

1.3 Radioactivity of (antique) household items

Subjects: Introduction to chemistry, atomic structure, nuclear chemistry

Description: A Geiger counter is used to detect radiation from certain objects.

Materials:

Orange Fiestaware™
Radium dial alarm clocks
Uranyl sulfate (test tubes with yellow powder)
Geiger counter*
Radon detector

*A Geiger counter is located in the drawers opposite the bin storage shelves. It is a battery operated unit that can be used as a standalone device or with the LabQuest interface.

Procedure:

1. Use the Geiger counter to measure radiation emitted from the items listed above.
2. Demonstrate that using your hand or other material can shield alpha radiation.

Discussion:

Radioactivity or radioactive decay is the natural process in which one isotope of an element spontaneously transforms into the isotope of a different element, emitting radiation in the process.

Alpha (α) radiation is composed of helium nucleus (two protons and two neutrons with a charge of +2). This is the least penetrating of the three types of radiation and is easily shielded.

Beta (β) radiation is composed of electrons. β particles can penetrate into tissue and bone. Aluminum at least 0.5 cm thick is needed to shield from β radiation.

Gamma (γ) radiation is not a particle as α or β radiation, but a form of electromagnetic radiation more energetic than x-rays. Shielding γ radiation requires thick layers of lead or concrete.

Vintage Fiestaware™ used uranium oxide for its reddish-orange glaze from its introduction in 1936 until WWII, when the US needed the uranium for the war effort. The original red was reintroduced using depleted uranium after the war in the 1950s and continued until the early 1970s. Uranium oxide is a naturally occurring mineral of uranium and is radioactive, emitting primarily α radiation.

In the early 1900s, dials on clocks, watches, and gauges were painted with radium containing luminescent paint allowing them to glow in the dark. Radium has a half-

life of over 1600 years and thus old clocks with radium dials are still radioactive. Radium decays by emission of an α particle to produce radon gas.

Uranyl sulfate (UO_2SO_4) is a lemon-yellow powder salt of uranium and is also radioactive, emitting primarily α radiation.

Safety: The items are primarily alpha particle emitters and therefore do not pose a high danger. Prolonged exposure to radiation should be limited.

Disposal: None

References:

1. J. Kotz, P. Treichel, J. Townsend; *Chemistry & Chemical Reactivity*, 7th Ed. Teachers Ed; Brooks/Cole; 2009; p. 1061-1065
2. Prof. Voigtman
3. Wikipedia:
<http://en.wikipedia.org/wiki/Fiestaware>
http://en.wikipedia.org/wiki/Radium_dials