

# Welcome to the Challenge!



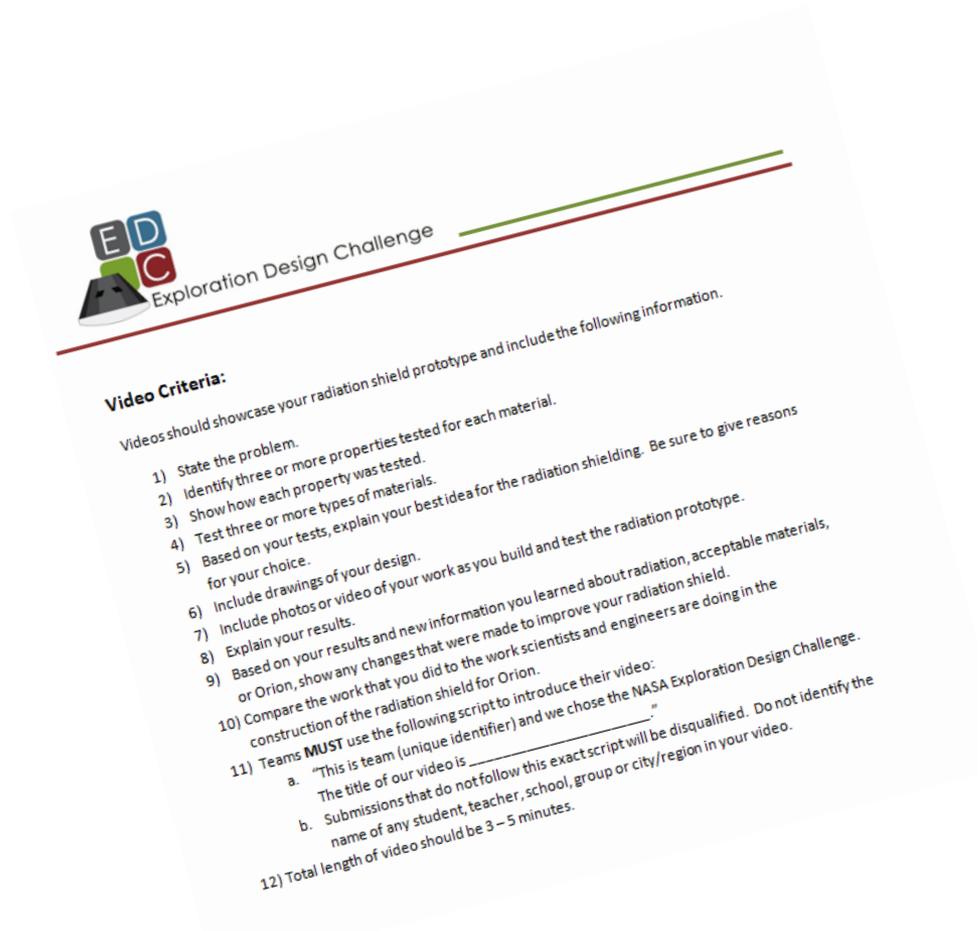
Astronaut Sunita Williams, aboard the International Space Station, invites you to help NASA chart *your* pathway to Mars! [www.nasa.gov/education/edc](http://www.nasa.gov/education/edc)



# Exploration Design Challenge



# Share Your Work



Create a video to share your results.

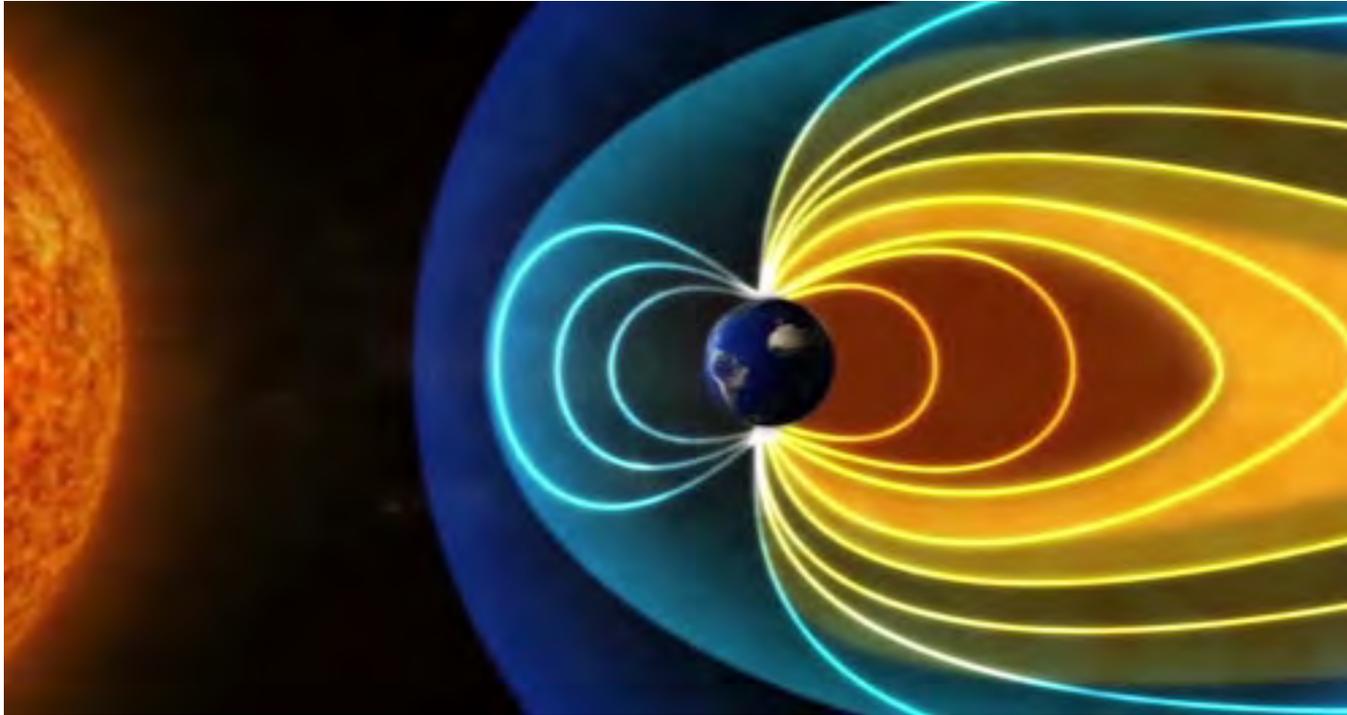
# Our Sun



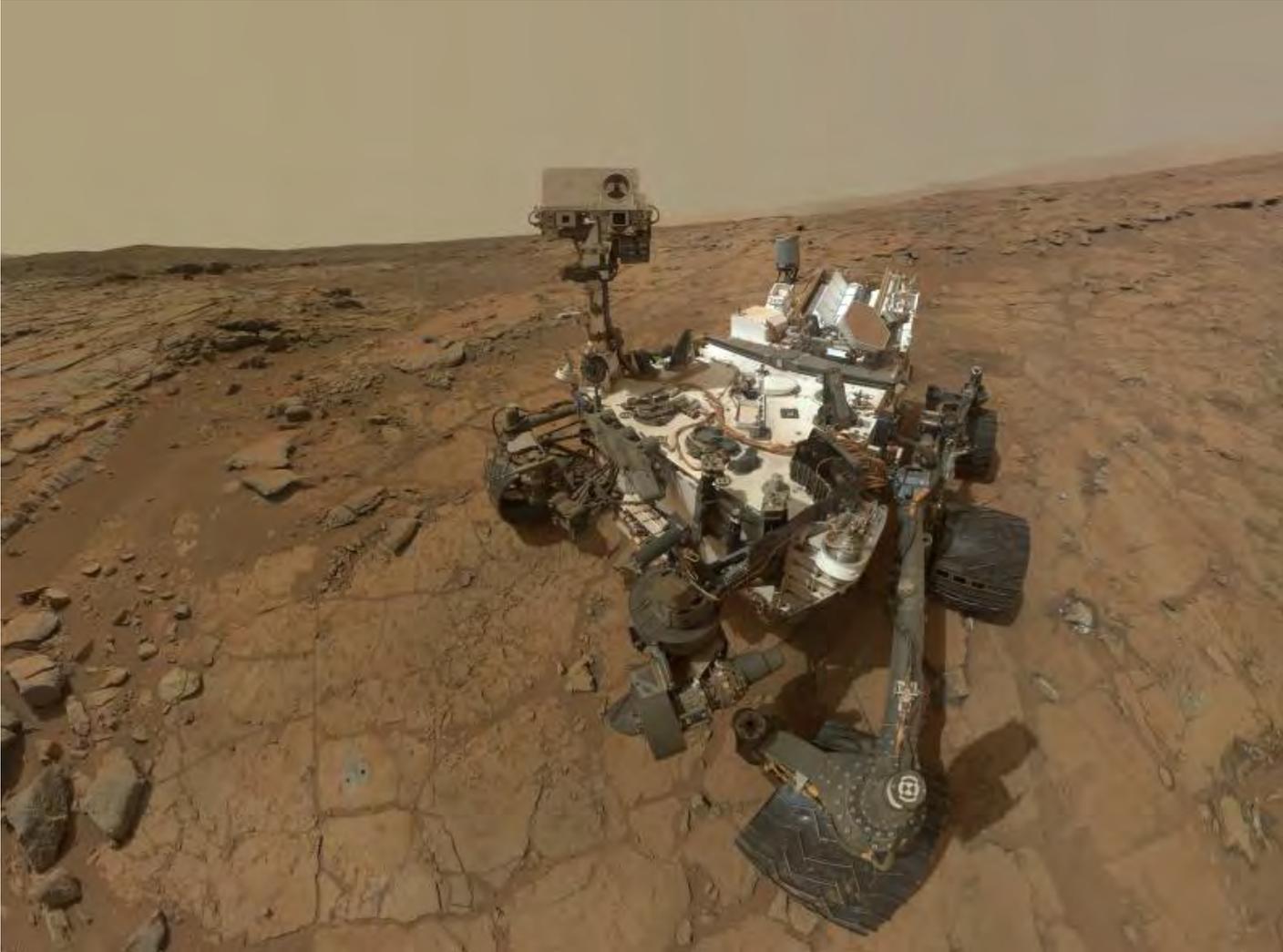
Animation:

<http://sdo.gsfc.nasa.gov/gallery/animations/item/248>

# Protection from Radiation

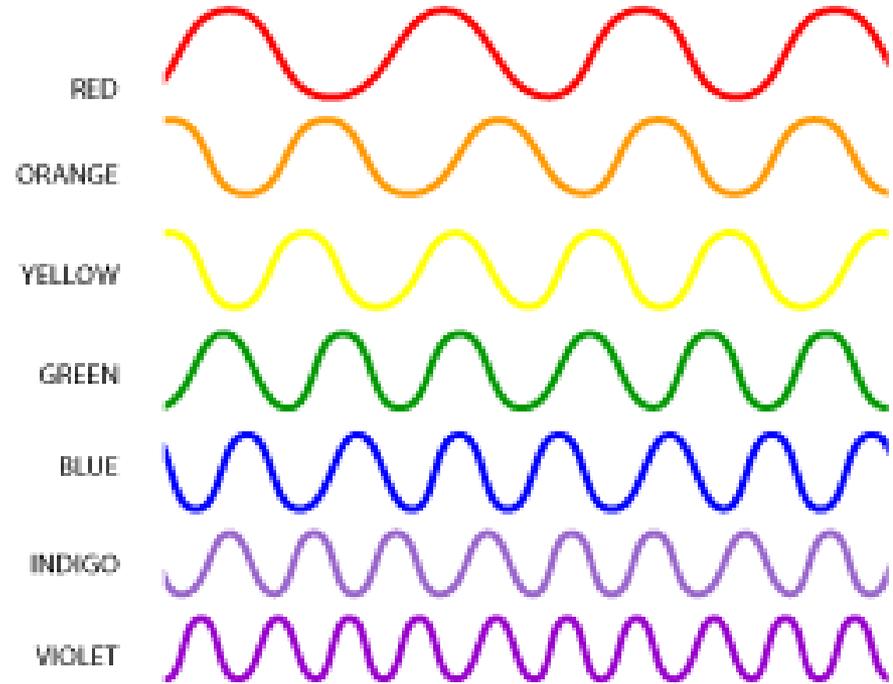
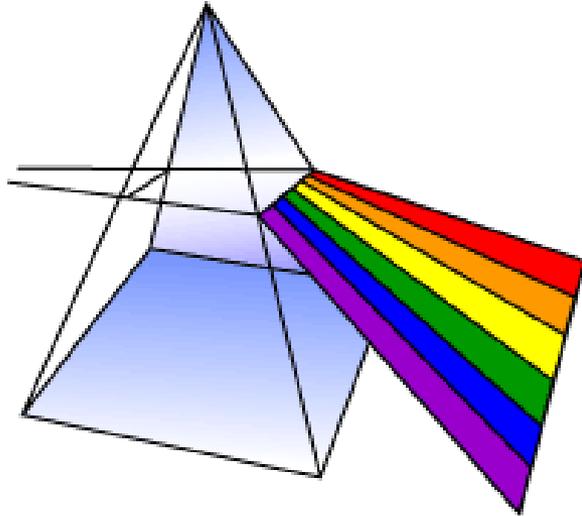


How do Earth's atmosphere and magnetosphere protect us from radiation?



Mars Science Laboratory

# What is Radiation?



Think first about visible light:

- Organized by wavelength
- Red waves are long – not much energy
- Violet are short – lots of energy

# Electromagnetic Spectrum

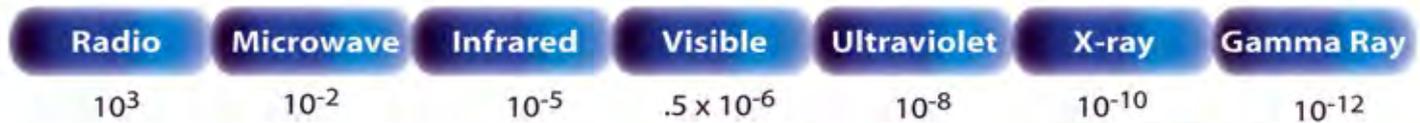


## THE ELECTROMAGNETIC SPECTRUM

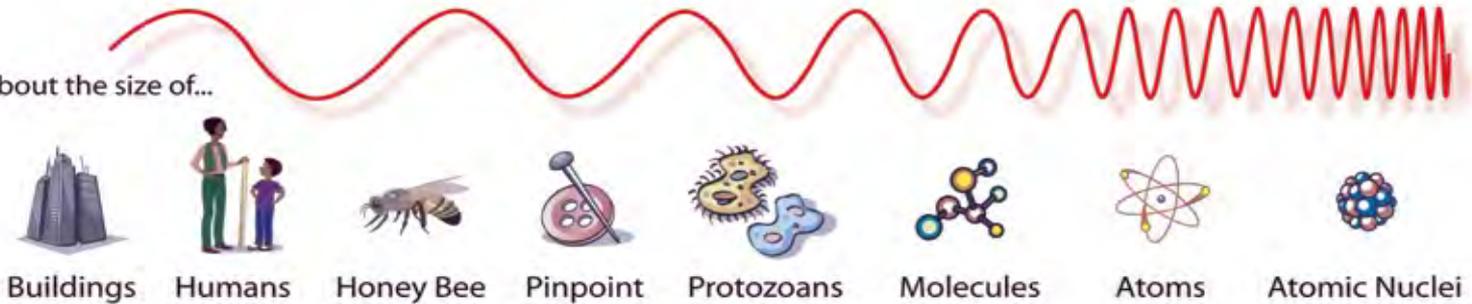
Penetrates Earth Atmosphere?



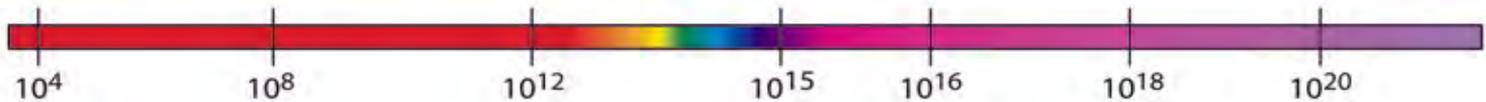
Wavelength (meters)



About the size of...



Frequency (Hz)



Temperature of bodies emitting the wavelength (K)

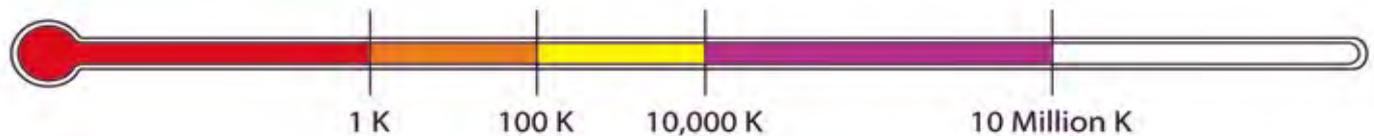
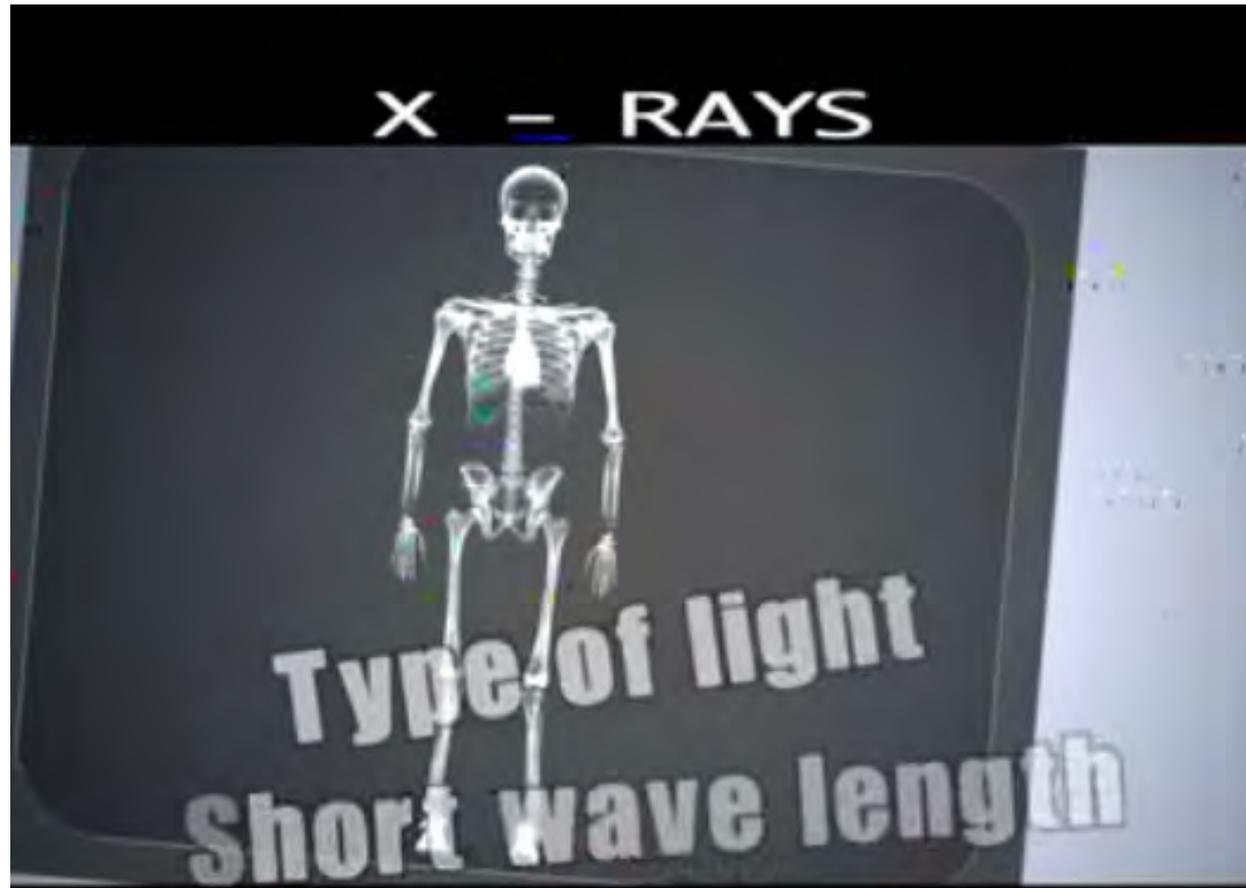


Image credit: My NASA Data

# X-Rays



# Transportation Capabilities to Enable Human Space Exploration



## Suborbital

Technology payloads and commercial passengers



## Low-Earth Orbit (LEO)

Scientific research and technology testing that improves life on Earth and enables future deep space exploration



International Space Station (ISS)

## GEO

Location for communications support to LEO missions



TDRS-K

## Trans-Lunar

Space environment to test and prove exploration capabilities and operations



Asteroid Retrieval Mission



## Deep Space

Human journeys of exploration and discovery, taking us farther into space than ever before



Curiosity  
(Robotic Precursor to Human Exploration)

Commercial Cargo		Commercial Crew		
Falcon 9	Antares	Atlas V	Falcon 9	Atlas V
SpaceX	Orbital Sciences	Boeing	SpaceX	Sierra Nevada Corp.

Orion Crew Vehicle

Space Launch System (SLS)

## Why Do Humans Explore?

Discovery | Scientific Knowledge | Returning Benefits To Humanity  
 Technology & Economic Growth | Expansion of Human Civilization | International Cooperation | Public Engagement

Last Updated:  
05/03/2013

# What Do You Know?





# Orion Spacecraft

The Orion vehicle will carry a crew of 4 astronauts and is designed for missions up to 600 days.

## 6000°F



Crew Module

Service Module

The Orion heatshield can withstand temperatures up to **6000° F**, nearly half the temperature on the surface of the sun.



Launch Abort System

## 13,000



The crew module returns to earth at a speed of **27,000 miles per hour**, 1.5 times as fast as the space shuttle, and 45 times faster than a commercial airliner.

If the launch abort motor energy could be converted to electric power, it would be enough to power **13,000 houses for an entire day**.

## 27,000 mph!



Image credit: Lockheed Martin

Footer

# Testing – Think Like a Scientist





What are benefits to working in a team?

<http://www.youtube.com/watch?v=ul754j31M3A>



# Record Data and Observations

## Record Data

### PART 1:

### Ray Shielding Analysis Chart

Dimension of sheets in centimeters:

Length \_\_\_\_\_

Width \_\_\_\_\_

Predict and test to find the number of sheets required to completely block the light from your flashlight.

	Copy		Tissue		Card stock		Construction	
	Predict	Actual	Predict	Actual	Predict	Actual	Predict	Actual
Total weight of all sheets in grams								
# sheets to block the simulated space radiation								

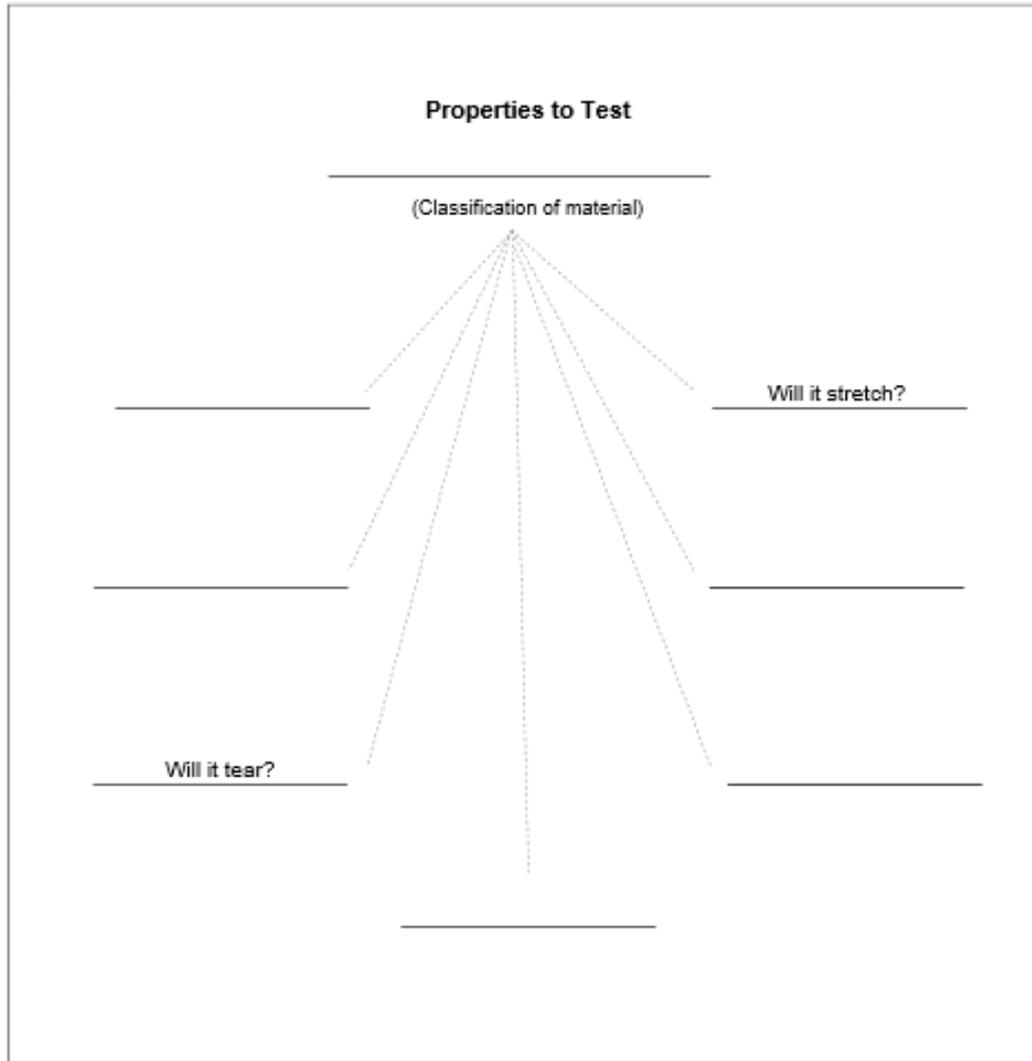
# Record Data and Observations



Record Data

PART 2:

Further Materials Analysis Web



Decide which properties you want to test.

# Record Data and Observations



## Record Data PART 2: Further Materials Analysis Chart

Record observations about each of the properties you chose to test.

Rank the materials from 0 to 5					
0	1	2	3	4	5
No sign of property	Medium sign of property			Large sign of property	

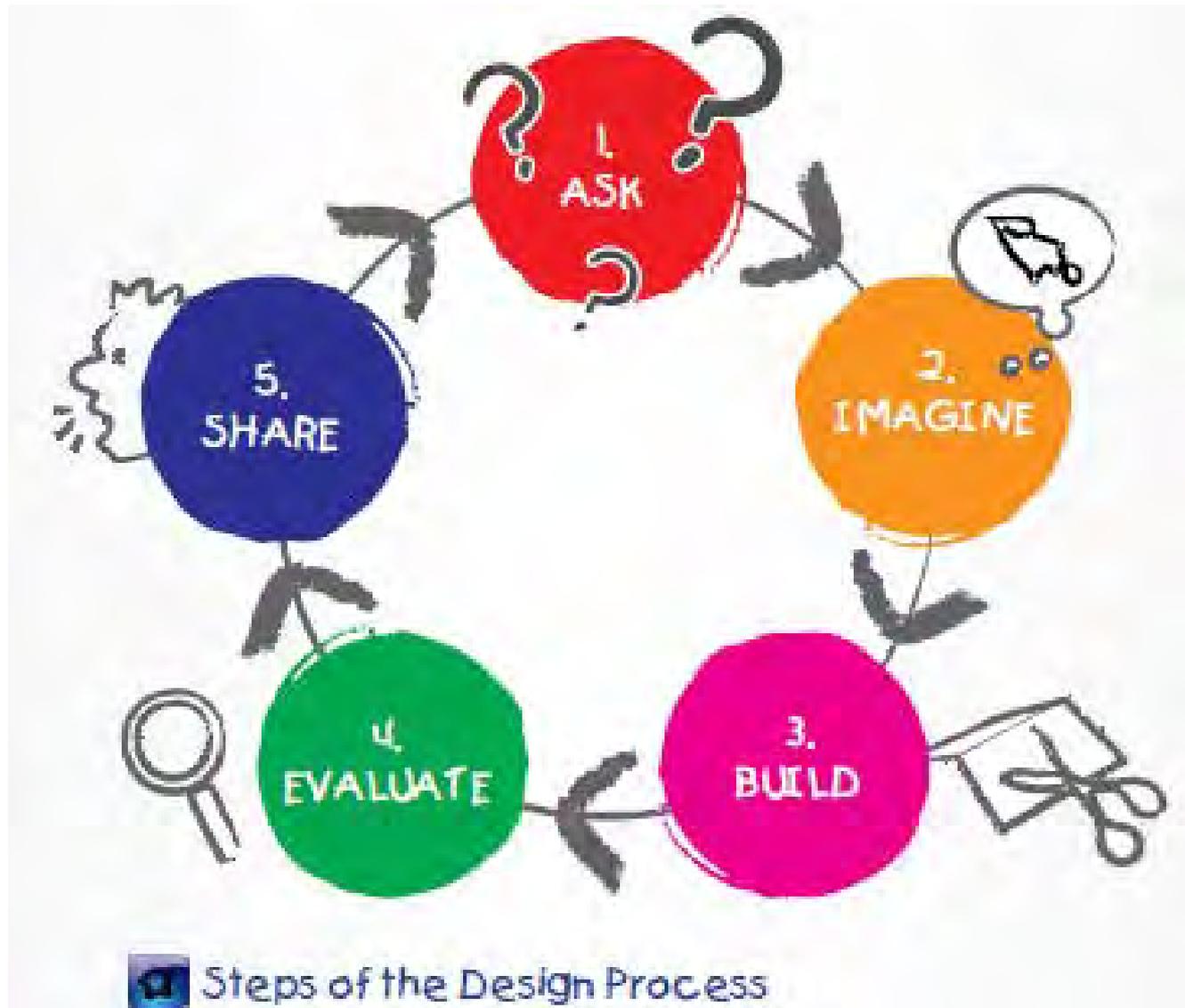
Property to test	Describe the test	Copy	Tissue	Card stock	Construction
Will it tear?	I will tear the material with my hands.				
Will it stretch?	I will pull outward on the sides of the paper.				



## Problem Statement:

Using the materials tested, how can we design and build a radiation shield that will block visible light?

# Engineering Design Process



# Evaluate – Improve Your Model



## What are low-Z materials?

[www.youtube.com/watch?v=SB7b5sJJco&feature=youtu.be](http://www.youtube.com/watch?v=SB7b5sJJco&feature=youtu.be)

**Periodic Table of the Elements**

1 1IA 11A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A																		
1 H Hydrogen 1.0078	2 He Helium 4.0026											3 Li Lithium 6.941	4 Be Beryllium 9.01218	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.0074	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797																
11 Na Sodium 22.989769	12 Mg Magnesium 24.305	3 Al Aluminum 26.981539	4 Si Silicon 28.0855	5 P Phosphorus 30.973762	6 S Sulfur 32.065	7 Cl Chlorine 35.4527	8 Ar Argon 39.948	9 K Potassium 39.0983	10 Ca Calcium 40.078	11 Sc Scandium 44.95591	12 Ti Titanium 47.88	13 V Vanadium 50.9415	14 Cr Chromium 51.9961	15 Mn Manganese 54.938	16 Fe Iron 55.845	17 Co Cobalt 58.9332	18 Ni Nickel 58.6934	19 Cu Copper 63.546	20 Zn Zinc 65.38	21 Ga Gallium 69.723	22 Ge Germanium 72.64	23 As Arsenic 74.9216	24 Se Selenium 78.96	25 Br Bromine 79.904	26 Kr Krypton 83.80										
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9062	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29	55 Cs Cesium 132.90545	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon [222]
87 Fr Francium 223.0187	88 Ra Radium 226.0254	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Uuq Ununquadium [285]	115 Uup Ununpentium unknown	116 Uuh Ununhexium [285]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown																		
		57 La Lanthanum 138.9055	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93403	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967																			
		89 Ac Actinium 227.0287	90 Th Thorium 232.0377	91 Pa Protactinium 231.03689	92 U Uranium 238.02891	93 Np Neptunium 237.04817	94 Pu Plutonium 244.0642	95 Am Americium 243.0613	96 Cm Curium 247.07125	97 Bk Berkelium 247.07125	98 Cf Californium 251.07958	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [260]																			
Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanides	Actinides																										

# Evaluate – Improve Your Model



What are some easy-to-find low-Z materials?

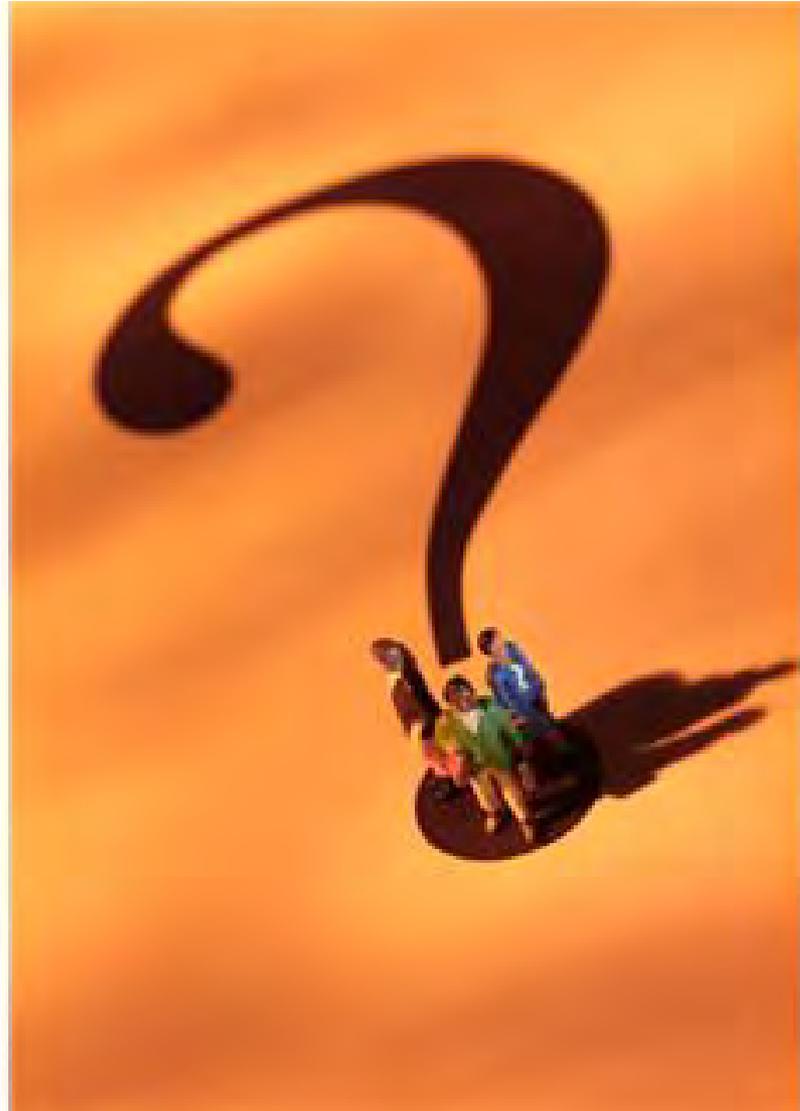


[www.youtube.com/watch?v=5nSxFbDVlo8](http://www.youtube.com/watch?v=5nSxFbDVlo8)

# Questions?



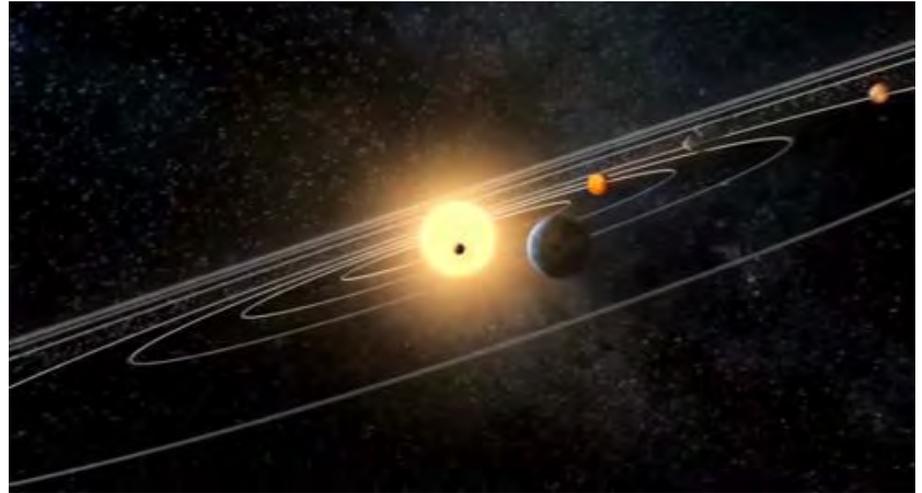
What questions  
would you ask an  
engineer or  
scientist?



# Space Radiation



How is radiation in space different from radiation on Earth?



# Electromagnetic Spectrum

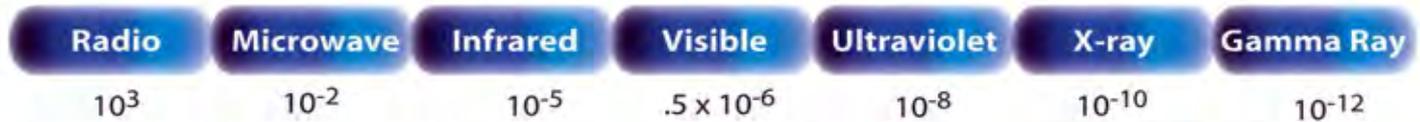


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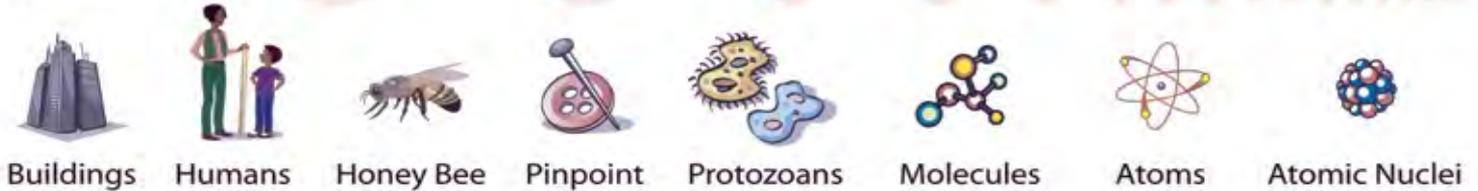
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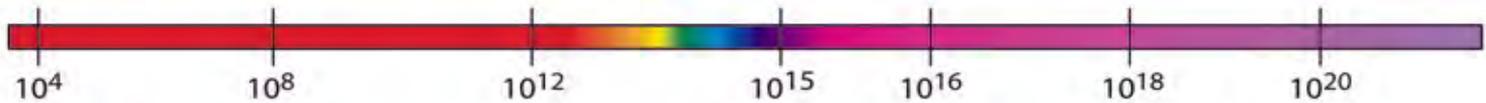
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About the size of...



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Temperature of bodies emitting the wavelength (K)

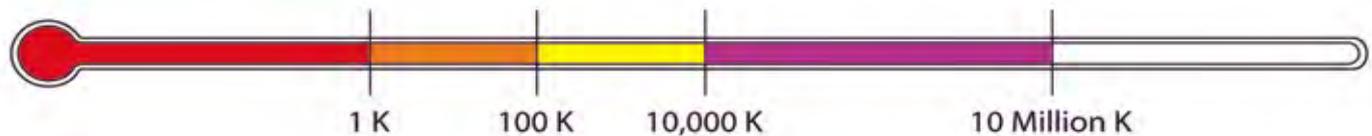


Image credit: My NASA Data



How do scientists and engineers work together?

How does what we know about radiation influence the design of Orion?



# Re-Design – Think Like an Engineer



Re- design and build a radiation shield that will block both visible and UV light.

# Congratulations!

