VIDEO PROJECT THREE – THE EFFECTS OF DIFFERENT TYPES OF RADIATION

11. e. *Students know* alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

Alpha, beta, and gamma rays are *ionizing radiations*, meaning that those rays produce tracks of ions of atoms and molecules when they interact with materials. For all three types of rays, the energies of particles emitted in radioactive decay are typically for each particle on the order of 1MeV, equal to 1.6×10^{-13} joule, which is enough energy to ionize as many as half a million atoms.

Alpha particles have the shortest ranges, and matter that is only a few millimeters thick will stop them. They will not penetrate a thick sheet of paper but will deposit all their energy along a relatively short path, resulting in a high degree of ionization along that path.

Beta particles have longer ranges, typically penetrating matter up to several centimeters thick. Those particles are electrons or positrons (the antimatter electron), have one unit of either negative or positive electric charge, and are approximately 1/2000 of the mass of a proton. These high-energy electrons have longer ranges than alpha particles and deposit their energy along longer paths, spreading the ionization over a greater distance in the material.

Gamma rays can penetrate matter up to several meters thick. Gamma rays are high-energy photons that have no electric charge and no rest mass (the structural energy of the particle). They will travel unimpeded through materials until they strike an electron or the nucleus of an atom. The gamma ray's energy will then be either completely or partially absorbed, and neighboring atoms will be ionized. Therefore, these three types of radiation interact with matter by losing energy and ionizing surrounding atoms.

Alpha radiation is dangerous if ingested or inhaled. For example, radon-222, a noble gas element, is a naturally occurring hazard in some regions. Living organ-isms or sensitive materials can be protected from ionizing radiation by shielding them and increasing their distance from radiation sources.

Because many people deeply fear and misunderstand radioactivity, chemistry teachers should address and explore the ability of each form of radiation to penetrate matter and cause damage. Students may be familiar with radon detection devices, similar to smoke detectors, found in many homes. Discussion of biological and health effects of ionizing radiation can inform students about the risks and benefits of nuclear reactions. Videos can be used in the classroom to show demonstrations of the penetrating ability of alpha, beta, and gamma radiation through paper, aluminum, and lead or through other dense substances of varying thicknesses.

Geiger counter measurements can be used to record radiation data. The order of penetrating ability, from greatest to least, is gamma > beta > alpha, and this order is the basis for assessing proper shielding of radiation sources for safety. There are a number of naturally occurring sources of ionizing radiation. One is potassium-40, which can be detected easily in potash fertilizer by using a Geiger counter. The other is background cosmic and alpha radiation from radon. This radiation can be seen in cloud chambers improvised in the classroom.

18 **A 2-cm-thick piece of cardboard placed over a radiation source would be *most* effective in protecting against which type of radiation?**

A alpha

B beta

C gamma

D x-ray