Geiger Counter Demos

Summary

This demonstration will help students understand how a Geiger counter works to measure radioactive decay.

Time Frame

1 class periods of 30 minutes each

Group Size

Large Groups

Materials

Geiger counter
radio active samples such as bananas, fresh plants, smoke detector, thorium lantern mantle or commercially available samples of radioactive elements

Background for Teachers

Safety:

It is recommended that you wear gloves while handling radioactive samples and that you wash your hands immediately when finished.

Instructional Procedures

Explain how the Geiger counter measures radiation by making a click each time it detects a radioactive particle.
People: We are exposed to background radiation every day. In fact, people are slightly radioactive because of the Potassium-40 and Carbon-14 in our bodies (more radiation/second from potassium than carbon). Use the Geiger counter to measure a person's radioactivity. It's not very high, but it exists.
Bananas: lots of potassium, so lots of potassium-40 (even though it makes up 0.01% of the potassium in the world). Again, it's not very high, but it exists.
Fresh Plant sample: lots of carbon, so lots of carbon-14. Same as bananas, maybe slightly higher depending on the sample and how fresh it is.
Smoke Detector: Contains Americium-241. The sample is inside the metal circle. There isn't a lot of radioactivity, but it's enough to detect. The alpha particles emitted by the americium ionize the nitrogen and oxygen in the air, releasing electrons that cause a small voltage to flow. But if there is smoke, the alpha particles get stopped by the smoke, so no (or fewer) electrons are released, the voltage is lowered, and the alarm goes off. Demonstrate that paper will stop the alpha particles by putting a sheet between the smoke detector and the Geiger counter. How a Smoke Detector Works
Thorium Lantern Mantle: All known isotopes of thorium are radioactive: Th-228, 230 and 232. Because of the long half lives of the heavier isotopes, probably most of the radiation detected is from the Th-228. This is alpha radiation. (I think it may also emit beta and gamma from what I read online, but I'm not sure). The thorium is added as thorium oxide, which is incandescent (meaning it glows when it gets hot, just like the filaments in incandescent light bulbs), so it increases the light output of the lanterns considerably. Newer lantern mantles are made with Yttrium and are not radioactive.

- Thorium website

- Thoriated Lantern Mantle Gamma-Ray Spectrum website.

Pb-210, Bi-210, Po-210 sample: The lead-210 undergoes beta decay to bismuth, which decays again to polonium. To test it, take the stopper out of the tube and hold the tip of the pin near the detector on the Geiger counter. It is moderately active.

Carbon-14 sample: This is a white powder in the bottom of the plastic tube. This is a pure sample so it is very active. Normally C-14 makes up only a trace percentage of the carbon in living samples (1 part per trillion according to Carbon 14 website). Carbon 14 is made continuously by cosmic rays in the atmosphere (unlike the heavier radioactive elements, like uranium, that are here since the earth was formed or are decay products of isotopes that were here when the earth was formed). To test it, open the top of the tube and hold the Geiger counter near the top of the tube. It is very active. You can also see the effect of distance by moving the counter farther away or closer. Since it is beta radiation, it will go through a piece of paper, and it is active enough to go through your hand also.

Bibliography

Lesson Design by Jordan School District Teachers and Staff.

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Utah LessonPlans