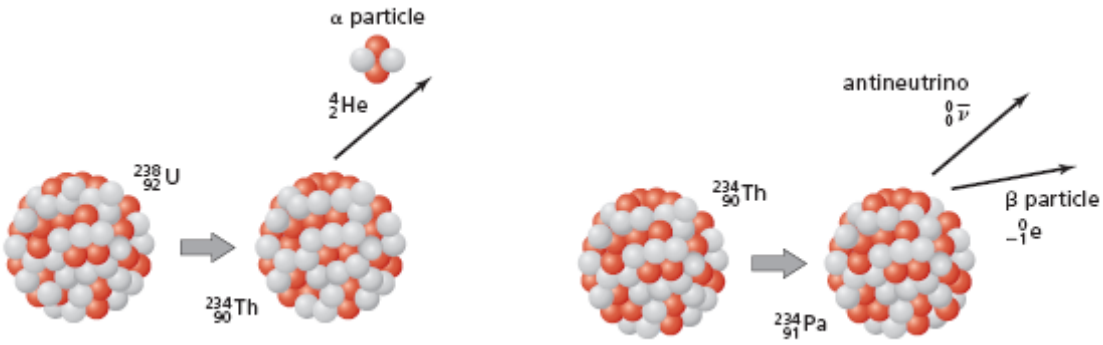
# *MND Physics*

## Radiation Properties Lab




Three common types of radiation emitted by radioactive substances are alpha, beta, and gamma radiation. An alpha particle is the same as a helium nucleus, a beta particle the same as an electron (except it originates in the nucleus!), and a gamma ray is high energy photons. Radiation can be detected by a Geiger-Mueller tube. In this lab, you will investigate the strength of three types of radiation. In part 1 of this lab, you will examine radiation strength as a function of distance. In part 2, various barriers (shielding) will be tested for their capacity to stop the passage of the three types of radiation to the Geiger-Mueller collector.

**EQUIPMENT:**
A Geiger-Mueller tube (Geiger counter), radioactive alpha sample, radioactive beta sample, radioactive gamma sample, meter ruler, timer, paper aluminum, and lead shielding with holders.

**HANDLING THE RADIOACTIVE SAMPLES:**
The radioactive samples used in this experiment are not highly concentrated. However, caution must still be used when handling these samples. **Do not place any food, drink, or makeup in the vicinity of the lab tables.** Handle samples with the tongs or tweezers provided. Thoroughly wash your hands with soap and water before you leave the laboratory.

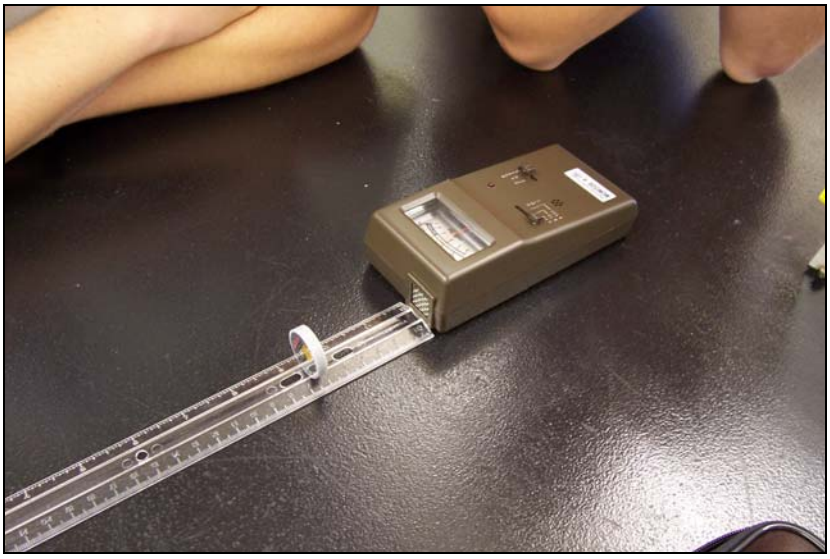
**INSTRUMENT SETTINGS:** You have a choice of counting "hits" with the sound switch on, or you can read the meter directly.
**AUDIBLE:**
Use the audible setting when the count is low i.e. below 20-30 counts/minute (use the audible setting for counting background radiation). Be sure the sensitivity setting is on "1".
**METER:**
Your Geiger counter has 3 sensitivity settings: 1, x10 and x100. When set at sensitivity "1", read the meter directly in counts/min. When the sensitivity is set at "x10", multiply the reading <u>times ten</u> to get actual counts per minute, etc.

**PROCEDURE:**

**PART 1: Investigating the relationship of beta radiation and distance.**

1. You need to establish the "background" radiation level of the room. With your radioactive samples far from your work station, turn on the Geiger counter to "audible" (and sensitivity to "1") and count the number of clicks per minute. Run your background radiation test for 2 minutes: divide the total clicks by two and record this value as the background activity/minute.

2. Set up the apparatus as shown in the picture. You will only use the beta sample in part 1.



3. Set the radioactive beta sample on the metric ruler as shown. The label side should face away from the Geiger counter. Start your examination by placing the sample 2 cm away from the counter.

4. Estimate the average activity over a period of 10-20 seconds and record this value in counts/minute.

5. Move the beta source 1 cm further away and repeat the data collection procedure. Record the activity.

6. Repeat this process until you reach 16 cm (16 cm is the final reading).

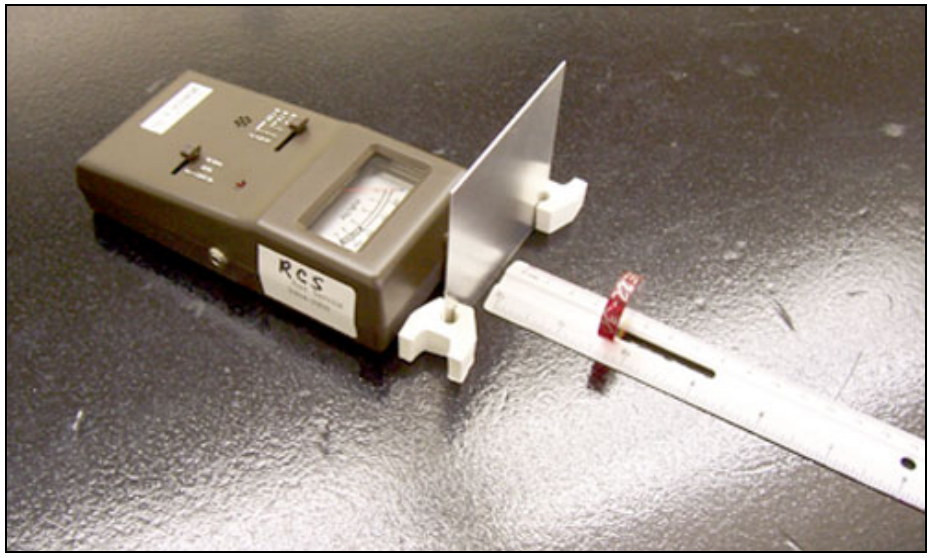
**PART 2: Investigating the <u>effects of shielding on radiation</u>.**

1. Once again, you need to establish the "background" radiation level of the room. With your radioactive samples far from your work station, turn on the Geiger counter to "audible" and count the number of clicks per minute. Run your background radiation test for 2 minutes: divide the total clicks by two and record this value as the background activity/minute.

2. You will be testing the activity of <u>all three samples in part 2</u>.

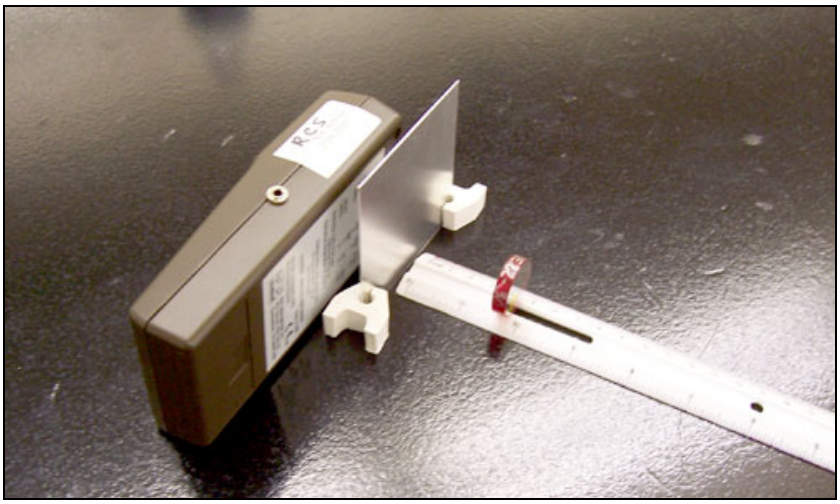
   **Alpha and Beta Radiation Trials:**

   Set the apparatus up as shown here for the alpha and beta trials. The samples will always be placed on the same mark (approx 2-5 cm.), the barriers should always be placed so that they rest on the table top. NOTE: This set up is for alpha and beta samples ONLY.



**Gamma radiation trial special Geiger counter configuration:**

The apparatus needs to be slightly modified since the gamma detector is located in a different location and orientation (the gamma detector is underneath the meter display pointing out the underside of the Geiger counter). Set the Geiger counter on its side as shown; use this configuration for all three barrier trials only when testing the gamma sample. The gamma source should be 2-5 cm from the detector, the barriers as shown.



3. Collect data for the alpha source (c/min). Start with no barrier, than one sheet and finally two sheets.

4. Remove the alpha source and repeat the process with the beta source.

5. Remove the beta source, CHANGE THE CONFIGURATION OF THE EQUIPMENT TO THE GAMMA CONFIGURATION, and repeat the process with the gamma source.

6. Return the sources to their containers; return containers to Mr. Peppercorn.

**DATA:**

**PART 1: Investigating the relationship of beta radiation and distance.**

BACKGROUND RADIATION LEVEL_____ c/min

| Distance (cm) | Activity (c/min) | Adjusted Activity (C/min) | Distance$^2$ ($cm^2$) | 1/Distance$^2$ ($cm^{-2}$) (decimals only) |
|---|---|---|---|---|
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |

**DATA:**

**PART 2: Investigating the effects of shielding on radiation.**

BACKGROUND RADIATION LEVEL_____ c/min

| # of sheets | Measured Activity (c/min) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Paper **(3x5 Note Cards)** | | | Aluminum Sheets | | | Lead Sheets | | |
| | **Alpha** | **Beta** | **Gamma** | **Alpha** | **Beta** | **Gamma** | **Alpha** | **Beta** | **Gamma** |
| 0 | | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |

**PART 1 ANALYSIS:**

1. Calculate the adjusted activity for each reading (measured activity – background activity).

2. Plot a graph of activity vs. distance (adjusted activity on the y-axis).

3. Plot a graph of activity vs. reciprocal of distance squared (adjusted activity on the y-axis).

**PART 1 QUESTIONS:**

1. What is the source of the background radiation?

2. What do your two graphs reveal about the nature of radiation?

**PART 2 ANALYSIS:**

1. Collect and record data for all three sources.

**PART 2 QUESTIONS:**

1. Which type of radiation is most easily absorbed?

2. Which type of radiation is least easily absorbed?

3. What effect has barrier thickness to radiation absorption?

4. Was it possible in this experiment to eliminate all of the alpha radiation? beta? gamma?