KEEP IT SEPARATED

INTRODUCTION

The Manhattan Project was what the government named the huge program to develop a nuclear bomb. It is hard to explain how amazing this program was. The program encompassed dozens of sites in the United States and Canada that employed tens of thousands. Leading this effort, Robert Oppenheimer and General Leslie Richard Groves built nuclear reactors and giant centrifuges. That initiative produced three bombs powered by the fission of uranium and plutonium—all of this only five years after the discovery of plutonium, seven years after the discovery of fission, and 25 years after the discovery of the atomic nucleus. The project cost about two billion dollars in 1940s dollars—that's about 40 billion today.

The main project sites were Hanford, Washington, where the plutonium was produced in a reactor; Oak Ridge, Tennessee, where the rare Ur 235 was separated from the predominant Ur 238; and Los Alamos, New Mexico, where the bomb design and mechanisms were made. The personnel included some of the most prominent physicists of the century, including Enrico Fermi, Richard Feynman, and Ernest Lawrence.

One of the biggest hurdles in the Manhattan Project was separating the particular isotopes that were needed from all the others. This hurdle was mainly overcome by using differences in mass. The separation of materials by their physical and chemical properties is very important to teach from elementary grades up. To separate isotopes, the project used their different masses in diffusion and centrifuges.

Discussing a project that resulted in nuclear weapons can be challenging. Focus on the basic science and other uses of nuclear science.

In Keep It Separated students will learn about how isotopes were separated using a centrifuge by seeing a demonstration of a centrifuge.

MATERIALS

+ Salad spinner
+ Dry beans
+ Puffy cereal

If the activity is approached as a team activity instead of a demonstration, you will need a set for each team.

STANDARDS

NGSS 5 PS1-3
Make observations and measurements to identify materials based on their properties.

NGSS MS PS1-1
Develop models to describe the atomic composition of simple molecules and extended structures.

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Students don't need to know all about atomic structure to understand that some atoms are heavier than others, and thus can be separated by centrifuges or other methods that use their mass or density. Students will also practice in Developing and Using Models, a very important Science and Engineering Practice.

NAME: DATE:

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Scientists and engineers are always working to separate things. Any given TV episode of *CSI* is about separating things by their chemical or physical properties.

Centrifuges are a great way to separate things by the property of density. A centrifuge spins the sample around. Because different substances have different densities, they end up in different parts of the centrifuge. Density is just how much matter, or mass, is in a given volume.

You know that old joke, "Would you rather be hit with a ton of feathers or a ton of lead?" The difference between the two is that a ton of feathers would take a lot more space than a ton of lead because it's much less dense. Lead and feathers can be easily separated in a centrifuge.

Centrifuges are in the news from time to time because they are often used to separate different isotopes of uranium. Only one kind of uranium is good for power plants and weapons, and so it needs to be separated from the other isotopes. This type of uranium is less dense than the other kind of uranium, and so a centrifuge can do the job.

TRY OUT A CENTRIFUGE!

Which of the two substances is less dense? Which is more dense?

What do you think will happen when you put them in the centrifuge (yes, a salad spinner is a centrifuge)?

Centrifuges are also used to separate plasma from blood. Density is also used to separate many other things—for example the numbers on all those plastic bottles represent their density. They are separated by density before recycling.