Shielding – Play it safe!

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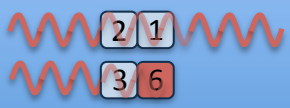
The radiation produced in a nuclear reactor like the one you have visited at MIT is dangerous due to the fact that it has enough energy to cause permanent damage to human beings, electronic devices and structural material.
The type of material used to shield the surrounding environment depends on the type of radiation which includes high energy neutrons, gamma (γ) rays, and X-rays.
It is the purpose of this class assignment to determine which would be the most cost effective material to be used to shield gamma rays which is a form of electromagnetic radiation that has higher energy levels than those displayed by ultraviolet or visible light.

Example:



γ ray passes

γ ray is stopped

RULES:

1. To determine the penetrability of a gamma ray through a particular block of a material roll the die and note the result in the block. The ray is coming from the left and travels through the material until it is stopped or exits on the right.
2. The following rules must be applied:

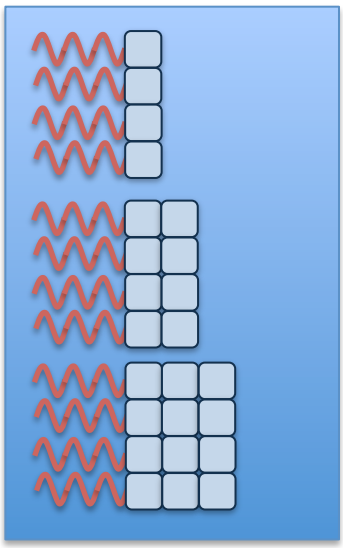
LEAD: The ray passes if a 1, 2 or 3 is rolled and stops when 4, 5 or 6 is rolled. Price ($$$)

IRON: The ray passes if a 1, 2, 3 or 4 is rolled and stops when 5 or 6 is rolled. Price ($$)

CONCRETE: The gamma ray stops only at a 6 and continues otherwise. Price ($)

Assignments:

a) Play the game according to the rules above and try to summarize your results.



number of rays passing:

number of rays passing:

number of rays passing:

Notes:

b) (In groups of three) Compare your results. How does the number of passing γ-rays relate to the thickness and type of shielding material?

c) (In groups of three) Imagine the MIT nuclear reactor needs a new wall. Using the results of assignments *a* and *b*, develop a wall for the reactor which is both safe (at most 1 in 10 γ-rays get through the wall) and cost-effective (take the relative cost of materials $/$$/$$$ into consideration). Compare your result to the results of another group of students and discuss possible improvements. Think about further aspects which have not been taken into consideration yet.