Shedding Light on Nuclear Radiation Episode 7: Natural Radioisotope Production

Name: _____

Part A:

1. What are cosmic rays? _____

   _____

2. Carbon-14 is a "cosmogenic" nuclide. What does this mean? _____

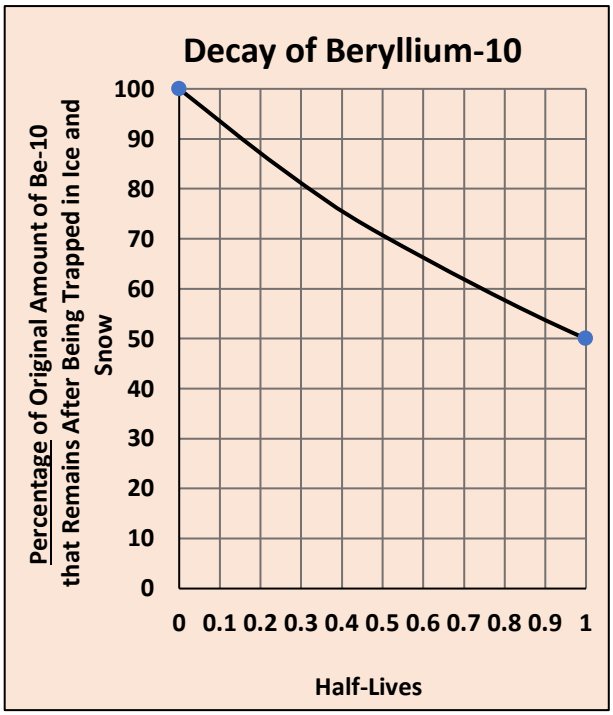
   _____

3. Briefly describe the 2-step process by which beryllium-10 is produced in the atmosphere.

   _____

   _____

   _____



4. What is beryllium-10's half-life? _____

A small section of a deep ice core taken in Antarctica is discovered to contain ash that was deposited when a large volcano erupted in ancient times. When scientists examined the beryllium-10 content of that section of the ice core, they found that it contained only about 93% of the beryllium that exists on the Earth's surface today.

5. Approximately how many beryllium-10 half-lives have passed since the ice core formed?

   _____

6. Approximately how many years ago did the volcano erupt?

   _____

A: mass number: number of protons + number of neutrons
Z: atomic number: number or protons

$${}^{A}_{Z}X$$

In atomic notation, carbon-13 can be written as ${}^{13}_{6}C$

7. Application Question: Aluminium-26 atoms ($t_{1/2}$ = 717,000 years) can be used to determine the erosion rates of rocks. They are created when neutrons (created by cosmic ray collisions with oxygen or nitrogen atoms) crash into silicon-28 atoms in rocks. In the process a proton and two neutrons are knocked out of the original nucleus (which leaves behind an Al-26 nucleus. Write the nuclear equation for the nuclear reaction.

8. Application Question: Calcium-41 is produced when a neutron collides with a calcium-40 nucleus and then sticks to it. A gamma ray is released in the process. Write the nuclear equation for the nuclear reaction.

Part B:

9. The Big Bang is the event that has been theorized to have kicked off the existence of the universe. Currently, it is believed that only _____ and _____ atoms were created in the Big Bang and maybe tiny amounts of _____ and _____.

10. Briefly describe how the other elements that exist on Earth were believed to have been created.
    _____
    _____
    _____

11. How did the atoms created in your answer to Q10 end up on Earth? _____
    _____
    _____
    _____

The following 6 questions refer to the Thorium-232 Decay Series

12. What is the initial radioisotope in the thorium-232 decay series? (This is a bit of a trick question.)
    _____

13. Identify the first daughter product formed in the decay of thorium-232. _____

14. What type of decay does thorium-232 undergo? _____

15. What type of decay does lead-212 undergo? _____

16. What is the stable end product of the thorium-232 decay series? _____

17. How many alpha decays and beta-minus decays need to occur in the entire thorium-232 decay series before the final end product is made? (The fact that there are two different "pathways" in the series doesn't affect the answer.)
    Number of alpha decays: _____
    Number of beta-minus decays: _____

18. Primordial radionuclides and their daughter products produce lots of heat under the surface of the Earth. What are the three radionuclides that contribute most to this heating?
    (a) _____
    (b) _____
    (c) _____

19. When scientists talk about the age of a rock, what do they mean? _____
    _____
    _____