



science



CANADA

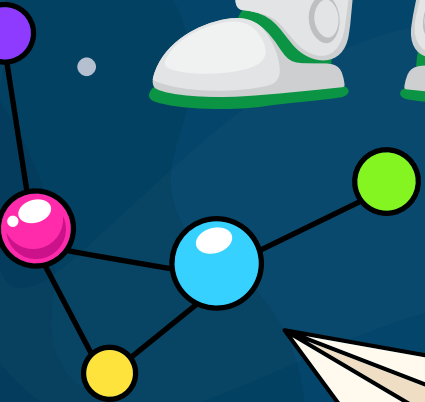


technology

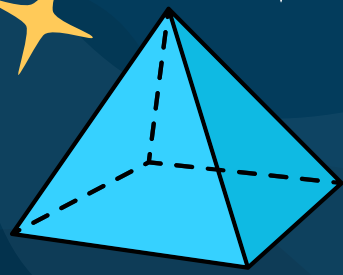


AGENTS of STEM

Mission Manual



engineering



math

Acknowledgements



CANADA

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Content Advisory Panel • Bayer Crop Science • CNH Industrial • 4-H Canada Staff • 4-H Canada Youth Advisory Committee Members: Neleah Lavoie, Sarah Maloney, and Ashlyn Whetter.

Written by Rochelle Strauss
Designed by Em Dash Design

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Agents of STEM offers 4-H Canada members and their clubs across the country an opportunity to increase engagement in STEM within and outside the 4-H program and increase STEM skills to support life and career readiness. This initiative would not be possible without the dedicated support of our sponsors.

AGENTS OF STEM ACTIVITY KIT PARTNERS

Funded by the
Government
of Canada

Canada



CNH



Foundation

This activity kit contains:

- ✓ Notebook and pen
- ✓ LED Bulb
- ✓ Zinc covered nails
- ✓ Alligator Clips
- ✓ Copper Wire
- ✓ Hobby motor
- ✓ LED Bulbs

4-H Canada is a positive youth development organization that empowers youth to be responsible, caring, and contributing leaders, making positive change in the world around them. The 4-H movement in Canada includes over 19,000 youth members across Canada with the support of more than 7,500 dedicated volunteer leaders. To learn more about 4-H Canada's programming, visit 4-h-canada.ca

Share your experience with us. Tag us @4HCanada on Twitter (X), Facebook, Instagram or LinkedIn

AGENTS of STEM Mission Manual

Table of Contents

INTRODUCTION page 4

SCIENCE page 12

page 14

MISSION 1 THE FORCE FIGHTS BACK



- | | | |
|---------------------|----------------------------|-----------------|
| In your kit: | You will also need: | |
| ✓ Notebook and pen | ✓ Running shoe | ✓ Scissors |
| | ✓ Tape | ✓ Ruler |
| | ✓ Rubber band | ✓ Test surfaces |

MISSION 2 POP! POTENTIAL ENERGY INTO KINETIC ENERGY

page 16

- | | |
|---------------------|----------------------------|
| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Craft or popsicle sticks |

TECHNOLOGY page 18

page 20

MISSION 3 You're In For a Shock!

- | | |
|---------------------|----------------------------|
| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Zinc covered nails |
| ✓ LED Bulb | ✓ Alligator Clips |
| ✓ Copper Wire | |

page 24

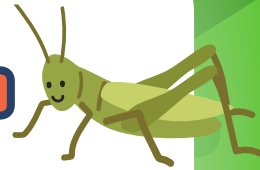
MISSION 4 BLOWING IN THE WIND



- | | | |
|---------------------|----------------------------|-----------------|
| In your kit: | You will also need: | |
| ✓ Notebook and pen | ✓ Small paper cups | ✓ Scissors |
| ✓ Hobby motor | ✓ Medium paper cups | ✓ Drill and bit |
| ✓ LED Bulb | ✓ Glue | ✓ Wind source |

ENGINEERING page 26

MISSION 5 DESIGN A BOT TO BATTLE PESTS!



- | | |
|---------------------|----------------------------|
| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Paper |
| | ✓ Pencils |
| | ✓ Drawing supplies |

page 28

page 30

MISSION 6 MAKE IT FLOAT!

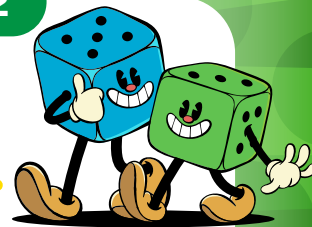
- | | |
|---------------------|----------------------------|
| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Rock |
| | ✓ Household materials |
| | ✓ Bucket |
| | ✓ Water |



MATH page 32

page 34

MISSION 7 NUMBER KNOCKOUT



- | | |
|---------------------|----------------------------|
| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Dice |

MISSION 8 Planting Projections



page 36

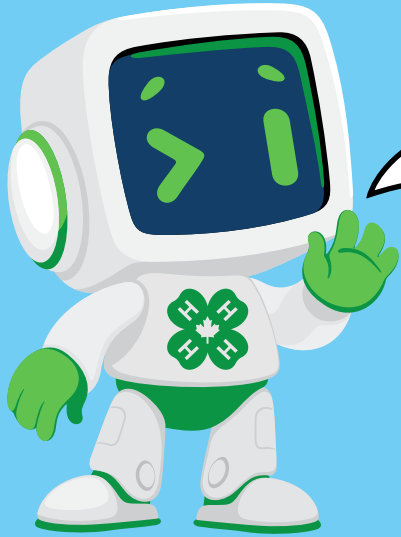
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| In your kit: | You will also need: |
| ✓ Notebook and pen | ✓ Paper |
| | ✓ Pencils |



**WELCOME
AGENTS OF
STEM!**



Introduction



AHHHHH - THERE YOU ARE. I'VE BEEN EXPECTING YOU.

MY NAME IS **SAGE**. THAT'S SHORT FOR **SCIENTIFIC ADVISOR FOR GUIDANCE AND EXPLORATION**. I WILL BE RUNNING MISSION CONTROL FOR YOUR NEW MISSION.



BEFORE WE START, I'D LOVE TO LEARN MORE ABOUT YOU! PLEASE SCAN THE QR CODE TO ANSWER A FEW PRE-MISSION QUESTIONS.

Welcome Agents!

On this mission, you'll join an elite team of curious minds, problem solvers, and undercover sleuths — otherwise known as **Agents of STEM** — to tackle puzzles, test theories, tinker with tech, and crack codes.

Your mission? Unlock the hidden power of STEM all around you!

From unexpected reactions to towering creations, prepare to observe, experiment, decode, and discover. Stay sharp, take notes, and remember: every great discovery begins with a curious question.



MINI MISSION

STEM is an acronym. An acronym is a word made up of the first letter in a series of words. Your first mini mission? Decode the acronym STEM. What do you think each letter stands for?

S: _____

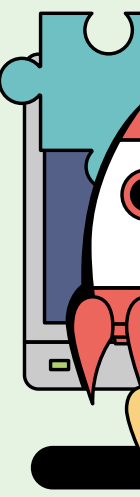
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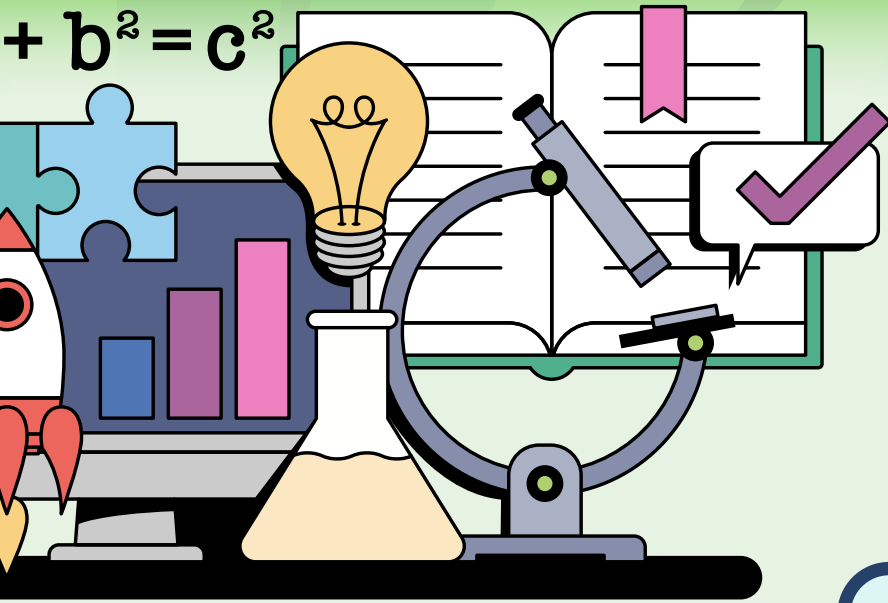
E: _____

M: _____



a^2





Understanding STEM

Now that you know STEM stands for science, technology, engineering and math, what exactly is STEM? Let's look at each of the words in the acronym.

Science: is learning about how the world works by watching things, asking questions, and doing experiments.

Technology: is using our knowledge of science to make things that help us in everyday life.

Engineering: is using our knowledge of science to design and build things that help solve problems.

Math: is the language of patterns, numbers and logic. It provides the tools to measure, analyze, and make predictions.



Facilitators: Use this QR code to download the facilitator notes, materials lists and other resources.



LIGHTBULB MOMENT

SCIENCE + TECHNOLOGY + ENGINEERING + MATH ... THEY ALL WORK TOGETHER! ONCE A PROBLEM IS IDENTIFIED, WE CAN USE OUR UNDERSTANDING OF SCIENCE TO DESIGN AND CREATE SOLUTIONS (TECHNOLOGY) THROUGH ENGINEERING, WHICH REQUIRES MATH.



Find 3 examples of science, technology, engineering and math happening around you.

Science:

Technology:

Engineering:

Math:



There are so many different aspects to STEM. Find all the words in this word search to learn more about the components of STEM. Once you've found all the words listed, find a hidden last word. (Hint: it's one of the most important features of an Agent of STEM)

Agents of STEM Word Search

F	C	Y	P	R	O	T	O	T	Y	P	E	N	G	V
A	D	D	I	T	I	O	N	C	K	U	F	F	Q	R
E	M	B	I	N	Y	T	L	A	F	O	S	S	I	L
T	H	C	S	Y	E	W	P	O	L	L	E	N	P	I
U	A	L	G	O	R	I	T	H	M	K	C	K	I	P
R	R	B	J	A	C	C	L	Q	X	S	O	X	L	K
B	A	B	P	P	E	D	R	U	L	M	D	A	X	E
I	T	L	L	P	L	Y	E	U	B	D	I	M	U	C
N	I	U	A	S	L	I	P	X	U	Y	N	A	N	O
E	O	E	S	D	E	S	I	G	N	K	G	X	A	S
S	D	P	E	C	U	R	I	O	S	I	T	Y	E	Y
T	R	R	R	W	J	E	Q	U	A	T	I	O	N	S
A	O	I	F	O	R	C	E	Y	K	J	E	E	P	T
T	N	N	X	H	W	C	I	R	C	U	I	T	T	E
S	E	T	J	E	U	Y	B	R	I	D	G	E	D	M

Force
Ecosystem
Fossil
Cell
Pollen

Coding
Circuit
Laser
Drone
Apps

Design
Prototype
Bridge
Blueprint
Turbine

Algorithm
Equation
Addition
Stats
Ratio

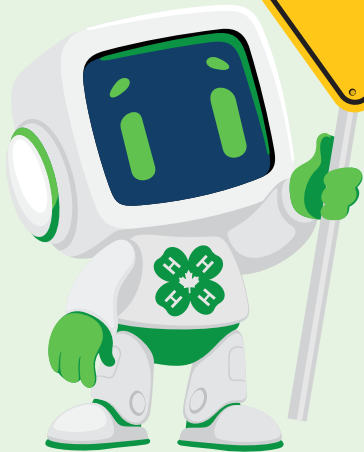
Mystery word: _____

Mission-Specific Training

This training will help you practice and build the skills you need to solve each mission safely.



MY JOB AS MISSION CONTROL IS TO MAKE SURE ALL AGENTS OF STEM (THIS MEANS YOU!) ARE PREPARED FOR THEIR MISSIONS. SAFETY FIRST!



101 of STEM safety

- **Follow the Mission Manual:** read all the instructions before starting each mission to avoid any explosions or other mishaps (just kidding about the explosions, but seriously, read all instructions first!).
- **Gear up:** before you start your mission, make sure you have all the safety gear you need. If your mission calls for it, wear goggles and/or gloves. Tie your hair back and roll up your sleeves. Follow all safety protocols as detailed in each mission.
- **Materials Alert:** you'll be handling different materials and substances. Be sure to handle them appropriately. If you're unsure about something, don't touch it or sniff it unless the mission asks you to. And definitely don't eat it!
- **Security Notice:** safety comes first so that everyone has a good time and the experiments run smoothly.
- **Keep it Clean:** spills and messes happen; that's part of the fun! But when they do, clean them up right away. A messy lab could sabotage your mission.



What other safety tips need to be included? Brainstorm on your own, or with your group. Keep safety tips visible for the whole group to see.


The Scientific Method

Throughout your missions, you'll need to apply the **scientific method**. The scientific method is a process that scientists use to figure out how things work in the world. It's a problem-solving approach that helps us understand what, why, and how. For example, a farmer notices a change in their crops. They aren't growing as well as they have in the past. If our farmer wonders why that's changed, they can use the scientific method to help figure out the problem.

As an Agent of STEM, you'll be applying the scientific method for some of your missions. So, let's go over the five basic steps of the scientific method.

- 1. Ask a question:** this is what we want to investigate. Our farmer might ask: Why are the crops not growing as well as they have before?
- 2. Make a prediction:** this is called the hypothesis. It's a possible answer to the question. Our farmer might predict that the soil the crops are growing in isn't healthy.
- 3. Gather data:** this evidence is needed to prove (or disprove) the hypothesis. Our farmer can observe how other crops in the field are growing. They can look at historical and current data, like weather patterns, storms, etc. to see if any environmental factors might be impacting the soil. They can also test the soil to see if it has the right nutrients.
- 4. Analyze data:** review all the data and look for trends. By reviewing their observations and test results, our farmer can look for patterns or trends that might show what's happening.
- 5. Draw conclusions:** use the data to test your hypothesis. Does the evidence prove or disprove the hypothesis, and what learning can you take away? For our farmer, if the evidence proves the hypothesis, then they can start to figure out the next steps to take to solve the problem. They might need to add more fertilizer to improve the soil to make sure the plants are getting the nutrients they need. If the evidence disproves the hypothesis, then our farmer may need to run their testing again, with a different hypothesis or questions.

This may sound complicated and time-consuming ... but following all the steps helps you get the answers you need.



DID YOU KNOW YOU USE THE SCIENTIFIC METHOD ALL THE TIME, WITHOUT EVEN REALIZING IT?!

Let's say you're playing Mario Kart. The track you want to race on has lots of hairpin turns and curves. You build your cart based on what you think will work best.

You might choose a cart you think will handle the turns well, or one you think will fly better down the straightaways or even choose wheels you think give speed or grip.

The cart you build is what you predict (hypothesize) will work best to get you the win. Then you run your race - testing your hypothesis.

At the end of the race, you analyze the data. A first-place finish might mean you've proved your hypothesis correct. The data tells you that the accessories you chose worked best for the track.

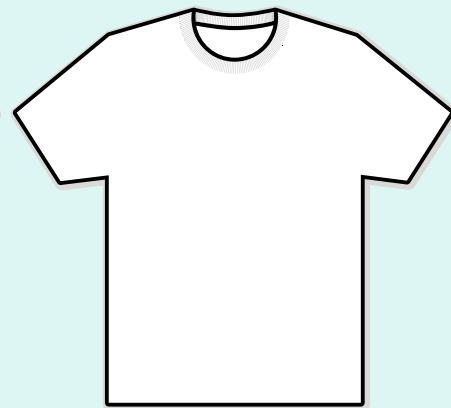
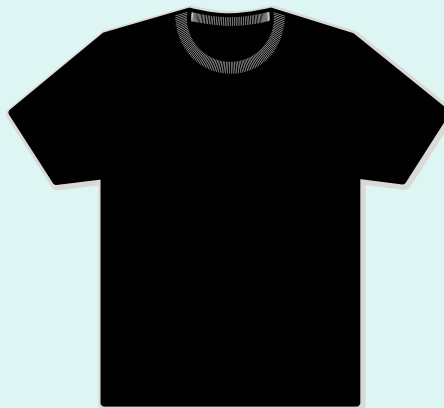
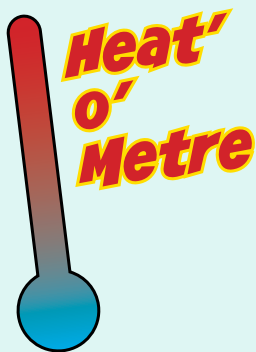
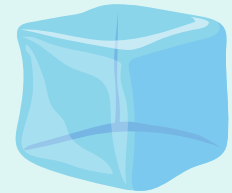
If you finished mid-pack or flew off the Rainbow Road, you didn't get the results you expected. Next time you race on that track, you'll use the data you gathered to build a new hypothesis and select a car design based on the data from your last race.



For this mini mission, apply the scientific method to test and answer one of the questions below (or choose your own). Record your data in the space provided. If you're working in small groups, gather everyone back together to discuss their results.

1. Define a question: choose one of the following questions to solve. Or create your own!

- Does an ice cube melt faster in saltwater or plain water?
 - » To run this test, prepare a glass of salt water and a glass of plain water. Plop an ice cube in each and see which one melts faster.
- Which colour absorbs more heat, black or white?
 - » To run this test, use the Heat'o'Metre provided. Place the Heat'o'Metre outside in direct sunlight for 5-10 minutes, then use your fingers to see which square feels hotter.



- Pick your own: _____

2. Make a prediction: what do you think will happen?

3. Gather the data: run the experiment and record your findings!

4. Analyze the data: review the results, what trends or patterns do you see?

5. Draw your conclusion:

Final Words

Hmmmm - I think that just about covers everything. But a few final words before you embark on your missions.

- STEM isn't about **knowing** the answer before you start. It's about the **journey** you take to discover the answer!
- STEM is about **trial** and **error**, so go ahead ... make mistakes or make a mess! Worst case scenario, you start over or try again - like all good Agents have done before you.
- It's ok to be nervous, especially if some of this is new to you. Remember, there's nothing wrong with asking for help, or discussing your thoughts, ideas, and worries as a group.
- Sometimes, no matter how well you prepare, an experiment or design will fail. And that's ok. These missions aren't about being perfect. They're about trying, testing, and discovering.
- Your Agents of STEM Mission Manual features several missions, but they don't need to be done all at once. Feel free to spread the missions out and do them at your own speed.
- Finally - if you feel like you're getting frustrated, take a break, catch your breath, and regroup. These are missions - **NOT** races! Tackle these missions at your own pace. And remember - even the best Agents of STEM get frustrated and need to walk away for a bit.



Set 3 goals you want to achieve during this STEM mission. For example:

- I want to understand more about science
- I want to explore new technologies
- I want to build something
- I want to feel brave when I try something new
- I want to feel ok when I make a mistake
- I want to have fun!

My goals:

1. _____

2. _____

3. _____



LIGHTBULB MOMENT

DID YOU KNOW THAT THE REUSABLE NOTES WE STICK ALL OVER THE PLACE WERE CREATED WHEN AN EXPERIMENT WENT WRONG? RESEARCHERS AT 3M WERE TRYING TO DEVELOP A NEW SUPER ADHESIVE - STRONGER THAN ANYTHING THEY'D EVER MADE BEFORE. BUT INSTEAD, THEY ACCIDENTALLY DEVELOPED A VERY WEAK GLUE. THE GLUE COULD BE STUCK, UNSTUCK, AND REUSED, OVER AND OVER AGAIN. SO, THE RESEARCHERS PIVOTED! INSTEAD OF A SUPER GLUE, THEY USED THEIR DISCOVERY TO CREATE THE ADHESIVE NOTES WE NOW KNOW AS POST-ITS. FROM A FAILED EXPERIMENT CAME A PRODUCT FOUND IN ALMOST EVERY HOUSEHOLD, SCHOOL, OR WORKPLACE AROUND THE WORLD!

One final note ... more than experimenting, building, and doing, science is also thinking about what you've done. **Come back to the questions below at the end of each section** to think about the mission, what you've learned, and how you felt. This is NOT a test. There are no wrong answers. This is just a way for you to reflect on the missions, what you've learned or done, and your STEM journey. Record your answers in your Mission Notebook.

1. What's one new thing that you learned or discovered?
2. What's one thing that was hard or challenging? How did you navigate the challenge? (For example: did you ask for help, did you take a break, or did you try again?)
3. What made you say WOW or surprised you the most?
4. What is something you'd like to learn more about?



Well done!!! You've completed your mission-specific training. You're officially ready to begin your mission

AGENT OF STEM Robert Larsen



Operations Manager
(Norrington Road Custom)

Job Farmer on family-owned beef cattle feedlot and manages an agri-services planting and harvesting business

Why does STEM matter? STEM is now foundational to the world we live in today, even in farming. It drives innovation, progress, and economic activity.

"Knowledge is power! Exploring STEM education through 4-H, regardless of whether you are interested in a STEM career path, will empower you to be a more resilient individual. It will improve your critical thinking skills, problem solving abilities, and help you understand the world around you."





Discovering Why!

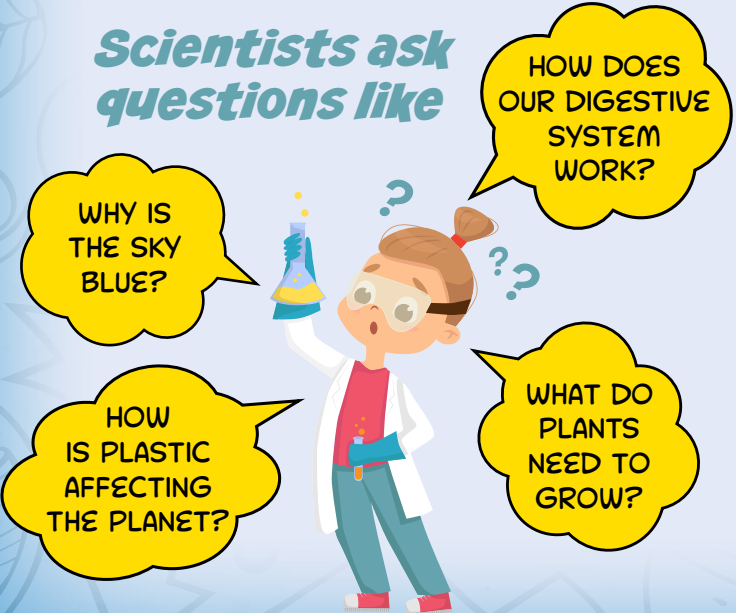
You might think that science is people wearing white lab coats and running experiments in labs. But I'm here to tell you that science is so much more. Science is happening all around you!

So ... what is science, exactly?

Science is a discovery mission. It's about asking questions and hunting down answers. It fuels innovation, drives discoveries, and builds our understanding of the world.

Scientists are curious by nature. They ask bold questions, test ideas, run experiments, and dig deep to figure things out. They study everything, from tiny cells, bacteria and viruses to plants and animals ... from chemicals and forces, to ecosystems, volcanoes, and space.

Scientists ask questions like



There are many areas of science, such as:

- **Biology** - the study of living things
- **Paleontology** - the study of dinosaur bones and fossils
- **Astronomy** - the study of the skies - stars, planets, the universe

How many other fields of science can you think of?



LIGHTBULB MOMENT

WHEN IT COMES TO SCIENCE, THE BIGGEST DISCOVERIES ALL HAVE ONE THING IN COMMON. THEY ALL STARTED WITH THE SIMPLEST QUESTION - WHY?

In science, no question is too big or too small.

Understanding the science of how the world works helps us solve problems. We use science to test ways to improve energy efficiency, develop more sustainable materials, grow resilient crops, work to solve the climate crisis, tackle global hunger, and fight diseases. For example, by understanding how plastic is negatively affecting the planet, we can develop better plastic alternatives, such as bioplastic made entirely from biodegradable, organic materials, like corn husks or food waste.

Science and the products of science are a big part your day, whether at home, school, on the farm, or all the places in between.

When you're in the kitchen baking - that's science! Baking is rooted in chemistry - a series of chemical reactions that transform ingredients into delicious chocolate chip cookies.

When you play baseball, physics is at work. Hitting and throwing the ball is about force - the push or pull of the ball that affects its speed and direction. Spin rate and aerodynamics are behind the way different pitches move.

Agriculture uses science all the time. Agronomists study the soil through tests and sampling to know which crops will grow best in which soil. Farmers track climate and weather data to know when to plant crops. A plant geneticist uses genetics and plant breeding to grow better and stronger crops - such as crops resistant to diseases or pests. Innovators experiment with new ways to water using AI, drones, and robots. And let's not get started on all the different types of farm equipment and vehicles, which are also products of science.

STEM in the Field

CNH brings STEM to the forefront

CNH brings STEM to the forefront of their work combining science, technology, engineering, and math to SenseApply and One Smart Spray. These technologies use multispectral cameras that see more than just colour. They can detect plant health and identify weeds. This allows the systems to only apply herbicide where needed. The combination of plant biology and environmental science with AI technology means farmers can reduce their use of chemicals when farming by as much as 80 per cent.

AGENT OF STEM Jodi Holzman



Sustainability and Environment Lead

(Bayer Inc.)

Job Works with stakeholders to ensure that Bayer Inc. complies with all federal and provincial environmental regulations.

Why does STEM matter? STEM helps us as individuals and society to be better stewards of our environment.

"By being curious we can learn so much about the intricacies of our environment and truly be in awe of our world."



MISSION 1

THE FORCE FIGHTS BACK!



Friction is the *force* that causes resistance when you slide or roll two surfaces over each other.

For example, if you try to push a box across the floor, friction is created between the box and the floor when they rub together. When the surfaces are smooth, you might experience very little friction like when your sled barrels down a smooth, snowy hill. But if the surfaces are rough, more friction is produced. Imagine sledding on a hill of sand – you won't get very far!

YOUR MISSION

DISCOVER FRICTION!

Using the scientific method, test different surfaces to see which one creates the most and least amount of friction.

MATERIALS

- **A running shoe** (or other type of shoe)
- **Strong tape** like scotch tape or duct tape
- **1 rubber band**
- **Scissors**
- **Ruler**
- Different **test surfaces** (see chart)



INSTRUCTIONS

- 1 Cut the rubber band in half and tape it to the bottom of the shoe (at the toe), so that the rubber band extends beyond the shoe. You're going to be pulling on the rubber band as part of this test.
- 2 Start with the scientific method to create a hypothesis. Which surface (see chart below) do you think will create the most friction against the shoe? Which surface will create the least? Record your hypotheses below.
- 3 Let the testing begin! Place your shoe on your first test surface.
- 4 Place a ruler next to the shoe so that the 0 end of the ruler lines up with the toe of the shoe. You might want to tape the ruler down so that it doesn't move.
- 5 Slowly and carefully pull the elastic until the shoe moves. If the elastic slips off, you may need to use more (or stronger) tape.
- 6 Looking at the ruler, measure how far the elastic stretches **before** the shoe starts to move.
- 7 Record your answer in the chart below.
- 8 Repeat by pulling the same shoe across as many different surfaces as you want to test. Use the ones suggested in the table - or pick your own!

BONUS: You can also try using different shoes - boots, slippers, sneakers, high heels, sandals, cleats. Do different shoes react differently on different surfaces? Talk with your group or an adult about why this might be.

Which surface caused the most friction and which surface caused the least? You can tell by looking at the distance the rubber band stretched before the shoe moved. The longer the elastic stretched, the harder you had to pull to overcome the friction. Did you confirm or disprove your hypotheses?

Don't worry if your hypotheses weren't correct. The most important thing to remember about science is that it isn't about always being right. Science is about learning from asking, observing, and testing. And sometimes you need to test multiple times before you get an answer.



RECORD YOUR HYPOTHESES AND RESULTS HERE:

- Which surface do you predict will create the most friction? _____
- Which surface do you predict will create the least friction? _____

SHOE TYPE	GRASS	CONCRETE	SAND	CARPET	WOOD FLOOR	PEBBLES / STONES

**MISSION 2**

POP!

POTENTIAL ENERGY INTO KINETIC ENERGY



ENERGY IS WHAT MAKES THINGS GO, MOVE, OR CHANGE. IT CAN BE GROUPED INTO TWO MAIN TYPES:

- 1. Potential energy** - this is the stored energy an object has because of its position, stress within itself, or other conditions. A stretched rubber band is an example of potential energy. It has stored energy ready to make the rubber band snap as soon as you let go.
- 2. Kinetic energy** - is the energy of motion. Anything that is moving has kinetic energy - like the wind blowing, water flowing, a vehicle running, or that rubber band when you let go.

On the farm, you can spot examples of potential and kinetic energy everywhere. Grain stored in a silo has potential energy. When you open the silo gate, potential energy becomes kinetic energy as the grain falls. If your farm has a wind turbine, it also has potential energy. Once wind blows to turn the blades, that potential energy becomes kinetic energy.

YOUR MISSION

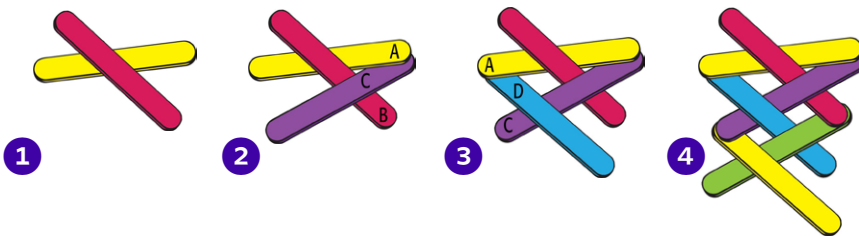
CONVERT POTENTIAL ENERGY INTO KINETIC ENERGY!

Note: this activity works best in pairs but can be done solo.

MATERIALS
Colourful craft or
popsicle sticks, at least
20-30 per pair

INSTRUCTIONS

- 1 Lay one popsicle stick over another to make an X
- 2 Place a third popsicle stick under the top popsicle stick **A**, at its tip and over popsicle stick **B**
- 3 Grab a fourth stick and place it under **A**, on the other side, and over **C**
- 4 Repeat steps 2 and 3 until you get the length you want
- 5 Someone will need to hold the chain down as you add more and more sticks
- 6 When the chain is as long as you want, let go and watch what happens when potential energy transforms into kinetic energy!



That chain reaction was neat, wasn't it? But what exactly happened?

As you bent each stick over or under the other sticks, it created tension, which represents potential energy. Adding more popsicle sticks continued to build tension and more potential energy.

When you held the popsicle sticks down, the force you were applying was greater than the tension in the popsicle sticks. But as soon as you let go, you released the tension. The potential energy that was stored in the sticks changed to kinetic energy, which sent the sticks flying!

If you're curious, try this again, using more popsicle sticks. Can you create an even bigger chain reaction?

Congratulations!

Congratulations! You've passed your SCIENCE missions with minimal friction and maximum kinetic flair!

You don't need a fancy lab or a PhD to be a scientist. All you need is:

- A curious mind
- A few good questions
- A notebook to record your questions, hypothesis, observations, and results
- And the courage to try things!

DON'T FORGET TO THINK ABOUT THE QUESTIONS ON PAGE 11 AND WRITE YOUR THOUGHTS IN YOUR MISSION NOTEBOOK. USE THIS QR CODE TO SHARE YOUR THOUGHTS AND PHOTOS WITH MISSION CONTROL.





Solving Problems!



MINI MISSION

When you think about TECHNOLOGY, what items come to mind?



Let's take a closer look at what you've listed. I bet you've included smartphones and tablets. Perhaps computers, robots and drones too? Maybe there's a gaming system on that list? When we think about technology, these are often the first things that come to mind. But technology is so much more than cool gadgets, blinking machines and glowing screens.

Technology (or tech for short) is about using scientific knowledge to build tools, processes, or networks that solve problems or that make life easier (and sometimes even more fun!).

For example, in agriculture, scientific knowledge helps us design technologies that make agriculture easier. These technologies can include:

- Precision farming tools that help assess crop health and problem areas
- Automated steering and navigation systems on tractors and other machinery
- Online platforms like Bayer's FieldView that collect, stream and centralize data from all equipment in one place
- Smart spraying technology, like CNH's SenseApply and One Smart spray that use cameras to detect plant health and apply herbicide when needed
- Radio-Frequency Identification (RFID) tags that attach to animals to help farmers track their location, movement and health status
- The Richardson Pioneer Ltd. CropMatrix platform that collects satellite imagery and uses the data to support crop production and management practices



LIGHTBULB MOMENT

HAVE YOU HEARD ABOUT THE INDUSTRIAL REVOLUTION? OVER 150 YEARS AGO, THE FIRST INDUSTRIAL REVOLUTION BROUGHT US STEAM ENGINES AND MACHINES. INSTEAD OF HAND STITCHING A SHIRT, MACHINES COULD MAKE HUNDREDS OF SHIRTS IN A DAY. ELECTRICITY ARRIVED IN THE SECOND INDUSTRIAL REVOLUTION, AND THE THIRD INDUSTRIAL REVOLUTION BROUGHT US ELECTRONICS AND COMPUTERS. GUESS WHAT? WE'RE NOW IN THE FOURTH INDUSTRIAL REVOLUTION. TODAY, WE'RE SEEING THE RISE OF ARTIFICIAL INTELLIGENCE, SMART MACHINES AND THE INTERNET OF THINGS (OBJECTS, LIKE FRIDGES, THAT ARE CONNECTED TO THE INTERNET).

Technology has played a huge role throughout human history, but tech is growing faster now than ever before. Simple tools from knives, eyeglasses, and wheelbarrows to more complex tools and machines like lightbulbs, telephones, steam engines, and combine harvesters are all part of our technological past. Our present is lined with drones that can monitor crop health and track livestock, apps that can warn about storms, solar panels that capture the sun's energy, and robots that can do everything from vacuum floors and monitor crops, to optimize fertilizer applications and milk cows.



And our future? Who knows what amazing technologies you and your peers may design.



Digital farming FieldView, from Bayer

FieldView, from Bayer, is the next step in digital farming. The suite of digital tools helps farmers see what worked and what didn't. It allows them to collect, stream and centralize their data season after season. Through the power of machine learning, AI, and data science, FieldView offers real-time data to help farmers improve their processes and operations.



Think/talk as a group about TECHNOLOGY again. What else can you add to your list?



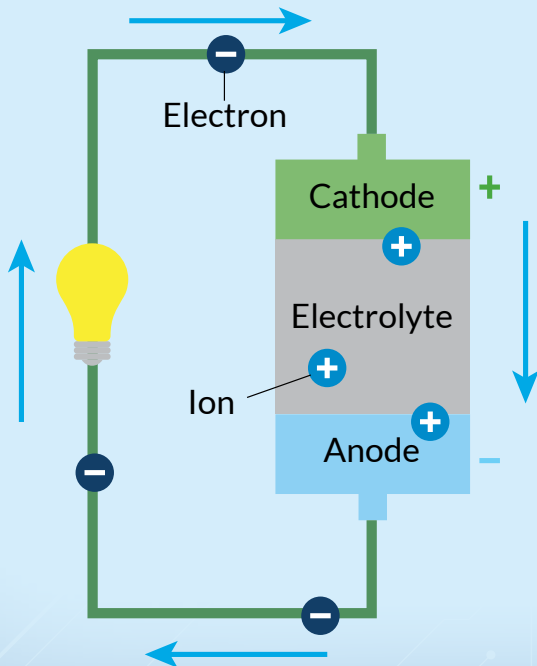
MISSION 3

You're in for a SHOCK!

Batteries may seem like a modern technology, but they've been around for over 200 years! Alessandro Volta, an Italian physicist, invented the first battery in 1800. His battery was made by building alternating layers of zinc, copper, and cloth soaked in brine (saltwater). Though Volta's batteries didn't have enough charge to power up a modern-day computer, we now measure battery power in VOLTS, named after Alessandro!



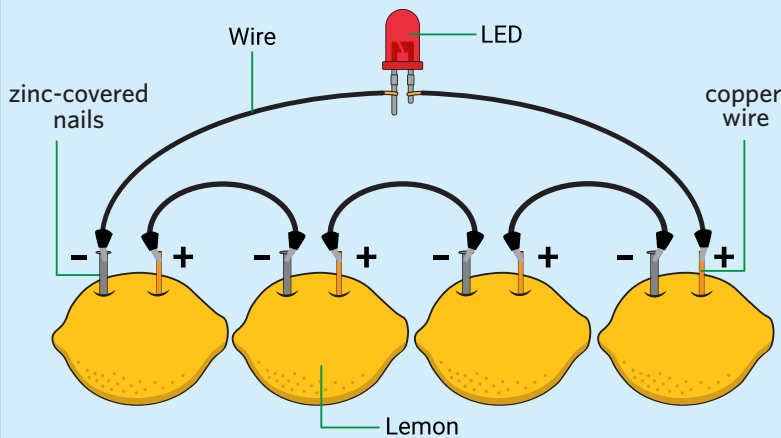
How a battery works



Batteries work by using a chemical reaction inside the battery to convert chemical energy to electrical energy, creating electricity. Inside a battery there are two metal electrodes. The positive electrode is called the cathode, and the negative electrode is called the anode. Between them is an electrolyte - a material that allows for the transfer of electrons. Electrons are tiny negatively charged particles produced by a chemical reaction at the anode. The electrons then flow from the anode through the electrolyte to the cathode, completing the circuit. For Volta's battery, zinc disks were the negative electrode, the copper disks the positive, and the saltwater cloth was the electrolyte.

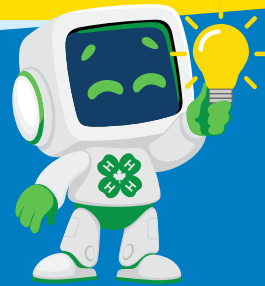
Your mission: Create a battery!

Note: this activity works best in pairs but can be done solo.



Materials

- 1 LED bulb
- 4 lemons
- 4 zinc-covered nails (such as galvanized roofing nails)
- 5 alligator clips (with clips on both sides)
- 4 pieces of medium gauge copper wire (about the same length as the nail)
- Optional:* goggles and gloves. Lemon juice is acidic, so it might sting if you get it in your eyes or a cut



LIGHTBULB MOMENT

DO NOT EAT THE LEMONS (OR ANY OTHER FOODS YOU MAY TRY) AFTER

YOUR EXPERIMENT. THERE MAY BE TRACE AMOUNTS OF ZINC OR COPPER LEFT BEHIND IN THEM. THEY CAN BE COMPOSTED, OR YOU CAN SQUEEZE THE LEMONS AND USE THE JUICE TO WRITE INVISIBLE MESSAGES TO SHARE WITH YOUR FRIENDS AND SEE CHEMISTRY IN ACTION! (CHECK OUT THE LINK IN THE RESOURCE MATERIALS TO LEARN HOW!)

Instructions

- 1 Roll each lemon against a table or countertop, pushing down with just a **little** force (but not hard enough to make lemonade!). This helps loosen the juice.
 - 2 Stick one nail in the first lemon. The nail is your negative electrode, or anode.
 - 3 Stick a copper wire on the other side. This is the positive electrode, or cathode.
 - 4 Repeat for the next 3 lemons
 - 5 Line up your lemons! Make sure the copper wire on the first lemon is facing the nail on the second lemon. Repeat that pattern for the next two lemons
 - 6 It's time to connect the lemons. Using the first alligator clip, connect the copper wire from the first lemon to the nail of the second lemon and repeat the chain two more times.
 - 7 Attach an alligator clip to the **nail** on the first lemon, leaving the other clip free
 - 8 Attach an alligator clip to the **copper wire** on the last lemon, leaving the clip end free
- Now test your battery!**
- 9 Fasten the end of the alligator clip attached to the copper wire to the **positive** end of the LED (it's sometimes the longer leg)
 - 10 Now fasten the end of the alligator clip attached to nail to the **negative** end of the LED (it's sometimes the shorter leg)

continues on next page...



You're in for a SHOCK!

Did your LED light shine bright?

A lemon on its own isn't a battery but add electrodes and you may be shocked to learn that lemons (and other citrus fruits) can produce a small voltage. For this battery, zinc nails were the negative electrodes, copper wires were the positive electrodes, and the juice in the lemons served as the electrolyte. Since lemons only produce about 9/10th of a volt, four lemons should have done the trick to light a 3-volt LED bulb.

If your light wasn't too bright, you may need fresher or juicier lemons. You could also try using a little sandpaper to clean your wires and nails to improve conductivity. Or you might want to add another lemon to your chain.

Curious to see what else you can use besides lemons? Try other citrus fruits, like limes, grapefruits, and oranges, or other produce like apples, tomatoes, or potatoes.



AGENT OF STEM Kevin Hendriks



Digital Transformation & Risk Analysis Manager
(CNH Capital)

Job Works with data modelling projects, AI, data querying and visualization, and robotic process automation to deliver analytic and technology-based solutions.

Why does STEM matter? STEM provides us with a toolkit that helps us see the difference between fact and fluff. STEM's peer review process means that no single person is driving progress. Instead, it's driven by a community of thinkers who challenge each other's ideas, debate differences, and work collaboratively to drive knowledge forward.

"Working within the realm of technology means that I have a never-ending stream of new things to explore. I never stop learning."

AGENT OF STEM Shaunak Juvekar



Digital Transformation Analyst
(CNH Capital)

Job Build software programs, including backend logic and schema as well as frontend design and deployment. Automates business processes using robotic process automation.

Why does STEM matter? Learning STEM equips us with critical thinking and an analytical mindset.

"You might think only engineering and technological fields require STEM but that's not the case. Even careers in arts require logical reasoning and methodologies. Conversely engineering also requires creativity, especially for solving hard problems."

MISSION 4

BLOWING IN THE WIND



Batteries are not the only way to generate electricity. Wind is also an excellent source of energy. Wind capturing devices are great examples of both historic AND recent technologies.

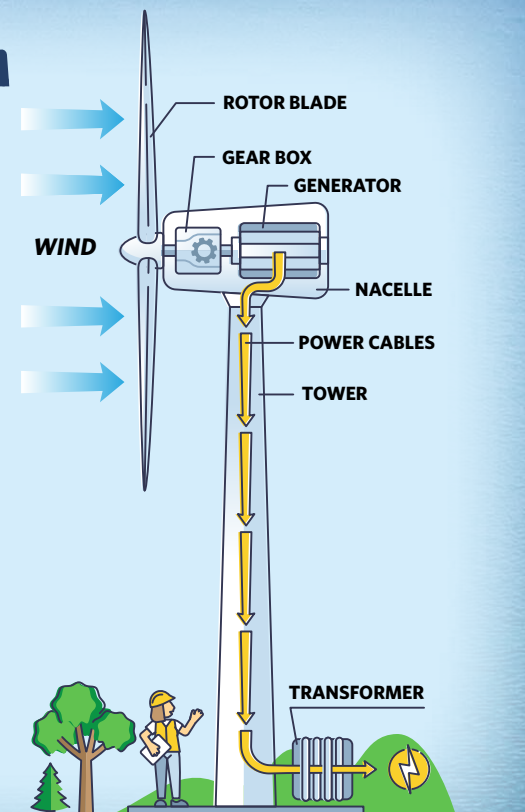
Wind energy has a long history in agriculture, dating back to old school windmills that used wind to generate mechanical energy. This mechanical energy powered the wheels and gears needed to grind grain, turning it into flour. As technology advanced, wind turbines were developed to harness wind to produce electrical energy to power farms, homes, communities, and even cities.

HOW DO TURBINES WORK?

The blades of a wind turbine are specially designed to capture wind. When they do, the wind makes the blades spin. These blades are attached to a low-speed shaft, which sits inside the turbine. The low-speed shaft rotates at about the same speed as the blades. But we need more speed to generate electricity. So, the low-speed shaft is connected to a gearbox, whose gears rotate much faster. The gearbox is connected to a faster high-speed shaft, which is connected to a generator. This generator transforms the **kinetic** wind energy into electricity.

Wind turbines also have sensors that allow them to turn towards the wind or rotate the blades to maximize the amount of wind captured. If the winds are high enough, the sensor will trigger the turbine to shut off for safety.

On farms, this wind-generated electricity can be used to power lights, electric fences, milking machines, or irrigation systems.





YOUR MISSION BUILD A MODEL WIND TURBINE



Note: this activity works best in pairs but can be done solo.

MATERIALS

- **Small hobby motor** (6-12 volts)
- **1 LED bulb**
- **4 craft sticks**
- **Small paper cup**
- **Medium paper cup**
- **Glue** (white glue, wood glue, or hot glue - whatever you have on hand, but hot glue works best)
- **Scissors**
- **Drill and drill bit** the size of the motor shaft
- **Wind source** (a windy day or a fan)



INSTRUCTIONS

- 1 Glue two craft sticks together to make +.
- 2 Cut the sides of the smaller cup (from top to bottom) in four roughly equal parts. Remove the round bottom. These are your turbine blades.
- 3 Once the sticks are dry, drill a small hole the size of the motor's shaft (the part that sticks out) at the centre of the two sticks.



4 Glue the outside of each blade to the end of the craft sticks, so that each craft stick has a blade and all the blades face the same way. For best results, don't glue the blades in the centre. Glue them closer to one side of the sticks, making sure you do it the same way for each blade. This is the front of the turbine.



5 Attach your LED to the terminals at the back of the motor by twisting each "leg" around each terminal.

6 Slide your finished turbine blades onto the shaft of the motor. It should fit snugly.

7 With the open mouth of the cup facing down, glue the remaining two craft sticks to either side of the cup. The sticks will angle inward, getting narrower at the top. This is the base of your wind turbine.



8 Now squeeze the motor between the two sticks, at the top, and glue it in place. Make sure that the motor is placed so that the blades face forward and can rotate without these two sticks getting in the way.

Congratulations!

You really took charge of your **TECHNOLOGY** mission.

Remember, this generation is the most technologically literate generation ever! Whether you pursue a tech career or are a tech user, your innovations and/or how you use technology will shape the future.

DON'T FORGET TO THINK ABOUT THE QUESTIONS ON PAGE 11 AND WRITE YOUR THOUGHTS IN YOUR MISSION NOTEBOOK. USE THIS QR CODE TO SHARE YOUR THOUGHTS AND PHOTOS WITH MISSION CONTROL.



Now test your turbine!

Use a small fan or take the turbine outside. Can you light the LED?

Note: If you have plenty of wind energy, but the LED doesn't light up, you may need to change the LED connection. Reattach the LED of each leg to the opposite terminal they'd been attached to.

Keep experimenting with the turbine by designing different types of blades and testing them against different sources of wind (like simply blowing on the turbine or using a bicycle pump). Do some designs work better than others? Why do you think that is?





Design!

Engineers are champion problem solvers. They use their understanding of science (how the world works) and math, to design and build products, engines, machines, and structures that make our life easier, safer, more fun, and/or better for the planet. They are excellent at imagining new ways of doing things and can tackle everything from projects that lie deep beneath the ground, like mining, to outer space (Mars, anyone?), as well as everything in between.

Evidence of engineering is everywhere. You can thank an engineer for the home you live in and the toaster you used to make your breakfast. Engineering was behind the vehicle you used to get to school, the fuel needed, and the roadways you travelled on. An engineer designed the packaging your food comes in, and the machines that may have planted, watered, and harvested the crops to make your food. And the next time you experience the heart-pounding plunge of a roller coaster, thank an engineer for figuring out how to keep that coaster on its track!

Engineering is more than just building skyscrapers that reach the clouds or bridges that cross vast expanses!



LIGHTBULB MOMENT

FUN FACTS ABOUT SKYSCRAPERS AND BRIDGES ... AT 828 METRES TALL (OR 163 STORIES), BURJ KHALIFA IN DUBAI IS THE WORLD'S TALLEST BUILDING. ITS "Y" SHAPED DESIGN WAS ENGINEERED TO HELP DEAL WITH THE EFFECTS OF GRAVITY AND WIND ON SUCH A TALL STRUCTURE. AND THE WORLD'S LONGEST BRIDGE? THE DANYANG-KUNSHAN GRAND BRIDGE IN CHINA IS 164 KM LONG. IT WAS ENGINEERED TO WITHSTAND EARTHQUAKES, TYPHOONS, AND EVEN ACCIDENTS, LIKE GETTING SLAMMED INTO BY A SHIP.



Engineers don't just throw stuff together and yell taaa-daaa! They follow specific process called the *engineering design process*. It's like the scientific method, but each step in the process allows engineers to design, build, test, and refine their projects to arrive at the final product.



There are so many different branches of engineering. Civil engineering, for example, is all about building structures – like skyscrapers and bridges. Can you match each type of engineering with what those engineers do? Draw a line to connect them.

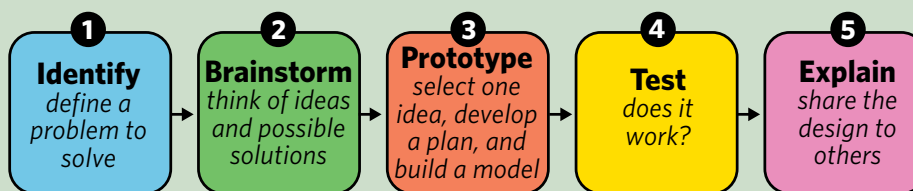
Type of Engineering

- Aerospace
- Biomedical
- Chemical
- Electrical
- Agricultural
- Environmental
- Nuclear

Design and Build ...

- Technologies and machines for healthcare, everything from X-rays and MRIs to prosthetics
- Systems that use nuclear energy as a power source
- Systems that protect and manage natural resources
- Machines that fly, like planes, drones and rockets
- Foods, medicines and fuels using chemicals
- Power systems, like EV charging stations
- Machines, tools and systems to improve farming

The engineering design process follows these five steps:



This design process is iterative, meaning engineers may repeat the steps over and over again (especially steps 3 and 4). For example, they build and test a prototype and then tweak and revise it until they land on their final product. Failing and making mistakes (or missing the mark) is an important part of the process – it’s how they learn what works best or doesn’t work at all.

Chances are, you’ve used the design process to make or build something yourself! For example, if you’ve ever built something out of LEGO, you’ve applied the design process.

1. You decided what to build (identify)
2. Then you considered ways to approach the build (brainstorm)
3. Next you picked your idea, developed your plan, and began the build (prototype)
4. When you finished your build, you checked to see if it works (test)
5. Did you get the results you wanted? If not, then you probably thought about ways to improve it or fix it, and then tried again (iteration)
6. When you finally got the build you wanted, hopefully you were so excited (and proud!) that you shared your build with friends and family (explain).

STEM in the Field

Autonomous and semi-autonomous machines

Farming equipment, like autonomous and semi-autonomous machines that do jobs independently with little or no human help, are products of engineering. CNH’s FieldOps platform, for example, is a cloud-based digital ecosystem that connects machines, collects real-time data, and enables remote control, monitoring and decision making. Through FieldOps, every piece of equipment can work seamlessly together, making farming more efficient and simpler.

**MISSION 5**

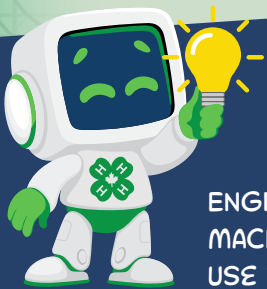
When we talk about robots, we often imagine them as large, humanoid objects. In movies, they tend to be mechanical, metallic machines that have a blend of human traits and characteristics. But robots are so much more!

Robotics is a branch of engineering that is all about designing, building, and operating robots or machines that can do work.

What a robot looks like will depend on what it was engineered to do. Flying robots, for example, may have wings or blades like a helicopter. Cleaning robots for your home may look like mini vacuums. Delivery robots are designed like mini vehicles.

To be called a robot, it must be able to do three things:

- 1. Sense:** sensors on the robot must be able to detect what it's programmed to detect, like moisture, light, pressure, sound, or obstacles.
- 2. Process:** take the data it senses, evaluate it, and then "decide" what to do next. Robots are programmed with variables and instructions, such as if "X" happens, then do "Y". For example, when a robotic vacuum senses an obstacle in its way, it changes course.
- 3. Act:** take the action it's programmed to take in each scenario. For example, if a robot has been designed to monitor moisture levels in the soil and it senses the levels are too low, it will initiate watering.

**LIGHTBULB MOMENT**

ENGINEERING BEGAN WITH SIX SIMPLE MACHINES – ALL OF WHICH WE STILL USE TODAY.

- **WHEEL AND AXLE:** MAKES MOVING HEAVY LOADS EASIER ACROSS DISTANCES
- **WEDGE:** HELPS SPLIT OR PUSH APART OBJECTS
- **LEVER:** HELPS LIFT OR MOVE A HEAVY OBJECT
- **INCLINED PLANE:** HELPS SLIDE HEAVY OBJECTS UP OR DOWN, INSTEAD OF LIFTING THEM
- **PULLEY:** HELPS LIFT HEAVY OBJECTS BY PULLING DOWN INSTEAD OF LIFTING UP
- **SCREWS:** FASTENS TWO OBJECTS TOGETHER

In agriculture, you can find autonomous robots working independently to perform farming tasks, such as seeding, watering, weeding, harvesting, and packaging. These robots use science, AI, GPS and machine learning to work precisely and efficiently on each specific task (or set of tasks).

YOUR MISSION DESIGN A BOT TO BATTLE PESTS!

Use steps 1 - 3 of the engineering design process to design a PDR - a **P**est **D**etection **R**obot!

Materials

- Notepad or paper
- Pens, pencils, crayons - anything you want to use to draw or sketch your designs

Instructions

1 Identify the problem



Weevils in the wheat? Caterpillars in the cabbage? Design a PDR - a Pest Detection Robot to patrol the fields, identify pests, and take action.

Note: You can also identify and design a bot to solve a different farming challenge.

2 Brainstorm ideas!

Working with a team, partner, or on your own, brainstorm ideas. Record as many ideas as you can in your notebook. Remember, this is brainstorming, which means no idea is bad or too wild. Record everything.

- Think about what makes a robot a robot - the ability to sense, think and act!
- Think about:
 - » Is there a specific pest you want the PDR to detect?
 - » What will it use to see and identify the pest(s)?
 - » How will it tell the difference between a pest and a helpful bug?
 - » What will it do when a pest is detected?
 - » How will it be powered?
 - » How will it move?
 - » What other issues might you need to consider for your design? (weather, terrain, distance, etc.)

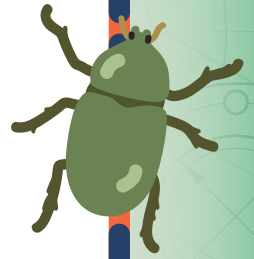
3 Prototype!

Now comes the fun! Review all the ideas and select what you want for your PDR. Then start to draw or sketch your vision. Be sure to include everything you've decided your PDR needs - use arrows and labels to mark what's what on your PDR. Your drawing doesn't have to be perfect because this is just a prototype. You can use symbols, shapes or even emojis to convey parts of your PDR.

Note: For this part of the mission, you can work on your own or work with a team or partner.

4 Share!

Walk your friends or family through what you've designed and explain how the PDR works. Remember that the engineering design process is iterative, so ask for their feedback. Make as many revisions to your PDR as you want, until you're happy with the design.



I BET THAT GOT YOUR CREATIVE JUICES FLOWING! NOW, IF YOU'RE FEELING SUPERCHARGED, YOU CAN TAKE IT A STEP FURTHER BY BUILDING A 3D PROTOTYPE. USE CRAFT SUPPLIES, HOUSEHOLD OBJECTS, RECYCLED MATERIALS, LEGOS, MODELLING CLAY OR WHATEVER YOU HAVE ON HAND TO CREATE A SCALED MODEL OF YOUR PDR!



**MISSION 6****MAKE IT FLOAT!**

Dwayne

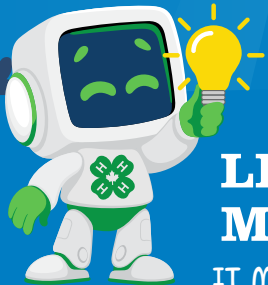
Meet Dwayne. Dwayne is a rock (but not THE Rock). He loves nothing more than to chill by the water and take a quick dip when he gets too hot. Unfortunately, every time Dwayne goes for a swim, he sinks.

YOUR MISSION

Use the engineering design process to design and build a personal flotation device for Dwayne!

MATERIALS

- **A rock** – about the size of a walnut (or larger if you're feeling brave!)
- **Notebook or paper**
- **Pen, pencil or crayons**
- **Household materials to build Dwayne's personal flotation device**
 - » Options: string, rope, cork, bubble wrap or Styrofoam, paper towels, cardboard tubes, glue, sticks, foil, containers, straws, etc. Get creative and check your recycling bin for supplies!
- **A water vessel**, such as a bucket, large bowl, etc.
- **Water**
- Optional: materials to decorate Dwayne! Draw a face, add googly eyes or even hair!

**LIGHTBULB MOMENT**

IT MAY SURPRISE YOU TO LEARN THAT NOT ALL ROCKS SINK IN WATER. PUMICE IS A VOLCANIC ROCK THAT FORMS ONCE LAVA COOLS. IT IS FULL OF AIR POCKETS THAT HELP IT FLOAT.

INSTRUCTIONS

- 1 **The problem:** Dwayne sinks in water. Your objective, design a Personal Floatation Device (PFD) to keep Dwayne from sinking.
- 2 **The rules:**
 - The PFD must attach to Dwayne in some way
 - It must keep Dwayne floating in the water, which means some part of Dwayne must be submerged in the water. (Think about how a life jacket works on a person.)
- 3 **Brainstorm:** Working as a team, in pairs, or solo, brainstorm your approach. Consider the materials that you have, what you're trying to achieve and what designs you might try.

Note: If you're working your own, you can brainstorm solo – or get family, friends, or even your dreaded sister or brother to help. Brainstorming is fun when you do it with someone else.
- 4 **Prototype:** Once you have a design you want to test, sketch it out so you have a blueprint of how to build the prototype. And then build it! If you make changes along the way, keep track of the changes on your blueprint.
- 5 **Test:** Ready? It's time to test your prototype. Did Dwayne float or sink? If he sank, not to worry. Remember this is an iterative process – review your design, make tweaks and try again!
- 6 **Share:** Whether successful or not, share your results. Who knows, sharing what you learned may help inspire new ideas to try!

Rocks like Dwayne are very dense, much heavier for their size than water. When you tossed Dwayne into the water, the upward push from the water (called buoyant force) wasn't strong enough to hold him up. Gravity took over, pulling Dwayne down to the bottom (ahhhh, physics!).

If Dwayne floated with the PFD you engineered, then you succeeded in helping Dwayne (with the PFD) take up more space, without adding much extra weight. As a bigger object, Dwayne and the PFD displaced more water (pushed it aside), which increased the buoyant force enough to keep Dwayne afloat!

If you want to explore more, try this mission again, using bigger rocks!

Congratulations!

You've designed and iterated your way through the ENGINEERING missions!

Imagine what engineering might bring us in the future. Self-driving flying cars? A new fuel from seawater? Solar panel roads that melt ice? Villages on Mars? An elevator to space? Who knows?!

What we design and build in the future is limited only by our own imagination!

DON'T FORGET TO THINK ABOUT THE QUESTIONS ON PAGE 11 AND WRITE YOUR THOUGHTS IN YOUR MISSION NOTEBOOK. USE THIS QR CODE TO SHARE YOUR THOUGHTS AND PHOTOS WITH MISSION CONTROL.





It All Adds Up!



MINI MISSION

Can you think of 5 things you do every day that need math?

1. _____
2. _____
3. _____
4. _____
5. _____

Though you may not see it, math is mathing all around you!



Math is much more than numbers on a page or the equations and formulas your teachers want you to memorize. Math is a language, like English or French, but based on logic, patterns, and relationships. It helps us explain how and why things work, like the path planets take to orbit the sun, how musical notes combine to make harmonies, and why the moves in your favourite video game feel so real.

We call math a universal language because it is the **ONE** language that every human on earth can understand. The symbols, rules and patterns of math are the same from country to country. So, whether you're in Canada, Japan or Kenya, $1 + 1 = 2$... always.

Math is a vital part of science and technology. It provides the tools for measuring, calculating, and analyzing data. It helps scientists, engineers, and innovators by providing ways to solve problems, understand patterns and communicate solutions.

In science, researchers use math to analyze the data they collect. Biologists, for example, use statistics and data to estimate things like the global population of an animal.

Engineers use math to design and build new technologies. It allows them to calculate the volume (or amount) of grain a new grain cart will hold and run modelling and simulation programs that help



LIGHTBULB MOMENT

BECAUSE MATH IS A UNIVERSAL LANGUAGE, A CIVIL ENGINEER IN CALGARY CAN SEND BLUEPRINTS FOR A BRIDGE TO AN ENGINEER IN SEOUL, KOREA. THE KOREAN ENGINEER CAN IMMEDIATELY UNDERSTAND AND BUILD THAT BRIDGE SIMPLY BY READING THE MATH IN THE BLUEPRINTS.

predict how a machine or building will respond under different conditions.

Computer programmers use math to write code. Code is the set of instructions that tells a program what to do. It includes math formulas, logic, and decision-making. For video games, programmers use geometry to model and shape 3D objects in a game, like the carts in Mario Kart. Physics formulas direct how an object or character moves and reacts. When two carts collide in Mario Kart? The carts are coded to respond by pushing away from each other. (Psst! That's Newton's 3rd Law of Motion at work in code – for every action, there is an equal and opposite reaction!)

Math isn't just for scientists. It's a powerful tool that helps all of us navigate the world.

Farmers use formulas and equations to ensure their animals receive the right combination of grain, hay, vitamins, and minerals for a balanced diet. By knowing how big a grazing area is and how much grass cows can eat in a day, farmers can calculate how long their cows can stay in one area before they need to be moved. Farmers also keep very detailed records of their animals (like your 4-H record books), such as weight, genetic background, growth rate, and volume of food they eat. Using the averages of this data helps farmers assess which animals are thriving and which may need attention.

STEM in the Field



CNH planting machines

At CNH, their planting machines use math to figure out the best way to plant seeds. Statistical modeling, optimization algorithms, and agronomic data analysis allows the planters to gather data such as soil type, moisture, and temperature. Using this data, the planters can optimize seed placement. These systems can plant over 1,000 seeds per second, improve crop yield by up to 26 per cent, and save farmers as much as 12 per cent in seed and fertilizer costs.



Making a pie isn't just about baking; it's a full-on adventure in math! Fill in the blanks using the math words below to see all the ways math is used.

You have fresh-picked cherries and want to bake a pie. Recipe in hand, you start by _____ your ingredients. You want to make two pies, so you must _____ all your ingredients by two. You need to preheat the oven, but your recipe is in Celsius, and your oven is in Fahrenheit. You must _____ 180°C into Fahrenheit to know what temperature to set the oven. You wonder if you can fit both pies into the oven at once, so you use _____ to figure it out. The pies are ready, and your friends are eager to dig in. Since you have two pies and need 16 pieces, you use _____ to cut each pie into eight equal pieces so everyone has a slice. Each piece you serve represents a _____ of the pie.

Division

Fraction

Multiply

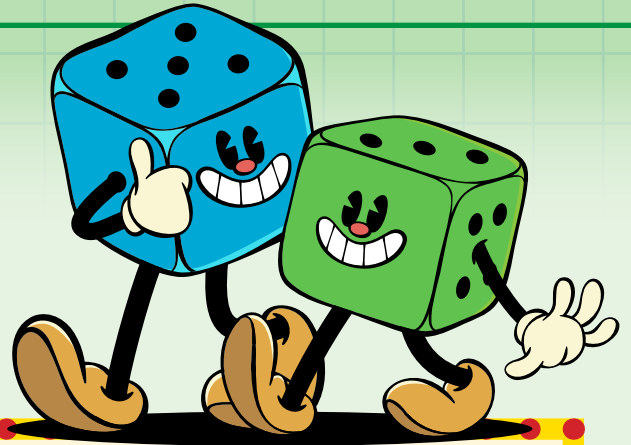
Convert

Geometry

Measuring



MISSION 7



NUMBER KNOCKOUT

Your mission: Be the first to knock out all your numbers!

In this game, you'll use math as you race to be the first Agent of STEM to knock out your numbers.

PLAYERS

- 2 or more
- For larger groups, consider playing in teams

MATERIALS

- 2 dice
- Pencil or pen
- Game board design template

1	2	3	4	5
6	7	8	9	10
11	12	FREE SPACE	1	2
3	4	5	6	7
8	9	10	11	12

PLAY THE GAME

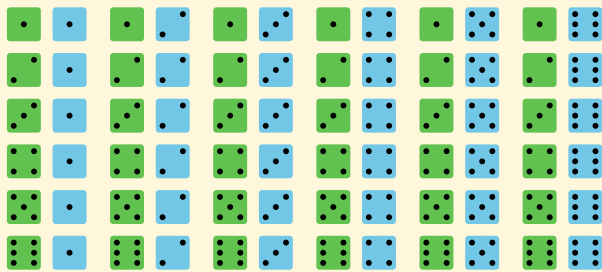
- The goal of the game is to knock out all the numbers on your game board.
- Start by using the game board design template to draw a game board in your Mission Notebook
- Roll the dice to see who goes first. Highest roll starts.
- Player One goes first and rolls the dice.
- Based on the roll, the player has three choices. Using BOTH dice, they can add, subtract or multiply the numbers.
 - » For example, if the player rolled 3 and 2, they can either:
 - $3 - 2 = 1$ (subtract)
 - $3 + 2 = 5$ (add)
 - $3 \times 2 = 6$ (multiply)

- The player then chooses which action to take and knocks out the corresponding number on their board. In this example, they can choose to knock out either 1, 5, or 6.
- To knock out the number, simply put an X through it.
- Moving clockwise, the next players take their turns.
- Play continues until one person has knocked out all their numbers.
- When a player rolls the dice but can't knock out any numbers, they skip their turn.
- The first person to knock out all their numbers wins.

Option: If you want to play a quick game, compete to see who can knock out a single line, in any direction, first.

This might seem like a simple game of math – adding, subtracting and multiplying, but there’s more to this game than you realize. Chance and probability play a role, too.

When you roll one die, there are six possible outcomes. But when you roll two dice, there are 36 possible outcomes. The number of outcomes on one die is multiplied by the number of outcomes on the other, so $6 \times 6 = 36$.



In the game, there will be multiple combinations that will allow you to knock out each number. Some numbers have fewer combinations than others, so they’ll be the harder numbers to knock out because the chance of getting the right combination of numbers is lower.

For example, the number 11 can only be achieved by rolling 6 and 5. There are only two ways to get this roll:

Dice A	Dice B	Total
5	6	$5 + 6 = 11$
6	5	$6 + 5 = 11$

The chance of getting a roll that lets you knock out the number 11 on your score card will only happen two times out of every 36 rolls, or 5.56 per cent

The number 1 on your scorecard is one of the easiest numbers to knock out because 11 different combinations will get the number 1. (Keep in mind, unlike math equations, the order of the dice doesn’t matter, just the number that is rolled.)

Dice A	Dice B	
1	1	$1 \times 1 = 1$
2	1	$2 - 1 = 1$
1	2	$2 - 1 = 1$
3	2	$3 - 2 = 1$
2	3	$3 - 2 = 1$
4	3	$4 - 3 + 1$
3	4	$4 - 3 + 1$
5	4	$5 - 4 + 1$
4	5	$5 - 4 + 1$
6	5	$6 - 5 = 1$
5	6	$6 - 5 = 1$

The chances of getting a roll that lets you knock out the number 1 on your score card will happen 11 times out of every 36 rolls, so 31 per cent of the time.

Now that you know about the probabilities of different roll combinations, what strategies will you use when you play this game again?



LIGHTBULB MOMENT

YOU USE MATH EVERY DAY JUST TO GET TO SCHOOL ON TIME. THAT FORMULA MIGHT BE CALCULATED LIKE THIS:

- FIRST BELL IS AT 9 A.M.
- ADD: THE AMOUNT OF TIME TO GET READY (60 MINUTES) + TIME IT TAKES TO COMMUTE TO SCHOOL (30 MINS) = 90 MINUTES
- SUBTRACT: 90 MINS FROM THE TIME OF FIRST BELL (9 A.M. - 90 MINS) = 7:30 A.M.
- YOU NEED TO SET YOUR ALARM FOR 7:30 A.M. TO GET TO SCHOOL ON TIME
- BUT PERHAPS YOU SET IT A BIT EARLIER TO ACCOUNT FOR THE 90 PER CENT PROBABILITY THAT YOU WILL HIT SNOOZE AT LEAST ONCE!!



WAKE UP



LEAVE HOME



ARRIVE AT SCHOOL



MISSION 8



Planting Projections



Your mission

Use math to choose the best crop to grow

You're plotting a garden and plan to sell your harvest. Your goal is to figure out which crop to plant to make the most money.

You can only plant one type of crop. Which crop will it be?

Materials

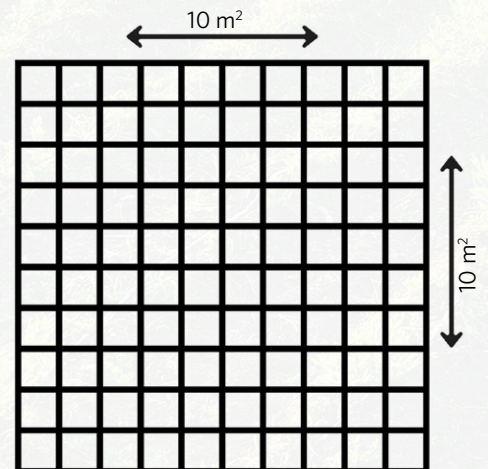
- Pens and pencils
- Paper
- Tables below
- Optional: **calculators** (or cellphones)

Instructions

This is a word problem, so remember to read the instructions closely!

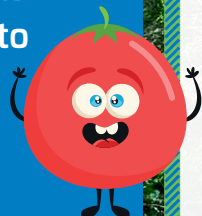
You have an area of land that measures 100 square metres (100 m²). Each side of the plot measures 10 m x 10 m, which makes a perfect square!

To calculate how many plants you might be able to fit in your plot, start by imagining your land as a grid that is 10 squares by 10 squares. Your grid would look something like this →



How many squares do you have within your plot of land?
(Hint: 10 x 10 = _____)

Do you know all the ways math is used on a farm? Before planting, farmers measure the total area of a field. Then they use math formulas to calculate the rows and ideal distances between plants, so that they can maximize how much they can plant and know how much seed they need for the best results. When spraying their fields, farmers calculate how much product they need to use to ensure the entire crop is protected. Finally, farmers don't guess how much they might harvest, they sample plants, seeds, and fruits in an area and use math to make estimations and projections about total crop yield.





You can choose between planting potatoes, carrots, corn, tomatoes, or cucumbers, but **you can only plant ONE type of crop**. The first thing you need to calculate is how many total plants you can plant on your plot.

To calculate how many plants you can plant, you first need to know how many plants fit into a single square. Column A in Table 1 gives you that data.

To project how many plants you can grow on the entire plot, you multiply the number of plants you can grow in one square by the number of squares you have. Let's use onions as an example. If you can grow 5 onion plants in a single square, then on 100 squares of land, you could grow 500 plants ($5 \times 100 = 500$).

Ok, now calculate the rest.

TABLE 1
Project the Number of Plants

Crop	A	B
	Number of plants per square	Number of plants per plot of land (A x 100)
Onions	5	500
Potatoes	4	
Carrots	16	
Corn	6	
Tomatoes	4	
Cucumbers	2	

Now that you know how many plants you can grow on your plot of land, which plant might you choose?

Your answer: _____

You might think carrots would be the plant for you since you can grow about 1,600 carrot plants, but there's more to planning crops than how many plants you can grow. You need to consider other factors too, such as:

- Yield:** how many vegetables you can harvest from each plant
- Income:** how much money you might earn from each plant.

To calculate yield and income, multiply how many plants you have times how much you can earn per plant. For onions, you'd expect to get 1 onion per plant. Let's say you earn \$0.86 for each onion on the plant. That means that 500 onion plants will produce 500 onions, so $500 \times \$0.86 = \430 . You can project an income of \$430.

Potential income per plant is listed in column C for you. Your job is to use the chart to calculate how much you might make by growing each crop. For column B, bring down your results from Table 1 above.

TABLE 2
Project Your Income

Crop	A	B	C	D
	Number of plants per square	Number of plants per plot of land (A x 100)	Income per plant	Total Income (B x C)
Onions	5	500	\$0.86	\$430
Potatoes	4		\$3.20	
Carrots	16		\$0.20	
Corn	6		\$0.33	
Tomatoes	4		\$8.20	
Cucumbers	2		\$11.28	

Which crop will bring you the most income? _____

continues on next page...



Planting Projections



It's interesting that even though you could plant so many more carrots, you'd earn more money by planting tomatoes (or even cucumbers). That's because each carrot plant only yields one carrot, whereas each tomato plant may yield 10 (or more) tomatoes.

Of course, there are so many other factors at play, like soil conditions, weather, disease, pests, time it takes to plant, grow and harvest each crop, and so on, but this kind of math (or data) helps farmers make estimations and predictions about their potential yield and income, helping them decide what to plant.

If you're curious, play around with combining crops. Maybe grow 20 squares of cucumbers, 50 tomatoes and 30 corn. How do the numbers change?



Congratulations!

By my calculations, you've conquered the equations and mastered the formulas to complete the MATH Missions!

From shapes, numbers and patterns, to building things, programming computers and solving problems, math is all around you. Keep your eyes open and you will soon discover many other exciting ways you use math every day.

DON'T FORGET TO THINK ABOUT THE QUESTIONS ON PAGE 11 AND WRITE YOUR THOUGHTS IN YOUR MISSION NOTEBOOK. USE THIS QR CODE TO SHARE YOUR THOUGHTS AND PHOTOS WITH MISSION CONTROL.



AGENT OF STEM Juliano Barela



Field Agronomy Lead Canada

(Bayer Inc.)

Job Leads research and development for new crop protection products for Canada.

Why does STEM matter? STEM can make a difference in people's lives and better prepare them for the future.

"Learning STEM subjects equips us with critical thinking and an analytic mindset. My passion is supporting STEM programs that encourage young people to develop these skills and find opportunities in the future."





Mission Accomplished!

WELL DONE, AGENTS!
YOU'VE TACKLED ALL THE MISSIONS AND
LEVELLED UP YOUR SKILLS IN STEM.

Through the lens of science, technology, engineering, and math, you've explored the world around you in new ways.



MINI MISSION

Remember, an important part of STEM is reflection – thinking about what you did, what you accomplished, and what you learned. Use these questions to reflect with your group or on your own.

- Did you achieve the goals you set for yourself at the start of the STEM mission?
 - What was your favourite mission and why?
 - What was the biggest challenge you faced and why? (For example, you couldn't get Dwayne to float or your lemon battery to work).
 - What strategies did you use to overcome the challenge?
 - Finish this sentence: When I think about STEM, I feel
-

You've learned how to ask questions, make a hypothesis, test, experiment, design, build, iterate and reiterate. You can make predictions and estimations and play with probabilities, too. You've built resilience when things didn't go as planned and even got to meet and learn about the work of other Agents of STEM.

Most importantly, you uncovered the invisible force that is the STEM all around you.

Becoming an Agent of STEM is like developing your own superpower. It means you aren't afraid to ask bold questions, tackle tricky problems, explore new ideas, confront complicated challenges, or think creatively about the future.

But your mission doesn't stop here. As a certified Agent of STEM, you've got the skills to continue to spot and explore hidden STEM in action. Think beyond STEM in your classroom. Look for the STEM hiding all around you — at your 4-H meetings/projects, in your barn, workshop, or kitchen, and throughout your community. Keep asking questions about how things work and test out your ideas, theories, and hypotheses. And on the farm, or in the garden, notice how STEM helps you plant, grow, protect, and harvest your crops.



NOW THAT YOU'VE COMPLETED YOUR MISSIONS, I'D LOVE TO HEAR MORE ABOUT WHAT YOU LEARNED! PLEASE SCAN THE QR CODE TO ANSWER A FEW POST-MISSION QUESTIONS.



Your next STEM mission is up to you! Where will you go??



960 Carling Avenue, Building 106
Ottawa, ON K1A 0C6
1-844-759-1013
4-h-canada.ca
info@4-h-canada.ca

