Radiation Shielding

Alpha, beta, gamma, and X-rays can pass through matter, but can also be absorbed or scattered in varying degrees depending on the material and on the type and energy of the radiation. Medical X-ray images are possible because bones absorb X-rays more so than do soft tissues. Strongly radioactive sources are often stored in heavy lead boxes to shield the local environment from the radiation.

Some materials absorb beta rays. A sheet of aluminum will absorb some of the betas, but will allow most to pass through. You can measure this absorption by fixing a beta source and a radiation monitor so their positions do not change, and then inserting layers of aluminum between them.

When an absorber is in the path of beta rays, it will allow a certain fraction to pass through. The fraction depends on the density and thickness of the absorber, but will be a constant for identical absorbers and fixed beta ray energy.

In this experiment, you will use a small source of radiation. Gamma Rays are photons, electromagnetic waves. Beta rays are high-energy electrons. *Follow all local procedures for handling radioactive materials.*

OBJECTIVES

- Use a radiation counter to study how the radiation emitted is absorbed by different materials.

MATERIALS

Chromebook
Vernier Radiation Monitor or Student Radiation Monitor
Cardboard squares
Radioactive sources
Paper squares
Aluminum sheets
Lead pieces

PROCEDURE

1. Launch Graphical Analysis. Connect the Radiation Monitor to your Chromebook, computer, or mobile device.

2. Set up the data-collection mode.

   a. Click or tap Mode to open Data Collection Settings. Change Mode to Event Based.

   b. Enter **Layer** as the Event Name and leave the Units field blank. The default value of 50 seconds/interval is correct for this experiment.

   c. Click or tap Done.

3. Determine the background radiation of the room. Point the sensor away from any radioactive source and click collect. Click Keep, date will collect for 50 seconds. A dialogue box will

appear asking for the number of layers. Type 0 for layers. Repeat this one more time type 0 for your layers.

4. Click stop and record these values in your data table for background radiation of the room, take the average and record that as well.

5. Obtain 1 of the 4 types of radioactive sources. They are C-14 a beta source, Ba-133 a gamma source, Co-60 a gamma source and, Cs-137 a gamma and beta source. Record this in your data table.

6. Place sources about 3 cm from the sensor and make sure the radiation is pointing at the sensor. Confirm that the sensor is picking up the radiation from the source.

7. Click KEEP to begin collecting data, data will collect for 50 seconds and it will again ask you for layers. Type 0. Record this value into your data table.

8. Insert one layer of paper between the source and detector. Be sure that the paper completely covers the source's "view" of the Geiger tube in the detector. Click KEEP to collect more data, and wait 50 seconds. Enter the new number of layers, **1**.

9. In the same way as before, place 5 layers of paper between the source and monitor without moving the source or monitor, click KEEP and wait 50 seconds, and enter the number of layers of paper.

10. Repeat this process with cardboard, first with 1 piece then with 5.

11. Repeat this process with aluminum foil, first with 1 piece then with 5.

12. Repeat this process with a piece of lead, only use 1 piece.

13. Complete this for each of the other sources.

DATA TABLE

Background radiation			Average value	
Radioactive source	C-14	Co-60	Ba-133	Cs-137
Unshielded				
1 sheet of Paper				
5 sheets of paper				
1 piece of cardboard				
5 pieces of cardboard				
1 sheet of aluminum				
5 sheets of aluminum				
1 piece of lead				

ANALYSIS

1. Background radiation gives you a zero value. With radiation we never down to zero because there are radioactive isotopes present everywhere. Any value close to this should be assumed to be completely shielded.

2. Inspect your table, what does it tell you about the shielding power of the different materials for each source? Answer about **<u>each isotope individually</u>** including what type of radiation it releases.