



Apollo capsule (Image: NASA)

INSTRUCTIONAL OBJECTIVES

Students will

- decompose a geometric shape into smaller parts;
- apply the appropriate formulas for various geometric shapes;
- verify observations and deepen their understanding of crew exploration vehicles through Internet resources; and
- compare the structure and function of an Apollo capsule (Apollo 11) with the Orion Crew Exploration Vehicle (CEV).

BACKGROUND

"...I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth ... No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space ... it will not be one man going to the moon ... it will be an entire nation. For all of us must work to put him there."
President John F. Kennedy, May 25, 1961

(Audio excerpts from Kennedy's speech can be downloaded at: <http://www.jfklibrary.org/Historical+Resources/Archives/Reference+Desk/Speeches/JFK/003POF03NationalNeeds05251961.htm>)

President Kennedy's vision became reality on July 20, 1969, when Apollo 11 commander Neil Armstrong stepped onto the Moon's surface. With, "this one small step for man; one giant leap for mankind," Neil Armstrong became the first man to set foot on the Moon.

On January 14, 2004, 34 years after Apollo 11's historic mission, President George W. Bush announced a bold new vision for NASA and the future of space exploration. President Bush's vision for space exploration includes:

"...completing the International Space Station, developing a new exploration vehicle... and extending human presence across the solar system starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations."

NASA's Constellation Program represents the future and the next generation of spacecraft for human exploration. The Orion spacecraft will carry a new generation of explorers back to the Moon, Mars, and beyond. As part of the Constellation Program, Orion will succeed the space shuttle as NASA's primary vehicle for human space exploration.



Earth (Image: NASA)



"Black Eye Galaxy" M64
(Image: NASA)

NATIONAL EDUCATION STANDARDS National Science Education Standards

- **Science as Inquiry**
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
- **Physical Science**
Motions and forces
- **Earth and Space Science**
Energy in the earth system
- **Science and Technology**
Abilities of technological design
Understandings about science and technology
- **Science in Personal and Social Perspective**
Natural and human induced hazards
Science and technology in local, national, and global challenges

National Educational Technology Standards

- Creativity and Innovation
- Communication and Collaboration
- Research and Information Fluency
- Critical Thinking, Problem-solving & Decision Making
- Digital Citizenship
- Technology Operations and Concepts

National Council of Teachers of Mathematics

- Algebra
- Geometry
- Measurement
- Problem Solving
- Communication
- Connections
- Representation



Apollo capsule (Image: NASA)

ENGAGE

Use the Discovery Now audio clip, Apollo 11, to discuss with your students their understanding of this mission and NASA's plans to return to the Moon. The clip can be found at:

<http://www.discoverynow.us/2008/nasa50.html>

These questions can help guide your discussion:

- What materials and observations did Buzz Aldrin and Neil Armstrong gather during their time on the Moon?
- How did this mission affect future space exploration?
- What do you know about NASA's plans to return to the Moon?

EXPLORE

Space exploration incorporates new and existing technology to continually evolve and change. Orion's improved, larger blunt-body is similar to the shape of the Apollo capsule. With an outside diameter of 5 meters, Orion will have about three times the volume of an Apollo capsule. While the Apollo capsule carried three astronauts, Orion is designed to carry four to six astronauts into space.

Although NASA's intention was not to make the Orion spacecraft similar to the Apollo capsule, experts found that this design not only met the requirements but was also the most effective within the safety goals.

During this EXPLORE Activity; your students will determine the area of the largest vertical cross-section of the Orion Crew Exploration Vehicle (CEV). This will give them a sense of the surface area inside the Orion CEV. Keep in mind that the Orion dimensions are 140% of the Apollo capsule.

This problem is a modification of a lesson within NASA's Exploring Space Through Algebra. This lesson and other related resources can be found at: www.nasa.gov.

A. Orion, the Next Generation Spacecraft

1. Prepare for the Lesson:
 - Organize students into teams of two.
 - Copy Teacher Resource 1 and Teacher Resource 2 on transparency film.
 - Copy Student Handout 1 and Student Handout 2 for each student.
2. Gather these materials for each team of students:
 - Calculator
 - Colored pencils
3. Use Teacher Resource 1 to help students analyze the vertical cross-section of the Orion crew module. These questions may guide discussion:
 - What resources can you see inside the Orion?
 - How are astronauts arranged inside the module?
 - If you were to break the module into shapes, what shapes do you see?



TEACHER RESOURCE 1: Vertical Cross-section of Orion (NASA Concept)



Earth (Image: NASA)



"Black Eye Galaxy" M64 (Image: NASA)



Apollo capsule (Image: NASA)

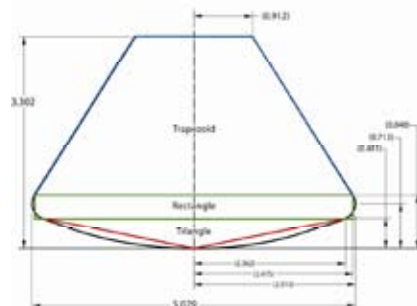


Earth (Image: NASA)



"Black Eye Galaxy" M64
(Image: NASA)

4. Give students copies of Student Handout 1. In order to determine the total vertical area, students will decompose, or break the figure down into smaller parts. Have them use colored pencils to draw the different shapes within the figure.
5. Use the transparency of Teacher Resource 2 to help students check their work.
6. Pair teams to check results.
7. Help students calculate the area of each shape by using Student Handout 2 and a calculator. Use Teacher Resource 3 as a guide.



TEACHER RESOURCE 2: Largest vertical cross-section of the Orion crew module

EXPLAIN

- A. Ask students to compare the different ways that they approached this problem. Emphasize that there are many ways to solve this problem.
- B. If the actual largest vertical cross-sectional area of the crew module is 11.665 m², how far off were their estimates? Help students use the formula in Teacher Resource 4 to calculate their percentage of error.
- C. Discuss reasons for these errors.
- D. Would the largest vertical cross-section of the Orion crew module fit in your classroom? Explain your answer.

ELABORATE

- A. Use Teacher Resource 5 to visually compare the Apollo and Orion spacecraft. Use these questions to guide discussion:
 - What is significant about the shape of the two vehicles?
 - What are the major differences in size between the vehicles?
 - Are there any visible modifications on one vehicle that are not on the other? If so, describe them in detail.
 - What types of materials do you think make up the vehicles?
 - How does the structure of these vehicles support their function?
 - How does technology shape space travel?
- B. Share these resources with your students to help deepen their understanding about the research and technology behind the Apollo and Orion crew modules:
 1. Project Apollo
 - Project Apollo Program Overview
<http://science.ksc.nasa.gov/history/apollo/apollo.html>
 - The Apollo Program
<http://www-pao.ksc.nasa.gov/history/apollo/apollo.htm>
 - Apollo Lunar Surface Journal
<http://www.hq.nasa.gov/office/pao/History/alsj/>
 - Apollo Image Gallery
http://www.apolloarchive.com/apollo_gallery.html
 2. Orion Crew Exploration Vehicle
 - Lockheed Martin Website
<http://www.lockheedmartin.com/products/Orion/index.html>



Another Giant Leap for Mankind

Lesson Development (continued)

GRADES 9-12



Apollo capsule (Image: NASA)

- 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>

C. Challenge your students to create PowerPoint™ slides to compare the two spacecraft.

It may also be helpful for your students to review Nortel LearnIT video tutorials for help in creating their PowerPoint™ slides. They can be found at: http://nortellearnit.org/technology/PowerPoint_Presentations/

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 differences and similarities between the Apollo 11 capsule and the Orion CEV.

To evaluate PowerPoint™ slides, use a rubric found at the Nortel LearnIT site:

- PowerPoint™ Presentations
<http://nortellearnit.org/resources/Handouts/>

EXTEND

This activity may be used to extend or continue your students' exploration.

Encourage your students to listen to these additional Discovery Now audio clips from previous Discovery Now seasons:

- Moon Rox
- ARES
- ORION

The clips can be found at:

<http://www.discoverynow.us>

Once they've listened to the clips, challenge them to write and record their own Discovery Now radio spots. They might imagine that they are reporters covering the Apollo 11 mission and interview family and friends to determine where they were during the historic landing of Apollo 11.

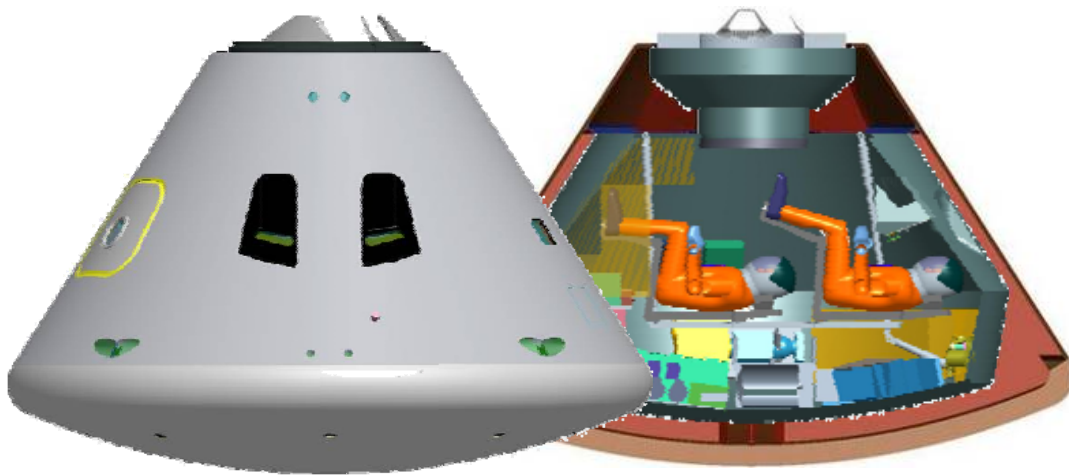


Earth (Image: NASA)

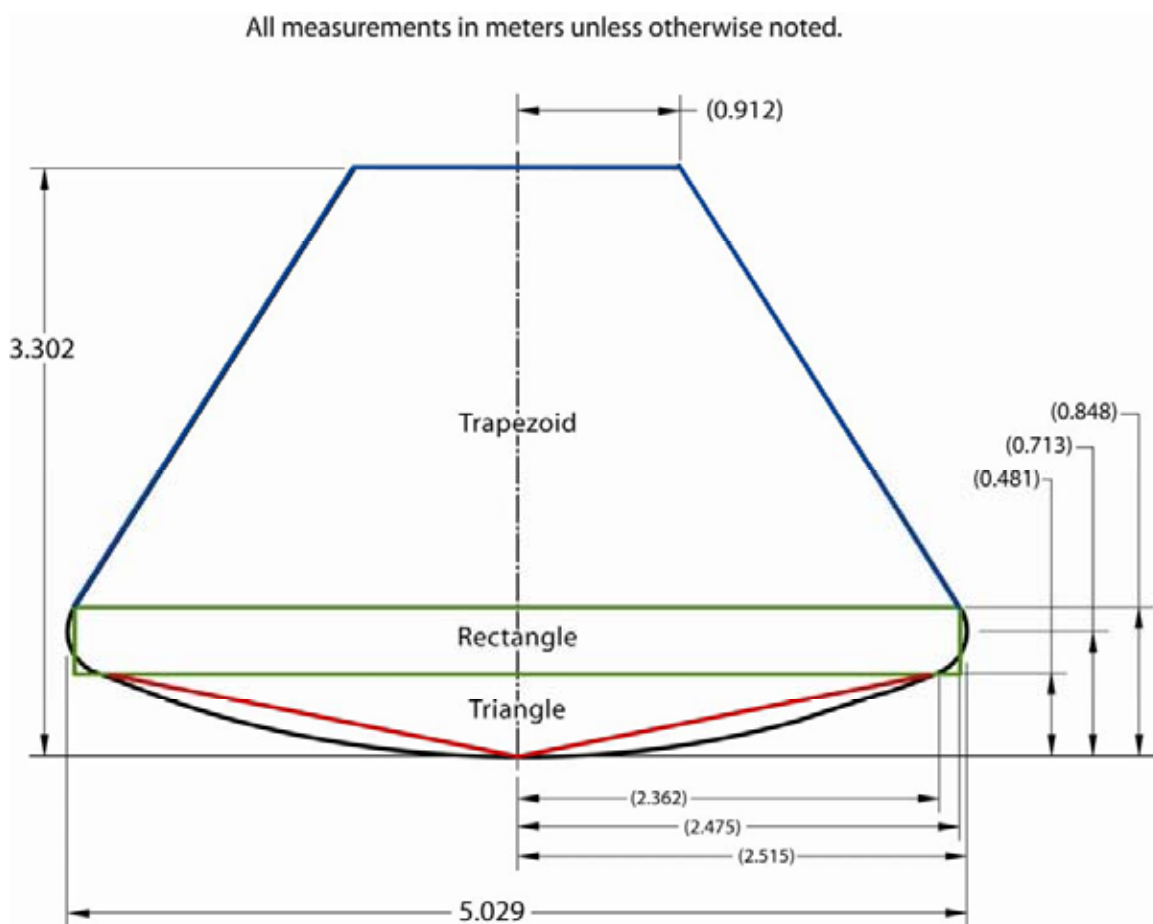


"Black Eye Galaxy" M64
(Image: NASA)





Vertical cross-section of the Orion crew module (NASA Concept)



Largest vertical cross-section of the Orion crew module
(This figure shows the student version with decomposition.)

Vertical Cross-Section Area Data

Figure	Area Formula	Area Formula with Values	Area (m ²)
Trapezoid	$A = \frac{1}{2}(b_1 + b_2)h$	$A = \frac{1}{2} \times [(2 \times 2.475) + (2 \times 0.912)] \times 2.454$	$A = 8.312$
Rectangle	$A = lw$	$A = (2 \times 2.475) \times 0.367$	$A = 1.817$
Triangle	$A = \frac{1}{2}bh$	$A = \frac{1}{2} \times (2 \times 2.362) \times 0.481$	$A = 1.136$

Total Area = Area of Trapezoid + Area of Rectangle + Area of Triangle

$$A = 11.265 \text{ m}^2$$



Another Giant Leap for Mankind

Teacher Resource 4

GRADES 9-12

Calculate Percentage of Error

If the actual largest vertical cross-sectional area of the crew module is 11.665 m^2 , how far off was your estimate? Express your answer in terms of a percent (percent error). Please round your answer to the nearest percent.

$$\% \text{ error} = \left| \frac{\text{actual value} - \text{estimated value}}{\text{actual value}} \right| \cdot 100$$

$$\% \text{ error} = \left| \frac{11.665 - 11.265}{11.665} \right| \cdot 100$$

$$\% \text{ error} = 3\% \text{ under}$$



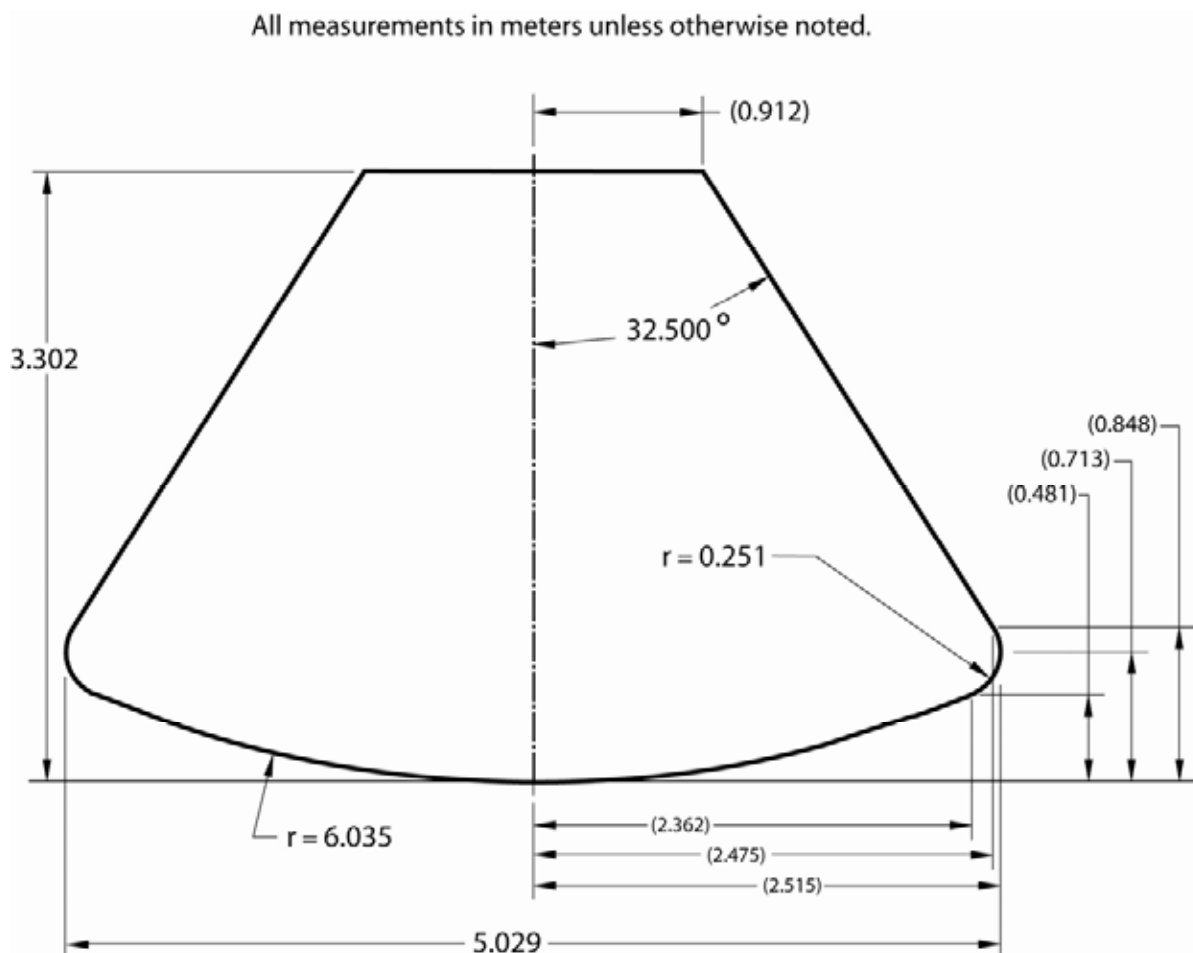


Apollo 11 Command Module (NASA)



Orion Crew Exploration Vehicle (NASA concept)

NOTE: The Apollo Capsule and the Orion CEV are not to scale. The Orion CEV dimensions are 140% of the Apollo Capsule.



Largest vertical cross-section of the Orion crew module
(This figure shows the student version with decomposition.)

