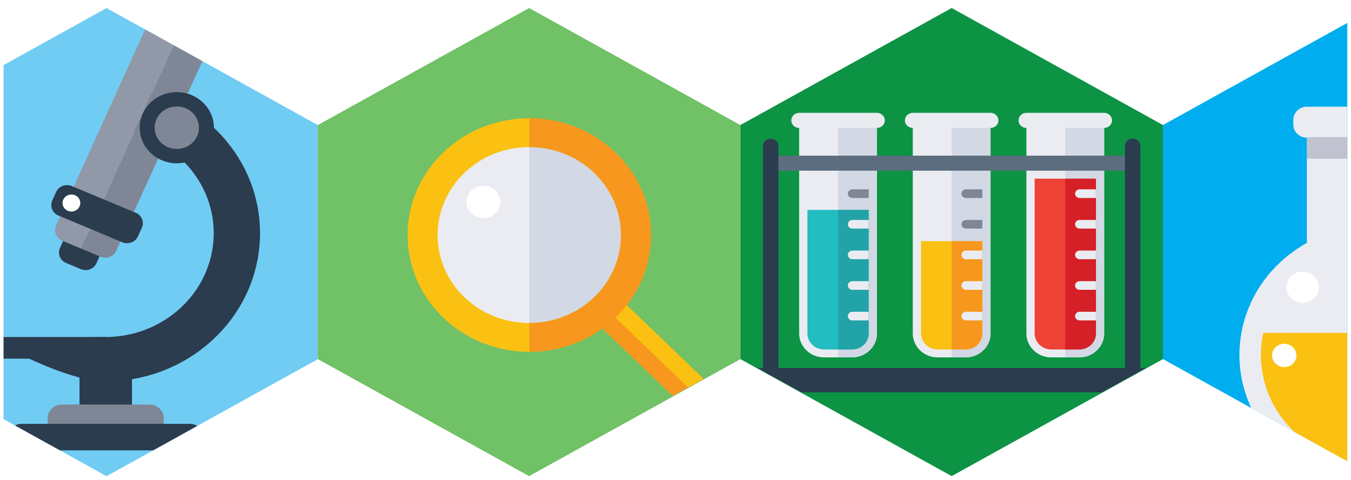
CANADA
4-H Ontario

www.4-hontario.ca

4-H ONTARIO PROJECT



4-H Adventures in STEM

REFERENCE MANUAL

The 4-H Pledge
I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service,
my Health to better living,
for my club, my community and my country.

The 4-H Motto
Learn To Do By Doing

CANADA
4-H Ontario

4-H Ontario Provincial Office
111 Main Street, Box 212
Rockwood, ON N0B 2K0
TF: 1.877.410.6748
TEL: 519.856.0992
FAX: 519.856.0515
EMAIL: inquiries@4-hontario.ca
WEB: www.4-HOntario.ca

Project Resource Information:
Written by: Teresa Ierullo
Edited by: Elizabeth Johnston and Marianne Fallis, 4-H Ontario
Layout by: Mary-Kathleen Dunn
Date: March, 2017

Thank you to the 4-H Adventures in STEM! Advisory Committee members who assisted with the creation of this resource:

Jennifer Pollock, Wellington 4-H Association
Melina Found, Science Coordinator, 4-H Canada
Carole Mutton, Parry Sound 4-H Association
Barb Scott-Cole, Renfrew 4-H Association

Thank you to those who piloted and/or reviewed the project.

Club Leaders - Paulette & Wayne Macdonald; Club Members - Hannah Ethier, Jena Ethier, Meaghan Ethier, Gabriel Glover, Amy Onolack, Austin Pavan, Avery Perigo, Hunter Perigo, Kaitlyn St. George; Sudbury 4-H Association
Jeff McCallum, Elgin 4-H Association

The development of this project resource was made possible through the support of Cargill.

Contents

INTRODUCTION

Welcome to 4-H Ontario's 'Adventures in STEM Project!'

What is STEM? It stands for Science, Technology, Engineering and Math.

Problem solving is at the heart of this Adventures in STEM project, energizing your curiosity and giving you a chance to be an investigator of challenges, problems and things that make you go "hmmm!" In this project, you will have opportunities to be innovative and creative trouble-shooters; figuring out how things work (and to fix them when they don't)! All of the activities are hands-on learning; in an environment that is supportive and encourages you to make it, break it, and fix it! You will work on a variety of interesting science, technology and engineering experiments while using math skills for each one; you will learn how important it is to accurately measure and calculate everything!

And you never know; at the end of this Adventures in STEM project, you might see yourself in one of the many careers in science, technology, engineering or math!

Have fun!

What is STEM and why is it important?

Objectives

1. Conduct fun and interesting experiments.
2. Gain a deeper understanding of how science, technology, engineering and math work in the real world.
3. Learn about STEM occupations.
4. To learn about the elements of judging and public speaking.
5. Learn the proper use of parliamentary procedure.
6. Have fun through "Learn To Do By Doing" experiences!

How to Use This Manual

4-H Ontario's Adventures in STEM project is made up of 2 parts:

- The Reference Book:

The reference book is laid out into 6 meetings:

Meeting 1 – One Smart Cookie: Food Science

Meeting 2 – Monkey See, Monkey Do: Animal Science

Meeting 3 – Green Fingers: Plant Science

Meeting 4 – Wacky Weather Experiments

Meeting 5 – Gadgets & Widgets: Technology

Meeting 6 – Are you Canada's Next Top Inventor?

Each meeting has been broken down into an Introduction with Sample Meeting agendas, References and Resources, Topic Information and Activities.

Sample Meeting Agendas: are at the beginning of each meeting. The agendas give suggestions for topic information, activities, recipes and judging and/or communications activities along with suggested times for each section. These are only suggestions – you will know your group best and will know the skill and attention level of your members. There is more topic information and activities than what can be completed in a two hour meeting. Be creative!

Activities: should be used in combination with the discussion of topic information to teach members in a hands-on, interactive learning environment.

- The Record Book

This booklet is designed to make it easier for members to record information throughout the club. Members are to record their expectations and goals for the project in addition to contact information, meeting dates, roll calls and records of experiments at the meetings and at home. Print or photocopy pages from the Reference Book that you think will benefit the members either as a resource or an activity.

The Record Book should be given to each member at the beginning of the first meeting. Ask members to keep it in a binder or duotang so they can add to it easily.

Go through the Record Book with the members and explain the charts and forms. Encourage them to use their Record Books at every meeting and record as much information as possible. As an added incentive, a prize could be given at the end of the project for the best Record Book.

Planning a Meeting

Plan your meetings well. Review all the information well in advance so you are prepared and ready to cook up a storm!

Before Each Meeting:

- Read the topic information and activities and photocopy any relevant resources for the members' Record Books.
- Be familiar with the topic information for each meeting. Think of imaginative ways to present the information to the members. Do not rely on just reading the information out loud. Review available resources, plan the meetings and choose activities and themes that complement the ages and interests of your members.
- Gather any equipment, ingredients and/or resources that will be needed to complete the meeting.
- At least 12 hours of club meeting time is required for every project; including club business, specific project information and social recreation. The delivery format for that material is left to the discretion of the leaders. Before each meeting, create a timeline to ensure that you are providing an adequate amount of instructional time for club completion. **Note:** the best practice recommendation is that a club have multiple meeting times for each project.

Included on the following page is a Leader's Planning Chart to help with the planning of meetings. In addition to the chart, keep track of what went well and what should be changed next time. That way, each time this project is run, the content of the meetings can be different!

When planning each meeting, a typical 4-H meeting agenda should include the following:

- Welcome & Call to Order
- 4-H Pledge
- Roll Call
- Parliamentary Procedure:
- Secretary's Report
- Treasurer's Report (if any)
- Press Report
- New Business: local and provincial 4-H activities/opportunities, upcoming club activities
- Meeting content, activities and recipes
- Clean-up
- Social Recreation and/or refreshments
- Adjournment

Judging and Communications

Each meeting must include either a judging or public speaking activity.

- Judging gives the members an opportunity to use judging techniques as part of the learning process. Through judging, members learn to evaluate, make decisions and communicate with others. They also develop critical thinking skills, confidence and self-esteem. Many examples are used in this reference book but use your imagination! As long as members are setting criteria and critically thinking about where items fit within that set of criteria, they are learning the basic skills of judging!
- A communications activity has been provided for each meeting but can be included in the Roll Call or social recreation time. These activities do not need to involve the topic of milk as the outcome is more about understanding the concepts of effective communication.

Leader's Planning Chart

Meeting #	Date/Place/ Time	Topics Covered	Activities	Materials Needed

As a club volunteer your responsibilities are to:

- Complete the volunteer screening process and to attend a volunteer training session.
- Notify the local Association of the club, arrange a meeting schedule and participate in club meetings, activities and the Achievement program.
- Review the project material in the Reference, Record and Recipe books to familiarize yourself with the information and adapt it to fit your group. Be well organized and teach the material based on your group's age, interest and experience level.
- Organize the club so members gain parliamentary procedure, judging and communication skills.
- Have membership lists completed and submitted along with fee collected (if applicable) by the end of the second meeting.
- Have members fill out a Participant Agreement Form and identify any health concerns. Ensure that all members, leaders and parent helpers know the appropriate actions during any emergency. Check with members for any food allergies or dietary restrictions and plan snacks accordingly.

As a club member your responsibilities are to:

- Participate in at least 2/3 of his/her own club meeting time. Clubs must have a minimum of 12 hours of meeting time.
- Complete the project requirement to the satisfaction of the club leaders.
- Take part in the project Achievement Program.
- Fill in and complete the Record Book.

Achievement Program Ideas/Suggestions

- Hold a science competition night and invite family members to participate.
- Do a demonstration of one experiment at school or a community event.
- Create a poster promoting STEM careers and display it in the community.
- Create a video promoting STEM careers and present at a community event.
- Make a presentation at school or community event about careers in STEM.
- Create a display about STEM career choices and display it at a local fair, school or community event.
- Write a press release about the benefits of a STEM career.
- In a team, work on developing a product to create a winning new trail mix. Each team member will specialize in a certain area such as marketing, food chemistry, graphic design, and cost. Try to feature Ontario grown crops in your recipes. Present your products to family members. (Ask about any allergies first!)
- Create a skit about life as a scientist/engineer/veterinarian/computer scientist, etc.

Perform it live or videotape it.

- Design and create your own invention. Have family test it.
- Make a presentation about famous Canadian inventors/inventions.
- Create a promotion to encourage girls to consider a STEM career.
- Participate in a Lego Robotics or similar competition.

Special Projects (could be used for Senior Projects)

These projects are done outside of meeting time and are for members interested in doing more – often senior members. It's up to you as the leader to decide if you will require members to complete a Special Project for club completion. Some ideas include:

- Change the variables of one of the experiments listed in this project and see if it alters the results.
- Videotape yourself doing a weather report.
- Make a seed museum, collecting different types of seeds from fruits and vegetables.
- Determine why some fruits and vegetables float while others sink in water.
- Determine what happens when you mix coca cola with milk and why.
- Compare a dog's sense of smell with that of humans.
- Design and create your own experiment.
- Create a video about one of the experiments in this project and post on YouTube.
- Interview someone working in the STEM field. Write an article or videotape it or create a podcast.

Senior Activity Ideas (Optional)

Some of these projects can be done as an individual, in pairs or small groups.

- Change the variables of one of the experiments listed in this project and see if it changes the results.
- Create a biosphere using a clear, plastic container.
- Make a hydroponic garden.
- Determine how well seeds grow under different environmental influences.
- Determine how long can different plants survive without sunlight and water.
- Find out what happens when you cross-pollinate—or remove pollen from one type of flower and put it onto another type.
- Test if people can tell the difference between a soy-based and an animal-based food product.

- Research how to find a lost dog and build an application or a website that will help in this effort.
- Research online how to make a simple robot. Design and create one.
- Design your own video game using free, online sources.
- Find a simple household problem. Design and create your own experiment to solve the problem.

Tour Ideas

- Visit a science centre, college/university research lab, livestock farm, greenhouse, weather station or any other science related centre.
- Attend a Lego Robotics competition.
- Have guest speakers attend meetings to supplement the material in the Reference Manual. Speakers could include an animal or human nutritionist, veterinarian, doctor, nurse, researcher, college or university student or professor, meteorologist, agronomist, engineer, architect or any other science related profession.
- Additional suggestions can be found with each meeting.

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service
my Health to better living
for my club, my community and my country.

CANADA
4-H Ontario

Additional References and Resources

4-H Canada https://www.4-h-canada.ca/

A Dash of Science http://adashofscience.com

About Science http://www.aboutbioscience.org/topics

Agriculture & Agri-Food Canada http://www.agr.gc.ca

Agscape (Ontario Agri-Food Education) www.agscape.ca

Alberta Government Occupations and Educational Programs http://occinfo.alis.alberta.ca

Animal Nutrition Association of Canada http://www.anacan.org

Animal Smart http://animalsmart.org/animal-science

Brigham Young University – College of Life Sciences http://ndfs.byu.edu

Canadian Society of Animal Science https://www.asas.org/CSAS

Canadian Council on Animal Care in Science http://www.ccac.ca

Canadian Food Inspection Agency http://www.inspection.gc.ca

Canadian Intellectual Property Office (Patent Office) http://www.ic.gc.ca/opic-cipo/cpd/eng/introduction.html

Canadian Inventions http://www.careerchem.com/NAMED/Canadian-Inventions.html

Canadian Space Agency http://www.asc-csa.gc.ca

Canadian Textile Industry Association http://www.canadiantextiles.ca/industry

Careers in Food http://www.careersinfood.com

Climate Kids – NASA's Eyes on Earth http://climatekids.nasa.gov

Education.com http://www.education.com

Environment and Climate Change Canada https://ec.gc.ca

Exploratorium https://www.exploratorium.edu

Food Chemistry http://foodchemistry101.weebly.com

Home Science Tools http://www.hometrainingtools.com

How Stuff Works – Science http://science.howstuffworks.com

Kid's Science Challenge http://www.kidsciencechallenge.com

Layers of Learning http://www.layers-of-learning.com

Let's Talk Science http://www.letstalkscience.ca

Maple Leaf Foods http://www.mapleleaffoods.com

McGill University Career Planning Services http://www.mcgill.ca/caps/files/caps/career_animalscience.pdf

Michigan 4-H Youth Development – 4-H Animal Science Anywhere http://msue.anr.msu.edu/uploads/236/65684/4H1659_ASA-DigestiveSystem_2016.pdf

Mother Nature Network http://www.mnn.com

National Agriculture in the Classroom http://www.agclassroom.org

National Geographic Kids http://kids.nationalgeographic.com

National Oceanic and Atmospheric Administration http://www.noaa.gov

Nuffield Foundation http://www.nuffieldfoundation.org

Office of Response and Restoration http://response.restoration.noaa.gov

Ontario Association of Certified Engineering Technicians & Technologists https://www.oacett.org

Ontario Ministry of Agriculture, Food & Rural Affairs www.omafra.gov.on.ca

Ontario Veterinary Medical Association https://www.ovma.org

PBS Kids http://pbskids.org

Practical Action http://practicalaction.org

Purdue 4-H Science Kit https://extension.purdue.edu/4h/Documents/Volunteer%20Resources/Livestock%20Volunteers/Animal%20Science.pdf

Robotics http://www.galileo.org/robotics/intro.html

Science Buddies http://www.sciencebuddies.org

Science Boffins http://www.scienceboffins.co.uk

Science Fair Adventure http://www.sciencefairadventure.com

Scientific American https://www.scientificamerican.com

Society for Canadian Women in Science and Technology http://www.scwist.ca/weblinks/women-in-science-and-technology/

Solar Cookers International http://www.solarcookers.org

Service Canada http://www.servicecanada.gc.ca

Stem Curriculum Resources http://stem.wesfryer.com

Stem Jobs http://www.stemjobs.com

Stem Works http://stem-works.com

Steve Spangler Science https://www.stevespanglerscience.com/

Teach Engineering https://www.teachengineering.org

University of Guelph www.uoguelph.ca

University of Toronto https://www.utm.utoronto.ca

Web Weather for Kids http://eo.ucar.edu/webweather

MEETING 1 - ONE SMART COOKIE: FOOD SCIENCE

Objectives:

- Introduce members to the Adventures in STEM project.
- Familiarize members with the 4-H club process (pledge, parliamentary procedures).
- Introduce members to the process of public speaking and judging.
- Introduce members to proper procedures used in experiments.
- Learn about food science, the industry, and careers.

Roll Calls:

- Why did you decide to participate in the Adventures in STEM project?
- Which part of STEM (science-technology-engineering-math) is your favourite and why?

Sample Meeting Agenda – 2 hrs. 5 minutes plus activities

Welcome, Call to Order & Pledge		5 min
Introduction	Get to know each other/Introductions – Activity #1 (found at the end of this meeting)	15 min
Roll Call		5 min
Parliamentary Procedure	Elect executive, hand out Record Books and discuss club requirements. Fill out club and member information in Record Books, and have each member fill out their "Member Expectations and Goals" page.	20 min
Outline of Club Project	Discuss: what you plan to cover at meetings and expectation of club members for club completion: meeting attendance, judging event, achievement event, setting up of future meeting dates, etc.	15 min
Topic Information Discussion/Activities	Topic Information ▪ Food science & technology ▪ Is a food scientist a chef? ▪ Will work for food: Cool jobs in food science ▪ Activities ▪ Pre-activity #1 – Practice Documenting your Experiments ▪ Pre-activity #2 – Drops on a Penny ▪ Activity #2 - Colour changing milk ▪ Activity #3 - When life gives you a lemon, make a battery! ▪ Activity #4 - Sun s'mores ▪ Activity #5 - Bake a chemistry cake ▪ Activity #6 - Why do chefs add salt when boiling vegetables? ▪ Activity #7 - STEM CHALLENGE: The squashed tomato	30 min + Activities

Public Speaking/ Judging Activity	Introduce members to judging: see the 4-H Ontario Judging Toolkit: Activity #8 - Public Speaking Activity or Judging Activity	20 min
At Home Activity	Choose one *At Home* activity to complete.	5 min
Wrap up, Adjournment & Social Time!		10 min

Electing Your Executive

Elections can be chaired by a youth leader, senior member or club leader. The person chairing the elections is not eligible for any positions.

Procedure:

1. All positions are declared vacant by the chairperson, who indicates this by saying "I'd like to declare all positions vacant."
2. The group decides on the method of voting (i.e. show of hands, ballot or standing).
3. The chairperson accepts nomination from members for each position being filled. Nominations do not require a seconder. Nominations are closed by motion or declaration by the chairperson.
4. Each member nominated is asked if he/she will stand for the position. Names of members who decline are crossed off.
5. Voting takes place by selected method and majority rules (i.e. member with most votes).
6. Announce the name of the successful member. Offer congratulations and thank all others that ran for the position.
7. If ballots are used, a motion to destroy the ballots is required and voted on.

Steps in Making a Motion

The motion is a very important key to having good meetings. Motions are a way of introducing topics for discussion and allowing each member to speak and vote. Any member can make a motion.

Steps in Making a Motion:

1. Address the chairperson (i.e. raise your hand).
2. Wait for the chairperson to acknowledge you.
3. Make the motion: "I move that…"
4. Another person seconds the motion: "I second the motion."
5. Chairperson states the motion.
6. Chairperson calls for discussion of the motion.
7. Chairperson restates the motion.
8. Chairperson calls the vote: "All in favour? Opposed?"
9. Chairperson announces the result of the vote: "Motion carried" or "Motion defeated."

Topic Information - Food Science & Technology

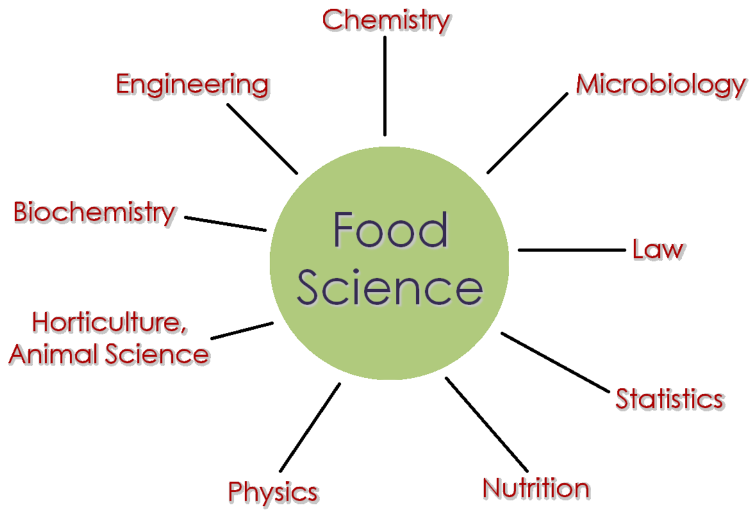


Image Credit: Brigham Young University College of Life Sciences
http://ndfs.byu.edu/programs/undergraduateprograms/food-science/whatisfoodscience.aspx

We all know that farmers are the ones who grow and harvest fruit, but how do we get fruit bars? From food scientists! With fewer farmers, it's getting harder to feed the world's population, so food must be properly preserved and packaged to eat at a later date. We're now in a time of scientific agriculture where chemistry, biology, and engineering have a part to play in food production. There is a demand for scientists, engineers and technical experts who will work in labs, not farms, continuing to create the food we love to eat.

Significance of Food & Beverage Industry in Canada

Food and beverage processing is the second largest manufacturing industry in Canada.

- It supplies approximately 75% of all processed food and beverage products available in Canada and is the largest buyer of agricultural production.
- The food processing industry is the largest manufacturing industry in most provinces.

Food Science

Food scientists do a variety of work, from a variety of disciplines, for example:

- Chemistry: studying how ingredients interact with each other.
- Microbiology: learning about harmful and helpful bacteria in our food.
- Nutritional: how to make a food healthier or assessing the calories, proteins, etc.
- Engineering: creating the machinery needed to manufacture the food.

Is a Food Scientist a Chef?

No. A chef orders ingredients, develops menus, and prepares meals for large numbers of people. A food scientist prepares food for entire populations. Engineering, chemistry, microbiology, and physics are just some of the courses required. Depending on their area of specialization, food scientists may develop ways to process, preserve, package, or store food, according to industry and government regulations.

	Food Science	Culinary Arts
Industry	Food Industry	Food Service
Consumer	Populations	Individuals
Creations	Prototypes	Final Products
Deadlines	Few Months	Minutes – Weeks
Work Space	Lab	Kitchen
Instructions	Formulas	Recipes
Uniform	Lab Coat	Chef Coat

Source: A Dash of Science *http://adashofscience.com/2013/03/14/food-science-vs-culinary-arts/*

Food Science has given us:

- Frozen foods
- Canned foods
- Microwave meals
- Milk that doesn't spoil
- Ready-to-eat/convenience snacks
- Nutritious new foods
- More easily prepared traditional foods

FOOD SCIENCE IN ACTION!

From Cabbage to Kimchi

Image Credit: Agriculture & Agri-Food Canada http://www.agr.gc.ca

The signature side dish of Korea is kimchi, a spicy pickled cabbage recipe that has a short "shelf life". But a team of Canadian food scientists have developed a new technology that extends one batch of kimchi from a shelf life of a month to almost a year, without pasteurization or adding any preservatives!

Will Work for Food: Cool Jobs in Food Science

The food industry is one of the largest on the planet. This means there will always be jobs because we all have to eat! And you aren't limited to working in a lab or sitting at a desk. There is something for everyone, whether it be in quality, research and development, sales, marketing, manufacturing, teaching or in government. Below is a sampling of a few cool jobs in the food industry.

Image Credit: Alberta Government Occupations and Educational Programs http://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002488

Food scientists and ***technologists*** usually work in the food processing industry, universities, or the government to create and improve food products. They use their knowledge of chemistry, physics, engineering, microbiology, biotechnology, and other sciences to develop new or better ways of preserving, processing, packaging, storing, and delivering foods.

Food Flavourists (also known as flavour chemists) focus on improving product taste and nutrition, making sure that any added chemicals do not make foods unsafe. They often spend their days in a lab, conducting experiments.

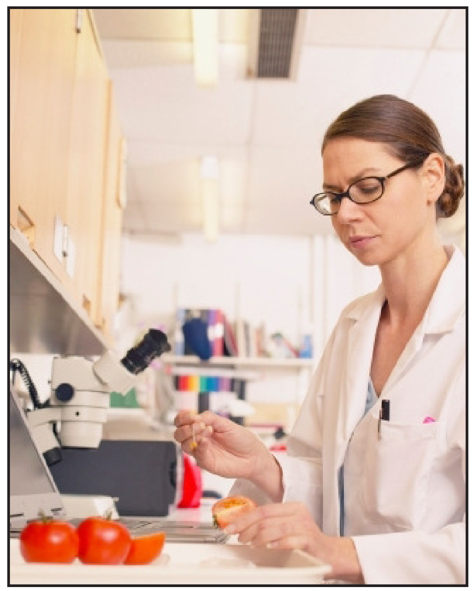


Image Credit: Food Chemistry http://foodchemistry101.weebly.com/overview-of-food-chemistry.htm

Image Credit: https://www.pinterest.com/DesignCanada/top-25-packaging/

Packaging Engineers play a key role in the look and feel of products that will appear on local store shelves. Packaging engineer jobs can involve creating packaging for new products as well as developing more creative or less expensive packaging for products.

Food Safety Officers create and implement food safety programs to make sure companies are following the rules so that our food is safe.

Image Credit: Maple Leaf Foods http://www.mapleleaffoods.com

Image Credit: Mother Nature Network http://www.mnn.com/earth-matters/space/stories/even-in-space-the-psychology-of-food-matters

Canadian Space Agency Food Scientists are responsible for creating the food that is safe to eat in space!

Butcher, baker or scientist? Where do you fit?

Find your future career in the Canadian Food & Beverage sector with this 10-question quiz.

http://tasteyourfuture.ca/butcher-baker-or-scientist-where-do-you-fit/

Image Credit: http://cookfearless.com/firehouse-challenge-potatoes/

> A Canadian Invention!
>
> **Did you know…instant mashed potatoes were invented by Canadian scientist Edward Asselbergs in 1966?**

Science Experiments 101: Variables

What are variables? They are the factors, traits, or conditions that can exist in differing amounts or types in an experiment. There are 3 kinds of variables in science experiments:

- The independent variable is one thing that is changed by the scientist. Why just one? Well, if you changed more than one variable it would be hard to figure out which change is causing what you observe.
- For the penny experiment, what variables could you change? (amount of liquid in each drop; height of drop; different coin, temperature of liquid, type of liquid used, etc.)
- The dependent variables are the things that the scientist focuses his or her observations on to see how they respond to the change made to the independent variable.
- For the penny experiment, the number of water droplets on the penny is what we are observing and measuring.
- Experiments also have controlled variables. Controlled variables are things that a scientist wants to remain constant (no change), and s/he must observe them as carefully as the dependent variables.
- In the penny experiment, some constants are accurate measuring, the same person doing the drops, etc.)

Keep learning and practicing the art of scientific documentation!

Scientific Method

The Scientific Method is not absolute. It's a framework for learning more about the world around us in a scientific way. Sometimes you might start with an observation and then you form a question; other times you might question something and then start to observe it. Below are the main steps scientists take when they want to test something.

1. **Make an Observation**: You are naturally curious about the world and if something peaks your interest, you are the type of person who wants to think about it some more and investigate it.
2. **Form a Question**: Why do things happen like they do? How does it happen? After making an interesting observation, you want to find out more about it and you start forming questions.
3. **Do Research:** Rather than starting from scratch to answer your question, you should do research (internet, library, interviews, etc.) to help you find the best way to do things and to be sure that you don't repeat mistakes made by other scientists.
4. **Form a Hypothesis**: Once you've done some observations, you develop an explanation or a theory as to why/how something is happening. It's an informed guess to the possible answers to your questions. The purpose of the hypothesis is not to guess the perfect answer but to give you a starting direction for your scientific investigation.
5. **Conduct an Experiment:** Once a hypothesis has been formed, it must be tested. This is done by conducting a carefully designed and controlled experiment. The experiment is one of the most important steps in the scientific method, as it is used to prove a hypothesis right or wrong. In order to be accepted as scientific proof for a theory, an experiment must

meet certain conditions, and it must be controlled- especially the variables- and it must be reproducible so that it can be tested for errors.

6. **Conclusion**: The results of the experiments are measured, analyzed, and assessed.
7. **Communicate Results**: Share your results with other scientific methods. Scientists often find solutions to problems by knowing the results of other scientists' experiments.

Additional Resources

Science Buddies: Steps of a Scientific Method http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml#keyinfo

- Scientific Method for Kids http://www.elcsd.k12.oh.us/Downloads/Logston%20-%20Blizzard%20Bag%20Day%201%20.pdf
- Classroom Experiments http://serc.carleton.edu/sp/library/experiments/index.html
- All about Food http://allaboutfood.aitc.ca

Additional Kitchen / Food Experiments

- Kitchen Chemistry http://stem.wesfryer.com/home/kitchen-chemistry
- Kitchen & Garage Experiments http://novastem.blogspot.ca/p/stem-activities-and-experiments-for.html
- Teaching STEM in Your Learning Garden https://thekitchencommunity.org/lesson-plans/stem-in-your-learning-garden/

Possible Guest Speakers

- Canadian Food Inspection Agency http://www.inspection.gc.ca/about-the-cfia/cfia-jobs/eng/1299857348736/1299857657230
- Canadian Institute of Food Science & Technology https://www.cifst.ca
- OMAFRA (Ontario Ministry of Agriculture, Food & Rural Affairs) http://www.omafra.gov.on.ca/english/
- Agriculture & Agri-Food Canada http://www.agr.gc.ca/eng/industry-markets-and-trade/exporting-and-buying-from-canada/export-agriculture-and-food-products-from-canada/agriculture-and-food-trade-contacts/associations/?id=1410072148297
- Food Nutritionist/Dietician

Career Resources

- AgScape (formerly Ontario Agri-Food Education Inc.) http://www.oafe.org
- Careers in Food Science (brochure) https://www.mcgill.ca/foodscience/files/foodscience/ift_careers_in_food_science_brochure.pdf
- Careers in Food: Career Planning http://www.careersinfood.com/career-planning

BEFORE THE NEXT MEETING

Can You Walk On Eggs Without Breaking Them?

NOTE: Be sure to ask your parents/guardian if it's okay to use a couple of dozens of eggs!

Eggs are amazingly strong, despite their reputation for being so fragile. But, are they strong enough to support the weight of your body? If you just want to attempt the feat of standing on eggs, you'll only need two cartons of eggs (two dozen eggs) and plastic garbage bags (or any other plastic material) to cover the flooring so you don't make a mess!

- Spread a plastic trash bag (or bags) out on the floor and arrange the egg cartons into two rows.
- Inspect all of the eggs to make sure there are no breaks or fractures in any of the eggshells. Make any replacements that might be necessary.
- It's important to make sure all of the eggs are oriented the same way in the cartons too. One end of the egg is more "pointy" while the other end is more round. Just make sure that all of the eggs are oriented in the same direction. By doing this, your foot will have a more level surface on which to stand.
- Remove your shoes and socks.
- Find a friend/family member to assist you when you are ready to step onto the first carton of eggs. The key is to make your foot as flat as possible in order to distribute your weight evenly across the tops of the eggs. If the ball of your foot is large, you might try positioning it between two rows of eggs instead of resting it on the top of an egg.
- When your foot is properly positioned, slowly shift all of your weight onto the egg-leg as you position your other foot on top of the second carton of eggs. NOTE: You may want to try placing a piece of 2x4 wood on the eggs to distribute the weight. Or turn this into another challenge: is weight distribution better if a piece of wood is used?

Discussion for the next meeting:

- Plain and simple, the shape of the egg is the secret! The egg's unique shape gives it tremendous strength, despite its seeming fragility. Eggs are similar in shape to a three-dimensional arch, one of the strongest architectural forms. The egg is the strongest at the top and the bottom (or at the highest point of the arch). That's why the egg doesn't break when you add pressure to both ends. The curved form of the shell also distributes pressure evenly all over the shell rather than concentrating it at any one point. By completely surrounding the egg with your hand, the pressure you apply by squeezing is distributed evenly all over the egg. However, eggs do not stand up well to uneven forces, which is why they crack easily on the side of a bowl (or why it cracked when you just pushed on one side). This also explains how a hen can sit on an egg and not break it, but a tiny little chick can break through the eggshell. The weight of the hen is evenly distributed over the egg, while the pecking of the chick is an uneven force directed at just one spot on the egg.
- If you guessed that the egg carton probably played a role in keeping the eggs from breaking, you're right. Joseph Coyle is credited as the inventor of the first container made specifically to keep eggs from breaking as they were transported from the local farm to the store. As the story goes, Coyle invented the egg carton in 1911 as a way to solve a dispute between a farmer and a hotel operator who blamed the farmer for delivering broken eggs. Coyle designed a container made out of thick paper with individual slots that supported each egg from the bottom while keeping the eggs separated from one another.

DIGGING DEEPER I

For senior members

How do batteries work?

To envision how a battery works, picture yourself putting alkaline batteries, like double AAs, into a flashlight. When you put those batteries into the flashlight and then turn it on, what you're really doing is completing a circuit. The stored chemical energy in the battery converts to electrical energy, which travels out of the battery and into the base of the flashlight's bulb, causing it to light up. Then, the electric current re-enters the battery, but at the opposite end from where it came out originally.

- To learn more, visit: "How batteries work". http://www.livescience.com/50657-how-batteries-work.html

Senior Member Activity: Make a Simple Circuit

- Build a switch that allows you to control the flow of electricity. This switch can then be used in the other experiments.
- See the handout: Make a Simple Circuit at the end of this meeting.

DIGGING DEEPER II

For senior members

Design a more advanced solar cooker than what is found in Activity #4. For different designs and plans, visit: Build a Solar Cooker http://www.solarcooking.org/plans/

DIGGING DEEPER III

For senior members

If you are interested in the food industry, try to speak to one person about their occupation and what it's like to work in their industry. This is called an information interview.

When you call this person, you can say:

"Hello, my name is_____________, and I understand that you are a (or work as a) _________________. I'm currently exploring this career/occupation as a possibility for the future. I wonder if I could take about 10 minutes of your time to find out more about what you do?"

Some questions you might want to ask include:

- On a typical day in this position, what do you do?
- What training or education is required for this type of work?
- What personal qualities or abilities are important to being successful in this job?
- What are the ideal qualifications for someone in this job?
- What kind of education/training is needed for this position?
- What part of this job do you find most satisfying? Most challenging?
- How did you get your job?
- How do you see jobs in this field changing in the future?
- Is there a demand for people in this occupation?

Share your information at the next meeting.

To learn more about information interviews, visit: https://www.jobsetc.gc.ca/pieces.jsp?category_id=420

ACTIVITIES

NOTE: For each STEM activity, encourage members to use the handout "A record of our experiment" OR to record their notes and findings in their 4-H Record Book.

Activity #1: Get to Know Each Other Activities

Select either activity to introduce members to each other and to begin the group bonding process.

- **Hot Chocolate**: Get together the four ingredients you need to make hot chocolate (mugs, spoons, hot chocolate mix, and marshmallows- make sure you provide hot water or milk). Divide everybody into four even groups. Give each group only one hot chocolate ingredient and enough for each person in the group to have 4 each. Group 1: each person is given 4 mugs. Group 2: each person is given 4 spoons. Group 3: each person is given 4 marshmallows. Group 4: each person is given 4 packets of hot chocolate mix.

Once all the ingredients are handed out, get everybody to form new groups that have all the hot chocolate ingredients. There should now be newly formed groups of 4 people which now have enough hot chocolate ingredients to make one cup of hot chocolate for each person in the group. Provide each group with hot milk or water. When each group has made their hot chocolate, ask them to sit down and give a sharing question for them to discuss. For example:

- Have you ever been in a STEM project before, maybe at school?
- How long have you been a member of this or any other 4-H club? What other projects have you done?

Variations of this mixer could be: Banana splits (bowls, bananas, chocolate topping, ice cream).

- **Me too!**: One person says her or his name and starts to describe herself or himself. As soon as another person hears something in common, that person interrupts, giving her or his name (e.g., "I'm ____________ and I have two older sisters, too"). Then that person begins a self-description until yet another person finds something in common and interrupts in turn. Continue until everyone in the group has been introduced.

PRE-ACTIVITY #1 - Practice Documenting your Experiments (30 minutes)

The Adventures in STEM project will have you doing lots of fun and interesting activities. But as Adam Savage of Mythbusters says, *"The only difference between messing around and science is writing it down."*

This pre-activity will help you practice writing all the important information about the experiments you will be doing in this 4-H project.

Image Credit: http://kids.niehs.nih.gov/topics/how-science-works/scientific-method/index.htm

You have two options to document your experiments:

- Use your 4-H Record Book
  - See the 4-H Canada Science Fair Logbook Guide as a great reference
- Use the templates included in this project:
  - A Record of our Experiment
  - Observation Sheet

Pre-Activity #2 - Drops on a Penny

Materials:

- Handout “Scientific Method”
- Pennies
- Tap water
- Paper towels
- Eye drops

Instructions:

Preparation:

1. Together, review these handouts and stress the importance of following procedures:
   - Scientific Method
   - 4-H Framework Poster (addendum)
2. Decide what you will use to document your information (4-H Record Book or template).
3. As you go through each step of this activity, write down the information. Get feedback from your instructor and club members to be sure you’re writing it all down correctly.

Next Steps:

- Wash and rinse a penny in tap water. Dry it completely with a paper towel.
- Place the penny on a flat surface. The flatter the surface is, the better this experiment is going to go.
- Use an eyedropper to draw water and, carefully, drop individual drops of water onto the flat surface of the penny.
- Keep track of the water drops as you add them, one at a time, until water runs over the edge of the penny.
- Repeat the experiment as many times as you want, or take it further by testing another liquid like vegetable oil, salt water… whatever you want! Use the handouts “A Record of Our Experiment” and “Observation Sheet” (located at the end of this meeting) to keep track of your trials.

Discussion:

- Review each other’s documentation and compare your results.
- Why do different liquids allow for more/less drops?
- Why did some people get more water drops on their penny than others?

Activity #2 – Colouring Changing Milk (15 minutes)

Objective:

- To learn how unusual interactions occur when mixing ingredients and the scientific secrets of soap.

Materials:

- Milk (homogenized)
- Dinner plate
- Four kinds of food colour
- Liquid soap
- Cotton swab

Instructions:

1. Pour about 1/4 of an inch deep (half a centimeter) of milk into a dinner plate.
2. In the center of the plate, add 1 drop from each of the four different food colouring bottles: red, yellow, green and blue, keeping the drops separate, but close together.
3. Put a drop of liquid soap on the end of a cotton swab and TOUCH it (don't move it) to the middle of the milk plate, holding it there for 10-15 seconds.

Discussion:

- Describe and compare with other members in the group what happened in this experiment.
- Why do you think this reaction happen?

Dish soap is made up of "bipolar" molecules (nonpolar at one end and polar on the other) and weakens chemical bonds holding proteins and fats in the milk. Soap molecules join with fat molecules in the milk. Milk with more fat content produces more colourful results because there is are more fat molecules to combine with the soap.

Open-Ended Inquiry Questions:

- What is the reason for the movement of the liquid?
- What variables would you change (independent variables)? What would you keep the same (constant variables)?
- What would happen if you used low-fat milk?
- Will the results change if you use different kinds of soap?

Activity #3 - When life gives you a lemon, make a battery! (20-30 minutes)

Objective:

- To learn how batteries work and to experiment making a battery.

Material:

- 2 lemons
- 3 copper wires
- 2 large paper clips (uncoated)
- 2 pennies
- a digital clock
- scissors
- knife

Instructions:

Explain the expression, "When life gives you a lemon, make lemonade".

Ask: Where do we use batteries? What do you have with you, right now, that needs a battery? (cell phone, watch, etc.) or in this room? (smoke alarm, clock, etc.) Batteries are very important in our everyday life and in this experiment, we will make a battery using a lemon!

1. Attach one of the paperclips to a wire.
2. Attach a penny to a second wire.
3. Attach another penny to one end of the third wire, and a paperclip to the other end.
4. Squeeze and roll two lemons to loosen the pulp inside.
5. Make two small cuts in the skins of both lemons, an inch apart.
6. Put the paper clip that is attached to the wire and the penny into one of the cuts until you get to the juicy part of the lemon.
7. Stick the penny into a hole in the other lemon.
8. Put the other paper clip into the second hole of the lemon with the penny.
9. Then put the last penny into the last open hole.

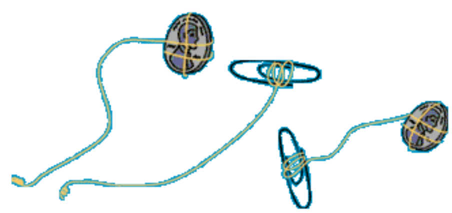


Image Credit: http://pbskids.org/zoom/activities/sci/lemonbattery.html

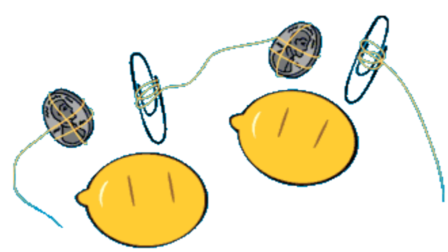


Image Credit: http://pbskids.org/zoom/activities/sci/lemonbattery.html

10. Connect the free ends of the wires to the terminals of the digital clock.

11. Watch how the lemons make enough electricity to turn the clock on. If you've hooked everything up and the clock isn't running, try switching the wires.

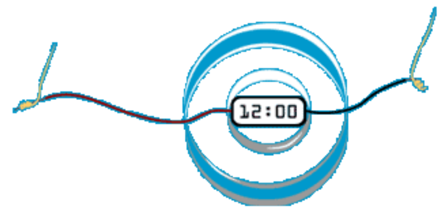


Image Credit: http://pbskids.org/zoom/activities/sci/lemonbattery.html

Discussion:

- How does the lemon battery work? Try to describe what you think is happening and why.

There's a chemical reaction between the steel in the paper clip and the lemon juice. There's also a chemical reaction between the copper in the penny and the lemon juice. These two chemical reactions push electrons through the wires. Because the two metals are different, the electrons get pushed harder in one direction than the other. If the metals were the same, the push would be equal and no electrons would flow. The electrons flow in one direction around in a circle and then come back to the lemon battery. While they flow through the clock, they make it work. This flow is called electric current.

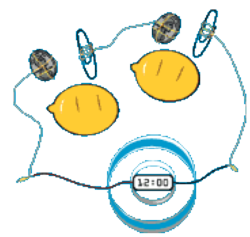
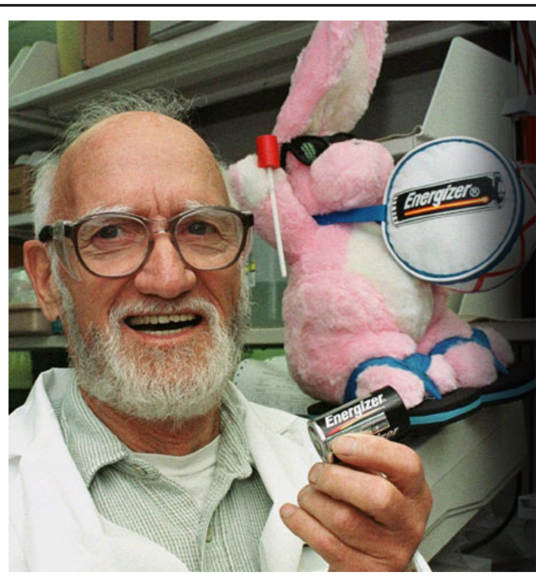


Image Credit: http://pbskids.org/zoom/activities/sci/lemonbattery.html

Open-Ended Inquiry Questions:

- What independent variables would you change? What would you keep constant? What are you trying to observe and measure, no matter what you change or keep the same?
- Make this experiment better: The quality of the copper and zinc can be a problem for a battery like this. Pennies are not pure copper. Try substituting a length of 14-gauge copper wire (common house wire) for the penny. Experiment with different lengths. Other sources of zinc and copper may be found in the plumbing supply department of a hardware store.



FUN FACT

Lewis Frederick Urry, a chemical engineer and inventor from Ontario, improved the original versions of the battery and is considered the creator of our modern-day battery!

Image Credit: http://www.theglobeandmail.com/report-on-business/small-business/meet-the-canadian-who-invented-the-modern-day-battery/article1390903/

Activity #4 - Sun S'mores (90 minutes)

Objective:

- To follow simple instructions to build a box solar oven and to learn about sunlight as a source of energy.

Materials:

- Cardboard box with attached lid. Lid should have flaps so that the box can be closed tightly. Box should be at least 3 inches deep and big enough to set a pie tin inside.
- Aluminum foil
- Clear plastic wrap
- Glue stick
- Tape (transparent tape, duct tape, masking tape, or whatever you have)
- Stick (about 30 cm) to prop open reflector flap
- Ruler or straight-edge
- Box cutter or X-acto knife (with adult help)

Instructions:

Part I- Make the solar oven

1. Using the straight edge as a guide, cut a three-sided flap out of the top of the box, leaving at least a 1-inch border around the three sides (with adult assistance).
2. Cover the bottom (inside) of the flap with aluminum foil, spreading a coat of glue from the glue stick onto the cardboard first and making the foil as smooth as possible.
3. Line the inside of the box with aluminum foil, again gluing it down and making it as smooth as possible.

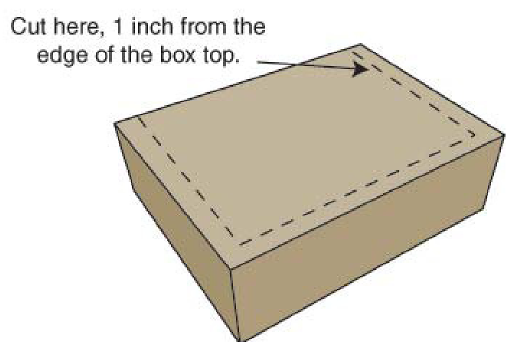


Image Credit: http://climatekids.nasa.gov/smores/

4. Tape two layers of plastic wrap across the opening you cut in the lid—one layer on the top and one layer on the bottom side of the lid.
   - Test the stick you will use to prop the lid up. You may have to use tape or figure another way to make the stick stay put.

Part II- Make the S'mores

NOTE: Start cooking at the beginning of the meeting to ensure there is enough time. The time of day is also critical- this activity will have to be done when you have full sun.

Materials:

- Graham crackers
- Large marshmallows
- Plain chocolate bars (thin)
- Aluminum pie pan
- Napkins

Instructions:

1. Break graham crackers in half to make squares. Place four squares in the pie pan. Place a marshmallow on each.
2. **Note:** Unlike most recipes, these s'mores have the marshmallow UNDER the chocolate. That's because, in the solar oven, it takes the marshmallow longer to melt than the chocolate.
3. Place the pan in the preheated solar oven.
4. Close the oven lid (the part with the plastic wrap on it) tightly, and prop up the flap to reflect the sunlight into the box.
5. Depending on how hot the day is, and how directly the sunlight shines on the oven, the marshmallows will take 30 to 60 minutes to get squishy when you poke them.
6. Then, open the oven lid and place a piece of chocolate (about half the size of the graham cracker square) on top of each marshmallow. Place another graham cracker square on top of the chocolate and press down gently to squash the marshmallow.
7. Close the lid of the solar oven and let the Sun heat it up for a few minutes more, just to melt the chocolate a bit.

Discussion:

- What is the basic principle that is powering the solar cooker?
- Does the colour of the surface matter in terms of how hot it can get?

Most solar cookers work on basic principles: sunlight is converted to heat energy that is retained for cooking. Sunlight is the "fuel." A solar cooker needs an outdoor spot that is sunny for several hours and protected from strong wind, and where food will be safe. Solar cookers don't work at night or on cloudy days. Dark surfaces get very hot in sunlight, but light surfaces don't. Food cooks best in dark, shallow, thin metal pots with dark, tight-fitting lids to hold in heat and moisture. One or more shiny surfaces reflect extra sunlight onto the pot, increasing its heat potential.

- When sunlight enters the box through the glass top, the light waves strike the bottom, making it scorching hot. Dark colours are better at absorbing heat, that's why the inside is black. The molecules that make up the box get excited and generate more heat. The box traps the heat, and the oven gets hotter and hotter. The effect is the same as what goes on in a standard oven: The food cooks.

- Some people think solar cooking can help poorer countries around the world, but there are challenges- what do you think are the drawbacks of solar cooking?
    - Solar cooking is really only possible for countries that have a dry, sunny climate for at least half the year. Areas of India, Brazil, Kenya and Ethiopia are some of the ideal locations for this cooking method.
    - The bigger problem is that even in places like India, the sun isn't always shining. Solar cookers won't work at all in nighttime or on cloudy days.

Open-Ended Inquiry Questions:

Experiment S'more with these variables:

- Test with and without a reflector.
- Try different types of heat-absorbing materials for the oven shelf/heat sink.
- Try different types of insulation between the inner and outer boxes.
- Why is it necessary to paint the shelf black and to use black cooking pots? See for yourself! Try black vs. shiny shelf and cooking pots.
- Try re-orienting the oven towards the sun once or twice an hour, vs. leaving the oven stationary.

> FUN FACT!
>
> Cool (or should we say "hot") Facts about Solar Energy
>
> Though the sun is 90 million miles (149.6 million km) from the earth, it takes less than 10 minutes for light to travel from that much of distance. If we add the amount of solar energy that is absorbed by the Earth's atmosphere, land and oceans every year, we end up with approximately 3,850,000 EJ (exajoules) or 2.7 million earthquakes!
>
> *Source: Conserve Energy Future http://www.conserve-energy-future.com/various-solar-energy-facts.php and Energy Informative http://energyinformative.org/solar-energy-facts/*

Activity #5 - Bake a Chemistry Cake (60-90 minutes) *

* Length of time depends if the cakes can be baked simultaneously or one at a time.

Objective:

- To witness how heat creates a chemical reaction and changes things; and to experiment how different ingredients can change the final product.

Materials:

- Small bowl
- Several sheets of aluminum foil
- Pie pan

- Cooking oil
- Measuring spoons
- Cup or mug
- Index card

Ingredients for one cake

(You'll need to measure and mix this set of ingredients four times to complete all four experiments—with the exceptions that are noted below.)

- 6 tablespoons (90mL) flour
- 3 tablespoons (45mL) sugar
- pinch of salt
- 2 or 3 pinches of baking powder
- 2 tablespoons (30mL) milk
- 2 tablespoons (30mL) cooking oil
- ¼ teaspoon (1mL) vanilla
- Butter knife
- ⅓ of an egg (Break egg into a cup; beat until mixed, then use approximately one third of it. Save the rest for 2 of the other cakes.)

Instructions:

1. Wrap several sheets of aluminum foil around the outside of the small bowl to form a mold.
2. Remove your foil "pan" and put it in the pie pan for support.
3. Help the club member coat the inside of the foil "pan" with the cooking oil, or cooking spray so the cake doesn't stick.
4. Preheat the oven to 350 degrees.
5. Mix all of the dry ingredients together.
6. Now, add the wet ingredients (as stated in the ingredient list, only use one third of the egg; save the rest for the other cakes).
7. Stir the wet and dry ingredients until they're smooth and all the same colour.
8. Pour batter into the "pan."
9. Bake in the oven for 15 minutes.
10. After 15 minutes, remove the cake from the oven, set aside, and let cool for tasting later (yum!).

11. Label the first cake #1 on an index card. Make sure to label each cake with its number so it's easy to identify them once they're all baked. Then, go on to bake three more cakes, but with the following differences:
    a. Leave the oil out of one. Label the cake "#2 NO OIL"
    b. Leave the egg out of another. Label the cake "#3 NO EGG"
    c. Leave the baking powder out of the third. Label the cake "#4 NO BAKING POWDER"

Discussion:

Cut each cake in half to examine them.

- Do the cakes look different?
- Do they taste different?
- What did the chemical change and use of heat do to cakes #1–4?

A few things can happen when you bake a cake. Some chemical reactions to keep in mind while doing this tasty experiment are:

- Heat helps baking powder produce tiny bubbles of gas, which makes the cake light and fluffy;
- Heat causes protein from the egg to change and make the cake firm; and
- Oil keeps the heat from drying out the cake.

The cake dough isn't really a cake, but when it's heated in the oven, a chemical reaction occurs and new bonds are formed. How does heat change things? It creates chemical reactions. When it comes to heat and baking, there are two types of chemical reactions to consider; one is "exothermic," a reaction that produces heat, and the other is "endothermic," a reaction that takes heat in. As you bake a cake, you are producing an endothermic chemical reaction that changes batter into a fluffy, delicious treat!

Open-Ended Inquiry Questions:

- What variables would you change if you did this experiment again?
- What if you changed the oven temperature?
- What if you changed the ingredient amounts?

Optional: Consider turning the results of the Bake a Chemistry Cake activity into a judging activity! Judge cakes #1 to #4 against each other. While the cakes are baking, members can create and review a scorecard for judging the cakes.

Activity #6 - Why do chefs add salt when boiling vegetables? (30-60 minutes) *

*Dependent on how many tests are conducted.

Objective:

- To practice setting up an experiment, following protocol, and analyzing results.

Materials:

- Green beans
- Water
- Pot
- Salt
- Baking soda

Instructions:

1. Members can be divided into teams, each conducting their own experiment while the other groups are conducting different experiments, later comparing the results of each group.
2. Members can conduct all of the experiments and compare their own results, as well as the results of other members.

Introduce experiment:

When cooking vegetables, for example green beans, chefs will add salt to the water for a variety of reasons:

- It keeps the beans green;
- It raises the boiling point of water so the beans cook faster;
- It prevents the beans going soggy; and/or
- It improves the flavour.

Some chefs will even add baking soda when cooking green vegetables to maintain the colour. ***But do any of these tricks really work?***

Your task is to create experiments that can test whether some of the suggestions above are correct. Your experiments must be fair tests and that you must only change one factor at a time if you are to be able to draw sensible conclusions from your results. As well as deciding what to do, you will also have to think about how you record your results.

Discussion:

- How did you set up your experiment?
- What were the results? Would you change anything if you had to re-do the test? Explain your answer and what you would change and why.

Open-Ended Inquiry Questions:

- Are chefs wasting their time with these "tricks of the trade" or do they really work?

Activity #7: STEM CHALLENGE: The Squashed Tomato (60 minutes)

NOTE TO CLUB LEADERS: See the handout *Squashed Tomato- Teacher's Notes* (found at the end of this meeting) for more details about this challenge, how to set it up, and more.

The problem: In Nepal, many farmers living on the mountainside grow fruit and vegetables, including tomatoes. To earn a living, they need to sell these at the local market. The problem is getting to market involves a long, dangerous walk down the mountain side and over a river, at the end of which the tomatoes may well be a bit squashed.

The challenge: To design, build and test a way of moving tomatoes that won't squash them!

Materials:

You can only use the materials provided by your 4-H club leader.

- Cherry tomatoes
- A means to attach members' basket/framework to the mode of transport and pulleys, ramps or similar to allow everything to move
- Things to make a framework or basket from (e.g. K'Nex, Lego, Meccano, margarine tubs)
- Ways to stick everything together (e.g. string, tape)
- Any equipment/material can be used, for example: lego, paper straws, pulleys, pins, paper clips, newspaper, nets, rulers, cards, paper cups, boxes, dried spaghetti, ramps with various surfaces, string/thread, cardboard tubes, etc.

Instructions:

1. Instead of moving full-size fruit and vegetables down a Nepalese mountain, we want you to transport cherry tomatoes from a height set by your club leader to the floor. Your club leader might also give you a rope or string to work with.
2. If your tomatoes fall to the floor by themselves, don't count them (if they fell down a Nepalese mountainside, they'd be very, very squashed!) Depending on the tomatoes your club leader chooses, and the height you're working from, they might squash for you too.
3. Your solution can be as simple or as complicated as you like, but remember – think first,

draw your ideas, check your materials, choose one design and make it. This is called a prototype. It's a first, model of something from which you develop more (if a successful model) or keep working on variations until you get it just right.

4. The bigger your container is the more tomatoes you will be able to carry. But, the heavier something is the greater the force of the impact when they hit the ground, so there is more chance the tomatoes will get squashed.
5. When you've made your models, test them and see who can carry the **most** cherry tomatoes down the mountain and across the river in one trip. You might use a table to record every team's result, so give your model a name.

Discussion:

Whether your model works or not, you will meet the challenge if you can tell your club leader why your model did or didn't work.

Open-Ended Inquiry Questions:

- Why did you choose to create your design the way you did?
- Would you change your design if you were transporting a different kind of produce, such as a banana?

Activity #8: Public Speaking/Judging

Choose either a public speaking activity **OR** a judging activity.

Public Speaking Activity

If you could invent one thing to make the world better, what would it be?

- You have one minute to think about your answer;
- You have one minute to share with the group your answer with reasons; and
- Remember: An important part of judging is learning to give reasons; this is your chance to explain **why** you made your choice. You don't have to agree with everyone else, but you do have to have an organized and thoughtful explanation of your choice.

Judging Activity

Judging is really comparing objects, whether they are seed samples or pencils. You are judging when you decide which pair of jeans to buy. Select one of these two judging activities.

1. Consider bringing in kitchen utensils for Meeting 1 (Kitchen Science) for members to judge; different kinds of: rolling pins, whisks, tongs, etc.
2. Use any item(s) on hand to give members a chance to practice the art of judging and to receive constructive feedback on which to build their skills and confidence

Judging: Give Reasons

Giving reasons can be the most rewarding part of the judging process but it takes practice - and confidence! The ability to give a good set of reasons depends on knowing what you're looking at, knowing the right words to use, knowing the right way to give your reasons and being able to convince everyone that you're right!

How to give reasons:

1. Reasons should be short, clear and convincing. They shouldn't take more than two minutes to give.
2. Stand straight and look right at the person to whom you are speaking.
3. Start by naming the class and giving the order of placement.
4. Explain why you placed the first over the second, the second over the third, and the third over the last.
5. Never go back. Say everything you want to say about one placing and then move on to the next one.
6. Keep a clear picture in your mind of what you are judging.
7. Be positive. Talk about the important points that were better in each exhibit.
8. Don't be too hard on the exhibit that was the last. Talk about two or three things that were wrong and then quit.
9. Speak loudly enough for the judge to hear you and with confidence.
10. Know the right words to use and use them correctly. Don't get stuck just using the same words over and over.
11. Always do your best.

Optional: Use the 4-H Ontario Judging Toolkit for more information about how to judge properly.

A RECORD OF OUR EXPERIMENT

EXPERIMENT

We want to find out:

____

____

____

HYPOTHESIS

In science, a **hypothesis** is an idea or explanation that you test through an experiment.

We think this will happen:

____

____

CONSTANTS ("Controlled Variables")

It is important for your experiment to be a fair test. You can change only one factor (variable) and keep all other factors/conditions the same.

To make our test fair, we are keeping these things the same:

____

____

VARIABLES

An experiment starts and finishes with the factors that change during the experiment. These are the **variables**. You will purposely change one of the variables at one time.

We are only changing:

____

____

We will measure: (identify the units you will use to measure)

____

____

RESULTS

Now is the time to analyze the data (information) you collected from your experiment and make a conclusion.

We found out that:

____

____

We think this is because:

____

____

REPEATED TRIALS

You may want to change a variable and repeat the test to see if the results are different.

NOTE: if you have time, it's a good idea to repeat your experiment in exactly the same way (don't change any variables) more than once to be sure your first results are correct.

Trial	Changed Variable(s)	Results
#2		
#3		

COMMUNICATE YOUR RESULTS

Share what you learned.

OBSERVATION SHEET

NOTE: This observation sheet can be edited to suit the individual activity.

Timeline	Variables/Constants	My Observations
1st observation Date: Time:		
2nd observation Date: Time:		
3rd observation Date: Time:		
4th observation Date: Time:		
5th observation Date: Time:		

Make a Simple Circuit

Source: http://www.energizer.ca/science-center/make-a-simple-circuit

For this project, you'll build a switch that allows you to control the flow of electricity. This switch can then be used in the other experiments.

Materials You Will Need:

- Energizer® Power Pack
- Spring-tension wood or plastic clothespin
- Number 22 insulated copper bell wire (three 10" pieces with 1" of insulation stripped off both ends of all wires)
- Small blocks of wood
- One drywall nail, thumbtacks, paper clip
- 3-volt flashlight bulb

PLEASE READ CAREFULLY!

All experiments use safe, low-voltage battery power. Household electrical current contains high voltage that could cause serious injury. DO NOT use household electrical current for any of these experiments. ALL experiments should be conducted under adult supervision.

- Carefully follow wiring instructions for each experiment - improper wiring can result in battery leakage and/or rupture.
- DO NOT take a battery apart - contact with internal battery material can cause injury.
- DO NOT dispose in fire, recharge, put in backwards, mix with used or other battery types - may explode, leak and cause personal injury.

How to Build a Switch:

- Wind a bare wire end around a thumbtack. Hook a paperclip around the tack and press it into a wood block.
- Wind the second bare wire end around another thumbtack and press it into the wood.
- This wire will connect to your Energizer® Power Pack positive (+) lead wire.
- Place a third thumbtack in the middle of the wood block to hold your paper clip switch in place. Your switch is now completed.

Alternate: Insulated knife blade switches are available commercially, and are used to illustrate the experiments throughout this site.

How to Build a Bulb Holder:

- Nail a clothespin to a wood block.
- Place a loose wire from switch (step #1) with a tack into the wood directly under the clothespin jaws.
- Wrap one stripped end of the remaining unconnected wire around the bulb. Clamp it in

the jaws of the clothespin with thumbtack below in order to make a complete circuit.

- Tack the loose wire to the wood. This wire will connect to your Energizer® Power Pack negative (-) lead wire.

Alternate: Insulated light bulb holders are available commercially, and are used to illustrate the experiments throughout this site.

How to Complete the Simple Circuit:

- Take wire from “How to Build a Switch” step 3 and bend stripped end at right angle. Connect wire to positive (+) lead of your Energizer® Power Pack with tape.
- Take wire from “How to Build a Bulb Holder” step 3 and bend stripped end at right angle. Connect write to negative (-) lead of your Energizer® Power Pack with tape.

When the circuit switch is open, the current does not flow to the bulb. With your finger, press down on the paper clip switch. You are closing and completing the circuit so the electricity can flow to the bulb.

The switch, bulb holder, and portable power are a complete circuit and arrangement of conductors; they allow the passage of electric current through the wire. Metal objects make the best conductors. Copper, brass, steel, or a strip of tin can have many free electrons capable of being moved along by an electromotive force such as voltage from the battery. In insulators, such as the wire covering, electrons do not move easily, so you can work with electricity safely.

Discussion

- What challenges did you have in creating a circuit? What did you do to resolve these challenges?
- How will you use this circuit for other experiments?

The Squashed Tomato Challenge

Challenge your students to take on a real-life problem affecting people in Nepal.

What's the challenge about?

A fun hands-on and brains-on challenge suitable for KS2–5 students based on a real transportation problem facing farmers living on the mountains of Nepal.

The challenge is flexible and can help you deliver:

- Enrichment activities – for STEM and National Science and Engineering Week
- CREST Discovery Award
- Science curriculum on forces, friction and levers at Key Stages 2-4
- Cross curricular opportunities

If you would like to use this as a fundraising opportunity please see our **squashed tomatoes fund-raising pack** for everything you will need.

Above: Farmer ready to transport tomatoes down the mountainside in the traditional way using a basket with a head strap.

Running the challenge

Introduce the challenge by discussing the various ways in which food is transported from where it is produced to the local market or shop. Talk about rail, lorries, boats, planes, bicycles etc.

The problem: Many farmers in Nepal grow their crops (including tomatoes) on the mountainside. To sell them at the local market they need to transport them to the bottom of the mountain, BUT it's a long and hazardous journey and they need to cross a river. Tomatoes are quite easily squashed so need to be transported with care. You can demonstrate this by dropping a few – the riper the better!

The challenge: Set the context of the challenge by introducing the problem faced by farmers in Nepal. You could show the students some of the **images** from Nepal. The students work in small groups to design and build a model that can transport as many cherry tomatoes at the same time without squashing them.

practicalaction.org/schools

PRACTICAL ACTION
Technology challenging poverty

MEETING 2 - MONKEY SEE, MONKEY DO: ANIMAL SCIENCE

Objectives:

- Introduce members to animal science.
- Have members follow proper procedures and documentation used in experiments.
- Learn about animal science industry in Canada and careers in this industry.

Roll Calls:

- Which do you think came first, the chicken or the egg? Explain your answer.
- Name one career related to animal science.
- What is your favourite animal?

Sample Meeting Agenda – 1 hr. 15 minutes plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Activity #9 - Minutes and Business	5 min
Judging Activity	Judging	10 min
Topic Information, Discussion & Activities	Topic Information What is animal science? The fields of animal science Ethics in animal science Activities ▪ Activity #10 - Build a Nest ▪ Activity #11 - Textiles: What burns faster and why? ▪ Activity #12 - A Stomach at Work ▪ Activity #13 - Modelling Animal Digestion ▪ Activity #14 - STEM CHALLENGE: What's the best way to clean oil off bird feathers?	30 min + Activities
At Home Activity	Choose one *At Home* activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information - What is Animal Science?

Animal science is the study of animals that live alongside humans. Around the world, humans rely on animals for food, clothing, labour and companionship. Animal scientists help us understand and manage these animals.

Animal scientists work with farm animals, wildlife, laboratory animals, pets and zoo animals. They study these animals to help keep them healthy and productive.

What do animal scientists do?

- Help put food on our tables. Animal scientists work with farmers to improve animal breeding, growth and nutrition. When animals grow well and stay healthy, farmers can produce more meat, milk or eggs for us to eat. Animal scientists also work with farmers to decrease the environmental impact of animal agriculture (for example: water, land, fuel, etc. needed to raise animals and how this affects the environment).
- Study animal products after harvest. They check meat and egg quality or check milk for pathogens (bacteria/viruses that might cause disease).
- Keep us clothed. For example, in cold climates, people need wool to stay warm. Animal scientists work to keep animals like sheep and alpacas healthy.
- Protect human health. It is important for scientists to study how diseases spread between humans and animals. (Diseases that spread between humans and animals are called ***zoonotic*** diseases.) Animal scientists can also use animals as models for humans. For example, studying fetal development in sheep (from a fertilized egg to a fully formed lamb), can help us understand fetal development in humans.
- Keep our pets healthy. They work on important issues like pet obesity and breeding. And zoos rely on animal scientists to create breeding programs, nutrition programs and help preserve exotic wildlife.

Animals in Canadian Science

In Canada and throughout the world, animals are studied in scientific work. Though the ethics and care of animals in science is an important issue to many Canadians, people are often unclear as to what animal-based science looks like in Canada. How are the animals treated? Why are animals being used? But in Canada, animal-based science is only acceptable if it promises to contribute to better scientific understanding and knowledge that will benefit humans and animals.

Did you Know?

Which animals did scientists and educators work with the most in 2014?

- **Fish- 43%**
- **Mice- 33.4%**
- **Birds- 6.7%**

For the most up-to-date data, take a look at the annual animal data reports provided by the Canadian Council on Animal Care. http://www.ccac.ca/en_/facts-and-figures/animal-data

Codes of Practice: Care and handling of farm animals

In Canada, there are Codes of Practice (guidelines) for the care and handling of farm animals. The Codes serve as a national understanding of animal care requirements and recommended practices. For Canadian Codes of Practice for different animals (cattle, chickens, sheep, etc.) visit the website. http://www.nfacc.ca/codes-of-practice.

The Fields of Animal Science

Animal Nutrition

The feed industry is big in Canada's agri-food economy. The estimated total commercial production of feed in Canada is 20 million tonnes, and an estimated 10 million tonnes is produced on-farm. Scientists, including nutritionists, work to make new discoveries to improve the lives of pets. They conduct studies to see how formulas affect pets.

There are many career paths in animal nutrition. As an animal nutritionist, you will keep animals healthy by giving them the right food, the right amount, type, and formulation. You might work in research and development, creating or improving feed products. Or you might work in sales, helping customers to buy the correct feed products and formulas.

Image Credit: *http://www.cargill.com/feed/*

Nutrition Associations

- Animal Nutrition Association of Canada http://www.anacan.org/en

Genetics and Breeding: Animal Biotechnology

The term "animal biotechnology" refers to genetically engineered or modified animals in which the genes of the animal have been changed so that certain traits of an animal change. Cloning of animals is also part of animal biotechnology.

Since the early 1980s, many changes to animals have been created using biotechnology:

- Increased growth rates.
- Enhanced lean muscle mass.
- Enhanced resistance to disease.
- Improved use of dietary phosphorous to lessen the environmental impacts of animal manure.
- Poultry, pigs, goats and cattle that create large quantities of human proteins in eggs, milk, blood or urine with the goal of using these products to create human pharmaceuticals (medicine).

An Example of Biotechnology & Animals:

AquAdvantage Salmon: A genetically modified Atlantic salmon developed by AquaBounty Technologies. They changed a growth hormone-regulating gene from a Pacific Chinook salmon, which resulted in this salmon to grow year-round instead of only during spring and summer. The purpose of the change was to increase the speed at which the fish grows without affecting its size or other qualities. Now, the fish grows to market size in 16 to 18 months rather than three years.

Animal Science Associations

- Canadian Society of Animal Science https://www.asas.org/CSAS

Veterinary Medicine

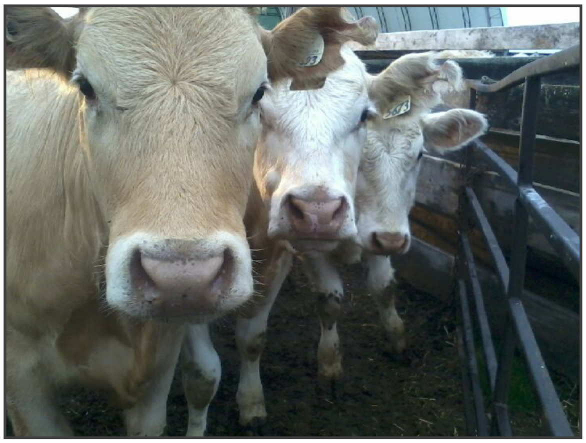


Image Credit: *Elizabeth Johnston*

Veterinarians prevent, diagnose and treat diseases and disorders in animals. They give farmers and other customers advice on animal feeding, hygiene, housing and general care. Veterinarians work in private practice or may work in animal clinics and laboratories or with the government. There is also a demand for animal medicine required for horses, wild and exotic animals in zoos, and the livestock industry. Some veterinarians work in public health. With the public concern about contagious diseases (e.g. mad cow disease), monitoring of animals, food inspection and the use of drugs and growth hormones in animals and their effects on humans becomes serious.

Veterinary Associations

- Canadian Veterinary Medical Association http://www.canadianveterinarians.net
- Ontario Veterinary Medical Association https://www.ovma.org

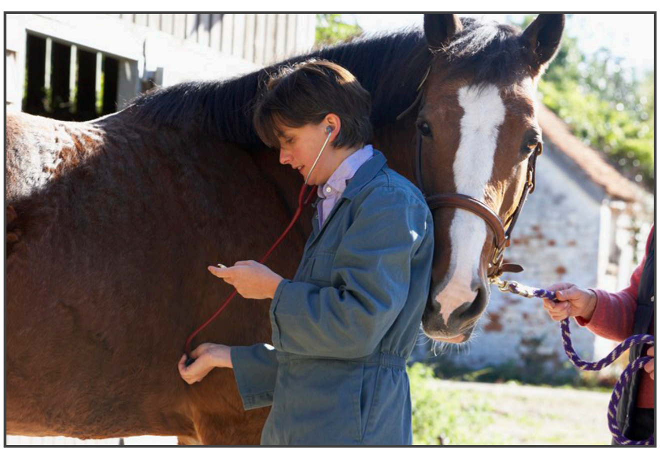


Image Credit: Ontario Veterinary Medical Association
https://www.ovma.org/pet-owners/find-a-veterinarian/

Animal Products & By-Products

Image Credit: Agriculture & Agri-Food http://www.agr.gc.ca/eng/industry-markets-and-trade/traceability/?id=1382971713721

Many people rely on animals for food and they play very important roles in our lives. Animals are pets, they are raised as food, and they provide products important to everyday life. You may not realize how many things come from animals. These are called animal by-products: any material that comes from the body of an animal.

For example:

- **Pigs**: People eat many different pork products, such as bacon, sausage and pork chops. But several valuable products come from pigs, including: insulin for the treatment of diabetes, valves for human heart surgery, suede for shoes and clothing, and gelatin for foods and non-food uses. Lard is fat from pig abdomens and is used in shaving creams, soaps, make-up, baked goods and other foods.
- **Cattle:** When dairy animals can no longer produce milk, they are often used for meat, primarily in the form of ground beef. But there are many by-products that come from all types of cattle. Tallow is fat from cattle, and it is used in wax paper, crayons, margarine, paints, rubber, lubricants, candles, soaps, lipsticks, shaving creams and other cosmetics.

> FUN FACT!
>
> **Can you guess which of these animal products/byproducts are used in humans for medical purposes?**
>
> - **Powdered deer horn**
> - **Dried bladders**
> - **Dried beef bones**
> - **Dried duck gizzard lining**
> - **Tiger bones**
> - **Dried chicken feet**
> - **Shredded bones of various species**
> - **Pork skins**
>
> **The answer is…all of them!**

Animal Husbandry

Animal husbandry is the science of breeding and caring for farm animals.

Breeding: Selective breeding for desired traits (bigger, faster, more production, etc.) was first started as a scientific practice in the 18th century. Breeding techniques such as artificial insemination is regularly used today, not only as methods to guarantee that females breed regularly, but also to help improve genetics. Breeding for traits improves the ability of the animals to convert feed to meat, milk, or fiber more efficiently, and improve the quality of the final product; but on the other hand, it decreases genetic diversity, meaning the animals are too similar to each other, which increases the chances and difficulty of diseases.

Caring: Good husbandry practices (GHP) are a set of high standards to make sure of the health of the animals, regardless of their use (to eat, as by-products, etc.)

With good husbandry practices, death of animals is reduced, and therefore, farmers are spending less money due to sickness, medications, and lost production.

Careers in Animal Sciences

Animal science offers many different career options: genetics (animal breeding), nutrition, physiology (digestive, environmental, reproductive), and basic sciences (immunology, microbiology, molecular biology). As an Animal Science graduate, your knowledge of how animals function and the business of caring for them gives you access to professional opportunities like these:

Image Credit: Ontario Pork http://www.ontariopork.on.ca

- **Veterinary Medicine or Preventive Medicine**: Veterinarian (small animal, large animal, holistic, wildlife) Associate Veterinarian; Veterinary Specialist; Veterinary Pharmaceutical Representative
- **Veterinary Offices, Hospitals, And Clinics**: Veterinary Technician; Veterinary Technologist; Veterinary Assistant
- **Shelters, Sanctuaries, and Refuges**: Shelter Manager; Pet Adoption Counselor; Wildlife Rehabilitator; Animal Control Officer
- **Animal Advocacy Organizations**: Publicist: Lobbyist; Publications Editor
- **Zoos and Aquariums**: Zookeeper; Habitat Specialist; Community Relations Directory
- **Pet food, pet supply and pet merchandise stores**: Store Manager; Sales Associate; Animal Attendant
- **Teaching and Research organizations**: Research Veterinarian; High School Science Teacher
- **Wildlife Conservation and Biodiversity**: Conservation Officer; Wildlife Technologist
- **Nutrition**: Animal Nutrition Specialist; Research Technician; Food Promotion and Inspection
- **On the Farm**: Livestock Specialist; Farm Manager

Life as a Scientist!

"Once when I worked as a field biologist, we were out sampling a lake for invasive fish in the Sierra Nevada in California. I heard a loud whistle from the direction of the tree under which I had left my backpack with my lunch. I turned to glimpse a marmot running off with my potato chips. I chased him under a large bolder. I reached in with a stick and pulled out several bags of trail mix. This little guy was a certified thief and was hording stolen snacks. I did get my chips back and left him his other booty."

Ethics in Animal Science

Whenever a scientist needs to use animals as part of a research study, ethics are very important in order to ensure animal welfare. Ethics are what you think or value as being right and wrong.

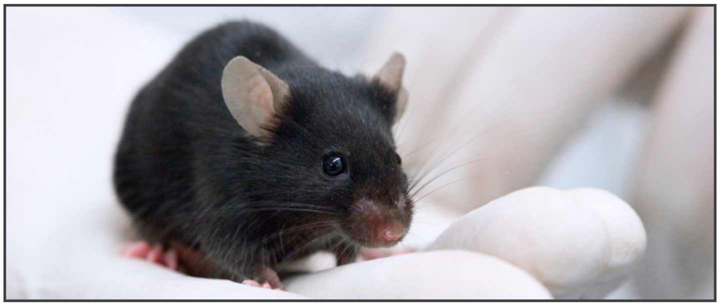


Image Credit: Canadian Council on Animal Care in Science
http://www.ccac.ca/en_

The Canadian Council on Animal Care in Science follows the three R's (Replacement, Reduction and Refinement) which are accepted internationally as the ethics of animal experimentation:

- **Replace**: Avoid or replace the use of animals wherever possible.
- **Reduce**: Use strategies that will result in fewer animals being used.
- **Refine**: Change procedures to reduce pain and distress on the animals.

Just like scientists must do, if you plan to use animals for scientific purposes, you must complete the ***Ethics Review Request Form*** and submit it to 4-H Canada for approval prior to starting your project/activity.

See: Ethics Review Request Form (at the end of this meeting)

Additional Resources

Canadian Council on Animal Care (in Science) http://www.ccac.ca/en_/

- Canadian Association for Laboratory Animal Science http://calas-acsal.org
- Canadian Association for Laboratory Animal Medicine http://calam-acmal.org
- Canadian Animal Health Institute http://www.cahi-icsa.ca
- Animal Nutrition Association of Canada http://www.anacan.org/en
- Canadian Society of Animal Science https://www.asas.org/CSAS

Additional Animal Science Experiments

- Zoology Science Fair Projects: Science Buddies http://www.sciencebuddies.org/science-fair-projects/Intro-Zoology.shtml
- Zoology Experiments: I Explore STEM http://iexplorestem.org/zoology-activities

Possible Guest Speakers / Tours

- Veterinarian
- Association member (see above list)
- Tour a feed mill
- Farmer
- Animal Trainer/Behaviourist

Career Resources

- Videos: Career Profiles in Animal Care http://www.growingcareers.ca/component/k2/itemlist/filter?searchword5=Animal+Care&moduleId=217&Itemid=264
- Agri-Pathways: http://www.cahrc-ccrha.ca/agri-pathways-how-it-works

BEFORE THE NEXT MEETING

1. Make a better animal toy: What helps keep your pet healthy? Just like people, animals need the right food, clean water, grooming, rest, and exercise. Exercise is best when it uses the animal's natural skills and instincts like climbing, swimming, hunting, fetching, or digging because exercise in this form conditions the animal's brain, as well as its body. Sketch out an idea for a new toy that will excite your animal, or, take an existing animal toy and make it better by sketching out a plan of what you would change and why.

DIGGING DEEPER I

For senior members

Established over 150 years ago, in small, urban communities that offered a stable labour supply and rivers ideally suited for water-generated power and dyeing/finishing processes, the Canadian textile industry started with the manufacturing of yarns and fabrics from natural fibres. Currently, the industry is located mainly in Quebec and Ontario, is heavily capital-intensive, uses natural, artificial and manmade fibres.

Activity:

Dyeing is as much an art as a science and experimenting is encouraged! In this activity, you will be dyeing fabric and exploring variations.

Materials:

- White clothing (e.g. t-shirt) or pieces of fabric for dyeing
- Liquid dye (one colour or multiple, your choice)
- Plastic bowl– large enough to hold the fabric you are using
- Mixing spoon – use one you don't care about; it will be dyed along with the fabric

Instructions:

1. Gather supplies
2. Mix dye and hot water in a bowl
3. Add fabric and mix periodically for one hour or more
4. Drain and rinse fabric
5. Wash and dry fabric in a machine

Take your activity to the next level and combine your creativity with science to figure out the following:

- Do natural or synthetic fibers take dye better? Test it and find out.
- If you combine liquid dyes, what colours can you create?
- If you modify your techniques for items other than fabric, how do these items take the colour?

DIGGING DEEPER II

For senior members

Research the average life span of a human, a cat, a dog, a horse, a canary, a goldfish, and a guinea pig, then illustrate these in a bar graph. Identify the variables that impact the life expectancy of the different animals listed.

At the next club meeting, share the long-term commitment of pet ownership by choosing one pet as an example.

ACTIVITIES

Activity #9 - Judging Activity

1. Which animal is the most important to have on a farm and why? OR Which animal is most important to humans and why?
2. Alternatively, bring in any items (Leader or members) to judge. Or bring in pictures of animals and have members judge.

NOTE: For each activity, encourage members to use the handout "*A record of our experiment*" **OR** to record their notes and findings in their 4-H Record Book.

Activity #10 – Build a Nest (45 minutes)

Objective:

Members will learn how animals' build a nest to keep warm.

Materials: (each material needed per pairs/group)

- Two "cold" cups (plastic or paper, just make sure they aren't insulated)
- Two round cardboard oatmeal containers, cut so they are about 2 inches taller than cups
- Source of warm water (100 degrees F)
- Two thermometers
- Wood shavings (used for chicken nests)
- Feathers (can buy sterilized at craft stores)
- Hay or straw (be aware of member allergies)

Instructions:

1. You are a mother hen and your job will be to keep your chicks warm. You will receive two cups of warm water that represent your chicks. One chick you will leave unprotected. The other you can protect by building a nest.
2. In one oatmeal container, build a nest for your "chick." You may use one material or a combination of materials.
3. Get your "chicks" (cups of warm water) from your instructor. Put one chick in the nest and leave one out. Put a thermometer in each cup and write down the temperature at the start.
4. Take temperature readings every two minutes. How are you doing at keeping your chick warm? How fast is the other chick getting cold?

Discussion:

- What did you learn about temperature?
- Describe a time when you might need the skills/knowledge you learned today.
- How do animals maintain their body temperature?

Most people dress in clothes appropriate to the season (lighter clothes in summer; heavier clothes in winter), drink cold water, have hot soup, go swimming, soak in a hot bath, sit by a fire or sweat to help maintain body temperature. What do animals do to keep from losing body heat or to keep from getting too hot?

- For an animal to keep the right body temperature, they use thermos-regulation. Thermo-regulation is the ability to keep the right body temperature even when the outside temperature is different. A thermos-conforming animal (like a reptile) will adapt to the same temperature as their surroundings.
- Why don't all animals use thermos-conformation? Most animals need a certain temperature for their bodies to function. If their temperature gets too high, ***hyper***thermia occurs. The opposite condition, ***hypo***thermia is when the body gets too cold.
- There are different ways of thermos-regulation. A lot of animals will evaporate water through sweat glands. Animals that are covered in fur have limited ability to sweat and need to use heavy panting to increase the evaporation through the tongue, mouth and lungs. Dogs, cats and pigs rely on panting for their regulation. Birds avoid overheating by flapping the wings close to the skin at the throat (examples: cormorants, pelicans and owls).
- Mammals like polar bears and walruses have thick skin and a layer of blubber for protection. They also use goose bumps to decrease heat loss. When the skin creates goose bumps, it slows down the air flow over the skin and minimizes heat loss.
- Reptiles cannot produce or store heat in their bodies. They need to warm up in the sun (or by lying on hot rocks). When they get too hot they will move into shade to cool down. This is used by reptiles.

Open-Ended Inquiry Questions:

- Try to make a better nest. Recycle/reuse materials to improve your first nest and build a new one in that same container. Get two new chicks and start over.

Activity #11 - Textiles: What Burns Faster and Why? (45 minutes)

SAFETY NOTE: CAUTION MUST BE TAKEN WITH THIS ACTIVITY, ESPECIALLY WITH YOUNGER MEMBERS!

Objective:

- To determine which material burns faster and why.

Materials:

- Scale

- Hardware cloth
- Cotton; cotton/polyester blend
- Lighter
- Stopwatch
- Blue painters tape
- 1⁄4 inch plywood
- Stapler/staples
- Tin foil

Instructions:

Share the following basic information with members to introduce the topic of textiles:

Textile processes generally include:

Yarn spinning

- Spinning of staple fibres into industrial and commercial yarns
- Texturing or throwing of chemical-based filament yarns (artificial and synthetic)
- Manufacturing of thread for crafts, embroidery, sewing

Fabric manufacturing

- Woven fabric
- Nonwoven fabric
- Knit fabric

Finishing or dressing, and coating of fabrics and textiles

- Textile ennobling
- Coating of fabrics (laminating, coating, bonding, etc.)

Apparel Manufacturing

- Protective clothing and footwear
- Workwear

Process

1. Cut the hardware cloth into six eight by eight squares.
2. Place the hardware cloth at a 45-degree angle with each other.
3. Cut ten 6.5 inch by 6.5 inch squares of both fabrics (or change the size of the fabric) so that they each weigh three grams.

4. Place one square of the fabric on one side of the hardware cloth.
5. Place lighter at the bottom center of the cloth and ignite.
6. Hold lighter for ten seconds.
7. Time how long it takes the fabric to fully burn.

Discussion:

Which fabric burned faster? Why?

The cotton/polyester blend burned faster than the cotton, because as polyester burns it melts and spreads the flame throughout the material faster.

Open-Ended Inquiry Questions:

- Why would it be important to know which fabric burns faster? In what occupations would you want to be sure you have non-flammable uniforms?

If club members are more interested in textiles, some optional activities/resources include:

- Visit the Textile Museum of Canada (Toronto, ON) http://www.textilemuseum.ca/education/school-visits
- (Web resource) An interactive project that brings the city to life in stories and memories that show the significant role textiles have played in shaping Toronto's urban landscape. http://www.txtilecity.ca/index.php
- (Additional textile experiments) http://www.juliantrubin.com/fairprojects/chemistry/fabrics.html

Activity #12 - A Stomach at Work (45 minutes)

Objective:

- Discuss how digestive acids break down carbohydrates. Explain the difference between monogastric and ruminant animals.

NOTE TO LEADERS: See Discussion section for an explanation of how the stomach works.

Materials:

- Re-sealable plastic sandwich bags (one per participant plus one for demonstration)
- Sliced white bread (one piece per participant plus one for demonstration)
- 2-liter bottles of orange juice or cola (about one bottle per 15 participants)
- 3-ounce disposable cups (one per participant)
- Paper towels (one sheet per participant and enough for clean-up)

- Flipchart or other large paper
- Markers
- Easel or display space
- Masking tape
- Clock or stopwatch
- Large trash bag (one or more depending on the size of your group)

Instructions:

1. Ask: What is digestion?
    - Digestion is the process of breaking down food in the mouth, stomach, intestines and other organs so that it can be used by the body.
    - Today, we're going to make model stomachs and "digest" slices of bread in them so we can observe the digestion process. A little later we'll also learn about the two main digestive systems of livestock animals.
2. Give each member one of the bags with a piece of white bread in it. Explain to the group: In this activity, the bag will act like a stomach – a muscle that contains and squeezes the food (in this case, the bread) to break it down.
3. Now have them take turns bringing their plastic bag stomachs to the supply station to pick up a cup of orange juice or cola to pour into their bags. Explain that the liquid will play the part of the digestive juices in their model stomachs – that is, the stomach acid and enzymes that react chemically with the food in the stomach.
4. Observe what happens with the bread.
5. What do you think might happen if you squeezed your model stomach for a little while? *(The bread will break into smaller pieces. The bread will be squished.)*
6. Give one piece of paper towel to every member. Tell them to wrap the paper towel around their model stomachs so that they cannot see what is happening inside.
7. Now tell them that on your signal, they will act as the muscles for their model stomachs by gently squeezing their towel-covered bags for 2 minutes. Emphasize that they need to keep the towels wrapped around their bags and be gentle to avoid poking holes in them. Have a volunteer keep track of the time.
8. After two minutes, tell them to remove the paper towels and – without opening the bags! – observe the changes to the contents. After they've had a moment to observe and think about the changes, ask the group the following questions:
    - What caused the changes to the bread? (The mechanical action of squeezing and the chemical breakdown of the bread fibers by the acids in the liquid.)
    - Would the change have been different if the liquid we added was just water? Why or why not? (Yes, because it is the acids in the orange juice or cola that accelerate the

breakdown process.)

- How is animal digestion similar to what we did with our model stomachs? (An animal's stomach churns and squeezes and breaks down its contents in nearly the same way that we churned and squeezed and broke down the bread in our model stomachs. The acidic fluid – the orange juice or cola – we added to our model stomachs reacted chemically with the bread in them, just as real stomach acid reacts chemically with the contents of the stomach.)

Discussion:

- Do humans have monogastric or ruminant digestive systems? *(Monogastric or simple.)*
- What does monogastric mean? ("Mono" means "one" or "single," and "gastric" means "stomach" or "related to the stomach," so "monogastric" means "one stomach" or "one stomach compartment.")
- Name one livestock species that has a stomach that is similar to the human stomach. *(Swine and rabbits.)*
- Do sheep have monogastric or ruminant digestive systems? Cows? *(Ruminant.)*
- What does "ruminant" mean? *("To chew over again.")*
- What is the biggest difference between the ruminant and monogastric digestive systems? (Ruminant stomachs have four compartments, and monogastric stomachs have only one compartment. Ruminants are able to digest grasses and other fibrous feeds better than animals with monogastric systems can. Ruminant animals are able to do this because they chew their food several times through a process of regurgitation and rumination that is more familiarly called "chewing their cud.")

Optional: Watch the video (3:04) "Ruminants GI Tract" (Canadian Museum of Nature)

https://www.youtube.com/watch?v=SVNNJf_28KE

Open-Ended Inquiry Questions:

- What would be the ruminant digestion process from the perspective of a piece of grass being eaten by a cow, at each stage? Repeat the experiment, but this time, use grass clippings instead of bread.

Activity #13 - Modelling Animal Digestion (60 minutes)

Objective:

- Members will investigate the different digestive systems of livestock and learn how animals have unique nutritional needs based on these structures. Members will also discover the responsibilities of an animal nutritionist.

Materials:

- Foam board
- Modeling materials: balloons, tubing, hoses, straws, string, rope, empty soft drink

bottles, pipe cleaners, milk jugs, or food containers

- Scissors
- Tape or glue
- Handouts (at the end of the meeting):
  - Got Guts Teacher Review
  - Pig & Cow Digestive Tract
  - Handout: Got Guts? Pig Labels
  - Handout: Got Guts? Pig Descriptions
  - Handout: Got Guts? Cow Labels
  - Handout: Got Guts? Cow Descriptions
- Additional Web Resources (optional)
- National Agriculture in the Classroom http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=292

Instructions:

1. Tell members that today they are going to act as ***animal nutritionists***. Animal nutritionists must have an extensive knowledge of how animals digest food. They use their knowledge to formulate diets for animals. The diets they create must be nutritionally sound, good-tasting, and economical for the ages and types of animals that will use them.
2. Briefly review the human digestive system, and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of digesting food. Allow members to identify the parts they know, and if possible, the related function. Highlight the following features:
   - Digestion begins in the mouth. As the teeth tear and chop food, saliva moistens it for easy swallowing.
   - From the throat, food travels down a muscular tube in the chest called the esophagus. Waves of muscle contractions force food down through the esophagus to the stomach.
   - The stomach muscles churn and mix the food with acids and enzymes, breaking it into smaller, more digestible pieces.
   - Digestion continues in the small intestine, a tube-like structure that absorbs nutrients into the bloodstream.
   - The large intestine's main function is to remove water and minerals from the undigested matter and form solid waste that can be excreted.
   - The colon is part of the large intestine. Bacteria in the colon help to digest the remaining food products.
3. Tell members they will use household materials to construct models of both monogastric and ruminant digestive systems. Divide the club into small groups. Assign each group

a cow or pig digestive tract. Give each group the *Pig Digestive Tract* or *Cow Digestive Tract* handout. Distribute foam board, modeling materials (including balloons, tubes, hoses, straws, string, rope, and empty soft drink bottles, pipe cleaners, milk jugs, and food containers), and corresponding *Got Guts? Labels* for the cow and pig. Instruct members to research their assigned animal, using Web resources, and then create a model of the animal's digestive tract on the foam board using the labels and materials provided.

Discussion:

- Monogastric and ruminant digestive systems are different. Monogastric systems have one true stomach, while ruminants have a multi-chambered stomach.
- Animals prefer foods that can be easily digested and used by their body. Cattle have ruminant digestive tracts with large microbial populations that allow them to eat complex plant materials. Pigs and humans have monogastric digestive tracts.
- Animal nutritionists use their knowledge about animals and their digestive tracts to formulate diets that are nutritionally sound, good-tasting, and economical.
- The proper nutrition of livestock animals is a key component of a successful production system. Just like humans, animals that consume the nutrients they need will stay healthy and grow stronger.

Open-Ended Inquiry Questions:

- How long do you thing is the length of animal intestines? Research and use rope to model and compare the different lengths. Why do differences exist?
- What if we compare the teeth of different animals; how are they designed to break down specific foods?

Activity #14 - STEM CHALLENGE: What's the best way to clean oil off bird feathers? (45 minutes)

Objective:

- To develop a scientific method to accurately measure which washing method is most effective in cleaning the oil off birds in an oil spill.

Materials:

- Clean, dry feathers (good places to find feathers are beaches, parks, and pet stores)
- 4 bowls
- Vegetable oil
- Dish-washing detergent (variety)
- Hot, cold, and room-temperature water (the hot water should be about the same

temperature you'd use to wash dishes and not too hot to put your hands in)

- 1 tablespoon cocoa powder (optional)

Instructions:

Read the following out loud:

Oil can kill birds. Oil enters the water-proof layer of the bird's feathers creating problems for its ability to stay warm. Also, the toxic nature of most oils will kill the bird if they eat it. When birds are covered in oil, the damage to their feather system causes cold ocean water to soak through to their skin. Despite a fat layer under the skin that acts as an extra layer of insulation, the birds' efforts to stay warm quickly use up this fat supply. Within days, the birds die of hypothermia unless their feather system is repaired. Oiled birds can also lose their ability to fly, and are then unable to feed themselves which can quickly lead to dehydration and starvation.

This next activity gives an idea of how wildlife professionals might clean oil off of affected birds.

1. Fill a bowl with room-temperature water to an inch or two below the rim. Pour some oil on the water. The oil will spread out over the surface of the water. (Optional: If you'd like, you can mix a little cocoa powder into the vegetable oil to make it show up better and look more like crude oil.)

2. Dip some of your feathers into the oil on the water. You're imitating what happens when a bird lands on an oil slick on the ocean.

3. Take a look at the feathers now, and then try to answer the following questions:

    a. What happened to the feathers when they got oiled? (Possible answers: they got soggy, matted, heavier.)

    b. How do you think this might affect a water bird wearing these feathers? (Possible answers: Oiling makes it harder for the bird to stay warm; Oiling makes the bird less waterproof; Real, fresh oil is toxic, so it can poison the bird.)

    c. Be sure to record this as part of your scientific documentation!

4. Take a bowl of hot water (not too hot to burn yourself!) and add some of your detergent. Wash your feather and record what happens/how well it cleans the oil off of the feather.

5. Repeat the experiment with room-temperature and cold water.

Discussion:

- Which method worked best?
- Which variables were controlled and which were changed?
- How could you measure what happened to the feathers? (e.g. weigh them before and after).
- Now imagine that you're washing a real, live bird that has been oiled. What things would you need to think about? Which method would you choose to clean the bird

You probably found that washing the feathers with hot water and detergent was the best way to remove the oil from the feathers. However, this actually isn't the best method to use when you're washing a live bird. When a bird has been coated with oil, it becomes weak, and it isn't able to regulate its body temperature very well. Putting a live bird in hot water when it's in this condition can be dangerous for it. People cleaning oiled birds use water that's at the same temperature as the environment around the bird. They also make sure to keep the building where they're washing the birds warm: this way, the birds don't get too hot or too cold.

Open-Ended Inquiry Questions:

- Now try different methods for washing the feathers. What if you washed the feathers in cold water with detergent? What if you used no detergent and water only? What if you used a different kind of detergent?

Ethics Review Request Form
4-H Canada Science Fair

Instructions

If your science fair project will involve the participation of humans or the use of animals, please complete this form and email it to Melina Found, mfound@4-h-canada.ca before beginning your project. Your science project will be reviewed and you will receive a response regarding project appropriateness or special measures that should be taken from the 4-H Canada Ethics Committee. Please refer to the 4-H Canada Science Fair guidebook available at 4-h-canada.ca/4HCanadaScienceFair for more information.

Project Title			
	First Name	Last Name	Email
Member 1			
Member 2 (if applicable)			

Questions to Be Addressed in Your Description (next page)

1. **Is your project using vertebrate animals or cephalopods?**
   a. Describe your proposed project in a paragraph.
   b. Describe any special precautions you will take.
   c. Where will you carry out these experiments?
   d. Who will be your scientific supervisor and what are his/her qualifications?
   e. Where will you obtain the animals?
   f. How will they be cared for during your project?
   g. What will happen to the animals after your project is finished?

2. **Is your project involving human participation?**
   a. Describe your proposed project in a paragraph.
   b. Describe any special precautions you will take.
   c. Where will you carry out these experiments?
   d. Who will be your scientific supervisor and what are his/her qualifications?
   e. How many people will participate in your experiment?
   f. What are the age ranges of the human participants?
   g. Include the Informed Consent Letter of Information and Permission Form you will use. These *provided templates are the forms participants will sign when agreeing to participate in your project.*

Got Guts? Cow Descriptions

Tear and chop food.
Muscle contractions force food through this tube and into the stomach.
Good bacteria help the cow digest her food and provide her with protein and energy.
Brings the undigested feed back up the esophagus in the form of cud, to be re-chewed.
Folds regulate flow of partially digested food to the fourth chamber.
Prepares the nutrients that are present for absorption in the small intestine.
A tube-like structure that absorbs nutrients into the bloodstream.
Removes water and minerals from the undigested matter and forms solid waste that can be excreted.

Got Guts? Cow Labels

Teeth
Esophagus
Rumen
Reticulum
Omasum
Abomasum
Small Intestine
Large Intestine

Got Guts? Pig Descriptions

Tear and chop food.
Muscle contractions force food through this tube and into the stomach.
Muscles mix the food with acids and enzymes, breaking it into smaller, more digestible pieces.
A tube-like structure that absorbs nutrients into the bloodstream.
Removes water and minerals from the undigested matter and forms solid waste that can be excreted.

Got Guts? Pig Labels

Teeth
Esophagus
Stomach
Small Intestine
Large Intestine

Got Guts? Teacher Review

Teeth (Pig and Cow)
This part is the most distinctive and long-lasting features of mammal species. To an animal, these are the tools that help them *tear and chew food*.

Cattle have flat teeth and enjoy eating grasses and grains. Pigs have a variety of teeth. They are omnivores and enjoy eating plants and animals.

Students place the description, "tear and chew food," near the teeth of both pig and cow models.

Esophagus (Pig and Cow)
This is the route food takes to get to the stomach, or rumen. *Muscle contractions force food through this tube and into the stomach.*

Students place the description, "muscle contractions force food through this tube and into the stomach," near the esophagus of both pig and cow models.

Stomach (Pig)
Species with a monogastric digestive system have this organ. This is where *muscles mix the food with acids and enzymes, breaking it into smaller, digestible pieces.*

Students place the description, "muscles mix the food with acids and enzymes, breaking it into smaller, digestible pieces," near the stomach of the pig model.

Rumen (Cow)
Cattle have one stomach with four chambers. This is the first chamber where *good bacteria help the cow digest her food and provide her with protein and energy.*

Students place the description, "good bacteria help the cow digest her food and provide her with protein and energy," near the rumen of the cow model.

Reticulum (Cow)
This chamber of the stomach sorts particles entering or leaving the rumen. This organ *brings the undigested feed back up the esophagus in the form of cud, to be rechewed.*

Students place the description, "brings the undigested feed back up the esophagus in the form of cud, to be rechewed," near the reticulum of the cow model.

Omasum (Cow)
This is a small chamber. It's *folds regulate flow of partially digested food to the fourth chamber.*

Students place the description, "folds regulate flow of partially digested food to the fourth chamber," near the omasum of the cow model.

Abomasum (Cow)
This chamber is most like the stomach of a monogastric animal. It *prepares the nutrients that are present for absorption in the small intestine*," it contains strong acids and digestive enzymes.

Students place the description, "prepares the nutrients that are present for absorption in the small intestine," near the abomasum of the cow model.

Small Intestine (Pig and Cow)
In both species, food travels through *a tube-like structure that absorbs nutrients into the bloodstream.*

The small intestine of a steer is 20 times the animal's length. The small intestine of pig is approximately 15-20 meters.

Students place the description, "a tube-like structure that absorbs nutrients into the bloodstream," near the small intestine of both pig and cow models.

Large Intestine (Pig and Cow)
Despite its name, this structure is actually shorter than the small intestine. It *removes water and minerals from the undigested matter and forms solid waste that can be excreted*. This is the final structure food moves through before the animal defecates.

Students place the description, "removes water and minerals from the undigested matter and forms solid waste that can be excreted," near the large intestine of both pig and cow models.

MEETING 3 - GREEN FINGERS: PLANT SCIENCE

Objectives:

- Introduce members to Plant Science
- Have members follow proper procedures and documentation used in experiments
- Learn about plant science industry in Canada and careers

Roll Calls:

- What plant(s) have you grown on your farm/in your garden/in your house?
- Name a career that someone that works with plants can have.

Sample Meeting Agenda – 1 hr. 15 minutes plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes and Business	5 min
Judging Activity	Activity #15 - Judging	10 min
Topic Information, Discussion & Activities	Topic Information Passionate about plants? On the job as a plant scientist Cool jobs in plant science Activities ▪ Activity #16 - A plant’s favourite colour ▪ Activity #17 - Look! No soil! ▪ Activity #18 - Plant propagation without seeds ▪ Activity #19 - Cloning a living organism ▪ Activity #20 - Make a pop bottle ecosystem ▪ Activity #21 - STEM CHALLENGE: Make your own drip irrigator	30 min + Activities
At Home Activity	Choose one *At Home* activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

Passionate about plants?

Imagine experimenting with different ways to increase the amount of food a farmer can grow in order to feed our growing population. Or what if you could develop new or improved varieties of field crops to eliminate plant disease? These are all possible in the world of plant science.

Plant Scientists make a positive difference in the world by working on our most challenging problems:

- Producing enough food for a growing world population
- Breeding plants to tolerate heat/drought caused by climate change
- Developing sustainable cropping practices to produce healthful and nutritious food
- Investigating new methods to fight plant diseases
- Restoring damaged ecosystems
- Conserving species, through plant collections in gardens and arboretums, for future generations
- Creating sustainable non-food products using plant-based material (e.g. biological plastics).

On the Job as a Plant Scientist

Plant scientists work in a variety of environments. Some work in basic research to understand the how crops grow, such as determining the role of a particular gene in plant growth. Scientists in applied research use this knowledge to discover machinery and other mechanisms to improve the quality, quantity, or safety of agricultural products. Other plant scientists manage marketing or production operations in companies that produce agricultural chemicals, seeds, and machinery.

Examples of what plant scientists work on:

- Provide information and recommendations to farmers about how they can best use land and increase plant growth
- Conduct experiments to develop new or improved varieties of field crops, focusing on characteristics such as yield, quality, disease resistance, nutritional value, or adaptation to specific soils or climates
- Develop new or improved methods and products for controlling and eliminating weeds, crop diseases, and insect pests
- Conduct research to determine best methods of planting, spraying, cultivating, harvesting, storing, processing, or transporting horticultural products
- Conduct experiments regarding causes of bee diseases, and factors affecting yields of nectar pollen.

Cool Jobs in Plant Science

Plant Science graduates have gone on to a wide variety of careers, including:

- Plant technologist
- Plant biology technician
- Greenhouse manager
- Crop production manager
- Plant tissue culturist
- Plant propagator
- Floriculturist
- Landscape manager
- Crop advisor
- Fruit and vegetable producer
- Nursery crop producer
- Agrochemical sales representative
- Plant breeding technician
- Seed production/quality control technician
- Technologist industries
- Agriculture and horticulture consultant
- Farmer
- Irrigation Engineer
- Agrologist

To learn more about food sustainability, visit www.journey2050.com It takes users on a virtual simulation that explores world food sustainability.

Additional Resources:

- Canadian Society of Plant Biologists http://www.cspp-scpv.ca
- Plant Canada - Federation of Canadian Plant Science Societies http://plantcanada.ca
- Ontario Institute of Agrologists http://oia.on.ca
- Online films about Pollen & Pollination
- Jonathan Drori: Every pollen grain has a story (7:12)
  Pollen goes unnoticed by most of us, except when hay fever strikes. But microscopes reveal it comes in stunning colours and shapes -- and travels remarkably well. Jonathan

Drori gives an up-close glimpse of pollen, and introduces how it's been used in forensic cases, from murder hunts to identifying the sources of illegal drugs. Watch the film: http://www.ted.com/talks/jonathan_drori_every_pollen_grain_has_a_story

- Louie Schwartzberg: The hidden beauty of pollination (7:48)
  An amazing film showing pollination in slow motion with plants around the world. For anyone like me who's wondered why cacti have such incongruously large and beautiful flowers, the shots of bats pollinating cacti are a must see. A truly breathtaking resource. (Louie's film begins at 3.19)
- Jonathan Drori: The beautiful tricks of flowers (13:48)
  The extraordinary ways flowering plants have evolved to attract insects to spread their pollen: growing 'landing-strips' to guide the insects in, shining in ultraviolet, building elaborate traps, and even mimicking other insects in heat.

Additional Plant Science Experiments

10 Plant Experiments for Kids http://www.education.com/slideshow/plant-science-fair-projects/

- Botany Science Fair Projects http://www.education.com/science-fair/botany/?page=2
- Hands-On Lessons & Activities about Plants http://beyondpenguins.ehe.osu.edu/issue/polar-plants/hands-on-lessons-and-activities-about-plants
- Plant Scientist http://www.sciencebuddies.org/science-engineering-careers/life-sciences/plant-scientist#projectideas
- Plant Biotechnology http://www.apsnet.org/edcenter/K-12/TeachersGuide/PlantBiotechnology/Pages/Activities.aspx

Possible Guest Speakers

- Farmers
- Farm equipment representatives
- Greenhouse Owner
- Professional from any of the occupations listed under “Cool Jobs in Plant Science”

Career Resources

- Videos and stories about Plant Scientists at work http://www.plant.uoguelph.ca/stories_videos
- Ag Careers: Plant Scientists/Field Agronomists http://www.agcareers.com/career-profiles/plant-scientist-field-agronomist.cfm

BEFORE THE NEXT MEETING

Fresh Flowers Experiment

Materials:

- 2 fresh flowers
- Scissors
- journal to document the experiment.

It will take less than 5 minutes to set-up and up to 3 days to observe the results. Here’s what to do:

- Cut the stem off of one of the flowers using scissors.
- Place your 2 flowers (1 with the stem, 1 without a stem) in a safe place.
- After an hour, check the plants and write any noticeable differences in your 4-H Record Book.
- Next, wait 24 hours and check the plants again, notating the differences in your 4-H Record Book.
- Repeat step 4 for an additional 2 days. What is happening to the plants?

DIGGING DEEPER I

For senior members

When natural light shines on a plant, that plant takes in the light from the different wavelengths and uses it to make food. This natural light is called white light, and it contains all of the types of light. If there's only one colour of light shining on a plant, then only some of the pigments work, and the plant doesn't grow as well. This is why your plant under the full light spectrum grew better than the plants with the cellophane filters.

How do plants move? They do so with the help of chemicals called auxins. Think of auxins as an elastic band for cells. They help cells get longer and move.

Why don't plants move toward green light? Plants are green, which means that they reflect green light. It bounces off the leaves. This means that they can't use green light very well, and the green light bounces off the plant instead of encouraging movement toward the light.

Senior Activity: Make it Bloom

Some common ornamental plants are day length sensitive plants requiring specific light conditions to initiate bloom. Poinsettia and chrysanthemums are short-day plants. To set bloom, the night (dark period) must be longer than 12 consecutive hours. Some plants are so sensitive that if the dark is interrupted by even a blink of light the plants will not bloom.

- For this activity, set up an experiment with a chrysanthemum plant (that is not yet in bloom) and force it to bloom with the knowledge you have gained about phototropism. Remember to record all of it as a scientific experiment!

DIGGING DEEPER II

For senior members

GMO's — or genetically modified organisms — refer to the plants or animals created through the gene splicing techniques of biotechnology. Genetically engineered is also a common term used as GMO. The first GMO crop (the Flavr Savr tomato) was approved in 1994. Since then, varieties of corn, soya, sugar beets and canola have become common local crops in Canada.

- Research and explain how new plants are made using genetic modification.

DIGGING DEEPER III

For senior members

Do some research about hydroponics and find the answers to these questions:

- What are the basic types of hydroponic systems?
- Why does Hydroponics work so well?
- Is pH important in hydroponics?

DIGGING DEEPER IV
For senior members

Can a Venus Flytrap Count?

Objective:

- To investigate a carnivorous plant's trigger response and food digestion.

Materials:

- 3-5 Venus Flytrap plants (quantity of plants depend on number of members in the club, if you will pair or group them, etc.)
- Fine pin or needle (one per group or one per person)
- Stopwatch
- Very small pieces of items to put in the plant: soil, insect, piece of food, water, tiny stone, piece of a leaf, etc.
- Magnifying glass (optional- to observe plant hairs up close)

Instructions:

Background Information

Carnivorous plants, or meat eaters, use the sneakiest of tricks to trap their insect dinners. Take bladderworts, for example. They appear so small and delicate growing in a quiet pond. But these are the fastest-known killers of the plant kingdom, able to suck in unsuspecting mosquito larvae in 1/50 of a second using a trap door! Once the trap door closes on the victim, digestive enzymes similar to those in the human stomach slowly consume the insect. When dinner is over, the plant ejects the remains and is ready to trap again.


Image Credit: https://www.britannica.com/plant/bladderwort

Bladderworts can be found in lakes, streams, and waterlogged soils around the world

Investigation #1: Can a Venus Flytrap count? Does it have a memory?

1. Examine 3-5 open Flytraps. Do not touch them! Look for the trigger hairs. How many are there on each side of the trap? Is there the same number of trigger hairs in all Flytraps? Record this information.
2. Use a very fine pin or needle and a stop watch to investigate the following:
   - Touch 1 hair once and note the response.

- Touch 1 hair twice in quick succession (e.g. 1 second)
- Touch 1 hair twice with a longer interval (e.g. 1 minute)
- Touch 1 hair once and then another hair on the same side once. And so on.

3. As soon as you touch the trigger hair the second time, use a stop watch to measure the time it takes the trap to close. Repeat this with as many traps as possible. Record your results.
4. Find the average closing time from your results.

Investigation #2: Flytrap digestion

1. Sometimes a Flytrap will close on something which is not suitable 'food' e.g. a soil particle. If this happens it will open again without trying to digest it. Investigate this by placing very small quantities of different substances in closed traps and observe if they open. Examples: soil, insect, piece of food, water, tiny stone, piece of a leaf, etc.
2. Record your observations.

Discussion:

1. How does the Flytrap know when to close and when not to close?
2. What sort of substances did the plant digest and which did it "refuse"?
3. How does the plant know what to digest?
4. Does the trigger timing affect the speed of Venus Flytrap closure?

Venus Flytraps come from bogs and marshes where the soil is very acidic and minerals and other nutrients are scarce. The vast majority of plants could never survive in an environment like this because they would not get all the vitamins and nutrients and energy sources they need from the soil to grow. But Venus Flytraps evolved. Specifically, they evolved to thrive in exactly these low nutrient environments by finding other ways to get the nutrients it needs. And that´s where the insects come in. Insects provide a great source of nutrients like nitrogen and phosphorous and carbohydrates that are missing from the soil in the typical Venus Flytrap environment.

ACTIVITIES

Activity #15 - Judging

1. Judging produce (bring in any produce that is in season). Consider: What are the qualities you look for in an apple? What are you looking for when judging? Why do you think one item is better over another one? Criteria to consider: shape, colour, maturity, appeal, etc. **Optional**: Refer to the Fruit & Vegetable scorecard found in the 4-H Judging Toolkit.

2. Alternatively, bring in any items (Leader or members) to judge.

    - **NOTE:** For each activity, encourage members to use the handout "A record of our experiment" OR to record their notes and findings in their 4-H Record Book

ACTIVITY #16 – A Plant's Favourite Colour: Plant Phototropism (45 minutes- day one; 7 days- total)

Objective:

- To determine if plants bend toward certain colours of light.

Materials:

- 4 1-foot tall cardboard boxes with lids
- Piece of cardboard
- Ruler
- 4 small lamps
- 4 full spectrum light bulbs
- Box cutter knife
- Masking tape
- 1 3" x 3" piece each of clear, red, blue and green cellophane
- Water
- Spray bottle
- Camera
- 4 bean seeds (plus extra to ensure germination)
- 4 small pots (plus extra to ensure germination)

Instructions:

You can change this experiment by using only two of the colours (clear and red, for example) instead of all four colours. Fewer materials will be required.

1. First, get your plants growing. Plant one bean seed in each of the four different pots,

water them, and wait for them to poke out of the ground. NOTE: It might be a good idea to grow extra pots of seeds just in case you don't get 100% germination.

2. After your seeds have germinated, get your boxes ready. Cut a hole 2" in diameter about 3 inches from the bottom of each box. Place the clear cellophane over the hole of one box. This will let all of the light into the box. Over the hole in the second box, place the red cellophane. This will only let red light into the box. In the third and fourth boxes place the blue and green cellophane.
3. Put one plant in each of the boxes. Use a ruler to position each bean plant two inches away from the cellophane window. Take a photo of the plants, looking downward from the top of the box.
4. Put the boxes on different sides of the same room.
5. Now it's time to light things up! Put the lamps next to the boxes on the side with the cellophane window. Take out your ruler again and measure to make sure that the lamps are the same distance from the hole.
6. Put the lids on each box.
7. Every morning, turn on each lamp. Every night, turn off the lamps. Leave the plants to grow for a week.
8. After a week has passed, remove the lid and take a photo looking downward. Then remove the plants and take a photo from the front. Observe the plants and record your findings.

Discussion:

- Do the plants look different?
- Is one taller than the other?
- Is one twisted in a different direction?
- What are the reasons for differences in plant growth?

The control plants will do better than the plants that are only exposed to one wavelength of light. The plants will grow better in red and blue light than in green light. The plants will grow toward red and blue light but will not move toward the green light. Why?

Plants love the light, right? Yes, and no. Plants do love the light, but they like some wavelengths of light more than others. When you look at a rainbow, you can see that the visible spectrum of light actually has different colours or wavelengths inside it. The **visible spectrum** is the light that we can see. Different objects reflect different types of light. A blue bowl reflects blue light. A green plant reflects green light.

Inside a plant are **chloroplasts**. Inside the chloroplasts are tiny molecules called **photopigments**. Photopigments help the plant absorb light. A plant has different types of photopigments so it can absorb different colours of light.

Open-Ended Inquiry Questions:

- Compare the photos of each bean plant after it had been growing for a week. Did the plants turn more toward a certain colour? Was there a colour they didn't like?

Activity #17- Look! No Soil! (30 minutes- day one; 7-10 days- total)

Objective:

- To determine whether a bean plant grows faster and taller using a traditional soil planting method or hydroponic method.

Materials:

- Bean plant seeds
- Four plastic plant pots
- One bag of potting soil
- Two- to four gallons of distilled water
- Two peat pellets
- Two potting nets for hydroponic growing
- Ruler
- 4-H Record Book

Instructions:

1. Prepare two soil pots with potting soil. Plant bean plant seeds about ¼ to ½ inch into the soil and cover loosely with a sprinkling of soil on the top. Give the plants plenty of sun and keep them in the same climate. Any variables between the soil and hydroponic plants can affect the experiment, so try to keep variables nonexistent or at a low.
2. Prepare the hydroponic growing pots by placing the seeds in a peat pellet and saturating with water to cause them to "puff up." Make sure the bean plant seeds are covered by a little bit of peat before "planting."
3. Fill the other two pots with distilled water. Place the hydroponic potting nets on top of the pots, making sure that the water touches the nets. Place the peat pellets with the seeds inside the nets.
4. Water the soil plants every three days or when the soil feels dry to the touch. For the hydroponic pots, sprinkle a little water on the peat pellet to keep the pellet moist. As the roots grow, they will grow down into the pot of water. Remember to keep the pot full!
5. Observe, record, and analyze: Measure the hydroponic bean plants and the soil plants every three days or so. Determine a good schedule in which to measure the plants. Record in millimeters how tall the plants are getting and how quickly they are growing. Compile a chart of the results.

Discussion:

- Which method of growing the bean plants worked the best?
- Which produced the fastest growth?
- Which produced the tallest growth?
- Overall, which do you think was the better medium – soil or water?

Optional activity – Invite a hydroponics farmer or equipment supplier as a guest speaker.

Open-Ended Inquiry Questions:

- Would the results change if you used a different type of seed to grow?

Activity #18 - Plant Propagation without Seeds (4 weeks)

Objective:

- To determine how different growth media affect the development of roots in newly propagated plantlets.

Materials:

- 12-ounce (oz.) Styrofoam cups, to be used as potting containers (9)
- Masking tape
- Permanent marker
- Soilless potting mix, sterile (1 bag); available at any plant nursery
- Vermiculite (1 bag); available at any plant nursery
- Water, tap
- Bases for potting containers, such as small plastic plates or bowls
- Spider plant - it should be healthy and have lots of plantlets hanging from it.
- Rubbing alcohol
- Scissors
- Scale, accurate to 1 gram (g)
- Pencil
- Ruler
- Plastic bags, 1-gallon (9)
- Magnifying glass
- Watering can, 1-gallon
- 4-H Record Book
- Graph paper, or graphing software
- Helper

Image Credit: https://s-media-cache-ak0.pinimg.com/736x/8e/cd/45/8ecd4531bded3d951799f66217c2b87d.jpg

Instructions:

Introduction

Did you know that apple trees do not “breed true”? This means that if you plant seeds from an apple, say a Granny Smith, you will get apple trees, but they will make apples that are actually different than Granny Smiths. So how do farmers produce new Granny Smith trees? They use a method called *vegetative propagation.* For instance, they may cut a branch off of a tree that grows Granny Smith apples and attach (graft) the branch onto a different tree trunk. This method of making new trees is called *vegetative,* or *asexual propagation* because the tree was not produced by the usual mixing of pollen (male) and ovule (female) to form a seed. In this activity, you will investigate the factors that influence the success of vegetative propagation, using a *spider plant.*

Process:

1. Label three containers, using the masking tape and permanent marker, as follows:
    a. Sterile potting mix. Date:___
    b. Vermiculite. Date:___
    c. Water. Date:___
2. It is important to include the date, as you will be staggering the start dates.
3. Fill the labeled plant containers with the appropriate planting **media**. Leave about 3 cm of space at the top. Two pots should have solid media, the other should just have water.
4. Poke three small holes in the bottom of the containers that are holding the potting soil and the vermiculite, for drainage. Keep them on bases, such as small plastic plates or bowls.
5. Water the potting mixture and the vermiculite. Add water so that the growth medium is moist, but not saturated. Allow it to drain completely.
6. Record the entire procedure in your 4-H Record Book.
    a. Make a data table showing the type of planting media and the date.

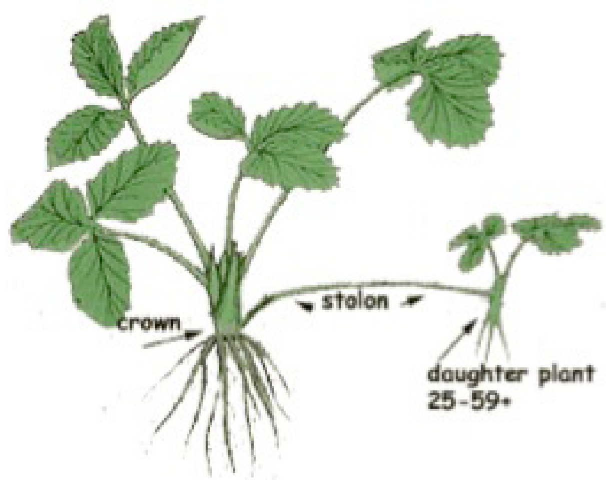


Image Credit: http://www.slideshare.net/raiuniversity/bsc-agri-i-po-h-unit-2-method-of-plant-propagation-and-planning-orchard

7. Cut off three plantlets from the spider plant.
    a. Prior to cutting, sterilize the scissors with rubbing alcohol.
    b. Use the scissors to cut each stolon (stem) attached to the plantlet.
8. Use the ruler to measure the length of the leaves on each plantlet. Record the leaf length in your 4-H Record Book.

9. Create a 1-cm hole in both of the solid planting media with a pencil.
10. Carefully place the base of one plantlet into each hole you made in your planting media and gently push in the growth medium around them.
11. Place the third plantlet in the cup with water. Place it so that base of the plantlet is in the water and the sides of the container support the foliage.
12. If the plantlet is too small for the container, use a smaller container.
13. Place a plastic bag over each container. The bags will keep the humidity high and hold in heat. *Note:* Do not seal the bags completely, as you want to allow some airflow.
14. Place the containers with the plantlets in a warm area with indirect lighting.
15. Don't put them into full sunlight until new growth appears and they can be removed from the bag.
16. Repeat steps 1–15 two more times, on different days, so that you have three sets of plants growing.

Caring for the Plants

- Check your plants regularly. If there is condensation in the bags, remove the bags temporarily to let the plant dry out.
- Keep the solid media moist, but not saturated.
- When the roots of the plantlet that is in the water are about 2 inches long, check for roots in the plants in the solid media by tugging gently on the cuttings and testing for resistance. If no roots have formed, or if they are very small, put the cutting back into the media, recover it with the plastic bag, and check for roots again in 1–2 weeks.
- Once the cuttings have developed roots, they are ready to be analyzed.
- Use your judgment about when to start processing (measuring and observing) the plants. Ideally, all of the plants should have developed roots. But if most of the plants have developed roots and some fail to grow, go ahead with the processing of the growing plants. Record all observations, including those about the plants that did not grow, in your 4-H Record Book.

Analyzing the Plants

- Process the plants after an equal period of growth. For example, if you started three sets of plants on three consecutive days, perform the weighing and other processing on three consecutive days, too.
- Record the number of plants that were successfully propagated in each of the growth media.
- Record the height of each plant.
- Record the leaf length for each plant.
- Determine the change in the leaf length for each plant.
- Pull the plants that are in the solid media out of the soil and look at the root systems.

- Make notes in your 4-H Record Book about your observations. Are the roots dense or thin?
- Rinse the roots out thoroughly in running water.
- Dry the plants.
- Count the number of roots on each plant.
- Weigh each plant on the kitchen scale.
- Repeat steps 2–11 for the rest of the trial sets on the appropriate day.
- Graph your data, showing the kind of planting mix on the x-axis. Graph the number of plants that grew, the average height, the change in the leaf length, the number of roots, and the plant weight.

Discussion:

- Did the kind of growth medium affect the ability of the plantlet to form roots?

Open-Ended Inquiry Questions:

- What variables could you change to alter the experiment? For example: What would happen if you repeat the procedure, but use more plantlets? What if you tried other growth media, such as soil from your backyard, or sand?

Additional Resource:

- See the Science Buddies page, Measuring Plant Growth for more information about how to measure your plants. http://www.sciencebuddies.org/science-fair-projects/project_ideas/PlantBio_measuring_growth.shtml

Activity #19 - Cloning a Living Organism (40 minutes day 1; 2-3 weeks total time)

Objective

- To learn about genetic cloning via plant cuttings.

Materials: (per group)

- White tile
- Scalpel
- Plant pot, 10 cm diameter
- Compost, enough to fill the pot
- Plastic bag
- Beaker, 100 cm3
- Magnifier or hand lens

Materials (Preliminary set up by the Club Leader or Senior Members):

- Plants from which cuttings can be taken – busy lizzie (*Impatiens*) and pot geranium (*Pelargonium spp*) are ideal.

Instructions:

NOTE: Rooting powder contains hormones that could promote rooting, but there is some evidence that the main way it promotes root formation is by its fungicidal action. This is very hard to test, but it could be interesting to see if the rooting powder has any effect, by comparing cuttings treated with and without rooting powder.

Preparation:

1. Ensure you have enough cutting material for each student or pair.
2. Buy some rooting powder; if you decide to compare plantings with and without rooting hormones, make up a substitute powder (see **Note** above).

Investigation:

1. Collect a pot filled with compost, a white tile and a scalpel.
2. Cut off a non-flowering stem from the plant to be used. Choose a section about 10 cm long.
3. Trim the cutting by removing all but the top pair of leaves, or the top two pairs. Cut through the stem on an angle at one of the places where you have removed some leaves.
4. Take a close look at the end of the stem. Use a magnifier.
5. Choose which rooting powder to use.
6. Dip the cut end into the rooting powder, then push it firmly into the middle of the compost so that the cut end is at least 3 cm under the surface.
7. Collect a plastic bag and a small beaker of water.
8. Put the pot in the bag. Pour in the water. Seal the bag.
9. Take the cutting home and keep it moist – but not soaking – in water. You can take the bag off after 2-3 days, and leave the cutting on a saucer on a windowsill. Keep watering every 2-3 days.
10. Make notes of the features of the original plant.
11. Keep the original plant for comparison if it has not been entirely used up in making cuttings.
12. Collect observations of the cuttings after 2/3 weeks (or more) to compare with the original plant.

Discussion:

- What changes did you observe in your cuttings?
- How does your new growth compare to the original plant?

Some of the features of the cutting such as leaf shape, leaf colour, and flower colour (revealed as the cutting develops) depend on the genetic make-up of the plant. Other features such as number of leaves and height of cutting are strongly influenced by environment. All the cuttings have been kept in different conditions (members' home windowsills), so there should be significant variation in the features affected by environment and no variation in the features determined by genetics.

Taking cuttings is a simple method for producing large numbers of plants with the same genetic composition. This can be valuable in commercial production of plants in demand for horticulture, particularly rare plants such as orchids.

Plants occasionally produce 'sports' – when a mutation in the growing tissue changes a characteristic of the plant. This might result in a single branch with significantly different leaves, flowers or fruit from the rest of the plant. Cuttings may resemble the 'sport' or revert.

Plants grown from cuttings will be genetically identical to one another and to the parent material, whereas plants grown from seed show significant variations.

Open-Ended Inquiry Questions:

- Would the results change if you didn't use rooting hormone powder?
- What if you tried cutting other parts of the plant; would it work?

Activity #20 - Make a pop bottle ecosystem (45 minutes)

Objective:

- To learn about and create an ecosystem and to be responsible to care for living creatures.

Materials: (per individual or group)

- 2 litre plastic bottle, clear (and emptied)
- Knife (to cut plastic bottle)
- Scissors
- Aquarium rocks
- Water, room temperature
- Goldfish
- Coffee filter papers x 2 per group/individual
- String
- Plants
- Potting soil

Instructions:

1. Cut the top off the bottle, just below where the straight sides begin on the bottle. Seniors members can do this for younger members to do this, safely.
2. Next add some aquarium rocks, some water, and a few goldfish. Make sure you use water your goldfish are acclimated to temperature wise. If you leave the water sitting out at room temperature for a few hours before you add it to the goldfish water it will be fine.
3. Now get two coffee filter papers and cut two small holes in the center. Cut a piece of string long enough so it can reach from the top of the bottle down to the water with the goldfish. Tie a knot in one end of the string. Thread the un-knotted end through the top of the filter papers, through the little holes you made. Set the filter paper down inside the inverted top of the bottle that you already cut off.
4. Place the plant into the coffee filter inside the inverted top of the pop bottle. You may need a little extra potting soil to fill up the space. The base of the plant should end up about level with the upper cut edge of the pop bottle.
5. Place the plant and top of the bottle into the lower part of the bottle, the part with the goldfish in it, so that the string dangles down into the water.

Discussion:

Be responsible! When you are finished making the Pop Bottle Ecosystem, take it home and place it in a windowsill. Now you are responsible for this ecosystem and the fish! Discuss how the club members must feed the fish each morning, without reminders. Explain how much food to give the fish, just a flake, or two if the flakes are small. Talk about responsibility.

What is an ecosystem? A system is a set of interconnected processes that depend on each other for their function. An ecosystem is a particular interconnected zone where life exists. It includes the air, the water, the soil, the animals, the plants, and the bacteria in that zone. The space an ecosystem takes up depends on how a person defines it. The entire Amazon rain forest could be an ecosystem, but so could the life cradled in the water trapped in a single leaf high in the canopy of the rain forest. When scientists start to talk about a particular ecosystem they define the area they are talking about. The concept of an ecosystem is used to help people understand how living things interact with each other and with the non-living things in their environment. It helps us see that life is interconnected and when one living thing or species is affected so are they all. We see how materials, like water, are cycled through the whole ecosystem to benefit each part of it. The fish and the plants and the soil are all affected by the same water, for example.

Activity #21 - STEM CHALLENGE: Make Your Own Drip Irrigator (45 minutes)

Objective:

- To design and build your own cost-effective, drip irrigation system.

Materials:

Provide teams with a variety of items and tools to design and create their own system:

- 2-Litre plastic soda bottles (with caps)
- Nails
- Hammer
- Drill
- Plastic tubing

Instructions:

1. Divide participants into pairs or teams.
2. Instruct them to design and build a drip irrigation system using any of the items you have provided for them.

NOTE: A Senior Member or Leader should help each group when using the drill, nails and hammer.

Discussion:

- Compare your irrigation system with other members/teams. Explain why you designed the system in the way you did.
- What is your hypothesis about your system? What do you expect will happen when you start using it at home?

One member from each team must take their drip irrigation system home to test (either in a potted plant or in the ground). Come to the next meeting with your results.

Web Resources:

- http://www.wikihow.com/Make-a-Drip-Irrigator-from-a-Plastic-Bottle
- http://yougrowgirl.com/make-your-own-pop-bottle-drip-irrigation-system/

Open-Ended Inquiry Questions:

- What changes did you have to make at home to improve the irrigation system, if any?
- What did you learn about designing a product versus testing it to make sure it works?

MEETING 4 - WACKY WEATHER EXPERIMENTS

Objectives

- Introduce members to Weather/Environmental Science
- Have members follow proper procedures and documentation used in experiments
- Learn about the weather industry in Canada and careers

Roll Calls

- Why do you think Canadians like to talk about the weather so much?
  (According to David Phillips, senior climatologist at Environment Canada, much of our apparent obsession arises from the fact that we live in such a large, geographically diverse country with weather patterns that can vary widely from province to province, season to season and even day to day.)
- What is the worst or most diverse weather event you have ever seen?
- If you could be a storm chaser, what type of weather would you want to see the most?

Sample Meeting Agenda – 1 hr. 15 minutes plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes and Business	5 min
Judging Activity	Activity #22 - Judging	10 min
Topic Information, Discussion & Activities	Topic Information What is weather? Weather forecasting Weather & technology Severe weather Cool (and hot) weather careers Activities ▪ Activity #23 - What is the greenhouse effect? ▪ Activity #24 - Make a thermometer ▪ Activity #25 - Measure wind speed with your own wind meter ▪ Activity #26 - A partly cloudy experiment ▪ Activity #27 - Make Lightning ▪ Activity #28 - STEM CHALLENGE: Severe Weather Safety	30 min + Activities
At Home Activity	Choose one *At Home* activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

What is Weather?

The term weather describes the state of the atmosphere at a given point in time and geographic location. And the main purpose of "telling the weather" (meteorologist) is to get the weather information out to the public quickly. No matter how perfect the forecast, if it does not reach the public in time, it has no value. As a result, the Canadian weather service has always been one of the largest users of telecommunications services in Canada, creating and changing technologies to deliver more weather information to more people, more quickly.

Weather Forecasting

Weather forecasts are made by collecting as much data as possible about the current state of the atmosphere (particularly the temperature, humidity and wind). Weather forecasting is a prediction of what the weather will be like in an hour, tomorrow, or next week. Weather forecasting involves a combination of computer models, observations, and a knowledge of trends and patterns. By using these methods, reasonable accurate forecasts can be made up to seven days in advance.

Weather & Technology

In the 1920s, the weather service changed with the technological breakthrough of the wireless radio. Information could be gathered from hundreds of remote weather stations across the country and transmitted to isolated logging camps, island communities and even ships at sea. Today, you can get a weather update or alert on your phone or other devices as soon as a meteorologist has the information!

Severe Weather

Severe weather events such as tornadoes, tropical storms, hurricanes, floods, lightning strikes and extremes of heat or cold can be costly and deadly. Knowing how to recognize threatening weather conditions, where to get reliable information, and how to respond to this information can help save lives.

FUN FACT!

Canadians are weather nuts! Nine in ten Canadians say they make a point of checking weather forecasts at least once a day.

Try This!

Turn on a fan. Stand in front of it. You will feel colder because of the wind cooling your skin, but the temperature in the room has not changed. You cannot make the room any colder, no matter how high you turn up the fan. Similarly, no matter how strong the wind blows, the temperature of the air outside does not change. Now dab some water on your skin. Stand in front of the fan again. The wet skin will feel much colder.

Discussion:

Anyone who has ever waited at a bus stop or taken a walk on a blustery winter day knows that you feel colder when the wind blows. We call the cooling sensation that is caused by the combined effect of temperature and wind, the wind chill.

On a calm day, our bodies insulate us somewhat from the outside temperature by warming up a thin layer of air close to our skin, known as the boundary layer. When the wind blows, it takes this protective layer away, exposing our skin to the outside air. It takes energy for our bodies to warm up a new layer and, if each layer keeps getting blown away, our skin temperature will drop and we will feel colder.

Wind also makes you feel colder by evaporating any moisture on your skin - a process that draws more heat away from your body. Studies show that when your skin is wet, it loses heat much faster than when it is dry. This fan experiment demonstrates how important it is to stay dry when outdoors in cold and windy conditions!

Cool (and Hot!) Weather Careers

Meteorologist

In a meteorology job, you use software tools to assess current and future weather conditions. Most meteorologists work in weather stations or labs and report their predictions (or forecasts) on future temperatures and conditions.

Climatologist

The primary difference between a meteorologist and a climatologist is that climatologists study weather patterns and trends over a long period of time as opposed to making short-term predictions. The long-term studies by climatologists are used to develop assessments of historical climate conditions in various cities, provinces, regions, countries and continents. Climatologists also watch for any significant changes in climates over time, which may affect long-term future weather conditions in an area.

Storm Chaser

Storm chasers develop weather and climate reports using charts, graphs and computer software as well as up-close-and-personal experience and photographs of tornadoes, rain storms, hurricanes and other natural phenomena. These people are definitely thrill seekers!

Environmental Scientist

Environmental scientists study nature to monitor and discover potential threats to natural resources and populations. Much of their research involves taking samples of air, water and other natural substances to identify harmful threats or changing conditions. Careers in this field of science emphasize study of the impact of climate changes and environmental conditions on people, animals and plant life.

A Canadian Invention!

Where else but in Canada could the snowblower be invented! It was invented by Arthur Sicard in 1925 in Montreal.

Additional Resources

- Environment and Climate Change Canada https://www.ec.gc.ca/default.asp?lang=en&n=FD9B0E51-1
- Sky Watchers: Interactive Meteorology for Students and Teachers http://ec.gc.ca/meteoaloeil-skywatchers/
- Canada's Top 10 Weather Stories (annually) http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=3318B51C-1
- 10 Surprising Facts about Canadian Weather http://www.canadiangeographic.ca/article/10-surprising-facts-about-canadian-weather

Additional Experiments

- Weather Wiz Kids http://www.weatherwizkids.com/weather-experiments.htm
- Weather Experiments http://www.srh.noaa.gov/bmx/?n=kidscorner_weatherexperiments
- Web Weather for Kids https://eo.ucar.edu/webweather/activities.html

Possible Guest Speakers

- Representative from Environment and Climate Change Canada
- Meteorologist from your local TV station
- Climatologist
- Coast guard
- County/district emergency management coordinator

BEFORE THE NEXT MEETING

Predicting the weather without technology

- For a period of a week, use one or more of the techniques listed on the handout (at the end of this meeting) to predict the next day's weather. The following day, record the actual weather, using a professional forecast from a weather website. Which techniques are the most accurate at predicting the weather? Which are the worst?

Predicting the weather with homemade technology

- For a period of a week, use homemade measurement instruments, like a hygrometer, barometer, and weather vane to predict the next day's weather. The following day, record the actual weather, using a professional forecast from a weather website. You will need to do research on what these instruments are, and how to build them yourself. Which instruments are the most accurate at predicting the weather? Which are the worst?

DIGGING DEEPER I

For senior members

We see meteorologists on TV or online, telling us what the weather will be for the next few days. But what do they do for the rest of the day? Research the occupation of a meteorologist using web resources or try and conduct an interview with a meteorologist. Maybe your club can have a meteorologist come in as a guest speaker. Find out the education needed to be a meteorologist, which schools in Ontario offer these programs, and what a day in the life of a meteorologist is like.

DIGGING DEEPER II

For senior members

Earth's two closest neighbours, Venus and Mars, have very different atmospheres than Earth does in pressure and chemical composition. For this activity, research the differences in atmospheric gases in Earth, Venus and Mars. Materials you will need:

- Coloured jelly beans (or similar materials) to represent gases in the atmosphere
- Re-sealable plastic bags

Use the jelly beans (or any other items) to represent the atmospheric gases with different coloured beans (e.g. Nitrogen are red jelly beans; Oxygen are green jelly beans, etc.) placed in the plastic bags. You will have to translate percentages into numbers of jellybeans, and in many cases, will face the difficulty of cutting the jellybeans into small enough pieces to represent small atmospheric concentrations.

DIGGING DEEPER III

For senior members

Build an entire weather station, adding on to the anemometer made as one of the activities in this reference manual (activity #25).

See handout: Build your own weather station (see information at the end of this meeting)

ACTIVITIES

Activity #22 – Judging

1. Judge a variety of weather tools (rain gauge; thermometer; etc.)
2. Alternatively, bring in any items (Leader or members) to judge.

NOTE: For each activity, encourage members to use the handout "*A record of our experiment*" **OR** to record their notes and findings in their 4-H Record Book.

Activity #23 - What is the Greenhouse Effect? (20 minutes plus 60 minutes wait time)

Objective:

- To explore how greenhouses gases affect temperature.

Materials:

- Bowls x 2
- Water
- Plastic food wrap
- Bright light or a sunny day
- Thermometer
- Pen and paper

Instructions:

1. Fill both bowls with the same amount of water.
2. Measure the temperature of the water in each bowl. Record it on a piece of paper.
3. Cover one of the bowls with plastic food wrap.
4. Place both bowls under a bright light source or in the sun.
5. Make a prediction on how you think the temperature will change in each bowl.
6. After an hour, measure the temperature of the water in each bowl. Record again. How has the temperature changed in each bowl?

Discussion:

- What is the purpose of the plastic wrap? What is it doing?
- Greenhouse effects happen naturally, but what are humans doing to make it worse?

The plastic wrap acts like carbon dioxide in the atmosphere trapping most of the heat energy

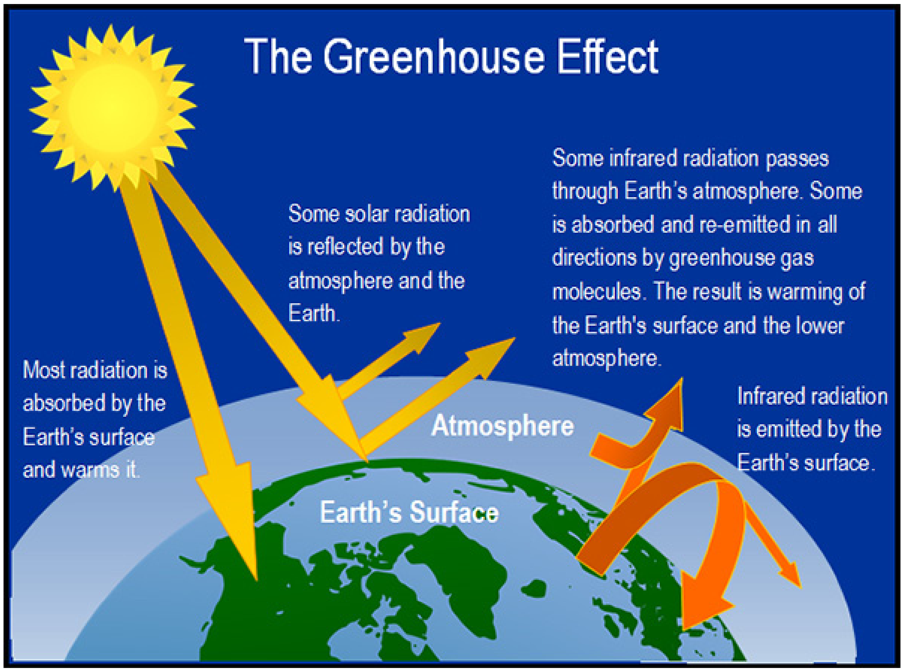


Image Credit: Let's Talk Science http://www.letstalkscience.ca/programs-resources/activities/item/what-is-the-greenhouse-effect.html?category_id=14

that would otherwise escape. Then, the heat energy from the air (a gas) is being transferred to the water (a liquid), which warms up the water.

The Earth absorbs some of the energy it receives from the sun and radiates the rest back toward space. However, certain gases in the atmosphere, called greenhouse gases, absorb some of the energy radiated from the Earth and trap it in the atmosphere. These gases essentially act as a blanket, making the Earth's surface warmer than it otherwise would be. While this greenhouse effect occurs naturally, making life as we know it possible, human activities in the past century have substantially increased the amount of greenhouse gases in the atmosphere, causing the atmosphere to trap more heat and leading to changes in the Earth's temperature.

Open-Ended Inquiry Questions:

- How can you alter the experiment to trap even more heat, mimicking how human activities are also increasing the Earth's temperature?
- What variables would you change or keep the same?

Activity #24 - Make a Thermometer (45 minutes)

Objective:

- To observe how a thermometer works.

Materials:

- Glass bottle
- Clear plastic straw
- Cold water
- A large bowl or container of hot water (big enough to place the filled glass bottle into it)
- Food colouring
- Modeling clay
- Oven gloves (to remove hot bottle from one container to another)

Instructions:

Begin by talking about energy:

- Heat is a kind of energy.
- Thermometers are tools used to measure temperature.
- We are going to see how a thermometer works by making one.
- Then we will use thermometers in a short experiment using the scientific method.

Image and Video Source: https://www.youtube.com/watch?v=IlflLvYIn3U&sns=em

Procedure:

1. Add food colouring to the glass bottle and fill it with cold water.
2. Insert the straw a couple inches into the bottle and mold the clay around it to seal the bottle and hold it in place. When you have a tight seal, water should go up into the straw.
3. Use a marker to mark the level of the water in the straw.
4. Set the bottle in a large bowl or container of hot water. Watch the water level and then mark the level again.
5. Using your oven gloves, carefully (consider using gloves) move the glass bottle into a bowl of cold water and watch what happens, then mark the level.

Discussion:

- Why did the water go up the straw? What did you do in your experiment that caused this to happen?
- Are you really measuring temperature with this experiment? Explain your answer.

As water heats up, it expands and becomes less dense, rising to the surface. When it cools down, it contracts, becoming denser and sinking down. This cycle is called **convection**. (Water is unique, however - when it gets cold enough to freeze, the molecules line up in an open crystalline structure that is actually less dense than the liquid form. This is why ice floats.) When the water in your bottle thermometer heated up, it expanded. But since the bottle was sealed, it had nowhere to go but up through the straw.

Real thermometers don't use water inside because it doesn't respond to temperature change very quickly. With your homemade thermometer, you aren't actually measuring temperature, just seeing temperature changes. If you have a real thermometer, you can use it to make a scale on your homemade thermometer: let your bottle get to room temperature and then mark the straw with what the actual room temperature is. Then set the bottle in the sun and do the same. Mark several different temperature levels and then watch your thermometer for a day and see how accurate it is.

Open-Ended Inquiry Questions:

- Repeat the experiment but move the glass bottle into a bowl of ice (instead of cold water). Are the results different, and if yes, how?
- Try filling your bottle with 50% rubbing alcohol and 50% water. Does the liquid move up and down the straw faster? Why do you think this is?

Activity #25 - Measure Wind Speed with Your Own Wind Meter (45 minutes)

Objective:

- To build a device to measure wind speed.

Materials:

- Five three-ounce paper cups (such as Dixie Cups); all the same colour except for one of the cups
- Paper hole punch or sharpened pencil
- Ruler
- Two straws
- Pin
- Stapler
- Pencil with eraser
- Fan with different speeds (optional)
- Timer (optional)

Instructions:

Introduction:

- Have you ever wondered how wind is made? Wind is caused by a difference in air pressure. Air travels from areas of higher pressure to places where there is less pressure. And just as air flows out of the high-pressure inside an inflated balloon if the opening is not tied, air in the atmosphere will move to a lower pressure area, creating wind. The speed of that wind can be measured using a tool called an anemometer.

- An anemometer looks like a weather vane, but instead of measuring which direction the wind is blowing with pointers, it has four cups so that it can more accurately measure wind speed. Each cup is attached to the end of a horizontal arm, each of which is mounted on a central axis, like spokes on a wheel. When wind pushes into the cups, they rotate the axis. The faster the wind, the faster the cups spin the axis. How fast will your homemade anemometer whirl?

- Air is made up of tiny molecules. When molecules are heated, they move faster. Consequently, when air is heated, its molecules move faster and become spaced farther apart, which makes the air less dense (meaning that there are fewer molecules in a given volume). This also means that the air has a lower overall pressure. In comparison, cold air is made of more tightly packed molecules, and so it is denser and has relatively higher pressure.

- Because air pressures are inclined to balance out, when there is an area of relatively lower air pressure, the surrounding air in higher pressure areas moves in. This movement of air from a higher pressure area to a relatively lower pressure area is what generates wind. When wind pushes the cups on the anemometer, they spin around the central axis. How fast the cups revolve can be measured in revolutions per minute (rpm), or how many times one cup returns to the position where it started in one minute. Consequently, faster wind will result in a higher rpm than will a slower air movement.

Preparation:

- Prepare four cups this way: Punch one hole in the side of each cup, about one half an inch below the rim.

- For the fifth cup, punch four equally spaced holes in its sides, about one quarter an inch below the rim. Also punch one hole in the center of the bottom.

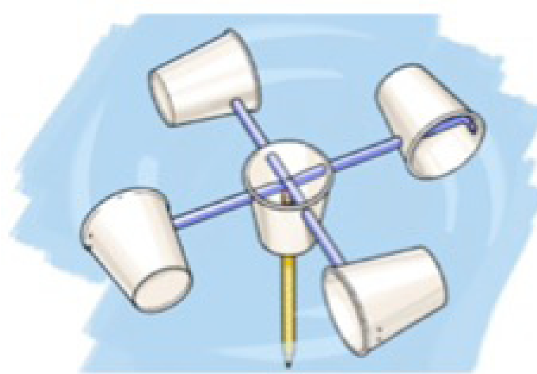


Image Credit: Scientific American *https://www.scientificamerican.com/article/bring-science-home-wind-speed/*

Procedure:

1. Take a single-hole cup and push a straw through the hole until about one inch of the straw is inside the cup. Make sure the straw is horizontal and staple it to the side of the cup. Repeat this with another single-hole cup and straw.

2. Push the empty end of each straw into one of the side holes in the five-hole cup and out the one across from it. Turn the cups so that they face the same direction. *Why do you think the cups should face the same direction?*

3. Push the empty ends of each straw protruding from the fifth cup into the other two single-hole cups until about one inch of the straw is inside each cup. Turn the new cups so all the bottoms of the cups face the same direction. Staple the ends of the straws to the side of each cup like you did for the first two cups.
4. After making sure all cups are about the same distance from the center of the five-hole cup, carefully push the pin through the two straws where they intersect, in the middle of the five-hole cup. Use caution when handling the sharp pin. *Why do you think it is important to use something as small as a pin for this?*
5. Push the pencil through the hole in the bottom of the five-hole cup, eraser-end first, until it reaches the straws. Carefully push the pin into the eraser.
6. The anemometer is now ready to measure wind speeds. While sitting down, try blowing very gently straight into one of the four open cups for a few seconds, then blow harder. *How did blowing harder change how the anemometer turns?* (If you feel light-headed or dizzy, stop and take a breather.) NOTE: Having one cup in a different colour will help with being able to count, especially if you decide to use a fan with different speeds.

If you are using a fan with different speeds:

- Hold the anemometer in front of the fan and count the number of times one cup completely turns around for 15 seconds, then multiply that value by four. This number will be in revolutions per minute (rpm). Repeat this while keeping the fan at the same distance, but changing its speed. *How did the rpm change when you held the anemometer in front of the fan at a slow speed compared with a faster speed? Compared with the faster speed, do you think the rpm would be greater if you used your anemometer outside on a very windy day?*

Discussion:

- What are we really feeling when the wind hits our skin?
- Why does a faster wind hit us harder?

Because air is made up of tiny molecules, when wind hits something it is all of these molecules that are hitting the object. This is why when we feel wind we are really feeling these molecules hitting us. A faster wind hits us harder, and also moves the cups on the anemometer more, compared with a slower wind, because the faster wind is moving the molecules at a faster speed. Consequently, in the same amount of time, a faster wind hits an object with more molecules than a slower wind does.

Open-Ended Inquiry Questions:

- Were you able to see wind make the cups on the anemometer spin around?
- Did the faster winds make the anemometer cups spin faster compared with the slower winds?

Activity #26 - A Partly Cloudy Experiment (45-60 minutes)

Objective:

- To simulate cloud formation by rapidly changing the temperature of water in a jar.

Materials:

- Glass jar with tight-sealing lid (such as a mason jar or clean pickle jar)
- Half a cup of very hot water (handled with caution and an adult's help)
- Half a cup of very cold water
- Aerosol spray can (use something clear, for example hair spray; you will only be using 2-3 sprays per experiment)
- Bowl of ice cubes
- Permanent marker or piece of tape
- Piece of black construction paper to help you visualize the cloud (optional)
- Food colouring to make your cloud stand out more (optional)

Instructions:

Introduction:

- Have you ever imagined what it might be like inside of a cloud? Did you know that if you were in one, you would get soaking wet? There are many different types of clouds, but one thing they have in common is that they're all made of water (or ice). But how do clouds form, and how is it possible that water can float above us in the air? In this activity you'll make your own cloud in a jar and get to test the conditions that are required to make a cloud form!
- In order to understand cloud formation, we need to understand the processes of vaporization (water going from a liquid to a gas) and condensation (water going from a gas to a liquid). If you've ever boiled a pot of water or watched one boil, you've seen water change from a liquid to a gas. In liquid form, water molecules are packed very close together. This proximity allows the formation of hydrogen bonds between individual water molecules, so that each water molecule is connected to the water molecules surrounding it. You can observe this by looking at a droplet of water on a flat surface. Instead of spreading out flat, the water droplet holds a rounded shape. The droplet can hold this shape due to the strength of hydrogen bonds between the individual water molecules that form the droplet.
- In this activity, you will simulate cloud formation by rapidly changing the temperature of the water in the jar. You will try different variables to determine what the important factors are in cloud formation—and how different conditions determine whether or not clouds form in the atmosphere.

Preparation:

- Pour half a cup of water into the jar and use a marker or piece of tape to mark the water level on your jar. Empty the jar.

- If you choose to use black construction paper, set it up against a wall or propped against a book near where you will be conducting your activity. This paper will serve as a backdrop—but you can't pick up the jar once you put the hot water in, so the paper should be right next to your workstation.
- Remove the lids from the jar and the aerosol spray so that they're ready to use.
- If you choose to use food colouring to dye the water, drop a few drops into both the hot and cold water before starting
- Gather all materials and arrange them in easy reach of your workstation. This activity requires you to work quickly, so prepare by having everything ready to go before starting.
- With the help of an adult, heat the water to boiling

Procedure:

1. Have an adult carefully pour the boiling water into the jar. Notice whether the water level reaches the mark you made on the jar. If it doesn't, pay attention to exactly where the water level is right when you pour the water into the jar. What do you notice about the water? Can you see steam rising?
2. Quickly spray a few full sprays (2-3 sprays) from the aerosol can into the jar, then have an adult seal the jar with the lid. (Use caution to avoid the very hot steam from the jar.) *What happens when the spray enters the jar? Do you notice anything changing?*
3. Place the ice cubes on top of the jar lid.
4. Take a few minutes to observe what is happening inside the jar. What do you notice? What is different about the jar after you sealed the water and spray inside?
5. Before opening the lid, check whether the water level has changed since you first poured the water into the jar. Has the water level changed? What might cause a change in the water level inside the jar?
6. Slowly and carefully loosen then lift the lid from the jar.
7. Observe the open jar. What do you notice about its contents? What is happening inside? Is anything leaving the jar? What is it?
8. Carefully (avoiding a splash) drop a few ice cubes into the jar.
9. Observe the jar for a few more minutes. Did the ice cubes change what was happening inside? If so, what changed?
10. Carefully pour out the water and rinse the jar.
11. Repeat the activity with the cold water using the steps below.
12. Carefully pour the cold water into the jar. Notice whether the water level reaches the mark you made on it. If it doesn't, pay attention to exactly where the water level is right when you pour the water into the jar. What do you notice about the water? Can you see steam rising? Why don't you see steam rising with cold water?
13. Quickly aim a few full sprays from the aerosol can into the jar, then seal the jar with the

lid. What happens when the spray enters the jar? Do you notice anything changing?

14. Place the ice cubes on top of the jar lid.
15. Take a few minutes to observe what is happening inside the jar. What do you notice? What is different about the jar after you sealed the water and spray inside? What is different about this experiment, compared with when you tried it with hot water?
16. Before opening the lid, notice whether the water level has changed since you first poured the cold water into the jar. Has the water level changed? What might cause a change in the water level inside the jar?
17. Slowly and carefully loosen then lift the lid from the jar.
18. Observe the open jar. What do you notice about its contents? What is happening inside? Is anything leaving it? Why or why not?

Discussion:

- Did you see a cloud forming? If not, or the experiment was underwhelming, what would you do differently to create a more interesting outcome?

When you performed this activity with the hot water, did you observe a cloud forming? This is what is expected. When you repeated the activity with cold water, did you observe cloud formation? You shouldn't have seen a cloud when you used cold water, because you need heat to generate enough water evaporation to form a visible cloud.

Open-Ended Inquiry Questions:

- Repeat this activity without using the aerosol spray. Does it still work? Why or why not?
- What if you repeat this activity using a different liquid (for example, juice or soda)? What are the results and what do you think might account for the difference?

Activity #27 - Make Lightning (30 minutes)

Objective:

- To conduct an experiment to observe lightning formation.

Materials:

- Styrofoam plate
- Thumbtack
- Pencil with new eraser on the end
- Aluminum pie pan
- Small piece of wool fabric

Instructions:

1. Push the thumbtack through the center of the aluminum pie pan from the bottom.
2. Push the eraser end of the pencil into the thumbtack. (The pencil becomes a handle to lift the pan.)
3. Put the Styrofoam plate upside-down on a table. Rub the underside of the plate with the wool for one minute. Rub hard and fast.
4. Pick up the pie pan using the pencil “handle, “ and place it on top of the upside-down plate.
5. Touch the pie pan with your finger. If you don’t feel anything when you touch the pan, try rubbing the plate again.
6. Try turning the lights out before touching the pan. Do you see anything when you touch the pan?

Discussion:

- It’s all about static electricity! Lightning happens when the negative charges (electrons) in the bottom of the cloud (and your finger) are attracted to the positive charges (protons) in the ground (and the pie pan). The resulting spark is like a mini-bolt of lightning.
- The accumulation of electric charges has to be great enough to overcome the insulating properties of air. When this happens, a stream of negative charges pours down towards a high point where positive charges have clustered due to the pull of the thunderhead.
- The connection is made and the protons rush up to meet the electrons. It is at that point that we see lightning. A bolt of lightning heats the air along its path causing it to expand rapidly. Thunder is the sound caused by rapidly expanding air.

Open-Ended Inquiry Questions:

- What happened when you touched the metal pie pan? What caused that? How do you think this experiment relates to the formation of lightning?

Additional Information

- Lightning Canada http://www.ec.gc.ca/foudre-lightning/default.asp?lang=En&n=73364E34-1
- How lightning forms https://scied.ucar.edu/webweather/thunderstorms/how-lightning-forms
- (Video) Lightning 101: National Geographic http://video.nationalgeographic.com/video/101-videos/lightning

Activity #28 - STEM CHALLENGE: Severe Weather Safety (35 minutes)

Objective

- To create a family Emergency Plan for a specific severe weather situation.

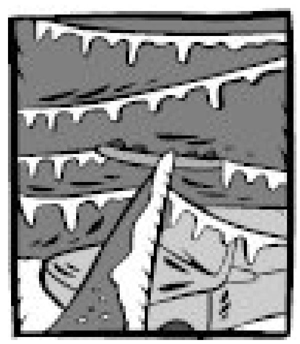
Materials:

- Variety of hardware store catalogues (enough for each pair/team)
- Glue
- Scissors
- Paper/binder to create a booklet (per pair/team)

Instructions: (In teams or pairs)

Develop an emergency plan for your family to prepare for and deal with one of the following events at home. Be sure to indicate which things should be done in advance, which should be done during the event and what should be done after the threat has ended. Search for items in the catalogues provided; cut them out and lay them out in your Emergency Plan.

Tornado



Flood

Snow Storm / Ice Storm

Image Credits: Environment and Climate Change Canada *https://ec.gc.ca/meteoaloeil-skywatchers/default.asp?lang=En&n=664F561F-1&offset=8&toc=show*

Discussion:

Share what you included in your Emergency Plan and why you selected what you did.

Open-Ended Inquiry Questions:

- Would you change your Emergency Plan for different weather conditions? How?

Myth Busting!
Predicting the weather without technology

Weather Prediction Method	My Prediction	Actual Weather Forecast
Detect the direction of the wind. If you are unable to immediately detect the wind's direction, throw a small piece of grass in to the air and watch its descent. Easterly winds, which blow from the east, can indicate an approaching storm front; westerly winds mean good weather. Strong winds indicate high pressure differences, which can be a sign of advancing storm fronts.	Date:	
Check the grass for dew at sunrise. If the grass is dry, this indicates clouds or strong breezes, which can mean rain is coming. If there's dew, it probably won't rain that day. However, if it rained during the night, this method will not be reliable.	Date:	
Observe the leaves. Deciduous trees show the undersides of their leaves during unusual winds, supposedly because they grow in a way that keeps them right-side up during typical prevalent winds.	Date:	
Take a deep breath. Close your eyes and smell the air. Plants release their waste in a low-pressure atmosphere, generating a smell like compost and indicating an upcoming rain. A proverb says *Flowers smell best just before a rain.* Scents are stronger in moist air, associated with rainy weather.	Date:	
Check for humidity. Many people can feel humidity, especially in their hair (it curls up and gets frizzy). You can also look at the leaves of oak or maple trees. These leaves tend to curl in high humidity, which tends to precede a heavy rain.	Date:	

Pine cone scales remain closed if the humidity is high, but open in dry air. Under humid conditions, wood swells (look out for those sticky doors) and salt clumps.	Date:	
Take note of the birds. If they are flying high in the sky, there will probably be fair weather. Falling air pressure caused by an imminent storm causes discomfort in birds' ears, so they fly low to alleviate it. Large numbers of birds roosting on power lines indicates swiftly falling air pressure. Seagulls tend to stop flying and take refuge at the coast if a storm is coming. Birds get very quiet immediately before it rains.	Date:	
Pay attention to the cows. They will typically lie down before a thunderstorm. They also tend to stay close together if bad weather is on the way. They may also run around in a circle before a storm.	Date:	
Look at ants' hills. Some say ants build their hills with very steep sides just before a rain.	Date:	
Watch nearby turtles. It is said that they often search for higher ground when a large amount of rain is expected. You may see them in the road 1 to 2 days before a rain.	Date:	

Build Your Own Weather Station

"I believe there is a train under here somewhere!"

Standing tall on North Dakota snow. A March blizzard nearly buried utility poles. Caption jokingly read "I believe there is a train under here somewhere!" Courtesy Dr. Herbert Kroehl, NGDC

Every year, thousands of lives and millions of dollars are saved by severe weather warnings from the National Weather Service. From its earliest beginnings (on February 9th, 1870), the primary mission of the National Weather Service has been to protect life and property by providing information about dangerous weather conditions. Originally, the National Weather Service was called "The Division of Telegrams and Reports for the Benefit of Commerce" and was part of the U.S. Army. Later, its name was shortened to the Weather Bureau and it became part of the Department of Agriculture, then the Department of Commerce.

The first "weathermen" were "observing-sergeants" of the Army's Signal Service Corps. Weather forecasting in those early years was based almost entirely on the assumption that the weather observed in one location on a particular day would move to downwind locations on following days. Today, satellites, computers, and a variety of scientific instruments are added to this basic assumption to make accurate weather predictions and provide warnings about dangerous weather.

Here's how you can make your own weather observation station!

What You Will Do

Build six instruments that you can use to make scientific measurements of your local weather

MEETING 5 - GADGETS & WIDGETS: TECHNOLOGY

Objectives

- Introduce members to Robotics (technology, engineering and math)
- Have members follow proper procedures and documentation used in experiments
- Learn about the industry in Canada and careers

Roll Calls

- What do you think are the 5 greatest technical inventions of all time?
- Name one inventor.
- Name one Canadian invention (answer can be any invention, not necessarily a technical invention)

Sample Meeting Agenda – 1 hr. 15 minutes, plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes and Business	5 min
Judging Activity	Activity #29 - Judging	10 min
Topic Information, Discussion & Activities	Topic Information What is technology? Importance of technology There is no “technology” industry What is robotics? Careers in technology Activities ▪ Activity #30 - Build your own motor ▪ Activity #31 - Coding ▪ Activity #32 - Sending a very valuable item to Saturn ▪ Activity #33 - Poking fun at math ▪ Activity #34 - Ready, Aim, Marshmallows! ▪ Activity #35 - STEM CHALLENGE: Tallest, strongest, heaviest	30 min + Activities
At Home Activity	Choose one *At Home* activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

What is Technology?

Let’s make a simple comparison of technology versus science:

- Technology: Taking action to meet a human need.
- Science: Understanding the workings of the natural world.

The inventions of the telephone, computer, washing machine, automobile and so much more were to help us live better lives through technology.

Take coffee as an example. Many people like to drink coffee, often in a coffee shop. That coffee may have come from trees which have been bred specifically for increased yields that support a small farmer and his family but that requires pesticides that were developed and manufactured in another country. The harvested coffee beans will themselves be transported around the world, to be processed and placed in packages which are distributed to shops that then make the cup of coffee in a plastic cup that was manufactured for the purpose and so on.

Technology is a hands-on profession where people have to be skilled in many of the following: engineering, communicating, designing, developing, innovating, managing, manufacturing, modelling, and systems thinking.

Importance of Technology

Why is technology so important today? Just look around and you’ll know why! Technology is all around us and we are using it almost all of the time (whether at work or at play). Technology has made life easier. You can connect with anyone living anywhere, in seconds, and in real time. You can find information quicker than ever. Tasks that took hours to do before can now be done in minutes (or seconds- think of the microwave!)

There is no “Technology” Industry

That’s because technology is in every industry. It does not stand alone. For example:

- *Agriculture*: Portable computers and smartphones are already on farm tractor cabs, pickups and offices.
- *Transportation*- Technology to count traffic, detect crashes, collect tolls and fares, and manage transit operations and traffic signal systems.
- *Education*: Teachers can use the cloud (an online network of servers) to set, collect and grade work online. Students will have instant access to grades, comments and work via a computer, smartphone or tablet.
- *Healthcare*: Doctors use technology to keep track of patient history, stay up-to-date on medical research and analyze treatment options.

What is Robotics?

Robotics is the study of robots. Robots are machines that can be used to do jobs. Some robots can do work by themselves. Other robots must always have a person telling them what to do. The type of robots that you will encounter most frequently are robots that do work that is too dangerous, boring, or nasty. Most of the robots in the world are of this type. They can be found in auto, medical, manufacturing and space industries. In fact, there are over a million of these type of robots working for us today. In agriculture, one example is robotics milking cows, not people!

Most robots have three main parts: a controller (a brain); mechanical parts to help it move (robots can be powered by air, water, or electricity), and sensors that can tell the robot about its surroundings. These parts work together to control how a robot functions.

A Canadian Invention!

Canadarm is Canada's most famous robotic and technological achievement. It made its space debut on the Space Shuttle Columbia on November 13, 1981.

Canadarm
Image Credit: Canadian Space Agency http://www.asc-csa.gc.ca/eng/canadarm/pictures.asp

Careers in Technology

ICT (Information & Communications Technologies)

Information and communications technology (ICT) is another term for information technology (IT) which stresses the role of unified communications and telecommunications (telephone lines and wireless signals), computers as well as software, storage, and audio-visual systems, which allows us to access, store, transmit, and manipulate information. However, ICT has no universal definition, as the concepts, methods and applications involved in ICT are constantly evolving on an almost daily basis.

Resources/Guest Speaker:

- Information Technology Association of Canada http://itac.ca

A sampling of occupations in ICT:

- Information systems analysts and consultants
- Computer and network operators and web technicians
- Computer programmers and interactive media developers
- Software engineers
- Graphic designers and illustrators
- Computer and information systems managers
- Database analysts and data administrators

Computer Science

Computer Science is the study of computers and systems. Unlike electrical and computer engineers, computer scientists deal mostly with software and software systems; this includes theory, design, development, and application. Studying Computer Science includes artificial intelligence, computer systems and networks, security, database systems, human computer interaction, vision and graphics, numerical analysis, programming languages, software engineering, and theory of computing.

Although knowing how to program is essential to the study of computer science, it is only one element of the field. Computer scientists design and analyze to solve programs and study the performance of computer hardware and software.

A Sampling of Computer Science Careers

Computer Engineer	Electronics Engineering Technician
Computer Network Specialist	Management Consultant
Computer Programmer	Industrial Engineering
Computer Support	Statistician
Computer Trainer	Operations Research Analyst
Database Developer	Logistics Specialist
Desktop Publisher	Research Analyst
Graphic Designer	GIS Specialist
Inventor	IT Project Manager
Medical Imaging Tech	Technical Writer
Scientist	Software Analyst
Video Game Developer	Systems Architect / Analyst
Web Developer	Information Specialist
Webmaster	Computer Systems Specialist
Website Designer	CSIS- Canadian Security Intelligence Service position
Multimedia Developer	Strategic Planner
Illustrator	Telecommunications Specialist
Business Systems	E-Commerce Specialist
Analyst	Network Architect
Technical Sales Representative	High School Teacher
Corporate Trainer	Professor

Engineering Technicians/Technologists There are many different kinds of engineers and each do many different things. They design, create, explore and innovate in many different environments. Engineers create products used in our every-day lives. Engineering and science technologists and technicians work in the engineering field with engineers, tradespeople and scientists.

Engineers

- There are many kinds of engineering careers to explore, including:
- Aerospace
- Chemical
- Civil
- Computer
- Electrical & Electronics
- Geological
- Industrial & Manufacturing
- Mechanical
- Metallurgical & Materials
- Mining
- Petroleum
- Software

Women Rock in Science & Technology!

Elizabeth Muriel Gregory (Elsie) MacGill, born in Vancouver, British Columbia in 1905, became Canada's first woman graduate to hold a degree in electrical engineering. Her primary responsibility was the production of the Hawker Hurricane fighter aircraft.

Roberta Bondar, Canada's first woman astronaut, had flair. She took her favourite food, Girl Guide cookies, into space with her in 1992!

Resources/Guest Speakers:

- Ontario Society of Professional Engineers https://www.ospe.on.ca
- Engineers Canada http://engscape.engineerscanada.ca
- Farmer with a robotic milking system
- Robotics company representative
- A professional engineer from a local engineering company
- Ontario Association of Certified Engineering Technicians and Technologists https://www.oacett.org
- Information & Communications Technology Council http://www.ictc-ctic.ca

Additional Resources

Technology

- Dash & Dot (for purchase): Real robots, responding to voice, navigating objects, dancing, and singing with ability to code. https://www.makewonder.com
- Tynker: Coding for kids. https://www.tynker.com

Additional Experiments

- Summer Engineering Challenges http://magnetschoolssummer.weebly.com/stem-challenges.html
- The Engineering Place https://www.engr.ncsu.edu/theengineeringplace/index.php
- Smarter Science: Space Related Sites https://smarterscience.youthscience.ca/links
- Mars Education https://marsed.asu.edu/stem-lesson-plans
- STEM Lessons from Space https://www.nasa.gov/audience/foreducators/stem-on-station/lessons
- 19 Cool Math STEM Activities for Middle School http://www.dreambox.com/blog/girls-math-more-stem-women
- I explore STEM http://iexplorestem.org/engineering-activities

Additional Websites with STEM Activities / Information

- Discovery Kids http://discoverykids.com/category/science/
- Exploratorium (search for activities by subject) http://www.exploratorium.edu/snacks/snacks-by-subject
- Science Kids http://www.sciencekids.co.nz/experiments.html
- How Stuff Works http://science.howstuffworks.com
- Masters in Data Science: 239 Cool Sites about STEM http://www.mastersindatascience.org/blog/the-ultimate-stem-guide-for-kids-239-cool-sites-about-science-technology-engineering-and-math/
- Agriculture: Educational Activity Kits (free downloads) http://cafmuseum.techno-science.ca/en/education/educational-activity-kits.php
- Canada Science & Technology Museum: EduKits (borrow for a fee) http://cstmuseum.techno-science.ca/en/education/cstm-edukits.php

BEFORE THE NEXT MEETING

1. Prepare for the last meeting. Select an experiment you will do at home before the next meeting. It can be an experiment we already did in this project that you want to repeat (an important part of scientific testing) or perhaps you want to change the variables (another very important step to determine accurate results). Or maybe you want to select an entirely new experiment; the choice is yours!
2. Conduct the experiment using everything you learned in this project, especially ensuring you accurately document everything you do. Write it all down and at the final meeting, you will share what experiment you selected, your hypothesis, how you did it, and the results.
3. You can even videotape yourself doing parts of the experiment!

You will have **10 minutes** for your presentation.

Senior Members

- Same as above, plus, include all of the steps of a scientific method in your presentation.

You will have **15 minutes** for your presentation.

NOTE: If your club has many members and 10 minutes per member takes too much time to present, (or 15 minutes for Senior Members), do this activity in groups and present as a group.

Scientific Method

Getting Started
Your Question
4-H Record Book/Documentation Used

Doing Background Research
Finding Information

Constructing a Hypothesis
Variables
Hypothesis

Testing Your Hypothesis by Doing an Experiment
Experimental Procedure
Materials List
Conducting an Experiment

Analyzing Your Data and Drawing a Conclusion
Data Analysis
Conclusions

Communicating Your Results
Final Report

DIGGING DEEPER I

For senior members

Building Bigger, Faster Motors

Experiment with batteries of higher voltage, as well as more powerful magnets. You can also try using ceramic magnets. One design was to set the armature over 4 ceramic ring magnets and connect the supporting paperclips to a 6V battery. You can also try increasing the size of the armature, and how many coils there are, to make a stronger electromagnet. NOTE: When using batteries of higher voltage, and bare wires, be very careful. The circuit can emit enough heat to cause a burn if the wire is held too long.

DIGGING DEEPER II

For senior members

Create a Video Game for Visually-Impaired Players

Objective:

For Senior Members to become a game designer, using the Engineering Design Process to devise a video game that a blind or visually impaired person can play.

Materials:

- Computer with Internet connection
- GameMaker Lite; you can download the PC version at no charge from YoYo GameMaker for PC and the Mac version for free from YoYo GameMaker for Mac.

Optional: Audacity or other sound and audio recording software; You can download Audacity free of charge from audacity.sourceforge.net/download/

Instructions:

Part I: Plan Your Game in GameMaker

1. In this video and computer games science project, you will create a game that entertains both sighted and blind or visually impaired players. The goal for players is to drive their car through a busy city and make it home in time for dinner without hitting any obstacles along the way.
2. First, download the GameMaker Lite program from YoYo GameMaker for Mac or YoYo GameMaker for PC. Make sure that your computer's operating system fits the requirements for running GameMaker listed on the download page.
3. Before you start programming your game, work through the first two beginner (Level 1) tutorials listed in the GameMaker User Guide. These tutorials, each only about 30 minutes long, will walk you through the steps of making a video game with GameMaker. Even if you've never programmed before, you will be ready to tackle this driving game project after working through the tutorials.

Once you have completed the two beginner tutorials, have practiced with GameMaker, and feel comfortable with the programming environment, it is time to start the project. As noted at the beginning of this procedure, this project follows the Engineering Design Process.

Part II: Follow the Engineering Design Process

Background Information

- The engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times, the solution involves designing a product (like a machine or computer code) that meets certain criteria and/or accomplishes a certain task.
- This process is different from the Scientific Method. If your project involves making observations and doing experiments, you should probably follow the Scientific Method. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process.
    - The steps of the engineering design process are to:
    - Define the Problem
    - Do Background Research
    - Specify Requirements
    - Brainstorm Solutions
    - Choose the Best Solution
    - Do Development Work
    - Build a Prototype
    - Test and Redesign

Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change to your design. This way of working is called **iteration**, and it is likely that your process will do the same!

Start the Engineering Design Process

1. *Define the problem.* In this case, you will create a fun video game that both sighted and blind or visually impaired players can enjoy.
2. *Do background research.* Do online research to develop an understanding of **blind gaming**. You should also study the YoYo Games tutorial What Is a Good Game? to start thinking about the goals of building a successful video game.
    a. *Develop the project requirements.* The project requirements are the characteristics that your video game must have to be a successful and educational video game. Here are some ideas to consider when formulating the requirements:
    b. For sighted players, what kind of images or animation do you want to use? Do you want to use cars, motorcycles, trucks, or bicycles? Where will you get these images and animation?
    c. How do you want the game to feel, in terms of sound cues, pacing (how fast the game moves), and other elements that will engage everyone who plays?
    d. How will you make the roadway? Will it be a maze or a scrolling pathway (a path that moves across the screen)? If you use a scrolling pathway, how fast will it

move and what obstacles will pop up?

   e. Using sound is a requirement. Will you use your own sounds in the game or will you reuse sounds from the GameMaker tutorials? If you plan to make your own sounds, you can use audio editing and recording software like Audacity. Download Audacity for free from the Internet.

   f. How long will the game last?

3. How will the game be won or scored?

4. *Create and analyze solutions.* Keeping your project requirements in mind, think about different ways that you could build your game. Once you have developed a few solutions, analyze the solutions by making rough sketches and/or flow charts for each one.

5. *Build and test a sample video game.* Once you have created a set of requirements and a possible solution, it is time to open GameMaker and start working on building a sample video game. Build a character and an object and have it drive around a simple maze or scrolling pathway. Remember to review your requirements so that you keep yourself focused on the task. Remember that your goal is to create a video game that is appealing and fun for both sighted and visually impaired or blind players.

6. *Program your video game.* Keep testing the game as you work. When you have fulfilled a requirement or task, run the game and test it out.

   a. Break the game programming up into smaller tasks so that the project is not overwhelming.

   b. Test the game along the way so that you can fix small issues as they come up. This will prevent your having a long set of events at the end that don't work.

7. Once you have finished your game, check to see that all of the project requirements are fulfilled.

Test and redesign. Test your game out on your family, your friends, and yourself. Make sure either to have people in your test pool who are blind or visually impaired, or to simulate that situation as closely as possible by having some of your test subjects play the game blindfolded. Take notes on what your players enjoyed and didn't enjoy about the game. Use the feedback to improve your game.

Part III: The Final Product: Presenting Your Game

1. When presenting your game (maybe at the 4-H Ontario Science Fair or at your club), try to bring in a computer. If you are not able to do so, take screenshots of your work, print them out, and mount them to a poster board.

   a. You should include the following items in your presentation:

   b. A list of your project requirements that guided your building of the video game.

   c. The rough sketches or flow chart that describes how the game works.

   d. An explanation of what you learned from your research and from creating the video game.

ACTIVITIES

Activity #29 - Judging

1. Bring in any technical/engineered items to compare: e.g. computer mouse (variety); cell phone versus landline phone; scissors (variety); etc. Criteria to consider: age of the item; usefulness of the item; appearance; etc.

Alternatively, bring in any items (Leader or members) to judge.

NOTE: For each activity, encourage members to use the handout "*A record of our experiment*" **OR** to record their notes and findings in their 4-H Record Book.

Activity #30 - Build Your Own Motor (45 minutes)

Objective:

To experience the forces of electricity and magnetism to build a motor using a magnet.

Materials:

- Insulated copper wire
- Black permanent marker (such as a Sharpie)
- Scissors
- Small neodymium disc magnets
- D-size battery
- Battery holder (sticky tack or modeling clay can be used instead)
- Large rubber band (not needed if using a battery holder)
- 2 large paper clips
- Pen or pencil

Instructions:

Introduce the topic:

- See for yourself how the forces of electricity and magnetism can work together by building a motor using simple materials! Electricity and magnetism are both forces caused by the movement of tiny charged particles that make up atoms, the building blocks of all matter. When a wire is hooked up to a battery, negatively charged electrons flow *away* from the negative terminal of the battery *toward* the positive end, because opposite charges attract each other, while like (similar) charges repel each other. This flow of electrons through wire is electric current, and it produces a magnetic force.
- In a magnet, atoms are lined up so that the negatively charged electrons are all spinning in the same direction. Like electric current, the movement of the electrons creates magnetic force. The area around the magnet where the force is active is called a magnetic field. Metal objects and other magnets that enter this field will be pulled toward the magnet.

The way the atoms are lined up creates two different poles in the magnet, a *north pole* and a *south pole.* As with electrical charges, opposite poles attract each other, while like poles repel each other.

Optional:

View the video how to build a simple motor. http://www.hometrainingtools.com/a/build-motor-project/#video

What to do:

1. To make a bundle, wrap each end of wire several times around the loops to hold them in place. Position the ends so they are directly across from each other and extending out in a straight line on either side of the bundle, to form an axle. What you just made is called the **armature**.
2. Hold the wire bundle you have made so that it would be flat against a wall, rather than a table, and colour the top side of each wire end using the marker. Leave the bottom side of each wire bare.
3. Carefully bend each paperclip, forming a small loop by wrapping one end around a small object such as a pencil or pen. Thick wire and pliers may be used instead of a paper clip if you want. Be sure to use caution when using the pliers.
4. If you are using a battery holder, attach a paper clip to either side, and insert the battery. If you don't have a battery holder, wrap the rubber band tightly around the length of the battery. Insert the paperclips so each one is touching one of the terminals, and they are securely held by the rubber band. Attach the curved side of the battery firmly to a table or other flat surface using the clay or sticky tack.
5. Set one neodymium magnet on top of the battery, in the center. Position the armature in the paper clip loops, with the shiny, uncoloured side touching the paperclips. Make sure it doesn't touch the magnet.
6. If your motor doesn't start immediately, try giving it a start by spinning the wire bundle. Since the motor will only spin in one direction, try spinning it both ways.
7. If your motor still is not working, make sure that the paperclips are securely attached to the battery terminals. You may also need to adjust the insulated wire so both ends are straight, and the bundle you have made is neat, with the wire ends directly opposite of each other.
8. With the motor spinning, hold up the other magnet, above the armature. As you move it closer, what happens? Turn the magnet over and try again to see what happens.

Discussion:

- What two forces are working together to spin the motor?

When you held the second magnet over the top of the armature, did it stop or make the motor rotate more rapidly? Why did this happen?

The armature is a temporary magnet, getting its force from the electrical current in the battery. The neodymium magnet is permanent, meaning that it will always have two poles, and cannot lose its force. These two forces - electricity and magnetism - work together to spin the motor. The poles of the permanent magnet repel the poles of the temporary magnet, causing the armature to rotate one-half turn. After a half-turn, the insulated side of the wire (the part you coloured with permanent marker) contacts the paperclips, stopping the electric current. The force of gravity finishes the turn of the armature until the bare side is touching again and the process starts over.

The motor you created uses direct current, or DC, to rotate the armature. The magnetic force is only able to flow in one direction, so the motor spins in only one direction. AC, or alternating current, uses the same principle of electron flow, but the pole is rotating rather than in one place. AC motors are often more complex than DC motors, like the simple one you were able to make. Unlike a fixed DC motor, AC motors can switch the direction of rotation. (The DC motor you made is only able to spin in one direction because its direction is determined by the poles of the permanent magnet. If you turn the magnet over, so the other pole is facing up, it will change the direction the motor spins.)

When you held the second magnet over the top of the armature, it either stopped or made the motor rotate more rapidly. If it stopped, it's because the pole was in the opposite direction of the first magnet, in a sense canceling out the rotation of the armature. If it moves faster, the same poles of the first and second magnets, which repel each other, work to spin the armature more quickly than with only one magnet.

Open-Ended Inquiry Questions:

- What variables would you change in this experiment if you did a second trial?

Activity #31 - Coding (40 minutes or more)

Objective:

- To learn about and practice computer coding using web-based programs.

Materials:

- Computer
- Internet access

Instructions:

Ahead of time:

1. Select which programming websites you will use for the session (or select one of your own). Be sure to familiarize yourself with the site(s).
2. Introduce the topic: It's hard to imagine a single career that doesn't have a need for someone who can code. Everything that "just works" has some type of code that makes it run. Coding (a.k.a. programming) is all around us. Today we are going to look at one website to learn how to code.
3. Ask members to go to the selected website/webpage and start together.
4. At the end of the allotted time, ask members to share what they did.

Coding Programs (free)

- **Scratch**: Program interactive stories, games, and animations. https://scratch.mit.edu
- **Code.org**: A great starting point for coding novices. https://code.org/learn
- **Code Academy**: Teaches kids basic code through fun and simple exercises that feel like games. https://www.codecademy.com
- **Code Combat**: Best for older kids; uses an interactive, competitive gameplay mode. https://codecombat.com
- **Lightbot***:* Integrates fun gameplay with coding lessons. https://lightbot.com

Discussion:

- What did you create? Show it or explain it to your club members.

Open-Ended Inquiry Questions:

- Why did you decide to create what you did?
- What were your challenges?

Activity #32 - Sending a very valuable item to Saturn (45 minutes)

Objective:

- To learn to constantly revise and improve a design with added constraints.

Materials:

- 5 sheets of construction paper (any colours)
- 5 pipe cleaners (any colours)
- glue stick (small)
- 10 large paperclips
- 15 small paper clips
- 1 pencil
- 4 straws with elbow (ones that bend)
- 1/3 yard of 12 " aluminum foil
- 3 sheets of regular white printer paper
- 5 craft sticks (any size - but all need the same size)
- 9" x 12" Manila Extra-Heavyweight Clasp Envelopes
- hardboiled egg (one per team)

Instructions:

1. Introduce the Engineering Design Process: Engineers use the engineering design process to invent and improve technologies, objects and systems. The engineering design process includes five critical steps:

   Ask – What is the problem? What have others done?

   Imagine – What is the best solution? Brainstorm ideas.

   Plan – Draw a diagram. List the materials you need.

   Create – Follow your plan and test it out.

   Improve – How can you improve your design? Go back to Step 1

2. Tell members: All challenges have constraints, or the rules we must follow. In this challenge, your constraint is you can only use the materials in this list and in the quantity listed (show list on flipchart paper or provide as a handout). You don't have to use all of the materials, but if you do, you can't use more than what is allowed and you can't add materials to the list. But you do have unlimited use of masking or scotch tape.

   - Challenge:
   - As engineers of the future, you have to send a new satellite to Saturn! The satellite is very sensitive and breaks easily. (It also costs taxpayers like a zillion dollars!!!!)
   - You need to design a "capsule" to carry a sensitive item (hardboiled egg!) to a land on an unknown planet.

3. Constraints: materials (listed above); Plus: base of your "capsule" has to be at least 12 inches long and 10 inches wide; the height of the highest point of your device has to be at least 12 inches tall

4. Your solution might not be perfect and you may try several times. As an engineer, you will constantly revise and improve your design.

5. When everyone is ready, test your design with everyone watching.

Discussion:

- Did your design work? Why did it work (or why did it not work)?
- In this activity, you had to practice building, testing, and reworking a model several times until you had a prototype that worked. What did you learn about the importance of building a prototype?

Open-Ended Inquiry Questions:

Which materials, if any, did you wish you had more of? Why? How would different materials change your design?

Activity #33 - Poking Fun at Math (30-45 minutes)

Objective:

To investigate pinholes with a simple viewing device and collect data to create a real mathematical formula.

Materials:

- Cardboard tube measuring approximately 2 to 3 inches (5 to 8 centimeters) in diameter and 4 to 7 inches (10 to 20 cm) in length (such as from a roll of paper towels or gift wrap; poster tubes and PVC tubes will also work)
- Aluminum foil
- Wax paper (or a white translucent plastic bag)
- Two rubber bands
- Pushpin
- Red, green, and blue screw-in light bulbs, one of each colour (can be CFL, LED, or incandescent)
- Three screw-in light sockets
- Power strip with at least three parallel outlets
- Power source (and extension cord if needed)
- Darkened room
- Partner
- Handout: *Data Collection Form for Poking Fun at Math* (found at the end of the meeting)
- Optional Handout: *Multiple Light Ray Diagram* (found at the end of the meeting)

Optional:

- Black construction paper
- Two more rubber bands

Instructions:

Build your pinhole viewer:

1. Cut the wax paper to a size slightly larger than the diameter of the tube. Do the same with the aluminum foil.
2. Cover one end of the tube with the cut piece of aluminum foil, folding the ends over tightly and securing the foil in place with a rubber band.
3. Cover the other end of the tube with the cut piece of wax paper, also folding the ends over tightly and securing in place with a rubber band. Make sure the surface of the wax paper is as smooth and wrinkle free as possible; this will be your viewing screen.

Optional: for better viewing, you may want to add a shade to your screen (wax paper). Roll the black construction paper around the wax paper end of the tube, leaving the foil end exposed by a few inches (10 cm). Secure the construction paper in place with rubber bands.

Put together your light source:

1. Screw the red, green and blue bulbs into the light sockets.
2. Plug one, two, or three bulbs into the power strip and turn it on.

To do and notice:

- Use the worksheet *"Data Collection Form for Poking Fun at Math"* (addendum) to collect and record data from the following experiments:
- Use your pushpin to poke a single hole anywhere in the foil on your viewer. Turn on one light (of any colour). Hold the viewer up to the light, with the foil side oriented towards the light, and look at the image on the wax paper. Record your data. Turn on a second light, and then the third light. How many images do you see?
- Poke a second hole in your foil and hold it up to the light, again starting with only one light on, then two lights on, then all three lights on. Record this data.
- Continue poking additional holes in the foil. For each new hole, test the viewer against different numbers of lights, and record your observations as you go.

Discussion:

- Do you see a pattern in the data?
- What is the relationship between holes, bulbs, and images?
- Based on that relationship, make a prediction: if you know the number of holes poked and the number of bulbs, how many images will appear? Can you represent this as a mathematical formula?

You've created a pinhole image multiplier! The number of images on the wax paper is related to the number of pinholes and the number of bulbs:

bulbs x pinholes = images on screen

Light rays travel in straight lines and in all directions from a light source. However, your pinhole device limits the rays that can reach the wax-paper screen. The aluminum foil blocks all the light except that which passes through the pinhole(s).

Because the red, green and blue bulbs are in slightly different positions relative to a given pinhole, the light from each bulb reaches that pinhole at a different angle, making a "set" of one red, one green, and one blue image, each in a slightly different position on the screen. Each additional pinhole you create (because it's in a different position and light passes through it at different angles) creates another set of red, green and blue images.

Optional: See handout Multiple Light Ray Diagram (at the end of the meeting)

Open-Ended Inquiry Questions:

What if you added more pinholes? What if you created fewer pinholes? What would happen?

Activity #34 - Ready, Aim, Marshmallows! (40 minutes)

Objective:

To learn about physics concepts, such as energy and motion, by making a catapult.

Materials:

- One-inch rubber band
- Marshmallows
- Electrical tape
- Three pencils
- Hole punch
- Plastic spoon
- Markers
- Thin shoe box
- Ruler
- Craft knife

Instructions:

1. Cut one end of the shoe box so that there's a one-inch piece at the bottom.
2. From that side, put a dot 1 inch from the top and 2.5 inches from the back wide side of the box.
3. Punch a hole through that dot big enough that a pencil can stick through.
4. Do steps 2 and 3 on the other wide end. Put a pencil through the holes. Put another hole where the other pencil will touch the bottom of the shoe box. Refer to the photo.
5. Have your young scientist tape the handle of the spoon to another pencil. Then, tape this pencil to the first pencil.
6. Put the rubber band through the bottom hole. Insert the last pencil into the rubber band loop underneath the shoe box so that the band doesn't escape. Loop the band over the second pencil.
7. Put marshmallows or other small objects on the spoon, and have the member gently pull it back. When the rubber band extends, it has a lot of potential energy, and when s/he lets go of the spoon, this becomes kinetic energy!

Discussion:

- What were the challenges you faced?
- What did you think would happen versus what actually happened?

Open-Ended Inquiry Questions:

What changes would you make to your catapult to make the marshmallows go even farther?

Activity #35 - STEM CHALLENGE: Tallest, strongest, heaviest (30 minutes or more)

Objective:

To build a structure that meets certain criteria (tall, strong) out of everyday items.

Materials:

- Almost anything: cups, plastic straws, toothpicks, tape; plastic forks, etc.; tape measure
- Optional: “play” money

Instructions:

1. Ahead of time, decide what type of structural challenge the members will be doing: tallest, strongest.
2. Put members into teams. Each team will build a structure that has certain characteristics (tallest, strongest, etc.) more so than the rest of the group. This activity can be done in 30 minutes or an hour, depending on how much time the club members want/have.

Give each team the same amount of materials and set them free to build the tallest, strongest, etc., structure that they can build. Alternately, if you want to add math skills to the activity, provide teams with “play money” and set a price for everything; allow them to buy materials, each group starting with the same amount of money.

Suggestion: For a strong structure, make a rule that the structure has to maintain a certain height, such as six inches. This makes it clear when the structure is crushed. If you’re going to compete on height, measure vertically from the floor and declare at the beginning whether the structures can be taped down.

Discussion:

- Discover as a group what works, what doesn’t and why.

Open-Ended Inquiry Questions:

- How would you change your structure if the height had to be 10 inches tall?

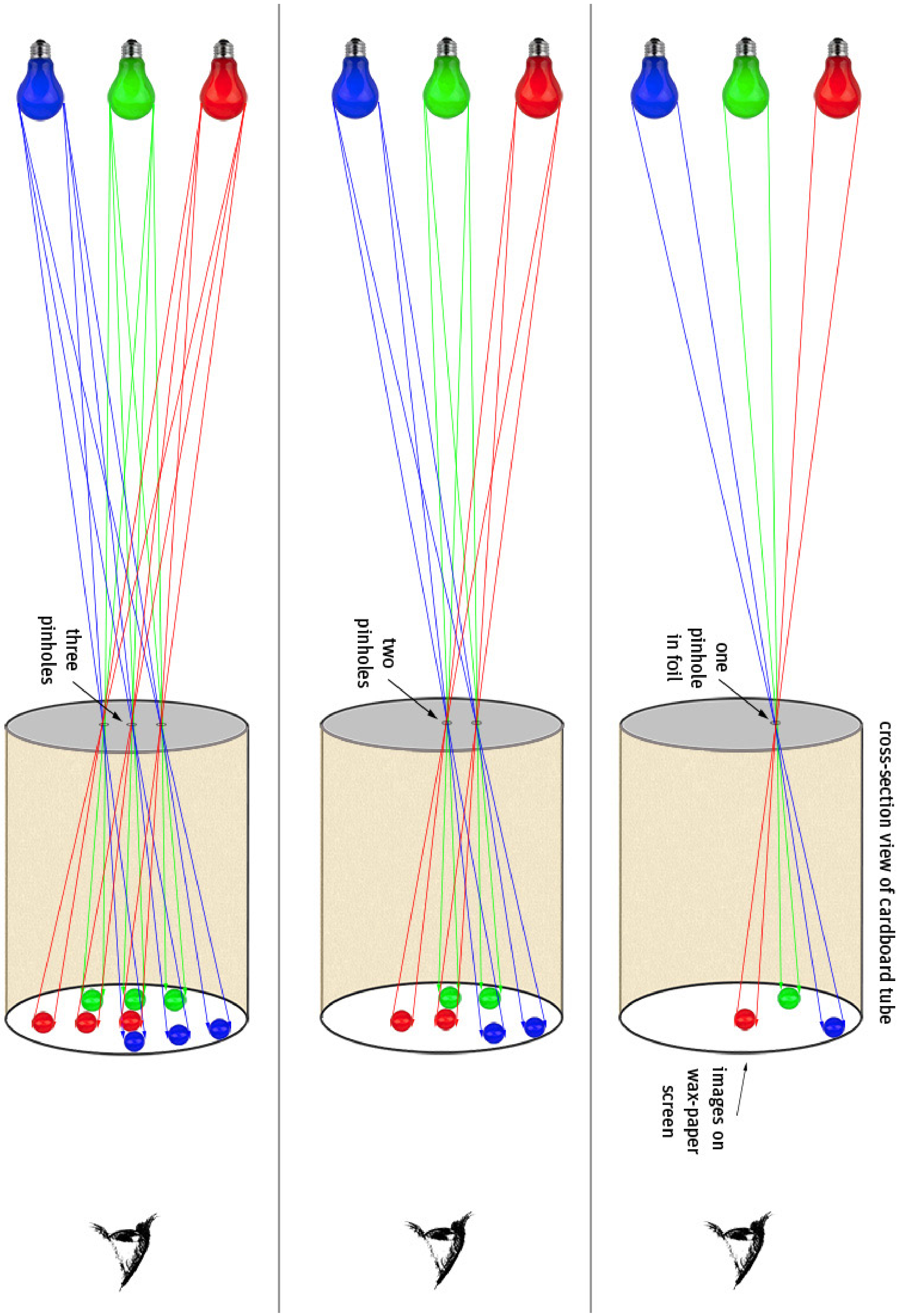
Data Collection Form for Poking Fun at Math

Record your observations as you poke holes in your foil and turn on different numbers of bulbs:

1. Start with one hole and one bulb. How many lights (images) do you see on the wax-paper screen?
2. Turn on another bulb and record what you see. Then turn on the third bulb and record what you see.
3. Poke a second hole. Start over with only one bulb, then turn on a second bulb, then all three bulbs. Record the number of images you see each time.
4. Continue with this pattern of adding a new hole and turning on one light at a time until you have enough data to see a pattern.

# holes in foil	# bulbs turned on	# lights visible on wax paper
1	1	

Can you come up with a formula that predicts the number of images based on the number of holes and the number of bulbs that are turned on?


three pinholes
two pinholes
one pinhole in foil
cross-section view of cardboard tube
images on wax-paper screen

MEETING 6 - ARE YOU CANADA'S NEXT TOP INVENTOR?

Objectives

- Recognize Canadian contributions to science and technology
- Learn the steps it takes to become an inventor
- Have members follow proper procedures and documentation used in experiments
- Encourage members to participate in the 4-H Canada Science Fair

Roll Calls

- What did you learn from this project?
- Which experiment/activity did you like the best?
- If you were to do this project again, what new experiment would you like to try?

Sample Meeting Agenda – 1 hr. 15 minutes, plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes and Business	5 min
Judging Activity	Activity #36 - Judging	10 min
Topic Information, Discussion & Activities	Topic Information Canadian inventors Becoming an inventor Activities ▪ Activity #37 - Share your experiment results (last week's *At Home* activity) ▪ Activity #38 - Lemon volcanoes ▪ Activity #39 - Diet coke explosion ▪ Activity #40 - Make your own blast	30 min + Activities
At Home Activity	Choose one *At Home* activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

Canadian Inventors

Have you ever seen a product and said to yourself, "I thought of that idea a long time ago!" Lots of people think of really good ideas, but it's the inventors who turn them into reality. Canadians are responsible for many inventions you use every day. If you like to play the games Trivial Pursuit, hockey, or baseball and then eat peanut butter on McIntosh apples as an after-game snack, you can thank Canadians for all of those inventions!

Some Famous Canadian Inventions

Insulin- Dr. Frederick Banting

Diabetes - a disease that doesn't allow your body to produce insulin - was a feared disease that most certainly led to death. In October 1920 in Toronto, Dr. Frederick Banting, an unknown surgeon with a bachelor's degree in medicine, started his experiments on dogs and invented insulin that could be given to people with diabetes.

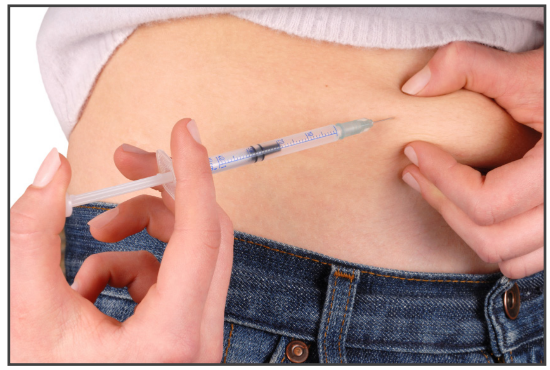


Image Credit: http://www.mediatrainingtoronto.com/blog/2013/6/29/50-great-inventions-canada-gave-the-world

Image Credit: http://www.mediatrainingtoronto.com/blog/2013/6/29/50-great-inventions-canada-gave-the-world

Garbage Bag- Harry Wasylyk

Harry Wasylyk was a Canadian inventor from Winnipeg, Manitoba, who together with Larry Hansen of Lindsay, Ontario, invented the disposable green plastic garbage bag. Garbage bags were first sold to the Winnipeg General Hospital, but then the garbage bags were under the name "Glad Garbage" bags for home use in the late 1960s.

McIntosh Apple- John McIntosh

The first McIntosh orchard was started in 1811 in Ottawa when John McIntosh bought a farm and discovered 20 apple trees in the woods. He transplanted them into a garden but all the trees, except one, had died by 1830. This one tree survived and forty years later his son Allan used the seedlings to plant a red apple nursery where the original tree grew fruit until 1906.

Image Credit: Ontario Apple Growers http://www.onapples.com/apple-varieties.php

Here are a few more famous inventions by Canadians:

- *Basketball* - Invented by James Naismith in 1891.
- *Canola* - Created in the early 1970s by Keith Downey and Baldur R. Stafansson.
- *Canada Dry Ginger Ale* - After hundreds of experiments, John J. Mclaughlin achieved the perfect formula for his Ginger Ale in 1904.
- *Walkie-Talkies* - Invented by Donald L. Hings and Alfred J. Gross in 1942.
- *The Goalie Mask* - Invented by Jacques Plante in 1959. And of course, ice hockey was invented in Canada, too!

Kids are inventors, too!

Popsicles, earmuffs and trampolines. Do these seem like foolish ideas? Probably at the time adults thought so because each of these items were invented by kids!

- To learn more about kids' famous inventions, watch this video: ***Top 10 inventions thought up by kids*** https://www.youtube.com/watch?v=aO8X40p2LMA

Becoming an Inventor

So, what do you do if you have an idea for the most amazing new technology or you think you can improve an existing product? How do you turn your idea into an invention? Here is a list of the basic steps to make an invention in Canada.

1. **Develop your idea**
   Make rough sketches, perform tests, and ***always*** keep detailed notes. Lawyers often tell people to keep a logbook (just like your 4-H Record Book!) and to get it stamped regularly with a date (by a notary public) This logbook not only helps you to remember what worked and didn't work with your experiments, but it becomes important if someone else has an identical invention and you have to prove who was the first person to think of it!

2. **Get a patent / Do a patent search**
   There is no sense in putting in more of your time and money into an idea if it already exists or someone else "owns" the idea. So you need to do a patent search. A patent is control and ownership of your invention that the Government of Canada, and other governments in other countries, give to inventors for a period of time (for example, 20 years in Canada). This means no one else can take it from you during this period of time! But you can't patent something that's already been patented, so the first step to getting a patent is to do a patent search. Go to the Canadian Patents Database to do a preliminary patent search. http://www.ic.gc.ca/opic-cipo/cpd/eng/introduction.html

3. **NOTE**: To get a patent, it must fit these three rules: your invention must be a new idea; it must work as it's supposed to; and your invention must not be obvious to someone who is skilled in that occupation/field of work.

4. **Build a prototype**
   Create a working model of your invention. Don't worry about making it with expensive materials, just make a version of your invention yourself. Once you have your prototype, it's time to troubleshoot your invention. Think about the problems it might have or how others will be able to use it. Share it with people you trust (who won't steal or share your

idea) and get their feedback, too.

5. **Find a manufacturer to create your product**
Once you have your patent and prototype, you can start making presentations to potential manufacturers and buyers. Find manufacturers that create products similar to yours and make a deal with them to produce your invention for you. Start meeting with buyers and creating agreements with them to buy your product as it is produced.

6. **Produce your invention**
Once you get a manufacturer, start mass-producing your product. Although it will probably be best to start in small amounts, you will no longer be creating only a few products at once, rather, hundreds or thousands!

7. Advertise

Use a variety of ways to advertise your product: making presentations, social media, TV and radio commercials, newspaper (ads and articles about your product).

Remember: It takes a lot of time and your own money to make an invention a reality; but it could be worth it!

4-H Canada Science Fair - Take your experiments to the next step!

Are you a 4-H youth in grade 7-12 with a curiosity about the world around you? The 4-H Canada Science Fair is an opportunity for you to explore, experiment and discover! As part of the 4-H Canada Science Fair, 4-H'ers plan, research, complete and submit science projects, independently or as pairs, to be judged virtually, in the hopes of moving to our in-person round and ultimately to the Canada-Wide Science Festival.

To learn more about registering, building a science project, finding a mentor and where the science fair can take you (hint: it's across the country!), visit the 4-H Canada website: http://4-h-canada.ca/4HCanadaScienceFair

To learn how to set up a science fair project, take a look at the 4-H Canada Science Fair Guide Book: http://4-h-canada.ca/science-fair-project-members

ACTIVITIES

Activity #36 – Judging

1. Bring in a variety of lemons to judge (which will also be used for one of the activities). Before judging, have members create a scorecard.
2. Alternatively, bring in any items (Leader or members) to judge.

Activity #37 - Share your experiment results *(last week's At Home activity)*

After the last club meeting, you were asked to conduct one more experiment at home (individually or in pairs or in groups) and to be prepared to share the results of your experiment today. Share the results of your experiment with all of us. Each person/group will have 10 minutes (15 minutes for senior members).

Activity #38: Lemon Volcanoes

Materials:

- Lemons (2 per volcano)
- Baking Soda
- Food Colouring
- Craft Stick
- Dish soap
- Tray
- Cup & Spoons

Optional Materials: (if you choose to do the open-ended inquiry experiments)

- Vinegar
- Ketchup
- 50-100 ml of 30% hydrogen peroxide (H2O2) solution
- Saturated potassium iodide (KI) solution
- Disposable gloves
- Safety glasses

Instructions:

1. Prep your lemon by slicing the bottom off to make them sit flat. Flip the lemon over and slice out the core. If you are making an open-faced volcano, slice the lemon in half.
2. Prepare extra lemon juice by slicing a second lemon in half and juicing it. Pour juice into a cup and set aside.
3. Place your cored lemon on a tray. Use your craft stick to mush the center of the lemon and bring out the juices. Be sure to keep the juice in the lemon!
4. Place a few drops of food colouring or liquid watercolours (do not dilute) in the center of the lemon.
5. Add in a good squeeze of dish soap to the lemon. This is not necessary but causes the bubbles to ooze and froth more and longer.
6. Add a spoonful of baking soda into the lemon. It should start to fizz. Take your craft stick and stir the lemon and lemon juice. It should start foaming really well as you stir it!
7. To keep the reaction going alternatively add more baking soda, colouring, dish soap and the reserved lemon juice to the reaction. Squeezing the lemon to release the juices also enhances the reaction.

Discussion:

- What causes the eruption to happen?

Lemon juice contains citric acid which when mixed with baking soda (sodium bicarbonate) reacts to form carbon dioxide and sodium citrate, which causes the liquid to fizz and bubble. Citric acid is a common food additive used in soft drinks as a preservative and flavouring.

Open-Ended Inquiry Questions:

- Try taking this activity to the next level! Use different combinations of ingredients and compare the level of eruption. Your task is to figure out how much to use to get the right kind of eruption. In this way, you are practicing repeat trials and documenting everything. You will need a volcano-type container, food colouring and dish soap
    - Baking soda and vinegar
    - Baking soda and ketchup

Senior Members *only*)

- 50-100 ml of 30% hydrogen peroxide (H2O2) solution and saturated potassium iodide (KI) solution.
- **NOTE**: Wear disposable gloves and safety glasses. Oxygen is evolved in this reaction, so do not perform this demonstration near an open flame. Also, the reaction is exothermic, producing a fair amount of heat, so do not lean over the graduated cylinder when the solutions are mixed. Leave your gloves on following the demonstration to aid with cleanup. The solution and foam may be rinsed down the drain with water.

Activity #39 - Diet Coke Explosion

WARNING: This experiment must be done outside because of the mess it will make! Members should **wear safety goggles and should stand back immediately after putting the Mentos candy in the pop bottle.**

Materials:

- 1 2-liter bottle of diet soda (or more if you want to repeat the experiment
- 1 package of Mentos candy (or more if you want to repeat the experiment)

Instructions:

1. Position the bottle on the ground so that it will not tip over.
2. The goal is to drop all seven Mentos into the bottle of soda at the same time (which is trickier than you might think). One method for doing this is to roll a piece of paper into a tube just big enough to hold the loose Mentos. Load the seven Mentos into the tube, cover the bottom of the tube with your finger, and position the tube directly over the mouth of the bottle. When you pull your finger out of the way, all seven Mentos should fall into the bottle at the same time.
3. Drop in the Mentos.
4. This final step is very important . . . run away! But don't forget to look back at the amazing eruption of soda.

Discussion:

- Why did the eruption happen? What do you think is the science behind it?

A bottle of soda is full of carbon dioxide (the bubbles.) The bubbles stay in the liquid until the bottle is opened. When you drop any sort of object into a bottle of soda, bubbles form on the surface of the object. The Mentos drops to the bottom of the bottle, forming lots and lots of bubbles on its pitted surface along the way. When all of this gas is released it forces the liquid up and out of the bottle in a giant whooshing geyser of sticky soda.

Open-Ended Inquiry Questions:

- How many more Mentos would it take to create an even bigger explosion?
- What other ways can you think of to get the Mentos quickly into the bottle?
- What happens if you use regular cola, instead of diet?

Activity #40 - Make your own blast

NOTE: This experiment must be done outside because of the mess it will make!

Materials: (per member/pairs/group)

- Vinegar
- Baking soda
- Toilet paper (one sheet per member/pair/group)
- Warm (not hot) water
- Zip lock bag

Instructions:

1. Make sure your zip-lock bag is water and air tight. If you have any doubts, test it with some water. Half fill the bag, close the zip and turn it upside down. If no water comes out, you are fine. If the water pours out, you need to find another bag.
2. Put one teaspoon of baking powder in the centre of the toilet paper square. Fold 1/3 of the paper in from one side and then 1/3 from the other.
3. Fold in the long side by 1/3 on both long sides so you end up with a square. (The paper acts as a fuse to delay the reaction and give you time to run for cover.)
4. Prepare about half a cup of vinegar and about 1/3 cup of warm water.
5. Grab hold of the zip-lock bag and pour in the vinegar and water. Hold the bag upright so it doesn't all spill out! Half close the bag.
6. Now, here is the tricky part, take your packet of wrapped baking powder and tuck it just under where you have closed the bag. Hold it in place above the liquid and close the rest of the bag.
7. Very important part now. Make sure the zip is closed properly. There will be air trapped in the bag so you could test the lock by a gentle squeeze of the bag to make sure that the air does not escape. But remember to keep the paper packet out of the vinegar!
8. Drop the baking powder pack into the vinegar/water mixture. Give it a little swoosh around and quickly put the package down and stand back. What you should see is the bag blow itself up and up until it suddenly bursts.

Discussion:

- Why did the bag blow up? What do you think is the science behind it?
- How did you tuck your package of wrapped baking powder under the bag? This was tricky, so how did you manage to do it?
- If this experiment didn't work, what do you think went wrong? What would you differently the next time?

Mixing vinegar and baking soda starts a chemical reaction that produces carbon dioxide, or CO2, and water. The chemical names of the two ingredients are acetic acid, which is the vinegar, and sodium bicarbonate, which is the baking soda. When vinegar and baking soda is mixed in a bag or similar container, the carbon dioxide produced fills up the container. The container bursts or “explodes” when there is no more space for the gas in the bag or container.

Open-Ended Inquiry Questions:

- What would happen if you don’t use the toilet paper to delay the reaction? How would the experiment change?