Using Radionuclides to Date Materials

Using information drawn from the enrichment reading "Using Radionuclides to Date Materials" and your own knowledge, answer the following questions. Do additional research if necessary. (The Internet might be the quickest tool for brief additional information.) If your teacher tells you to work in groups, be sure to discuss your reasoning with each other.

Some of the following items could be dated by the technique of radiocarbon (carbon-14) dating; some could not. If the item could be dated by carbon-14 dating, place a capital "Y" (for "Yes") on the line next to the item. If it could not be dated by this method, place a capital "N" (for "No") next to the item. After each item, briefly explain why you chose "Y" or "N."

1._*(Y)*___ The bones of a horse owned by one of the Roman emperors

(Yes. Explanations will vary, but the following points are relevant: The various lines of Roman emperors started with Julius Caesar in 48 B.C. and lasted until 476 A.D. This is well within the 50,000-year limit of the radiocarbon dating technique. If enough of a carbon sample could be obtained, a horse owned by one of the emperors could be dated by the carbon-14 method.)

2. _*(N)*___ A pure gold drinking cup

*(No. Gold is a stable element. Any item made of pure gold could not be dated by a radioisotope technique. Items found **with** the gold cup, however, might be datable by radioisotopes [e.g., cotton or woolen cloth, a wooden box] and could help an archeologist estimate the age of the cup.)*

3. _(*N)*___ Dinosaur bones

(No. The dinosaurs died out at least 65 million years ago. Although their bones would have contained carbon-14 at the time of death, after 50,000 years, all the carbon-14 in their remains would have decayed. Other radioisotopes, such as potassium-40 and uranium-238, help date their bones, however.)

4. _*(Y)*___"Oetzi," the frozen intact, middle-to-late stone-age (specifically, copper-age) hunter found by hikers in the Italian/Australian Alps in 1991

(Yes. Answers will vary, but the following is relevant: "Oetzi," named for the mountain pass in which his remains were found, actually was carbon-14 dated. He died about 9,000 years ago. The mesolithic, or middle stone age, is considered to have started about 10,000 to 12,000 years ago, at the end of the last ice age. Oetzi worked with copper, as evidenced by the large amount of that element in his body. Even his final two meals have been established, because the food in his stomach and intestines was also preserved by freezing.)

5. ___*(Y)*__Petrified bone or skin of an Egyptian mummy

(Yes. Egyptian civilization took root in the Nile River valley about 5,000 years ago, well within the 50,000 years for which carbon-14 dating works.)

6. _ *(N)*___A recently excavated diamond

(No. Although a diamond is crystallized carbon, which may have originally included some small portion of carbon-14, it takes millions of years of heat and pressure for a natural diamond to form. No matter when it was excavated, a natural diamond is far too old to be dated by carbon-14 measurement.)

7. __*(Y)*__The pages of a medieval manuscript made of stretched goat skins

(Yes. The goat skin parchment of a medieval manuscript is organic and could range from about 500 to perhaps 1,200 hundred years old, depending on how one defines the "medieval" period.)

8.__*(Y)*__A papyrus manuscript from ancient Egypt

(Yes. Papyrus, an early form of paper, was made from the papyrus plant. Plants, like all living things, contain carbon-14, and Egyptian papyri are no more than about 5,000 years old. The age of papyrus can be determined by carbon-14 dating.)

9.___*(Y)*__Fossilized kernels of grain found in the cooking area of an Athenian home from the time of the Pelopennesian War

(Yes. The Pelopennesian War between Athens and Sparta lasted from 431 to 404 B.C., thus placing the kernel of grain well within the time frame amenable to carbon-14 dating.)

10. __*(N)*__ An iron grave marker

(No. Although a grave marker is probably within the time frame of recorded human history, iron is a stable element, which does not decay radioactively. So iron doesn't tell us the age of the item.)

11.___*(Y)*__An iron grave marker, with preserved decorative enameled paint made partly of local berries

(Yes. If enough of the organic-containing paint can be obtained for testing purposes, the paint applied would probably be useable for dating — if the paint were applied when the marker was first erected.)

12.___*(N)*__A copper arrowhead

(No. Copper is a stable element. By itself, it won't give any indication of its age.)

13.___*(Y)*__The skeleton of "Kennewick Man," found in 1996 just below the shoreline on Lake Wallula on the Columbia River during hydroplane boat races in Kennewick, Washington

(Yes. Kennewick Man's nearly intact skeleton has caused much controversy because his skull indicates he could be European in ancestry, yet carbon-14 testing showed that his remains are more than 9,000 years old. That places him on the North American continent well before any previously known European-descended human being. Other studies have suggested similarities to the Ainu [hairy] people of Japan.)

14.___*(N)*__A pure silver coin from the time of the Second Punic War

(No. The Second Punic War, during which Hannibal of Carthage invaded Italy, ended in 202 B.C., only a little over 2,200 years ago. But silver is a stable element and by itself cannot give its own date.)

15.____*(Y)*__A wooden bow and arrows

(Yes. Any bow and arrows made of wood have been crafted long after the end of the stone age, so there would still be carbon-14 in the wood.)

16. ____*(N, but …)*__A medieval knight's suit of armor

(Probably not, but it depends. The metals in a medieval knight's suit of armor would contain carbon, but not enough carbon-14 from organic materials to be measurable — unless some animal or plant material were part of the suit. This could include leather straps, etc.)

17.____*(Y)*__Ceremonial burial robes for a pre-Christian Irish king

(Yes. The robes would be made of plant-derived fibers or animal skins and/or furs, all of which would contain carbon-14, and inhabitation of Ireland by human beings is well within 50,000 years.)

18.____*(Y, but ...)*___Bones of a white American settler who died while traveling westward on the Oregon Trail

(Probably. White settlers took to the Oregon Trail less than 200 years ago. Human bones of that age would still have sufficient carbon-14, but the decreased ratio may be difficult to determine with precision. Enough carbon-14 must decay to make the decreased ratio measurable.)

19.____*(N)*__Bones of a Homo Erectus hominid

(No. Because Homo Erectus lived between 1.6 million and 250,000 years ago, his or her bones would no longer contain carbon-14. Other dating techniques would have to be used, including other radioactive dating techniques.)

20. __*(N)*___The preserved hide and bones of a steer branded as belonging to the C-14 Ranch in Texas, the last group of cattle from which were sold at auction in 1925.

(No. Although the steer's bones and hide would still have carbon-14, the remains would not be old enough for the ratio of carbon-14 to carbon-12 to have decreased measurably. Carbon-14 dating requires that the object be several hundred years old so that the decreased ratio will be measurable. Only then can the half-life of 5,730 years be meaningful in light of the new ratio. In this case, more traditional historical research methods would probably be appropriate — i.e.,