurement

  - Count the number of leaves you need to cover one 8 1/2 x 11" piece of paper in a single layer. Pictured above right is an example of covering a paper plate with leaves. You will be able to estimate the number of leaves with this information.
  - Determining the number of leaves requires some jig saw puzzle-solving skills. Use a range of leaf sizes from large to small from the leaves you collected earlier.

- Average crown spread measurement



  - Locate the point on the ground immediately below the branch tip on the longest spread. Mark that position. Move to opposite side of the crown and locates the point under that branch tip. Mark that position. Measure the two marks in a straight line. Record. This is the Longest Spread measurement.
  - Find the point midway on your last measurement. The longest Cross-Spread measurement will pass through this point at a 90° angle. immediately below the branch tip on one the longest spread. Mark that position. Move to opposite side of the crown and locate the point under that branch tip. Mark that position. Measure the two marks in a straight line. Record.

- **You will be using these data in a later activity.**

REFLECT:
WHAT MAKES A TREE A TREE

How do trees differ from other plants? How are they similar?

Materials:
- None

Trees belong to the Kingdom Plantae. The characteristics that are shared by plant organisms are:
- **Eukaryote** cells—DNA is located in a **nucleus**, and is formed into **chromosomes.**
- Contain **chlorophyll** in **organelles** called **chloroplasts.**
- Cell walls of plant cells are comprised of cellulose (like strings in celery).
- Plants have organs (root, stem, leaf, reproductive structures).
- Plants obtain their energy from sun through **photosynthesis**, and this occurs in chloroplasts.
- Plants are multicellular.
- Most plants are autotrophic, meaning they make sugar from water and carbon dioxide through photosynthesis.
- Seaweed and kelp are NOT plants even though they can photosynthesize. Their cells are not complex like plant cells.
- Some bacteria can also photosynthesize.

Colorado State Forest Service separates trees from all other plants with this set of characteristics:
- A tree is a tall plant with woody tissue. Trees gather light for photosynthesis through their leaves; this process creates food (sugars) for the tree.
- Most of a tree trunk is dead tissue and serves only to support the weight of the tree crown. The outside layers of the tree trunk are the only living portion. The cambium produces new wood and new bark.
- The band of tissue outside of the cambium is the **phloem.** Phloem transports new materials (sugars created from photosynthesis) from the crown to the roots. Dead phloem tissue becomes the tree bark.
- The band of tissue just inside of the cambium is the **xylem**, which transports water from the roots to the crown. Dead xylem tissue forms the heartwood, or the wood we use for many different purposes.
- Every year, trees grow two annual rings. In the spring, usually a wider and thinner-walled layer called springwood forms. In the summer, a thicker-walled layer, called summerwood, develops. Annual rings are typical in temperate forest trees. (Tropical trees do not grow rings, since daylight is basically the same all year long.)

work in an ever-expanding breadth of jobs related to the conservation and management of forests and other renewable natural resources in the US and beyond. From urban, private and industrial forests to conservation easements and wilderness tracks, managers are needed to guide the use and sustainability of our nation's natural resources.

- **Policy and Planning**: With a background in forestry/ natural resource policy and planning, you will develop strategies for putting your knowledge about environmental and natural resources into action. Policy includes both the big and little decisions needed to manage our environmental and natural resources. These decisions can entail something as big and formal as the federal Clean Water Act or as small as a local recycling program.

ANSWERS PG 31:
The pith of the tree represents the tree as a sapling—year one. There are 11 more rings, making this tree 12 years old. The cambium and bark are not included in the count because they are not rings.

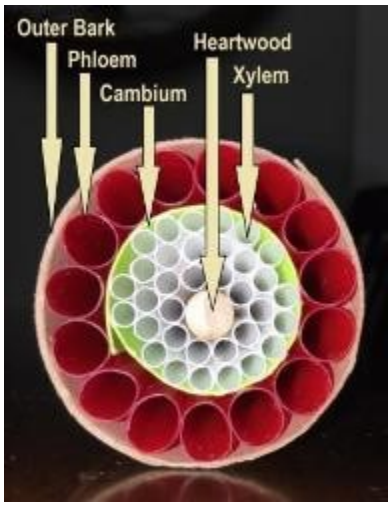
- **Forestry and Natural Resource Sciences**: Studies in this discipline provide a broad exposure to the biological and physical sciences, from the study of water systems (hydrology), forest ecology, tree physiology and insects and disease (entomology and pathology) to forest soils, geology, and microclimatology.

- **Environmental Science and Technology**: In this highly interdisciplinary field, students use technologies like GIS and sophisticated air and water sampling to conduct environmental monitoring, measurements and assessments, prevent pollution, manage hazardous materials, and guide forest management decisions. Graduates work as GIS experts, environmental scientists and consultants, and laboratory analysts.

ANATOMY OF A TREE—STEMS

(This activity modified from Project Learning Tree—Inner Parts of a Tree)

The tree organs are stem, leaf, root, and reproductive structures. We will explore trees and other plants reproductive structures (flowers and cones) in the spring. This ST[EMpower] article will focus on stem, root, and leaf organs.



Stems provide support, move sugars made in photosynthesis where they are needed through cells called phloem, and allow **transpiration** through cells called xylem. You will build a model of a stem, and experiment and explore the ideas of transpiration.

The trunk of a tree and all the branches are stems.

Materials:

- Copy pages 31
- Markers or color pencils
- Empty toilet paper tube
- 34 Coffee stirrer straws
- 15 Drinking straws
- Unsharpened wood pencil
- Rubber band
- Ruler
- Scissors
- Hand garden shears (to cut the pencil)
- Scotch tape
- Piece of color paper (construction paper works great)
- Hand lens

Directions:

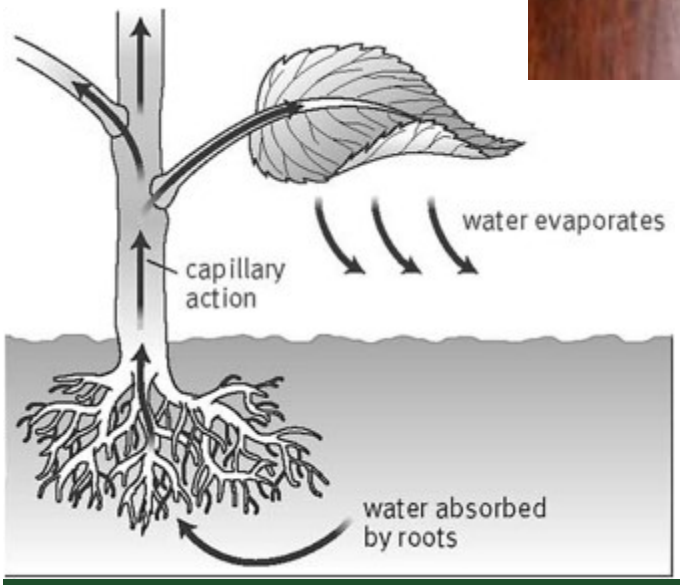
- Cut off the eraser end of an unsharpened wood pencil leaving a 4” piece of pencil (the length of the toilet paper tube).
- Measure and cut the color paper to measure 3 ¼ inches by 4 inches.
- Cut the plastic drinking straws into 4-inch lengths.
- Cut the plastic coffee stirrers into 4-inch lengths.
- Grip the coffee stirrers in your hand and wrap the rubber band around them.
- Insert the pencil into center of the coffee stirrers.
- Wrap the color paper around the coffee stirrers and tape the edge tightly.
- Slide the toilet tissue tube over the paper and stirrers
- Place one row of drinking straws between the card stock paper and the toilet tissue tube.
- Make adjustments where needed to get the appropriate look.

Explain your model:

- Heartwood – (includes the pith, or the growth when the tree was a

sapling) forms the center of the tree. It is made up of dense dead xylem cells. It provides support and strength for the tree. It is represented by the pencil.

- Xylem – brings water and nutrients up from the roots to the leaves. Over time, xylem gets plugged with minerals, and eventually dies. The dead cells become heartwood, and provide support for the tree. The xylem cells are represented by the coffee stirrer straws.
- Cambium – is a very thin layer of cells that line the entire tree like a hollow tube. They produce xylem cells on the inner edge, and phloem on the outer edge. These cells also produce cambium cells. Since trees constantly produce more xylem and phloem cells, the tree gains girth (gets larger in circumference). The cambium is represented by the piece of paper.
- Phloem – carries sap from the leaves to the rest of the tree. At certain times of the year, phloem may also move stored sugars from the roots up to the rest of the tree. The phloem is represented by the drinking straws.
- Outer Bark – protects the tree from injury caused by insects, animals, plants, diseases, and fire. The outer bark is represented by the toilet paper tube.
- Look at your copy of the images on page 31. Use the color pencils to label the different structures on the images and answer the questions on that page.
- Challenge: can you count the number of rings on the older tree? It is really hard!
- With your garden shears, cut one of your small branches (or twigs) that you brought back with you from your Adopt a Tree outing. Use your hand lens to closely examine the sample branch.
- With smaller twigs, you will only see the pith, still functioning xylem cells. Look carefully, and you will be able to identify the cambium.
- If you have a branch, you may be able to tell how old the branch is by the number of rings.



- **Wood and Paper Science**: Students in wood and paper science learn to design and produce myriad products from nature's most abundant and versatile renewable material. Creative utilization of wood will ultimately dictate whether we can sustainably achieve global standards of living that reflect those of the developed world.

- **Genetics and Biotechnology**: From plant breeding to forensic biology, graduates learn what makes forest organisms grow, adapt, and interact with their environment. Learn to measure and conserve genetic diversity in natural populations, or manage it in tree breeding programs. Study the tremendous

potential, and possible risks, of planting genetically engineered trees. Discover the genes that make a tree, a tree!

Who Determines what happens to our public lands?

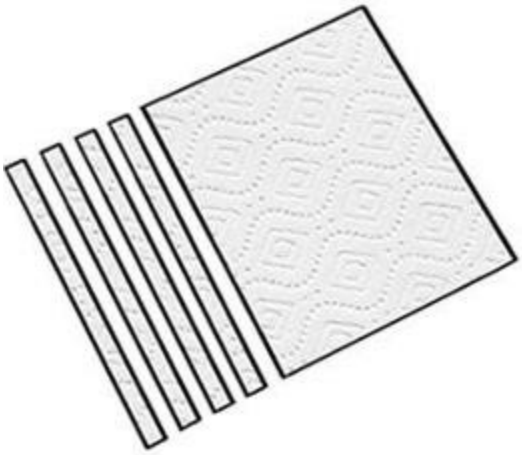
- Policy and Planning
  - Chief Forester, Deputy Forester
  - Regional Administrator
  - Environmental Planning
  - Environmental Compliance Specialist
  - Environmental Lawyer
  - Litigation Assistant
  - Environmental Policy
  - Environmental Consultant
  - Regulatory Affairs Specialist
  - Economist
  - Professor / Educator

How do we sustain our renewable forest resources?

- Management and Conservation
  - Forester / Urban Forester / Research Forester / Arborist
  - Forest / Environmental Consultant
  - Forest Resource Administrator
  - Forestry Technician
  - Conservation Biology (Soil, Plant, Hydrology, Wildlife, Etc.)
  - Fire Suppression Specialist
  - Rangeland Specialist
  - Environmental Protection Specialist
  - Land Use Planner / Land Investment Analyst
  - Habitat Conservation

XYLEM

This activity is adapted from the OMSI activity Plant Piping



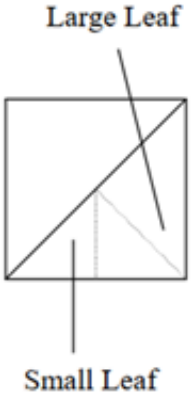
You will model how xylem carries water up through the tree and out the leaves. The plant pulls water from the soil into the root system through tubes called xylem. It travels up against gravity through the stems. When the water reaches the leaf, it fills an area of the leaf that has loose cells with space for the water vapor and carbon dioxide gas. The difference in high humidity in the leaf and low humidity in the air pulls the water vapor out of the leaf. The water moves against gravity because of the pressure in the tubes, like when you suck on a straw, and you pull the milk from the cup, against gravity, into your mouth.

Materials:

- 2 straws
- 2 paper towels
- Bath towel soaking wet
- Thread
- Scissors
- Paper clip opened
- 2 canning jars cup size
- Permanent marker
- Measuring cup
- Food coloring (any color)
- 2 small pieces of plastic wrap
- 2 identical rubber bands
- Sharpened pencil

Make the xylem for the experiment.

- Take one paper towel and cut it lengthwise into approximately 2-inch strips.
- Soak the towel until it is dripping wet. Fold neatly and leave in the sink.
- Take the paper towel strips to the sink and gently press the strips into the wet towel until they are completely wet. Water should not be dripping on the floor.
- Twist the wet paper towel strips into a rope and tie a piece of thread (about 10” long) on one end of the paper towel.
- It may help to add a needle to the other end of the thread for a little weight. Place the thread in the straw and out the other side, Gently pull on the thread while pushing on the paper towel to insert it



into a straw. When you are done, the straw should have paper towel all the way through it with no gaps. Repeat for the other straw.

- Make the leaves—one per straw.
- Cut a paper towel in half diagonally.
- Cut one half of the paper towel in half again diagonally. One of these pieces will represent the large leaf.
- Cut the remaining small piece in half diagonally. This small triangle will represent the small leaf.
- Take the paper towel leaves to the sink and gently press the strips into the wet towel until they are completely wet. Water should not be dripping on the floor.
- Twist the base of the leaf and insert it into the straw far enough that it won't fall out. It helps to use a paper clip to push the end into the straw.
- With the permanent marker, label one cup "Large Leaf" and one cup "Small Leaf." Include the date on the cups.
- Measure the water and fill the first cup about half way. For example, if you have 12 ounce cups, you will add ¾ cup of water (6 ounces). Add the same amount of water to the other cup. Mark the water level on each cup with a marker. Add ten drops of food coloring to each cup and carefully swirl to mix. Use the same food coloring in both cups.
- Tightly cover the top of each cup with plastic wrap and rubber band. Be careful not to tip them over.
- Using a sharp pencil carefully poke a small hole in the middle of the plastic wrap.
- Carefully put each prepared straw (xylem) into the hole—one per cup. Make sure the leaves are still attached.
- Place the cups in a window for 24 hours.
- Which cup will have the most water "transpire" through the "xylem?" This will be your hypothesis.
- Clean up.
- Wait 24 hours.
- Use a marker to put a line on the cup showing the new water level.
- Observe the two cups. What do you see happening?
- Compare the amount of water each leaf was able to move through the straw. Which leaf had a faster rate of transpiration?
- Form a conclusion.
- Was your hypothesis supported? Why or why not?

Specialist
- Biometrician
- Biostatistician
- Natural Resource Specialist
- Nursery/Greenhouse Manager
- Silviculturalist
- Soil Management
- Insect and Disease Management
- Land Rehabilitation Specialist
- Realtor / Real Estate
- Professor / Educator

Hiking, Camping, and talking to people! I can get paid to do these things?

- Parks, Recreation, and Tourism
- Adventure Travel Guide
- Parks & Recreation Coordinator
- Recreation Specialist
- Environmental Educator
- Park Interpreter
- Park Naturalist
- Public Information Officer
- Environmental Sociologist
- Supervisor/Parks Maintenance
- Park Superintendent
- Park Administrator
- Scientist / Professor / Educator

What does GPS and GIS stand for?

- Environmental Science and Technology
- Forestry GIS Analyst
- GIS Technician
- Environmental Technology
- Air and Water Quality Specialist / Chemist

- Environmental Health Specialist
- Environmental Safety Specialist
- Geotechnical Engineer
- Toxicologist
- Water Recycling and Solid Waste Engineer
- Watershed Program Director
- Water Quality Specialist
- Photogrammetry

Salmon, Deer, and Bears, Oh My!

- Fish and Wildlife Management
  - Scientist
  - Project Manager
  - Fisheries Biologist / Technical
  - Wildlife Animal Control Technician
  - Wildlife Biologist / Wildlife Refuge Manager
  - Hatchery Manager
  - Aquatic Toxicologist / Ecologist
  - Wildlife Forester
  - Game Warden
  - Aquaculturist
  - Wildlife Keeper
  - Mammalogist
  - Professor / Educator

How might climate change influence our forest ecosystems?

- Forestry and Natural Resource Sciences
  - Biologist
  - Botanist
  - Hydrologist
  - Forester
  - Environmental Protection Specialist
  - Microbiologist
  - Naturalist

XYLEM PRESSURE

Modified from: https://www.explorationeducation.com/activities/Force/pressure.html

In transpiration, water is pulled from the roots against gravity. As air moves across the leaf, it causes a drop in pressure at the **stoma**, increasing the pull of water through the xylem system.

Materials:

- 2 straws (clear work best)
- 1 canning jar cup size
- Food coloring (any color)

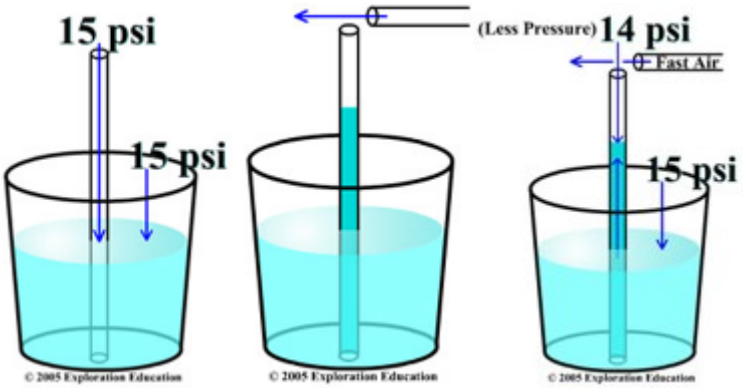
Instructions:

- Fill a clear drinking glass close to the top with any liquid (water works fine, but a colored liquid allows you to see it a bit easier.)
- Hold one straw in the glass straight up and down (vertically).
- Hold the second straw horizontally at the top of the vertical straw.
- Now blow hard through the horizontal straw so that the air stream is flowing across the top of the straw that is in the water.
- The water will move up the straw. The faster the air blows across the top of the straw, the higher the water will rise up into the straw.

There are two scientific principles at work in this experiment.

1. **Air pressure** – Our atmosphere is comprised of mostly nitrogen and oxygen molecules about 300 miles thick. Believe it or not, gravity pulls on these molecules like it pulls on you and me. The column of air above you presses down on you. As you may know, air is made up of molecules that are in constant motion. At sea level, this pressure is approximately 15 pounds per square inch (psi). The pressure pushes down on the water both outside and inside the straw.
2. **Bernoulli's principle** – Daniel Bernoulli, an 18th century Swiss scientist discovered that fast moving air (e.g. blowing through the straw at the top of the straw in the water) has less pressure than slower moving air. The air pushing down on the water in the cup is15 psi, but the fast moving air going across the top of the straw is less than that (shown in the example below as 14 psi). High pressure pushes against low pressure. The high pressure pushes the water in the cup and straw equally. Blowing across the top of the straw lowers the pressure in the straw. As a result, the water in the cup has more pressure pushing on it than the water in the straw. As a result, the water in the straw moves up the straw.

This is the same principle of how birds or planes fly. Air moves across the top of the wing faster than the bottom of the wing, creating lift.



XYLEM DIAMETER AND LENGTH:

Experiment how xylem functions in transpiration.

Materials:

- 12 coffee stirrer straws
- 12 drinking straws not bendable
- 24 bendable drinking straws
- 12 or more shake straws with wider **diameter**
- Small ball (racket, ping pong, or other light ball)
- Scissors
- 12" ruler
- Tape
- 6 identical rubber bands
- Clear plastic cup with water
- Placemat
- Step ladder or ladder
- Copy of Transpiration Datasheet on page 32

Activity 1: Two Straws of Different Diameter but Same Lengths

- Use one coffee stirrer straw, one drinking straw, and one shake straw. Cut the longer straws to the same length as the shortest straw.
- Set the ruler down on the table. Place the ball at the 0.
- Blow through each straw, one at a time, at the ball. Record how far the ball moved for each straw. (You may need to use a metal tape measure if you have a light ball.)
- Does the diameter of the straw affects the motion's resistance to move across the tabletop? What given evidence supports this?

Activity 2: Two Straws of Same Diameter but have Different Lengths

- Use two coffee stirrer straws, two drinking straws, and two shake straws. In each pair of straws, cut one of them half the length of the other and leave the other straw. Measure each of the straws and record on the datasheet. The short straws are grouped, as are the long straws.
- Set the ruler down on the table. Place the ball at the 0.
- Blow through the short coffee stirrer straw and record the distance the ball moved on your datasheet. Blow through the long coffee stirrer straw and record how far the ball moved.
- Repeat this for the short and long drinking straws and the short and long shake straws. Record how far the ball moved for each straw. (You may need to use a metal tape measure if you have a light ball.)
- Does the length of the straw affects the ball's resistance to move across the tabletop?
- What given evidence supports this?

Activity 3: Six Straws of the Same Diameter and Lengths

- Take 6 of each type of straw. Leave 1 straw alone. Rubber band 2 straws, and then rubber band 3 straws together – side-by-side. See picture on this page.
- Set the ruler down on the table. Place the ball at the 0.

- Ecologist
- Soil Scientist
- Pathologist / Entomologist
- Fisheries and Wildlife
- Limnologist
- Zoologist

Breed, test and fingerprint trees: Do they have genes too?

- Genetics and Biotechnology
  - Tree Breeder
  - Tree Improvement Technician
  - Forest Geneticist
  - Lab Technician
  - Field Technician
  - Biochemist
  - Molecular Biologist
  - Tissue Culture Specialist
  - Genetic Engineering Specialist
  - Professor / Educator

POWER WORDS

chlorophyll: a green pigment, present in all green plants responsible for the absorption of light to provide energy for photosynthesis.

chloroplast: in green plants, an organelle that contains chlorophyll and in which photosynthesis takes place.

chromosome: a threadlike structure of nucleic acids and protein found in the nucleus of most living cells, carrying genetic information in the form of genes.

circumference: the enclosing boundary of a curved geometric figure, especially a circle.

conifer: a tree that bears cones and evergreen needlelike or scalelike leaves.
control: take into account (an extraneous factor that might affect results) when performing an experiment.
cotyledons: an embryonic leaf in seed-bearing plants, one or more of which are the first leaves to appear from a germinating seed.
cuticle: a protective and waxy or hard layer covering the epidermis of a plant.
deciduous: (of a tree or shrub) shedding its leaves annually.
diameter: a straight line passing from side to side through the center of a body or figure, especially a circle or sphere.
epidermis: the outer layer of cells covering an organism.
eukaryote: an organism consisting of a cell or cells in which the genetic material is DNA in the form of chromosomes contained within a distinct nucleus.
girth: measurement of the distance around a tree trunk 4.5 feet (1.4m) above ground level.
mass: the quantity of matter that a body contains (measured as weight when pulled down by gravity).
nucleus (of a cell): an organelle present in most eukaryotic cells containing genetic material
organelle: any of a number of organized or specialized structures within a living cell
palisades parenchyma: a layer of columnar cells rich

- Starting with the 1 coffee stirrer straw, blow the ball and record the distance. Repeat with the 2 coffee stirrer straws, and finally the 3 coffee stirrer straws. Record the distance the ball travels each time.
- Remember each straw needs to get the same amount of pressure at every set. For example, you blow at 1 unit for one straw, then for two straws you need to blow for 2 units so that the first straw gets the same amount as the first, and so forth for the third.
- Does adding more straws affect the motion's resistance to move the ball across the tabletop? What given evidence supports this?

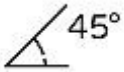
Activity 4: One Straw with a Nick

- Take one of each type of straw (coffee stirrer, drinking, and shake).
- Place the straw in the water and sip.
- Remove the straw from the water. With the scissors, put a small nick in the straw about 1" below the top of the straw.
- Place the straw in the water and sip.
- Repeat with the other two types of straws.
- What happened?
- When florists receive flowers, they cut the bottom of the stem before placing it back in water. Can you figure out why?

Activity 5: A Really Long Straw (modified from Scientific American Science Buddies)

- Use the bendable straws for this activity. Cut 1/2 inch slit down the straw lengthwise in one end of a plastic straw. Repeat this cut opposite side. These cuts will help you slip the end of one straw over another one.
- Wrap the area where the straws overlap with Tape so you have an airtight seal.
- Test your extra-long straw. Place the glass of water on top of the placemat on the floor. Hold your straw at a 90° angle and try to drink with it. Ask a friend, sibling, or parent to hold the cup on the floor, so it does not tip over. Does water reach your mouth?

- If little or no liquid enters the straw, check the seal where you joined the straws. Is it airtight? If not, add tape or undo and redo this connection. If the seals at all joints seem airtight, check for holes in other areas of your mega-straw and seal them with tape.
- Play around with your first mega-straw. Suck lightly to remove a little air from the straw then suck hard to remove more air. Observe each time how high the water rises in your mega-straw. What happens if you suck up more air? Why do you think this happens?
- Try sipping the water at a 45° angle. Is that easier or harder?



- Try sipping the water as close to horizontal as you can. You will need to fill your glass as full as possible, and someone will need to hold your glass to keep it from tipping over.
- Add another straw. Make your slits, push onto the straw, and with the tape, make an airtight seal. Test your three-straw-long straw. Is your new straw functioning properly? Does it get harder to suck up water?

- Test your three-straw-long straw at 90°, 45°, horizontal.
- Add another straw. Make your slits, push onto the straw, and with the tape, make an airtight seal.
- Test your four-straw-long straw at 90°, 45°, horizontal.
- Keep adding one straw at a time. Test 90°, 45°, horizontal each time you add a straw and check that it is airtight. You will eventually have to stand on the step ladder or ladder. How many straws can you add until you can no longer sip water from your straw?
- How the difference in height between your mouth and the glass changed depending on the angle at which you held the mega-straw. Do you see a correlation between the difference in height and the effort you needed to suck up water?
- Test what happens if you keep the height of your glass and your head the same but change the way you bend the mega-straw. Try a straight mega-straw and a mega-straw with one or several kinks. How do the levels of effort compare now that you keep the difference in height unchanged?

Observations and results

- Use your datasheet to evaluate your data. Make graphs of each activity to find trends.
- Reflect on these transpiration activities, and see if you can reason how trees transpire.
- Even with a complete vacuum, you could only draw water up about 30 feet. How do trees efficiently transpire? Easier to imagine shorter trees, like the Rocky Mountain Maple that can grow to 25 feet. How do redwoods (which are the tallest trees in the world) transpire? Redwoods can grow to 300 feet, and the tallest known redwood is Hyperion, that was discovered in 2006. It is 379.7 feet tall!

in chloroplasts found beneath the upper epidermis of foliage leaves.

phenology: the study of cyclic and seasonal natural phenomena, especially in relation to climate, plant, and animal life.

phloem: the vascular tissue in plants that conducts sugars and other metabolic products downward from the leaves.

photosynthesis: the process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water.

radius: a straight line from the center to the circumference of a circle or sphere.

sexual reproduction: the production of new living organisms by combining genetic information from two individuals of different types (sexes).

spongy parenchyma: layer of loosely packed cells in the interior of leaves, consisting of loosely arranged, irregularly shaped cells that have chloroplasts to facilitate gas exchange of water vapor and carbon dioxide.

stoma (plural stomata): any of the minute pores in the epidermis of the leaf or stem of a plant, forming a slit of variable width that allows movement of gases in and out of the intercellular spaces.

transpiration: the process where plants absorb water through the roots and then give off water vapor through pores in their

leaves.

treatment: In an experiment, the factor (also called an independent variable) is an explanatory variable manipulated by the experimenter.

vegetative reproduction: multicellular structures become detached from the parent plant and develop into new individuals that are genetically identical to the parent plant.

xylem: the vascular tissue in plants that conducts water and dissolved nutrients upward from the root and also helps to form the woody element in the stem .

FASCINATING FACTS

- Trees are the longest living organisms on Earth, and never die of old age.
- Trees drink about 2,000 liters of water each year.
- "Moon trees" were grown from seeds taken to the moon during the Apollo 14 mission in early 1971. NASA and USFS wanted to see if being in space or the moon's orbit caused the seeds to grow differently.
- Trees are able to communicate and defend themselves against attacking insects. Scientists have found that trees can flood their leaves with chemicals called phenolics when the insects begin their raid. They can also signal danger to other trees so they can start their own defense.
- The "knock on wood"

ANATOMY OF A TREE—ROOTS

Roots have three functions in a plant: anchor the plant to the soil, absorb water and nutrients, and store sugars from photosynthesis. This simple sugar (sucrose) is the perfect fuel source to make ATP, the packet of energy cells use to function. In this activity, you will germinate different types of seeds, mass the roots and stems with both green and dry weight to determine the proportion of root to stem and leaf.

Materials:

- 4 quart canning jar
- Paper towels
- Water
- Spray bottle
- Seeds lima beans, sunflower, peas, corn
- Permanent marker
- Hand lens
- Copy of Roots Datasheet on page 33
- Cooking scale in grams (you can convert to grams)
- Cookie sheet
- Oven

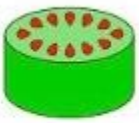
Directions:

- Label each jar with one of the types of seeds you will be germinating.
- Crumple and stuff paper towels into the jar. It should be snug, but not stuffed.
- Add water with the spray bottle until the paper towels are thoroughly wet.
- Place in a window, and moisten the paper towels as needed. Do not under or over water.
- Record the days until germination. You will see **cotyledons** (first leaves).

- Continue growing your seedlings until they have reached the above state, with the leaves starting to protrude from the jar.
- Remove each sapling and examine the roots with a hand lens. You will be able to see roots and root hairs. Be sure to keep the four types of plants separate.
- Cut the roots from the green (photosynthesizing) part of the plant.

You should have the roots separate from the stems and leaves.

- Mass (weigh) your roots for each type of plant. Mass the stems and leaves for each type of plant. For example, if you have 8 germinated lima beans, weigh the 8 roots together and the 8 leaves and stems together. Record after each time you mass.
- Botanists use dry weight of plants. Each plant will have different water requirements, and this will find the mass of just the plant (not the plant and water). Keep each type of plant separate, and keep the roots separated from the stems and leaves. Place on cookie sheets and be sure that the plants are spread out to dry. Place the cookie sheets in an oven, and set the oven to 100°F for 12 hours (overnight).
- Remove the cookie sheets (remember that they will be hot), and cool the plants.
- Mass the roots and mass the leaves and stems for each of your 4 plants. Record the mass.
- What is the total mass of all the roots? What is the total mass of all the stems and leaves? How much of the plant is not seen?
- Look at your individual plant data. Do you notice anything different about corn? Corn is a monocot. It is a grass. It will have 1 cotyledon, rather than 2. The roots do not form a taproot, but instead are fibrous. The leaves have parallel veins. Below is a chart that compares the differences between these two plants. Trees are only dicots. Tall monocots, like banana or coconut, are not true trees. They are tree-like forms, but they do not have wood, which is the definition we are using for tree. As scientists learn more, this may change.

	Seed	Root	Vascular	Leaf	Flower
Monocot					
	One cotyledon	Fibrous roots	Scattered	Parallel veins	Multiples of 3
Dicot					
	Two cotyledon	Tap roots	Ringed	Net-like veins	4 or 5

tradition comes from a time when primitive pagans used to tap or knock on trees to summon the protective spirits that resided in them.

- A tree can absorb as much as 48 pounds of carbon dioxide each year and can sequester 1 ton of carbon dioxide by the time it reaches 40 years old.
- Trees can help you find your way if you get lost in the woods. In northern temperate climates, moss will grow on the northern side of the tree trunk, where there is more shade.
- A tree's rings can help point you in the right direction too. If you're in the northern hemisphere, you can see the rings of the tree grow slightly thicker on the southern side since it receives more light. In the southern hemisphere, the opposite is true, with rings being thicker on the north side.
- Pine trees grow on six of seven continents, with Antarctica being the only one left out.
- Trees can lower the air temperature by evaporating water in their leaves.
- if a birdhouse is hung on a tree branch, it does not move up the tree as the tree grows.
- Trees improve water quality by slowing and filtering rain water, and protecting aquifers and watersheds.
- The different parts of a tree grow at different times

throughout the year. Typically, most of the foliage growth happens in the spring, followed by trunk growth in the summer and root growth in the fall and winter.

- Earth has more than 60,000 known tree species.
- An average size tree can provide enough wood to make 170,100 pencils!
- The first type of aspirin, painkiller and fever reducer came from the tree bark of a willow tree!
- 85% of plant life is found in the ocean!
- Bananas contain a natural chemical which can make people feel happy!
- Brazil is named after a tree!
- The Amazon rainforest produces half the world's oxygen supply!
- Cricket bats are made of a tree called Willow and baseball bats are made out of the wood of Hickory tree!
- Dendrochronology is the science of calculating a tree's age by its rings!
- Caffeine serves the function of a pesticide in a coffee plant!
- Apple is 25% air, that is why it floats on water!
- Peaches, Pears, apricots, quinces, strawberries, and apples are members of the rose family!
- Apple, potatoes and onions have the same taste, to test this eat them with your nose closed!
- The tears during cutting an onion are caused by sulfuric acid present in them!

ANATOMY OF A TREE—LEAVES

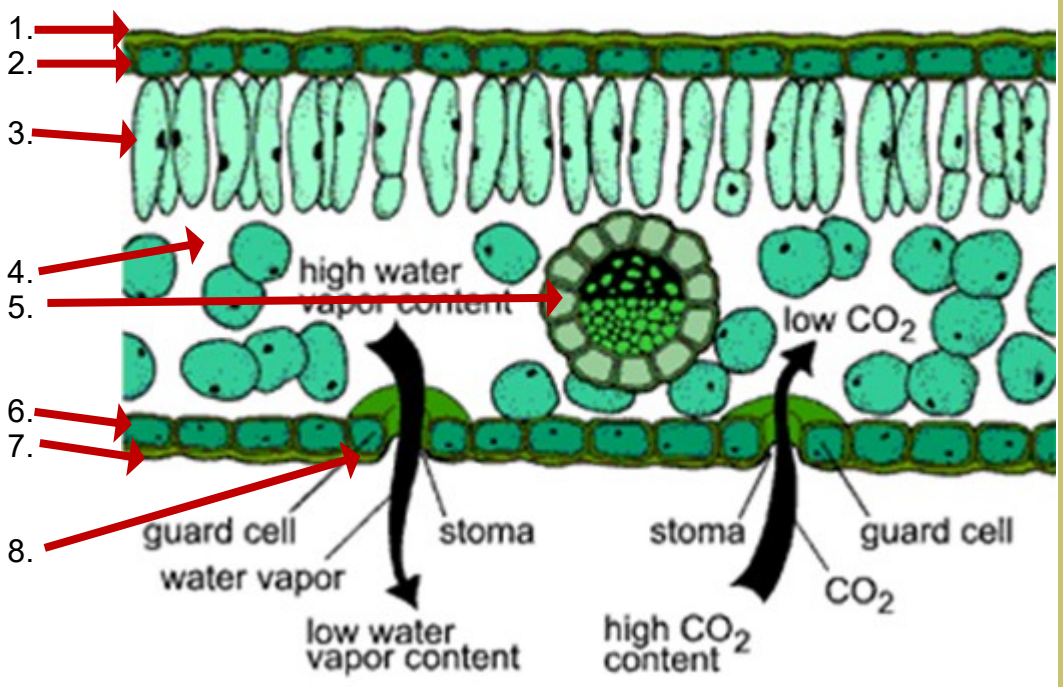
Leaves are the organs that contain chloroplasts. Stems can contain chloroplasts in some plants, but not trees. Chloroplasts are the organelles that contain chlorophyll that give leaves their green color. They also have photosynthetic pathways to use carbon dioxide from the atmosphere and water to form sucrose sugar. As the day grows shorter in the fall, chloroplasts begin to breakdown, and the green slowly disappears, leaving other pigments. We can see aspen's yellow, gold, orange and red pigments masked through the summer by chlorophyll. We will explore form and function of leaves facilitating photosynthesis.

Materials:

- Copy page 34 Model of a leaf cross section (cardstock, if available)
- Copy page 35 (Photosynthesis Datasheet)
- Scissors
- Tape
- 6 cup canning jars
- Red, yellow and blue food coloring
- Paper towels
- Fresh spinach leaves
- Metal paper hole punch
- 2—10 mL or larger plastic syringe (without needle) at local pharmacy
- Baking soda
- Liquid dish soap
- Measuring cup
- Mortar and Pestle or food processor (hammer will also work)
- Isopropyl alcohol
- Acetone (Nail polish remover; get clear, pure and largest bottle)
- Flat coffee filters
- Pencil
- Fresh leaves from your Adopt a Tree

FORM FOLLOWS FUNCTION

Leaves are a perfect example of form follows function.



The diagram above is a cross section of a leaf looking at the edge.

1. The leaf is covered by a heavy, waxy **cuticle** to prevent water loss.
2. The next layer of upper **epidermis** cells cover the leaf for protection.
3. Under that are **palisades parenchyma** cells, packed at the top of the leaf for the most exposure to sunlight for photosynthesis.
4. The next layer is loosely packed **spongy parenchyma** cells to permit carbon dioxide to enter the cell, water vapor and oxygen to leave the cell for photosynthesis.
5. Leaf veins are in the spongy parenchyma. The top cells in the vein are **phloem**, that carry the sugar products of photosynthesis to the roots for storage, and the bottom cells (in the lighter green) are the **xylem** cells, transpiring water from the roots.
6. The bottom layer is the protective lower **epidermis** cells.
7. The lower epidermis is covered by a waxy **cuticle** preventing water loss. This allows the plant to control water loss.
8. The plant controls water loss and gas exchange through the stomata, holes in the leaf bottom (although there are some stomata on the top of the leaf). These holes have two special guard cells that allow the hole to be open when there is lots of water, and close when water is limited to protect the entire plant from wilting or dying.

- The tallest tree ever was an Australian eucalyptus – In 1872 it was measured at 435 feet tall!
- The first potatoes were cultivated in Peru about 7,000 years ago!
- The evaporation from a large oak or beech tree is from ten to twenty-five gallons in twenty-four hours!
- Strawberry is the only fruit that bears its seeds on the outside. The average strawberry has 200 seeds!
- Leaving the skin on potatoes while cooking is healthier as all the vitamins are in the skin!
- Around 2000 different types of plants are used by humans to make food!
- Small pockets of air inside cranberries cause them to bounce and float in water!
- Bamboo is the fastest-growing woody plant in the world; it can grow 35 inches in a single day!
- A sunflower looks like one large flower, but each head is composed of hundreds of tiny flowers called florets, which ripen to become the seeds!
- Cabbage has 91% water content!
- Banana is an Arabic word for fingers!
- The California redwood (coast redwood and giant sequoia) are the tallest and largest living organism in the world!
- Ginkgo (Ginkgo biloba) is one of the oldest living tree species, it dates back to about 250 million years

ago!

- The word pineapple comes from European explorers who thought the fruit combined the look of a pinecone with flesh like that of an apple!
- The Elephant grass found in Africa is named so as it is 4.5 meters high and even elephants can hide in it!
- Eating lots of onions will make you sleepy, as it acts as a sedative!
- A cucumber is a fruit and not a vegetable since it has seeds in the center!
- A cluster of bananas is called a hand and consists of 10 to 20 bananas known as fingers!
- Vanilla flavoring comes from the pod of an orchid, Vanilla planifolia!
- The first certified botanical garden was founded by Pope Nicholas III in the Vatican City in 1278 AD!
- There are over 300,000 identified plant species and the list is growing all the time!
- Oak trees are struck by lightning more than any other tree!
- Carrots were originally purple in color!
- During the 1600s, tulips were so valuable in Holland that their bulbs were worth more than gold. The craze was called tulip mania and caused the crash of the Dutch economy!
- The baobab tree found in Africa can store 1,000 to 120,000 liters of water in its swollen trunk!

MODEL OF LEAF CROSS SECTION

In this activity, you will make a model of a cut out from a leaf like the one pictured to the right.

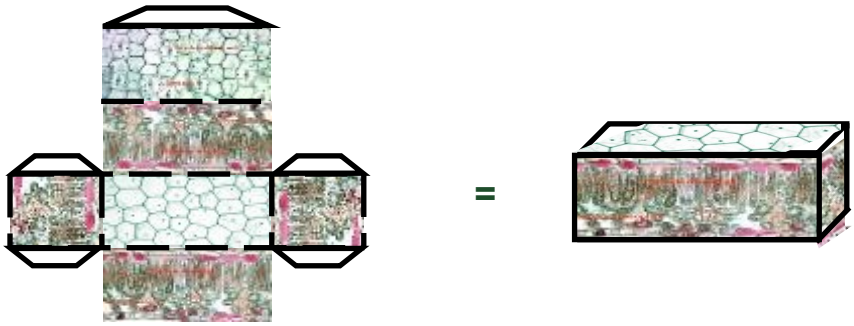
Materials:

- Copy on page 34 (use cardstock if available)
- Scissors
- Tape

Directions:

- Cut outer edges.
- Fold on the black dashed lines.
- Tape or glue the tabs inside to form a rectangular prism

Examine the model and compare it to the diagram on page 18. Can you locate these structures? The cross sections are actual leaf images from the University of Ohio Lima's botany lab.



PHLOEM

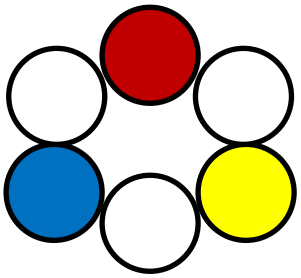
Phloem are cells that move sugar made in photosynthesis and transported to the roots for storage. As the plant needs to make energy, the sugar can be transported to that part of the plant. In this next activity, you will explore how products can be transported.

We will use paper towels, made from wood products, and they can best demonstrate the functions we are examining.

Materials:

- 6 canning jars 1 cup size
- Red, blue, and yellow food coloring
- 6 paper towels
- Measuring cup

Directions:



- Fill each canning jar with ¾ cup of water.
- Squeeze red food coloring into one jar until you have a good red color.
- In another canning jar, squeeze yellow food coloring until you have a good yellow.
- In a third canning jar, squeeze blue food coloring until you have a good blue.
- Find a place where the jars will not be disturbed.
- Set the jars in a circle touching the two next to it, as diagramed on the right. Every other jar must be a the clear jar of water.
- Separate your 6 paper towels, and roll them lengthwise to make a paper towel rope. Insert each paper towel into one of the jars all the way down to the bottom of the jar.

- Take each paper and fold it over and insert it to the jar next to it, pushing it all the way to the bottom of the jar. Each jar should have 2 paper towels in it as pictured above.
- Check your jars about once an hour. What is happening? Why?

Explanation:

- In this experiment, the paper towels represent phloem, and the food coloring represents the product of photosynthesis, sugar. Sugars, like the food coloring, can be transported around the tree to go where it is needed.

- Oak trees don't produce acorns until they are 50 years old!
- At over 2000 kilometers long, The Great Barrier Reef is the largest living structure on Earth!
- The first product to have a bar code was Wrigley's gum!

JOKES

Q: What did the tree wear to the pool party?
A: Swimming trunks!

Q: What did the beaver say to the tree?
A: It's been nice gnawing you!

Q: Why did the leaf go to the doctor?
A: It was feeling green!

Q: What is a tree's least favorite month?
A: Sep-timber!

Q: What kind of tree can fit into your hand?
A: A palm tree!

Q: How do trees get on the internet?
A: They log in.

Q: How can you tell that a tree is a dogwood tree?
A: By its bark!

Q: What did the little tree say to the big tree?
A: Leaf me alone!

Q: Did you hear the one about the oak tree?
A: It's acorn-y one!

Q: Why did the pine tree get into trouble?
A: Because it was being knotty.

Q: What did the tree do when the bank closed?
A: It started a new branch.

Q: Why do unicorns paint their horns pink?
R: So they can hide in fireweed patches!

- If you don't do anything in an entire day but wander around, you're called a lazy bum.

  If you don't do anything in an entire day but wander around staring at plants, you're called a botanist.

- The volunteer naturalist found the two easterners climbing around on a slope just above the east entrance to Rocky Mountain National Park, apparently looking for something.

  "Can I help?" she asked.

  "We wanted to see a red columbine like the ones back home," the man said, gesturing to a photo in the plant guide book.

PHOTOSYNTHESIS

In this activity, you will conduct an experiment to demonstrate that, in the presence of light and carbon dioxide, leaf tissues produce gas bubbles. Unless you have an oxygen probe, you will not be able to prove that the gas bubbles are oxygen. You can, however, demonstrate, by use of a control, that the bubbles only form when the leaves are submerged in a sodium bicarbonate solution (which releases CO_2) and not when they are submerged in pure water. You can also discover that the bubbles will only form in a strong light.

When we dissolve baking soda ($NaHCO_3$) in water, carbonic acid (H_2CO_3) and sodium hydroxide (NaOH) are formed. The carbonic acid then breaks down into water and carbon dioxide gas, which is why dissolving baking soda in water causes it to fizz.

$$NaHCO_3 + H_2O \rightarrow H_2CO_3 + NaOH$$
$$H_2CO_3 \rightarrow H_2O + CO_2 \text{ (gas)}$$

Materials:

- Fresh spinach leaves
- Metal paper hole punch
- 2 plastic syringes 10 mL or larger without needle (at local pharmacy)
- Baking soda
- Liquid dish soap
- 5 canning jars 1 cup size (use cleaned jars from phloem experiment)
- Access to plenty of light (south facing window or grow light)
- Permanent Marker
- Hand lens
- Photosynthesis Datasheet on page 35




Directions:

- Measure 250 ml (1 cup) water, and dissolve 5 ml (1 teaspoon) dish soap in a canning jar.
- Measure 250 ml (1 cup) water, and mix in 15 ml (1 tablespoon) baking soda in a canning jar. Stir until baking soda is completely dissolved.
- Use the metal hole punch to cut out 20 circular disks from the fresh spinach leaves, 10 for a **control** and 10 for a **treatment**.
- Separate the two parts of the syringe, drop 10 of the spinach disks inside, reassemble the syringe.
- Push the plunger almost to the bottom but don't crush the disks.
- T**reatment**—label one canning jar "Treatment"
  - Draw up ~1 mL of detergent solution
  - Draw up ~3-5 mL of **baking soda solution**
  - Point the syringe upward, tapping the sides, so that any air bubbles rise, and gently squeeze the syringe until liquid begins to come out.

- Put a finger on the end of the syringe, and draw the plunger back slightly, creating a partial vacuum.
- Repeat until the leaf disks are suspended in the solution. This action forces the liquid into the interior of the leaf.
- Swirl the liquid to try to keep the disks from sticking to each other or the sides of the cups and then let them sit.
- Set the Treatment (with baking soda) in the jar labeled "Treatment".

- **Control**—label one canning jar "Control"
  - Draw up ~1 mL of detergent solution
  - Draw up ~3-5 mL of **water**
    Point the syringe upward, tapping the sides, so that any air bubbles rise, and gently squeeze the syringe until liquid begins to come out.
  - Put a finger on the end of the syringe, and draw the plunger back slightly, creating a partial vacuum.
  - Repeat until the leaf disks are suspended in the solution. This action forces the liquid into the interior of the leaf.
  - Swirl the liquid to try to keep the disks from sticking to each other or the sides of the cups and then let them sit.
  - Set the Treatment (with baking soda) in the jar labeled "Treatment".
- Set both your treatment and control in the window so that they receive the same amount of light. If you have a grow lamp, you can use that, but be sure that both the treatment and the control receive the same conditions.
- Monitor the disks every 60 seconds. Count how many disks are floating during each of the next 15 minutes.
- Examine with a hand lens.
- After all (or most) of the disks are floating, put the cups in the dark (a shoebox or a closet) and monitor for the next 15 minutes.
- Record how many disks remain floating after each minute until all (or most) of them have sunk.

Explanation:

- In the light, you should expect to see the disks in the control solution (water) stay on the bottom, but the disks in the treatment solution (baking soda) should begin to rise as they use the CO_2 to undergo photosynthesis and produce oxygen bubbles. The bubbles should cause the disks to float. After you remove the light and place the cups in the dark, the treatment disks should stop undergoing photosynthesis and the disks should begin to sink.

Some or all of the submerged disks should begin to float within about 15 minutes.

Questions:

1. Why don't the leaf disks soaking in the water (control) float?
2. What is the purpose of the baking soda solution?
3. What is the purpose of the light reaction?
4. Why do the leaf disks in the baking soda (treatment) begin to float?
5. Why do the leaves begin to sink again in the dark?
6. Why don't the leaves in the baking soda solution continue to produce oxygen in the dark?

"Those grow shade of the forest on the Western Slope, why are you looking here in the open of the eastern side of the Park?"

"Yeah," the visitor nodded, "we read that too, but the parking is much easier here."

- Camping in the Park, the mother assigned her teenage daughter, who, focused on her cell phone, declined to join the family hike, to make "gold soup" for dinner. Then the family hiked away, leaving the teen in camp. As afternoon cooled, the girl realized she had to make soup, but, well, she hadn't been listening carefully—she'd been trying to get cell phone reception to send a picture of the campsite to her friend.

"Gold soup, gold soup…"

She spotted a big patch of yellow flowers. "There's golden banner, that's what Mom must've meant."

Fortunately, her mother reappeared while she was still filling the pot.

"No! no! First, golden banner is poisonous. Second, this is a National Park and you can't gather plants. Third, don't you see, for the gold soup I set out those 24 carrots!"

CITATIONS

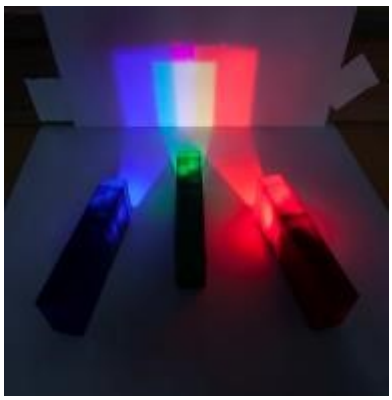
- Project Learning Tree: https://www.plt.org/
- By Edfrank01 - Created in Windows Paint, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=25430230; https://en.wikipedia.org/wiki/Tree_girth_measurement#/media/File:Tree_girth_measurement_diagram.tif
- https://www.wikihow.com/Measure-the-Height-of-a-Tree
- http://dnr.maryland.gov/forests/PublishingImages/diagram1.gif
- https://kdvr.com/2014/09/17/fall-color-guide-best-hidden-hikes-drives-and-events/
- https://benjaminblonder.org/wp-content/uploads/2014/11/aspen-colors.png?w=774
- https://www.nasa.gov/feature/goddard/2017/the-changing-colors-of-our-living-planet
- https://www.usanpn.org/partner/citizen-scientists
- http://parentingchaos.com/crawling-colors-color-mixing-science-experiment/
- http://complexwaves.com/physicsworkshops/labwriting/IPLWC6/PDF_StephanieRegina/Factors%20That%20Affect%20Resistance%20with%20Straws.pdf
- http://gleeson11biology.pbworks.com/f/1223354228/stomata.jpg
- https://plantbiologych9.files.

PHOTOSYNTHETIC PIGMENTS

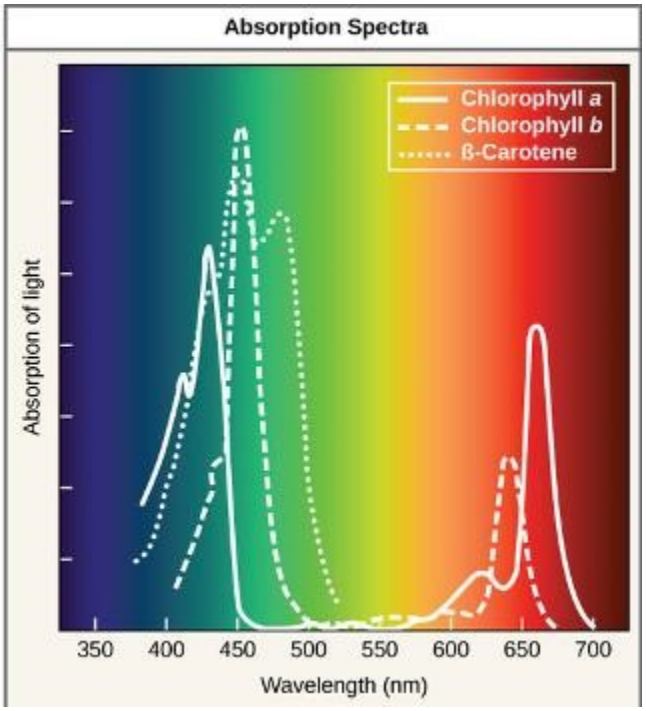
Photosynthesis is a two part metabolic process.

- The Light Dependent Reaction uses the energy in sunlight to push into a chemical called ATP, a packet of energy that is the perfect amount of energy needed by the cell to function properly. This happens in chlorophyll, the pigment that colors leaves green. Chlorophyll is found in the chloroplast.
- The Calvin Cycle takes ATP energy and builds a very simple sugar, sucrose, from carbon and water. This occurs in the chloroplast.

Chlorophyll has two forms, chlorophyll a and chlorophyll b. It is not the only pigment found in leaves. The other major pigment is **carotenoid** which is hidden by the chlorophyll during the summer. This pigment (xanthophyll is one type of carotenoid) is what autumn leaves turn after chlorophyll breaks-down as day light shortens in the fall. Sunlight is extremely powerful energy. We get sunburns if we stay out in the sun too long. That is because our epidermis (skin cells) gets blasted by this energy. It breaks even strong molecular bonds. Carotenoids help to absorb some of this energy, so that the chlorophylls can do their job.



One more thing before this activity (and totally cool information). Visible light is what we see in a rainbow once the wavelengths of light have been separated. Red, Orange, Yellow, Green, Glue, Indigo, Violet (ROY G. BIV) combined makes white light. You can try this out with 3 flashlights and three good quality gels in Red, Green (the primary color in light), and Blue.



Leaves are green because all of the red and blue wavelengths have been used for photosynthesis, but not the green! With carotenoid, it absorbs the blue-green through violet light, but not the red, orange, yellow. In the graph to the right, the high peaks are the colors that are removed. The low valleys are the colors that appear. Chlorophyll looks green because it does not absorb green. Carotenoid looks red through yellow-green because it does not absorb those colors. Xanthophyll absorbs most of the wavelengths except in the yellows. Chlorophyll b will be dark green, chlorophyll will be light green, xanthophyll will be yellow, and

carotenoid will be dark yellow in chromatography.
In this activity, you will extract leaf pigment on a filter paper (coffee filters work great) and use paper chromatography technique to separate the pigments to see both the chlorophyll and carotenoid pigments.

Materials

- Leaves from your Adopt a Tree
- Spinach (as your control)
- Scissors
- Mortar and pestle, food processor, or hammer
- 4 canning jars cup size (be sure to thoroughly clean)
- 90% or higher Isopropyl alcohol
- Pure nail polish remover (acetone)
- Flat coffee filter
- Tape
- Pencil
- Permanent Maker

Directions:

- Be sure your canning jars are clean. If you used them in prior experiments and labeled the jar, cross out those labels with the permanent marker.
- Labeling your 4 jars:
  - Tree—Isopropyl Alcohol
  - Tree—Acetone
  - Spinach—Isopropyl Alcohol
  - Spinach—Acetone
- Start with fresh leaves from your Adopt a Tree. Use the scissors to cut up those leaves to make a ½ cup of pieces.
- Use the food processor or mortar and pestle to grind the Adopt a Tree leaves into a fine pulp. If you don't have these available, you can use a hammer. Get a flat board, and pulverize the leaves with the hammer. Scrape the leaves (not splinters from the board), and use those.
- Divide the leaf pulp into two of your canning jars labeled with "Tree—…" *What color(s) do you see*?
- Clean your utensils.
- Use the scissors to cut up the spinach leaves to make a ½ cup of pieces.
- Use the food processor or mortar and pestle to grind the spinach leaves into a fine pulp. If you are using a hammer, turn the board over and use the other side to pulverize the leaves. Scrape the leaves (not splinters from the board), and use those.
- Divide the spinach leaf pulp into the two canning jars labeled "Spinach—…" *What color(s) do you see*?
- Pull the two jars labeled "…—Acetone." Pour enough acetone (fingernail polish remover) over the leaves to cover them in both the Tree jar and the Spinach jar. Be sure that they have equal amounts added to them. Stir.
- Pull the two jars labeled "…—Isopropyl Alcohol." Pour enough isopropyl alcohol over the leaves to cover them in both the Tree jar and the Spinach jar. Be sure that they have equal amounts added to

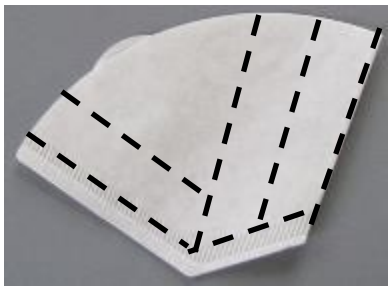
wordpress. com/2014/11/ astransp1.jpg

- http:// www.explorationeducation. com/activities/Force/ pressure.html
- https://www.fs.fed.us/ wildflowers/beauty/aspen/ grow.shtml
- https://omsi.edu/sites/all/FTP/ files/ expeditionnw/5.L.1.Piping.pdf
- http://www2.nau.edu/lrm22/ lessons/photosynthesis/ photosynthesis.html
- https:// education.seattlepi.com/ photosynthesis-experiments-kids-6302.html
- http://handmaps.org/maps/ hand_drawn_map_farm_map .jpg
- https://projects.ncsu.edu/ scilink/studysite/images/ directions/tree/shadmeas.gif
- https://www.thespruce.com/ the-difference-between-trees-and-shrubs-3269804
- https:// cdn.morningchores.com/wp-content/ uploads/2016/08/81b1Azarj 9L._SL1500_.jpg
- https://lima.osu.edu/ academics/departments/ biology/plant-anatomy/ leaves.html
- https://www.plt.org/educator-tips/diy-model-to-explain-inner-tree-parts
- http://complexwaves.com/ physicsworkshops/labwriting/ IPLWC6/PDF_Stephanie Regina/Factors%20That% 20Affect%20Resistance% 20with%20Straws.pdf

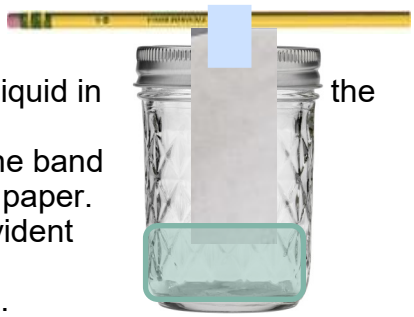
- Credit: George Retseck http://www.scientificamerican.com/article/a-really-long-straw/
- https://www.shutterstock.com/search/angles
- https://littlebinsforlittlehands.com/seed-jar-science-experiment-kids/
- http://media.collegeboard.com/digitalServices/pdf/ap/bio-manual/Bio_Lab5-Photosynthesis.pdf
- https://www.biologyjunction.com/LeafDisk.htm
- https://www.youtube.com/watch?v=XV9FOWIeErA
- http://www.berwicksclasses.org/AP%20Biology/Biology%20Assignments/AP%20BIOLOGY%20Lab%204.htm
- http://www.kabt.org/2008/09/29/video-on-sinking-disks-for-the-floating-leaf-disk-lab/
- http://laserclassroom.com/wp-content/uploads/2017/07/Light-Blox-Action1-e1502988692104.jpg
- https://www.uccs.edu/~dcorey2/ges2050/web/lab_6/Absorption%20of%20Light_files/figure-08-02-05abcd.jpe

them and to the Acetone jars. Stir.

- *Why can't you use water as solvent?*
- Cut out strips of coffee filter paper about 6 inches long and 1 inch wide. The diagram on the right shows how you can cut 6 strips from 1 filter (3 strips on the two layer filter). Cut off the crimped paper, and then cut your strips. You need four of them.

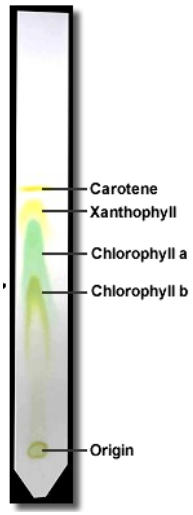


- Attach the strip to the pencil with a piece of tape. Make sure the bottom of the strip hangs straight.
- Adjust the length of the filter paper strip so that the bottom just touches the green liquid in the cup.
- Checking every couple minutes, wait for the band
- of solvent to migrate to the top of the filter paper. Different colored bands should become evident along the strip.
- Study your strip, and identify the pigments.



Observations and results

- Compare your results between the isopropyl alcohol and the acetone. Which worked better?
- Compare your results between your Adopt a Tree leaves and the spinach. What do you notice?
- Can you predict what color your adopt a tree leaves will turn as fall progresses?
- You might not see all the pigments. An orange-colored band is likely to be near the top. Below that, you should see a yellowish band, a blue-green band, and a greenish-yellowish band, respectively.
- When you ground up your leaves, the pulp was green because of the overwhelming amount of chlorophyll. The orange colored band, made of the pigment called carotenoid. It is the smallest molecule, so it traveled the farthest. The yellow xanthophyll (one of the carotenoid family of pigments) is the next smallest, followed by the blue-green chlorophyll A. The largest pigment is the yellow green chlorophyll B. What effect does the size of the molecule have on chromatography? Think of running an obstacle course. If you have to hold hands with another person, it will slow you down. If you have to hold hands with 5 other people, it will slow you down even more. Same with the molecules weaving though the paper. The smaller, the faster they can move.



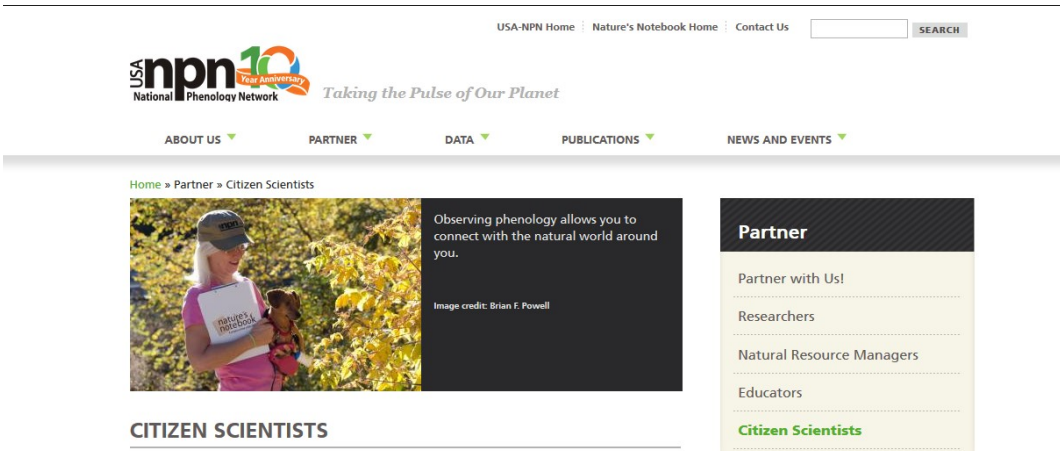
- Plants have more than one pigment to absorb different colors of light. They can use more of the light energy and protect themselves from the solar radiation. shining down them.

APPLY:
OUT AND ABOUT!

There are several TV stations in Colorado that provide information for getting out and about during the fall to enjoy amazing fall colors. The map below (FOX Denver) predicts the dates and locales of peak fall colors.

Channel 9's website, https://www.9news.com/article/weather/fall-colors/colorado-fall-colors-guide-where-and-when-to-see-the-best-fall-foliage/470062796, has a guide of great hikes, including Denver. Go on one of these hikes with your family and/or friends!

CHANGING FOLIAGE CITIZEN SCIENCE PROJECT

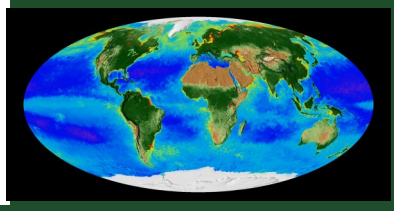


The National Phenology Network (website pictured above) has a wonderful citizen scientist program to help track plant and animal phenology, the study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.
To find out more about this program, click https://www.usanpn.org/partner/citizen-scientists. This page describes the project and how you can participate in collecting data for scientists. Best of all, it is the PERFECT excuse for getting outside all year long to enjoy our beautiful state!

- http://www.walterreeves.com/gardening-q-and-a/tree-leaves-calculating-the-number/
- https://www.precisiontreemn.com/tips/14-fun-facts-about-trees.html
- https://www.funfactsabout.net/plant-facts/
- http://forestrycareers.org/index.html
- https://www.ducksters.com/jokes/tree.php
- http://awanderingbotanist.com/plant-jokes/

NASA has an amazing website on the Changing Colors of our Living Planet! Check out: https://www.nasa.gov/feature/goddard/2017/the-changing-colors-of-our-living-planet

The website includes a short YouTube video on humans entering space to see our world as a planet and a new NASA visualization that shows 20 years of continuous observations of plant life on land and at the ocean's surface, from September 1997 to September 2017. On land, vegetation appears on a scale from brown (low vegetation) to dark green (lots of vegetation); at the ocean surface, phytoplankton are indicated on a scale from purple (low) to yellow (high).



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ADOPT A TREE—YOUR DATA ANALYSIS

At the very beginning of this activity, you started by adopting your tree and collecting data. You can analyze your data to learn more about your tree. The analysis in this activity is very simplified, just to give you a taste of a forester's work. If you want to be more accurate in your analysis, check out the websites listed in the citation under Adopt a Tree Analysis.

Materials:

- Completed Adopt a Tree Datasheets 1-3
- Adopt a Tree—Your Data Analysis on page 36-37
- Calculator
- Pencil
- Computer with internet access
- Camera

Directions:

Plan on visiting your tree once a month and take a picture of it. Take the picture at the same spot each time. After 12 months, you will have an amazing set of pictures! Check out the 4-H photography project!

How tall is your tree?

- You measured your tree's shadow, your shadow, and your height. To find out your tree's height, we use a ratio equation. This is a very simple and powerful equation that can help you find the height of your tree, alter a recipe if you only have 1 2/3 cup of flour when the recipe calls for 2 cups, adjust a dress pattern to a different size, and so many more applications. To find the height of your tree, put your numbers into the correct space (note color coding on the Datasheet and the Data Analysis). How tall is your tree?

How heavy is your tree?

- You measured the girth of your tree, which is the circumference © at 4.5 high. Knowing the circumference, you can calculate the **radius** (r). $C = 2\pi r$; rearrange the formula, and you have $r = C/2\pi$. That together with the height of your tree will give you the estimated volume of your tree. Go to: https://www.timberpolis.co.uk/calc-timber-weight.php#goToPage, insert the information, and voila! Estimated Weight.

How many leaves on your tree?

- How many leaves—can we even count that high? It isn't an infinite number of leaves, even if it seems that way when you have to rake your front yard in the fall! To determine the number of leaves, we need to estimate the volume of leaves in the crown. We find the area of the crown spread and times it by 4. This is a convenient way botanists estimate the volume of leaves. To find the number of leaves, you need to times the volume by the number of leaves that fit on 1 meter square. To make your data collection a bit easier, you counted the number of leaves on a piece of 8½ x 11" paper. We can extrapolate (make a good guess) the number of leaves in a square meter by using some basic math. To simplify, you need to multiply your leaves on a piece of paper by 42 to estimate how many would fit on 1 meter square area.

ADOPT A TREE DATASHEET—1

What is the species of your tree? _____

Draw a map of where your tree is located:

Sketch your tree

Take a picture, print and attach it

ADOPT A TREE DATASHEET—2

Bark Rubbing:

Sketch a Leaf:

Leaf Rubbing:

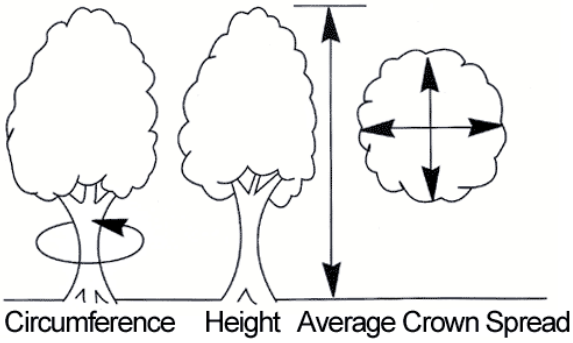
ADOPT A TREE DATASHEET—3

Collect measurements to calculate for later

Units:

Are you measuring in Metric (centimeters) or Imperial (inches)? _____

It is imperative that you are consistent in your measurements. If you start in metric, continue in metric. If you start in Imperial, continue in imperial. Be sure to label each measurement cm or inches (”) to confirm the measurement is the same. Measure in centimeters or inches, rather than meters or feet. You can convert all your numbers later, but it is easier to measure in the same unit.



Girth of your tree:

How big around (circumference) is your tree trunk 4.5 feet above the ground : _____

Height of your tree measurements:

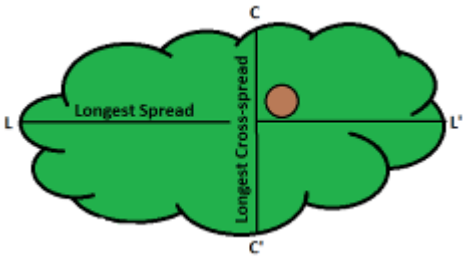
How long is the tree shadow: _____

How tall are you (keep on your shoes): _____

How long is your shadow: _____

Crown spread measurements:

To estimate the crown spread, measure in a straight line along the longest spread, and a straight line across the longest cross-spread. Stand directly under the leaf furthest from the trunk and measure a straight line to the far side of the tree until you are standing directly under the leaf furthest from the trunk on that side.



Longest spread length : _____

Longest cross-spread length: _____

Average leaf measurement:

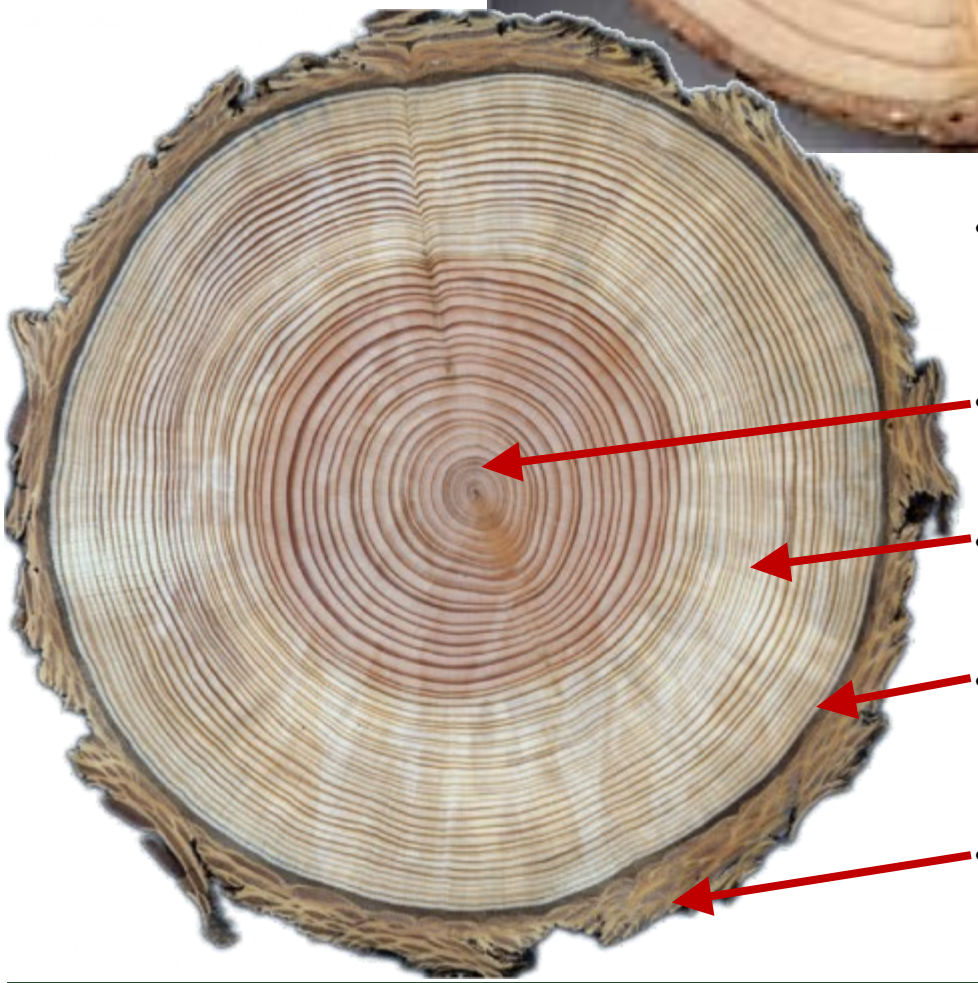
Collect leaves from your tree. If the leaves are beginning to change color from green to yellow, orange, red, and brown, collect a variety of colors. Place leaves on this piece of paper like a jigsaw puzzle. Try to completely cover the page without overlapping leaves. You can tear a leave into bits to fill in the blanks, but be sure to count each leaf and not the bits. Bring the leaves back home.

How many leaves covered this piece of paper: _____

Tree Anatomy

- The age of the tree is one light plus dark ring. (The red arrow points to an encased knot—where a branch started to grow.)
- How old is the tree pictured to the right? Each light ring is rapid growth (spring and summer) and each dark ring is slow growth (fall and winter).
- Number the oldest growth with 1, and continue to number, with the total age on the youngest growth.
- What plant organ (stem, leaf root, or reproductive structure) is the trunk of a tree?

Answers on page 6.



- Narrow rings indicate years of drought. Wide rings represent plenty of sun and rain. Label years of high growth and years of drought.
- The dark wood is called heartwood. Cells are dead and only provide support. The center is the pith.
- The lighter area is called sapwood and contains xylem, cells active in water transpiration.
- The dark line is called cambium. Xylem cells divide on the inside, and phloem cells divide on the outside of this line adding tree girth.
- Phloem cells carry sugars made in photosynthesis to the roots. Bark protects these cells.

TRANSPIRATION DATASHEET

Activity 1—How far did the ball move (record your results in centimeters, or convert inches to cm)

- Straw length (all equal) _____" x 2.54 = _____ cm
- Coffee stirrer straw _____" x 2.54 = _____ cm
- Drinking straw _____" x 2.54 = _____ cm
- Shake straw _____" x 2.54 = _____ cm

Activity 2—How far did the ball move (record your results in centimeters, or convert inches to cm)

Short straws

- Length short coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm
- Length short coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm
- Length short coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm

Long straws

- Length long coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm
- Length long coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm
- Length long coffee stirrer straw _____" x 2.54 = _____ cm
  - Ball distance _____" x 2.54 = _____ cm

Activity 3—How far did the ball move (record your results in centimeters, or convert inches to cm)

- One Coffee Stirrer Straw _____" x 2.54 = _____ cm
- Two Coffee Stirrer Straws _____" x 2.54 = _____ cm
- Three Coffee Stirrer Straws _____" x 2.54 = _____ cm
- One Drinking Straw _____" x 2.54 = _____ cm
- Two Drinking Straws _____" x 2.54 = _____ cm
- Three Drinking Straws _____" x 2.54 = _____ cm
- One Shake Straw _____" x 2.54 = _____ cm
- Two Shake Straws _____" x 2.54 = _____ cm
- Three Shake Straws _____" x 2.54 = _____ cm

Activity 4—What did you observe?

Activity 5—How many straws?

- How many straws at 90° when you could no longer sip the water _____
- How many straws at 45° when you could no longer sip the water _____
- How many straws at horizontal when you could no longer sip the water _____

ROOTS DATASHEET

If your scale only weighs in ounces: convert ounces to grams (g), multiply your ounces times 28.35.

Seed Type ______________________ Date Planted ______________________
Date Examined ____________________ How many seeds germinated __________
Mass of leaves and stems ____________ g Mass of roots ____________________ g
After drying in the oven:
Dry mass of leaves and stems _________ g Dry mass of roots _________________ g

Seed Type ______________________ Date Planted ______________________
Date Examined ____________________ How many seeds germinated __________
Mass of leaves and stems ____________ g Mass of roots ____________________ g
After drying in the oven:
Dry mass of leaves and stems _________ g Dry mass of roots _________________ g

Seed Type ______________________ Date Planted ______________________
Date Examined ____________________ How many seeds germinated __________
Mass of leaves and stems ____________ g Mass of roots ____________________ g
After drying in the oven:
Dry mass of leaves and stems _________ g Dry mass of roots _________________ g

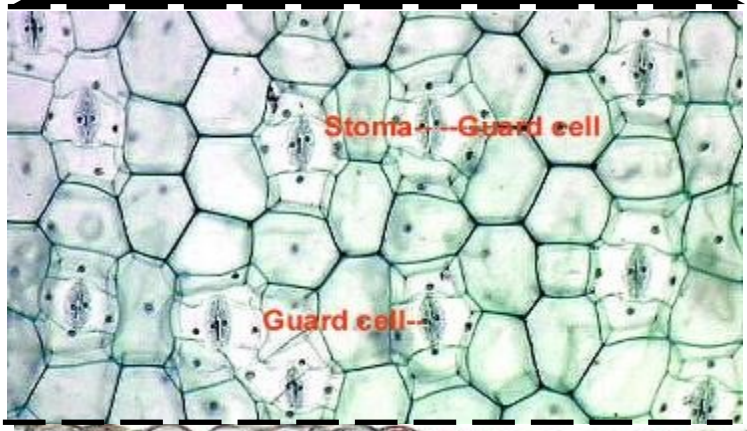
Seed Type ______________________ Date Planted ______________________
Date Examined ____________________ How many seeds germinated __________
Mass of leaves and stems ____________ g Mass of roots ____________________ g
After drying in the oven:
Dry mass of leaves and stems _________ g Dry mass of roots _________________ g

Analysis:
Add all 4 plants together:
Total dry mass of leaves and stems:______ g Total dry mass of roots ______________ g

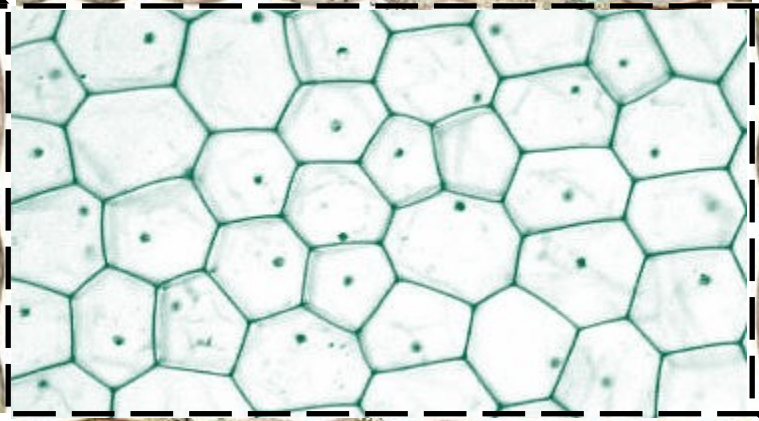
What is the proportion of the plant that is root? ______________________________
What is the proportion of the plant that are stems and leaves? ______________________

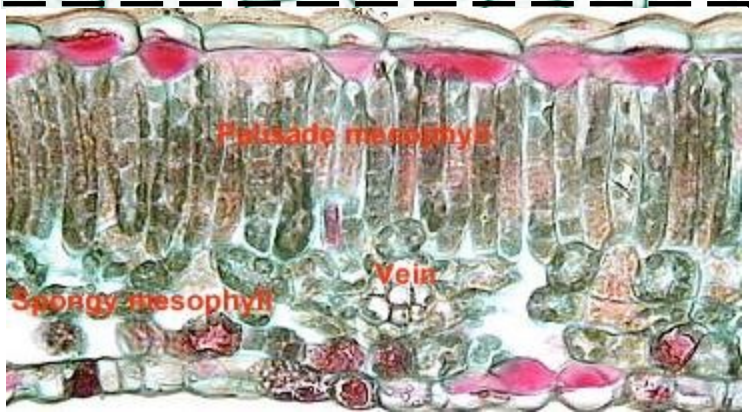
LEAF ANATOMY

The bottom of the leaf is covered by a waxy cuticle to prevent water evaporation. It contains stomata (holes in the leaf) to allow for CO_2 to enter for photosynthesis, and water vapor to leave through transpiration. The guard cells control if the stomata are open or closed. If dry, they close to prevent water loss.



The side of the leaf contains palisades (elongated) cells packed with chloroplasts, the organelles of photosynthesis. The bottom of the leave has spongy cells, loosely packed to allow room for water vapor and CO_2 molecules. Note veins, made from xylem (water) and phloem (sugars) to be transported through the tree.





The top of the leaf rarely has stomata or guard cells. Instead, it is covered with a very thick, waxy cuticle to prevent water evaporation.

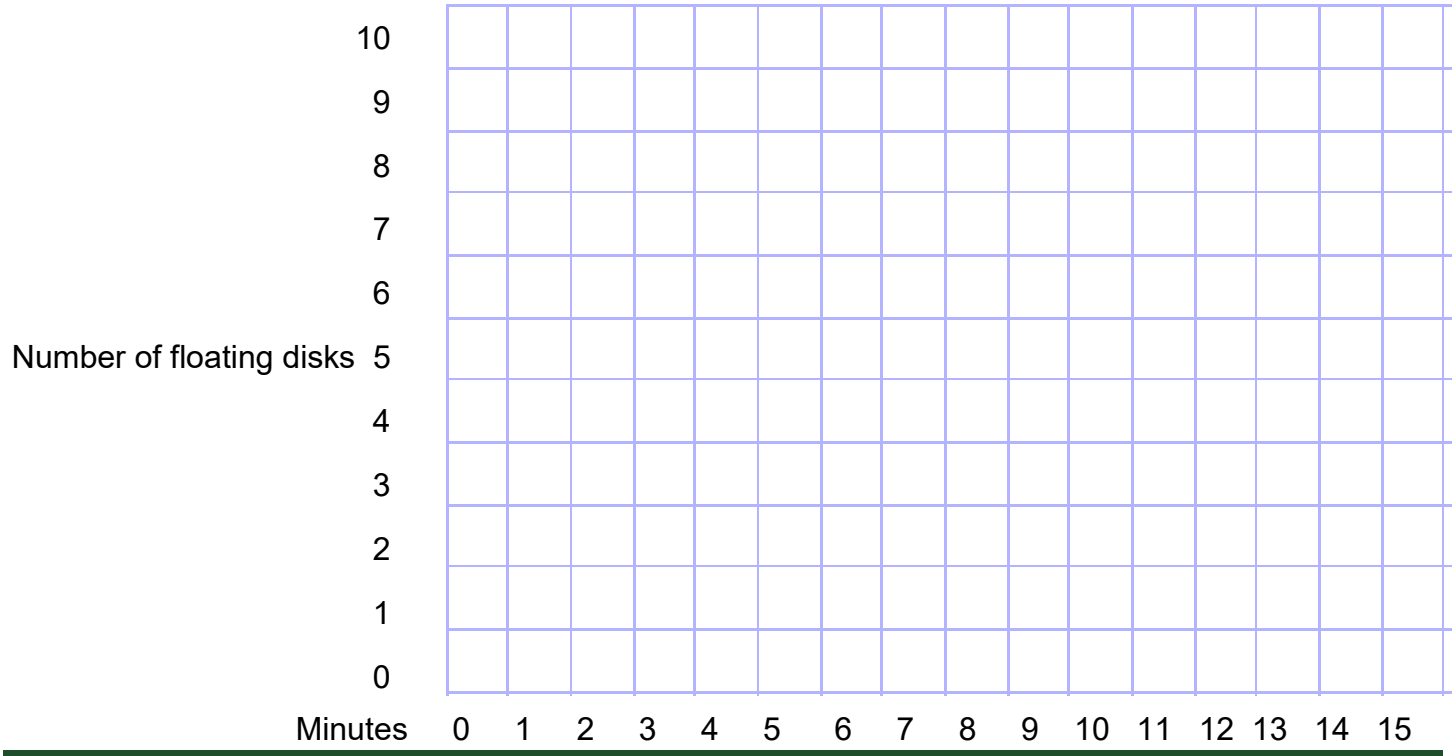
Directions:

- Cut outer edges.
- Fold on the black dashed lines.
- Tape or glue the tabs inside to form a rectangular prism.

PHOTOSYNTHESIS DATASHEET

Record how many disks float each minute, then graph your results.

Minutes	Treatment	Control
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		



ADOPT A TREE—YOUR DATA ANALYSIS

Did you measure in inches or centimeters?
Be sure to use the same units throughout these calculations.

Height of your tree (note the color coding):

How long is the tree shadow: _____

How tall are you (keep on your shoes): _____

How long is your shadow: _____

$$\text{Tree height (X)} = \frac{\text{Your height} \times \text{Tree shadow length}}{\text{Your shadow's length}}$$

Read as: tree height = your height times the tree shadow length divided by your shadow length.

X = _____ x _____ / _____

X = _____ / _____

Note: "/" symbol means "divide by" (10/5 reads 10 divide by 5).

If you measured in inches:
X = _____" x 2.54 = (to find centimeters) = _____ cm

X = _____cm / 10 (to find meters) = _____ meters

Mass of your tree (note the color coding): (Note: 2π (2 x 3.14 = 6.28; read 2 times pi)

What is the girth of your tree? _____ / 6.28 = r (radius) _____

X = _____" / 12 (to find the feet) = _____ feet
or
X = _____cm / 10 (to find meters) = _____ meters

What is the height (h) of your tree (feet or meters)? _____

Volume = π x r^2 x h (read pi time radius squared times height. (π = 3.14 and r^2 is r x r)

V = 3.14 x _____ x _____ x _____

V = _____ What is the species of your tree? _____

Go to this website: https://www.timberpolis.co.uk/calc-timber-weight.php#goToPage.
Enter your volume (V) and the tree species. Use 100% moisture for a living tree, and the site will calculate the mass of your tree.

Record the mass here in kg: _____

ADOPT A TREE—YOUR DATA ANALYSIS

Mass of your tree continued (note the color coding):

What is the mass of your tree from the website calculations (trunk and branches)? _____kg

That does not account for the roots or the leaves. To estimate the mass of the roots, a general rule of thumb is that however big the tree is above ground, it needs that mass in roots to anchor it!

Mass of trunk, branches, and roots = _____ kg x 2 = _____

How Many Leaves?:

We can next estimate the number of leaves on your tree. For this, we need the crown spread measurement and the average leaf count on a piece of paper.

Longest spread length : _____ / 2 = radius r_1 _____

Longest cross-spread length: _____ / 2 = radius r_2 _____

To find the area of your tree foliage, we need to first find the area of an oval. The formula is

$A_{\bigcirc} = \pi \times r_1 \times r_2$

Plug your numbers: $A_{\bigcirc}$ = 3.14 x _____ x _____ = _____

Notice your answer is in square units—either inches or centimeters squared. Convert to metric:

If you measured in inches:

X = _____ $''^2$ x 2.54 = (to find centimeters) = _____ cm^2

X = _____ cm^2 / 10 (to find meters) = _____ $meters^2$

Estimate the volume of the crown (rule of thumb) = 4 x _____ $meters^2$

Volume of crown = _____ $meters^2$ (read that as square meters) leaf area of tree

To determine how many leaves, we need to convert your number of leaves per a page of paper 8½ x 11" to number of leave per $meter^2$. The conversion factor of 42 has been made for you.

Number of leaves times square meters on a piece of paper = number of leaves per square meter.

Number of leaves per square meter = Number of Leaves covering paper _____ x 42.

Number of leaves per square meter = _____ x volume of crown

Number of leaves = _____