Name  **Key**  Class Date

**Half-life Calculations**

1. Define **half-life**.  **A half-life is the time in which half the atoms of a radioactive nuclide undergo**

**decay.**

1. Use references to find the half-life of each of the following radioactive isotopes.
   1. carbon-14  **5730 years**
   2.   **4.46 x 109 years**
   3. Th-235 14 Billion years
   4.  47 Billion years
2. What fraction of the original atoms of radioactive sample will remain after the given number of half-lives has passed?

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number half-lives passed** | **0** | **1** | **2** | **3** | **4** | **5** | **6** |
| **Fraction of atoms remaining** | **1/1 or 1** | **1/2** | **1/4** | **1/8** | **1/16** | **1/32** | **1/64** |

1. Iodine-131 is used in radiotherapy of the thyroid gland and has half-life 8 days. What fraction of the dose given a patient will remain 24 days after the treatment?

**24 ÷ 8 = 3 half-lives have passed**

**(1/2)3 = 1/8 of the original atoms remain**

1. A phosphorus-32 sample originally had mass 20. grams. After 28 days, only 5.0 grams of it remained. How many half-lives have passed? What is the half-life of ?

**5.0 ÷ 20. = ¼ of the original mass remains**

**¼ = (1/2)2 so 2 half-lives have passed**

**If 2 half-lives spans 28 days, each half-life must be 14 days.**

1. Bits of bone are found at an archeological dig. The amount of carbon-14 left in the bones is 1/16 as much as living bones contain. Determine the number of half-lives that has passed since the animal died, then calculate the bones’ age in years. (Round to the hundreds of years.)

**If 1/16 of the original C-14 remains and 1/16 = (1/2)4, then 4 half-lives have passed.**

**Each half-life is (see problem #2) 5730 years.**

**4 x 5730 years = 22 900 years**

|  |  |
| --- | --- |
| **Isotope** | **t1/2** |
| carbon-11 | 20.3 minutes |
| carbon-12 | NA |
| carbon-14 | 5730 years |

1. The table at right lists three isotopes of carbon and the half-life of each.
2. Which of these is most stable? Explain.
3. Why is carbon-14 used for radioisotope dating of artifacts rather than either of the other two isotopes?
   1. **Carbon-14 has the most stable nucleus. It does not have a half-life because it does not undergo decay. You might think of it as having an infinitely long half-life. The longer the half-life, the more stable the nuclide’s nucleus is.**
   2. **C-12 cannot be used because it does not undergo decay and its amount in a sample would be constant. The half-life of C-11 is so short that it is not useful for dating objects that are thousands of years old. Carbon-14 has a reasonably long half-life and would be present in anything that was living. (The chemistry of organisms is based on carbon chemistry.)**

**Half-life Practice Worksheet**

1. Sodium-24 has a half-life of 15 hours. How much sodium-24 will remain in an 18.0 g sample after 60 hours?



1. After 42 days a 2.0 g sample of phosphorus-32 contains only 0.25 g of the isotope. What is the half-life of phosphorus-32?



1. Polonium-214 has a relatively short half-life of 164 seconds. How many seconds would it take for 8.0 g of this isotope to decay to 0.25 g?



1. How many days does it take for 16 g of palladium-103 to decay to 1.0 g? The half-life of palladium-103 is 17 days.



1. By approximately what factor would the mass of a sample of copper-66 decrease in 51 minutes? The half-life of copper-66 is 5.10 minutes.



1. In 5.49 seconds, 1.20 g of argon-35 decay to leave only 0.15 g. What is the half-life of argon-35?

