



SPACE SCIENCE

for Young Catholics




SETON PRESS

Table of Contents

Space Science for Young Catholics

Introduction	1
Chapter 1: Astronomy.....	2
Chapter 2: Astronomy in the Modern Age.....	22
Chapter 3: The Moon	42
Chapter 4: The Solar System: Part 1	64
Chapter 5: The Solar System: Part 2	84
Chapter 6: The Solar System: Part 3	104
Chapter 7: The Farthest Regions of the Solar System.....	124
Chapter 8: Stars.....	144
Chapter 9: Galaxies.....	164
Chapter 10: The Space Race	184
Chapter 11: Exploring Space Travel Beyond the Moon	204
Glossary.....	225
Image Attributions	235
Alphabetical List of Lessons	238



Pope Paul VI Viewing
Moon Landing, 1969

INTRODUCTION

Welcome to *Space Science for Young Catholics*. This worktext was written *by* Catholics *for* Catholic homeschooled students. It focuses on the created universe, most especially, our own planet Earth.

Many of the concepts, and much of the information, in this book will be new and more in-depth than a student is accustomed to. Every effort has been made to keep material approachable in an age-appropriate way. You will find yourself asking, “Didn’t we study this already?” The answer is, “Yes.” Repetition is the key to learning and makes what may seem difficult at first become familiar and, perhaps, even easy. Pay special attention to vocabulary. Science has its own language. Beginning to master this language now will be a tremendous help in future science study.

This book is the second book in a science course for Seton Home Study School students. The first book, *Earth Science for Young Catholics*, covers general topics including the Scientific Method, measurement, Newton’s Laws of Motion and Newton’s Laws of Universal Gravitation. If you have not purchased that book, you may need to review these concepts with your student.

Each chapter consists of five lessons. Lessons one through four contain the content for the week’s concepts and information. Special attention was given to keeping these lesson uniform in length, so parents and students know how much time needs to be allocated daily. Each lesson has a short “review.” There are no “trick” questions. Most are taken directly from the text—many word for word. Students should be able to complete the review with little or no help from the teaching parent.

Lesson five is meant to be more relaxed. The written portion is about half the length of the other days and the content is intended to be high interest. Sometimes, lesson five will tie topics to our Catholic faith. (Who was Monsignor Georges Lemaître? Why are asteroids named after Catholic priests?) Other times, it may address topics that are less religious, but hopefully just as interesting. (Are there practical benefits to space exploration? Can human beings travel to Mars?) Enrolled Seton Home Study students will not be tested on lesson five text, but will enjoy reading it.

Lesson five also includes a chapter review of the week’s work and a cumulative review that includes material from previous chapters. Each teaching parent must decide how much review is appropriate for an individual student, hopefully remembering that, “Repetition is the key to learning.” Enrolled Seton students will be tested on this information.

Every effort has been made to fill this book with colorful graphics that aid understanding. We encourage you to look up additional resources online. Enrolled students will find suggestions in their lesson plans.

CHAPTER 11

EXPLORING SPACE TRAVEL BEYOND THE MOON

11.1

THE SPACE SHUTTLE

What Was the Space Shuttle?

Projects Mercury, Gemini and Apollo, despite tremendous achievements, had drawbacks as well. Programs were very expensive. All involved disposable rockets used to launch capsules into space. Most equipment present at the launch was jettisoned or burned up in the Earth's

Space Shuttle with External Tank and Rocket Boosters



Sally Ride



atmosphere. Only a single, relatively small capsule splashed into the ocean, never to be used again. Space capsules can be found in museums all over the country.

By contrast, the **space shuttle** was designed to be a reusable vehicle. The size of a jetliner, it would be launched into space using powerful boosters, and land intact on a runway, much like airplanes do. Built with wings, the space shuttle orbited Earth at 28,000 kilometers (17,500 miles) per hour. Every 45 minutes, the shuttle's crew would witness a sunrise or sunset.



THE SPACE SHUTTLES



What Was the Purpose of the Space Shuttle?

The space shuttle was proposed right around the close of the Apollo program in the early 1970s. It would be used as a “space truck” to bring materials and aid in the construction of a space station. A total of 135 missions were flown on five space shuttles: *Columbia*, *Challenger*, *Discovery*, *Atlantis*, and *Endeavour*. In addition to being key to the construction of the **International Space Station**, the space shuttle also brought materials

to improve and repair the station, as well as keeping it supplied with crew and supplies.

The space shuttle helped bring scientific equipment, including satellites, into low and higher Earth orbit, and aided in equipment repair. In 1983, aboard the space shuttle *Challenger*, Sally Ride became the first American woman to travel in space. At age 32, she was also the youngest astronaut to fly in space. In 1990, the space shuttle *Discovery* carried the Hubble Space Telescope into space. Freed from the Earth’s gravity, the space

Discovery Landing with Parachute



shuttle allowed important research to be conducted in several fields of science.

Tragedies in the Air

Overall, the space shuttle program was a great success, but two of its 135 missions ended in tragedy.

On January 28, 1986, the space shuttle *Challenger* exploded just 73 seconds after takeoff. A rubber seal, called an O-ring, intended to separate rocket boosters failed due to freezing temperature. This caused a fire that quickly spread to the rocket itself. At the time, the shuttle was moving faster than sound travels and began to break apart. The shuttle slammed into the ocean at 333 kilometers (207 miles) per hour. All seven astronauts aboard died.

President Ronald Reagan delayed his State of the Union Address, which had been scheduled for that evening. Instead he spoke to the nation from the Oval Office. He concluded his remarks by saying, “The crew of the space shuttle *Challenger* honored us by the manner in which they lived their lives.

We will never forget them, nor the last time we saw them, this morning as they prepared for their journey and waved good-bye and ‘slipped the surly bonds of Earth’ to ‘touch the face of God.’”

The space shuttle *Columbia* was the first to fly in space and flew twenty-seven successful missions. At the end of its twenty-eighth mission in 2003, after sixteen days in space, the shuttle was approaching Kennedy Space Center to land. At the time, it was near Dallas, Texas, traveling at Mach 18. (**Mach** 18 is eighteen times the speed of sound, equivalent to 21,468 kph or 13,340 mph.) When mission control lost contact, the shuttle was at an altitude of 61 kilometers (38 miles). Damage to its left wing caused the shuttle to disintegrate, killing all seven crew members.

Last Mission

Atlantis flew the 135th and last space shuttle mission in July 2011. The Space Shuttle Program formally ended that same year.

Final Landing of *Atlantis* in 2011



11.1 LESSON REVIEW

➤ Circle the letter next to the correct answer.

1. A disadvantage of the Mercury, Gemini, and Apollo programs was that
 - a. space capsules were too small to be useful
 - b. the programs did not accomplish their goals
 - c. the equipment was used only once
 - d. they never actually brought people into space
2. The space shuttles were designed
 - a. to be reusable
 - b. to carry equipment into space
 - c. to allow scientific experiments outside the Earth's gravity
 - d. All of the above
3. Every 45 minutes, shuttle crews would see
 - a. a sunrise or sunset
 - b. phases of the moon
 - c. a comet zoom by
 - d. the asteroid belt come into view
4. The space shuttle program was key to the construction of
 - a. a lunar landing site
 - b. the International Space Station
 - c. the Hubble telescope
 - d. the Kennedy Space Center
5. Of the five space shuttles that flew in orbit, how many can students visit in the U.S.?
 - a. all five
 - b. four
 - c. three
 - d. two
6. Besides being the first American female astronaut, Sally Ride was also
 - a. the youngest astronaut
 - b. the oldest astronaut
 - c. the last astronaut to travel in the space shuttle
 - d. the only astronaut to travel in the space shuttle
7. Mach is
 - a. the speed of light
 - b. the speed of sound
 - c. a parsec per day
 - d. 10,000 kilometers per hour
8. How many space shuttle missions were there in all?
 - a. 5
 - b. 75
 - c. 135
 - d. 155

11.2

THE INTERNATIONAL SPACE STATION



International Space Station

What Is the International Space Station?

The International Space Station (ISS) is the largest human-built structure in space. The main sections were built between 1998 and 2011, with equipment brought to space by space shuttles. There has been a crew aboard the space station since November 2000.

Where Is the International Space Station?

The ISS orbits Earth about 400 kilometers (248 miles) above the surface. You remember that orbiting objects must maintain a balance by being high enough and traveling fast enough to escape

being pulled back by the Earth's gravity. Like the space shuttle did, the ISS travels at a speed of 28,000 kilometers (17,500 miles) per hour. It completes one orbit every ninety minutes.

On a clear night, an observer on Earth is able to see the ISS without a telescope. It appears to be about as bright as the planet Venus moving through the sky. NASA has a smartphone app to help sky gazers locate the station.

Who Owns the International Space Station?

Costing about 100 billion dollars, the ISS is the most expensive single item ever constructed. The ISS is funded by fifteen nations. NASA



Endeavour Docked to ISS

(United States), Roscosmos (Russia), and the European Space Agency (European Union) contribute most of the funding. Other funds come from the Japanese Aerospace Exploration Agency and the Canadian Space Agency, and other countries. Crews are assigned based on a nation's contributions. There have been as few as two crew members and as many as thirteen. Since the space shuttles were retired in 2011, crew members have been transported to the ISS by Russian Soyuz vehicles. Two Soyuz vehicles are docked to the station in case it needs to

be evacuated in an emergency. However, this transportation has been staggeringly expensive. Russia has been charging the U.S. as much as \$90 million per seat to fly Americans to the ISS.

What Does the International Space Station Look Like?

The International Space Station is huge. Including the large solar array that supplies it with power, the ISS is larger than an American football field. It is modified frequently, and its final form is expected to weigh more than 420,000 kilograms (925,000 pounds). The pressurized human-habitable modules are larger than a five-bedroom house, and have a gym and two bathrooms.

What Does the International Space Station Test?

The International Space Station is perhaps the most unique science laboratory in the universe. Although you remember that gravity is always exerting a force, the ISS is in a **microgravity** environment, meaning one with extremely weak gravity. Since

the end of the last century, there have been an average of 150 scientific experiments being performed at the ISS during any six-month period. What do they look at?

Much of the early work involved **studying Earth from above**. Details of glaciers, farm fields, forests, cities, and pollution can be studied from space and analyzed by scientists on Earth. Those observations are still going on today.

Just as we used early Mercury and Gemini missions to teach us about lunar travel, scientists use the ISS to learn about the **effects of**



Mission Specialists on the International Space Station

prolonged time in space on the human body.

How can the human body endure the years it would take to complete a successful Mars mission? We know, for example, that the human body loses substantial bone and muscle mass, and these losses must be offset by weight training.

Scientists need to know if humans could bring or pick up contaminants from other planets. A

particularly hardy type of bacteria was exposed to the virtual vacuum and extreme temperatures of space, and yet survived. It could survive on Mars' surface if accidentally deposited. Could there be bacteria on Mars that would survive a space trip back to Earth? The International Space Station keeps finding questions that need answers.



11.2 LESSON REVIEW

➤ **Circle the letter next to the correct answer.**

1. What is NOT true about the International Space Station?
 - a. It is the largest human-built structure in space.
 - b. For safety reasons, it is not yet inhabited by human beings, but that is expected to change in the next decade.
 - c. It is the most expensive single item ever constructed.
 - d. The majority of its funding comes from the United States, Russia, and the European Union.
2. Materials to construct the International Space Station were transported by
 - a. Apollo capsules
 - b. communication satellites
 - c. The Hubble Space telescope
 - d. space shuttles
3. Since the space shuttle program was ended in 2011, what vehicles have transported crew to the International Space Station?
 - a. Russian Soyuz vehicles
 - b. One shuttle was kept in commission
 - c. The lunar module
 - d. Agena docking station
4. *Microgravity* means
 - a. No gravity
 - b. Extremely weak gravity
 - c. The same gravitational force as Earth
 - d. None of the above
5. What powers the International Space Station?
 - a. Petroleum brought from Earth
 - b. Nuclear power
 - c. Solar power
 - d. Natural gas brought from Earth
6. What have been observed continuously from the International Space Station since it was constructed?
 - a. Stars in other galaxies
 - b. Planetary systems in the Milky Way
 - c. Natural satellites (moons) of gas giant planets
 - d. Features of the Earth's surface
7. What can the International Space Station help scientists study in order to complete a successful Mars mission?
 - a. effects of prolonged time in space on the human body
 - b. the possibility of life forms surviving in space
 - c. Both of the above
 - d. None of the above
8. In addition to the United States and Russia, which nations help fund the International Space Station?
 - a. Japan
 - b. Canada
 - c. European Union
 - d. All of the above



11.3

SPACEX



The History behind the Founding of SpaceX

American businessman **Elon Musk** has long been fascinated by space travel and exploration. Around the year 2000, he wanted to place a greenhouse with seeds and a growing medium filled with nutrients on Mars. Had his plan worked, there would definitely have been life on Mars! At the time, only Russian rockets could have taken him there, but the price was so high that he decided against the plan. You remember

that the reason space travel has been so expensive is that most of the equipment is single use. Musk considered this problem more as a businessman than as a scientist.



Elon Musk

Missions and Goals of SpaceX

In 2002, Elon Musk founded **SpaceX** as a private aerospace company. The company's mission is to overcome the present drawbacks to continued space

travel. The company aims to do this in at least two ways. First, it seeks to lower costs, primarily by developing reusable spacecraft. Second, it would like to expand opportunities for the company to make money by opening up space travel to private individuals, companies, and even other countries. What does this mean?

Like the United States and our private companies, other countries and their companies wish to have access to space. They would like to place communications satellites in space and perform experiments in microgravity conditions. SpaceX performs these space-related services, and others, for a fee.

Elon Musk also has a far greater ambition. He would like to launch a manned mission to Mars and someday establish a colony there.

SpaceX Achievements

The Space Shuttle program formally ended in 2011. The next year, SpaceX used its Falcon 9 rocket to launch the SpaceX **Dragon** capsule into space. The Dragon capsule brought supplies to the International Space Station, where it docked. This was the first time a private company serviced the ISS. In 2015, SpaceX moved outside the Earth's orbit and launched the Deep Space Climate Observatory (DSCOVR), a weather satellite that operates beyond Earth's orbit.



Crew Dragon's Astronauts of its First Two Crewed Missions: Douglas Hurley, Robert Behnken, Michael Hopkins & Victor Glover



SpaceX Dragon

On May 30, 2020, SpaceX launched the Falcon 9 rocket and **Crew Dragon** spacecraft into space from the Kennedy Space Center in Florida. Two NASA astronauts were on board the Crew Dragon: Bob Behnken and Doug Hurley. This marked the first time NASA astronauts launched from the Kennedy Space Center since the space shuttle was retired in 2011. SpaceX is now partnering with NASA to provide transportation to the ISS.



Crew Dragon Interior

Twenty-two hours after lifting off from Florida's Kennedy Space Center, astronauts Bob Behnken and Doug Hurley walked—actually floated—into the International Space Station. Their SpaceX Crew Dragon spacecraft had performed well, with Behnken calling it a “slick vehicle.”

The Future of SpaceX

SpaceX has not only designed vehicles to carry humans and supplies to Earth's orbit, they are

also developing a plan to travel to Mars. The **Starship** spacecraft will be the most powerful launch vehicle in history. It will fly into Earth's orbit, where it will be refueled. The trip to Mars is expected to take six months. Starship will land on Mars and then take off from it to return to Earth when the mission is complete. Space travel has come a long way in just over six decades.

Artist's Rendering of a Base on Mars with Multiple Starships





11.3 LESSON REVIEW

➤ Write **T** if the statement is **true** and **F** if the statement is **false**.

1. _____ Elon Musk is a prominent scientist.
2. _____ Elon Musk paid the Russian Space Agency, Roscosmos, to place a greenhouse with seeds and a growing medium filled with nutrients on Mars.
3. _____ Elon Musk founded SpaceX as a private aerospace company.
4. _____ SpaceX seeks to lower the cost of space travel, primarily by developing reusable spacecraft.
5. _____ For a fee, SpaceX places communications satellites in orbit and helps nations and companies perform experiments in microgravity conditions.
6. _____ Elon Musk would like to launch a manned mission to Mars but does not wish to establish a colony there.
7. _____ The SpaceX Dragon capsule brought supplies to the International Space Station, where it docked.
8. _____ So far SpaceX has only worked within Earth's low orbit.
9. _____ May 2020 marked the first time NASA astronauts launched from the Kennedy Space Center since the space shuttle was retired in 2011.
10. _____ The Starship spacecraft will be the second most powerful launch vehicle in history.



SPACE SCIENCE for Young Catholics

Space Science for Young Catholics takes students on an excursion through the created universe, most especially our own solar system. Topics include the history of space exploration, Earth's moon and other solar system bodies, and a closer look at each planet. The worktext moves outside the solar system to interstellar and even intergalactic space.

Students receive an update about modern space advances, and a glimpse into possible future exploration. *Space Science for Young Catholics* highlights important contributions Catholics have made to mankind's quest to understand the universe.

This worktext was written *by Catholics for Catholic* homeschooled students, and is easy to use. It is filled with colorful graphics to excite interest and aid in understanding.

ISBN 978-1-60704-179-5 9 0 0 0 0 >



SETON PRESS

1350 Progress Drive
Front Royal, VA 22630
(540) 636-9990



P-SC06-32