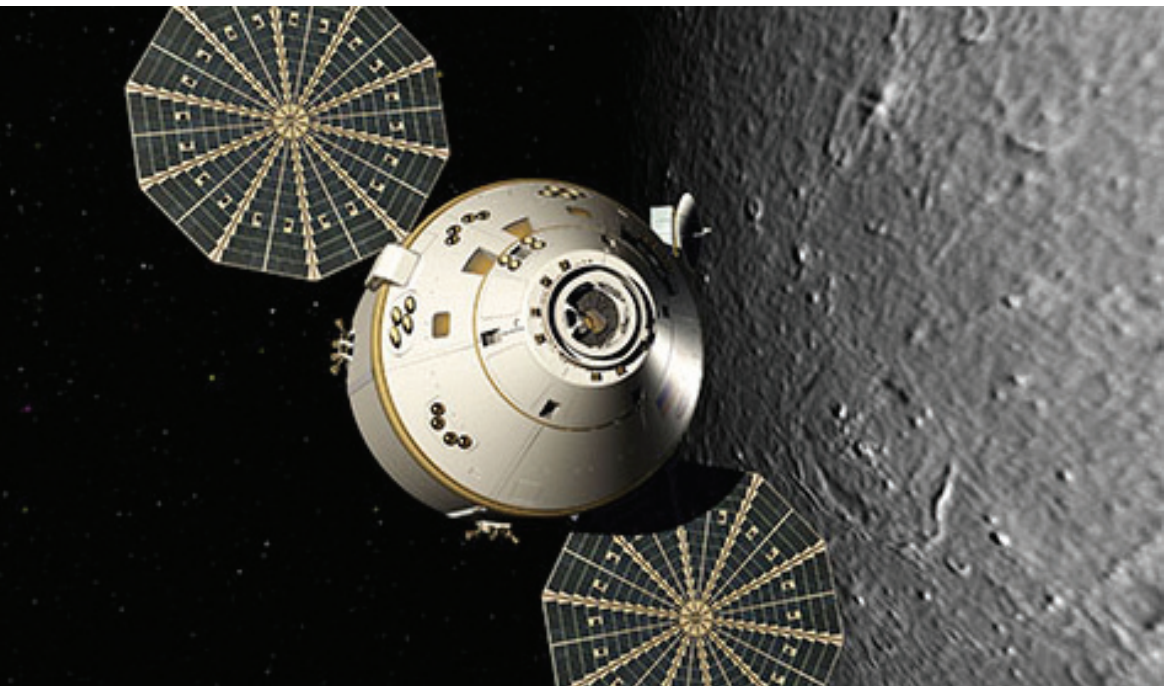
Design a Crew Exploration Vehicle



DESIGN challenge

To design and build a Crew Exploration Vehicle (CEV) that will carry two 2 cm-sized passengers safely and will fit within a certain volume (size limitation). The CEV will be launched in the next session.

OBJECTIVE

To demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.

PROCESS SKILLS

Measuring, calculating, designing, evaluating

MATERIALS

General building supplies

Digital scale

Mailing tube, oatmeal canister, or small coffee can (used as size constraint)

2 - 2 cm plastic people (i.e. Lego®)

STUDENT PAGES

Design Challenge

Ask, Imagine and Plan

Experiment and Record

Quality Assurance Form

Fun with Engineering at Home

PRE-ACTIVITY SET-UP

Select a size constraint (mailing tube, oatmeal canister or coffee can). Fill in the sentence on the Design Challenge so students will know what the size constraint is for their CEV.

exploration

MOTIVATE

- Show the NASA BEST video titled "Repeatability":

  http://svs.gsfc.nasa.gov/goto?10515

- Ask the students why it is important to test their own designs.

SET THE STAGE:

ASK IMAGINE **& PLAN**

- Share the *Design Challenge* with the students.
- Remind students to imagine a solution and draw their ideas. All drawings should be approved before building.

CREATE

- Challenge students to build their CEVs based on their designs. Remind them to keep within specifications.
- Visit each team and test their designs to ensure they fit within the size specifications of the cylinder you are using.

EXPERIMENT

- Each team must conduct three drop test (at 1, 2 and 3 m) and record the results.

IMPROVE

- After each drop test, the students improve CEV models based on the results of the experiment.

CHALLENGE CLOSURE

Engage the students with the following questions:

- What was the greatest challenge for your team today?
- Why was it important that the hatch stay closed during the drop tests?
- What process will your CEV undergo that makes it important for the astronauts to stay secured in their seats?

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PREVIEWING NEXT SESSION

Ask teams to bring back their CEV model for use in next session's challenge. You may want to store them in the classroom or have one of the facilitators be responsible for their safe return next session.

Ask teams to think about potential launch mechanisms before during the next session. Tell them they will be building a launcher out of the standard materials that have been available to them, including large rubber bands.

Design a CEV
Teacher page

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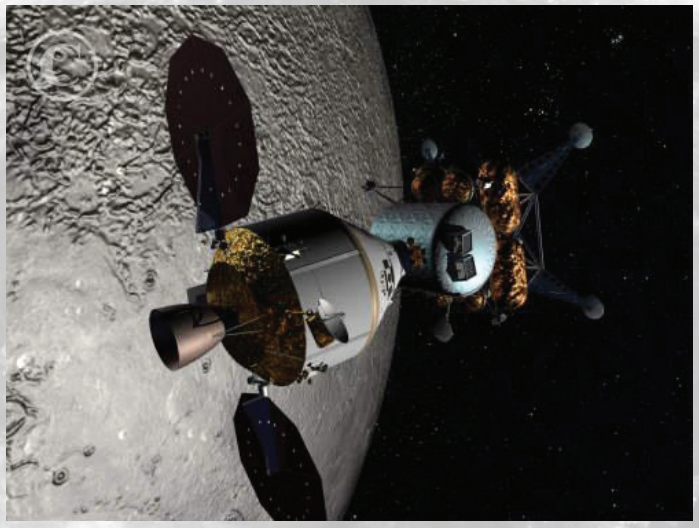
Taking humans back to the Moon...40 years later!



NASA needs a new vehicle to take astronauts to the Moon because the Space Shuttle was never designed to leave the Earth's orbit. NASA and its industry partners are working on a space vehicle that will 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.

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THE CHALLENGE:

Each team must design and build a Crew Exploration Vehicle with the following constraints:

1. ***The CEV must safely carry two "astronauts". You must design and build a secure seat for these astronauts, without gluing or taping them in place. The astronauts should stay in their seats during each drop test.***
2. ***The CEV must fit within the _____. This item serves simply as a size constraint. The CEV is not to be stored in this or launched from this item.***
3. ***The CEV must include a model of an internal holding tank for fuel with a volume of 30 cm^3. (Note: your tanks will not actually be filled with a liquid.)***
4. ***The total mass cannot exceed 100 grams. Use a scale or balance to measure the mass of your design components.***
5. ***The CEV must have one hatch that opens and closes and is a size that your "astronauts" can easily enter/exit from. The hatch should remain shut during all drop tests.***

Design a CEV
Student page

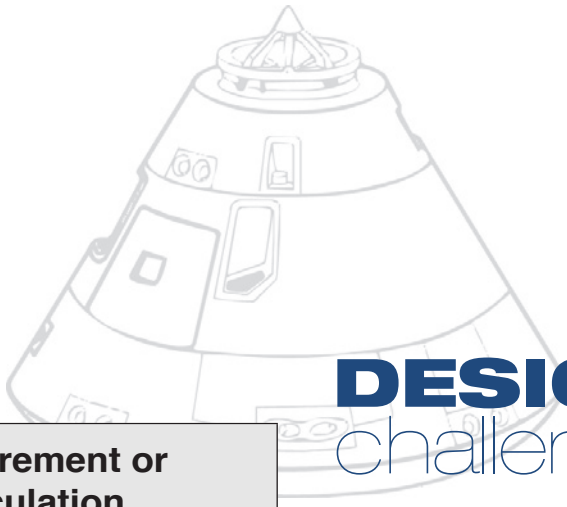
exploration

ASK IMAGINE &PLAN

What questions do you have about today's challenge?

Draw your Crew Exploration Vehicle (CEV) and show a view with the hatch. Also include an inside look (cutaway view) at where your astronauts sit and where the internal tank is positioned.

Approved by: _____



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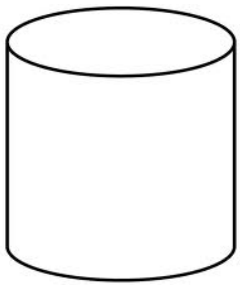
CEV Characteristics Data Table

Vehicle components	Use	Measurement or Calculation
Astronauts	Crew	Mass: _____ grams each _____ grams total
CEV	Carries crew to Moon	Mass: _____ grams
Hatch	Allows entry and exit	Dimensions: _____ cm (long) by _____ cm (wide)
Internal Tank	Stores liquid fuel	Mass: _____ grams Volume: _____ cm^3
Mailing Tube	To test size constraint	Volume: _____ cm^3

Hint

– How to calculate the volume of a cylinder:

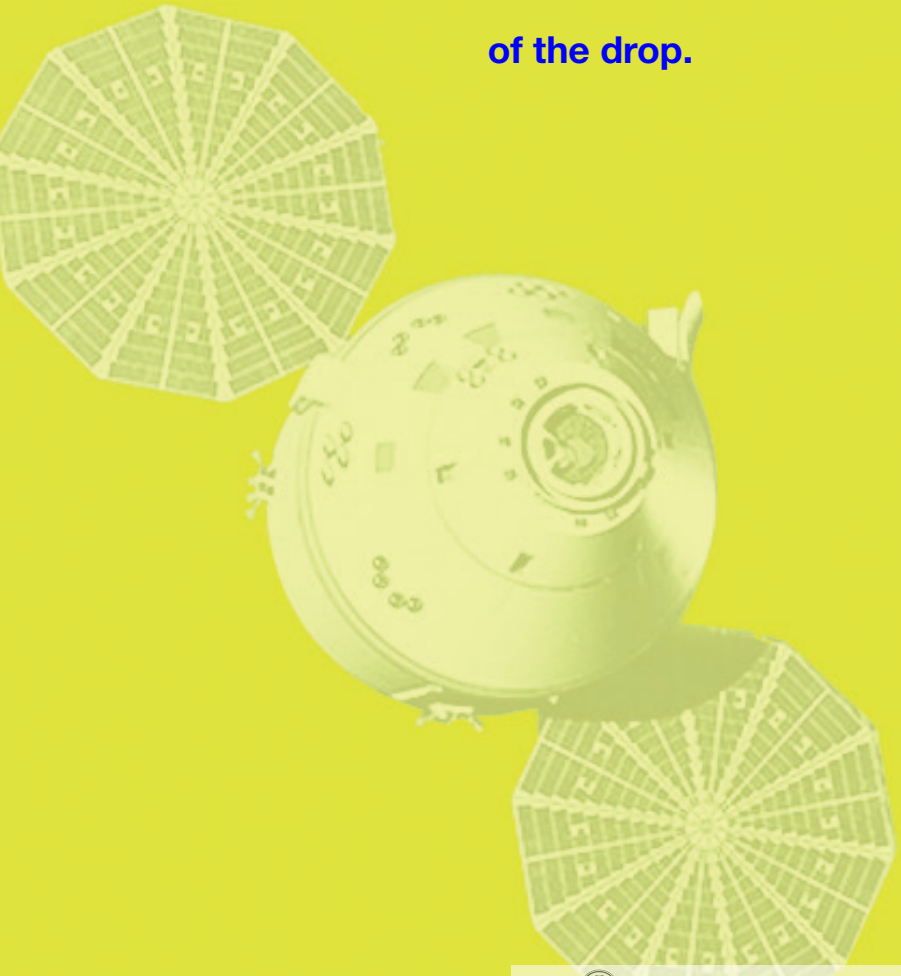
$V = \pi r^2 h$



1. **Find the radius of the circle found at the top and bottom of the cylinder. The radius (r) is half of the measurement of the diameter of the circle.**
2. **Square the radius value and multiply it by π (pi).**
3. **Determine the height (h) of your cylinder and multiply it by the value found in step #2.**

Experiment & Record

Drop your CEV model from three different heights: 1 meter, 2 meters and 3 meters. The drop height is the *independent variable* of this experiment. Record a *dependent* variable from each drop, noting the results of the drop. For example, the number of astronauts that stayed in their seats during the drop is a *dependent* variable because its results are dependent upon the height of the drop.



CEV Drop Test Data Table

Independent Variable Drop Height	Dependent variable(s)
1 meter	
2 meters	
3 meters	

What was the most difficult constraint to satisfy in your CEV?

_____

_____

_____

List the design changes made to your CEV between trials.

_____

_____

_____

QUALITY ASSURANCE FORM

Each team is to review another team's design and model, then answer the following questions.

Name of team reviewed: _____

Total mass of the Crew Exploration Vehicle is: _____ **grams**

Does the CEV fit within specified dimensions?

Does the hatch open and close?

Did the astronauts stay in their seats during the drop tests?

List specific strengths of the design.

List specific weaknesses of the design:

How would you improve the design?

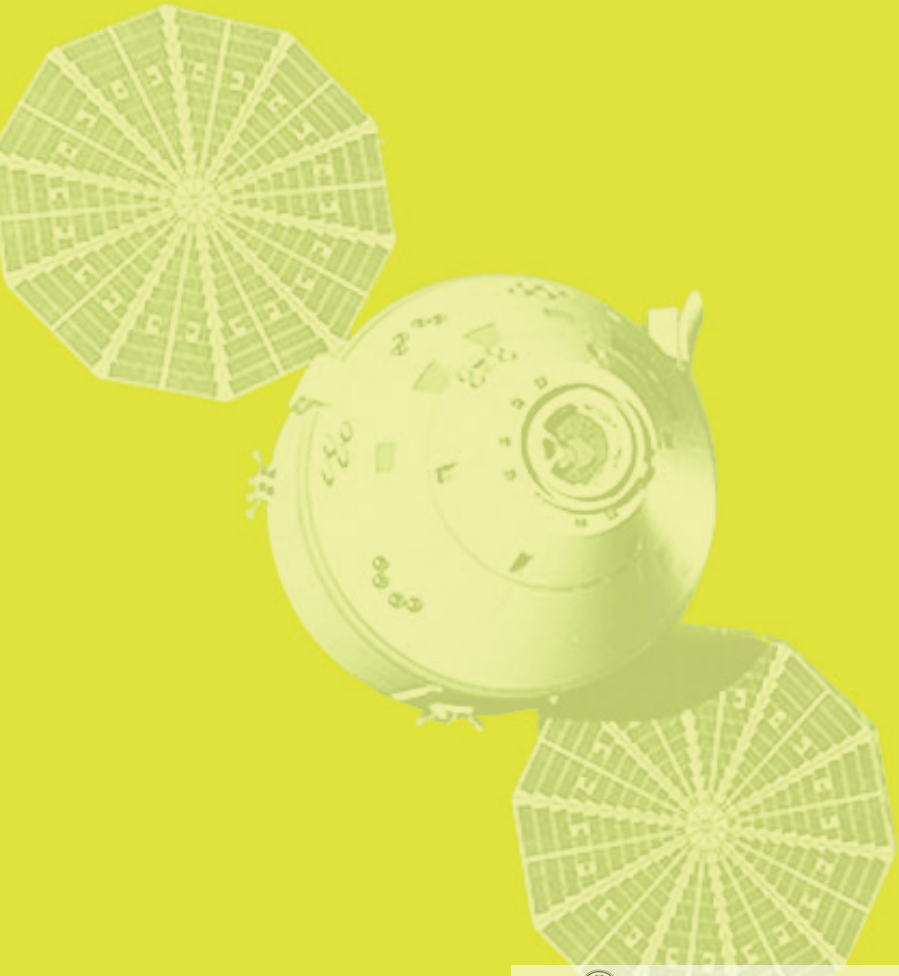
Inspected by: _____

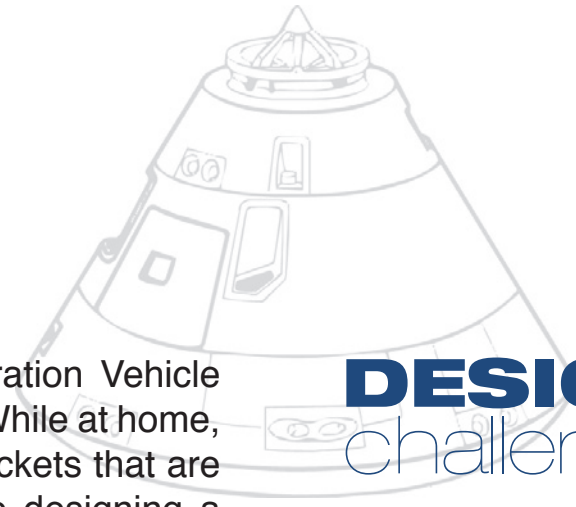
_____

_____

_____

Fun with Engineering at Home





DESIGN challenge

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Today you designed and built a Crew Exploration Vehicle (CEV) model to carry astronauts to the Moon. While at home, see what you can learn about satellites and rockets that are launched into orbit. Next session, you will be designing a launcher for the Crew Exploration Vehicle. It will be important to test launch the CEV several times so that in the future we may send humans SAFELY into space.

YOU BE THE TEACHER!

Sending humans back to the Moon is a highly debated subject amongst leading scientists, engineers, politicians and the public. Try hosting a family discussion about this topic. Use these questions as a guide:

1. *Do you believe we should send humans back to the Moon? Why or why not?*
2. *Would you want to go to the Moon?*
3. *What might be some of the dangers for humans in a new CEV?*
4. *What is the most dangerous part of the journey to Mars?*

Design a CEV
Student page

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