Topic 3.4

# What role does Canada play in space exploration?

## Key Concepts

- Canada contributes people and technology to explore space.
- Canada helps build the future of space exploration.

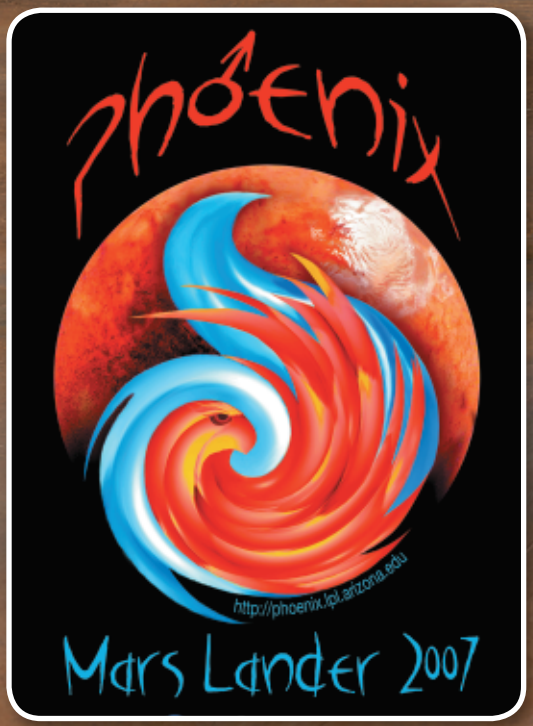
## Key Skills

Research

For five months, come haze or shine, the Canadian-built weather station onboard the *Phoenix Mars Lander* reported the weather from its location in the north polar region of Mars. The dates were given in Earth days as well as "Sols." Each Sol was one Mars day, measured from the date of landing, May 25, 2008.

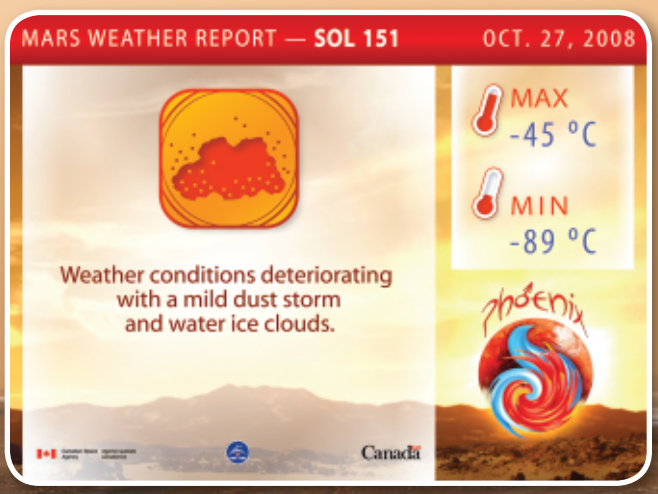
In addition to the weather station, Canada also supplied the distinctive logo for the *Phoenix* mission. Montréal's Isabelle Tremblay was the lead systems engineer for the weather station, as well as the logo's artist. Mission leader Peter H. Smith decoded the logo's symbolism with this explanation:

"Our jazzy logo cleverly unites all the elements of our mission: the planet Mars, water, and fire. The Mars image in the background shows the northern polar cap and just to the left, still inside the Arctic Circle, a droplet of water swirls out into space from our landing site. Superimposed on the water is the fiery Phoenix bird scanning the Universe with a hunter's eye. Clearly, the Phoenix is searching for something."



## Starting Point Activity

Imagine being asked to design the logo for a lander or orbiter mission to a planet of the solar system. Think about the characteristics of the planets from Topic 3.3. Pick two or three characteristics that likely would be a focus of exploration for a mission. For instance, a mission to Venus might explore its thick carbon-dioxide atmosphere and sweltering surface temperatures. Draw the logo for your lander or orbiter. Include labels to decode the symbolism of your logo.



# Canada contributes people and technology to explore space.

Did you know that Canadian scientists and engineers helped design the space capsule that carried the first American into space? Or that the oldest scientific institution in Canada was an observatory built in Toronto in 1839 to study Earth's magnetic field? Or that Canada built and launched the third satellite to orbit Earth? Canada has many notable achievements in the field of space exploration. A few of the more recent events are highlighted here.

**Research Focus**

## Activity 3.13

### WE GROW ASTRONAUTS, TOO

In early 2009, Canada had three astronauts on active duty, five who had retired, and sixteen new recruits vying for two open positions. What do you know about our first eight astronauts? Start by solving these eight puzzle-questions, and then choose one astronaut to explore in greater detail. Decide how to record your findings.

- Who knows all about Moon trees (trees grown on Earth with seeds that orbited the Moon)?
- Who has done missions in inner space (underwater) as well as in outer space?
- Who has made more trips to space than any other Canadian astronaut?
- Who was the first Canadian to walk in space?
- Who has a passion for taking photos of Earth from ground level as well as from space?
- Who was the first Canadian to operate the *Canadarm2* robotic arm?
- Who was the first Canadian to board the International Space Station?
- Who was the first Canadian trained as a mission specialist for both the space shuttle and the International Space Station?


Dr. Marc Garneau


Dr. Roberta Bondar


Dr. Steven MacLean


Col. Chris Hadfield


Dr. Robert Thirsk

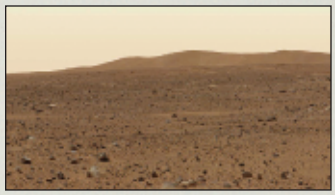

Bjarni Tryggvason


Dr. Dave Williams


Capt. Julie Payette

## Seeing It and Tracking It—Even on Mars

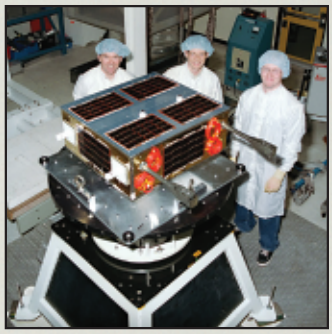
The *Phoenix Mars Lander* includes Canadian weather technology to study Mars's polar climate. Mars may have once been a lot like Earth, with liquid water and warmer temperatures. Today, it is a world covered with dry riverbeds and endless deserts. What happened? That's one question *Phoenix* and its Canadian weather station have gone to Mars to find out. A new part of the puzzle emerged in 2008. *Phoenix* observed snow falling from clouds high above the surface. Ontario's Jim Whiteway, lead scientist for the Canadian weather station on *Phoenix,* said, "Nothing like this view has ever been seen on Mars." The *Ottawa Citizen* newspaper noted: "Trust a Canadian weather instrument to find snow. Even on Mars."



The *Phoenix* Mars Lander will help scientists better understand the similarities and differences between the two planets.

## Let's Boast the MOST

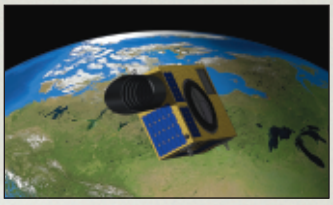
Canada's first space telescope, dubbed *MOST*, was designed to study the inside of stars like our Sun. It was supposed to last one year, but more than five years later it's still going strong. Scientists from around the world book time to use *MOST*. The *MOST* team has also asked Canadian stargazers for project proposals. Recently, amateur astronomer David Garney's proposal was chosen as a *MOST* mission. Garney teaches scouts in Toronto about the night sky. His idea was to study the supergiant star, Betelgeuse. Garney says, "In a way, Canadian kids are my collaborators on this proposal, because Betelgeuse means something to them."



*MOST* is a satellite-style telescope that orbits Earth. *MOST* stands for **M**icrovariability and **O**scillations of **St**ars.

## Earth, We Stand on Guard for Thee

Canadian space scientists have now entered the protection business. But instead of tracking down criminals, they are searching out asteroids that could possibly get near enough to strike Earth. Tens of thousands of asteroids have orbits that bring them near enough to Earth to warrant keeping a close eye on them. *NEOSSat* (**N**ear-**E**arth **O**bject **S**urveillance **Sat**ellite) is a small telescope-equipped satellite to monitor these asteroids. The satellite also keeps an eye on other satellites to prevent collisions.



Canada's *NEOSSat*

### LEARNING CHECK

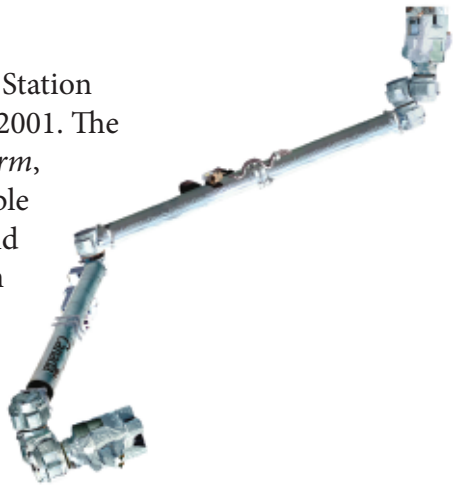
1. State the purpose of Canadian technology on the *Phoenix* Mars Lander.
2. Explain why it is important for Canada to have *NEOSSat* orbiting Earth.
3. Refer to all the material on these two pages. Identify four other contributions to space made by Canadians.

# Canada helps build the future of space exploration.

Space robotics play a key role in exploring planets. They also help maintain equipment and assemble spacecraft in space, as well as assist astronauts to complete many other tasks. Canadian-built and designed robotics were instrumental in building the International Space Station. They continue to be an important means of inspecting and fixing outer parts of the station. The three major components of the Mobile Service System responsible for these tasks are *Canadarm2*, *Dextre*, and the *Mobile Base System*.

## Canadarm2

*Canadarm2* is our main contribution to the International Space Station (ISS). The robotic arm (shown here) was installed on the ISS in 2001. The arm is larger and more flexible than its predecessor, the *Canadarm*, which retrieved and released satellites from the space shuttle. Able to reach most outer parts of the ISS, *Canadarm2* has helped build and maintain the space station. It also provides a stable platform from which astronauts perform tasks in space. The arm is a lot like a human arm, rotating at joints like those of the shoulder, elbow, and wrist. Thanks to advanced vision systems and touch sensors, *Canadarm2* can be controlled by astronauts directly from inside the station or by remote control.



## Dextre

*Dextre* is officially known as a Special Purpose Dexterous Manipulator. It is an advanced, highly co-ordinated or "dexterous" robot that connects to *Canadarm2*. (The word "dexterous" refers to skillful use of the hands.) The robot has a pair of seven-jointed arms that sit on a set of supportive shoulders. The arms let *Dextre* perform tasks that could once only be completed by astronauts outside the ISS. These range from handling small objects to completing delicate operations that require the use of tools.

## LEARNING CHECK

1. List the three Canadian-made components of the Mobile Service System.
2. Compare the design and roles of *Canadarm* to *Canadarm2*.
3. Explain how *Dextre* helps keep astronauts safe.

**Literacy Focus**

### Activity 3.14

**CANADIANS EXPLORING SPACE**

Canadian organizations have contributed human and financial resources on a large scale to develop space technologies such as *Dextre* and *Canadarm2*. These investments have helped build Canada's reputation as a world leader in space exploration. Research one Canadian company, government agency, university, or college provided by your teacher. Assess its contributions to Canadian space exploration. Communicate your findings in the form of an organizer or another presentation method of your choice.

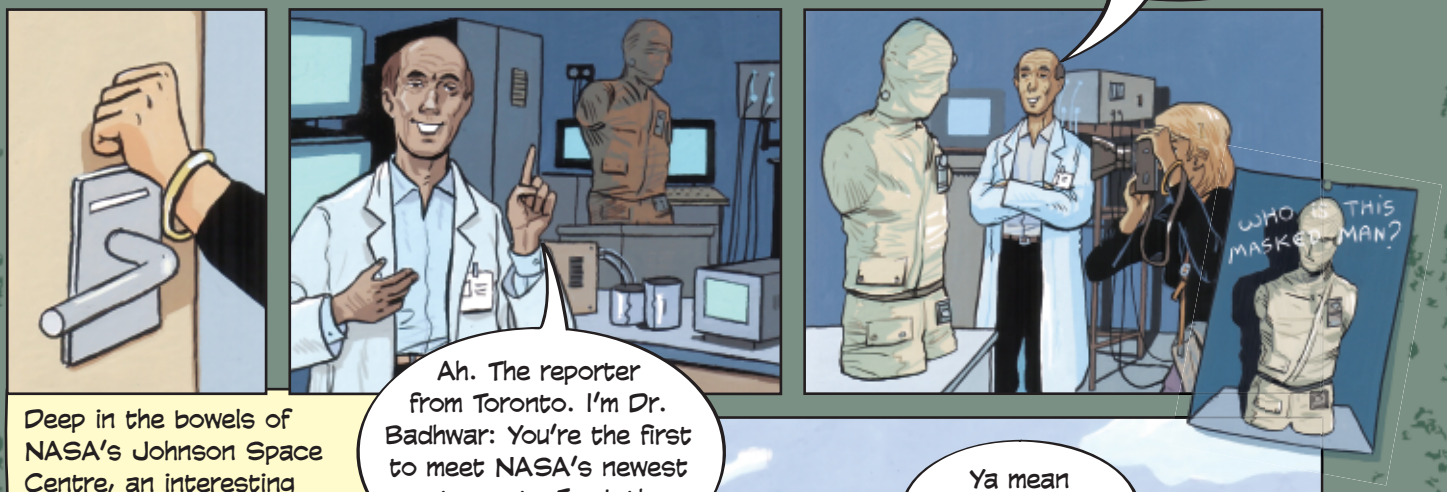
## Mobile Base System

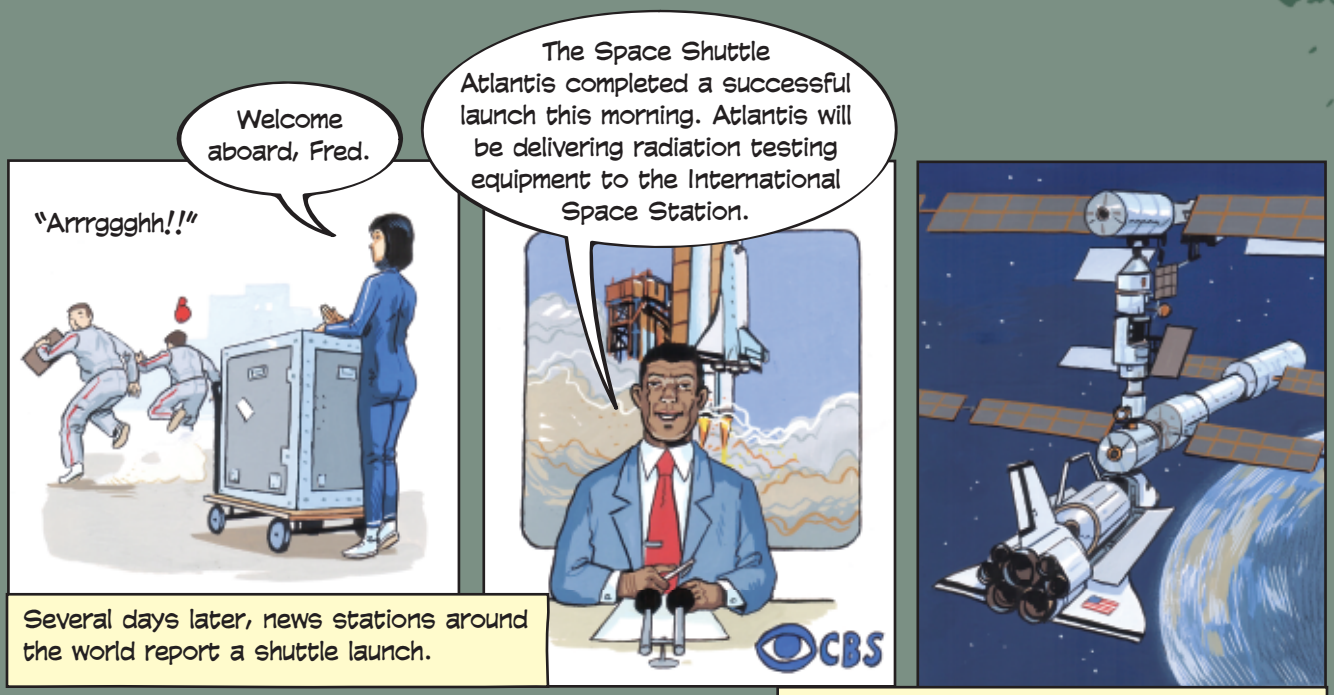
The *Mobile Base System* has several functions. It is a moveable platform that acts as a base for *Canadarm2* and *Dextre*. At the same time, it is a work platform and storage area for astronauts on space walks. The platform accesses the entire ISS through a track system that runs the length of the whole station.

# Strange Tales of Science

## The Phantom Torso

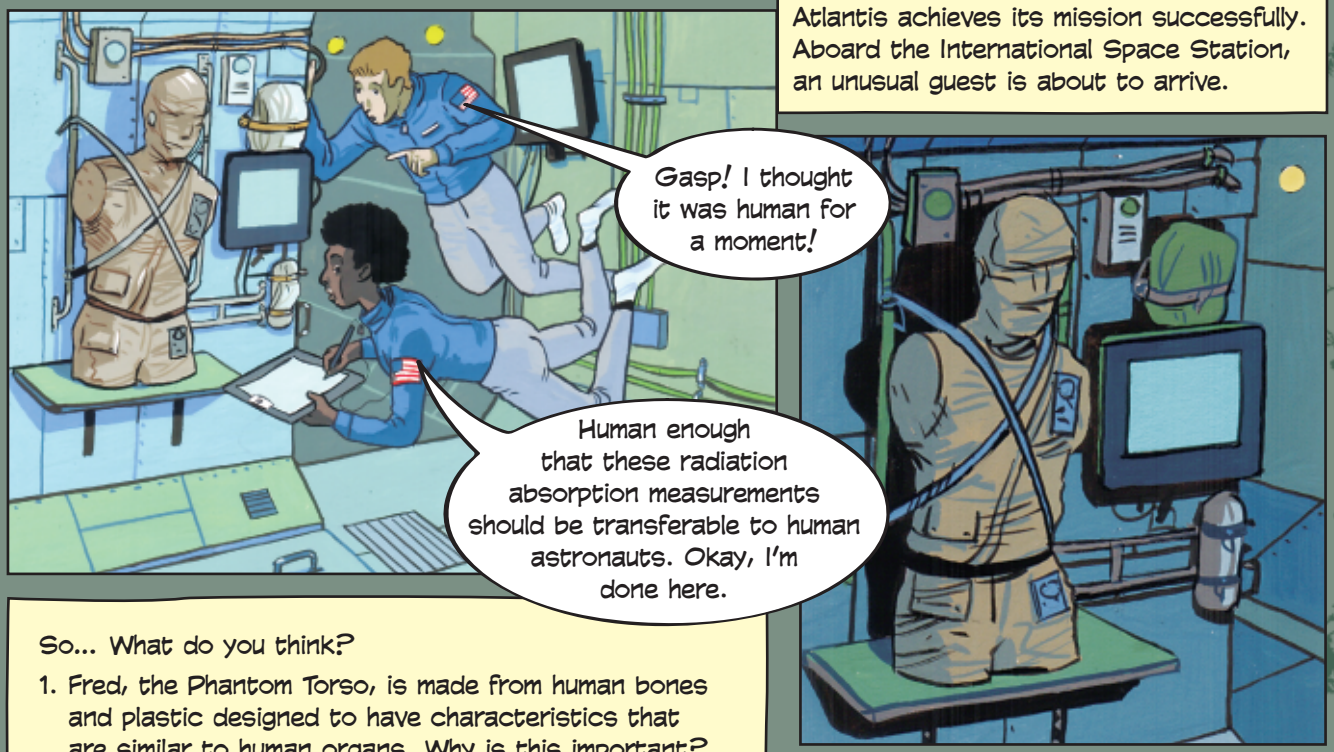
It reads like a script to a science-fiction movie, but it's not fiction at all. It's a NASA experiment designed to find out how much radiation enters the human body during space travel. Radiation is a threat to all astronauts who spend extended time in space. The knowledge gained from the Phantom Torso may help reduce this risk. But to successfully apply this knowledge to humans, the Phantom Torso must be a little human itself...






Several days later, news stations around the world report a shuttle launch.

Atlantis achieves its mission successfully. Aboard the International Space Station, an unusual guest is about to arrive.




So... What do you think?

1. Fred, the Phantom Torso, is made from human bones and plastic designed to have characteristics that are similar to human organs. Why is this important?
2. Find out more about the different types of radiation that can harm astronauts in space.
3. Design a Phantom Torso of your own. What would it be made of? What would it test and how? How would the knowledge gained benefit those who work or journey in space?

**Skill Check**

Initiating and Planning

✓ **Performing and Recording**

✓ **Analyzing and Interpreting**

✓ **Communicating**

# You, Robot

Because it is dangerous for astronauts to work in space, robots such as *Dextre* are designed to take over the job of performing repairs outside the space station. However, robots are not yet capable of the fine control and co-ordination that humans possess. This activity will help you get an idea of how tasks "feel" from an advanced robot's point of view.

## Safety

- Do not put the tongue depressors into your mouth.
- Be careful when handling the pliers.

## What You Need

- tongue depressor
- heavy gloves
- masking tape
- two pairs of pliers
- blindfold
- shoes with laces
- stopwatch

## What To Do

1. Copy the table into your notebook.

**Times for Robot Simulation Trials**

| Shoelace test | Trial 1 time (s) | Trial 2 time (s) |
|---|---|---|
| Hands | | |
| Blindfold | | |
| Gloves | | |
| Tongue depressors | | |
| Pliers | | |
| | | |

2. Work with a partner to complete this activity. Have your partner sit in a chair with shoelaces untied.
3. Time how long it takes you to tie the shoelaces.
4. Untie the shoelaces again. Time how long it takes you to tie them wearing a blindfold.
5. Remove the blindfold and repeat step 4 using heavy gloves.
6. Remove the heavy gloves and repeat step 4 with tongue depressors taped to your thumbs and forefingers.
7. Remove the tongue depressors and repeat step 4 holding a pair of pliers in each hand.
8. Switch places with your partner and repeat steps 2 to 7.

## What Did You Find Out?

1. Describe how your impaired abilities affected the completion of your task.
2. Based on your results in this activity, describe your impression of how well a robot can replace a human when it comes to making repairs outside the ISS. Keep in mind that astronauts also wear gloves and spacesuits that hamper their abilities.

# Topic 3.4 Review

## Key Concepts Summary

- Canada contributes people and technology to explore space.
- Canada helps build the future of space exploration.

## Review the Key Concepts

**1.** K/U Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.


**2.** T/I Use the Internet or print resources from your school's library to create a table like the one below to summarize the space missions undertaken by the Canadian astronauts. Give your table a suitable title.

| Astronaut | Mission | Mission Date | Launch Vehicle |
|---|---|---|---|
| | | | |

**3.** C Copy the following table into your notebook. Use your school's library to identify two specific examples of Canadian satellites for each category.

| Observation Satellites | Communications Satellites | Exploratory Satellites |
|---|---|---|
| | | |

**4.** C Use a Venn diagram to show how *Canadarm2, Dextre,* and the *Mobile Base System* are related.

**5.** A Magnetic storms in and around Earth's atmosphere are caused by the solar wind as it strikes the magnetosphere. During magnetic storms, communications satellites can be damaged by the radiation that these storms produce. Magnetic storms can also disrupt electrical power on Earth, causing blackouts over large regions. In March, 1989, a major storm caused one third of Canada and part of New York State to lose electrical power. In 1996, Canada placed a highly specialized camera, the auroral ultra-violet imager (UVAI), aboard the Russian satellite *Interball-2*. The goal of *Interball 2* was to study the Sun's influence on magnetic phenomena around the Earth.

**a)** Explain how your life could be impacted by a magnetic storm.

**b)** Do you think the benefits of this Canadian-made camera outweigh the costs of developing it? Justify your answer.

**6.** C You have an opportunity to join the Canadian Space Agency as an astronaut. Write a short report describing what you would like to accomplish during your career.

**7.** A Due to concern for global environmental monitoring and protection, Earth observation is a key goal of the Canadian Space Program. RADARSAT-1 was developed as Canada's flagship satellite to pursue this goal. Predict three current environmental issues that scientists might investigate using data from satellites such as RADARSAT-1.