Destination: Mars

DESCRIPTION
This lesson includes a series of activities that are based on the planet Mars and factors that affect space travel.

OBJECTIVES
Students will

- Compare the positions of planets as they move around the Sun
- Explore expenditures of time and fuel related to space travel
- Describe what happens on minimum fuel orbits
- Plot the paths of spacecraft leaving Earth for Mars and leaving Mars for Earth.
- Be introduced to the Design Process in Engineering
- Solve ratio problems to maximize the Mission Payload

NASA SUMMER OF INNOVATION

UNIT
Earth and Space Science—Destination Mars

GRADE LEVELS
7 – 9

CONNECTION TO CURRICULUM
Science, Mathematics, Technology, and Design

TEACHER PREPARATION TIME
20 minutes

LESSON TIME NEEDED
4 hours *Complexity: Basic*

NATIONAL STANDARDS

National Science Education Standards (NSTA)
Science as Inquiry

- Understanding of scientific concepts
- An appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- Dispositions to use the skills, abilities, and attitudes associated with science

Physical Science Standards

- Properties and changes of properties in matter
- Motions and forces
- Transfer of energy

Earth and Space Science Standards

- Structure of the Earth system
- Earth’s history
- Earth in the solar system

Common Core State Standards for Mathematics (NCTM)
Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems

Measurement and Data

- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit
- Represent and interpret data
- Geometric measurement: understand concepts of angle and measure angles

Geometry

- Understand congruence and similarity using physical models, transparencies, or geometry software
- Understand and apply the Pythagorean Theorem
- Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres

ISTE NETS and Performance Indicators for Students (ISTE)

Creativity and Innovation

- Apply existing knowledge to generate new ideas, products, or processes ADVANCING create original works as a means of personal or group expression
- Digital-Age Learning
- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

Communication and Collaboration

- Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats
- Develop cultural understanding and global awareness by engaging with learners of other cultures
- Contribute to project teams to produce original works or solve problems

Critical Thinking, Problem Solving, and Decision Making

- Identify and define authentic problems and significant questions for investigation
- Plan and manage activities to develop a solution or complete a project
- Collect and analyze data to identify solutions and/or make informed decisions
- Use multiple processes and diverse perspectives to explore alternative solutions

MANAGEMENT

Be sure to review vocabulary with the students thoroughly. They will need to understand International Units of Measurements (time and length) and how to read a data table and learn to use a compass.

CONTENT RESEARCH

What can we learn from images of other planets? Scientists use evidence from satellite images to build explanations. Science is about collecting data and using evidence to answer questions. They rely on laboratory experiments and modeling to better understand and test their ideas, then they use skills they have learned and apply them to new situations.

Vocabulary

Atmosphere—The layer of gases that surround the planet of Mars is relatively thin and is composed mostly of carbon dioxide.

Canyons—Mars has the largest canyon system in the Solar System. Valles Marineris has a length of 4,000 km and a depth of up to 7 km. The length of Valles Marineris is equivalent to the length of Europe and extends across one-fifth the circumference of Mars.

Craters—Mars has over 4,000 impact craters with diameters of 5 km or greater. Mars is close to the Asteroid belt. It is also more likely to be struck by short period comets that originate within the orbit of Jupiter.

MATERIALS

- Student Procedure, Plotting the Paths of a Spacecraft (pg. 8)
- Student sheet, Earth to Mars and Mars to Earth (pgs. 9-10)
- Pencils
- Drawing compass
- Recyclables (plastic bottles, egg cartons, cardboard, papers, plastic caps, small boxes, construction paper) etc.
- Tape
- Glue
- Markers
- Crayons
- Color pencils
- Rulers
- 3-D shapes (for modeling purpose only)
- Pennies
- Jars

Dust—Mars has the largest dust storms in the Solar System that can cover anywhere from a small region to the whole planet. These storms can raise the temperature of the planet.

Plains—A big flat area of land that is safe for landing spacecraft. Plains could be the result of lava flows.

Polar Ice Caps—Mars has two polar caps at the extreme North and South Poles of the planet.

Power—Refers to the energy needs of all the systems that the spacecraft needs to function.

Science goals—Clearly lay out what you hope to achieve by performing this mission.

Surface morphology—Patterns and types of features found on the surface of a planet.

Volcanoes—An opening in a planet's surface or crust, which allows hot magma, volcanic ash, and gases to escape from below the surface. Mars has the largest volcanoes in the Solar System.

Weight—Represents the **mass** of the spacecraft. The more mass the spacecraft has, the bigger the rocket booster will have to be to get it to Mars.

LESSON ACTIVITIES

Mars Bound

Students will be introduced to the design process, engineering, and technology. Students will learn that the design process is not a simple linear progression from one step to the next resulting in a finished product. Although there are steps, the design process is an iterative one: designing, modifying, testing, and redesigning until a finished product is made. A central tenet of engineering, however, is that there is no such thing as a "perfect design." http://marsed.mars.asu.edu/marsbound

Destination Mars

This lesson is designed to increase students' knowledge, awareness, and curiosity about the process of scientific exploration of Mars. As scientists look for evidence of life on Mars, they will focus on how to get there: Navigation and Trajectory.
http://ares.jsc.nasa.gov/education/activities/destmars/destmars.htm

Can We Take It With Us?

Although intended for a Lunar mission, this activity works well for Mars as a destination too. Students work in teams to determine the maximum amount of payload that they can take on a mission. Students are given a container that represents the maximum weight allowed. They are also given a list of mandatory mission ratios, a double balance, 80 pennies, and an empty container to weigh their trial payloads. The team closest to the maximum payload weight without going over is declared the winner. See page 27 of the guide.
http://www.nasa.gov/pdf/200173main_Lunar_Nautics_Guide.pdf

ADDITIONAL RESOURCES

Drive a Rover: http://www.marsquestonline.org/coolstuff/drivearover/index.html
Mars Science Laboratory: http://sse.jpl.nasa.gov/missions/profile.cfm?MCode=MarsSciLab
Curiosity Cam: http://www.nasa.gov/mission_pages/msl/building_curiosity.html.

DISCUSSION QUESTIONS

What are the orbital challenges of traveling from one planet to another? *Alignment of the planets at the precise coordinates and orbital paths*
What are the possible paths for a spacecraft traveling from Earth to Mars? *See data sheets for an example.*
What could make a spacecraft get to Mars faster? *Alternate fuel, lighter (in mass) spacecraft, and more efficient engines*
What are some of the problems considered by engineers and scientists as they design trips to Mars? *Life support, energy, and natural resources*

ASSESSMENT ACTIVITIES

- Ask students to submit their data sheets plotting their trajectory from Earth to Mars and from Mars to Earth

ENRICHMENT

Students can participate in “Mars to Earth Connection” hands-on activities.
http://www.nasa.gov/pdf/145913main_Mars.and.Earth.Guide.pdf