Dating Deep Blood Kettles

Fast Facts

Curriculum Area: Science
Grade Level: Grades 6-8
Suggested Duration: 135-180 minutes

Stage 1 Desired Results

Established Goals

Science Content Standard 6 Benchmark 8.1: Give examples of scientific discoveries and describe the interrelationship between advances and scientific understanding, including American Indian examples.

Essential Understanding 1: There is great diversity among the twelve sovereign tribes of Montana in their languages, cultures, histories, and governments. Each tribe has a distinct and unique cultural heritage that contributes to modern Montana.

Understandings

- In planning bison kills some Native Americans took into consideration many factors and employed a variety of strategies.
- Radiometric dating techniques can be used to establish when prehistoric events took place.
- Carbon-14 is a radioactive isotope that can be used to determine when kill sites were used by Native Americans.

Essential Questions

- What factors were taken into consideration in planning a bison kill?
- What are some strategies used by some Native Americans to kill bison?
- What types of evidence left at kill sites might help archaeologists learn about what took place there and when the site was used?
- How does radiometric dating work?
- How can radiometric dating be used to determine when kill sites were used?

Students will be able to…

- describe techniques that some Native Americans used to kill bison at kill sites.
- list types of evidence left at kill sites.
- explain how radiometric dating can be used to determine when the kill site was used.

Students will know…

- key terms: pishkun, kill site, radioactive isotope, half-life, radiometric dating;
- how some Native Americans killed bison;
- how evidence left at kill sites can be used to determine when the site was used.

Stage 2 Assessment Evidence

Performance Tasks

1. Participate in two experiments/labs that simulate half-life.
2. Collect data from their group and the class to complete a chart and graph on half-life.
3. Read information on how prehistoric people hunted bison.
4. Explore a web site on Montana pishkuns.

Other Evidence

- Students will discuss in small groups and as a whole class their ideas on how early hunters killed large numbers of bison.

Stage 3 Learning Plan

Learning Activities

Day 1
Engage/Question: Ask students if the class were going to hunt a large group of animals that were 12.5 feet long, 6.5 feet tall at the shoulders, weighed 1,200-1,800 pounds, and ran at a top speed of 50 mph, how would they do this? They would be on foot and only have spears and bows and arrows to use. Have students write their initial responses in their notebook/journal.

After a few minutes, have students share their ideas in a small group. Discuss as a whole group, asking students to elaborate ideas that are not well developed.

Explore: Have students work in pairs to examine the following web sites for background information about pishkuns: First Peoples Buffalo Jump State Park; Buffalo Hunt information; Dating Deep Blood Kettles information. While gathering background information, students should pay particular attention to defining the following important terms and concepts: atlatl; bison; bow and arrow; buffalo jumps; pishkun (piskan or pishkin); Continental Divide; drive line; forbs; natural traps; short grass plains; spears; wooden corrals. Have students refer to a dictionary if they are not able to define a term.

Discuss how these ancient people used the limited resources they had to develop an ingenious way to kill large numbers of animals that were much bigger and faster than themselves.

This next part can be done as a whole class with discussion or in small groups:

Go to the Dating Deep Blood Kettles Information web site (above). Click on the "Unique Pishkun in Central Montana" link on this page. This page shows two pishkun found in Montana. Next, explore the "Radiocarbon Dating at Montana's Bison Kill Sites" link (found on the first page of the site listed above). This page focuses on the First Peoples Buffalo Jump site near Great Falls. It will provide the link between the first part of this lesson and the second part, which is Radiometric dating of organic remains. Again, go over the information either as a whole class or in small groups. Below are some questions that can be addressed as a written assignment or as a class discussion for both the website and the reading pages.

1. What are some other characteristics of the ideal buffalo jump?
2. What kinds of evidence might an archaeologist hope to find at kill sites today?
3. Experts claim that Indians used the cliffs of First Peoples Buffalo Jump (Ulm Pishkun) as a kill site from roughly 900 AD to 1500 AD. What scientific technique can be used to determine this?
4. How were drive lines used to hunt bison?
5. What was another way ancient hunters captured bison? Explain.
6. How did ancient people use natural traps to help them hunt bison and other animals?

Another interesting site is the Head-Smashed-In Buffalo Jump Web site. This site provides many pictures, a virtual tour of the site and additional information.

Day 2 radiometric Dating

Engage: Explain to students that they will be engaging in an activity that will help them understand how scientists figure out how long ago these pishkuns were used.

Explore/Explain: Pass out the lab Understanding Half-life and the needed materials. Read through the introduction as a class. Before you start the lab explain the following to students:

- During carbon 14's half-life, every carbon 14 atom has a 50-50 chance of decaying. That means that if we had 100 Carbon 14 atoms in a jar, after about 5,700 years about half of them would be Nitrogen and half would still be Carbon 14. That's where the "half" in half-life comes from. As a class, fill in the "Ideal or Mathematical Results" chart in the lab. To complete the "Number of Carbon-14 Atoms" column, you divide the number of Carbon-14 atoms you started with by 2. To complete the "Number of Years Ago" column, you add one half-life (5,700 years) to the number you started with (see answer sheet). Depending on the level of your students, you may want to use calculators.

After students have completed part 1 of the lab, explain that just as every Carbon-14 atom has a 50-50 chance to decay, every penny has a 50-50 chance of landing heads or tails. This next part of the lab will simulate a more realistic example of half-life. Have the students conduct Part 2 of the lab.

Day 3 Determining the Age of Bison Bones Using Radiometric Dating

In this part of the lab, students will be building upon what they learned the day before.

Students will be using 128 cards instead of 100 pennies. This is much quieter, and the number 128 can be divided evenly more times than 100.

When making the cards, the two “atom” sheets are copied back to back. Be sure they line-up before you cut them.

Engage: Explain to students that they will be doing another lab that will help them to see how scientists figure out how old something is using Radiometric dating, specifically Carbon-14. Pass out the lab, Determining the Age of Bison Bones

Read through the background data together. Complete the data chart for half-life for this activity.

Go over the instructions for the lab. BE SURE STUDENTS KNOW THE DATES FOR THIS LAB ARE NOT ACCURATE. Most of the sites are less than one half-life old (5,700 years). This would be very difficult to demonstrate.

Have little cards with the names of the different pishkuns on them for each group. You can vary the number of groups to fit your class size. Either predetermine the number of half-lives you want each group to go through or have them randomly draw a number. You should check that each group knows and actually flip over the correct number of cards. This can be quickly determined using the chart that you construct as a group.

Have students do the lab. When they are done, discuss their findings and clear up any misconceptions.

Materials/Resources Needed

- Student journals or notebooks
- 100 pennies for each group of 3-4 students
- Large plastic cups or jars to fill with 100 pennies
- 124 Carbon-14 cards for each group (possibly laminate)
- Computer with internet access and projection device (one for the teacher and possibly up to one per student depending on if students will research independently or as a class).
- Pages 1-3 of Ancient Teachings document (page 4 contains a list of terms that may also be used)
- Understanding Half-life lab (to be edited to fit class size0, one copy per student and a transparency to record class data
- Determining the Age of Bison Bones, one copy per student and a transparency to record class data

Resource Websites

Head Smashed In Buffalo Jump

First Peoples Buffalo Jump State Park
Buffalo Hunt Information
Dating Deep Blood Kettles Information

Understanding Half-life

Name _____

Background Information

By some estimates 60-75 million bison populated the plains of North America before Europeans began settling the area in the 1800s. Although the Plains Indians fished, gathered fruit and berries, grew some food, and hunted other animals, they relied on bison for the bulk of their food, and materials for making clothing, tools, and shelters.

Because of the bison's tremendous size and speed, Indians devised sophisticated strategies to kill large numbers of them simultaneously. One method was to drive them over cliffs at locations known as "buffalo jumps", and then finish off and process the animals near the base of the cliff. Archaeologists refer to these as "kill sites". Many prefer the Blackfeet word "pishkun," which (loosely translated) means "deep blood kettle".

Hundreds of kill sites are scattered throughout the northern plains (over 300 in Montana). "The First Peoples Buffalo Jump" (formerly known as Ulm Pishkun) and the "Madison Buffalo Jump" are two of the better known ones in Montana, and the "Head-Smashed-In" site 40 miles north of Glacier National Park is world famous. Archeologists have learned much about Indian cultures from evidence left at these sites.

One of the ways that scientists can figure out how long ago these sites were used by native people is to use a technique called **Radiometric Dating** or **Carbon Dating**. All living things contain an element called carbon. Most carbon contains 12 protons, neutrons, and electrons, but every once in a while, a carbon atom contains 14 neutrons. This is called an "isotope". Some isotopes, such as **carbon 14**, are unstable, which means they break down or fall apart. When carbon 14 breaks down it turns into another element call Nitrogen. This breaking down process takes place at a steady rate. This is called radioactive decay or a "**half-life**". The half-life of carbon 14 is 5,700 years. That means it takes 5,700 years for half of the carbon 14 to decay or break down.

All living organisms have about the same percentage of carbon 14 because they constantly replace any that break down when they eat. When the organism dies, however, they stop replacing the carbon 14, and the percentage starts to go down. Scientist can figure out how long ago an animal died by looking at the percentage rate of carbon 14 that is left. This type of dating is only accurate for objects less than 50,000 years old.

The following activity will help you understand half-life.

Materials
100 pennies
Large plastic cup

Procedure

Part 1

1. With the teacher, complete the chart of the ideal or mathematical half-life.
2. Graph the results on the graph paper and connect the dots with a black pen.

Part 2

1. Place 100 pennies in the large cup. These pennies represent 100 Carbon-14 atoms.
2. Shake the pennies in the cup for a few seconds and then carefully pour them out so that they don't fall off the table. Spread them out so that they are not on top of each other. BE SURE TO NOT FLIP ANY OVER. This first shake represents the first half life of the isotope.
3. Carefully pick out the pennies that are "tails". These will represent the atoms that have decayed into Nitrogen. Put these pennies aside.
4. Count the number of pennies that are "heads" (Carbon-14 atoms) and record this in the Group Data Chart.
5. When asked, be prepared to tell how many "Carbon-14" pennies remain. This will be recorded in the Class Data Chart.
6. Repeat step 1-5 for the remaining "Carbon-14" pennies six more times. This will represent a total of seven half-lives.
7. Determine the number of years ago each half-life represents.
8. Copy down the class data in your Group Data Chart.
9. Find the class average for each of the half-lives.
10. On the graph, plot the class's results for each of the half-lives. Connect the dots with a line in red pen.
11. Compare the class's results (red line) to the ideal results (black line).
12. Answer the questions in the Conclusion section.

Observation/Results

Ideal or Mathematical Results

Number of Half-Life	Number of Years Ago	Number of Carbon-14 Atoms
0	0	100
1	5,700 years	
2		
3		
4		
5		
6		
7		

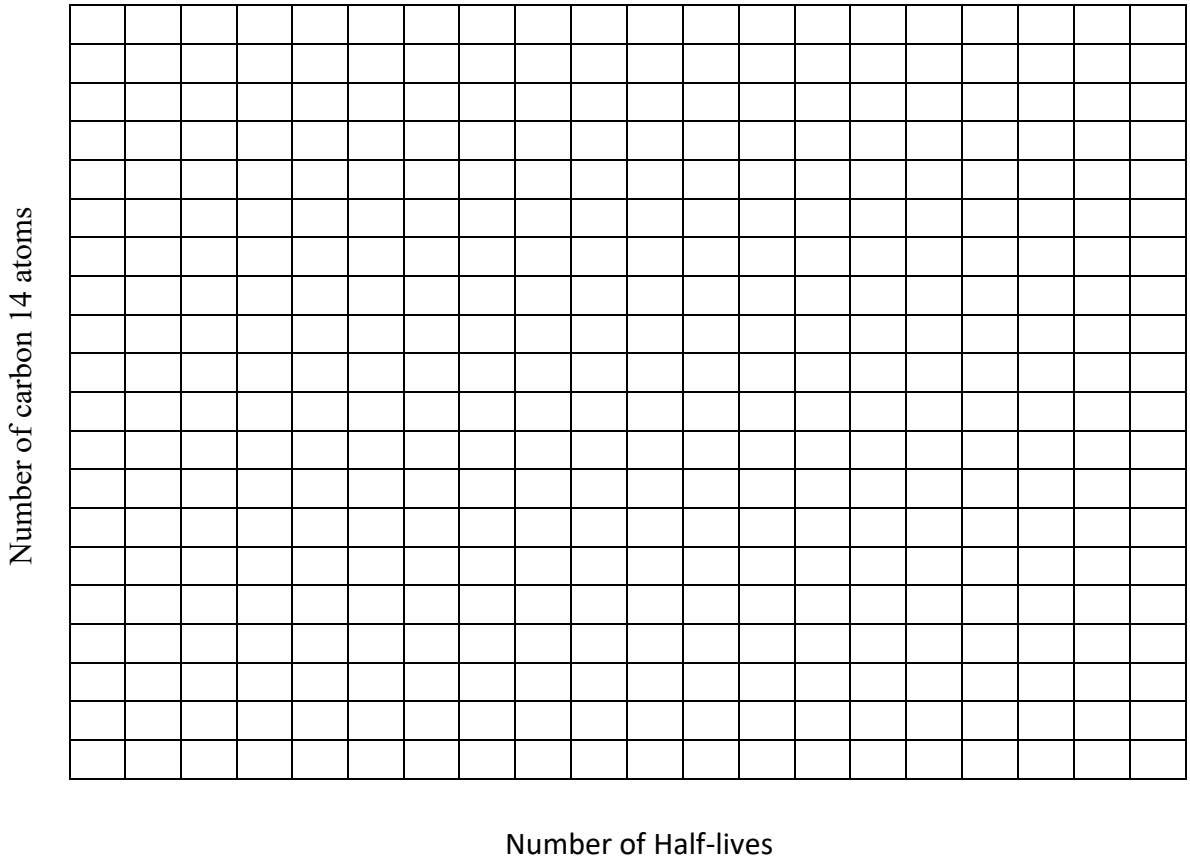
Group Data Chart

Number of Half-Life	Number of Years Ago	Number of Carbon-14 Atoms
0	0	100
1		
2		
3		
4		
5		
6		
7		

Class Data Chart – Number of Carbon-14 Pennies

Run	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Class Average
0	100	100	100	100	100	100	100
1							
2							
3							
4							
5							
6							
7							

Carbon-14 Decay Graph



Conclusions

How did the class' data (red line) compare to the idea results (black line)?

Based on the class' results, if there were about six pennies or Carbon-14 atoms left in our sample, how long ago, or how old, would our sample be?

Determining the Age of Bison Bones

Background Information

To date the bones of Bison, scientists take small samples of the bone and grind them up into a fine powder. They remove the carbon from the rest of the sample. They place this in a very specialized machine that counts all the regular carbon and compares it to the number of remaining Carbon 14 atoms.

When scientists date the bones found in the pishkuns, they are looking at very large numbers of atoms. In our lab, we are using much smaller numbers so that we can easily count the cards or pennies. Scientist also use a more complicated formula to find the exact age (or close to it) of the bison bones. We are using a much simpler way.

Activity

Materials

128 C-14/N-14 cards
Index cards with number of half-lives
Calculators

Procedure

As a class, fill in the half-life chart below.

Half-life Chart

Number of Half-lives	Number of C-14 Cards	Number of N-14 Cards	Years Ago
0	128	0	0
1			
2			
3			
4			
5			

Take out your cards. Place them on the table with the C-14 side facing up.

The teacher will give you an index card that tells you how many half-lives your team will perform.

You will have one minute to flip over half of the cards so that the N-14 side shows.

Repeat if your index card says you should. The class will go through a total of five trials, but not all groups will be doing the same number of half-lives. If you have only a 1-4 on your card, just pretend to flip the cards over.

Your table will be given the name of a pishkun. Fill out your data chart with the number of half-lives your group went through. Determine the age of your bison bones using the chart the class did together. Note: these numbers are made up for this activity. These pishkun are not as old as the activity show. It would just be much harder to show the actual dates.

Exchange places with another group.

Count up the number of C-14 cards and N-14 cards. Fill in the data chart for that pishkun.
Repeat steps 7-8 until you have visited each pishkun.

Determine how old the bison bones would be based on the number of half-lives. Complete the data chart below.

Observations

Pishkun Data

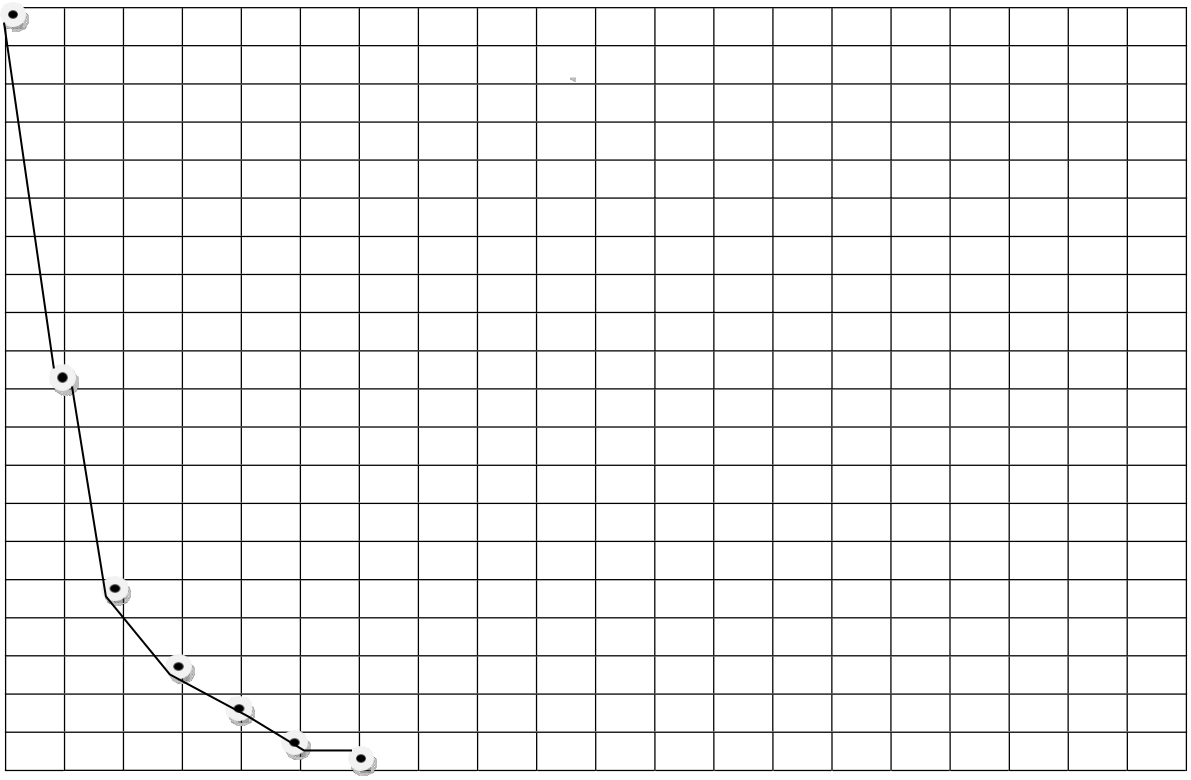
Name of Pishkun Site	Number of C-14 Cards	Number of N-14 Cards	Age of Site
Head-Smashed-In Buffalo Jump			
Madison Buffalo Jump			
First Peoples Buffalo Jump			
Wahkpa Chu'gn			
Belt Meteor Crater			
The Monarch Sink			

Answer Key: Understanding Half-life

Ideal or Mathematical Results

Number of Half-Life	Number of Years Ago	Number of Carbon-14 Atoms
0	0	100
1	5,700 years	50
2	11,400 years	25
3	17,100 years	12.5
4	22,800 years	6.25
5	28,500 years	3.125
6	34,200 years	1.5
7	39,900 years	.75

Carbon-14 Decay Graph



Conclusions

How did the class' data (red line) compare to the idea results (black line)?
The class' data should match this curve pretty closely.

Based on the class' results, if there were about six pennies or Carbon-14 atoms left in our sample, how long ago, or how old, would our sample be?

This would be about 22,800 years.

Answer Key: Determining the Age of Bison Bones

Half-life Chart

Number of Half-lives	Number of C-14 Cards	Number of N-14 Cards	Years Ago
0	128	0	0
1	64	64	5,700
2	32	96	11,400
3	16	112	17,100
4	8	120	22,800
5	4	124	28,500