# Radiation Hazards in Space

## Middle School Grades

### Lesson Summary
Students play a board game to become familiar with the hazards of space travel

### Prior Knowledge & Skills
**Understanding of:**
- Space travel
- Radiation and other energy forms

**Ability to:**
- Perform basic math
- Read simple instructions
- Work in a group setting

**Optional**
- Read and answer questions for Chapter 4 of the text.

### AAAS Science Benchmarks
**The Nature of Mathematics**
*Mathematics, Science, and Technology*

**The Nature of Technology**
*Technology and Science*

**The Physical Setting**
*The Universe*
*Energy Transformations*
*Motion*

### NSES Science Standards
**Science as Inquiry**
*Abilities to do Scientific Inquiry*

**Physical Science**
*Transfer of Energy*

**Earth and Space Science**
*Earth in the Solar System*

**Science and Technology**
*Understandings about Science and Technology*

### NCTM Mathematics Standards
**Number & Operations**

### Teaching Time:
One to two 45-minute periods

### Materials per Team
- Copy of game procedures and rules
- Copy of game board sheet
- Game pieces, 1 per individual
- Chance cards, cut to size
- Tally cards, cut to size
- One die
- Pencil
- Markers or colored pencils

### Advanced Planning
**Preparation Time:** 20-30 Minutes
1. Review lesson
2. Copy game board and cards
3. Form student teams

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*Solar Physics and Terrestrial Effects, pp. 1-10, NOAA (1996)*

[http://www.sec.noaa.gov/Curric_7-12/index.html](http://www.sec.noaa.gov/Curric_7-12/index.html)
Activity 9

Radiation Hazards in Space

Relevant Reading

Chapter 4, section 2

Purpose

To become familiar with the relative hazards associated with space travel, and the attendant personal and governmental problems that impact that travel.

Materials

Cardboard to mount game board sheets
Markers or crayons to color game board
Small colored paper squares or paper clips, distinctive for each player
Tally Cards, cut to size, and pencils
Chance cards, cut to size
one die

Procedures

1. Groups of two to four can play this game. Duplicate materials as needed for other groups.

   Mount the game board on a piece of cardboard. Color the board. (Mars is the “red planet.” What color would Earth be? the Sun be?)

   Cut out Tally Cards and Chance cards. Each player needs a Tally Card and a pencil. Cut out Chance cards and place face down in a pile. You may want to double the number of Chance cards by copying before cutting. There are several blank cards that can be used to make your own Chance cards.

2. Have group read over directions for the game. A game will take 10–15 minutes to play.

3. Review the scoring and plotting when a game is over.

4. Have Fun!
Rules of the Game

Object
The idea is to get from Earth to Mars and back along one of two pathways. Along the way you will acquire Radiation Points (RPs) and these are detrimental to your health. You will also acquire Mission Points (MPs) for significant events that measure your success.

When you have finished the game, plot your total Radiation Points and Mission Points on the back of the Tally Card to see how you did and who “won.”

Procedure
From two to four players may play at one time.
Use any small object for each person’s marker that moves on the board.
Use one die and begin play. Move the marker the number of spaces on the board.
Each player must select which path he/she will take to Mars at his/her first turn. If a player is sent back to Earth, that player may choose either path to proceed.
You must stop on each shaded space, regardless of your roll, and record your points. In your next turn, roll the die and proceed as usual.
If a player lands on Chance, draw a card off the top of the Chance pile, do as it says, and return the card to the bottom of the pack.
When one player finishes the game (you do not need an exact roll to move to the last space), all other players continue to play in turn until each has finished and received all points.

Scoring
Each player must record all Radiation Points and Mission Points on his/her card. At the end of the game, each totals his/her own points and plots the two values in a single point on the graph on the back of the Card. The player with the point that is most in the upper left-hand corner of the graph is the winner.

Record Mission Points for launching, landing, etc. next to the appropriate space on your tally card.
If you are sent back to Earth with a Chance card, your score card continues to accrue Mission Points and Radiation Points. You do not clear your card to 0’s.

Here are some real numbers for radiation exposure (from NASA)

<table>
<thead>
<tr>
<th>TYPES OF EXPOSURES</th>
<th>REM</th>
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<tbody>
<tr>
<td>Transcontinental Round Trip by Jet</td>
<td>0.004</td>
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<tr>
<td>Chest X–Ray (Lung Dose)</td>
<td>0.010</td>
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<tr>
<td>Living One Year in Houston, TX</td>
<td>0.100</td>
</tr>
<tr>
<td>Living One Year in Denver, CO</td>
<td>0.200</td>
</tr>
<tr>
<td>Living One Year in Kerala, India</td>
<td>1.300</td>
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<tr>
<td>Highest Skin Dose, Apollo 14 (Mission to the Moon: 9 day mission)</td>
<td>1.140</td>
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<tr>
<td>Highest Skin Dose, Skylab 4 (Orbiting Earth at 272 miles, 87 day mission)</td>
<td>17.800</td>
</tr>
<tr>
<td>Highest Skin Dose, Shuttle Mission 41–C (Orbiting Earth at 286 miles, 8 day mission)</td>
<td>0.559</td>
</tr>
<tr>
<td>Maximum Allowable in 1 Year to a Terrestrial Worker</td>
<td>5.000</td>
</tr>
<tr>
<td>Background radiation in 1 Year on surface of Earth</td>
<td>0.100</td>
</tr>
<tr>
<td>+ or –</td>
<td>Radiation Points</td>
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<td>Crew:</td>
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<td>Launch ☀:</td>
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<td>Land ☮:</td>
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<tr>
<td>Launch ☯:</td>
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<tr>
<td>Comic Rad:</td>
<td></td>
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<tr>
<td>Land ☯:</td>
<td></td>
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Total RPs_________ Total MPs_________
Plot your totals on the other side
You sprained your ankle —  
Get an x-ray and lose a turn  
(+1 RP)

Scientific Breakthrough!!  
Move ahead 5 spaces

Space walking during sudden flare,  
+130 RPs  
RETURN TO EARTH

President endorses program  
Move ahead 5 spaces

(Only if in space; otherwise ignore)

Comet whizzes by —  
Sends you off course, lose a turn  
But gain +20 MPs for discovery

Hit by orbital debris —  
repairs needed, lose a turn  
Cosmic ray dose +10 RPs

(Only if in space; otherwise ignore)

Congress Budget Subcommittee  
cuts funding.  
GO BACK 3

Claustrophobia sets in  
−20 MPs

(Only before launch from Earth;  
otherwise ignore)

Spacecraft charging anomaly  
Damage to communication  
Loose a turn

Computer guidance upset  
Reboot necessary; lose a turn

(Only if in space; otherwise ignore)
<table>
<thead>
<tr>
<th>Chance</th>
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</table>
Discover a Black Hole
You name it after your school +20 MPs

Observe planets orbiting a distant star +15 MPs

High Scorer on Tetris +5 MPs

Sick of Space Food! –10MPs

UFO rendezvous
You are happy +10 MPs,
but the crew is worried about your health +10RPs
(Only if in space; otherwise ignore)

APPROACHING ASTEROID!
Roll die to see how close it comes:
6 or 5 Photograph an asteroid +15 MPs
4 or 3 Close call! Stress high –10 MPs
2 or 1 HIT! You die. Remove your marker from the board
(Only if in space; otherwise ignore)