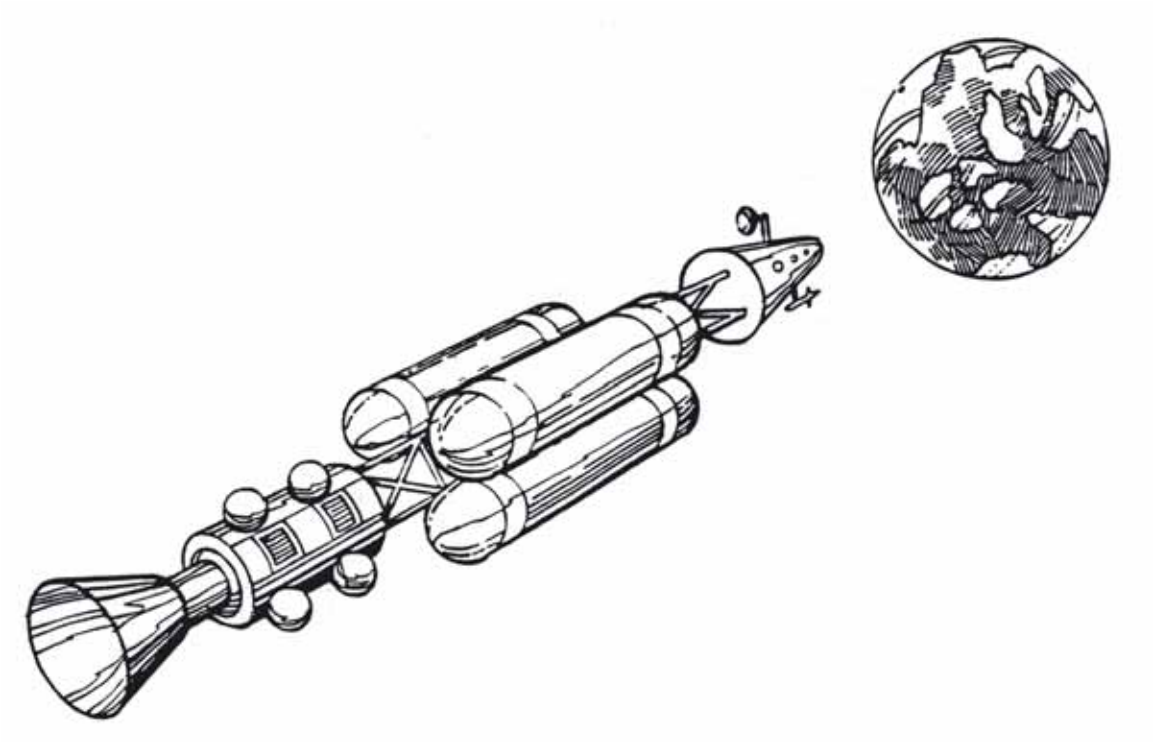
Exploration – Spaceship to Mars



Topic

Designing a spaceship for the trip to Mars.

Description

Students are challenged to work in teams to build and test the structure that will support the modules of an interplanetary spaceship.

Grade Level

Middle School (suggestions are included for extending to lower and upper grades).

Materials Needed

- 6 sheets of copy machine paper
- Masking tape
- Scissors
- Hard cover book or some other weight

Procedure

Step 1 Divide the class into teams of 2 to 4 students each.

Step 2 Distribute one student copy of the activity, to each team. Ask one member from each team to read the description of the manned mission to Mars and the engineering challenge.

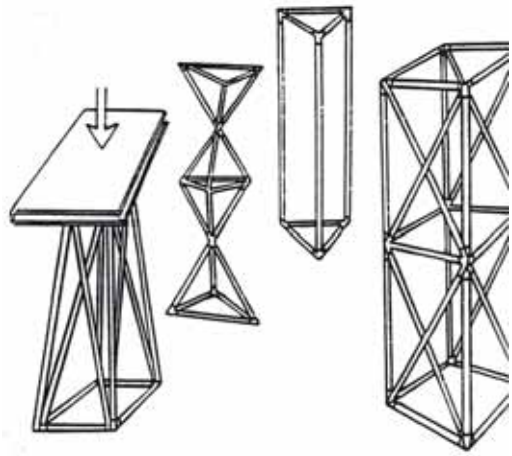
Step 3 Tell each team they have 20 minutes to design and construct their proposal for the spaceship framework. Demonstrate how the framework s will be tested. Refer to the diagram. As the teams are building their models, circulate among them and ask questions about their designs to encourage them to analyze what they are creating. Remind the students to keep track of the materials they use.

Step 4 At the completion of the construction period have each team bring their framework model to the testing area. Invite all the students to speculate on which structure should be the strongest. Discuss why they, made their choices.

Step 5 Begin testing the models by standing the first one up on a flat surface as shown in the diagram and placing the book or other weight on top. Be prepared to catch the weight if the structure collapses. The framework that uses the least amount of construction materials (lowest bid) and supports the weight is the winner.

Discussion

This activity can be adapted to be simple or complex, depending upon the time and equipment available and the level of the students. In its simplest form, the framework that supports the greatest mass of books is the strongest. A more advanced version of the activity would begin the testing determining the mass of the framework for comparison to its strength. The framework with the best mass to strength ratio would win the competition. If a balance for measuring the mass of the framework is not available, a rough approximation of the



mass of individual frameworks can be made by comparing the amount of scraps left over from the construction. Ask the students why it is important that the framework be both strong and light.

In this version of the activity, the students must keep track of the cost of their frameworks. Each sheet of paper represents $10 million in construction materials and labor and every centimeter of tape represents $100,000. By totaling up the materials they used to build their models they can submit a bid on how much the actual framework would cost. As in real life, the company, that submits the lowest bid while fulfilling all design requirements is awarded the contract.

In conducting the strength tests, be sure to relate the weight of the book or other object chosen to the G (gravity) forces the real framework would experience during acceleration. Each component of the spaceship, including the framework itself, has inertia. Inertia is the resistance of a body to a change in motion. If the framework is weak, the inertia of the crew compartment and propellant tanks will cause it to crumble.

During the tests encourage the students to analyze the structures they built. What make some frameworks stronger than another? Examine the geometry of the frameworks. Which geometrical shapes arc stronger? (Triangles, squares, etc.)

For Less Advanced Groups

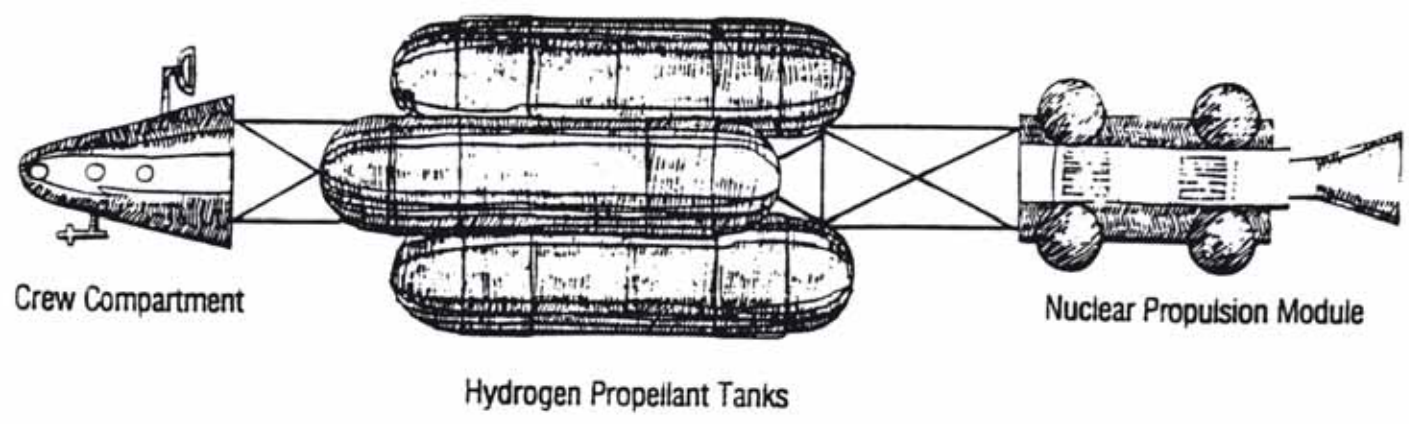
Spend more time preparing students to work in teams.

Think aloud with them about possible configurations and encourage them to think through a design before they begin cutting;

Instead of using paper and tape, have students use plastic straws (not flexible) and large gumdrops to build models. Use less weight for testing

To help students understand how far away Mars is, have them participate in a scale model. Show a cantaloupe for Earth, a lime for the moon, and a peach for Mars to show the relative size of the planets. (For the correct size ratio, use Moon = 1, Mars = 2, Earth = 4.) To demonstrate the distance among them, explain that the moon is 9 ½ times the circumference of the earth in distance. Measure that distance around the cantaloupe and have students hold the string stretched out for the class to see. Then explain that Mars is about 200 times farther from earth than that. In relation to their classroom, where might the end of the string be? On the playground? Across the street?

The National Engineers Week Committee wishes to thank NASA, particularly Gregory L. Vogt, Crew Educational Affairs Liaison, NASA Johnson Space Center, for its help with this project



Student Activity Sheet

Spaceship to Mars

Of all the adventures the National Aeronautics and Space Administration is considering, the one that offers the greatest challenges is the first manned space voyage to the planet Mars. Using current chemical rocket technology, under the most favorable conditions, a round trip to Mars could take as long as 450 to 500 days. Such a trip would require massive amounts of expendables such as food, oxygen, water, power, and propellants. A complete oxygen, water, and nutrient recycling system would be used on the vehicle to reduce the number of expendables required. Furthermore, maintaining astronaut physical and mental health would be an important consideration. For some Mars missions, the entire round – trip voyage might last more than three years!

To reduce the massive effort to make voyage to Mars possible, NASA is working on future technology that could shorten the one-way travel from 120 to 200 days. The technology centers on nuclear thermal engines. Such an engine, if developed, would consist of a nuclear reactor whose heat would be used to raise the temperature of hydrogen gas to about 3,000K. The superheated gas would be expelled out of engine nozzles at a rate that is far greater than is possible with chemical rockets. Higher engine exhaust velocities mean greater efficiency and the vehicle will be able to travel much faster through space. A faster vehicle means a shorter trip and that means fewer expendables will have to be carried.

The first: manned space vehicle to Mars is likely to consist of four major parts. The first is the nuclear propulsion module. Next are the hydrogen propellant tanks. Third is the crew compartment and the last is a framework for attaching all pieces together. Each of the components will be raised to Earth orbit by heavy-lift cargo rockets where they will be assembled for the trip.

Engineering Challenge

Background:

You are part of an engineering design team that has been assigned the task of designing the framework for assembling the components for the Mars vehicle. Other engineering design teams are also working on the problem. The team that comes up with the best design will receive the contract to develop the actual framework. It is your task to make the framework as strong and as light as possible. At the front end of the framework will be the crew compartment. Hydrogen propellant tanks will be attached to the middle and the propulsion module at the other end.

Assignment

Design the Mars space vehicle framework. Use the space below, to sketch your design. Using only, the provided materials, construct a model of your framework to be used for testing its strength. For the test, the framework will be stood on one end. The crew compartment end will be upward. The framework must be at least 40 centimeters tall and must be wide enough at the top to balance a weight your teacher has selected for the test. As you construct your framework, keep track of the materials you use. Each sheet of paper represents an investment of $10,000,000 in materials and labor and each centimeter of tape an investment of $100,000. Total the cost of all the materials. If your framework is able to support the weight, the cost of your materials will be your bid. The successful team with the lowest bid will win the competition.

Materials (per team)

- 6 sheets of scrap copy machine paper
- Masking sheet (1 meter strip)
- Scissors

Bid

Number of sheets of paper x $10,000,000 =

_____

Number of centimeters of tape x $100,000

= _____

Framework Design