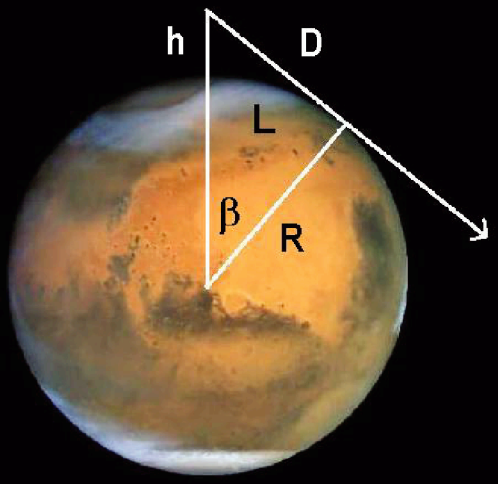
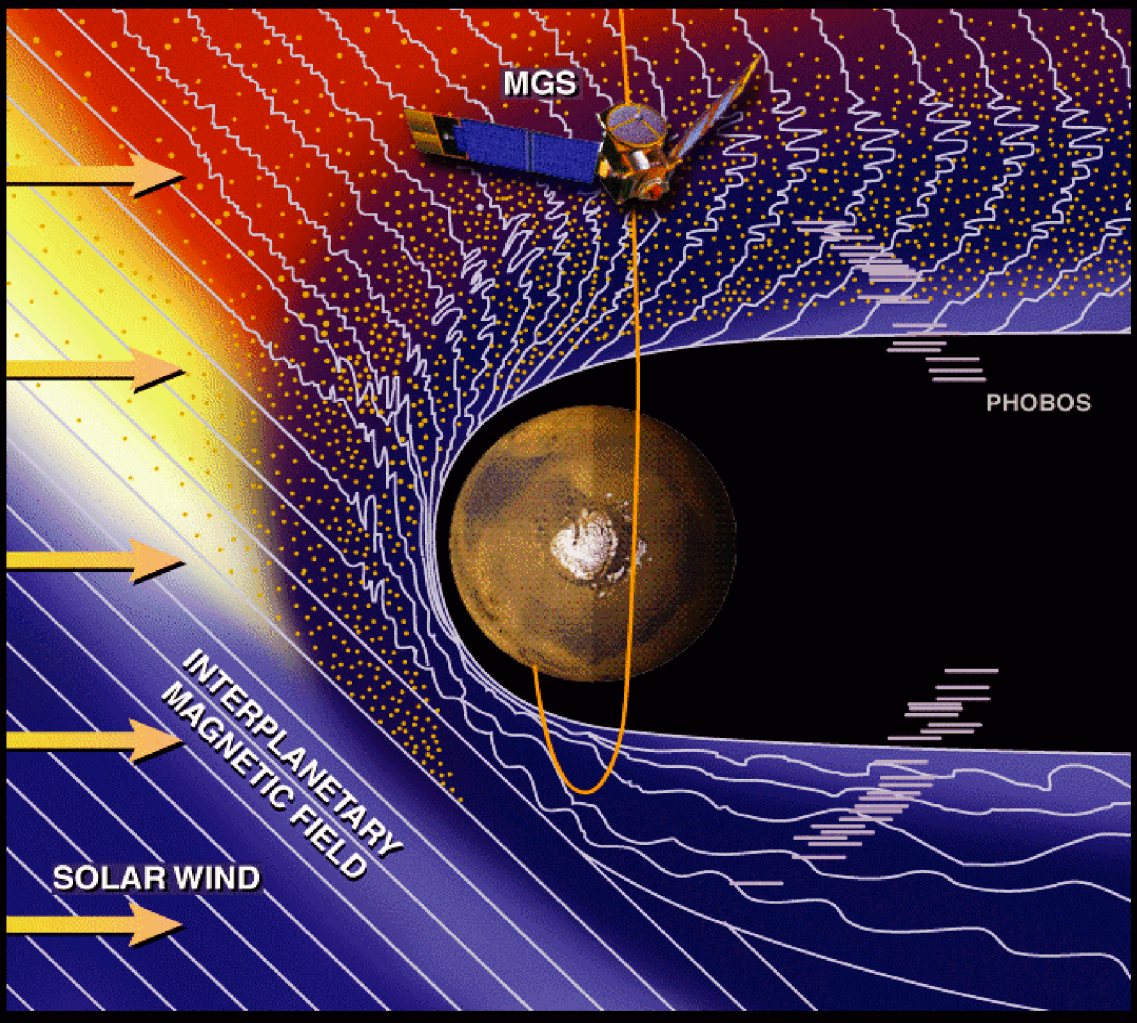
National Aeronautics and Space Administration





Space Math - III

This collection of activities is based on a weekly series of space science problems distributed to thousands of teachers during 2006-2007 school year. They were intended as extra-credit problems for students looking for additional challenges in the math and physical science curriculum in grades 9 through 12. The problems were designed to be authentic glimpses of modern science and engineering issues that come up in designing satellites to work in space, and to provide insight into the basic phenomena of the Sun-Earth system, specifically 'Space Weather'. The problems were designed to be 'one-pagers' with a Teacher's Guide and Answer Key as a second page. This compact form was deemed very popular by participating teachers.

This booklet was created by the NASA, Hinode satellite program's Education and Public Outreach Project.

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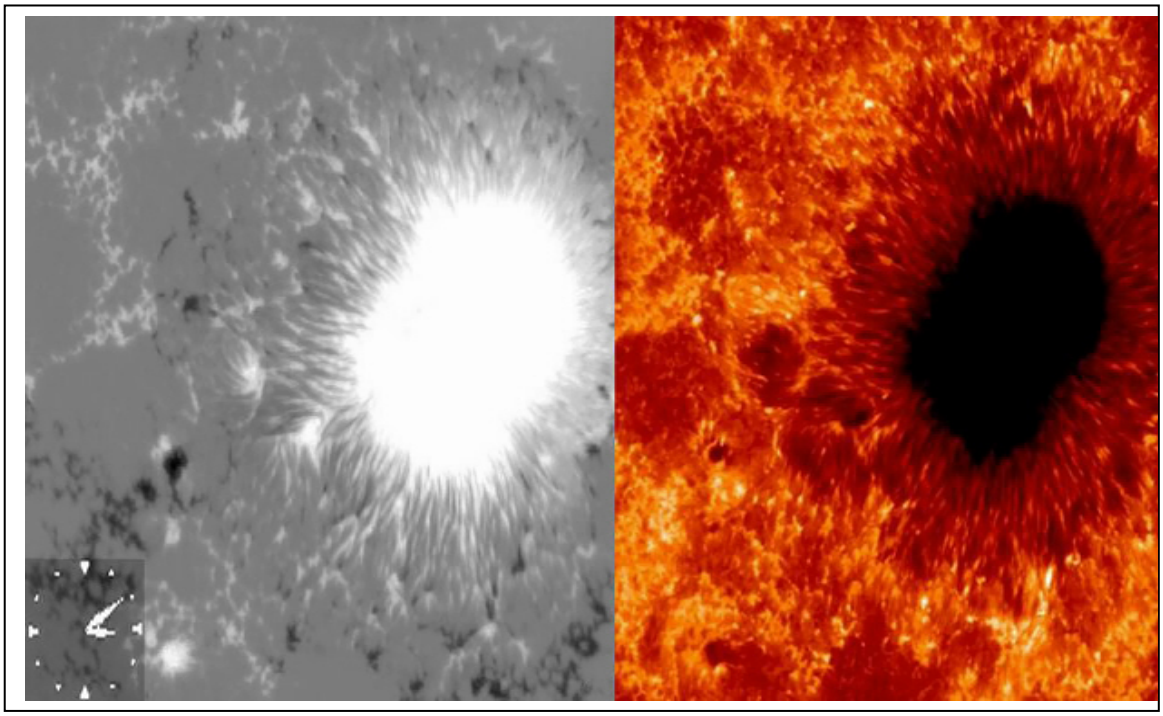

The pictures show sunspot magnetic fields imaged by the Hinode satellite in November, 2006.

For more weekly classroom activities about the Sun-Earth system visit the NASA website,

http://spacemath.gsfc.nasa.gov

Add your email address to our mailing list by contacting Dr. Sten Odenwald at

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Alignment with Mathematics Standards

The following table connects the activities in this booklet to topics commonly covered in geometry, algebra and calculus textbooks. The cells are shaded according to these three math content areas. The specific national math and science education standards (NSF 'Project 2061') targeted by this product are:

Grade 9-10 - Algebra I

Find answers to problems by substituting numerical values in simple algebraic formulas.
Use tables, charts and graphs in making arguments and claims in oral and written presentations.
Distances and angles inconvenient to measure directly can be found by using scale drawings.
Perform unit conversions in multi-step problems.

Grade 11-12 - Algebra II and Calculus

Solve simple equations for 'X', and compound interest.
Examine practical applications of matrix algebra.
Work with trigonometric functions in simple applications.
Use the Chain Rule for Differentiation.
Find the areas under curves, both graphically and using simple integrals.

Topic	Problem Number																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Logic														X												X	X										
Time, distance															X					X													X			X		
Area, and probability																		X										X									
Venn Diagrams percentages																					X					X	X									X		
Scale drawings				X			X						X		X			X	X	X		X	X	X					X			X	X		X		
Polygonal Areas			X	X	X		X																														
Geometry													X						X	X		X	X	X				X				X					
Sci. Notation						X			X							X													X								
Unit Conversions	X	X	X	X	X						X						X								X			X			X						
Graph Analysis		X	X	X		X	X				X		X												X			X		X		X			X	X	X	X
Systems of Equations								X																														
Sin, Cos, Tan																			X			X	X	X														
Solving for X												X							X			X	X	X														
Evaluating Fns									X	X		X				X			X			X	X	X							X	X						
Polynomials												X																										
Function Differentiation																			X																		X
Graphical Integration		X	X	X	X		X																														
Function Integration																								X								X					
Compound Interest																															X						

Teacher Notes. The order of the problems in this book reflects the order in which they were presented as Weekly Problems during the school year and do not represent a logical sequence of science study. Below are the general topic areas that are covered, and a suggested sequence of presentation by level of math difficulty if they are used as part of a course of study.

Teacher Notes. Here is the order in terms of the mathematics topics covered:

Addition, Subtraction, Multiplication, Division, unit conversion, percentages

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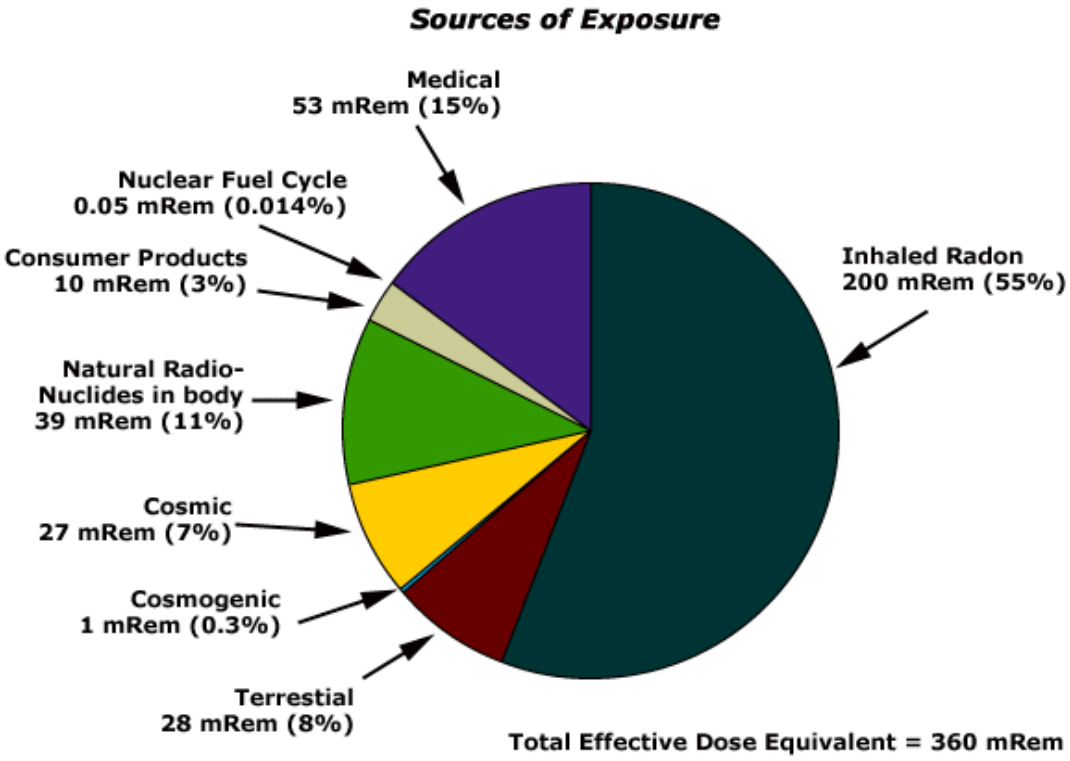
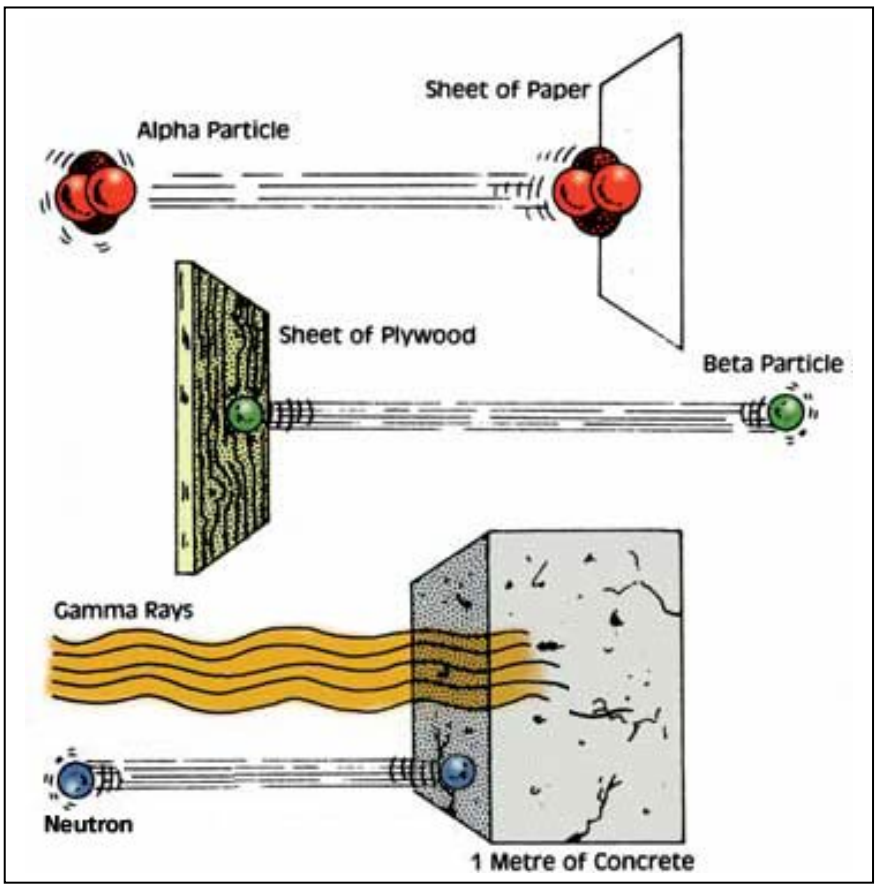
Cover Credits: Astronaut White (NASA/Gemini); Mars solar wind (NASA/JPL/ Mars Global Surveyor); International Space Station (NASA/ISS)

Inside Figure Credits: 1) Radiation Pie chart (Lawrence Radiation Lab); 3) Astronaut White (NASA/Gemini); 4) Mars radiation (NASA/Mars Orbiter); 6) Altair UAV (NASA/Dreyden); 7)Van Allen belts (WWW unattributed) Radiation dosages (NASA/CRRES); 8) solar images (NASA/SOHO) Satellite (Boeing); 9) Alien monster (WWW unattributed); 10) Aurora photo (Dick Hutchinson); 11) Radon Map (EPA); 13) Sunspot (Hinode); 150 Solar images (NASA/ESA/SOHO); 16) Magnetosphere model (University of Michigan/SPARC); 17) Squirrel (www unattributed); 18) Lunar impacts (NASA); 19) Mars (NASA); 20) Tsunami waves (National Solar Observatory); 21, 27) solar images (NASA/ESA/SOHO); 22, 23, 24) Earth image (NASA / Apollo 17); 29) Hinode spacecraft (Hinode/RAL - B. E. Johnson); 30) Solar surface (NASA/Hinode); 33) mercury transit (NASA/STEREO); 34) solar corona (Hinode)





Different types of radiation can be shielded by different materials

A note from the Author:

Hi again!

I hope you and your students are enjoying this collection of unusual math problems!

Through my middle school and high school years, I was constantly inspired and enthralled by space and astronomy. Not surprisingly, since it was the 1960's and these years in my life were bracketed by John Glen's famous orbit of Earth, and the Apollo-11 moon landing..and, oh yes, movies like '2001: A Space Odyssey' and TV programs like 'Outer Limits' and 'Star Trek'. (I never took 'Lost In Space' seriously!)

Although I have been a professional astronomer since 1982, Mathematics was not especially easy for me in elementary school, and in grades 7-12. I would regularly get Bs and a few As. But in those days that was enough to guarantee you admission into virtually all colleges, since only about 15% of high school seniors went on to a 4-year college. I went to U.C. Berkeley because it was only a 40-minute bus ride from my parent's front door where I would live as an undergraduate. Luckily for me, UC had one of the best Astronomy and Mathematics Departments in the world!

Despite my non-stellar grade-school abilities, I always enjoyed math and had a positive attitude about it. I was intrigued by algebra and trigonometry, but that was just a warm-up. When I got my first taste of calculus during the end of my Senior Year at Fremont High School in Oakland California, it was like some kind of epiphany. I was overpoweringly struck by how beautiful the various mathematical symbols were; the graceful integral signs, the elegantly loopy partial derivative sign, the mysterious capital-deltas and the choppy-looking sigmas. Each had a story to tell, and I was so excited that after 12 years of school, I could start to understand the beauty in this math. This inspiration and attitude paid off.

When I started college, my grades in math soared to straight-As with the occasional B. I credit all of that to a positive and inquisitive attitude towards math, but also to the simple fact that I had perhaps out-grown older ways of thinking that had silently held me back, and I had somehow 'matured' into the subject.

So, what does this long-ago experience have to do with today's student learning in mathematics? Perhaps it reflects on providing additional motivation to a struggling student, one of which would well have been me in today's educational system. Perhaps it means that, when a student has a sense of what they want to be, they can more easily see why math is going to be an important aspect of that future career dream. Perhaps it also means that students are still developing and unfolding at a time when they are asked to master mathematical concepts that may well be temporarily too advanced for where they are at that moment.

Whatever the situation, I would personally like you to know that achieving a career in science is a marathon, not a 100-yard dash. Some of the brightest students that race out of the gate first, may well not have the stamina that a slightly less adept student has, who has a dream of someday walking on the moon, or peering into the deepest recesses of the atom.

Sincerely,
Dr. Sten Odenwald
NASA Astronomer

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