Travel in Space

Lesson Development

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

INSTRUCTIONAL OBJECTIVES

Students will

- compare the structure and function of past, present and future launch vehicles;
- design and create their own two-stage balloon rocket models;
- compare the structure and function of past, present and future spacecraft;
- verify observations and deepen their understanding of rockets and spacecraft through Internet resources;
- create a timeline of greatest achievements in space exploration using a PowerPoint presentation or Website to organize their research and ideas;
- create and test a variety of model rockets and spacecraft; and
- design and justify a future space mission based upon research.

BACKGROUND

The first challenge to traveling in space is to break free from Earth's gravity, traveling fast enough to reach escape velocity. Rockets are powerful enough to do this and also carry people and equipment into space. Since 1957, rockets have launched artificial satellites to peer back at Earth, studying Earth's weather and increasing worldwide communications. Rockets also blast spacecraft beyond low-Earth orbit, exploring and studying planets, moons and space. Since 1961, rocket-powered spacecraft have carried astronauts and cosmonauts into low-Earth orbit and, by 1969, to the surface of the Moon. It's been over 35 years since the last astronaut walked the Moon's surface.

NASA's Vision for Space Exploration takes us back to the Moon and, someday on to Mars and beyond. New exploration launch systems and spacecraft will integrate new technologies with proven past successes.

Traveling through space begins with safe, simple and affordable launch vehicle systems. Cutting-edge science propels new space transportation.

ENGAGE

Discuss the image of the launch vehicles with your students, asking them to compare the vehicles and make connections between the structure of the vehicles and their function (TEACHER RESOURCE). Use a KWL (KNOW/WANT TO KNOW/LEARNED) chart to help organize what your students KNOW and WANT TO LEARN about traveling in space. These questions may help guide your discussion:

- What do you KNOW about traveling in space?
- What is the purpose of a launch vehicle?
- Compare the structure of each launch vehicle. How are they alike? How are they different?
- Which is the oldest launch vehicle? What criteria did you use to make this decision?
- How have the vehicles changed over time? What causes these changes?
- How does the structure of these vehicles support their function?
- How does technology shape space travel?
- What would you like to LEARN about space travel?

NASA's past, present and future launch vehicles shown to scale.

EXPLORE

Escaping Earth's gravity and traveling into space takes enormous amounts of energy. The thrust of the rocket must overcome Earth's gravitational pull on the total mass of the rocket and its load. One innovation to help solve this problem can be credited to the work of Johan Schmidlap, a16th-century fireworks maker. Experimenting with fireworks, Schmidlap attached small rockets to the top of larger rockets. When the larger rockets exhausted their fuel supply, these rocket shells

Travel in Space

Lesson Development *(continued)*

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

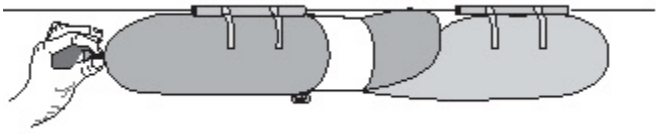
were dropped and the smaller rockets fired. Higher altitudes were reached with these simple two-stage rockets. NASA's use of two-stage and multi-stage rockets has taken spacecraft beyond Earth's gravity, to the Moon, past planets, and beyond.

During this EXPLORE activity your students will create a simple model of a two-stage rocket system. Once the lower stage has exhausted its propellants, that stage drops away, lightening the load and making the upper stages more efficient. The two stages are often mounted one on top of the other. In this alignment, the lowest stage is the largest and heaviest. In the space shuttle, the stages are side by side.

This activity is a modification of an activity found within NASA's *Rockets Educator Guide*. The entire guide can be found at ***http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html***.
The original lesson, *Balloon Staging*, can be found at
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Balloon_Staging.html.

A. Two-stage Rocket Model

1. Organize your students into teams of three or four. Gather these materials for each team:
   - Two long balloons
   - Two plastic straws
   - Masking tape
   - Two clothespins
   - Nylon monofilament fishing line (any weight)
   - One foam cup
   - Scissors
   - Design Sheet (STUDENT HANDOUT)
2. Set up a launch track for each group of students. To do this, thread fishing line through the two straws and stretch the fishing line between two chairs that span the widest side of the room. The line should be tight and about or below waist height. Caution students to be careful moving around the rocket launch paths.
3. Demonstrate for your students how to cut the foam cup in half so that the lip of the cup forms a continuous ring.
4. Ask your students to stretch the balloons by pre-inflating them. Show them how to inflate the first balloon about three-fourths full of air and hold the neck of the balloon tight. Demonstrate how they'll pull the neck of the balloon through the foam ring, twist the balloon neck and clamp it shut with one of the clothespins.
5. Demonstrate how students will inflate the second balloon with the front end of the first balloon extended a short distance through the foam ring. As the second balloon inflates, it will press against the twisted neck of the first balloon and put pressure on the first balloon to keep it clamped shut.
6. Show your students how to use the second clothespin to clamp the neck of the second balloon so that air doesn't escape.
7. Demonstrate how to tape each balloon to one of the straws on the fishing line. When taped to the straws, the balloons should be parallel to the fishing line.



Two-stage Balloon Rocket

8. Ask your students to predict what will happen when you remove the clothespin from the first balloon and untwist the neck of the balloon.
9. Remove the clothespin from the second balloon, but hold the nozzle of the balloon closed until students predict what they think will happen when you release the second balloon.
10. Lead a rocket countdown with your students and then release the second balloon.
11. If all goes as planned, the escaping air from the second balloon will propel both balloons along the fishing line. When the second balloon runs out of air, the nozzle of the first balloon will be unblocked so that air may now escape from the first balloon.
12. Ask your students to make predictions about how far one balloon might travel on its own. Lead a discussion with your students about ways to maximize the distance the balloons travel.

Travel in Space

Lesson Development *(continued)*

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

13. Distribute design sheets to each group and ask students to work together to design their own two-stage rocket. Challenge the students to improve upon the system you've just demonstrated.
14. Lead your students in a discussion about ways to improve this system. Discuss how this is a model of a two-stage rocket. Suggest that some students try to create a side-by-side multi-stage system.

B. A Trio of Spacecraft

1. Group your students into teams of three.
2. Randomly assign each team a Task Card (STUDENT RESOURCE). Three spacecraft are listed on each Task Card. These spacecraft all have similar "functions." However, they represent past, present, and future designs. The task cards also identify appropriate Websites for research. The Website links are interactive. If possible, allow students to work from the PDF file on a computer that has Internet access.
3. Each person in the team will research ONE of the spacecraft. Use these general questions to help guide your students' research:
   - Describe the "structure" of the spacecraft. Based upon what you observe, what might be the "function" of this spacecraft?
   - Is this a past, present or future spacecraft? By what criteria do you base your decision?
   - What "science questions" might be answered by this spacecraft's mission?
4. Once students have completed their research, ask them to create a "timeline" to help organize their research.

EXPLAIN

A. Use these general questions to help lead a discussion following the EXPLORE experiences:

- Sir Isaac Newton is quoted to have said, "If I have seen further than others, it is because I have stood on the shoulders of giants." How have past missions helped present and future missions "see further?"
- How has technology shaped our ability to explore and travel through space?

B. Share these resources with your students to help deepen their understanding of launch vehicles and spacecraft.

1.) Rockets

- World Book@NASA gives basic information about rockets. ***http://www.nasa.gov/worldbook/rocket_worldbook.html***
- View a 30-minute NASA CONNECT video, *Rocket to the Stars*, to learn more about two innovative propulsion programs. ***http://connect.larc.nasa.gov/programs/2004-2005/rocket_stars/***
- A brief history of rockets can be found at ***http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Brief_History_of_Rockets.html***
- Ask your students to discover more about the Ares Launch Vehicles. ***http://www.nasa.gov/mission_pages/constellation/ares/index.html***
- Share this NASA video segment with your students to help reinforce the concept of gravity and how Newton's three laws help rockets overcome the force of gravity. ***http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Using_Math_and_Science_to_Plan.html***
- This *Launch Vehicle Family Album* contains photos and descriptions of historic rockets, today's rockets and concept designs that might be used in the future. ***http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Launch_Vehicle_Family_Album.html***

2.) Space Travel

- Your students may review human space travel at the following NASA Websites: ***http://spaceflight.nasa.gov/history/*** ***http://starchild.gsfc.nasa.gov/docs/StarChild/space_level2/travel.html***

ELABORATE

A.) Based upon the research that your students have completed, ask them to answer this question:

- What have been some of the greatest achievements in space exploration?

B.) Take your students to this Space Exploration Timeline ***http://www.seasky.org/spacexp/sky5d.html*** to see if they agree that the events posted on this timeline represent significant events in space exploration.

Travel in Space

Lesson Development *(continued)*

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

C.) Challenge your students to create their own "timeline of greatest space exploration achievements" by using either a PowerPoint presentation or Web Page. Organize your class into eight groups, each group assigned to one of the following time decades:

- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2020

Each group will be tasked with determining the top five space exploration achievements of that decade. The groups tasked with the decades beginning with 2010 and 2020 may look ahead and predict the top five space exploration achievements for those decades. Encourage your students to return to NASA's Solar System Exploration Website for information about space missions. ***http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=1950&EndYear=1959***. Be sure your students can justify their choices for each decade.

D.) Students may create their timeline as:

- a PowerPoint presentation
- a Web Page

Before you begin, you may want your students to use a storyboard to help them plan and organize their projects. One example of a storyboard can be found at ***http://nortellearnit.org/resources/Handouts/***

It may also be helpful for your students to review these Nortel LearniT video tutorials for help in creating their PowerPoint presentations and Web pages. They can be found at ***http://nortellearnit.org/technology/PowerPoint_Presentations/*** and ***http://nortellearnit.org/technology/Webpage_Creation/***
Your students may want to use images found during their review of Websites in the EXPLORE and EXPLAIN sections of this lesson. They can either download those pictures to the hard drive, or save the URL as a "Favorite" in the Web browser.

Encourage your students to put a descriptive title screen, credits and references at the end of the project.

Please remind students to use only images that they have permission to include. Review copyright and copywrongs by watching the Nortel LearniT video tutorial at ***http://nortellearnit.org/technology/Digital_Ethics/***

EVALUATE

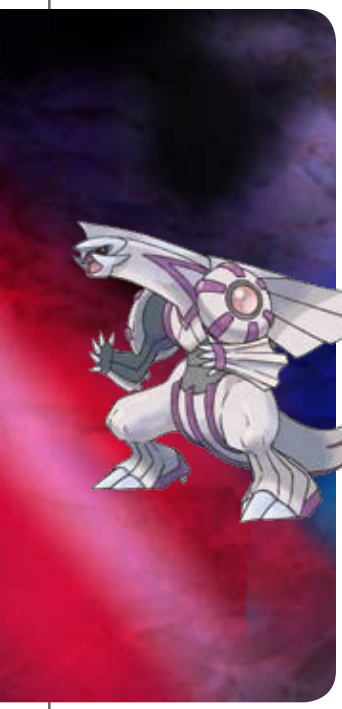
Through discussion and the results of the EXPLORE experience, determine if your students have an accurate and deeper understanding of the structure and function of various launch vehicles and spacecraft.
Complete the K/W/L chart started during the ENGAGE experience.

To evaluate PowerPoint presentations and Web pages, use these rubrics found at the Nortel LearniT site:

- PowerPoint Presentations
  http://nortelearnit.org/resources/Handouts/
- Web pages (Webpage Creation and Website Project)
  http://nortellearnit.org/resources/Handouts/

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)



EXTEND

These activities may be used to extend or continue your students' exploration.

A. EXPERT INTERVIEWS - WHAT DO YOU WONDER NOW?

What are your students wondering now that they've learned more about traveling through space? Generate a list of questions that your students might ask "the experts" from NASA, the National Institute of Aerospace and research universities. Submit this list following the link on this Website. Several questions from all submitted will be used in video interviews with "experts" and posted to this site.

B. Challenge your students to imagine that they are working for NASA and given the task to design a new spacecraft for a future space mission. Ask your students to consider these questions in their design:

- How will this spacecraft escape Earth's gravity?
- What type of energy will first launch this craft and then continue to propel the craft?
- What will be the science merit of this craft? What will be the focus of the mission?
- What new technology will help this craft accomplish its tasks?
- Is this a crewed or un-crewed mission?

Once your students have identified the focus of their mission, challenge them to create a PowerPoint presentation or Website to organize their thinking. If your students choose, they could also use another tool like Flash or Squeak to present their mission plan. Ask your students to share their presentations and then discuss the benefits and possible negative consequences associated with each mission.

C. With the help of an astronaut, your students can see whether they could plan the Dawn Mission or STS-120 Mission through NASA's Mission Planner, ***http://www.nasa.gov/externalflash/MissionPlanner/MissionPlanner.html***

D. Organize your students to create their own Starship 2040. Starship 2040 is a traveling exhibit, created by NASA, to help students imagine what it might feel like to travel through space. Find out more about NASA's Starship 2040 at ***http://www.nasa.gov/audience/forstudents/5-8/features/F_Starship_2040.html***

E. Lockheed Martin is designing, developing and building the Orion Crew Exploration Vehicle (CEV). This vehicle will replace the space shuttle. Encourage your students to find out more about the CEV through these Websites:

- Lockheed Martin Website
  http://www.lockheedmartin.com/products/Orion/index.html
- SPACE.com – *Lockheed Martin to Build NASA's Orion Spaceship*
  http://www.space.com/news/060831_nasa_cev_contract.html
- NewScientistSpace – *NASA to Boldly Go … with Lockheed Martin*
  http://space.newscientist.com/article/dn9895
- Astronomy – *Lockheed Martin to Build Orion*
  http://astronomy.com/asy/default.aspx?c=a&id=4502

F. Your students might enjoy making some of these models:

- Apollo Paper Model
  http://lunar.arc.nasa.gov/education/activities/active24a.htm
- Mars Pathfinder Spacecraft
  http://marsprogram.jpl.nasa.gov/MPF/mpf/education/cutouts.html
- Mars Odyssey
  http://mars.jpl.nasa.gov/classroom/odyssey_paper_model.pdf
- Paper Straw Rockets
  http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Paper_Rockets.html
- Bottle Rocket Launcher
  http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Bottle_Rocket_Launcher.html
- Balloon-powered Rocket
  http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rocket_Racer.html
- Balloon-powered Rocket and Paperclip Payload
  http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rocket_Transportation.html

Travel in Space

Teacher Resource

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

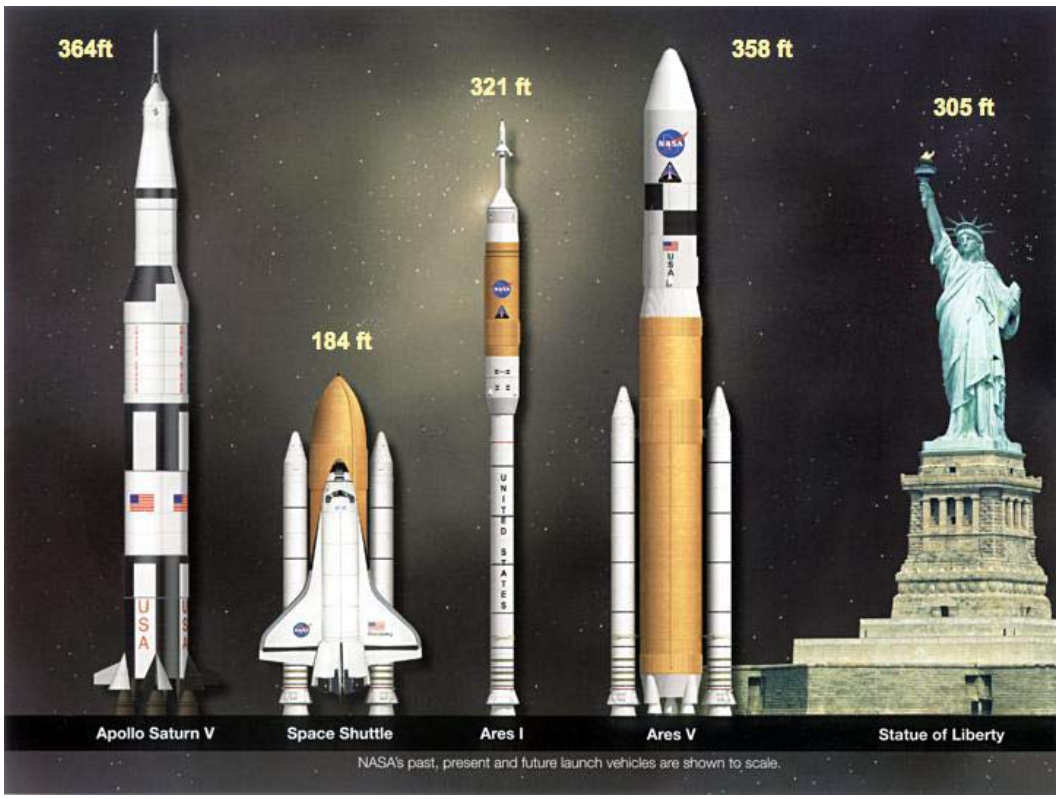


Image: NASA
NASA's past, present and future launch vehicles shown to scale.

Travel in Space

Student Handout

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

Design Sheet

Design a rocket that has at least two stages. In the space below, describe what each stage will do. Do not forget to include a place for payload and crew.

Top View

Description

Your Name: _____

Rocket Name: _____

Side View

Travel in Space

Student Resource

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

TASK CARD 1:

You will become experts on spacecraft that explore the surface of Mars.

Spacecraft to study:

- Mars Viking
- Spirit
- Mars Science Laboratory

During your research, be sure to look for information that will help answer these questions:

- Is this a past, present or future spacecraft? By what criteria do you base your decision?
- What is the "structure" of the spacecraft? Based upon what you observe, what might be the "function" of this spacecraft?
- What "science questions" might be answered by this spacecraft's mission?

This Website will help guide your research. This site will connect you to other NASA sites related to the spacecraft you're studying

- NASA's Solar System Exploration Website: Missions
  http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=1950&EndYear=1959

TASK CARD 2:

You will become experts on spacecraft that flyby planets within our solar system.

Spacecraft to study:

- Voyager
- Pioneer
- New Horizons

During your research, be sure to look for information that will help answer these questions:

- Is this a past, present or future spacecraft? By what criteria do you base your decision?
- What is the "structure" of the spacecraft? Based upon what you observe, what might be the "function" of this spacecraft?
- What "science questions" might be answered by this spacecraft's mission?

This Website will help guide your research. This site will connect you to other NASA sites related to the spacecraft you're studying

- NASA's Solar System Exploration Website: Missions
  http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=1950&EndYear=1959

Travel in Space

Student Resource

GRADES 6-8

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

TASK CARD 3:

You will become experts on several space observatories.

Spacecraft to study:

- Chandra
- Hubble
- James Webb

During your research, be sure to look for information that will help answer these questions:

- Is this a past, present or future spacecraft? By what criteria do you base your decision?
- What is the "structure" of the spacecraft? Based upon what you observe, what might be the "function" of this spacecraft?
- What "science questions" might be answered by this spacecraft's mission?

This Website will help guide your research. This site will connect you to other NASA sites related to the spacecraft you're studying

- NASA's Solar System Exploration Website: Missions
  http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=1950&EndYear=1959

TASK CARD 4:

You will become experts on spacecraft that explore deep space.

Spacecraft to study:

- Deep Space
- Dawn
- Kepler

During your research, be sure to look for information that will help answer these questions:

- Is this a past, present or future spacecraft? By what criteria do you base your decision?
- What is the "structure" of the spacecraft? Based upon what you observe, what might be the "function" of this spacecraft?
- What "science questions" might be answered by this spacecraft's mission?

This Website will help guide your research. This site will connect you to other NASA sites related to the spacecraft you're studying

- NASA's Solar System Exploration Website: Missions
  http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=1950&EndYear=1959