Space Achievements

Suggested time: 1.25 Hours

What's important in this lesson:

- The impact of developments in space research and technology on other fields of endeavour.
- Canadian contributions to space exploration.

Complete these steps:

1. Complete the Diagnostic/Introductory Activity. Get this checked as being completed on your Course Checklist.

2. Use a textbook, *Science 9 Concepts and Connections* and get started on the student handout. If you are having difficulty with a section note this in the box below: (Questions for Teacher) and move on to the next activity in your student handout. You may need to use the internet to aid you in better understanding the student handout.

3. Once the student handout is complete check your answers or your teacher will with the Answer Key. Get this checked as being completed on your Course Checklist.

4. You'll need at least 10 -15 minutes to complete the quiz on the material you've reviewed today. If you've got at least that much time ask your teacher for the quiz and hand the quiz in when you are done. If you don't have enough time move on to the Reflective Activity and try the quiz next day.

5. Complete the Reflective Activity. Get this checked as being completed on your Course Checklist.

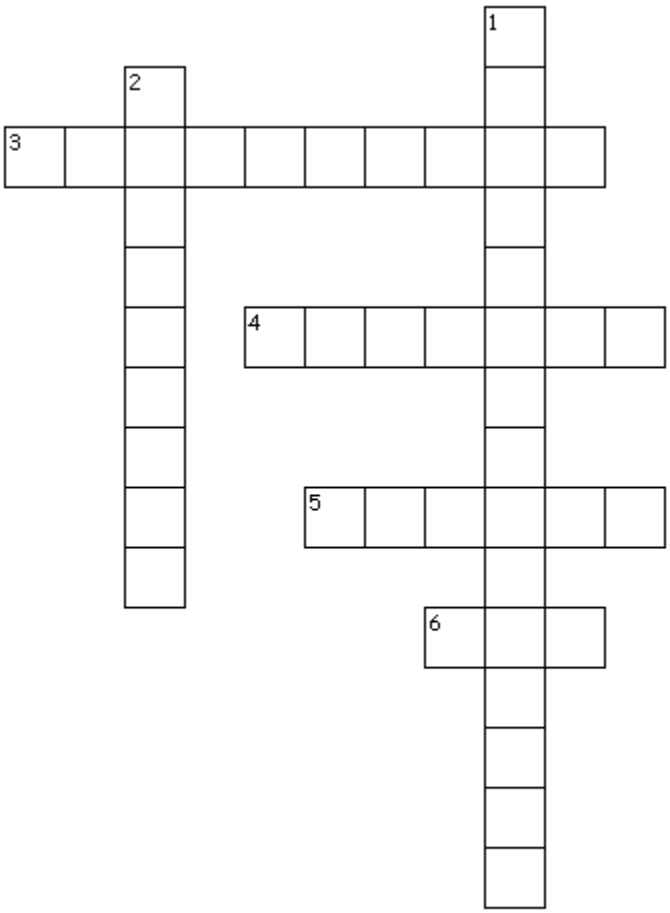
Hand-in the following to your teacher:

1. The lesson quiz.

Questions for the teacher:

Diagnostic/Introductory Activity:
Unit 4 Lesson 4

Complete the crossword using the words provided



Across
3. Artificial satellite
4. Canada's first astronaut
5. NASA name for Moon mission flights
6. International Space Station (ISS)

Down
1. Only space based telescope
2. Canada's contribution to ISS

Word bank

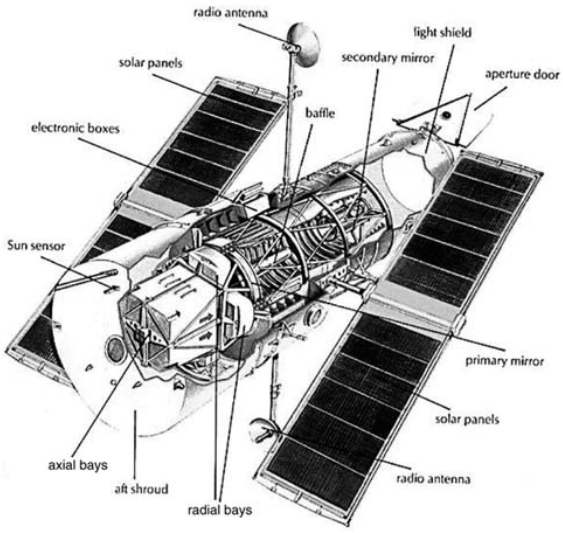
ISS, Apollo, Canada arm, Space probe, Garneau, Hubble telescope

Space Achievements

Space Age Astronomy
Hubble Space Telescope

As you read the following article, answer and fill out the boxes on each page. Then cut out the boxes and place them on the chart in Activity #1. When completed, this will create a timeline of the modern space age.

The atmosphere limits the capabilities of Earth-based telescopes. It produces turbulence, which causes images to shimmer and twinkle. Particles in the air produce airglow, which causes the background sky never to be completely black. On the darkest nights, the background sky appears to glow, meaning objects fainter are undetectable. Even Sir Isaac Newton realized that the capabilities of a telescope were limited to the atmosphere, and the only way to get perfect images would be to get above the atmosphere. As soon as the space age began, astronomers dreamed of putting a telescope in orbit above the Earth. The **Hubble Space Telescope** (HST) **(fig. 1)** went into orbit on the Space Shuttle in 1990, but the anticipation soon turned to disappointment. The Hubble Space Telescope (HST) cost more than every major observatory on the Earth combined, but an error in grinding the mirror produced blurred images. The diameter of the main mirror is 2.4 metres across, and it was ground 2 microns too flat, one 50th the width of a human hair. After spending millions of additional money to correct the error, Hubble began to produce incredible images. The HST has the ability to observe objects, a billion times fainter than can be seen with the naked eye. It can perceive objects about 30 times fainter than the largest Earth-based telescopes and has a resolution nearly 15 times better. The Hubble Space Telescope has produced some of the most amazing images of our Universe, and has given astronomers valuable information about everything from the solar system and the birth and death of stars to the beginnings of the Universe. In addition, the HST has contributed a number of products that are used to improve our lives. One of the most notable is a Charged Couple Device (CCD), this is used in imaging breast biopsy to accurately detect cancer.



Hubble Space Telescope (fig. 1)

The largest Earth-based telescopes are currently four times the size of the Hubble Space Telescope, but are limited because they have to look through the atmosphere. New technologies, however, have allowed Earth-based telescopes to compete with Hubble. This technology is relatively new, but has already produced images which rival HST's for clarity.

Student Handout: Unit 4 Lesson 4

He realized that early telescopes had limitations.
1.

First space based telescope launched by the Space Shuttle in 1990.
14. _____

Although visible light is only one form of radiation given off by stars, there are telescopes capable of detecting other forms. Because objects in the Universe emit energy in many forms, an object is not always perceivable in visible light. It can be advantageous to study the sky in other wavelengths, as some objects which are invisible in the optical wavelengths emit an enormous amount of energy in other wavelengths. There are also objects located behind obscuring gas and dust, such as the **Galactic centre**, which are not optically visible but can be detected because energy in other forms is unaffected. Radio telescopes are huge dishes that were first constructed in the 1950's. Radio waves are longer than optical waves, and are not as easily deflected by obscuring particles. Because of this, radio waves travel through planetary clouds or dust particles in the interstellar medium. **Radio telescopes** are used to image planetary surfaces hidden beneath thick clouds, and can determine the presence of background stars located behind dark nebulae. Other wavelengths of radiation are often deflected by the Earth's atmosphere, and most are not detectable unless observed from space. Infrared radiation is observable minimally from the Earth, but is better studied from above the Earth's atmosphere, displaying the warmth of interstellar gases. High energy astronomy includes the observation of X-rays and gamma rays and must be observed from space, as this radiation does not reach the surface of the Earth. X-ray telescopes have been used to strengthen the theory of black holes inhabiting the centre of galaxies, while gamma ray telescopes have been used to detect and study bursts of energy in distant galaxies.

Space Race Achievements

While telescopes gave valuable information about our solar system and the Universe, the Space Race opened a whole new realm of possibilities. Numerous **space probes** have flown by or landed on objects in our solar system, and orbiting satellites and telescopes now have clear and unobstructed views of the Universe. The **space age began in 1957** when the former Soviet Union launched **Sputnik 1**, the first **artificial satellite**. Four years later the first human traveled into space, a Soviet named Yuri Gagarin. With space craft being launched into orbit, scientists and astronomers dreamed of sending probes to other bodies in the solar system to obtain detailed views of their surfaces. The Moon was the obvious first target, and ten years after reaching the Moon with a spacecraft, man set foot on its surface during the historic **Apollo 11** mission in July of 1969. Over the next three and a half years, six American missions successfully landed on the Moon and through surface experiments and collections of rock samples, our knowledge of the Moon increased dramatically.

5. _____mission to the Moon in 1969.

4. Name the first person to travel into space, _____.

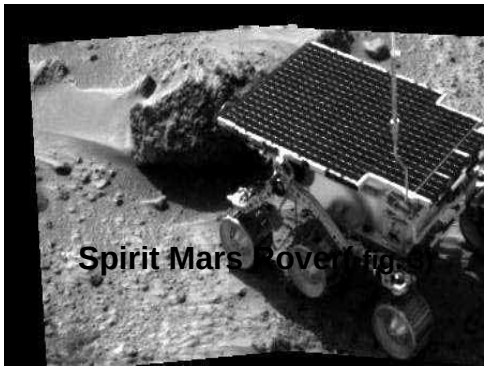
3. The Soviet Union launched _____ in 1957.

2. _____ telescopes were first constructed in the 1950's

Student Handout: Unit 4 Lesson 4

The proximity of Venus made it our first planetary target, reached by a spacecraft for the first time in 1962. In 1970, the probe **Venera 7** successfully landed on the surface of Venus and transmitted data for a few seconds before malfunctioning due to the planet's extreme conditions. Launched in 1978, the **Pioneer** Venus probe used radar to map over 90% of the previously unknown surface of Venus. The NASA **Magellan project** arrived at Venus in 1990 and spent four years using radar to obtain more detailed and accurate images. The more distant trip to Mars presented greater difficulties, and was first achieved in 1976. Because of the Earth-like qualities and the constant debate about the possibility of life forms in the past, Mars has now been visited by more spacecraft than any other planet. The first probes to land on its surface were the highly successful Viking missions. **Viking 1 and 2** were the culmination of several early missions of flybys and orbital missions, and after eight-month journeys, the probes finally landed on the surface. The Viking Project was a complete success, transmitting valuable data from the surface for several years. The Viking Landers provided scientists with over 4000 photos from the surface and contributed a huge amount of information regarding the soil and surface conditions.

Pathfinder (fig. 2)



Spirit Mars Rover (fig. 3)

After the Viking Project, there were no American missions to Mars until the early 1990's. Several spacecraft have traveled to Mars in the past ten years; some, such as the **Mars Pathfinder**, have been very successful **(Fig. 2).** In recent years however, NASA has also suffered setbacks with the loss of two Mars-bound probes due to miscalculations on the part of mission controllers. Presently NASA does have two Mars rovers, Opportunity and Spirit **(fig. 3)**, on the surface of the planet. Their primary purpose is find evidence of possible life. To date, this mission has been very successful, and evidence is building for the possibility of life from the past and/or present day.

The first probes to travel through the asteroid belt were the two **Pioneer probes**, launched in the early 1970's. Pioneer 10 was the first probe to visit Jupiter and Pioneer 11 was the first to reach Saturn. NASA's second project to the outer solar system, however, was much more successful.

6. First planetary target for investigation _____

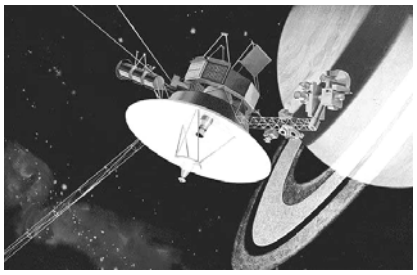
9. First probe to land on Mars in 1976 _____.

10 . Early 1990's successful Mar's rover, _____.

11. Presently on surface of Mars and collecting data, _____and_____

7. Soviets _____, in 1970 and then 8. USA, _____ in 1978

Voyager 1 and 2 were launched in 1977 and utilized a rare alignment of the gaseous planets to swing from one planet to the next, using their gravity as propulsion. The probes increased their speeds by about 60,000 kilometres per hour with each planetary gravity assist. Without this gravity assist method, a trip to Neptune would require about 30 years, but took only 12 with Voyager 2. Both Voyager probes were only expected to study Jupiter and Saturn, but engineers sent Voyager 2 on a trajectory which allowed the option of continuing on to Uranus and Neptune. Both craft flew by Jupiter in 1979, with Voyager 1 ending its primary mission after a flyby of Saturn in 1980. Voyager 2 passed by Saturn in 1981, and then funding was provided to keep the craft in operation during its flyby of Uranus in 1986 and Neptune in 1989. Both spacecraft will remain in operation for about 20 years and will study particles from the solar wind while searching for the boundary between the solar wind and interstellar space. Despite the probes' current speed of 60,000 kilometres per hour, they will not reach the nearest stars for at least another 80,000 years. The Voyager Project was extremely successful: Voyager 2 was 100 kilometres off target after a 7 billion kilometre journey, the equivalent of sinking a hole-in-one from 3630 kilometres away. The project also provided monumental images and data on the four gaseous planets and 48 of their satellites. Much of our knowledge of the outer planets has been due to the Voyager Project (fig. 4). Jupiter has since been visited by the Galileo probe in 1995, and the Cassini probe, which was launched in 1997 is scheduled to arrive at Saturn in 2004. Other probes have traveled to comets and minor planets as well, including a flyby of Halley's Comet in 1986 by the Giotto probe and two flybys of asteroids in 1991 and 1994 by the Galileo. Lastly, through all this exploration the space industry has produced a huge number of spin offs (material developed for the use in space, and then applied to products we use). The following chart displays examples of space industry spin-offs.



Voyager 2 (fig. 4)

12. Voyager Project was launched to investigate what two planets,

_____

Area of research	Examples
Electronics	Digital watches, home computers, peacemakers, handheld calculators
New materials	Nylon strips used to fasten clothing and objects, nonstick coating, flame-resistant materials
Metal alloys	Dental braces
Hard plastics	Safety helmets, in-line skates
Robotics	Mining, industry, offshore oil exploration, A situation that is too difficult, too repetitive, or too precise for humans
Vehicle controllers	Controllers for those with disabilities
Safety devices	Smoke detectors, infrared vision to aid in rescue efforts for firefighters, police
Recycling	Water recycling
Energy storage	Solar cells, chemical batteries
Food	Freeze-dried convenience foods
Pharmaceuticals	Anti-nausea medication
Pump therapy	Method to provide medication continuously to patients
Scanning	Medical scanning using techniques developed for satellites
Space vision technology	Satellite data applied to improving the efficiency of agricultural spraying
Lasers	Improvements in laser surgery

Canada's Role in Space Science

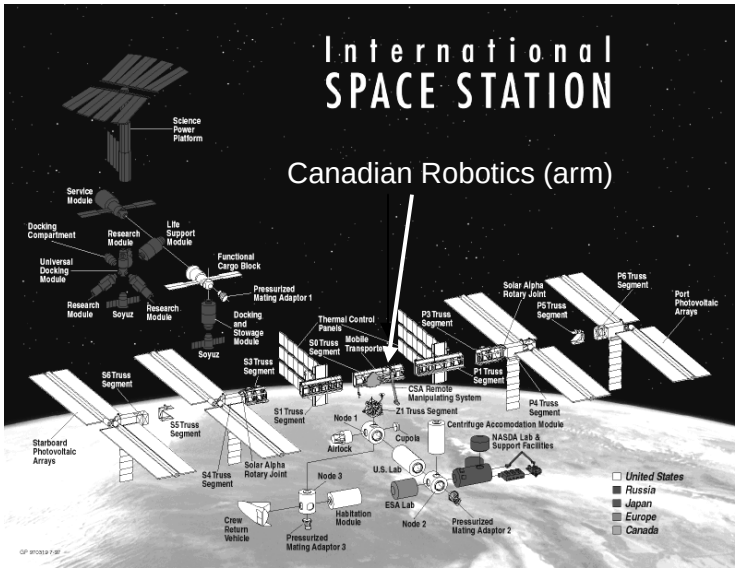
DRAO project (fig. 5)

Canada's role in the study of the Universe has been limited, but important nonetheless. The **Dominion Radio Astrophysical Observatory** (DRAO) in Penticton, B.C. includes some of Canada's most important telescopes. The site boasts an array of seven radio telescopes and also has a 26 metre radio telescope (fig. 5). These are used for the Canadian Galactic Plane Survey (CGPS) along with other important astronomical research. The CGPS is a project which observes the galactic plane at various wavelengths in the radio portion of the spectrum in order to improve our understanding of the interstellar medium. Our country has also contributed to many international projects, often in collaboration with the United States. The observatory most used by professional Canadian astronomers is the Canada-France-Hawaii Telescope in Hawaii. The **CFHT** is a 3.6 metre state of the art telescope used for valuable research by astronomers **(fig. 6).** Canadians have contributed to the construction of two new telescopes located in the Chilean Andes, called the **Gemini telescopes**. These telescopes are among the most technically advanced in the world, and their 8 metre mirrors equipped with adaptive optics will provide Canadian astronomers with the best available tools to conduct their research. Canada has also participated in space exploration, conducting various experiments on the Space Shuttle and the Russian space station Mir, as well as launching numerous satellites which have studied the Earth and its weather patterns. Our nation has satellites which measure pollution in the atmosphere, atmospheric chemistry and ozone depletion. Because of our location on the Earth, Canada experiences the best auroral displays in the world and has had several satellites designed to study the science behind the displays. A Canadian instrument called the Thermal Plasma Analyzer is currently traveling to Mars on a Japanese spacecraft designed to study the Martian atmosphere.

CFHT Hawaii (fig. 6)

13. DRAO project in Penticton BC, uses this type of telescope, _____	15. Name of the Canada-France telescope in Hawaii, _____	16. Name of telescope (Can) located in the Chilean Andes, _____

The first Canadian in space was **Marc Garneau** aboard the Space Shuttle Challenger in 1984, and **Roberta Bondar** was the second Canadian and first woman in space aboard the Space Shuttle Discovery in 1992.



International Space Station (fig. 7)

Canada's most important role has been its commitment to the development of the **International Space Station (fig. 7).** Our nation signed an International Agreement in 1986 to become a full partner in the International Space Station program. The ISS is currently under construction while in orbit around the Earth, and will be home to various scientific experiments and observations. Its construction would not be possible without the contribution from Canada. Canada is providing a system of robotic devices used to manoeuvre equipment outside the Station, essential for the assembly of the ISS. This system is known as the **Mobile Servicing System** (MSS), and consists of three parts. The main component is the Space Station Remote Manipulator System (SSRMS), also known as Canadarm2 which was installed on the ISS in 2001 by Canadian astronaut **Chris Hadfield (fig. 8).** It is an advanced device used to capture and transport equipment around the outside of the Station, and will be used to help in the assembly and maintenance of the ISS. The first Canadarm was deployed with the Space Shuttle in 1981 and will remain in use on the ISS, working in conjunction with its newer companion. Canadarm2 is more sophisticated: it is larger, can support heavier loads, and is not anchored at either end so it can travel around the Station inching along like a worm.

In addition to the Canadarm2, the MSS is composed of the Mobile Remote Servicer Base System (MBS), scheduled for launch in May of 2002, and the Special Purpose Dextrous Manipulator (SPDM), which is scheduled for launch in October of 2003. The MBS is a mobile platform which supports Canadarm2, and the SPDM is a dual-armed robot which will be connected to

18. Canada's three astronauts, _____,19. _____ and 20. _____

17. In 1986 Canada signed an international agreement to contribute to the _____.

the Canadarm2 and will be used to manoeuvre delicate objects. The construction of the International Space Station began in 1998 and is estimated to be complete in 2004 after 45 American and Russian missions. The Canadian Mobile Servicing System will be utilized on every one of the 45 missions. Because of the contribution to the ISS, Canada is entitled to use the Station for scientific experiments, and is in fact already utilizing the Station for this purpose. Our first experiment researched exercise requirements for astronauts while on extended missions in the weightlessness of space. Canada is also planning to conduct experiments on the radiation levels experienced by astronauts conducting space walks, as well as the study of an insect habitat on the Station Prominent.

Canadian Astronomers

Since the turn of the 20th Century, Canadian astronomers have played an important role in the study of the Universe. From astronomy education to the discoveries of comets and research of late-stage stellar evolution, Canadians have been and remain actively involved in the science of Astronomy.

The study of the Universe has come a long way since the ancient civilizations who viewed the sky with wonder and confusion. The motions of the stars have been understood for centuries, but the scientific explanations and mathematical models were more difficult to understand. In the 16th Century, mathematics evolved sufficiently to allow astronomers a correct determination of our presence in the solar system.

The Universe is far more complex than the solar system, of course, and before the invention of the telescope the full extent of the Universe was virtually unknown to astronomers. With increased size and improved optics, telescopes began to reveal more of our Universe. Catalogues of deep sky objects were created, but the nature of the objects was unknown until the 20th century. Galaxies were finally understood as distant collections of billions of separate stars, and our place in the Milky Way was discovered. Telescopes are now incredibly technical, with mirrors 10 metres across, adaptive optics systems which correct for turbulence, and an orbiting telescope worth billions of dollars.

Space probes traveling to other bodies in the solar system have provided scientists an immense amount of information undetectable by telescopes. Numerous missions to the Moon, Venus and Mars have helped scientists understand the chemical composition and atmospheric conditions of these objects. The Pioneer missions and especially the Voyager Project have returned thousands of detailed photographs of the outer gaseous planets and many of their satellites. Without these probes, the outer planets would not be appreciated as they are, and the surfaces of many of their satellites would still remain unknown.

The International Space Station (ISS), a space craft in orbit around the Earth, is home to various astronauts and scientific experiments. Canada has provided the Mobile Servicing System, including Canadarm2, which has been and will be essential in the assembly of the ISS. Several Canadian astronauts have had the good fortune to travel into space, and have conducted numerous experiments on behalf of our country aboard the Space Shuttle, Mir and the ISS studying the Earth, the human body and animals.

21. Name of Canada's main component and contribution to ISS, _____.

Student Handout: Unit 4 Lesson 4

Activity #1 From the reading complete the;

Modern Space Exploration Time Line

Realized that the early telescopes had limitations
1. _____

Radio 2. _____ were first constructed in the 1950's

DRAO project in Penticton, B.C uses this type of telescope
13. _____

The Soviet Union launched 3._____ in 1957.

First planetary target for investigation
6. _____

7. _____ in 1962 and then
8._ _____in 1978

Name of first person to travel into space
4. _____

5. The _____ mission to the Moon in 1969

First probe to land on Mars in 1976 9._____

Early 1990'ssuccessful Mars Rover 10._____

Presently on surface of Mars and collecting data
11. _____and_____

Voyager Project was launched to investigate the
12. _____

In 1986 Canada signed international agreement to contribute to the
17. _____

First space based telescope, launched by Space Shuttle in 1990
14. _____

Name of Canada-France Telescope in Hawaii
15. _____

Name of telescope (Can) located in the Chilean Andes
16. _____

Name of Canada 's three astronauts
18._____
19._____
20._____

Name of Canada's main component and contribution to ISS 21. _____

True/False

Indicate whether the sentence or statement is true or false.

True/ False	Question
	1. The space race began in 1957.
	2. Sputnik was the Earth's first artificial satellite
	3. The Earth has one natural satellite.
	4. The Earth has one artificial satellites.
	5. Satellites can be used to study Earth and other planets in our solar system.
	6. Satellites can be used to study space.
	7. Space probes carry people to other planets.
	8. Space telescopes study objects in can't be seen by traditional optic telescopes (ie. use other measurement devices such as inferred, radio waves, magnetic imaging etc).
	9. Space probes cannot land on planets.
	10. Voyager 1 and 2 studied Mars.
	11. Canada is highly involved around the world in space observatories.
	12. The Canadarm has very limited capability and range
	13. Canada has contributed to several important space experiments
	14. Canada is one of several counties involved in the International Space Station.
	15. Space exploration is extremely expensive, and cost billions of dollars

Reflection Activity

Space Exploration

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

Word List

1. APOLLO
2. CANADA ARM
3. GEMINI
4. HUBBLE SPACE TELESCOPE
5. VOYAGER
6. ROBERTA BONDAR
7. SPIRIT
8. MARK GARNEAU
9. NASA
10. OPPORTUNITY
11. VIKING
12. PATHFINDER
13. SPUTNIK