# DESIGNING A CREW EXPLORATION VEHICLE

*Activity topic selected from NASA's KSNN™ 21st Century Explorer newsbreak "What will replace the space shuttle?"*

Educator Section

**Grade Level:** 3-5

**Connections to Curriculum:** Science and Technology

**Science Process Skills**: observing, predicting, inferring, comparing, communicating
(Association for the Advancement of Science)

**Teacher Preparation Time:** 30 minutes

**Lesson Duration:** Two 45-minute periods

**Prerequisite:** none

**National Education Standards** addressed in this activity include Science (NSES) and Technology (ITEA). For an alignment to standards in this activity, see page 4.

## Introduction

NASA is designing and testing models of a possible future spacecraft that will take us back to the moon and to Mars. This spacecraft is called the Crew Exploration Vehicle (CEV). An expendable rocket will launch the CEV, though many components of the CEV will be reusable.

## Lesson Objective

To design and build a model of a Crew Exploration Vehicle (CEV).

## Problem

Can I design and build a Crew Exploration Vehicle (CEV) that will be a model for future space exploration?

## Learning Objectives

The students will

- design a model CEV for future space exploration.
- develop a conclusion based upon the results of this design.
- compare individual results to class results by looking for patterns.

## Materials

- NASA's KSNN™ 21st Century Explorer 30-second newsbreak, "What will replace the space shuttle?" (Download the newsbreak at http://ksnn.larc.nasa.gov.)

For educator (not recommended for student use)

- ice-pick or other sharp instrument to poke holes in the containers for the students
- hot-glue gun to help attach/build the CEV parts

Per group (3 - 4 students per group)

- an assortment of household recyclables such as paper plates, plastic containers, milk jugs or cartons, craft sticks, etc.
- assorted fasteners such as tapes, brads, staples, rubber bands
- graph paper
- scissors
- markers

**Materials Required**

household recyclables

fasteners

graph paper

scissors

markers

*Educator use only:*

ice-pick or sharp instrument

hot-glue gun

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NASA's KSNN™ 21st Century Explorer 30-second newsbreak – "What will replace the space shuttle?"

Per student

- Designing a Crew Exploration Vehicle Student Section

## Safety

Remind students about the importance of classroom and lab safety. Be sure recyclables are clean and dry with no sharp edges. Only the teacher should use the hot glue gun or sharp instruments.

## Pre-lesson Instructions

- Students should work in groups of 3 – 4 students.

## Lesson Development

To prepare for this activity, the following background information is recommended:

- Read NASA's KSNN™ 21st Century Explorer Web Text Explanation titled "What will replace the space shuttle?" at http://ksnn.larc.nasa.gov.
- Read the following text taken from the Observation Section of the Designing a Crew Exploration Vehicle Student Section.

### Observation

The space shuttle is the world's first reusable spacecraft and the first spacecraft in history that can carry large satellites both to and from orbit. The space shuttle is designed for low-Earth orbit. It cannot go to the moon or to Mars. Since we hope to send people to these places soon, we need to design a new space vehicle.

NASA scientists and engineers are working on a space vehicle that can take astronauts to the moon, Mars, and beyond. This spacecraft is called the Crew Exploration Vehicle (CEV). The CEV is a vehicle to transport human crews beyond low-Earth orbit and back again. The CEV must be designed to serve multiple functions and operate in a variety of environments.

Development of the CEV will take place in stages and will require many support systems. Support systems will include launch vehicles, in-space transportation, navigation and communication, life support, extravehicular activity (the ability to leave the spacecraft), and mission operations support.

Using recyclable materials, you will design and build a CEV model.

- If needed, additional research can be done on the following science topics:
    - rocket design such as fuel tanks, rocket boosters, landing systems, etc.

## Instructional Procedure

Throughout this lesson, emphasize the steps involved in the scientific method. These steps are identified in ***bold italic*** print throughout the Instructional Procedure Section.

1. Show NASA's KSNN™ 21st Century Explorer newsbreak "What will replace the space shuttle?" to engage students and increase student knowledge about this topic.
2. Review the process of design with students. They will sketch, build, test, rebuild, and test again.
3. Review the problem with the students.
   ***Problem:*** Can I design and build a Crew Exploration Vehicle (CEV) that will be a model for future space exploration?
4. Have the students read the ***Observation*** Section in the Designing a Crew Exploration Vehicle Student Section and discuss in their groups.

5. Encourage your students to discuss and make ***observations*** about this topic by completing the first two columns in the KWL (KNOW/WANT TO KNOW/LEARNED) chart on the Designing a Crew Exploration Vehicle Student Section. Use the KWL chart to help students organize prior knowledge, identify interests, and make real-world connections. As students suggest information for the "KNOW" column, ask them to share "How they have come to know this information."
6. Ask your students if they have predictions relating to this activity and the "problem question". Help them refine their predictions into a ***hypothesis***. In their Student Section, they should restate the "problem question" as a statement based upon their observations and predictions. Encourage students to share their hypothesis with their group.
7. Students will ***test*** their hypothesis following this procedure.
   (The following steps are taken from the Student Section. Educator specific comments are in italics.)

    1. Design your CEV on graph paper. Be sure you include these items:
        - a place for the crew
        - fuel tank
        - rocket boosters
        - storage space for life support (air, water, food and waste)
        - storage place for cargo
        - power source (fuel cells)
        - landing system
        - other items if you can explain why

       Make sure your drawing is complete:
        - label all parts
        - create a materials list
        - name the spacecraft
        - list all group members names
    2. Explain your drawing to your teacher and classmates. You may make changes based upon their suggestions.

       *Allow time for students to improve designs based upon suggestions.*

***-- SUGGESTED PLACE TO STOP ACTIVITY. RESUME AT NEXT CLASS PERIOD. --***

    3. Gather building materials. You may want to use paper towel rolls, yogurt cups, empty 2-liter bottles, jar lids, wire, empty cereal boxes, etc.

       *Students may bring in recyclable materials they choose from home.*

       *NOTE: Educator may want to have a sharp instrument (ice-pick) to poke holes in the containers for the students. A hot-glue gun may also be helpful to attach/build the CEV parts.*
    4. ***Collect data*** by making notes on your design paper as you build. Indicate changes in your plans.

       *Encourage students to add notes during the design process. Ask them to compare the final product to their first drawing. How has the design changed?*
    5. When your CEV is complete, write a short statement to convince NASA that your CEV is worthy of future space exploration.

6. Make improvements to your model and ***draw conclusions*** by answering the Study Data questions. Does your design support or refute your hypothesis?

   *Have the students answer the Study Data questions on the Designing a Crew Exploration Vehicle Student Section.*

## Conclusion

- Discuss the answers to the Designing a Crew Exploration Vehicle Student Section questions.
- Have the students update the LEARNED column in their KWL chart.
- Ask students to compare their designs. What patterns can be found?
- Ask students "what they wonder now?" Encourage students to design their own experiments.

## Assessment

- Assess student knowledge through questioning.
- Observe and assess student performance throughout the activity using the attached Scientific Investigation Rubric.

## Activity Alignment to National Education Standards

**National Science Education Standards (NSES)**:
Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry (K-8)
- Understandings about scientific inquiry (K-8)

Content Standard E: Science and Technology
- Abilities of technological design (K-8)

**International Technology Education Association (ITEA)**:
Design
- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World
- Standard 11: Students will develop the abilities to apply the design process.

## Curriculum Explorations

To extend the concepts in this activity, the following explorations can be conducted:

### Language Arts

Ask students to explain their design process. How would students change their designs if they could begin again?

National Council of Teachers of English Standards (NCTE):

- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

**Engineering and Design**

If you could have used other materials, how would you have designed your CEV?

Launch and entry stages are harsh on astronauts due to forces more than 3 times the Earth's gravity. How could you design a vehicle to help astronauts withstand these forces?

National Science Education Standards (NSES):
Content Standard E: Science and Technology

- Abilities of technological design (K-8)

International Technology Education Association (ITEA):
Design

- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

## Sources and Career Links

Thanks to subject matter experts Dr. Chirold Epp, Roger Crouch and Marc Timm for their contributions to KSNN™ and Noticiencias NASA™ on the development of this education material.

Dr. Chirold Epp is a physicist at the NASA Johnson Space Center and is working with the program to return humans to the moon. He is currently leading the development of technologies required to land humans safely and accurately on the lunar surface. To find out more about NASA's return to the moon see: http://www.nasa.gov/exploration.

Roger Crouch is a NASA astronaut, and you can find out more about him at http://www.jsc.nasa.gov/Bios/PS/crouch.html.

Marc Timm works in the Constellation Systems Division at NASA HQ Exploration Systems Mission Directorate (ESMD). This division is responsible for developing the Crew Exploration Vehicle (CEV) and related exploration architecture elements. Find out more at http://microgravity.grc.nasa.gov/constellations.

Lesson development by the NASA Johnson Space Center Human Health and Performance Education Outreach team.

## Scientific Investigation Rubric

**Experiment:** DESIGNING A CREW EXPLORATION VEHICLE

Student Name _____ Date _____

| Performance Indicator | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| The student developed a clear and complete hypothesis. | | | | | |
| The student followed all lab safety rules and directions. | | | | | |
| The student followed the scientific method. | | | | | |
| The student recorded all data on the data sheet and drew a conclusion based on the data. | | | | | |
| The student asked engaging questions related to the study. | | | | | |
| The student understood some engineering problems associated with CEV design. | | | | | |
| **Point Total** | | | | | |

**Point total from above: _____ / (24 possible)**

**Grade for this investigation _____**

**Grading Scale:**

A = 22 - 24 points

B = 19 - 21 points

C = 16 - 18 points

D = 13 - 15 points

F = 0 - 12 points