Next Generation Spacecraft – Orion

Background

This problem applies mathematical principles in NASA's human spaceflight.

Exploration expands human presence into the solar system providing the foundation of our knowledge, technology, resources, and inspiration. It seeks answers to fundamental questions about our existence, responds to recent discoveries, and puts in place revolutionary techniques and capabilities to inspire our nation, the world, and the next generation. Through NASA, we touch the unknown; we learn and we understand. As we take our first steps toward sustaining a human presence in the solar system, we can look forward to far-off visions of the past becoming realities of the future. This is the beginning of a new era in space exploration where NASA will build the transportation system to send humans deeper into space than ever before.

Over the past decade, fifteen nations have come together to design, assemble, occupy, and conduct research inside and outside of the largest and longest inhabited object to ever orbit the Earth—the International Space Station (ISS). Now NASA is working with U.S. industries to develop commercial spaceflight capabilities to the ISS while building America's new human space exploration vehicle, the Orion Multi-Purpose Crew Vehicle. Using its new space launch system, Orion will have the capability to take astronauts on exploration missions farther than any previous mission. When paired with additional propulsion and life support systems, Orion will eventually be able to take humans to Mars.

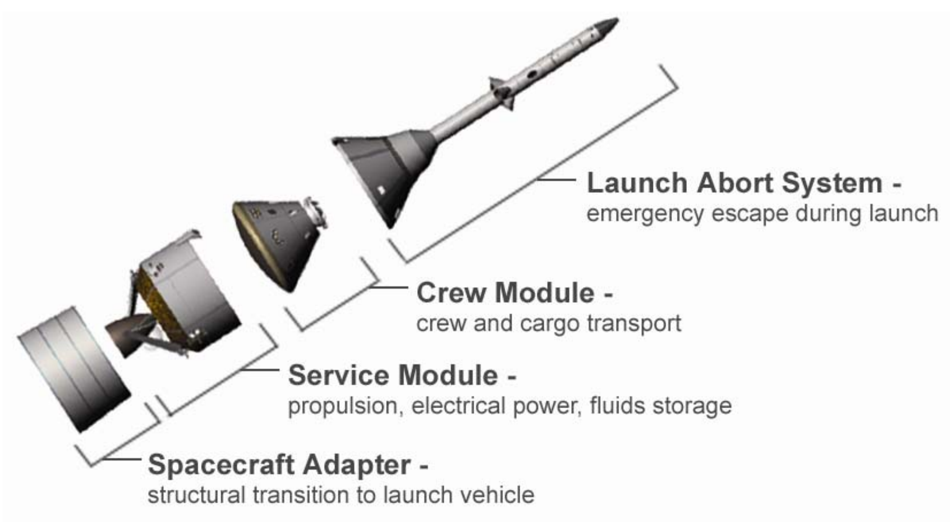

Figure 1: Components of the Orion spacecraft (NASA concept)

Drawing from more than 50 years of NASA spaceflight research and development, the Orion Spacecraft is designed to meet the evolving needs of our nation's space program for decades to come. Orion may resemble its Apollo-era predecessors, but its technology and capability are light years apart.

Drawing from more than fifty years of NASA spaceflight research and development, the Orion Multi-Purpose Crew Vehicle is designed to meet the evolving needs of our nation's space program for decades to come. Orion is being engineered by NASA as a state-of-the-art spacecraft to support long-duration deep space missions of up to six months. Its flexible design, and its unique life support, propulsion, thermal protection, and avionics systems, will allow future technical innovations to be later incorporated.

The crew module for Orion will be used to transport both astronauts and cargo. In comparison to the Apollo capsule (Figure 2), the Orion crew module will be larger and have a blunt-body shape. While it may resemble its Apollo-era predecessor, the technology and capability between them will be light years apart.

NASA concept of the Orion crew module

Apollo capsule

Figure 2: Shape comparison of the Orion crew module and the Apollo capsule (not to scale)

Instructional Objectives

- You will decompose a larger geometric shape into smaller parts.
- You will apply the proper area formulas for various geometric shapes.
- You will estimate the area of a complex geometric shape using decomposition methods.

Directions: Read through the problem set-up and work in pairs to complete the following questions.

Problem

Orion will replace the space shuttle as NASA's spacecraft for human space exploration. This activity focuses on the Orion crew module, one of Orion's four functional modules. The vehicle is designed to accommodate four to six astronauts traveling into space.

Figure 3: Vertical cross-section of the Orion crew module (NASA Concept)

1. To get a sense of the room inside the crew module, use the model on the graph paper provided in Appendix A to estimate the vertical cross-sectional area by counting squares and multiplying the number of squares by 0.032 m^2. Record your work on the provided graph.

Directions: Answer questions 2–4 in your group. Discuss answers to be sure everyone understands and agrees on the solutions. Round all answers to the nearest whole number, and label with the appropriate units.

2. Using the following figure, decompose the model of Orion into familiar geometric shapes and then name the shapes. Use different colored pencils or highlighters for each geometric shape to show the decomposition into smaller parts. Record the shapes and their corresponding area formulas in Table 1.

All measurements are in meters (unless otherwise noted).

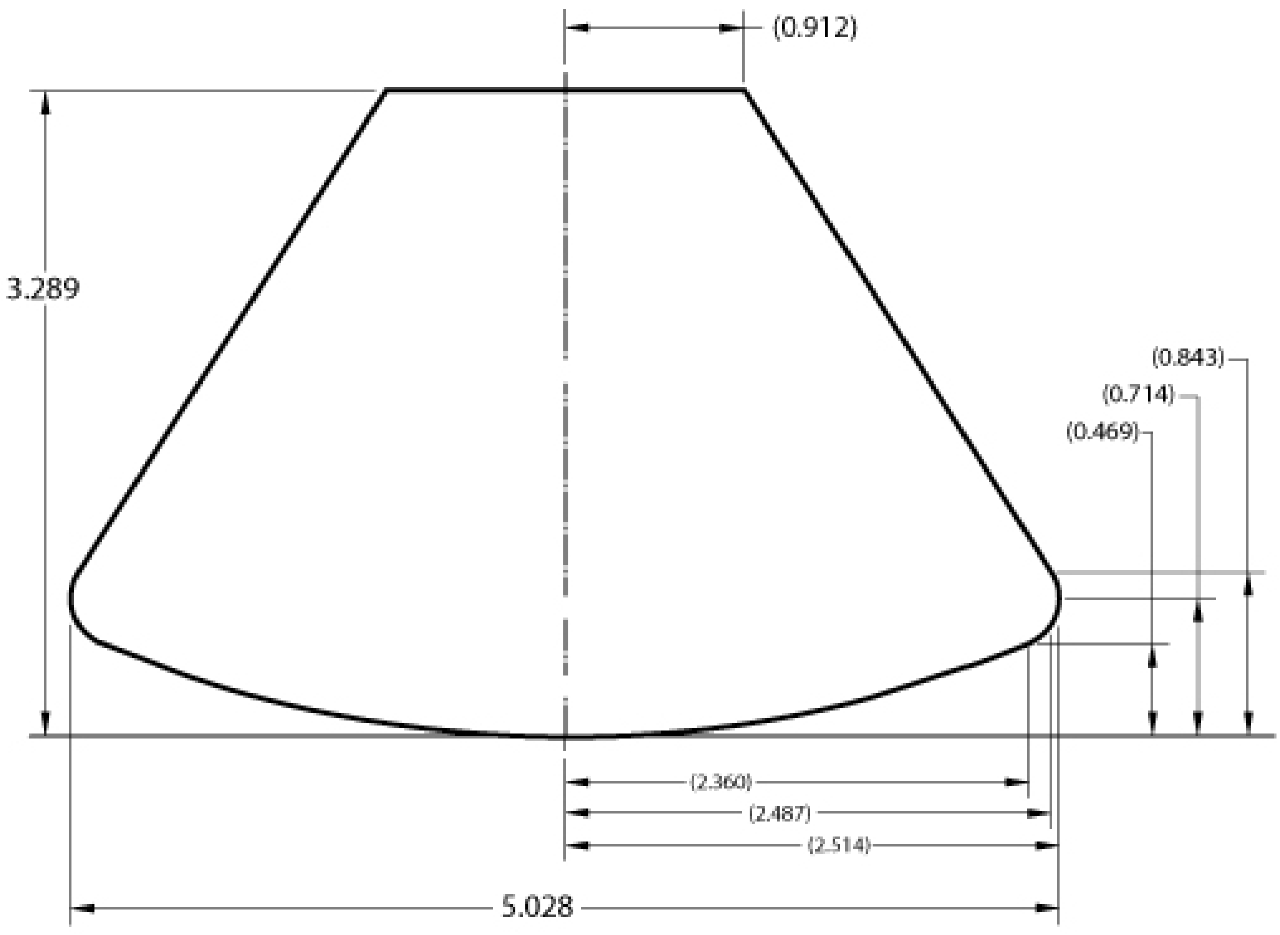

Table 1: Vertical Cross-Section Area Data

Figure	Area Formula	Area Formula with Values	Area (m^2)

3. Calculate the area of each shape and record your answer in Table 1. Round your answer to the nearest thousandth.

4. What is the total vertical cross-sectional area of the crew module?

Directions: Answer questions 5–6 in your group. Discuss answers to be sure everyone understands and agrees on the solutions. Round all answers to the nearest percent.

5. If the actual largest vertical cross-sectional area of the crew module is 11.665 m^2, how far off was your estimate from the graphing method in question 1? Express your answer in terms of a percent (percent error). Round your answer to the nearest percent.

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

Directions: Complete questions 7–8 in your group.

7. Which estimation method was closest to the actual area? Explain.

8. Discuss your approach and methods used to estimate the area with one other group. Compare your answers.

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Appendix A

Next Generation Spacecraft – Orion Grid