Name: _____ **Date:** _____

Chemistry *~ Ms. Hart* **Class:** Anions or Cations

10.1 Homework

Uses and Dangers of Radioisotopes

*Text taken from New York State Regents Review Book.

Radioisotopes have many practical applications in industry, medicine, and research. They also have potential dangers because of harm that could be done by the radiation released.

Uses of Radioisotopes

The following applications represent just a few of the many uses of radioisotopes. Although they must be used with proper precautions, certain radioisotopes provide information that could not be determined from isotopes that are not radioactive.

Dating: Carbon-14 is perhaps best known for its use in dating previously living materials. There is an extremely small amount of C-14 in the atmosphere. When an organism is alive, it uses this radioactive carbon in the same way as it uses stable C-12. When the organism dies, it no longer takes in any carbon.

Each gram of carbon in a living organism emits about 15 disintegrations per minute (dpm). After the organism dies and time passes, the radioactive carbon-14 continues to decay, but it is NOT replaced. Therefore the dpm decreases with time. Because the half-life of C-14 is 5730 years, after that time period there will only be about 7 dpm (half of 15) for each gram of carbon in the organism. Therefore, a reading of 7 dpm/g carbon indicates the remains are about 5700 years old, while a reading of 3.5 dpm would show a material to be about twice as old, about 11,000 years. After about four half-lives, C-14 becomes ineffective as a method for dating materials because too little C-14 remains to be accurately measured.

U-238 is a radioactive material that spontaneously decays through a series of steps until it forms stable Pb-206. As time passes, the amount of lead in the sample will increase as the amount of uranium decreases. Scientists can use the ratio of U-238:Pb-206 to date rocks and other geological formations.

Chemical Tracers: The ability to detect radioactive materials and their decay products makes it possible to determine their presence or absence in a substance. Any radioisotope used to follow the path of a material in a system is called a **tracer**. If radioactive P-31 is present in fertilizer administered to a plant, the uptake of the phosphorus can be traced by detectors. Scientists can then determine the proper amounts and timing of fertilizer applications. C-14 is another tracer used to map the path of carbon in metabolic processes.

Industrial Applications: Radioactive isotopes and gamma rays are absorbed in varying amounts by different materials. The thicker the materials, the more radiation will be absorbed. Thus, radiation products can be used to measure the thickness of materials such as a plastic wrap or aluminum foil or to test the strength of a weld.

Medical Applications: Certain radioisotopes that are quickly eliminated from the body and have short half-lives are important as tracers in medical diagnosis. Many are also used in treatment of various disorders and diseases. Others might be used to make materials free from bacteria or other disease-causing organisms.

I-131 has uses both in the detection and treatment of thyroid conditions. Because iodine accumulates in the thyroid gland, small amounts of I-131 can be administered to a patient and a radiogram made of the thyroid to diagnose a disorder. When a person has an overactive thyroid (hyperthyroidism), I-131 can be given in large enough doses to destroy some of the thyroid and reduce its production of thyroxin.

Cobalt-60 emits large amounts of gamma radiation as it decays. These rays can be aimed at cancerous tumors. The rapidly growing cells of the tumor are more likely to be killed than normal cells by the gamma rays.

Intense beams of gamma radiation can be used to irradiate foods to kill bacteria. Certain types of foods, such as spices, are irradiated on a regular basis. Irradiation of produce and meats has also been approved in many locations. By killing the bacteria present, the food lasts longer without spoiling and causes fewer bacterial infections in those who consume it. Other destruction of bacteria by radiation is also important. Co-60 and Cs-137 are two of the sources of gamma radiation currently being used to destroy anthrax bacilli.

Technetium, atomic number 43, is a radioactive element that is rapidly absorbed by cancerous cells. When Tc-99 is given to patients with cancerous tumors, it accumulates in the tumor and can easily be detected by a scan. When radioisotopes are used for diagnostic purposes, it is advantageous if thy have a short half-life and are quickly eliminated by the body so that they do not damage healthy tissue.

Radiation Risks

The uses of radiation are not without risks. While radioisotopes can be used to kill cancerous cells, they also have the potential of damaging normal tissue. High doses of radiation can cause serious illness and death. Radiation can cause mutations that could potentially be passed from generation to generation.

Nuclear power plants are a particular problem. After the fuel rods no longer have enough uranium to make them useful in the reactor, they contain many decay products, many with long half-lives. It is difficult to store and dispose of these waste products.

Of major concern to many people is the overall safety issue of nuclear power plants themselves. While the plants are designed to protect the public, there is still a danger of a nuclear accident that might release radioactivity in the air or water. The 1986 accident at Chernobyl in Ukraine destroyed farmland that will probably be unusable for generations.

Jot some notes down below about the different types of radioisotopes for studying purposes!

What would a reading be if you didn't have to answer questions about it!?

Review questions for the previous reading.

1. Which radioisotope is used for diagnosing thyroid disorders?
   a. Cobalt-60 c. lead-206
   b. Uranium-238 d. iodine-131

2. Which procedure is based on the half-life of a radioisotope?
   a. Accelerating to increase kinetic energy
   b. Radiation to kill cancer cells
   c. Counting to determine a level of radioactivity
   d. Dating to determine age

3. Radiated food can be safely stored for a longer period of time because radiation
   a. Prevents air oxidation
   b. Prevents air reduction
   c. Kills bacteria
   d. Causes bacteria to mutate

4. A radioactive-dating procedure to determine the age of a mineral compares the mineral's remaining amounts of U-238 and the isotope
   a. Pb-206 c. Pb-214
   b. Bi-206 d. Bi-214

5. Which isotopic ratio needs to be determined when the age of ancient wooden objects is investigated?
   a. U-235 to U-238 c. N-16 to N-14
   b. H-2 to H-3 d. C-14 to C-12

6. Which two characteristics do radioisotopes have that are useful in medical diagnosis?
   a. Long half-lives and slow elimination from the body
   b. Long half-lives and quick elimination from the body
   c. Short half-lives and slow elimination from the body
   d. Short half-lives and quick elimination from the body

7. A radioisotope is called a tracer when it is
   a. Kill bacteria
   b. Kill cancerous tissue
   c. Determine the age of animal skeletal remains
   d. Determine the path of an element in an organism

8. Which radioactive isotope is used in geological dating?
   a. U-238 c. I-131
   b. Co-60 d. Tc-99

9. Which isotope can be used as a tracer to study the age of organic material?
   a. C-12 c. C-14
   b. Sr-88 d. Sr-90

10. Brain tumors can be located by using an isotope of
    a. C-14 c. Tc-99
    b. I-131 d. U-238

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