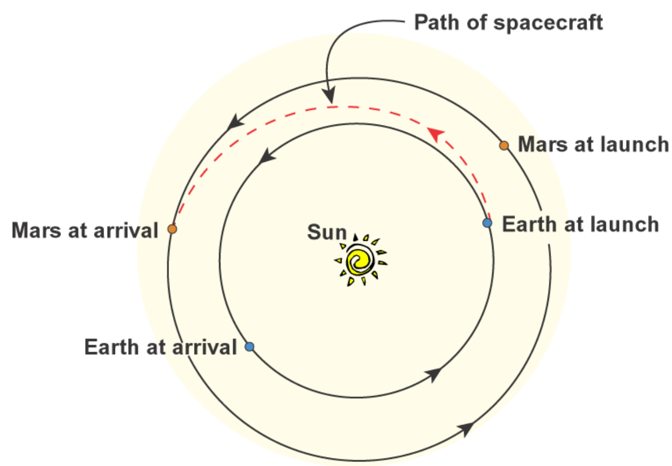
Originally published in The Technology Teacher*, December 2001, by the International Technology Education Association*

Packing for a L-o-o-o-ng Trip to Mars

It's been over 25 years since humans set foot on "unearthly" ground—the moon, that is. It took only a few days to get to the moon, so the Apollo astronauts didn't have time to get bored. Our next destination in the human exploration of space will probably be Mars. Although we don't yet have any definite plans for getting there, many people are busy working on the many problems that will have to be solved to accomplish this very difficult goal.

The main challenge is that Mars is much farther away than the moon. Mars is the fourth planet from the Sun, and Earth is the third planet from the Sun. It takes Earth about 365 days to make one orbit around the Sun (one Earth year). It takes Mars 687 Earth days to make its journey around the Sun. So to get to Mars, we blast off from Earth going in the same direction as Earth and Mars are both traveling around the Sun, and by adding a little speed using the spacecraft's engines, we eventually match up with Mars' orbit and catch up to Mars itself. If we don't care about gas mileage, we can really step on it and get there in six months! A more fuel-efficient trip takes about 11 months.



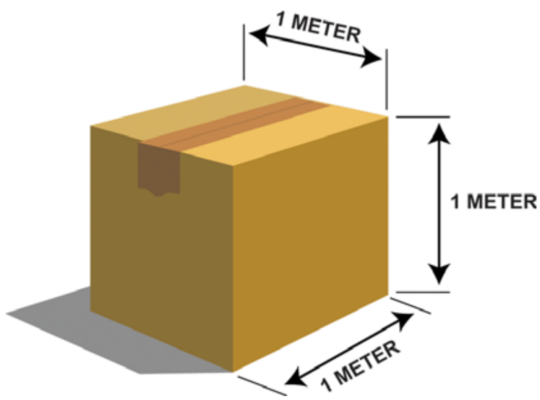
So, after a six-month journey, you land on Mars and have to stay at least 19 months, until Mars and Earth approach their closest positions again before you take off for the six-month journey home. You will be gone a total of about 2-1/2 years!

This is a long time to be cooped up in a spaceship or in a Mars habitat with a few other crewmates! How would you pass the time? And how would you plan for all the crewmates to get along together?

Plan Ahead!

Imagine you and your two, three, or four crewmates are planning for a trip to Mars. Assume that all your basic needs for air, food, water, and warmth will be met by the basic design of the spaceship and the supplies that have already been stowed aboard. All you and your mates must do is decide what personal items to take to pass the time and keep yourselves entertained and happy.

All the items your crew takes along must fit into a box 1 meter wide by 1 meter high by 1 meter deep—in other words, having a volume of 1 cubic meter (1 m^3). (One meter is about 39-1/2 inches).



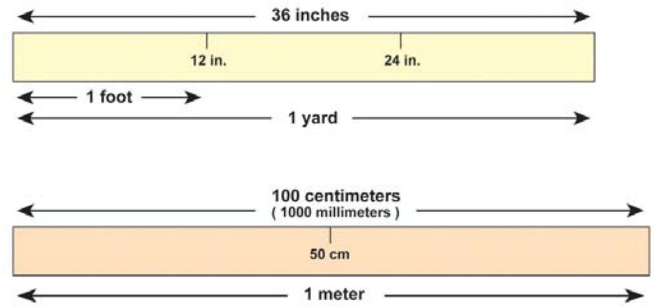
Remember, scientists and engineers almost always use the metric system of measurements, rather than the imperial system (using feet and inches). The metric system is based on tens and is much easier to work with. In the imperial system,you must remember odd numbers, like 12 inches to a foot, 3 feet to a yard, 5,280 feet to a mile, and so on. In the metric system, there are 1000 millimeters in a meter, 100 centimeters to a meter, 10 millimeters to a centimeter, and 1000 meters to a kilometer. Piece of cake!

Metric Units:

1 meter	=	1000 millimeters
1 meter	=	100 centimeters
1 $meter^3$	=	1,000,000,000 $millimeters^3$
1 $meter^3$	=	1,000,000 $centimeters^3$

Conversion factors:

Inches to millimeters:	in	x	25.4	=	mm
Inches to centimeters:	in	x	2.54	=	cm
Feet to centimeters:	ft	x	30.48	=	cm
Feet to meters:	ft	x	0.3048	=	m
Yards to meters:	yd	x	0.9144	=	m
Miles to kilometers	mi	x	1.6	=	km



Materials You Will Need for Planning:

- For the class, you will need a meter stick, poster board or cardboard, and tape (any kind).
- For each person, you will need a metric ruler or tape measure, graph paper, and pencil.
- For each team, you will need a collection of thin markers or colored pencils.

How Big is This Box Again?

To get a good idea of how big a 1-m^3 box really is, you might actually construct one for whole class to see. Use the poster board or card-board to tape together a cube 1 m on each side.

Strategies for Planning

Get into teams of 3 to 5 people. Decide together what you would like to take to Mars. All the items selected by your team must fit into the 1-m^3 box. You might start out by brainstorming ideas, writing everyone's suggestions on a board or paper. Then, as a group, discuss and decide on the best selection of items to take. Keep in mind . . .

- For maximum variety, you might want to pool your interests and take items you can all share and enjoy.
- For electronics that require batteries, you must take along enough batteries to last 2-1/2 years.
- There are no electronics repair shops or computer experts (unless you are one!) in space.

- There is no cell phone service in space.
- There is no internet in space.
- There is no cable and satellite TV in space.
- To save space, you might want to consider items that can be disassembled and reassembled when needed.
- For one year of this period you will be in zero gravity in the spaceship, and for the rest of the time you will be in gravity only one-third as strong as Earth's in your Mars habitat.
- The weight of your items doesn't matter. Assume your Mars-bound spacecraft will be assembled in space, so the entire weight of it does not have to be launched from Earth all at one time.

Making Sure It Will All Fit

Once you have your group's list, you need to find out whether everything will fit before you go to the trouble of obtaining all the items and trying to stuff them into the 1-m^3 box. You need to find out the volume of each of the items, then add them all up to see whether their combined volumes is equal to or less than 1 m^3.

Divide up the list so that each person in the group is responsible for obtaining the measurements of some of the items. Members of the group may actually own the items or may have to go to a store to find them. Once the item is in hand, just use a metric ruler or tape measure to get its height, width, and depth in centimeters or millimeters. Then, multiply these three numbers together to get its volume. If the object is an odd shape, consider how large a box it would take to hold it, and just measure its largest dimensions.

If no one knows where to get hold of the item, try looking on the internet for a site that sells the item and see if you can find out its dimensions. The dimensions will no doubt be given in inches, so you will need to convert to centimeters or millimeters before calculating the volume.

Packing Your "Virtual" Box

Now, without actually bringing in all the items and shoe-horning them into the box, we are going to pack the box on paper! This is called "planning." This is the way engineers design complicated things. They put all the parts together on paper (or using a computer), before going to all the bother and expense of making and then trying to fit together the actual parts.

Using graph paper, first decide the scale you will use. For example, you might have one square equal 5 centimeters.

Do the drawings as a group. Each person should have the opportunity to do at least one drawing.

Draw one side of the 1-m^3 box on the graph paper. Now, using colored pencils or thin markers, draw the items that would fit into the box, as they would appear from one side. Label the items, and include their measurements.

Now, using another piece of graph paper, draw another side of the box. Now, make a drawing that shows how the packed box would look from that side.

Using still other pieces of graph paper, draw the packed box from the top, bottom, and the other two sides. You should end up with six drawings, plus a list of the items in the box..

Hint: For odd-shaped items, if you know the measurements of the individual parts, you can nest the items together to take up the least space.

Explaining Your Rationale

Present your list and six drawings to the rest of the class, and explain . . .

- What was the process your team used to decide what to put into the box?
- What compromises were necessary in choosing the items?
- Why were the items picked?
- What items had to be left out?
- Do all the items represent the agreement of the team, or were some individuals given their chosen item for some reason?

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What is NASA Doing About Mars Right Now?

Artist's concept of a sample return mission blasting off from Mars.

No human expedition to Mars is being planned yet by the National Aeronautics and Space Administration (NASA). However, NASA is working on technologies that will enable future robotic (unmanned) missions to help solve some of the many mysteries about the red planet.

Missions being considered include orbiters, landers, rovers, robotic airplanes, balloons, subsurface explorers, life detectors, sample return missions, and advanced communications systems to get all this data back to Earth.

Using these technologies, NASA hopes to . . .

- Find out whether life ever existed on Mars.
- Learn about the climate on Mars.
- Learn about the geology on Mars.
- Prepare for humans to go to Mars!

Learn more about NASA's Mars Exploration Program at **http://mars.jpl.nasa.gov**, and play the Mars Adventure game at **http://spaceplace.jpl.nasa.gov/mars_rocket.htm** .

Facts to Know for Your Trip to Mars

Average distance of Mars from Sun:	1-1/2 times farther than Earth
Length of Mars year:	687 Earth days
Length of Mars day:	24 hours, 37 minutes
Mass (amount of matter it contains):	About 1/10th of Earth's
Diameter (distance across):	About ½ of Earth's
Number of moons:	2 (Phobos and Deimos)
Surface gravity compared with Earth:	0.38 (If you weigh 100 pounds on Earth, you will weigh only 38 pounds on Mars)
Atmospheric pressure at Mars surface:	Only about 1/100th (or less) of Earth's
Main gases in atmosphere:	Carbon dioxide, with a bit of nitrogen, oxygen, and argon.
Time for a spacecraft to travel to Mars from Earth:	At least six months, depending on the positions of the two planets in their orbits around the Sun.

This article was written by Diane Fisher, science and technology writer and developer of The Space Place website, and Rose Ryland, middle school math teacher in Pasadena, California. It is provided through the courtesy of the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. Illustrations are by Alex Novati.