# The Space Race Begins

**Session Time:** One, 50-minute session

## DESIRED RESULTS

### ESSENTIAL UNDERSTANDINGS

Appreciate the rich, global history of aviation/aerospace and the historical factors that necessitated rapid industry development and expansion. (EU1)

Develop interest in one or more aviation/aerospace career pathways and learn what is required to pursue future employment in the industry. (EU3)

### ESSENTIAL QUESTIONS

1. What was the United States trying to prove in the Space Race?

### LEARNING GOALS

**Students Will Know**

- The effects of the Cold War on the Space Race
- Why the Space Race began

**Students Will Be Able To**

- *Summarize* and *describe* events and innovations that were key to the advancement of space exploration. (DOK-L2)
- *Analyze* the significance of the Space Race. (DOK-L4)

## ASSESSMENT EVIDENCE

**Warm-up**
Students write what they know about U.S. space missions and explain why a country might want to be the first to conduct such missions.

**Formative Assessment**
Students will work in teams to create and perform a television news report about the launch of Sputnik I or Sputnik II.

**Summative Assessment**
Students write several paragraphs reflecting on why the Space Race began and how it impacted space exploration.

## LESSON PREPARATION

### MATERIALS/RESOURCES

- The Space Race Begins Presentation
- The Space Race Begins Student Activity (Going Further)

**Rocket Launch Activity (Going Further)**

- Scissors
- Clear Tape
- Paper
- Straw
- Digital scale
- Pencil
- Ruler
- Protractor
- Masking Tape
- Clay
- Tape Measure
- Other materials you would like to provide to your students

## LESSON SUMMARY

**Lesson 1: The Space Race Begins**
Lesson 2: To The Moon
Lesson 3: The Space Race Winds Down
Lesson 4: The Shuttle Program

To begin the lesson, the teacher will play a .wav file (Sputnik) and ask students what they think it might be. This will help students understand that space was an unknown entity at that point in history. Warm-up questions will be used to determine what understanding students may have about early space exploration.

Through video and a class presentation, students will learn how the Space Race started in the late 1950s. Students will understand the events that led up to the Space Race and the early battle between the United States and the Soviet Union to reach space first. The Soviets sent the first artificial satellite into space, followed by the first human, but the United States caught up when Neil Armstrong landed on the moon.

At the end of the lesson, students will write a paragraph reflecting on why the Space Race began and how it impacted space exploration. Their reflections should include ideas about global events that preceded the Space Race as well as the motivations of the United States and the Soviet Union. Students also should address how the Space Race drove innovation that allowed the United States to go to the moon.

If there is time, teachers have the option of extending student learning through a rocket activity. They will use engineering practices to design, build, test, modify and retest rockets made during class.

## BACKGROUND

Even before World War II, rockets were not a new idea. They had been around for hundreds of years, first recorded being used by the Chinese to thwart of a Mongol invasion. Throughout the next couple hundred years, rockets had little use beyond fireworks displays; however, their development didn't stop. Between the 16th and 19th centuries the first "step rocket" was developed. The "step-rocket" was a multi-stage system that propelled the rockets to altitudes not before reached by single stage systems.

Modern day rocket engine research in the United States was pioneered by Robert Goddard. In the early 1900s, Goddard, after much research with solid-propellants, determined that liquid propellants could be used to more effectively launch rockets. The development process was extensive, in that many of the components needed to support a liquid fuel system had to be developed from square one, but in 1926 Goddard's liquid fueled rocket took flight.

As development of rockets and rocket engines pushed forward, scientists would continue to develop and test new ideas. Different combinations of fuels and oxidizers would be used, finding the best combination for the application at hand. The goal was to discover the fuels that were the most power dense - that is the most power for a given weight of fuel.

Throughout the early years of rocket spaceflight, many other engine advancements would come to fruition as a result of the need for more control and capability such as engine restarts, pump fed systems, flight path control through the use of thrust vectoring, reusable engines, and variable thrust.

The chamber pressure of the rocket engine increased, as the required thrust need increased. From the low 50 - 100 psi, and even 350 psi of Goddards engines, scientist would increase the pressure to exceed 1,000 psi. These higher pressures drove development of newer materials and systems that would support increased loads.

While aeronautics rapidly advanced through World War II, the space race brought about new challenges. Objects in space fly differently, and they have to be designed differently to get there. The same four forces of flight that are considered with aircraft - lift, weight, thrust, and drag - are also present on a rocket but have a much different relationship. The majority of the aerodynamic forces on an aircraft are a result of air movement over the main wing and tail. For example, the force that opposes weight in an aircraft is lift, but on a rocket, thrust is the primary opposer to weight, and the lift created by control surfaces is used to control the flight path.

During World War II, the United States and the Soviet Union were allies, yet the relationship was tense. The United States prospered after the war and became the world's most powerful nation, with great advances in technology and innovation.

The progression and innovation of the United States' rocket program was challenged in the beginning keeping the United States one step behind the Soviet Union for much of the race. The country to truly reach space first was the Germans with the V-2 rocket, which was the first manmade object in space reaching an altitude of 176 km in 1944. After World War II many German rocket scientists were "relocated" by the Russian and American governments to their respective countries to ensure they were ahead in the space race, as well as the Cold War, recognizing the military and war fighting potential of space travel and rockets.

The first United States rocket/missile to be launched was Project Nike, developed as a line-of-sight anti-aircraft missile in 1946. The goal of the Nike system was to be able to shoot long range bombers out of the sky. Due to the complexity of targeting a bomber flying so high and fast, advanced targeting radars and systems were developed in parallel with the rocket system.

Not long after the Nike tests in 1947, General Chuck Yeager was the first human to achieve supersonic flight, in the rocket powered Bell X-1. This was a large achievement for rockets, as well as aeronautics. The research approaches used during the X-1 development would become the bedrock for subsequent research in the following decades.

To keep pace with Soviet developments, and in fear of Soviet ballistic missiles, the United States fast-tracked the PGM-17 Thor, the first operational American ballistic missile. The Thor program would eventually be the foundation for the Delta rocket program that is still used for space launch today.

On October 4, 1957, the Soviet Union shocked the United States when it launched Sputnik I into space. The size of a beach ball, it was the world's first artificial satellite and the first manmade object to be placed into Earth's orbit. It's beeping sounds could be heard on radios across the United States. This caused fear that the Soviets were spying on Americans, and distrust grew as the Soviets seemed intent on spreading communism. This also demonstrated to the United States that the Soviets could launch a rocket with a nuclear warhead, by this time the Soviets had also launched the first ICBM (intercontinental ballistic missile).

This turn of events launched the Space Race – a competition between the United States and the former Soviet Union for supremacy in space. The National Aeronautics and Space Administration (NASA) replaced the National Advisory Committee for Aeronautics (NACA) immediately after the launch of Sputnik I. At first, the United States struggled in its efforts when the Vanguard rocket barely lifted off the ground before exploding.

The first successful United States satellite, Explorer 1, was launched in January 1958 under the leadership of former German rocket scientist Wernher von Braun. It was around this time that the Langley Research Center became the home to the U.S. manned space program and the first NASA astronaut training center.

With the experience and technological advances that had been made in the late 1940's and throughout the 1950's, the 1960's saw the acceleration of the space race as we shifted from unmanned rockets to manned space flight and the goal of a lunar landing.

## MISCONCEPTIONS

Students may or may not know about the Cold War, or that Americans were not the first in space. They also may not know what the USSR was or stands for.

## DIFFERENTIATION

To support student motivation in the **ENGAGE** section of the lesson plan, allow students to make choices about which modalities to use for communicating messages effectively.

# LEARNING PLAN

## ENGAGE

**Teacher Material:** The Space Race Begins Presentation

**Slides 1-3:** Introduce the topic and learning objectives for today's lesson.

**Slide 4**: Conduct the **Warm-Up.**

First, play the .wav file of the Soviet's Sputnik I. Ask students what they think it might be. https://history.nasa.gov/sputnik/sputnik.wav

Explain to students that Sputnik was the world's first manmade object launched into space. Americans feared it. Sputnik could be seen from the ground, and the beeping could be heard on the radio as it passed overhead.

Collect student papers when they are done for grading. Take no more than 5 minutes to complete the Warm-Up. [DOK 3; identify, analyze]

**Warm-Up**

Have each student list three facts they know about space missions led by the United States. They may list different objects NASA has sent into space, such as satellites or telescopes, describe manned trips into space, or discuss the International Space Station. Ask students to write in complete sentences. Then have them write one sentence explaining why countries might have wanted to be the first to go to space.

## EXPLORE

**Teacher Material:** The Space Race Begins Presentation

**Slide 5**: Introduce the Space Race to students, showing a video.

- "The Great Space Race" (Length 6:45)

http://video.link/w/p8Ld

As students watch the video, ask them to consider and respond to the following questions. Have the students complete a Think-Pair-Share exercise once they have written down their responses.

**Questions**

1. Why did President Kennedy challenge the nation to go to the moon?

*President Kennedy challenged our nation to take the lead in space by being first to the moon even though we were not first to space. The U.S. felt pressure to "catch up" to Russia. President Kennedy knew it would be a technologically challenging feat because neither nation had a rocket powerful enough at the time.*

2. Is going to the moon an important endeavor today?

*There may be mixed responses about going back to the moon. Some may believe that it would be the best place to establish a colony and learn how to live away from Earth. Some may say we still have a lot to learn from the moon by having astronauts conduct scientific exploration there. Others may say that the moon is history and that it is better to explore other places.*

## EXPLAIN

**Teacher Material:** The Space Race Begins Presentation

**Slides 6-10:** Lead a discussion about how the Space Race started between the United States and the Soviet Union.

Although the Soviet Union and the United States were allies during World War II, there was tension between the two that grew after the war was over. The Soviets felt that the United States' delay entering World War II resulted in millions of Russian deaths leading to a sense of distrust after the war was over. Soviet expansion into Eastern Europe caused fear in many Americans that the Soviets were trying to take over the world.

## EXTEND

**Teacher Material:** The Space Race Begins Presentation

**Slide 11:** Conduct the **Formative Assessment** where students will create and perform a television news report about the launch of Sputnik or II.

Each group's presentation is worth up to 10 points for each student in the group. Take no more than 15 minutes of class time to complete this assessment. [DOK 4; create, dramatize]

**Formative Assessment**

Have students work in small groups to create and perform a brief television news report about the launch of Sputnik or Sputnik II. Reports should include a summary of the event, historical background, and reactions to it. Presentations may include roles such as a news anchor, a reporter on the street, and an everyday citizen reacting to the event.

## EVALUATE

**Teacher Material:** The Space Race Begins Presentation

**Slide 13**: Conduct the **Summative Assessment.**

Collect student work at the end of class. Use the 10-point Scoring Rubric for grading. Teachers may need to assign this assessment as homework. [DOK 3; analyze, interpret]

**Summative Assessment Scoring Rubric**

Follows assignment instructions

Postings show evidence of one or more of the following:

Explains events leading up to Space Race

Explains motivations of United States and Soviet Union in Space Race

Presents ideas thoughtfully and coherently

Contributions show understanding of course of the concepts covered in the lesson

Contributions show in-depth thinking including analysis or synthesis of lesson objectives

| Points | Performance Levels |
|---|---|
| 9-10 | Consistently demonstrates criteria |
| 7-8 | Usually demonstrates criteria |
| 5-6 | Sometimes demonstrates criteria |
| 0-4 | Rarely to never demonstrates criteria |

**Summative Assessment**

Have students write a paragraph reflecting on why the Space Race began and how it impacted space exploration. Their reflections should include ideas about global events that preceded the Space Race as well as the motivations of the United States and the Soviet Union. Students also should address how the Space Race drove innovation that allowed the United States to go to the moon.

## GOING FURTHER

**Student Material:** The Space Race Begins Student Activity (Going Further)

If there is additional time, have students do **The Space Race Begins Student Activity (Going Further).** Students will use what they have learned about the early history of the Space Race and NASA to build their own rockets. They will use engineering practices to design, build, test, redesign and retest their own rockets. This activity will require two sessions to complete.

Prior to having students begin the activity, share with them some background information about space flight that might be different to terrestrial flight. They might want to consider these factors when designing their rockets.

- Objects in space fly differently, and they have to be designed differently to get there.

- The same four forces of flight that are considered with aircraft - lift, weight, thrust, and drag - are also present on a rocket but have a much different relationship.

- The majority of the aerodynamic forces on an aircraft are a result of air movement over the main wing and tail. For example the force that opposes weight in an aircraft is lift, but on a rocket, thrust is the primary opposer to weight, and the lift created by control surfaces is used to control the flight path.

After the activity, be sure to have a class discussion on the straw rocket-launching experience. Discuss with students their thoughts on redesign, the modifications they made, and what strategies worked well for them. Encourage them to share what they may have done differently and what they learned in the process.

Students can experiment further with rockets: https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html

## STANDARDS ALIGNMENT

### NGSS STANDARDS

**Three-dimensional Learning**

- **HS-ETS1-1** - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - Systems and System Models
        - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.C: Optimizing the Design Solution
    - Crosscutting Concepts
        - none
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices

        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-4** - Use a computer simulation to model the impact of proposed solutions to a complex, real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
    - Science and Engineering Practices
        - Using mathematical and computational thinking
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Systems and system models

## COMMON CORE STATE STANDARDS

- **RL.9-10.7** - Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment.
- **RST.9-10.1** - Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **RST.9-10.2** -Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- **RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

## REFERENCES


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