Totally RAD!

Project ID: #
3500 Twin Peaks Blvd.
Farmington
New Mexico
87401
United States of America

Introduction

While humanity’s past is firmly grounded on our home planet, the humans of the future may possibly live on Mars. Besides curiosity, reasons for colonizing Mars may include the potential for humans to extend our knowledge past what we’ve learned from rovers, future of Earth's environment, making humans a multi-planet species, and decreasing the likelihood of human extinction. To prepare for this cosmic migration, today’s scientists are exploring how living in space affects the human body. Future settlers are unable to inhabit the “Red Planet” due to the harsh conditions that exist in the planets’ atmosphere, with an overwhelming 40-50 times the average radiation levels on Mars than Earth, being detrimental to all parts of the body! This has proven to be a difficult task, however, NASA has already made two main contributions to this obstacle, martian concrete and beta cloth. In this study, the researcher hopes to find more effective ways, the researcher will use engineering countermeasures to find primary resources to shield Alpha, Beta, and Gamma particles and prove the hypothesis.

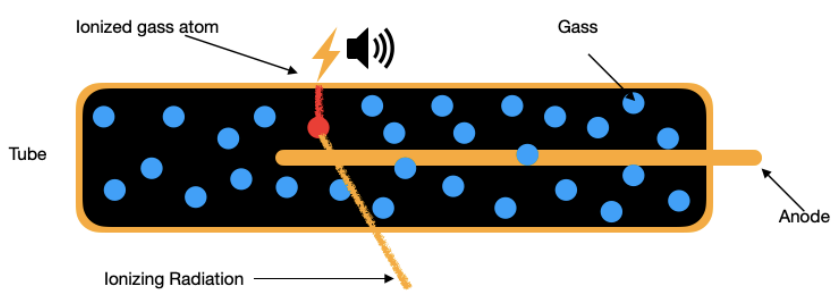
Methods

The two methods that the researcher will demonstrate to measure radiation exposure includes, the Geiger counter method and the cloud chamber method. With the Geiger counter, the researcher will place suspected known radiation blocking material candidates between the radiation sources (Po-210, Sr-90, Co-60) and a detector (Geiger counter). Testing will determine the amount of radiation that each material intercepts and how much of the material is adequate. The cloud chamber can be used as a more effective way to visually see the radioactive decay and verify which materials indeed blocked radiation. Both methods are repeated for each blocking material with each radiation.

EQUIPMENT

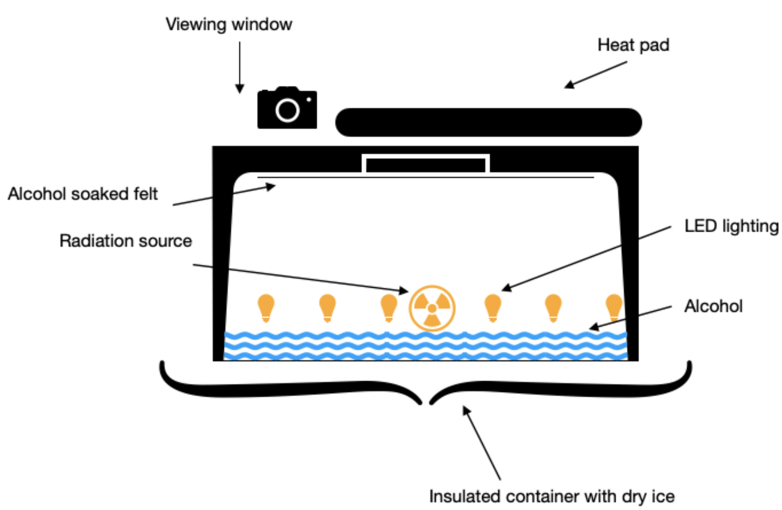
The geiger-muller tube is a chamber filled with a basic gas such as neon and an energy source. Though it can be used for all materials, it is more preferentially used in this experiment for the thicker materials. When the tube is exposed to ionized radiation, the ions collide with the gas and conduct energy creating the beeping/clicking sounds. Fig. 1

Figure 1 GEIGER COUNTER



The cloud chamber is used to make ionizing radiation visual. The combination of hot and cold causes the alcohol within the chamber too condense, when there is a disturbance, the condensation will gather in noticeable streaks. Each radiation type has its own unique streak that allows the researcher to identify the types of radiation escaping the blocking material.Fig. 2

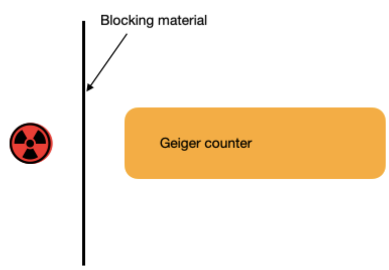
Figure 2 CLOUD CHAMBER



PROCEDURES

For the Geiger counter method, start with applying all the necessary protective gear for radioactive exposure (goggles, gloves, mask, etc.). After obtaining the recommended ionizing sources (radiation) and blocking materials, find an open, well ventilated area for testing. Use your radiation detector (geiger counter) and measure the original, unprotected radiation level for each of your sources individually. One by one, place each of your shielding materials between the geiger counter and each radiation source, time lapse will be thirty minutes for each test, for each material and source. Results of RADs (Radiation Absorbed Dose) are recorded by the geiger counter application, Capstone. Fig. 3.

Figure 3. GEIGER COUNTER METHOD- How the geiger counter method will be conducted



With this collected data, using the inches to block formula, Fig. 4, find how much of each resource you would need to shield the common radiations (alpha, beta, and gamma). Whichever deflects the most radiation and is more efficient.

Fig. 4 FORMULA- Used to find the needed inches to block each radiation source

$$\frac{\text{Results of radiation not blocked for each material}}{\text{The original amount of radiation given by each source}} = \text{\% not blocked}$$

$$100 - \text{\% not blocked} = \text{\% blocked}$$

$$\frac{\text{Inches of each material}}{\text{\% blocked}} = \text{Needed inches to block each of the sources}$$

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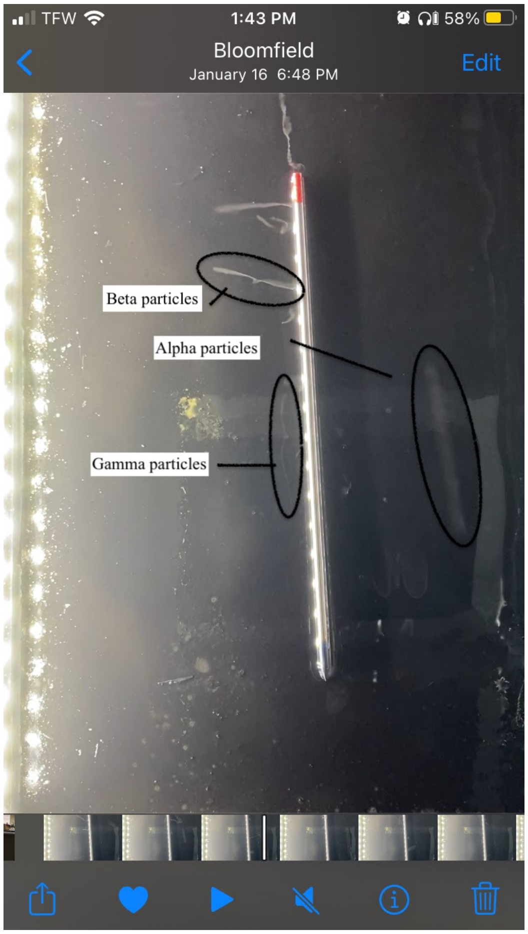
$$\frac{\text{Needed inches to block each of the sources}}{\text{The original amount of radiation given by each source}} = \text{Inches needed to block 1 milliard of block each type of radiation}$$

Creating a Cloud Chamber. Gather all the needed materials to build the cloud chamber, remove the bottom of a glass fish tank by using the utility knife to cut the silicone glue, removing the trim from the bottom and sides of the tank. Because heat is needed to transfer, replace the bottom of the tank, spray painted black matte to show the particles within the cloud chamber, aluminum sheet that will fit snuggly (glass is an insulator and aluminum is known for transferring heat) and attach it with silver tape. On one of the long sides of the tank, add a L.E.D. strip, covering completely with the silver tape. In order to increase contrast and reduce glare from LED light on the other side of the tank. Tape another un-painted sheet of aluminum onto half of the top and add a glass plate on the other half in order to video or snap pictures of the reaction. Hot glue the felt onto the inside of the top piece of aluminum. Add your alcohol, methanol, or ethanol to the bottom (Optional to make it last longer) of the tank, then douse the felt. Plug in the LED light strip to a close power outlet. Inside the insulated container cut a hole and fill with dry ice and set the cloud chamber on top of the aluminum plate to speed up the vaporization of the alcohol. Add radiation sources and watch the magic happen. Fig. 5, Cloud Chamber. Fig. 6, RadiationVisual.

Fig. 5 CLOUD CHAMBER

Cloud Chamber experiment, one by one, places chosen shielding materials within the cloud chamber over the radiation source in a manner that will make it easy to distinguish if the shielding materials are blocking radiation particles from the source. With each material, count and identify the radiation particle trails, the alpha, beta, or gamma interactions. Fig. 6. Note: Cloud Chamber is used strictly for visual purposes.

Fig. 6 RADIATION VISUAL IN CLOUD CHAMBER- Source’s original disruptions



Results

Accessibility was taken into consideration when deciding the best material for blocking alpha, beta, and gamma particles. It was determined by variables such as pricing, durability, and availability of material on Mars and Earth. Magnesium is abundant on both earth and the red planet (found in the regolith), "...has the advantages of low density(usually blocks better when denser), light weight, and high specific strength"(nature.com). With an accessibility score of 82.5%, magnesium was found to be the most accessible material to use while blocking. Fig. 7

Fig. 7 ACCESSIBILITY CHART- How readily available is each material.

Materials	On mars 1/10	On earth 1/10	Pricing 1/10	Durability 1/10	Overall %
Aluminum	7/10	9/10	9/10	5/10	75%
Beta cloth(control)	1/10	3/10	2/10	8/10	35%
Concrete	3/10	8/10	3/10	8/10	55%
Brass	2/10	3/10	8/10	9/10	55%
glass	9/10	8/10	4/10	2/10	57.5%
Iron	9/10	10/10	9/10	7/10	50%
Magnesium	9/10	10/10	5/10	9/10	82.5%
Aluminum Alloy	8/10	9/10	8/10	7/10	80%
Water	3/10	10/10	9/10	3/10	62.5%

The geiger counter method was tested three original times for each material and each radiation source; it was later averaged to find the median result. Fig 8. Each material and radiation source was tested again over 30 minute periods to create a scatter plot. example: Fig. 9. Once the results were recorded a simple math formula (Fig. 10) was used to calculate the needed inches per material it would need to block one miliRAD of each radiation type. Fig. 11.

Fig. 8 RESULTS- Overall results in MiliRADs

Materials	Po-210	Sr-90	Co-60
Aluminum-overall	1.86	0.31	3.53
Beta cloth (control)-overall	0.14	21.32	12.7
Concrete-overall	1.8	0.14	0.92
Brass-overall	0.14	2.8	1.2
Glass-overall	0.14	8.98	13.43
Iron-overall	0.17	0.22	1.31
Magnesium-overall	0.08	0.22	5.64
Aluminum alloy-overall	0.03	0.08	0.06
Water-overall	0.06	6.77	12.37

Fig. 9 RESULTS SCATTER PLOT EXAMPLE- Co-60 test with magnesium

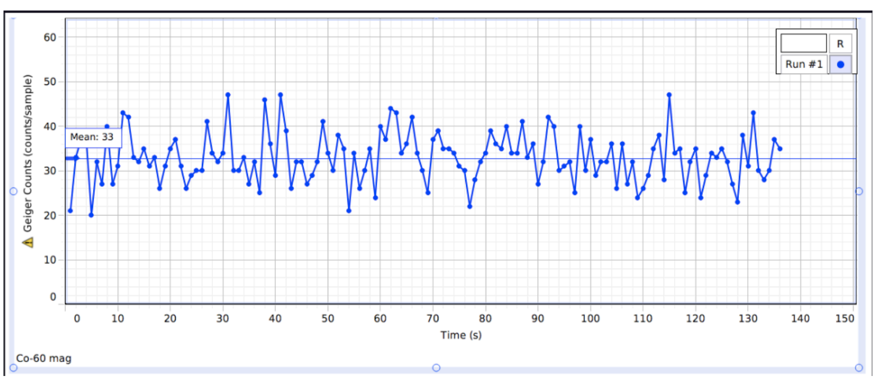


Fig. 10 FORMULA- Used to find the needed inches to block each radiation source

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$$\frac{\text{Needed inches to block each of the sources}}{\text{The original amount of radiation given by each source}} = \text{Inches needed to block 1 milliard of block each type of radiation}$$

Fig. 11 RESULTS- Needed inches to block one MiliRAD of each source

Materials	Width to block one rad of Po-210	Width to block one rad of Sr-90	Width to block one rad of Co-60
Aluminum-overall	7.15 inches	0.04 inches	0.08 inches
Beta cloth (control)-overall	0.21 inches	0.02 inches	0.1 inches
Concrete-overall	11.25 inches	0.09 inches	1.43 inches
Brass-overall	0.54 inches	0.05 inches	0.06 inches
Glass-overall	0.07 inches	0.01 inches	0.04 inches
Iron-overall	0.55 inches	0.04 inches	0.07 inches
Magnesium-overall	0.13 inches	0.08 inches	0.02 inches
Aluminum alloy-overall	1.02 inches	0.08 inches	0.12 inches
Water-overall	0.52 inches	0.05 inches	0.23 inches

CONCLUSIONS

The researchers’ goal was to test and discover a more effective shielding material that would aid in the blocking of radiation and that would be readily available for future Mars explorers and possibly settlers. The researchers' hypothesis that Magnesium will be the most efficient material was determined through experiment, to be correct. Following complex testing, the researcher discovered that the next best was glass and concrete was the worst substance for blocking radiation. The researcher attempted to keep all variables in check, but design errors such as temperature fluctuation and videography challenges occurred, making it difficult to record data. Radiation is one of the most prominent dangers to space travel, detrimental to all parts of the body, so it is important that people know more about this topic for a few reasons. First, for long-term exploration in space, next, the future of Earth's environment, making humans a multi-planet species, and last, possibly decreasing the likelihood of human extinction. Ideas for a continuation of this research project could be “Radiation shielding using magnetic fields” or “Further exploring different readily available materials or combining already known effective materials”.

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