9. “We know that it takes about **100 million years** for HALF of the atoms in a sample of Beanium to decay into Cornium atoms. What do we call that characteristic of Beanium?” Hopefully, your class will chorus “HALF-LIFE”. If not, try a prompt or two; you may need to back up a bit, and review this term.

10. “Shall we wait and watch this sample go through one half-life, or would you rather watch grass grow?

11. “Never fear… I just happen to have a rock sample which is exactly 100 million years old, so it’s gone through **one half-life**. How many atoms of Beanium should we have? [64]. And how many atoms of Cornium? [64]. After 2 half-lives, how many Beanium atoms remain? [32]… and Cornium? [96]. I think you’ve got it!

12. “I’m going to hand out several rock samples of different ages. [Remove samples from "layers" (shelves) in a block of sedimentary rock (any box with several shelves)]. Your job is to figure out how old your sample is, and report back to me.” Distribute the samples to teams of 2 or 3, let them count atoms, get their results, and enter them into the overhead table.

13. Point out that after an isotope goes through 6 or 7 half-lives, there may not be enough of it left to measure accurately. Explain that we have instruments which can accurately identify the elements and count the atoms of those elements, so we can date samples which have gone through as many as 10 half-lives. Since different isotopes have different half-lives, maybe we can use this information to give us an idea about how old the earth is. [You may stop here if your goal was merely to teach the half-life concept.]

14. DEEP TIME : “As a matter of fact, we’re going to take a look at ALL the known radioisotopes with half-lives of more than a million years.” Hand out the **Deep Time** envelopes containing the radioisotope strips (to teams of 2-3) and ask them to sequence them, from the longest half-lives to the shortest. As they begin to complete this, ask them to look for a pattern of “YES’s” and “NO’s” … how do these seem to be grouped? [Someone should recognize that all of those with half-lives greater than 80 million years have “YES’s”, an all the rest have “NO’s”.] Explain that the “YES’s” mean that they ARE found in nature, and the “NO’s” mean that they are NOT found in nature (in our solar system), even though they have been detected in younger stars.

15. Ask “What does this mean? Why is it that ALL of the longest half-lived isotopes are still around, and NONE of the shorter half-lived isotopes are here? What must have happened to the shorter lived ones? [Hopefully, students will explain that the shorter-lived isotopes have decayed away… they decayed faster, while there hasn’t been enough time for the slower-decaying isotopes to decay away.] Ask “What does this suggest about the age of the solar system?” [Desired response: “The solar system must be very old, say 100s of millions, or billions of years old, but **not too old**, probably not 100s of billions of years old.” If they don’t see this, ask “What if the solar system was only a few thousand years old, how would this affect the number of “NO” isotopes?” [All of them, or at least the longer half-lived ones, would still be around, they would have “YES’s”], and “What if the solar system was 100s of billions of years old?” [Most of them would be gone, they ALL would have “NO’s”, except possibly the very slowest decaying 2 or 3. Point out that this is a “Fair Test” measure of the validity of this method of age-dating; it could support either a “young earth” or an “old earth”, depending on the results. This, along with other age-dating methods, combined with the fact that there is NO evidence in nature suggesting a young earth, gives us considerable confidence that our earth is some billions of years old.]

16. Collect the envelopes with the strips in them. Hand out the 6 page Deep Time packets and the Deep Time worksheets. These can be started in class, and finished at home, to be discussed and collected next day. Pont out that we have already done Activity #15 (sequencing the radioisotopes), so they should be able to easily answer the questions asked about it. Ask them NOT to write on the 6-page packet, so it can be used in other classes.

Date a Rock!

SUGGESTED PRESENTATION SCRIPT

Come to your class dressed in your favorite field attire (sun hat, boots, grubby jeans, daypack, etc.)

1. Show a geological map (of your area, if possible), and even a geological cross section of that same area. Point out where there are prominent outcroppings in the area which are identified (by color and symbols) as being “Mesozoic” (and/or some particular period in the Mesozoic), and other periods, and mention about how old those layers are, pointing to a scaled classroom timeline, if possible.

2. Ask “How do we KNOW the ages of those rocks?” Responses will vary, depending on their backgrounds in your class and previous classes. Some may even challenge those ages, which is actually very good. Accept any suggested ideas, possibly recording them quickly on the board; even record any challenges, e.g. with a big question mark, saying something like…”How confident ARE we about those dates?” or “Can we really be SURE of those dates?” Then point out “Nevertheless, scientists generally agree that those dates are pretty accurate, so lets see why they’re so sure, and how they do it. Then we can take a look at the evidence which suggests otherwise.”

3. Show some fossils, giving their ages. Ask the same questions as before (#2), and respond in like manner.

4. Say “If we’re going to measure the ages of rocks, we need some kind of geological clock!… something which ‘ticks’ in a constantly steady, accurate way… over millions of years, and we have one, in fact we have a bunch of them. They’re called ‘radioisotopes’. Here’s how they work, and how we can use them to help us measure the ages of rocks and fossils.”

5. Place Ziplock bag with 128 beans in it on the overhead, saying "Here's a mineral sample with 128 radioactive atoms of 'Beanium'. You can see the atoms because this is a special super-high-powered electron microscope which magnifies rock samples jillions of times!" [look at you overhead projector proudly].

5. “Rocks are made of atoms, and some of those atoms give off radiation. [Place a bean and a corn seed on the overhead, draw an arrow from the bean to the corn, and some "rays" around the bean.] As a result, each atom which ‘decays’, gives off some radiation, and changes to a different atom, often of a different element. Eventually all the radioactive atoms (radioisotopes) will decay to the atoms of the new element (the ‘daughter product’).

6. “We know that, in a pure sample of a radioisotope, half of the radioactive atoms will decay in a certain period of time, and we call this **rate-of-decay** the **‘half-life’** of the element.

7. REALITY CHECK: “So what IS ‘half-life’?” Get kids to respond that it’s the ‘speed’ or ‘rate’ or ‘how fast or slow’ a radioisotope decays. It’s NOT the amount of radioactivity, or the age, or the number of atoms…etc. You can also ask "What do we mean by 'decay'? [seeking a response which refers to radioactive atoms giving off radiation AND breaking down into another atom.]

8. “So how do scientists use these radioisotope clocks to measure the ages of rocks? **They count their atoms!** Of course, atoms are extremely tiny, but with our super high-powered electron microscope here (look at your overhead projector), we can actually SEE an atom of **Beanium** decay into an atom of **Cornium**! With that announcement, proceed to open the Ziploc bag a bit, remove a bean, and insert a popcorn kernel. Announce, “You have just observed a radioactive Beanium atom decay into a Cornium atom!”