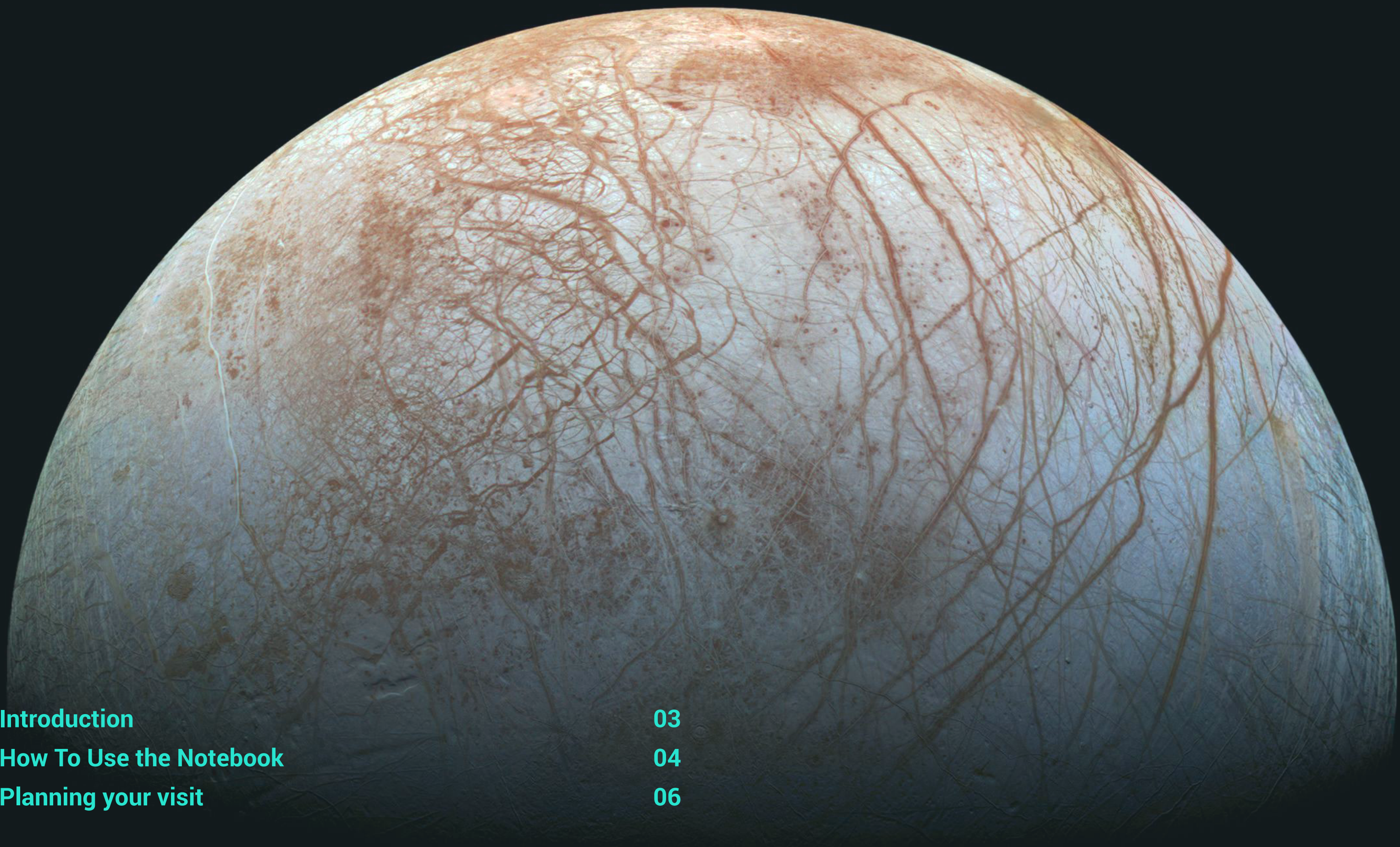
TEACHING ACTIVITY NOTEBOOK

MISSION COSMO ASTRALIS

COSMODOME

TABLE OF CONTENT



INTRODUCTION

This **Activity Notebook** is intended for teachers, parents, and young people interested in the conquest of space, a highly captivating subject, and more specifically long-term space missions. If it targets primarily young students from the 2nd and 3rd elementary cycles (from the 4th to 6th year), activities are also suitable for students of the 1st elementary cycle as well as high school.

Activities relate to the brand new 'Mission Cosmo', a simulated space mission to Europa, one of Jupiter's moons. These activities are meant to enhance both a visit to the Cosmodome and carrying out the Cosmo Mission. Said activities can be done before or after a visit.

Experiments can also be carried out at home, with the support of an adult. Recommended materials, tools and equipment are readily available within the community, at low cost.

The Teaching Notebook includes six scientific activities based on technological and scientific inquiry.

- **Team-Building Patch.** Students design a patch that will represent their team during their mission at the Cosmodome.
- **Do not touch!** Students design a very simple electrical circuit allowing them to move a ring around, making sure a light bulb does not light up.
- **Oxygen: Friend or Foe?** Students observe how various fruits and vegetables react when exposed to air.
- **The suit makes the astronaut.** Students will test various fabrics that could be used to manufacture a spacesuit.
- **What's on the menu?** Students must come up with a 5-day menu based on the preferences of someone close to them.
- **To be or not to be an explorer?** Students discuss the necessity and importance of space exploration, based on pros and cons.

HOW TO USE THE NOTEBOOK

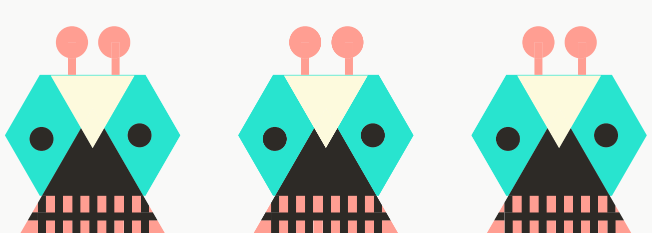
Each activity revolves around two sections that can be downloaded and printed, in all or in parts: the *Companion Guide* and the *Scientist Notebook*.

The *Companion Guide* will help the teacher or parent set up and facilitate the activity, in the classroom or at home. It contains the following subsections:

- The **Teaching Objectives** are specifically linked to the described activity. They summarize what the student should be able to achieve by the end of the activity.
- The **Context** sets up the activity and illustrates its relevance.
- The **Research Question** establishes the framework of the activity.
- **Activity Duration** is approximate.
- The **Likely Hypothesis** stems from the research question.
- Teachers are provided with some student **Preconceptions** about the activity, solely for guidance. Other preconceptions may arise in the classroom or at home.
- The **Glossary** provides simplified explanations of knowledge used throughout each activity.
- The required **Material** is readily available in the community, at low cost.
- Some activities include **Diagrams** to illustrate manipulations.
- **Manipulations** are described one step at a time. Occasionally, we have stated ‘Repeat steps x to y’ for the sake of conciseness. Additional information intended for teachers help clarify some actions.
- A **Result Table** is used to note experiment findings.
- The **Conclusion** provides the answer to the research question, by confirming or not the initial hypothesis.
- **Observations** introduce suggestions, precisions, and variants.
- Under **Recommended Resources**, we provide links to Websites of renowned aerospace organizations.
- **Links to the Progression of Learning** is a non exhaustive list of required knowledge and skills for the Elementary 2nd and 3rd cycles, primarily in Science and Technology, according to the Québec Education Program.
- **Connections with other subject areas** proposes activities and links to other programs.

The *Scientist Notebook* is designed to be printed and handed out to students. It contains all necessary information to carry out experiments and note the results.

- The **Context** is a short text the student must read when starting an activity. The teacher will ensure that everyone understand the terms used. It might be an opportunity to introduce some of the Glossary content.
- The **Research Question** is introduced by a character through a conceptual drawing. Other characters submit their own **hypotheses**. The student is then asked to provide his or her own hypothesis. Some of the hypotheses made by the various characters may seem outlandish!
- The experiment description includes :
  - a **List of the required material**;
  - one or several **Diagrams**, if need be;
  - the **Manipulations** to be done;
  - the **Result Table.**
- In the **Conclusion**, the student answers the Research Question by confirming or not his or her hypothesis.
- **Did you know…?** is intended to develop the student’s scientific knowledge by establishing links with historical, social, technological and native facts.



It is now 2045. After returning to the Moon and sending the first astronauts on Mars, humans have a new goal: reaching Europa, one of the many moons of Jupiter, more than 628 millions km away from Earth. The mission will last two years. Its objective: to find out if life has developed on this fascinating celestial body covered by an ice ocean.

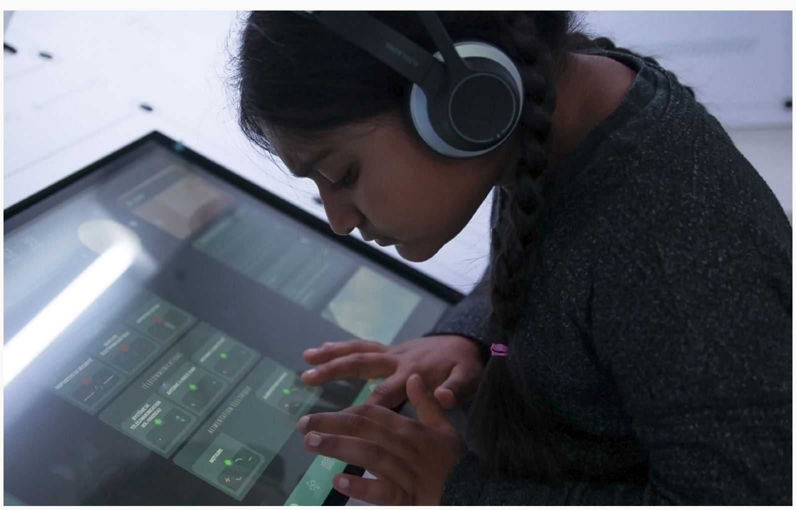
Great news! You have been selected to participate in a simulation of this mission. Should you succeed – you never know – you might be chosen to participate in the space mission of the Century!

Upon arriving to the Cosmodome, your mission supervisor (MS) will assign you a specific role: you could be part of the crew or join the flight control team. Whether you are acting as on-board pilot or mission specialist, or as flight director or doctor on the ground, your role will be crucial to the success of the mission.

Once you have been handed out instructions, you will climb aboard the Astralis spacecraft or enter the control room. With support from the Astralis Bot, you will implement the liftoff, transit and landing sequence on Europa. Warning! Incidents could occur in flight that threaten the safety of the astronauts. There is no room for mistakes!

If you are part of a group, you will also be able to carry out scientific experiments to study Europa and answer the following question: Is there life elsewhere?

Have a great mission!



Planning your visit to the Cosmodome

Your visit to the Cosmodome is fast-approaching? Here are some ideas to help you plan your visit with us.

Online Activities

Should your very inquisitive students or children want more information, please visit the online activity page of our Website.

cosmodome.org/en/online-activities/

Things to bring with you

- Wearing closed shoes and long pants is a must to try out the astronaut training simulators.
- Why not print and wear the patch that you designed? See the 'Team-Building Patch' activity.
- To get into the spirit of things, many visitors opt to wear clothing with space designs.

Pre-check

- Minimum height is 1.28m and maximum weight 100kg to use the astronaut training simulators.
- Teachers: Please let us know which student can be photographed.

Some information about the Cosmodome

- Free parking
- Easy access with public transit
- Free lunch space for groups
- Café Ariane is open on weekends and during the week in peak season.
- Wheelchairs are available
- The 'Mission Cosmo' experiment, exhibitions and virtual missions offered by the Cosmodome are open to all.

We cannot wait to meet you!

Have a great visit!

TEAM-BUILDING PATCH

COMPANION GUIDE

TEACHING OBJECTIVES

- Designing and making a **patch**, taking constraints into account.
- Identifying important elements of an activity (mission) to be carried out.
- Promoting a sense of belonging within a common activity.

CONTEXT

The sense of belonging to a team is crucial when undertaking a dangerous mission. Success depends on mutual reliance. In space, it is all about survival, or life and death!

Sport teams wear uniforms adorned with colours and **symbols** to proudly express their group identity.

During a space mission, astronauts must be part of a close-knit team. To illustrate the close collaboration between team members on Earth and in space, they wear a specifically designed patch that represents them.

RESEARCH QUESTION

You are about to embark on a space mission that will take you far into outer space. Which patch could best represent your class mission towards Europa?

DURATION

Duration of this activity will depend on the level of details required to design the patch. The minimum time is 60 minutes.

LIKELY HYPOTHESIS

Patches can be of various shapes. The round shape is the most likely. Let the students have fun, innovate and be creative.

PRECONCEPTION(S)

Students may think that they need a large design to represent their class.

GLOSSARY

- **Patch:** A small piece of fabric sewn on clothing or a uniform, adorned with distinctive symbols associated with a school, a movement, etc.
- **Symbol:** Sign representing a group (ex., sport teams), an activity (ex., a mission) or an operation (ex.: + when adding).
- **Destination:** Location targeted by something or someone.
- **Objective:** Goal, anticipated result of an activity.

REQUIRED MATERIAL

TO DESIGN IT

- Large sheet (11in x 17 in)
- Felt pens
- Stickers

TO MAKE IT

- Material selected by the group
- Scissors
- Glue
- Various pens (colour)
- Fasteners to attach the patch to clothing

DIAGRAM

See suggestions of prior patches.

MANIPULATIONS

1. Introduce the context
2. Discuss the mission with students, including its **objectives**, duration, destination, etc.
3. List the elements that must appear on the patch (see Project Specifications).
4. Have a brainstorming session about the mission's name.
5. Divide students in teams of 2 to design their patch.
6. Students submit their design to their classmates.
7. Display all patches and submit them to an 'impartial' judge who has been informed of the nature of the mission.
8. Once a patch design has been selected, students make their own patch based on that design.

RESULT TABLE

Displays proposals.

CONCLUSION

Upon completing this activity, students will have designed and made a patch worn by all during their mission at the Cosmodome.

OBSERVATIONS

- We assume that designing the patch comes after selecting the mission title.
- The young visitors must let their imagination run free.
- The patch can be made out of cardboard, fabric, plastic or any other material.
- The patch can be attached with a magnet.
- The teacher may provide functional blank patches (white) for the students to draw on or glue their design.
- The class can also be identified with a name.
- The group may determine the maximum weight of the patch. We suggest that you weigh the various materials to be used. It is an opportunity to remind students that weight must be taken into account when launching a rocket.

Project specifications are gathered in a document that states the requirements and constraints associated with making a technical object.

RECOMMENDED RESOURCES

ENGLISH RESOURCES

- Patch maker, patch maker, make me a patch
  https://www.asc-csa.gc.ca/eng/resources-young/junior-astronauts/activities/teamwork-and-communication/patch-maker-patch-maker-make-me-a-patch.asp
- Make your own mission patch
  https://www.youtube.com/watch?v=u6zHQ_GOoXc
- Design your own mission patch. Smithsonian National Air and Space Museum.
  https://airandspace.si.edu/sites/default/files/media-assets/12%20Mission%20Patches.pdf
- Mission Patches. NASA.
  https://history.nasa.gov/mission_patches.html
- Expeditions to the International Space Station. A-B Emblem.
  https://space.abemblem.com/collections/expeditions
- European human spaceflight patches. European Space Agency.
  http://www.esa.int/About_Us/ESA_history/European_human_spaceflight_patches
- Roscosmos, ESA, etc. SpacePatches.
  http://www.spacepatches.nl/

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

EXPLORATION STRATEGIES

- Studying a problem or a phenomenon from different points of view (e.g. social, environmental, historical, and economic).
- Distinguishing between the different types of information useful for solving the problem.
- Referring to similar problems that have already been solved.
- Becoming aware of his or her previous representations.
- Drawing a diagram for the problem or illustrating it.
- Formulating questions.
- Putting forward hypotheses (e.g. individually, in teams, as a class).
- Exploring various ways of solving the problem.
- Anticipating the results of his or her approach.
- Imagining solutions to a problem in light of his or her explanations.
- Taking into account the constraints involved in solving a problem or making an object (e.g. specifications, available resources, time allotted).
- Examining his or her mistakes in order to identify their source.
- Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification).
- Using empirical approaches (e.g. trial and error, analysis, exploration using one’s senses).

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY (CONT.)

INSTRUMENTATION STRATEGIES

- Using different sources of information (e.g. books, newspapers, Web sites, magazines, experts).
- Validating sources of information.
- Using technical designs to illustrate a solution (e.g. diagrams, sketches, technical drawings).
- Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, and logbook).

COMMUNICATION STRATEGIES

- Using different means of communication to propose explanations or solutions (e.g. oral presentation, written presentation, procedure).
- Exchanging information.
- Comparing different possible explanations for or solutions to a problem in order to assess their relevance (e.g. full-group discussion).

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
VISUAL ARTS The design process follows steps listed in the Government document: inspiration, development, focus (PFÉQ, p.209). Competency 2: To produce individual works in the visual arts. Competency 3: To appreciate a work of art, a cultural object from the world's artistic heritage, a personal or media image, his/her productions and those of classmates.	— Designing and making the patch.
ENGLISH Competency 1: To use language to communicate and learn Students explain their patch design. They listen to their classmates' explanations. Competency 3: To write self-expressive, narrative and information-based texts To represent her/his literacy in different media. Students could write a short text describing their patch design.	— Writing an explanatory text about the patch designed by his/her small team. — Explaining verbally to the group the patch designed by his/her small team.

CONNECTIONS WITH OTHER SUBJECT AREAS (CONT.)

DISCIPLINES AND COMPETENCIES	USED IN…
MATHEMATICS	
Competency 2: To reason using mathematical concepts and processes.	— Designing a patch based on Project Specifications.

ARITHMETIC

Calculating an area:

- Square:
  Length x Length (L^2).
- Rectangle:
  Length x Width (L x l).
- Circle:
  3.14 x diameter x diameter ($\pi \times r^2$).

MEASURES

A. Length

4. Evaluating and measuring an object's dimensions using standard units.
   b. Metre, decimetre, centimetre, and millimetre (2nd cycle).
   c. Metre, decimetre, centimetre, millimetre and kilometre (3rd cycle).

B. Areas

1. Evaluating and measuring a surface area.
   a. Using non standard units (2nd cycle).
   b. Using standard units (3rd cycle).

F. Mass

2. Evaluating and measuring mass using standard units (2nd and 3rd cycles).

VISUAL INSPIRATION

This mission patch was designed for the first space flight of Canadian Space Agency astronaut David Saint-Jacques.

The four stars surrounding the North Star symbolize all those who pool their talents in support of this mission. Earth figures prominently on the patch.

The image represents the power of dreams and evokes the role of space exploration in our evolving perspective of life on Earth.

The North Star (dreams) and compass rose (reason) have always guided explorers. These form the central element of the patch.

The trail of the star is composed of four colours, signifying pillars of innovation: red (energy and passion), orange (creativity), white (science) and blue (international collaboration).

(Credit: Canadian Space Agency)

TEAM-BUILDING PATCH

SCIENTIST NOTEBOOK

CONTEXT

A sense of belonging to a team is crucial when undertaking a dangerous mission. Success depends on mutual reliance. In space, it is all about survival, or life and death!

Sport teams wear uniforms adorned with colours and symbols to proudly express their group identity.

During a space mission, astronauts must be part of a close-knit team. To illustrate the close collaboration between team members on Earth and in space, they are not allowed to wear a team sweater or cap. Instead, for weight considerations, they wear a specifically designed patch that represents them.

DAVID SAINT-JACQUES (2019)

APOLLO 11 (1969)

PATCH OF DAVID SAINT-JACQUES' FIRST SPACE MISSION (2018)

ISS-59 (2019)

SPACEX DRAGON 1 FLIGHT (2012)

AND YOU, WHAT WOULD YOUR PATCH LOOK LIKE?

RESEARCH QUESTION

You are about to embark on a space mission that will take you far into outer space. Which patch could best represent your class mission towards Europa?

EXPERIMENT

— MATERIAL

To design it

- Large sheet (11 in x 17 in)
- Felt pens
- Stickers

To make it

- Material selected by the group
- Scissors
- Glue
- Various pens (colour)
- Fastener to attach the badge to clothing

— DIAGRAM

— MANIPULATIONS

1. Design a patch based on Projects Specifications.
2. Propose one's idea on an 11 x 17 in poster.
3. Select together the patch that will represent the group.
4. Make the selected patch with provided material.

— PROJECT SPECIFICATIONS

- The patch must be worn at all times during the mission.
- Patch shape: your choice.
- Patch material: your choice (must be light).
- Fastening to clothing: your choice.
- Maximum area: 78.5 cm^2
- Maximum weight: to be determined.
- Information on the patch:
  - **Mandatory**
    - Mission name
    - Year
    - Destination
    - Objective
    - Image representative of the mission
  - **Optional**
    - School logo
    - Your group number
    - Fastener
    - Space for the student's name

RESULT TABLE

MY MODEL
SHAPE OF MY MODEL: CALCULATION OF AREA

CONCLUSION

THE MODEL SELECTED BY THE GROUP IS...

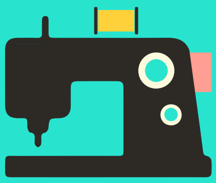
DID YOU KNOW…?

HISTORICAL FACT

In the Middle Ages, knights would use an emblem on their shield to show to which community they belonged.

SOCIAL FACT

During Olympic Games, countries use their respective flags to distinguish themselves.



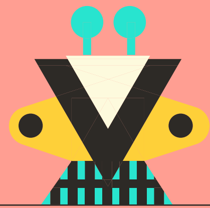
TECHNOLOGICAL FACT

Designers and manufacturers of patches use mechanical embroidering devices.

NATIVE FACT

On the coast of British-Columbia, the Haida indigenous nation uses totem poles to show its clan symbols.

DO NOT TOUCH!



TEACHING OBJECTIVES

- Explain that some manoeuvres require **manual dexterity** and craftsmanship.
- Assemble a simple electrical circuit.
- Identify the various work conditions of specific manipulations.

CONTEXT

Many of the things done by astronauts in space require great manual dexterity. One must pay attention to details and get things right. It involves working with tools and instruments of various sizes, at times in very confined spaces. Such is the case when an astronaut has to fix a satellite orbiting around Earth. The astronaut must also wear thick pressurized gloves that hamper his or her work.

Devices surrounding a defective object are often fragile. They can be damaged if touched. That would mean having to fix two devices rather than one! The cost of such a mistake can be...astronomical.

One can improve his or her manual dexterity, i.e. the skill to make precise movements. It requires training.

RESEARCH QUESTION

Using an electrical device of your own making, what movements could you make to improve your manual dexterity?

DURATION

60 minutes

LIKELY HYPOTHESIS

- Increase the working rate as acting quickly means less time spent in space.
- Extend the contact wire (the winding wire that we are trying not to touch), since two devices can be far apart.

PRECONCEPTIONS

Some students may be overconfident or lacking confidence. Automatic response is ever-present. They assume that they can succeed the first time around.

They believe that the gloves worn by astronauts are as supple and thin as those we use on Earth.

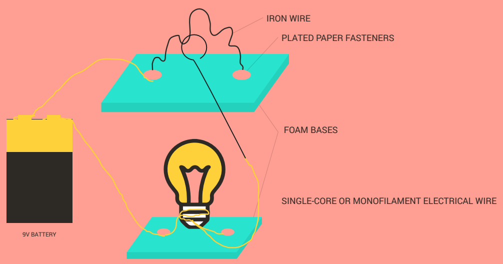
GLOSSARY

- **Manual dexterity:** Mastery of the hand during a specific action.
- **Craftsmanship:** Attention to details.
- **Parameter:** Measurable or observable quantity allowing for a quick and basic presentation of essential characteristics.

REQUIRED MATERIAL

- 9 V battery
- Small bulb (such as a Christmas light)
- Large paper clip
- Iron wire (non-braided wire like the one used to hang pictures is an option)
- Pliers
- Single-core or monofilament wire
- Chronometer
- Ruler
- Adhesive tape
- Plated paper fasteners
- Foam, wood, cardboard or foam-board bases

DIAGRAM



HANDLING PROCEDURE

1. Introduce the device to students.
2. Show them how it operates.
3. Ask the students what kind of exercises could help them train.
   The following **parameters** can be modulated:
   - Allotted time.
   - Wire length.
   - Ring diameter.
   - Meeting the challenge before or after an exhausting physical exercise.
   - Meeting the challenge blindfolded, while someone else gradually describes the path to be followed.
   - Wearing gloves of various thicknesses.
   - With one eye closed.
4. Distribute the material to students.
5. Have them make the device.
6. Students do the exercises they have selected.

RESULT TABLE

See the table in the Scientist Notebook.

CONCLUSION

In conclusion, exercises I could do to improve my manual dexterity are…

OBSERVATIONS

- The list of material is very basic. Student must take the time required to study the diagram.
- The bases must be secured to the table surface.
- Adhesive tape can be used to fasten the electrical wires to the 9V battery.

We recommend using foam bases. You may also opt for cardboard or foam-board. Being light, they may be prone to moving around on the table. Students can use adhesive tape to secure them to the table.

RECOMMENDED RESOURCES

FRENCH RESOURCES

- La vie dans l'espace. Agence spatiale européenne. https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Lessons_online/La_vie_dans_l_espace

ENGLISH RESOURCES

- Junior Astronauts https://www.asc-csa.gc.ca/eng/resources-young/junior-astronauts/default.asp
- Living and working in space. Canadian Space Agency. https://www.asc-csa.gc.ca/eng/search/video/watch.asp?v=1_pksm2u2f

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

THE MATERIAL WORLD

A. MATTER

1. Properties of matter

   j. Describes various other physical properties of an object, a substance or a material (e.g.: electrical conductivity) (3rd cycle).
   k. Recognizes the materials of which an object is made (3rd cycle).

B. ENERGY

1. Forms of energy

   b. Identifies sources of energy in his/her environment (2nd and 3rd cycles).

2. Transmission of energy

   b. Distinguishes between substances that are conductors and those that are insulators (3rd cycle).
   c. Identifies the components of a simple electrical circuit (wire, source, light bulb, switch) (3rd cycle).
   d. Describes the functions of the components of a simple electric circuit (conductor, insulator, energy source, light bulb, switch) (3rd cycle).

3. Transformation of energy

   e. Associates the transformation of energy with different components of a circuit (e.g. bulbs transform electrical energy into light) (3rd cycle).

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY (CONT.)

D. SYSTEMS AND INTERACTION

7. Electron technology
   a. Recognizes the influence and the impact of electrical appliances on people's way of life and surroundings (2nd and 3rd cycles).

E. TECHNIQUES AND INSTRUMENTATION (2ND AND 3RD CYCLES)

1. Use of simple measuring instruments
   a. Appropriately uses simple measuring instruments (rulers, chronometer).
3. Use of tools
   a. Appropriately and safely uses tools (pliers).
4. Design and manufacture of simple electrical circuits
   a. Knows the symbols associated with types of motion and electrical components.
   b. Interprets a diagram or plan containing symbols.
   c. Uses symbols associated with electrical components in a diagram or drawing.
   d. Draws and cuts parts out of various materials using appropriate tools.
   e. Uses appropriate assembling methods.
   g. Uses simple electrical components to make an object.

F. APPROPRIATE LANGUAGE(2ND AND 3RD CYCLES)

1. Terminology related to an understanding of the material world
   a. Appropriately uses terminology related to the material world.
   b. Distinguishes between the meaning of a term used in a scientific or technological context and its meaning in everyday language.
2. Conventions and types of representations specific to the concepts studied
   a. Communicates using appropriate types of representations that reflect the rules and conventions of science and technology.

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
ENGLISH Competency 3: To write self-expressive, narrative and information-based texts. To represent her/his literacy in different media. Expressions: — Get in touch. — Touch down! — Stay in touch. — I am touched (emotion). — To put the final touch to a project. — A touch of colour. — To have a soft touch. — To have the magic touch. — It is touch-and-go. — To have the golden touch — To be out of touch. — Do not touch!	— Writing a text on the job of an astronaut or on any other trade associated with aerospace. — Researching expressions with the word 'touch'. — Writing a short story based on one of these expressions.

CONNECTIONS WITH OTHER SUBJECT AREAS (CONT.)

DISCIPLINES AND COMPETENCIES	USED IN…
MATHEMATICS	
Competency 2: To reason using mathematical concepts and processes. *MEASURES* A. Length — Evaluating and measuring an object’s dimensions using standard units. • Metre, decimetre, centimetre and millimetre (2nd cycle). • Metre, decimetre, centimetre, millimetre and kilometre (3rd cycle).	— Measuring the length of required wires.
PHYSICAL AND HEALTH EDUCATION	
Partial Competency: To perform movement skills in different physical activity settings *EFFICIENCY OF EXECUTION* *MOTOR SKILLS:* C. Manipulations Skills — Object manipulation skills • Manipulates various objects used in specialised activities (2nd cycle).	— Moving the ring around the wire without the bulb lighting up.

DO NOT TOUCH!

SCIENTIST NOTEBOOK

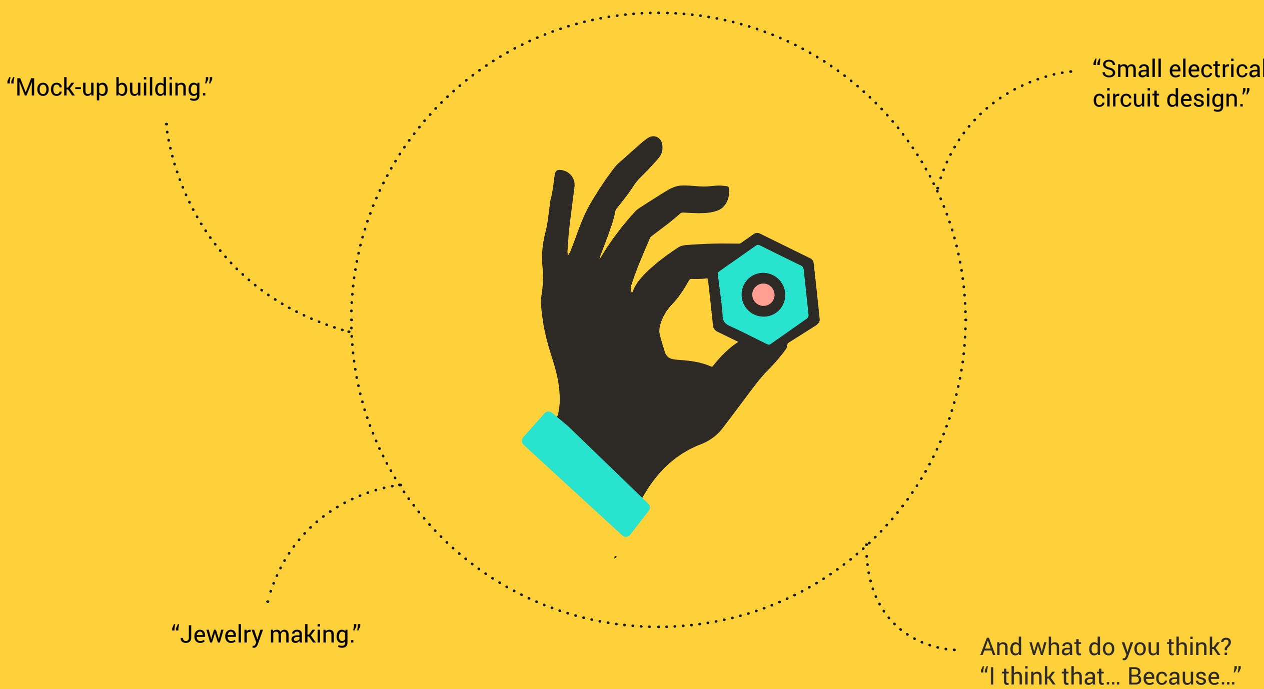
CONTEXT

Many of the things done by astronauts in space require great manual dexterity. One must pay attention to details and get things right. It involves working with tools and instruments of various sizes, at times in very confined spaces. Such is the case when an astronaut has to fix a satellite orbiting around Earth. The astronaut must also wear thick pressurized gloves that hamper his or her work.

Devices surrounding a defective object are often fragile. They can be damaged if touched. That would mean having to fix two devices rather than one! The cost of such a mistake can be...astronomical.

One can improve his or her manual dexterity, i.e. the skill to make precise movements. It requires training.

WHAT EXERCISES COULD YOU DO TO IMPROVE YOUR MANUAL DEXTERITY?



RESEARCH QUESTION

Using an electrical device of your own making, what movements could you make to improve your manual dexterity?

HYPOTHESIS

Exercises that I could do are…

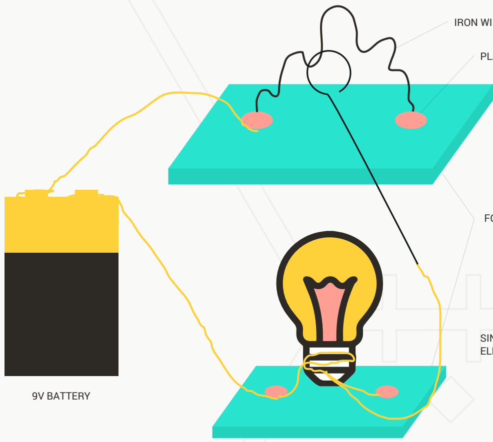
Because…

EXPERIMENT

— MATERIAL

- 9 V battery
- Small bulb (such as a Christmas light)
- Large paper clip
- Iron wire (non-braided wire like the one used to hang pictures is an option)
- Single-core or monofilament electrical wire
- Chronometer
- Ruler
- Adhesive tape
- Plated paper fasteners
- Foam, wood, cardboard or foam-board bases
- Pliers

— DIAGRAM



- Iron wire
- Plated paper fastener
- Single-core or monofilament electrical wire
- Foam bases
- 9 V battery

— MANIPULATIONS

1. Unfold the paper clip and make a ring at one of its extremities.

   MATERIAL
   • Large paper clip

2. Insert two plated paper fasteners in each of the foam bases.

   MATERIAL
   • Plated paper fasteners (x4)
   • Foam bases 10 cm x 7 cm (x2)

3. Make the assembly according to the diagram.
4. Energize!
5. Insert the ring around the wire and bring it back to the chosen starting point.
6. Select an exercise.
7. Move the ring along the wire without the bulb lighting up.
8. Note your observations based on the selected exercise.
9. Repeat steps 6 and 8 for all the other exercises.

RESULT TABLE

EXERCICES	OBSERVATIONS
Wearing thick gloves	
Duration	

CONCLUSION

EXERCISES THAT I COULD DO TO IMPROVE MY MANUAL DEXTERITY ARE…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

I ASK MYSELF…

1. Identify in the construction diagram the components that:
   - Conduct electricity.
   - Generate electricity.
   - Act as insulators.
   - Act as a switch.
2. What other jobs require as much precision as in this manual dexterity exercise involving the paper clip and the light bulb?

DID YOU KNOW...?

HISTORICAL FACT

Jewellers have long been admired for their exceptional manual dexterity. They actually make very ornate jewellery.

SOCIAL FACT

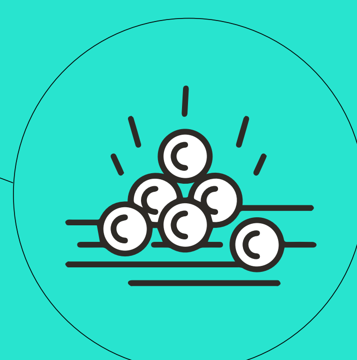
Many jobs in the health sector require tremendous manual dexterity. Neurosurgeons help save lives through very precise brain surgeries. Machines often give them a hand.

TECHNOLOGICAL FACT

More and more precise instruments allow us to miniaturize to the extreme electronic components of cell phones and computers. In this case, it is machines that show great dexterity.

NATIVE FACT

Native craft persons use great manual dexterity to work with all kind of materials, such as very tiny pearls. Wampums are belts made of pearls that are used as a memory aid to recall an agreement or an event, and even to narrate a story.



TEACHING OBJECTIVES

- Explain the oxidation process (oxygen makes various materials rust).
- Explain that oxygen is essential for us to live.
- Identity foods prone to oxidation.

CONTEXT

The oxygen present in the air we breathe is essential to life. Unfortunately this gas also affects some materials. You may have observed that some materials 'rust', such as iron that becomes reddish. Silver utensils also 'rust'. They lose their shiny aspect. Stainless steel, a mix of iron, carbon and chrome, was invented to prevent rust.

Oxygen is also essential to combustion as it fuels fire. We could not light a candle without oxygen. It is what we call a combustive.

The food brought in space by astronauts is also affected by oxygen present in the spacecraft. Oxygen can affect the quality of fresh foods. It actually makes these foods 'rusty'! To avoid that problem, astronauts have to bring food that can 'travel well'.

RESEARCH QUESTION

Which fruits and vegetables are prone to rusting in the presence of oxygen? (Name some fruits and vegetables.)

DURATION

Manipulations: 15 minutes
Observations: 2 days

LIKELY HYPOTHESIS

It will be stated based on selected fruits and vegetables.
Students must state their hypothesis based on selected foods. They should write down 'because'. In the majority of cases, they will refer to what they have observed at home.

PRECONCEPTIONS

All vegetables and fruits oxide.

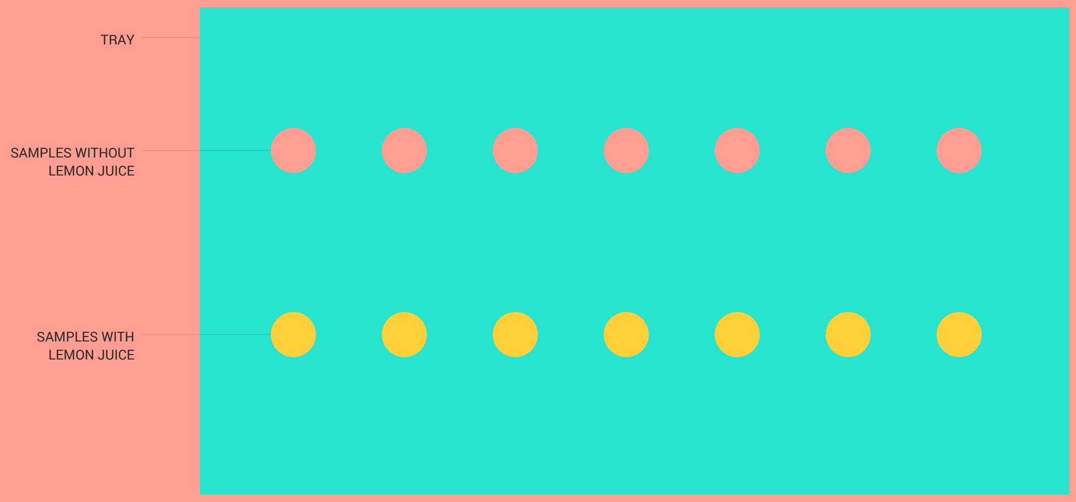
GLOSSARY

- Air. The mix of gases present in the atmosphere. It is naturally made of:
    - 78% nitrogen (N)
    - 21% oxygen (O)
    - The remaining 1% consists of carbon dioxide (CO^2),water vapour, helium, and other gases in small quantities.
- Oxygen: In its pure state and at room temperature, oxygen is a gas. It is essential to life and acts as a combustive with fire.
- Oxidation: Chemical reaction caused by oxygen. Signs of oxidation are for the most part visible. For example, iron goes from metallic grey to orange-brown when rusty.
- Combustion: Phenomenon occurring as a reaction when heat is dissipated, for example when we burn wood. It requires three elements referred to as the 'fire triangle':
    - fuel: log
    - combustive: oxygen
    - heat
- Vegetable: Cultivated plant whose leaves, roots, tubers, fruits or seeds we eat depending on the species.
- Fruit: Edible product of some plants, often sweet, and carrying the plant seeds.

REQUIRED MATERIAL

- Knife
- Fruits (apple, orange, banana, pear)
- Vegetables (carrot, potato, cucumber)
- Chronometer or clock
- Tray
- Magnifying glass
- Lemon juice
- Bowl
- Identification tags
- 15 ml graduated cylinder or table spoon
- Mixing spoon

DIAGRAM



MANIPULATIONS

1. Introduce the research question.
2. Ask the students to submit their hypothesis.
3. Cut selected fruits and vegetables in slices.
4. In a bowl, mix half of the slices with15ml of lemon juice.
5. Spread the slices in a tray. Identify those dipped in lemon juice.
6. Question for the students: How long should we expose these foods to the open air?
7. Regularly observe samples over a period of no more than 48 hours.
8. Write your observations for each type of food in the Result Table.

RESULT TABLE

See the Scientist Notebook.

CONCLUSION

Only some fruits and vegetables, such as apples, pears and bananas, oxide in the open air.

OBSERVATIONS

- This activity essentially concerns the oxidation process and choices to be made in regards to food preservation.
- Other than lemon juice, you could dissolve vitamin C capsules in water and pour the resulting liquid over the food slices.
- Students could weigh each sample before and after the oxidation period. A scale would have to be added to the list of materials, as well as three columns to the Result Table (initial weight/final weight/difference).

You may divide students into teams. Each team could have a different fruit and vegetable. But all teams must write down their observations.

RECOMMENDED RESOURCES

FRENCH RESOURCE

- Conservation des aliments : Toutes les techniques. France, Ministère de l’économie, des finances et de la relance. https://www.economie.gouv.fr/dgccrf/Publications/Vie-pratique/Fiches-pratiques/Conservation-des-aliments

ENGLISH RESOURCE

- Safe food storage https://www.canada.ca/en/health-canada/services/general-food-safety-tips/safe-food-storage.html

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

THE MATERIAL WORLD

A. MATTER

1. Properties and characteristics of matter
   e. Describes the shape, colour and texture of an object or a substance (2nd cycle).
5. Changes in matter
   b. Demonstrates that chemical changes (e.g. cooking, combustion, oxidation, acid-base reactions) change the properties of matter (3rd cycle).

E. TECHNIQUES AND INSTRUMENTATION

1. Use of simple measuring instruments
   a. Appropriately uses simple measuring instruments (chronometer) (2nd and 3rd cycles).

F. APPROPRIATE LANGUAGE (2NDAND 3RD CYCLES)

1. Terminology related to an understanding of the material world
   a. Appropriately uses terminology related to the material world.
   b. Distinguishes between the meaning of a term used in a scientific or technological context and its meaning in everyday language (e.g. source, matter, body, energy, and machine).

LIVING THINGS

A. MATTER

1. Characteristics of living things
   a. Explains the basic needs of the metabolism of living things (e.g. nutrition, respiration) (2nd cycle).
   b. Describes activities connected to the metabolism of living things (transformation of energy, growth, maintenance of systems and body temperature) (3rd cycle).

E. TECHNIQUES AND INSTRUMENTATION

1. Use of simple observational instruments
   a. Appropriately uses simple observational instruments (e.g. magnifying glass) (2nd and 3rd cycles).

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
ENGLISH Competency 3: To write self-expressive, narrative and information-based texts. To represent her/his literacy in different media.	– Writing a text explaining to students of previous levels what happened to the fruits and vegetables. – Doing the activity below.

Activity:

Finding expressions associated with air or oxygen. Below are some expressions containing the word 'air'.

- A breath of fresh air, something new or refreshing.
- As light as air, to describe something that is very light.
- To build castles in the air, to daydream about something that will most likely not happen.
- To appear out of thin air, appear suddenly or unexpectedly.
- To air dirty laundry, to talk about private and embarrassing matters in public.
- To be full of hot air, someone who exaggerates the truth quite often.
- To float on air, to be extremely happy.

Other inquiries about expressions with words such as oxygen, rust, and vegetable can be made.

DISCIPLINES AND COMPETENCIES	USED IN…
SOCIAL SCIENCES Partial Competency: (2nd and 3rd cycles): To interpret change in a society and its territory.	– Researching the different modes of food preservation in Iroquoian society. – Researching the different modes of food preservation in Quebec and Canadian society during the 19th and 20th centuries. Students could compare these methods with those in use today (3rd cycle).
MATHEMATICS Competency 2: To reason using mathematical concepts and processes. *MEASURES* F. Masses 2. Estimates and measures mass using standard units.	– Weighing the fruits and vegetables before and after.

OXYGEN: FRIEND OR FOE?

SCIENTIST NOTEBOOK

CONTEXT

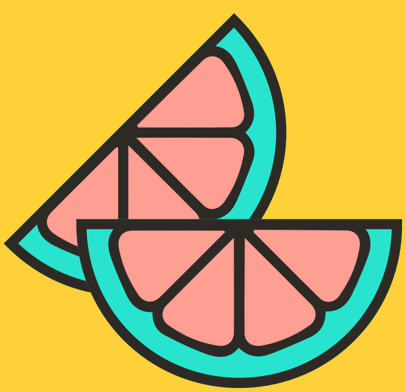
The oxygen present in the air we breathe is essential to life. Unfortunately this gas also affects some materials. You may have observed that some materials 'rust', such as iron that becomes reddish. Silver utensils also 'rust'. They lose their shiny aspect. Stainless steel, a mix of iron, carbon and chrome, was invented to prevent rust.

Oxygen is also essential to combustion as it fuels fire. We could not light a candle without oxygen. It is what we call a combustive.

The food brought in space by astronauts is also affected by oxygen present in the spacecraft. Oxygen can affect the quality of fresh foods. It actually makes these foods 'rusty'! To avoid that problem, astronauts have to bring food that can 'travel well'.

SO WHICH FRUITS AND VEGETABLES ARE AFFECTED BY OXYGEN?

"I believe that all the fruits and vegetables will oxidize since the apple does."



"I believe that all the fruits and vegetables will keep their natural colour since a cucumber remains unchanged."

And what do you think?
"I think that... Because..."

RESEARCH QUESTION

Which fruits and vegetables are affected by oxygen?

HYPOTHESIS

I think that...

Because...

EXPERIMENT

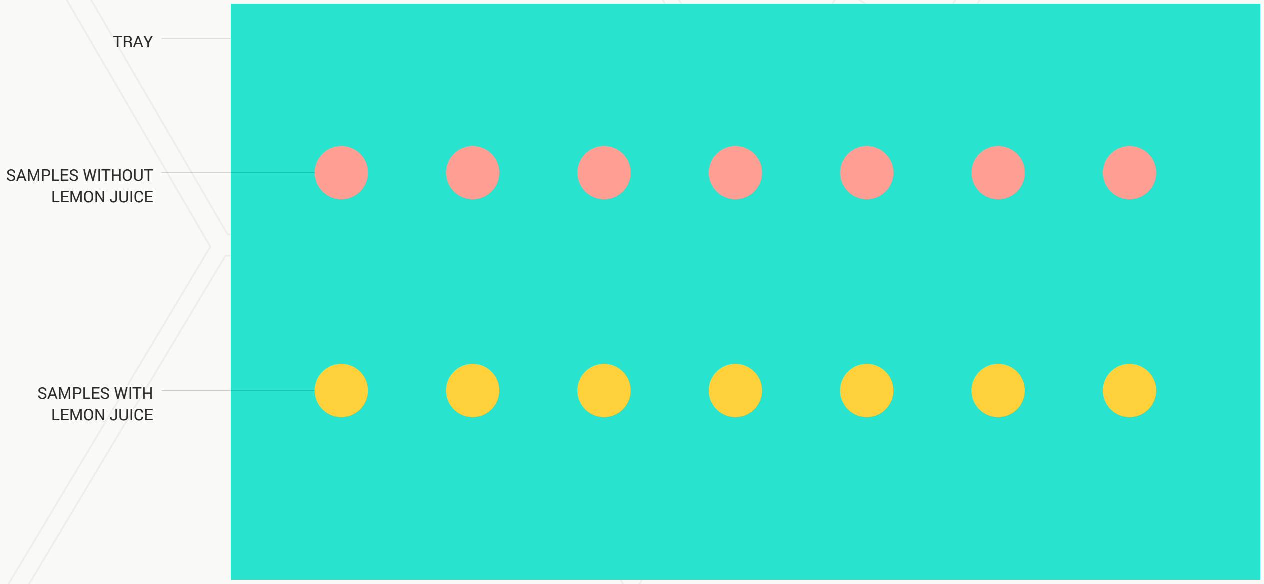
— MATERIAL

- Knife
- Fruits (apple, orange, banana, pear)
- Vegetables (carrot, potato, cucumber)
- Chronometer or clock
- Tray
- Magnifying glass
- Lemon juice
- Bowl
- Identification tags
- 15 ml graduated cylinder or table spoon
- Mixing spoon

— MANIPULATIONS

1. Cut selected fruits and vegetables in slices.
2. In a bowl, mix half of the slices with 15 ml of lemon juice.
3. Spread the slices in a tray. Identify those dipped in lemon juice.
4. Regularly observe samples over a period of no more than 48 hours
5. Write your observations for each type of food in the Result Table.

— DIAGRAM



RESULT TABLE

OBSERVATION DATE AND TIME	OBSERVATIONS			
	APPLE	BANANA	ORANGE	POTATO

CONCLUSION

FRUITS AND VEGETABLES AFFECTED BY OXYGEN ARE…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

I ASK MYSELF

- Does the exposed surface of a fruit or vegetable make a difference? Explain.
- Does the weight of the food make a difference? Explain.
- Does adding lemon juice make a difference?

DID YOU KNOW...?

HISTORICAL FACT

Preserving food has long been a challenge for humans. The development of agriculture 12,000 years ago has incited human beings to find ways to preserve what they produced in order to use it later, for example in winter.

SOCIAL FACT

Food preserving has allowed us to feed many more human beings. That in turn led to the birth of cities.

TECHNOLOGICAL FACT

Food preserving techniques have greatly evolved over time. For example, lyophilisation (or freeze drying) consists of freezing food very quickly. It will keep its nutritive value and appearance much longer. Conversely, ethylene, a gas, is used to make fruits mature more quickly.

NATIVE FACT

To preserve their food and protect it from bad weather, Natives often turn to the technique of drying. However, drying does not completely prevent oxidation, which changes the colour of dried goods.

TEACHING OBJECTIVES

- Explain that clothing is designed based on anticipated use.
- Select **materials** based on some of their features.

CONTEXT

For tens of thousands of years, human beings have manufactured clothing based on the surrounding environment. Clothing has enabled humans to adapt to temperature changes, namely warmth and cold.

To explore depths, humans invented devices to stay underwater for long periods: the air tank and the regulator. To explore great depths, humans must wear a special diving suit protecting them from high water pressure.

Since they began exploring space, humans had to take into account new risks to their survival, such as:

- No air
- No pressure
- Radiations from the Sun and the galaxy
- **Micrometeoroids**
- **Space debris**
- Extreme temperatures (+200 °C in the sun, -200 °C in the shade)

On extravehicular outings, an astronaut has to work, go from one place to another, move around, and repair things. Astronauts spend hours preparing themselves before each outing, and stay out for long periods. They must eat, relieve themselves, and communicate with their colleagues.

The spacesuit is like a mini spacecraft. It contains several systems, much like the human body. For example, it is equipped with an environment control system that supplies breathable air and evacuates the CO_2, just like our own lungs do.

Skin is our first line of protection against the outside world. In a space suit, it is the fabric it is made of. It is actually made of several layers of different materials, each having **specific useful features**. It is those **features** that protect the astronaut from the dangers in space.

During this activity, you will test the various properties of fabrics and materials in order to select the most appropriate one. You will test their resistance to tension, impact, abrasion, and leakage.

RESEARCH QUESTION

Which of the proposed materials is suitable to make a spacesuit?

DURATION

60 minutes

LIKELY HYPOTHESIS

Depends on provided fabrics.

PRECONCEPTIONS

The thickest material will be best. If all fabrics are of different colours, it is likely that the students will believe that the darkest one is the most appropriate.

GLOSSARY

- **Micrometeoroid:** very small meteoroid made of rocks or metals, moving at great speed in space.
- **Space debris:** Artificial object orbiting around Earth, left over by a space mission.
- Resistance to leakage: Property of a material that prevents anything going through it.
- **Impact:** Result of a body or projectile hitting another; shock.
- **Abrasion:** Erosion through rubbing with an abrasive product.
- **Tension:** State of a material under stretching.
- **Space suit:** Equipment worn by astronauts inside their spacecraft (launch, orbit manoeuvres, return) or on a space outing.
- **Fabric:** Common name given to any textile made of woven or knitted threads.
- **Material:** Any substance used in manufacturing objects, machines, buildings, etc. Materials are divided in various groups: metals, ceramics, glass, textiles, polymers, stone and concrete, and natural (wood, bone) or artificial composites.
- **Property:** Quality of an object distinguishing it from another.
- **Specific feature:** Quality of an object specific to that object or to a group of objects (e.g. boiling point of water or electrical conductivity of metals).

REQUIRED MATERIAL

Group display
See the description of individual experiments.

DIAGRAM

See each of the individual experiments.

MANIPULATIONS

1. Divide the group in 4 teams. Each team will carry out a specific experiment. It is however possible, depending on available time, to make rotations so that everyone may complete all of the experiments.
2. Assign experiments (**tension, impact, abrasion, resistance to leakage**).
3. Supervise teams during the experiments.
4. Students post their results on a group display.
5. Once all experiments have been completed, ask students to answer the research question based on common results.

RESULT TABLE

See each of the individual experiments.
Group display below.

CONCLUSION

Name of the material that will pass all the tests.

RECOMMENDED RESOURCES

FRENCH RESOURCE

- Les combinaisons spatiales
  http://www.astrosurf.com/luxorion/astronautique-combinaison-spatiale5.htm

ENGLISH RESOURCES

- Space Suit
  https://en.wikipedia.org/wiki/Space_suit
- Life-Support System
  https://en.wikipedia.org/wiki/Life-support_system
- Suited for Spacewalking: A Teacher's Guide with Activities for Technology Education, Mathematics, and Science. NASA. EG-1998-03-112-HQ
  https://www.nasa.gov/pdf/143159main_Suited_for_Spacewalking.pdf

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

THE MATERIAL WORLD

A. MATTER

1. Properties and characteristics of matter
   e. Describes the shape, colour and texture of an object or a substance (2nd cycle).
   j. Describes various other physical properties of an object, a substance or a material (tension, impact, abrasion, resistance to leakage) (3rd cycle).
   k. Recognizes the materials of which an object is made(3rd cycle).
5. Changes in matter
   a. Demonstrates that physical changes (e.g. deforming, breaking, grinding, phase changes) do not change the properties of matter (2nd cycle).

B. ENERGY

2. Transmission of energy
   a. Distinguishes between substances that are conductors and those that are insulators.

C. FORCES AND MOTION

4. Pressure
   a. Recognizes various manifestations of pressure (e.g. inflatable balloon, atmospheric pressure, airplane wing) (3rd cycle).
   b. Describes the effects of pressure on an object (e.g. compression, displacement, increase in temperature) (3rd cycle).
6. Effects of a force on the direction of an object
   d. Describes the effects of a force on a material or structure (2nd cycle).

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY (CONT.)

THE MATERIAL WORLD

D. SYSTEMS AND INTERACTION

6. Transportation technology
   a. Recognizes the influence and impact of transportation technology on people’s way of life and surroundings (2nd and 3rd cycles).

E. TECHNIQUES AND INSTRUMENTATION

1. Use of simple measuring instruments
   a. Appropriately uses simple measuring instruments (ruler, scale) (2nd and 3rd cycles).
4. Design and manufacture of instruments
   d. Draws and cuts parts out of various materials using appropriate tools.
   e. Uses appropriate assembling methods.

F. APPROPRIATE LANGUAGE

1. Terminology related to an understanding the material world
   a. Appropriately uses terminology related to the material world (2nd and 3rd cycles).
   b. Distinguishes between the meaning of a term used in a scientific or technological context and its meaning in everyday language (e.g. source, matter, body, energy, machine) (2nd and 3rd cycles).
2. Conventions and types of representations specific to the concepts studied
   a. Communicates using appropriate types of representations that reflect the rules and conventions of science and technology (e.g. symbols, graphs, tables, drawings, sketches, norms and standardization) (2nd and 3rd cycles).

EARTH AND SPACE

D. SYSTEMS AND INTERACTION

7. Technologies related to the Earth, the atmosphere and outer space
   a. Recognizes the influence and the impact of technologies related to Earth, the atmosphere and outer space, on people’s way of life and surroundings (e.g. prospecting equipment, meteorological instruments, seismograph, telescope, satellite, space station) (2nd and 3rd cycles).

LIVING THINGS

A. MATTER

1. Characteristics of living things
   a. Explains the basic needs of the metabolism of living things (e.g. nutrition, respiration) (2nd cycle).
   b. Describes activities connected to the metabolism of living things (transformation of energy, growth, maintenance of systems and body temperature) (3rd cycle).

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
ENGLISH	
Competency 3: To write self-expressive, narrative and information-based texts. To represent her/his literacy in different media.	— Writing a text about the results including comments on choices made.
Competency 3: Communicating verbally.	— Presenting team results verbally.
HISTORY AND CITIZENSHIP EDUCATION	
Competency 2: To interpret change in a society and its territory.	— Presenting the evolution of protective clothing over a timeline, with cross references to major events at different eras.
VISUAL ARTS	
Competency 1: To produce individual works in the visual arts. To produce media works in the visual arts.	— Making a spacesuit for a pet that will be moving around on Europa. It could be made of modeling clay.

- Various fabrics can be proposed to the students.
- If possible, fabric samples should be of the same colour.
- For each of the experiments:
    - The research question remains the same: Which fabric presents the best properties?
    - Students may make hypotheses.
    - Students may draft a conclusion.

ADDITIONAL QUESTION

Does the weight of a material used in making the spacesuit matter? Explain.

TENSION		
FABRIC	WEIGHT (g)	LENGTH (mm)
N°1		
N°2		
N°3		

IMPACT			
FABRIC	LARGE STONE (g)	MEDIUM STONE (g)	SMALL STONE (g)
N°1			
N°2			
N°3			

ABRASION	
FABRIC	OBSERVATIONS
N°1	
N°2	
N°3	

RESISTANCE TO LEAKAGE	
MATERIAL	OBSERVATIONS
N°1	
N°2	
N°3	

THE SUIT MAKES THE ASTRONAUT

SCIENTIST NOTEBOOK

CONTEXT

For tens of thousands of years, human beings have manufactured clothing based on the surrounding environment. Clothing has enabled humans to adapt to temperature changes, namely warmth and cold.

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- No air.
- No pressure.
- Radiations from the Sun and the galaxy.
- Micrometeoroids.
- Space debris.
- Extreme temperatures (+200 °C in the sun, -200 °C in the shade).

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The spacesuit is like a mini spacecraft. It contains several systems, much like the human body. For example, it is equipped with an environment control system that supplies breathable air and evacuates the CO_2, just like our own lungs do.

Skin is our first line of protection against the outside world. In a space suit, it is the fabric it is made of. It is actually made of several layers of different materials, each having specific useful features. It is those features that protect the astronaut from the dangers in space.

CONTEXT (CONT.)

During this activity, you will test the various properties of fabrics and materials in order to select the most appropriate one. You will test their resistance to tension, impact, abrasion, and leakage.

WHICH OF THE PROPOSED MATERIALS HAS THE REQUIRED PROPERTIES TO MAKE A SPACESUIT?

"I think the darkest one will be best as it will capture heat."

"I think that the thickest fabric will be best as it will better protect against large stones."

And what do you think?
"I think that... Because..."

GENERAL RESEARCH QUESTION

Which of the proposed materials has the required properties to make a spacesuit?

PROPERTIES TO BE TESTED

1. Tension: State of a material under stretching.
2. Impact: Result of a body or projectile hitting another; shock.
3. Abrasion: Erosion through rubbing with an abrasive product.
4. Resistance to leakage: Property of a material that prevent anything going through it.

EXPERIMENT 1: TENSION

The tension test helps to determine the capacity of a material to resist stretching.

RESEARCH QUESTION — **WHICH FABRIC BEST RESISTS TENSION?**

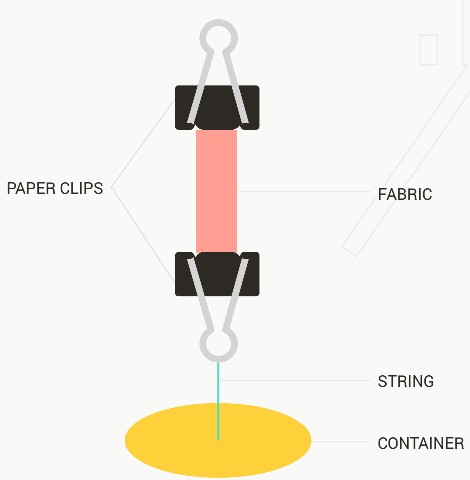
HYPOTHESIS

I think that...
Because...

– MATERIAL

- 3 different fabrics (#1, 2, 3)
- Scissors
- Ruler
- 2 big metal paper clips
- Container with a handle
- String
- Scale
- Various objects from the classroom (e.g. marbles of various dimensions, small rocks acting as meteorites, objects with a sharp end)

– DIAGRAM



– MANIPULATIONS

1. Tie a 30 cm piece of string to the handle of one of the clips.
2. Tie the other end of the string to the container's handle.
3. Cut a 1 cm x 10 cm piece out of fabric sample #1.
4. Insert the clip with string at one end of the piece of fabric.
5. Insert the second clip at the other hand of the piece of fabric, holding it with your fingers.
6. Add weights in the container until the fabric starts to stretch.
7. Note the total weight of objects that you have put in the container.
8. Remove fabric from both clips.
9. Note the overall length of the piece of fabric
10. Repeat steps 3 to 9 for the two remaining fabric samples.

RESULT TABLE

TENSION		
FABRIC	WEIGHT (g)	LENGTH (mm)
N°1		
N°2		
N°3		

CONCLUSION

THE FABRIC THAT BEST RESISTS TENSION IS...

BECAUSE (YOUR RESULTS)...

MY HYPOTHESIS IS: CONFIRMED DISPROVED

EXPERIMENT 2: IMPACT

The impact test helps to determine the capacity of a material to resist shocks.

RESEARCH QUESTION — **WHICH FABRIC BEST RESISTS IMPACT?**

HYPOTHESIS

I think that...
Because...

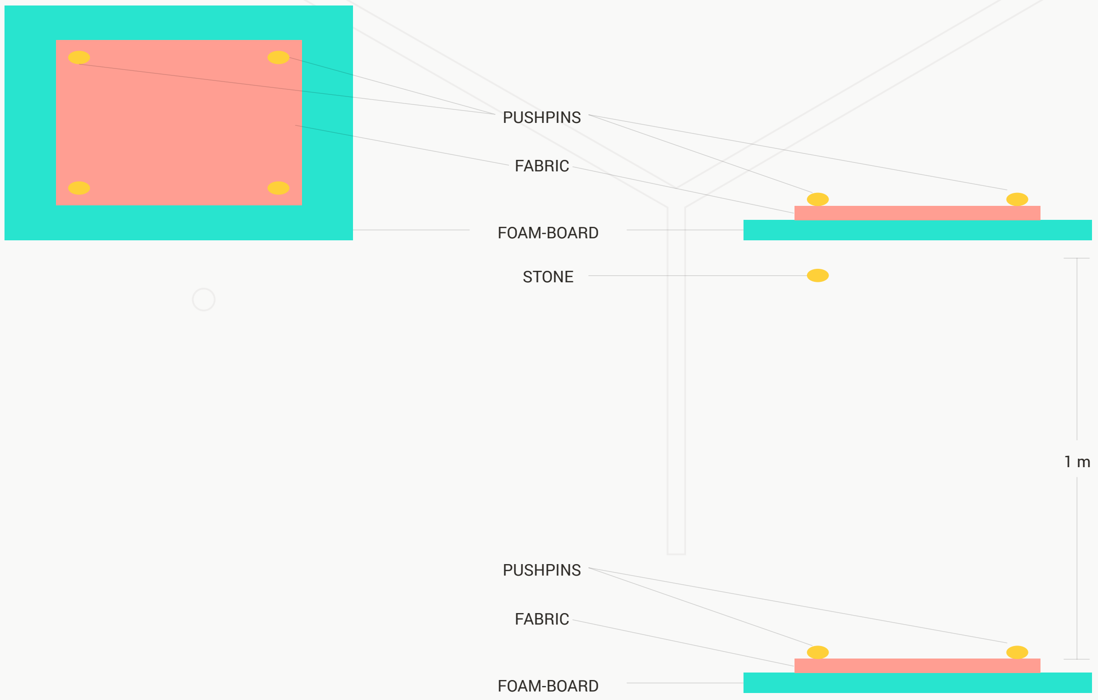
— MATERIAL

- Scissors
- Foam-board
- 3 fabrics (#1,2,3)
- Stones of three different sizes
- Ruler
- Thumbtacks
- Measuring tape
- Scale

— MANIPULATIONS

1. Weigh each stone on a scale.
2. Cut a 20 cm x 20 cm piece of foam-board.
3. Cut a 15 cm x 15 cm piece out of each fabric sample.
4. Using thumbtacks, attach sample #1 to the piece of foam-board.
5. Lay the assembly on the floor
6. Measure a distance of 1 meter above the assembly.
7. Let drop the biggest stone on the assembly from that height.
8. Note your observations (how the fabric is affected).
9. Repeat steps 7 and 8 with the medium-sized stone over a different section of the sample.
10. Repeat steps 7 and 8 with the smallest stone.
11. Repeat steps 4 to 10 with the other pieces of fabric.

— DIAGRAM



RESULT TABLE

FABRIC			
FABRIC	LARGE STONE (g)	MEDIUM STONE (g)	SMALL STONE (g)
N°1			
N°2			
N°3			

CONCLUSION

THE FABRIC THAT BEST RESISTS IMPACT IS…

BECAUSE (YOUR RESULTS)…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

EXPERIMENT 3: ABRASION

The abrasion test helps to determine the capacity of a material to resist rubbing.

RESEARCH QUESTION — WHICH FABRIC BEST RESISTS ABRASION?

HYPOTHESIS

I think that...
Because...

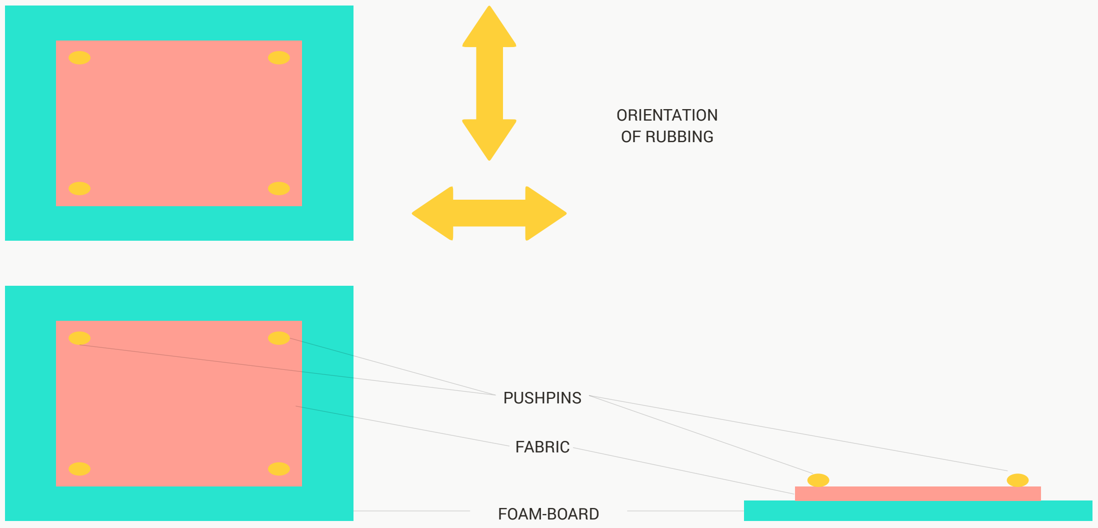
— MATERIAL

- Sanding paper
- Fabrics #1,2, 3
- Foam-board
- Scissors
- Thumbtacks
- Ruler

— MANIPULATIONS

1. Cut a 20 cm x 20 cm piece of foam-board.
2. Cut a 15 cm x 15 cm piece out of each fabric sample.
3. Using thumbtacks, attach sample #1 to the piece of foam-board.
4. While pressing lightly, rub the sanding paper against the fabric, from left to right and from right to left (x10).
5. Turn the foam-board base and, pressing lightly, rub the fabric at the same spot with the sandpaper (x10).
6. Note your observations.
7. Repeat steps 3 to 6 with the other pieces of fabric.

— DIAGRAM



RESULT TABLE

ABRASION	
FABRIC	OBSERVATIONS
N°1	
N°2	
N°3	

CONCLUSION

THE FABRIC THAT BEST RESISTS ABRASION IS…

BECAUSE (YOUR RESULTS)…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

EXPERIMENT 4: LEAKAGE

The leakage test helps to determine the capacity of a material to prevent a gas or liquid from leaking through.

RESEARCH QUESTION — **WHICH FABRIC BEST RESISTS LEAKAGE?**

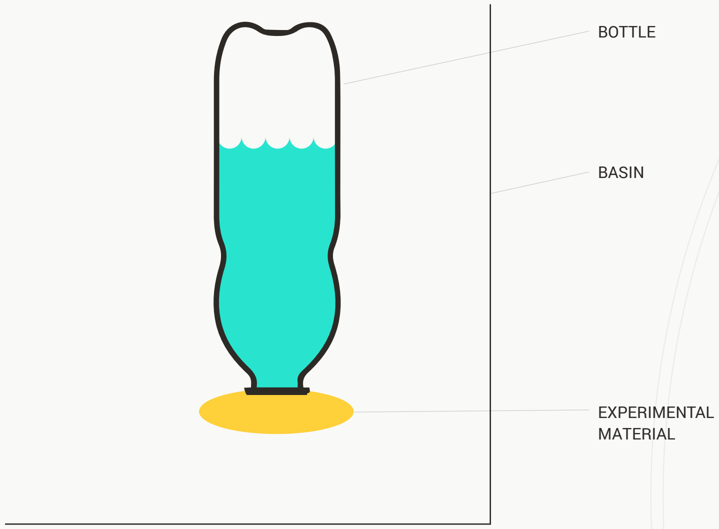
HYPOTHESIS

I think that...
Because...

– MATERIAL

- Empty plastic water bottle
- Water
- Basin
- Fabrics
- Rubber band

– DIAGRAM



– MANIPULATIONS

1. Fill half of the bottle with water.
2. Cover the bottle's opening with fabric #1.
3. Use a rubber band to attach the piece of fabric.
4. Turn the bottle upside down over the basin.
5. Note your observations.
6. Repeat steps 1 to 5 with the other pieces of fabric.

RESULT TABLE

LEAKAGE	
FABRIC	OBSERVATIONS
N°1	
N°2	
N°3	

CONCLUSION

THE FABRIC THAT BEST RESISTS LEAKAGE IS…

BECAUSE (YOUR RESULTS)…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

THE FABRIC HAVING THE OPTIMAL PROPERTIES IS…

BECAUSE (YOUR RESULTS)…

MY HYPOTHESIS IS: CONFIRMED DISPROVED

DID YOU KNOW...?

HISTORICAL FACT

Leonardo da Vinci (1452-1519) was one of the first persons to design a diving suit allowing humans to go underwater. The explorer Jacques-Yves Cousteau (1910-1997) designed and made the very first self-contained underwater breathing apparatus.

SOCIAL FACT

The clothes worn by a person are often representative of his or her trade. For example, one can easily recognise a policeman or a nurse.

TECHNOLOGICAL FACT

The design and manufacture of underwater diving suits has evolved. It went from diving with no equipment, apnea, diving helmet, and self-contained diving suit, to our modern rigid articulated diving suit.

NATIVE FACT

The North-American climate has influenced the traditional dress of the various Native Nations. Clothing worn by Innus in the North was made from animal pelts and furs that kept them warm. In the South, Navajos wore clothes made out of cotton, a plant that produces ‘breathable’ light fibres.

WHAT'S ON THE MENU?

COMPANION GUIDE

TEACHING OBJECTIVES

- Plan balanced menus for a five-day mission.
- Identify one's food requirements.

CONTEXT

Humans must feed themselves, on Earth and in outer space. We all share the same requirements in regards to the types of food needed to ensure our survival... and to stay healthy.

Activities carried out in space may differ from those undertaken here on Earth. We must keep exercising to maintain our muscles and heart health. But gravity is less in space. This feeling of weightlessness plays tricks on us. Our body receives different signals.

For example, our bones and our muscles have adapted to gravity on Earth. Gravity being much less in space, bones do not have to be so dense. As a result, they get rid of some of the calcium that they are made of. It is evacuated in the urine. This calcium-rich urine may block the kidneys. Furthermore, in so doing, bones become more brittle and more porous. The risk of breaking a bone is much higher. It is a bit as if our body was aging much more quickly in space.

Being an astronaut is not easy! An appropriate diet can make a huge difference.

Additionally, the requirements and tastes of everyone must be taken into account when planning a menu for the astronauts, just as we would for ourselves and others.

RESEARCH QUESTION

What should an astronaut eat over a five-day period?

DURATION

60 minutes

LIKELY HYPOTHESIS

Students will tend to base their choices on what they eat at home.

PRECONCEPTIONS

- All types of food can be brought in space.
- Astronaut food is inedible.
- Astronaut food is provided as pills.
- Astronaut food comes out of a toothpaste tube.

GLOSSARY

- **Manual dexterity:** Mastery of the hand during a specific action.
- **Craftsmanship:** Attention to details.
- **Parameter:** Measurable or observable quantity allowing for a quick and basic presentation of essential characteristics.

GLOSSARY (CONT.)

- **Calcium:** Element present in bones that gives them their solidity.
- **Bone density:** Ratio of bone mass to **volume**. The heavier a bone is, the denser it will be.
- **Mass:** Quantity of matter in a given body.
- **Volume:** Space taken by a body.
- **Gravitation:** Attractive force between two bodies. Acceleration due to gravity on the Earth is 1 g, i.e. 32.2 feet per square second or 980.6 cm per square second.
- **Weight:** Force exerted on an object present in the gravitational field of a planet. The stronger the gravitational force of a planet is, the heavier the relative weight of the object will be.
- **Gravity:** Attractive force exerted on an object on a planet's surface.
- **Weightlessness** (or zero-gravity): When one does not feel gravitational pull anymore.

REQUIRED MATERIAL

- Scientist Notebook with a blank menu.
- Canadian Food Guide

DIAGRAM

MANIPULATIONS

1. Introduce students to the context.
2. Distribute the Canadian Food Guide.
3. Supervise the students.

RESULT TABLE

See the Scientist Notebook.

CONCLUSION

As a Table whose content has been approved by the fictitious astronaut.

OBSERVATIONS

- To vary the menus, ask several adults to lend a hand.
- For the 2nd cycle, plan a simple menu.
- For the 3rd cycle, students must provide the edible quantities, based on the amount of calories.

Mathematics for the 3rd cycle: Identify the caloric value of the different foods.

RECOMMENDED RESOURCES

ENGLISH RESOURCES

- Eating in space
  https://www.asc-csa.gc.ca/eng/astronauts/living-in-space/eating-in-space.asp
- Astronaut Food – What do space explorers eat?
  https://asc-csa.gc.ca/eng/search/images/watch.asp?id=15774&search=
- Space Food and Nutrition: An Educator's Guide with Activities in Science and Mathematics. NASA(EG-1999-02-115-HQ).
  https://www.nasa.gov/pdf/190537main_Classifying_Space_Food.pdf
- Eating in Space. NASA.
  https://www.nasa.gov/audience/foreducators/stem-on-station/ditl_eating
- Space Food. NASA.
  https://spaceflight.nasa.gov/living/spacefood/index.html
- Canada's Food Guide
  https://food-guide.canada.ca/en/

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

THE MATERIAL WORLD

A. MATTER

1. Properties and characteristics of matter

   f. Distinguishes between the mass (quantity of matter) of an object and its weight (gravitational force acting on the mass) (2nd cycle).

5. Changes in matter

   a. Demonstrates that physical changes (e.g. deforming, breaking, grinding, phase changes) do not change the properties of matter (2nd cycle).

   b. Demonstrates that chemical changes (e.g. cooking, combustion, oxidation, acid-base reactions) change the properties of matter (3rd cycle).

C. GRAVITATIONAL ATTRACTION ON AN OBJECT

3. Gravitational attraction on an object

   a. Describes the effect of gravitational attraction on an object (e.g. free fall) (3rd cycle).

D. SYSTEMS AND INTERACTION

6. Transportation technology

   a. Recognizes the influence and impact of transportation technology on people's way of life and surroundings (2nd and 3rd cycles).

F. APPROPRIATE LANGUAGE

1. Terminology related to an understanding of the material world

   a. Appropriately uses terminology related to the material world (2nd and 3rd cycles).

   b. Distinguishes between the meaning of a term used in a scientific or technological context and its meaning in everyday language (e.g. source, matter, body, energy, machine) (2nd and 3rd cycles).

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY (CONT.)

2. Conventions and types of representations specific to the concepts studied

   a. Communicates using appropriate types of representations that reflect the rules and conventions of science and technology (e.g. symbols, graphs, tables, drawings, sketches, norms and standardization) (2nd and 3rd cycles).

LIVING THINGS

A. MATTER

1. Characteristics of living things

   a. Explains the basic needs of the metabolism of living things (e.g. nutrition, respiration) (2nd cycle).

   b. Describes activities connected to the metabolism of living things (transformation of energy, growth, maintenance of systems and body temperature) (3rd cycle).

B. ENERGY

1. Sources of energy for living things

   b. Explains the nutritional needs common to all animals (water, sugars, lipids, proteins, vitamins, minerals) (2nd cycle).

2. Transformation of energy in living things

   b. Describes an ecological pyramid of a given environment (3rd cycle).

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
MATHEMATICS	
Competency 2: To reason using mathematical concepts and processes (3rd cycle).	— Calculating the amount of food required to meet the needs of a control-astronaut. Women: min. 1,900 calories Men: max. 3,200 calories
ENGLISH	
Competency 1: To use language to communicate and learn.	— Presenting verbally the selected menu to the control-astronaut. The other students may comment on suggestions made by the presenters.
Competency 3: To write self-expressive, narrative and information-based texts. To represent her/his literacy in different media.	— Presenting the menu to the control-astronaut in a quick and pleasing manner.

WHAT'S ON THE MENU?

SCIENTIST NOTEBOOK

CONTEXT

Humans must feed themselves, on Earth and in outer space. We all share the same requirements in regards to the types of food needed to ensure our survival... and to stay healthy.

Activities carried out in space may differ from those undertaken here on Earth. We must keep exercising to maintain our muscles and heart health. But gravity is less in space. This feeling of weightlessness plays tricks on us. Our body receives different signals.

For example, our bones and our muscles have adapted to gravity on Earth. Gravity being much less in space, bones do not have to be so dense.

As a result, they get rid of some of the calcium that they are made of. It is evacuated in the urine. This calcium-rich urine may block the kidneys. Furthermore, in so doing, bones become more brittle and more porous. The risk of breaking a bone is much higher. It is a bit as if our body was aging much more quickly in space.

Being an astronaut is not easy! An appropriate diet can make a huge difference.

Additionally, the requirements and tastes of everyone must be taken into account when planning a menu for the astronauts, just as we would for ourselves and others.

WHAT WILL BE INCLUDED IN YOUR 5-DAY MENU FOR OUR SPACECRAFT?

"Personally, I would really like pizza as it contains everything I need."

"I want balanced meals since I must eat properly to stay in shape."

And what do you think?
"I think that... Because..."

RESEARCH QUESTION

What should an astronaut eat over a five-day period?

EXPERIMENT

You must elaborate a menu for a control-astronaut going on a 5-day mission.

1. Ask a fictitious astronaut (an adult other than your teacher) about his or her taste, preferences, dislikes, and allergies.
2. Elaborate a 5-day menu based on the Canadian Food Guide.
3. Present your menu to the control-astronaut to get his or her comments.

WARNING

You must avoid crumbling foods as they would spread around the spacecraft.

	DAYS				
MEAL	1	2	3	4	5
BREAKFAST					
SNACK					
LUNCH					
SNACK					
DINNER					

INFORMATION

Types of food (according to preservation method):

- Fresh: Unprocessed.
  E.g. bananas.
- Dry: Ready-to-eat, plastic wrapped.
  E.g. cookies, nuts.
- Dried: Food from which some water has been removed while leaving enough water to maintain its soft texture.
  E.g. dried fruits.
- Dehydrated: Food from which all water has been removed and which recovers its natural consistency by adding water.
  E.g. oatmeal, beverage powder.
- Canned: Heat-treated and vacuum-sealed for storage at room temperature.
  E.g. canned fruits and vegetables.
- Irradiated: Sterilized by exposition to radiation so that it might be stored at room temperature.
  E.g. meat.
- Refrigerated: Requiring cold temperatures to avoid spoiling.
  E.g. cheese.
- Frozen: By quickly dropping temperature below zero to avoid the production of ice crystals. It helps maintain taste and texture. For example, pies and casserole dishes.

ADDITIONAL QUESTION

You have respected the needs and tastes of your control-astronaut. Are there any other factors that you could consider to improve your menu?

Answer: Quantity, storage method, garbage to be brought back, type of packaging, weight.

DID YOU KNOW...?

HISTORICAL FACT

When explorers like Samuel de Champlain embarked on a voyage of several months, they had to plan food supplies, material, and everything else needed for the duration of their sea travel.

SOCIAL FACT

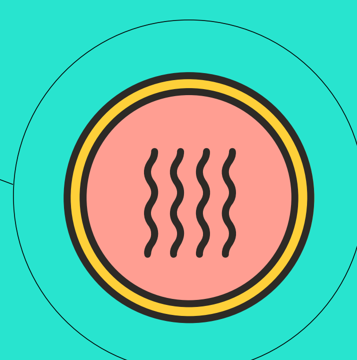
Nowadays, humongous cruise ships must plan food supplies for thousands of passengers who will be celebrating over several days.

TECHNOLOGICAL FACT

Food preservation methods have greatly evolved. Quick-freezing, or lyophilisation, is a good example of modern technology. We went from the icebox, which required ice taken from lakes, to huge electrical refrigerators.

NATIVE FACT

Natives used to dry game meat and prepare fruit and vegetables to feed themselves during the winter.



TEACHING OBJECTIVES

- Make presentations on ‘pros and cons’ of a given subject.
- Respect the right to speak of participants to a debate.
- Explain the difference between science and technology.

CONTEXT

Humans have always been driven to explore. They cannot help it. Just observe a baby’s behaviour. Discovering the unknown is natural to us.

According to studies, Homo sapiens left the Eastern part of Africa, probably in search of food or a better environment. One thing we know for sure is that Homo Sapiens spread over the entire planet.

In the past, many factors have triggered our desire to explore, to know more, and to satisfy our innate curiosity. For example, Alexander the Great wanted to extend his empire. Fernand de Magellan wanted to go around the globe. Coincidentally, the passage between the Atlantic and Pacific oceans is called the Strait of Magellan. Samuel de Champlain hoped to colonize New France for the glory and wealth of France.

More recently, Elon Musk, owner of the famous Tesla car company, has invested billions in his SpaceX company to promote space exploration.

Whatever the motives, there will always be ‘pros and cons’ to such endeavours. Debates are still raging, especially in light of the poor living conditions of many human beings on our planet.

RESEARCH QUESTION

Should we explore space?

DURATION

60 minutes

LIKELY HYPOTHESIS

Based on discussions, there should me more ‘pros’ than ‘cons’.

PRECONCEPTIONS

Space is accessible to all.

Space is a safe environment.

Other celestial bodies are close to us.

Humans are made to go into space.

There is oxygen on all celestial bodies for us to breathe.

Students are influenced by what they see on television and by science fiction.

GLOSSARY

- **Benefit:** Consequence, repercussion. For the aerospace sector, objects, technologies, etc., stemming from research, which apply to everyday living.
- **Exploration:** Action of exploring a land or a site and of studying it while travelling across it; discovery.
- **Investment:** Operation aiming to renew and increase an economy's capital.
- **Ethics:** Group of rules governing someone's behaviour.
- **Sci-fi novel:** Novel taking place in the distant future describing a technological or social state far from our actual reality, e.g. George Lucas' Star Wars.
- **Prospective novel:** Novel taking place in the near future describing likely consequences of contemporary social or technological evolution, e.g. George Orwell's 1984.

REQUIRED MATERIAL

- Cards listing representations of pros and cons
- A cockade (tag) for each role (x4)
- A large poster for each team
- Stickers
- Scissors
- Glue stick

MANIPULATIONS

1. Print trade cards. You can insert them in plastic jackets so that students may pin them to their clothes.

2. Print a copy of pros and cons representations for each student.

3. Explain the four types of outer space exploitation (see explanations below).

    1. Telecommunications. Represents 90% of space activities.
       E.g.: Satellite-based television and cell communications.

    2. Space Exploration.
       E.g. Europa Clipper Probe planned by NASA for 2020.

    3. Remote Sensing.
       E.g. Meteorological satellites, soil studies, Radarsat.

    4. Human Presence in Space. Manned flights.
       E.g. International Space Station

4. State that science "explains" while technology "applies". Introduce the two main types of research :

    1. Pure (fundamental): No immediate use.
       E.g. what are microwaves?

    2. Applied: Meets a specific need.
       E.g. what can be done with microwaves (microwave oven).

MANIPULATIONS (CONT.)

5. Set up 5 teams (e.g. teams of 5 in a class of 25 students).
6. Read them the description of the activity. Students assign the roles among themselves.
    1. Scientist
    2. Teacher
    3. Politician
    4. Doctor
    5. Investor
7. Give each team a copy of the “What they said” document. Ask one of them to read the observations made my others. Have a 5-minute discussion to find out whether they agree or disagree.
8. Give each student a copy of the “Representations of pros and cons” document.
9. Ask students to use scissors to cut out these representations.
10. Teams carry out the activity. You must supervise them. Duration of specific steps can be found in the Scientist Notebook.
11. Full-group meeting: each team makes representations to the other teams using a poster.

CONCLUSION

It will all depend on the 'space culture' of students. For the most part, they will endorse space exploration.

OBSERVATIONS

- Alternative:
  1. Divide the class in two groups.
  2. Assign the role of advocating 'pros' to one group and 'cons' to the other. The choice should be made randomly.
  3. Hand out representations to both groups.
  4. Ask each group to make its representations to the other group.
- Prior to the activity, students could conduct a public poll among their inner circle.
- Prior to the activity, a survey could be conducted among the group or class. For or against space exploration? A new survey is conducted at the end to find out if the discussions have influenced the opinion of participants.
- Here is an interesting quote:

  "How do you put a dollar value on scientific knowledge, inspiration, or the expansion of our frontiers?"

  Matthew S. Williams, "Is It Worth It? The Costs and Benefits of Space Exploration", Interesting Engineering. April 2019 https://interestingengineering.com/is-it-worth-it-the-costs-and-benefits-of-space-exploration
- Should you opt to have the students read the Jules Verne's book cited below, you could discuss the following question: "With his book "From the Earth to the Moon", was Jules Verne a visionary, a crazy person, or did he simply have a vivid imagination?"
- You may add the following trades: journalist and artist.

We are providing you with 16 pros and 16 cons. You may select them all or use an appropriate number based on your students.

RECOMMENDED RESOURCES

FRENCH RESOURCES

- La conquête spatiale a-t-elle encore un sens ? Le Drenche. https://ledrenche.ouest-france.fr/conquete-spatiale-encore-un-sens-5390/
- Verne, Jules. (2019). De la Terre à la Lune, suivi d'Autour de la Lune. Texte abrégé. Gallimard (Folio Junior Textes classiques). ISBN 978-2-075115-759.
- Débris spatial. Wikipedia. https://fr.wikipedia.org/wiki/D%C3%A9bris_spatial

ENGLISH RESOURCES

- United Nations treaties and principles on outer space. https://www.unoosa.org/pdf/publications/st_space_11rev2E.pdf
- Everyday benefits of space exploration. https://www.asc-csa.gc.ca/eng/about/everyday-benefits-of-space-exploration/default.asp
- Space debris. Wikipedia. https://en.wikipedia.org/wiki/Space_debris
- Benefits of space exploration. Wikipedia. https://en.wikipedia.org/wiki/Benefits_of_space_exploration

LINKS TO THE PROGRESSION OF LEARNING IN SCIENCE AND TECHNOLOGY

EXPLORATION STRATEGIES

- Studying a problem or a phenomenon from different points of view (e.g. social, environmental, historical, and economic perspectives).
- Distinguishing between the different types of information useful for solving the problem.
- Recalling similar problems that have already been solved.
- Becoming aware of his or her previous representations.
- Drawing a diagram for the problem or illustrating it.
- Formulating questions.
- Putting forward hypotheses (e.g. individually, as a team, as a class).
- Exploring various ways of solving the problem.
- Anticipating the results of his or her approach.
- Imagining solutions to a problem in light of his or her explanations.
- Taking into account the constraints involved in solving a problem or making an object (e.g. specifications, available resources, time allotted).
- Examining his or her mistakes in order to identify their source.
- Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification).
- Using empirical approaches (e.g. trial and error, analysis, exploration using one's senses).

INSTRUMENTATION STRATEGIES

- Using different sources of information (e.g. books, newspapers, Web sites, magazines, experts).
- Validating sources of information.
- Using different tools for recording information (e.g. diagrams, graphs, procedures, notebooks, and logbook).

COMMUNICATION STRATEGIES

- Using different means of communication to propose explanations or solutions (e.g. oral presentation, written presentation, procedure).
- Exchanging information.
- Comparing different possible explanations for or solutions to a problem in order to assess them (e.g. full-group discussion).

CONNECTIONS WITH OTHER SUBJECT AREAS

DISCIPLINES AND COMPETENCIES	USED IN…
ENGLISH	
Competency 1: To use language to communicate and learn.	— Presenting pros and cons verbally. — Commenting on other student's representations.
Competency 2 : To read and listen to literary, popular and information-based texts	— Reading Jules Verne's book "From the Earth to the Moon", followed by "Around the Moon".
Competency 3: To write self-expressive, narrative and information-based texts. To represent her/his literacy in different media .	— Writing a text on pros and cons.
MATHEMATICS (IF A SURVEY HAS BEEN CONDUCTED)	
Statistics 1. Formulating questions for a survey (2nd and 3rd cycle). 2. Collecting, describing and organizing data using tables. 3. Interpreting data using b) a data table (2nd cycle). c) a data table, a bar graph, a pictograph, a broken-line graph OR a circle graph (3rd cycle). 4. Displaying data using b) a data table, a bar graph, a pictograph OR a broken-line graph (2nd cycle). 5. Arithmetic mean (meaning, calculation) (3rd cycle).	— Conducting a survey among one's inner circle.
ETHICS AND RELIGION	
Competency 1: Reflects on ethical questions. Engages in dialogue.	— Discussing with others the merits of space exploration.

THE SCIENTIST

analyzes facts discovered by science and develops technologies.

THE TEACHER

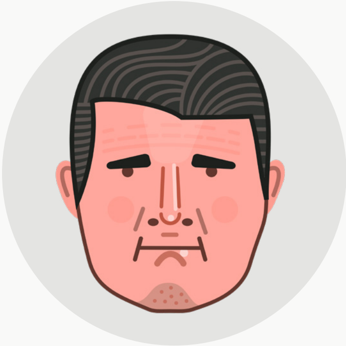
shares his or her knowledge of space exploration with students.

THE POLITICIAN

passes laws that govern citizen interactions and relations with other countries.

THE DOCTOR

analyzes the effects of space exposure on the human body.



THE INVESTOR

evaluates the costs and benefits of space exploration.

SPACE EXPLORATION: THE PROS AND CONS

P: Space exploration… promotes the invention of new technologies that improve the quality of life of living beings on Earth.	By designing survival systems for long missions, researchers have discovered a natural source of omega-3 fatty acid that is now incorporated to more than 90% of commercial infant formula.
P: Space exploration… attracts humans eager to live adventures and discover new worlds.	Travels to the Moon during the Apollo missions.
P: Space exploration… promotes the discovery of new materials.	Sodium polyacrylate, now used in baby diapers, is a benefit of space exploration. This substance was first used as an absorbent in diapers worn by astronauts!
P: Space exploration… promotes the discovery of new drugs and medications.	The lack of gravity in space results in the decalcification of bones. Osteoporosis, a common disease among the elderly, sets in, making astronauts' bones brittle. Space exploration has helped develop treatments and medication to fight this problem, not only in space but here on Earth.
P: Space exploration… is speeding up technological miniaturisation.	The technology used by miniature cameras in our cell phones was developed to miniaturize the cameras of spacecrafts.

SPACE EXPLORATION: THE PROS AND CONS

P: Space exploration… attracts people driven by risks.	One has to be brave to embark on a rocket that may explode at any given time during the launch or landing!
P: Space exploration… improves our safety here on Earth.	Meteorological satellites are helping us learn about the formation of hurricanes, storms and tornadoes, allowing us to find shelter.
P: Space exploration… creates jobs.	For each astronaut sent in outer space, some 5,000 people are working here on Earth. There is a multitude of trades associated with space exploration, from janitor to flight director, technicians and cooks!
P: Space exploration… helps discover new resources.	Thanks to remote sensing, we can locate potential ore deposits in the Earth's soil and better manage agriculture.
P: Space exploration… will make a dream come true: colonizing other planets	As lands to feed and lodge humans are starting to get rarer and rarer, we must find new places to inhabit, just like the settlers did through the Americas.

SPACE EXPLORATION: THE PROS AND CONS

P: Space exploration… will help us plan for potential meteorite impacts.	By putting observation satellites in orbit and further in outer space, we will be able to detect more quickly the arrival of near-Earth asteroids (objects crossing Earth's path). We could then launch missiles to destroy them or make them deviate from their course before they damage our planet.
P: Space exploration… inspires tomorrow's scientists and engineers.	Space exploration piques curiosity and fosters the imagination of children. Astronauts are models that make students dream and help them make these dreams come true.
P: Space exploration… is based on existing laws.	The United Nations' Moon Agreement came into effect in 1984.
P: Space exploration… helps us learn about the Universe.	Data collected by space probes, telescopes and rovers, for example, makes us continuously reassess our hypotheses. Over the last decades, we learned that our Universe contained a much greater number of planets, stars and galaxies than anticipated. Scientists even discovered ice on Mars and on the Moon…as well as liquid water on some moons of the Solar system!
P: Space exploration… is an economical investment that is already generating profits.	Several orbiting satellites are responsible for GPS technology. That technology is in turn responsible for a whole industry, that of geomatics.

SPACE EXPLORATION: THE PROS AND CONS

P: Space exploration… helps us protect the planet.	Through space exploration, we have orbiting satellites to observe what is happening here on Earth. We can for example measure the extent of logging and forest fires, and better plan reforestation.
C: Space exploration… is very, very, very costly.	The budgets for space exploration are in the billions of dollars. The Mars Climate Orbiter, which burned while crossing Mars atmosphere (a total loss), cost 328 million dollars. According to Elon Musk, owner of SpaceX, sending astronauts to Mars would cost 20 billion dollars.
C: Money invested in space exploration… could be used to eradicate starvation and diseases on Earth.	To this day, NASA (National Aeronautics and Space Administration) will have sent 126 billions $CA on the International Space Station, over and above the contributions of other countries. The construction and launch of the Perseverance probe cost 2.4 billion $US, up to its landing on Mars, on February 18th, 2021. Its operation for the first year will cost 300 million dollars. Sending four astronauts to Mars would cost a minimum of 6 billion dollars.
C: Space exploration… presents risks that we know nothing about.	We do not know what to expect beyond our planet's atmosphere. Who knows, we might be attacked by aliens, pathogen microbes, or unknown, evil-disposed -life forms.
C: Space exploration… contributes to the deterioration of our atmosphere and climate.	Upon leaving the atmosphere, a rocket produces vast quantities of GHGs (greenhouse gasses). That pollution contributes to climate change. And so does the production of rockets and other spacecrafts.

SPACE EXPLORATION: THE PROS AND CONS

C: Space exploration… is a mean to spy on us.	The presence of spy satellites orbiting around Earth lets foreign powers, and our own governments, spy on all of our activities.
C: Space exploration… is very risky for human beings.	Over nearly 50 years, roughly 30 American and Russian astronauts have died, during either their training (e.g. Apollo 1 in 1967) or mission (e.g. the Challenger shuttle in 1986 and the Columbia shuttle in 2003).
C: Space exploration… sometimes looks more like a sport competition, which is not very useful to humanity.	Space exploration was initially a contest between Russians and Americans. Russians were the first to send an artificial satellite into orbit, Sputnik 1 (1957), as well as a man in outer space, Yuri Gagarin (1961). Unable to accept defeat, Americans then invested huge sums of money in the space race, to show…that they were the best! They were first to land on the Moon (1969). The race is still on today, but with new players such as China, India, and the Arab Emirates.
C: Space exploration… is a source of pollution, not only on Earth but on other planets.	The Apollo missions left all kinds of objects on the lunar soil, which will never decompose They are there for eternity. The same goes for probes abandoned on Mars and other planets.
C: Humans have evolved on Earth. They are not suited to outer space travel.	We need protection to survive in the space environment. There is no air, as well as extreme temperature variance (from -200 °C to +200 °C). Weightlessness makes bones brittle. Cosmic radiation attacks our cells, which can give us cancer.

SPACE EXPLORATION: THE PROS AND CONS

C: Space exploration… requires far too much time and resources.	The round trip of a manned mission on Mars would take 3 years. Food, water and air would have to be brought along for that long a period.
C: Space exploration… and more specifically long missions, has an impact on the moral of astronauts.	It is difficult for some astronauts to be away from their family for an extended period of time and to live in close quarters with other individuals.
C: Space exploration… produces space debris that is dangerous to other astronauts and other orbiting satellites.	There are hundreds of thousands pieces of debris orbiting around Earth. Any collision with such debris travelling at high speed can be extremely dangerous for space missions: they are like cannonballs.
C: Space exploration… must be governed by laws implemented by all countries. Such laws do not yet exist.	Not all countries have signed the Moon Agreement. Who do planets belong to? To countries that will get there first or to humanity? These are difficult decisions to make and they could trigger conflicts among nations, and even space wars.
C: Space exploration... uses materials and natural resources (metal, plastic, energy sources) that would be put to better use elsewhere.	Materials used to build rockets and satellites would be better used building low-cost or common transport infrastructures, available to all.

SPACE EXPLORATION: THE PROS AND CONS

C: Space exploration…has made several astronauts sick, which is costly to our health system.	After spending 6 months in outer space, astronauts may lose as much as 15% of their bone mass. It cannot be restored upon returning to Earth. As a result, they remain vulnerable for the rest of their lives.
C: Space exploration… is a luxury reserved to a very small elite. Less than 1,000 individuals have travelled in space.	Astronauts are exceptional, handpicked individuals, who must be in better physical and mental shape than average, be multi-talented, and hold several diplomas.

WHAT THEY SAID

“Earth is the cradle of humanity, but one cannot
remain in the cradle forever.”

Konstantin Tsiolkovsky (1857-1935): Father of the Russian space program.

“Basic research is what I do when I do not know what I am doing.”

Wernhervon Braun (1912-1977): Designer of the V2 and Saturn V rockets.

“It is difficult to say what is impossible, for the dream
of yesterday is the hope of today and the reality of tomorrow.”

Robert H. Goddard (1882-1945): The first American to build rockets.

“Canada and space are a natural fit.”

Marc Garneau (1949-): First Canadian to go into outer space.

“When I was 8 years old, to be a spaceman
was the most exciting thing that I could imagine.”

Roberta Bondar (1945-): First Canadian woman astronaut.

“I could have kept flying in space forever.”

Yuri Alexeïevitch Gagarin (1934-1968): The very first human being in space.

“Once you have been in space, you appreciate
how small and fragile Earth is.”

Valentina Terechkova (1937-): The first woman in space. The Mother of Stars in Russia.

“Arf… Arf… Aaaarf!!!”

Laïka (1954-1957) Лайка ’small barker’: First female dog in space

TO BE OR NOT TO BE AN EXPLORER?

SCIENTIST NOTEBOOK

CONTEXT

Humans have always been driven to explore. They cannot help it. Just observe a baby's behaviour. Discovering the unknown is natural to us.

According to studies, Homo sapiens left the Eastern part of Africa, probably in search of food or a better environment. One thing we know for sure is that Homo sapiens spread over the entire planet.

In the past, many factors have triggered our desire to explore, to know more, and to satisfy our innate curiosity. For example, Alexander the Great wanted to extend his empire. Fernand de Magellan wanted to go around the globe. Coincidentally, the passage between the Atlantic and Pacific oceans is called the Strait of Magellan. Samuel de Champlain hoped to colonize New France for the glory and wealth of France.

More recently, Elon Musk, owner of the famous Tesla car company has invested billions in his SpaceX company to promote space exploration.

Whatever the motives, there will always be ‘pros and cons’ to such endeavours. Debates are still raging, especially in light of the poor living conditions of many human beings on our planet.

“Should we explore outer space?”*

Alexandre Le Grand
(356-323 BC)

“Yes since there is so much to discover.”*

Fernand de Magellan
(1480-1521)

“No, because it is much more dangerous than here on Earth.”*

Samuel de Champlain
(1567-1635)

And what do you think?
“I think that... Because...”

* Fictitious quotes

RESEARCH QUESTION

Should we explore space?

HYPOTHESIS

I think that...

Because...

DISCUSSION

– Your class will be divided in multidisciplinary teams. Each team will have the following players:

- A scientist, who analyzes facts discovered by science and develops technologies.
- A teacher, who shares his or her knowledge of space exploration with students.
- A politician, who passes laws that govern citizen interactions and relations with other countries.
- A doctor, who analyzes the effects of space exposure on the human body.
- An investor, who evaluates the costs and benefits of space exploration.

DISCUSSION RULES

While discussing, I make sure that:

- I participate by submitting my ideas.
- I respect the right to speak of everyone.
- I listen to what others have to say.
- I use appropriate language.

MANIPULATIONS

1. Read the description of each role.
2. Assign everyone's role with your teammates.
3. A member of your team reads the 'What they said' document.
4. Discuss your thoughts with your teammates (5 minutes).
5. Use scissors to cut the pros and cons.
6. Read together the pros and cons presented to you. You may add new ones that you think of.
7. Glue the pros and cons to your chart. Select those that are associated to your role.
8. As a team, discuss each pro and con and decide if you agree or disagree with them. Make sure that you respect the discussion rules (10 minutes).
9. With your teammates, decide if you agree or disagree with the Research Question.
10. Make a poster to present your arguments (30 minutes).
11. Present the poster to the other students of your class, while summing up your answer to the question, as well as the arguments that you based your answer on (3 minutes).

RESULT TABLE

MY ROLE	
MY PROS	MY CONS

CONCLUSION

WE SHOULD/SHOULD NOT EXPLORE SPACE...

BECAUSE (YOUR RESULTS)...

MY HYPOTHESIS IS: CONFIRMED DISPROVED

DID YOU KNOW...?

HISTORICAL FACT

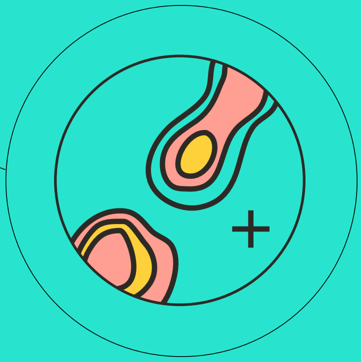
A first Homo sapiens left the Eastern part of Africa some 200,000 years ago, in search of new territories.

SOCIAL FACT

Thanks to the exploration of the Americas, Europeans discovered new foods, such as tomatoes, which are now used worldwide in daily meals, e.g. in pizzas.

TECHNOLOGICAL FACT

To remain in space over long periods of time, including during extravehicular outings, astronauts must wear...diapers. Unfortunately, old diaper designs were too heavy and cumbersome for NASA. Researchers came up with sodium polyacrylate, a new substance that can absorb up to 300 times its liquid weight. This technology has been used ever since to manufacture disposable baby diapers.



NATIVE FACT

First Nations had to constantly travel over their territory to find resources and trade with other nations.

RECOMMENDED READINGS

ELEMENTARY — 2ND ET 3RD CYCLES, SECONDARY — 1ST CYCLE

Here are some recommended readings that you may find useful to develop the students' scientific literacy. The **proposed adventure books** are adapted to young people of the elementary 2nd and 3rd cycles.

ADVENTURE BOOKS : ELEMENTARY — 2ND CYCLE

Agee, Jon. (2016). ***Seul sur Mars ?*** Seuil (Jeunesse).

Babley, Aaron. (2018). ***Les méchants, épisode 5 : Gaztronautes en mission***. Scholastic.

Balpe, Anne-Gaëlle & Garrigue, Roland. (2018). ***Mission Mobilus : Le grand zozo de l'espace***. Nathan (Jeunesse).

Balpe, Anne-Gaëlle & Garrigue, Roland. (2018). ***Mission Mobilus : Le vaisseau fantôme***. Nathan (Jeunesse).

Balpe, Anne-Gaëlle & Garrigue, Roland. (2019). ***Mission Mobilus : Piège sur Actaris***. Nathan (Jeunesse).

Bergeron, Alain M. & Mika. (2017). ***Nathan l'astronaute***. Québec Amérique.

Goldstyn, Jacques. (2019). ***Les étoiles***. Pastèque.

Hadfield, Chris & Fillion, Kate. (2016). ***Plus noir que la nuit***. Scholastic.

ADVENTURE BOOKS : ELEMENTARY — 3RD CYCLE

Agee, Jon. (2016). ***Seul sur Mars ?*** Seuil (Jeunesse).

Goldstyn, Jacques. (2019). ***Les étoiles***. Pastèque.

Mouriaux, Pierre-François & Halfbob. (2016). ***Comment on fait pipi dans l'espace ? et toutes les questions que tu te poses pour devenir un parfait astronaute !*** Fleurus (Petites et grandes questions).

ADVENTURE BOOKS : SECONDARY — 1ST CYCLE

Bravo, Émile. (2011). ***Une épatante aventure de Jules, tome 1 : L'imparfait du futur***. Dargaud.

Bravo, Émile. (2006). ***Une épatante aventure de Jules, tome 2 : La réplique inattendue***. Dargaud.

Bravo, Émile. (2011). ***Une épatante aventure de Jules, tome 4 : Un départ précipité***. Dargaud.

Bravo, Émile. (2011). ***Une épatante aventure de Jules, tome 6 : Un plan sur la comète***. Dargaud.

Card, Orson Scott. (2018). ***Le Cycle d'Ender, tome 1 : La stratégie Ender***. J'ai lu.

Corey, James S.A. (2018). ***The Expanse, tome 1 : L'éveil du Léviathan***. Livre de poche.

Dixen, Victor. (2015). ***Phobos 1***. Lafont.

Duhoo, Jean-Yves. (2020). ***Dans les secrets des labos***. Dupuis.

Heinlein, Robert A. (1955). ***Tunnel in the Sky***. Scribner's.

Heinlein, Robert A. (2014). ***En terre étrangère***. Lafont.

Karpyshyn, Drew. (2012). ***Mass Effect, tome 1: Révélation***. Milady.

Kaufman, Amie & Kristoff, Jay. (2020). ***Le cycle d'Aurora, tome 1: Aurora Squad***. Casterman

Montaigne, Marion. (2018). ***Dans la combi de Thomas Pesquet***. Dargaud.

Okorafor-Mbachu, Nnedi. (2020). ***Binti : Tome 1***. ActuSF (Naos).

Roth, Veronica. (2020). ***Marquer les ombres : Tome 1***. Pocket.

Runberg, Sylvain & Pellé, Serge. (2006). ***Orbital, tome 1 : Cicatrices***. Dupuis.

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