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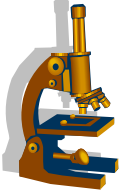
“NASA Paves Way for Commercial  
Space Exploration”  
Science Lesson Plan

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is a feature of

the.News

**A daily news broadcast for High School and Middle School students  
now under development by MacNeil/Lehrer Productions**



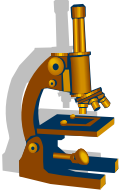
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Segment 5:  
“NASA Paves Way for Commercial Space  
Exploration”  
Science Curriculum

**Table of Contents**

Letter to the Educator.....	1
“NASA Paves Way for Commercial Space Exploration” Science Curriculum.....	2



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Winter, 2011

Dear Educator,

*the.News* online video reports for *the.Sci* provide middle and high school students with a valuable exercise in science with this **5:40** minute segment on “NASA Paves Way for Commercial Space Exploration” at [www.pbs.org/newshour/thenews/thesci](http://www.pbs.org/newshour/thenews/thesci) Correspondent, Antonio Neves reports on NASA’s plans to shift space exploration from the government to a public/private partnership. Lesson plans for science (*the.Sci*) and social studies (*the.Gov*) are available to support this video in the “For Educators” section of the website. All videos and curricula have been informed by *the.News* instructional design that can be found on the website [www.pbs.org/newshour/thenews](http://www.pbs.org/newshour/thenews). The curriculum includes content-based standards, discussion questions, student activities, vocabulary and primary reference sources. A complete transcript of each video report includes time codes to assist in isolating specific segments of the video and to augment the instruction of media literacy and multimedia production. All of this material is presented as options to fit teachers’ instructional needs.

References to Larry Bell’s “The 12 Powerful Words” are highlighted in **bold** in the lesson plans and in the “thought starter” questions on the home page and educator’s page, and in the transcript (to denote where they are used in the video segment).

We have also added general topics to correlate to the lessons and video as well as concept based standards with conceptual lens and enduring understanding.

We welcome our partners at the Omaha Public Schools who have joined *the.News* in the second year of a special pilot project. We have also developed a new authoring tool for students called *YOU.edit* which gives students an online tool to remix the content of *the.News* reports, so they can create their own multimedia presentations. This editing tool can be found by clicking on the *YOU.edit* button on the home page of the website. Currently used with our OPS teacher consultants it is password protected so that it can serve as a viable educational asset that allows classroom teachers to assign multimedia projects within the security and content safety of *the.News* website.

Answers to **student “thought starter”** questions listed below the video.

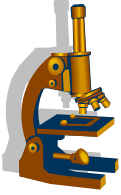
#1 gas station

#2. It’s risky, expensive, difficult, and takes a lot of money

#3. Po talks about new ideas, new money and new people who are excited with “fire in the belly.” Wong wants to see his own “instrument” get into space and feels his own personal growth and knowledge expanding.

Sincerely,

Karen W. Jaffe  
Manager, Education Projects, *the.News*  
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## Private Space Flight

This lesson was designed to support *the.News* video “NASA Paves Way for Commercial Space Exploration”  
The video can be found online at [www.pbs.org/newshour/thenews/thesci](http://www.pbs.org/newshour/thenews/thesci)

### Omaha Public Schools Standards

<http://www.ops.org/District/LinkClick.aspx?fileticket=Hbqyrrg2ydM%3d&tabid=912&mid=2006>

#### Grade 8

#### Physics

**Standard 6.** Examine the components of our solar system.

**Conceptual Lens:** Change

**Enduring Understanding:** Advances in technology have changed our understanding of the universe.

#### Grade 9-12

#### Physics

**Standard 4.** Investigate motion and technological design.

### Grade Level:

Grades 7–12

### Content Areas:

Science

### Key Concept(s):

Students will **compare** and **contrast** the way

NASA has conducted space missions in the past with proposed missions using private contractors. They will conduct research to learn more about proposed public-private partnership missions. And they will **formulate** a proposal detailing one such plan and how it will work.

### Objectives:

Students will

- Be able to define a public-private partnership.

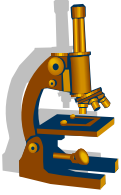
- **Compare** and **contrast** public and private space missions.
- **Analyze** one proposed private mission.
- **Analyze** the benefits and drawbacks of public and private space missions.
- Present a proposal that **supports** how one private mission might work.
- **Evaluate** proposed plans from private space contractors.

### Key Vocabulary:

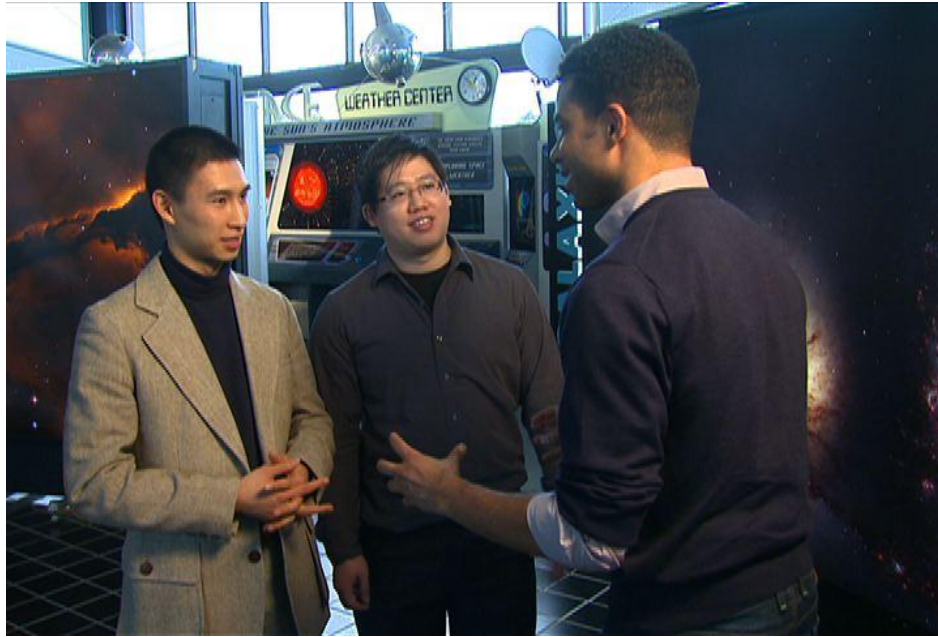
- **International Space Station (ISS):** Research station in orbit around Earth that was developed by space agencies from Canada, Europe, Japan, Russia, and the United States. Crew members from these nations maintain the station and conduct research there.
- **Proposal:** a plan for carrying out a task. Companies often submit proposals to other companies and government agencies that outline how a task can be completed and how much it will cost.
- **Public-private partnership:** an endeavor in which government agencies and private companies work together
- **National Aeronautics and Space Administration (NASA):** U.S. agency tasked with space exploration and research
- **Space shuttle:** Reusable vehicle that carries people and supplies into space and back. There have been 132 shuttle missions since 1981. Crew aboard the space shuttle have conducted scientific research, made satellite repairs, and carried crew and supplies to the International Space Station.

Sources: All my own definitions derived from New Oxford American Dictionary and various Web sources.





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(NASA Interns Sean Po of Harvard & Mark Wong of UMBC)

McRel ([www.mcrel.org](http://www.mcrel.org))

Science

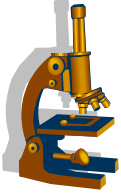
Level III (Grades 6–8)

**Standard 5. Understands the composition and structure of the universe and the Earth's place in it.**

- Knows characteristics and movement patterns of the planets in our Solar System (e.g., planets differ in size, composition, and surface features; planets move around the Sun in elliptical orbits; some planets have moons, rings of particles, and other satellites orbiting them)
- Knows that gravitational force keeps planets in orbit around the Sun and moons in orbit around the planets

**Standard 13: Understands the scientific enterprise.**

- Knows ways in which science and society influence one another (e.g., scientific knowledge and the procedures used by scientists influence the way many individuals think about themselves, others, and the environment; societal challenges often inspire questions for scientific research; social and economic forces strongly influence which science research programs are pursued and funded)



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## **Time Frame:**

Four to five class periods, one to introduce the activity and begin research, two to three for conducting research and producing the SketchUp proposal, and one to share proposals and wrap up

## **Materials:**

- Video Link: <http://www.pbs.org/newshour/thenews/thesci/>
- Computer and Internet access
- Copies of the handout Private Plans for Space Flight for each student
- Paper and pens

## **Lesson Topics:**

- Private Space Flight
- NASA Missions
- Public-Private Partnership
- Human Space Flight

## **McRel**

**Science** ([www.mcrel.org](http://www.mcrel.org))

**Level IV (Grades 9-12)**

**Standard 3: Understands the composition and structure of the universe and the Earth's place in it.**

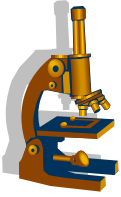
- Knows ways in which technology has increased our understanding of the universe (e.g., visual, radio, and x-ray telescopes collect information about the universe from electromagnetic waves; space probes gather information from distant parts of the Solar System; mathematical models and computer simulations are used to study evidence from many sources in order to form a scientific account of events in the universe)

**Standard 13: Understands the scientific enterprise**

- Understands that individuals and teams contribute to science and engineering at different levels of complexity (e.g., an individual may conduct basic field studies; hundreds of people may work together on a major scientific question or technological problem)

- Understands that science involves different types of work in many different disciplines (e.g., scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations; many scientific investigations require the contributions of individuals from different disciplines; new disciplines of science, such as geophysics and biochemistry, often emerge at the interface of older disciplines)

- Knows that creativity, imagination, and a good knowledge base are all required in the work of science and engineering



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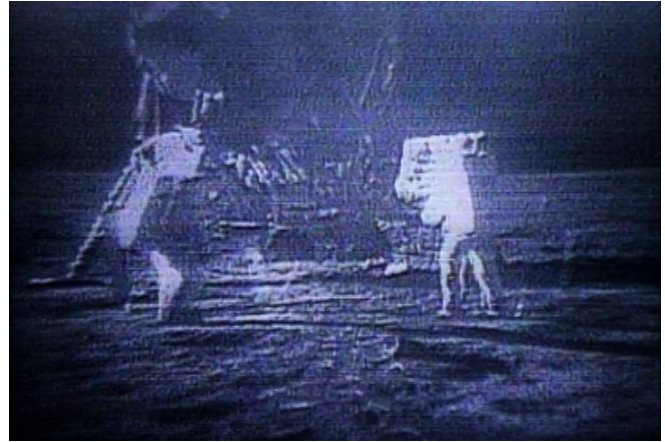


## **Background:**

Until the last several years, space was the domain of government-run programs. It was the Soviet government that launched Sputnik in 1957 and put a person in orbit in 1961. The United States space program, the National Aeronautics and Space Administration (NASA), landed people on the Moon in 1969 and developed the space shuttle. Since 1981, the shuttle has been NASA's workhorse, ferrying crew back and forth from the International Space Station (ISS), carrying crews to repair orbiting satellites, and conducting research. But the last shuttle mission is set for April of 2011, and President Obama has called for private, commercial businesses to develop the next generation of vehicles to take over some of these missions.

The ever-increasing cost of space missions is one reason for this new policy. Shifting research, development, and responsibility for space missions to private enterprise saves the government money and takes advantage of the resources, creativity, and innovation of myriad companies. Different companies will compete in developing new space mission technologies that will hopefully be less expensive, more reliable, and implemented more quickly than in the past.

This means that there may be many options for how a mission might be carried out.



Apollo 11 Moonwalk

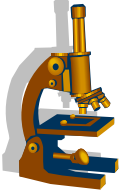
On December 8, 2010, A Falcon 9 rocket carried the Dragon spacecraft into orbit from Cape Canaveral. The craft orbited Earth, reentered the atmosphere, and splashed down in the Atlantic Ocean. Space Exploration Technologies (SpaceX), a California company formed by PayPal founder Elon Musk, built the rocket and craft. Rather than requiring the resources of an entire country, this achievement was made with 1,200 people who work at SpaceX. NASA awarded SpaceX a contract to carry out 12 missions to resupply the ISS. Another company, Orbital Sciences, will also fly eight similar missions for NASA.



Virgin Galactic – VSS Enterprise

The two companies are using similar—and familiar—technology to accomplish the missions. Rather than employing a space shuttle-type vehicle, the companies use rockets that carry a craft into space that can dock with the ISS then return to Earth. While SpaceX's Dragon craft can return crew to Earth, the Cygnus craft from Orbital will not be manned and is meant to safely disintegrate over the ocean upon reentry. These designs are not that different from those that carried astronauts to

space and the Moon and back. According to the Associated Press December 9, 2010, article "Company Is First To Return Spacecraft from Orbit," the space shuttle "proved extremely complicated, expensive, and



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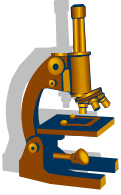
vulnerable to damage. Many engineers believe Apollo-style capsules will be cheaper, safer, and capable of a wider variety of missions.”

SpaceX and Orbital Sciences aren't the only private companies working with NASA or aiming for the stars. The Commercial Spaceflight Federation is comprised of more than 30 businesses and organizations. In addition to contracting with NASA for commercial crew and cargo (C3P) work, member groups seek to establish and support ventures in space tourism and even a private-sector space station. On another front, NASA's Kepler space telescope detected what is believed to be the smallest planet discovered so far outside our solar system on January 11, 2011. Orbiting a star 560 light-years away, the new planet, dubbed Kepler-10b, is 40 times larger than Earth. Because of the planet's high surface temperature, it's doubtful that it would support life.

It's an exciting time for the aerospace industry and a perfect opportunity for your students to learn about the science, technology, engineering, and math that go into space flight.



Virgin Galactic – VMS Eve flying over New Mexico Spaceport

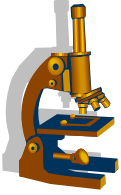


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## Lesson Plan:

1. Students view the *the.News* segment on NASA's public-private space flight partnership. You may also wish to have students view images and a video of the December 8, 2010, SpaceX mission at this page: <http://www.spacex.com/updates.php>.
2. Explain that NASA is pioneering a new way to work in and explore space by partnering with private companies to carry out missions for them. This is different from the way missions have historically been done, that is, carried out solely by the government agency. Ask students to brainstorm reasons why NASA is shifting to a public-private partnership strategy. Do they think the space program will benefit from the new strategy? Why or why not?
3. Students are to conduct research into some of the different methods proposed by various private companies and prepare a proposal that outlines each method and why it is a good choice for NASA.
4. To present their reports, students will use Google SketchUp, the free 3-D modeling software that enables students to collaborate on a project. Go to <http://sketchup.google.com/> to download and find out more about SketchUp. Allow students time to familiarize themselves with SketchUp's capabilities and interface. You can find video tutorials on using SketchUp at <http://sketchup.google.com/intl/en/training/videos.html>. If you do not have adequate computer or Internet access, students can still do research and present reports in written and printed form.
5. Divide students into four groups, and give each student a copy of the student handout. Each group will research one of four private companies vying for the chance to provide services to NASA. Answering the questions on the handout will help students focus their research. At the conclusion of research, students will **formulate** a proposal about their group's company and mission plans. Integral to the proposal will be a SketchUp model of the vehicle or craft and how it functions. The proposal should be written as if it were being presented to NASA in favor of the company's bid. Assign each group one of the following companies:
  - Boeing: [http://www.boeing.com/defense-space/space\\_exploration/index.html](http://www.boeing.com/defense-space/space_exploration/index.html)
  - Orbital Sciences: <http://www.orbital.com/HumanSpaceExplorationSystems/COTS/>
  - Sierra Nevada Corporation's SpaceDev: [http://www.spacedev.com/spacedev\\_advanced\\_systems.php](http://www.spacedev.com/spacedev_advanced_systems.php)
  - SpaceX: <http://www.spacex.com/>
6. After students have completed their proposals, each group should present its pitch to the entire class. Afterwards, wrap up with these discussion questions:
  - How are the private mission plans different from the way NASA has carried out such missions in the past?
  - Do students think the private plans are better, worse, or about the same as NASA missions?
  - What are pros and cons of each of the four proposals?
  - Might more than one approach work?
  - Which group presented the best proposal?
  - Which company or companies do students think should be awarded a NASA contract and why?



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## Extension:

- NASA's public-private partnership plans don't stop with supporting the ISS. Exploring our solar system and developing new technologies to do this are on the drawing board. Have students look into proposed missions and their goals. A good place to start is NASA's A New Space Enterprise: [http://www.nasa.gov/exploration/new\\_space\\_enterprise/home/index.html](http://www.nasa.gov/exploration/new_space_enterprise/home/index.html). Students can select a program and read more about it. Get together as a class to discuss what they find.

## **Partnership for 21st Century Skills** (<http://www.21stcenturyskills.org/>)

### *Core Subjects and 21<sup>st</sup> Century Themes*

- English, reading or language arts
- Arts
- Science
- Financial, economic, business and entrepreneurial literacy

### *Creativity and Innovation*

- Develop, implement and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas

### *Critical Thinking and Problem Solving*

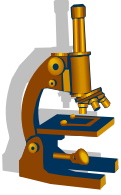
- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems
- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis
- Identify and ask significant questions that clarify various points of view and lead to better solutions

## Assessment:

Ask students to create a chart **summarizing** the pros and cons of each of the four proposals. After completing the chart, ask them to **evaluate** their findings and come up with a written recommendation for NASA.

## Resources:

- NASA's Commercial Crew and Cargo: <http://www.nasa.gov/offices/c3po/home/index.html>
- NASA Educator Ambassador Program
- [http://www.nasa.gov/audience/foreducators/5-8/features/F\\_NASA\\_Educator\\_Ambassador\\_Program.html](http://www.nasa.gov/audience/foreducators/5-8/features/F_NASA_Educator_Ambassador_Program.html)
- Commercial Spaceflight Federation: <http://www.commercialspaceflight.org/>
- Company Is First To Return Spacecraft from Orbit by the Associated Press. NPR. December 9, 2010. <http://www.npr.org/templates/story/story.php?storyId=131888347>



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- Space: The Final Frontier of Profit? by Peter Diamandis. The Wall Street Journal. February 13, 2010. <http://online.wsj.com/article/SB10001424052748703382904575059350409331536.html>
- President Barack Obama on Space Exploration in the 21st Century. April 15, 2010, White House press release. [http://www.nasa.gov/news/media/trans/obama\\_ksc\\_trans.html](http://www.nasa.gov/news/media/trans/obama_ksc_trans.html)
- Google SketchUp: <http://sketchup.google.com/>

**Activity Designer:** Rhonda Lucas Donald is a freelance writer and educational consultant.

## **Partnership for 21st Century Skills** (<http://www.21stcenturyskills.org/>)

### *Communication and Collaboration*

- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
- Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
- Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

### *Information Literacy*

- Access information efficiently (time) and effectively (sources)
- Evaluate information critically and competently
- Use information accurately and creatively for the issue or problem at hand
- Manage the flow of information from a wide variety of sources

### *ICT Literacy*

- Use technology as a tool to research, organize, evaluate and communicate information
- Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy

