Science of the B Reactor: ACTIVITIES

Total Lesson Time: 90 minutes

Lesson Introduction: 20 minutes

Activity 1: Circle - 25 minutes

Activity 2: Mini-Book - 40 minutes

Lesson Conclusion: 5 minutes

TIME, ACTIVITY, ACTION	SCRIPT OUTLINE *(Italics is just a suggested script)*
20 MINUTES GENERAL INTRODUCTION, LESSON INTRODUCTION, AND VIDEO	Introduce yourself and Manhattan Project National Historical Park Establish expectations of class Give the class expectations of the lesson Warm-up question or game
Play Hanford Made video (optional).	Show Hanford Made video for additional background information.
Show pictures of uranium ore and plutonium buttons.	*Today we are going to be talking about the science of the B Reactor at Hanford. We're going to learn more about what happened to the uranium in the B Reactor to turn it into plutonium.* **Show pictures of uranium ore and plutonium buttons.**
Show notecards with the vocabulary words.	*We are also going to learn a lot of new words today, including: atom, electron, proton, neutron, fssion, chain reaction, and transmutation.* **As you say each word, hold up a notecard with the word clearly written and place them where children can see throughout lesson.** *Do you already know any of these words?* **(Let children share what they know.)** *Well, by the end of this lesson you'll know all of them.*

25 MINUTES ACTIVITY 1 - CIRCLE	*Today we're going to be talking about things at the tiniest level. What is the smallest thing you can name? And what's smaller than that? And smaller than that?* **Let children answer, having fun and getting silly about smaller and smaller things.**
Have the "Atom" notecard.	*Well, I know of something even smaller than _____. It's called an atom.* **(Hold up notecard).** *The word comes from the ancient Greek word 'atomos' and it means 'indivisible,' so not able to cut up smaller. You see, some ancient Greeks believed that everything around them were made up of tiny atoms, things that were so small they couldn't even be seen.* *Even though others made fun of them, it turns out these guys were right. Eventually a special type of microscope was invented, and scientists were able to see atoms. Pretty amazing, huh?* *Over time, scientists started to realize that atoms were actually made of different subatomic particles, so there are technically things SMALLER than an atom!* *First, scientists found out about electrons. These are tiny, tiny, tiny particles fying around the atom. They have a negative charge.*
Distribute green circles to some students.	**Have children sit in a circle.** *This is going to be our atom. I need some volunteers to be our fying electrons.* **Give small green circles to electrons and let them run around with control in the circle. Since they are negative have them frown.**
Distribute purple circles to some students.	*Now, some time later a scientist realized that there were also positively charged particles which were bigger and liked to hang out together in the center, or nucleus, of the atom. Can I have some volunteers to become theses positive protons?* **Give volunteers purple circles and have them stand together in the middle and have them smile.** *Scientists also had a new idea- that instead of fying around like crazy, maybe the electrons went in circles around the protons in the nucleus.* **Help electrons slowly orbit protons.** *But something was wrong. Scientists could fgure out how much an atom weighed, and how much the protons and the tiny electrons weighed. The problem was that the atom was almost twice as heavy as the protons in its nucleus. That's when they realized that the protons had friends hanging out with them.*

ACTIVITY 1 - CIRCLE *(continued)* *Distribute yellow circles to some students.* *Retrieve circles and return to seats.*	*They were about the same size and when they added these numbers together scientists got the weight of the atom. Hurray! Let's get some volunteers to play these new particles- the neutrons.* **Give volunteers yellow circles and have them stand mixed in with purple circles in the center. They should have a blank face.** *These neutrons were neutral, or with no positive or negative charge. And this is generally what the inside of an atom looks like.* *Do you want to know something else pretty cool? Modern scientists have even found that protons and neutrons are made up of smaller things. What if those things are made of smaller things, and those of smaller things? When will it end?!* **Collect circles.**
40 MINUTES ACTIVITY 2 - MINI-BOOK *Distribute mini-books and colored pencils/crayons to the students.*	*Today everyone is going to make their own mini-book to take home with them. You'll be able to do some decorating in this book later, but let's start by putting your name on the cover.* *Now open your books and what's on the frst page? That' s right, the parts of an atom. What tiny particles are zooming around the atom?* *Electrons!* *Using your green colored pencil, draw some tiny electron dots in the space between the two circumferences. Don't forget to draw a green circle by the word electron in the key.* *Now what's in the middle, in the nucleus?* *Protons and neutrons!* *Let's draw some larger purple protons and yellow neutrons in the nucleus, the center of the atom. And draw each in the key as well.* *There are 92 different types of atoms, we call these elements, that are naturally on our planet. But you know how scientists like to understand and create things, so some scientists have even made NEW atoms. The one we'll talk about today is called plutonium.* *Hmmm….plutonium. Does that remind you of anything? Maybe a dwarf planet?* *Pluto!* *Yes, this element was made by starting with uranium, what do you think that was named after?* *Uranus!*

ACTIVITY 2 - MINI-BOOK *(continued)* *Have the students turn the page in their books.*	*Exactly. I wonder if we'll come across any other planet names in our lesson? Go ahead and turn the page in your book.* *When scientists wanted to make new atoms, they tried it out by taking extra neutrons and sending them into the nucleus of other atoms.* *They found that when you send a neutron into normal uranium, called U-238, sometimes the atom will take in the neutron and make a new uranium called U-239 which is pretty crazy and falls apart quickly. On this page, draw the craziest face you can in the circle next to U-239.* *It's so unstable that in just 23 minutes, half of it will have fallen apart and will turn into a completely different element. Scientists named this element neptunium. What planet do you think it was named after?* *Neptune!* *Well, neptunium was not as crazy, so draw a slight less crazy face next to Np-239. After two and a half days it also falls apart and half of it turns into plutonium. Plutonium is super stable and can stay like it is for thousands of years. This process of turning one element into another is called transmutation.* *This is what the B Reactor at Hanford did. It took uranium, turned it a little crazy and then into neptunium and fnally plutonium.* *These scientists named the elements they made after planets, others have named elements after people (einsteinium) or places (germanium) or myths (thorium). If you could name an element, what would you name it?* **On the next page children can write the name choice.**
Redistribute the colored circles.	*Now, the big question is- how was plutonium useful? I'll tell you, but frst we'll need to reform our atom. Can ever yone please move back into their places?* **Ask for one student who can take on a new job. Give them a yellow circle and have them stand outside the atom circle.** *Now, scientists found that if you take a neutron and slowly send it into some kinds of atoms like plutonium, (help the extra yellow circle move towards the atom) it can hit the nucleus and split the protons and neutrons into two new atoms.* **Help students split into two groups so that each has some protons, neutrons, and electrons.**

ACTIVITY 2 - MINI-BOOK *(continued)* *Toss more yellow circle into the students' atom.* *Collect the circles.* *Have the students turn the page in their books.*	*This is called nuclear fssion. The word fssion comes from a Latin word that means 'to split' and that's what happens- the nucleus splits apart.* *And something else happens. Not only are new atoms made, but a couple of neutrons are set free to fy out. When they do this, they send out energy which can do big things.* **Throw a couple of yellow circles out dramatically.** *I'll collect these circles and let's get back to our books. On the next page you can see a diagram of fssion happening. Please draw yellow neutrons where you see an N. One will be going into the atom, and the others will be coming out during fssion and giving off energy.* *You can see that two new atoms are made. Before we fip the page, what do you think would happen if one of those now free neutrons ran into another plutonium atom?* *They would cause fssion.* *And those free neutrons ran into more plutonium atoms?* *More fssion.* *We call this a chain reaction, because what's happening is linked together like a chain that is growing bigger and bigger. You can draw more atoms going through fssion in the extra space on this page.*
5 MINUTES CONCLUSION *Have the students turn to the back of their books.*	**Display or indicate notecards with new nomenclature. Have children look at back of their mini-book.** *At the beginning of the lesson, I said we were going to learn some new words. Can anyone tell me what any of these words mean?* **Let children answer giving their own defnitions. If they need help:** • *Atom- the smallest thing you can break matter into that still has its properties* • *Electron- particle of an atom which has a negative charge and is outside the nucleus* • *Proton- particle of an atom which has a positive charge and is inside the nucleus* • *Neutron- particle of an atom which has a neutral charge and is inside the nucleus* • *Transmutation- changing an element into another element* • *Fission- splitting the nucleus of an atom* • *Chain reaction- when free neutrons from fssion run into more atoms and cause more fssion*