Inside the Isotope

Trace nuclear change and evaluate a medical use of radiation.

PHY.6.1 "Analyze and explain the concepts of nuclear physics."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each statement about a change inside an atomic nucleus. Circle each fact that helps explain either the treatment's effect or a safety precaution.

A Radioactive Treatment

1. At a hospital, a patient may swallow a small dose of iodine-131 to treat an overactive thyroid. The thyroid absorbs iodine to make hormones, so much of the dose collects there. An iodine-131 nucleus has 53 protons and 78 neutrons. It is unstable: one neutron can change into a proton while the nucleus emits a beta particle, which is an electron. The resulting nucleus has 54 protons and 77 neutrons. It is xenon-131, not iodine-131, because an element's identity depends on its number of protons. The total number of protons and neutrons remains 131.

2. Beta particles released near thyroid cells can damage those cells and reduce the thyroid's activity. This is useful in treatment, but radiation can also harm healthy tissue. Some iodine-131 decays also release gamma rays, which can travel farther through the body than beta particles. Doctors choose the dose carefully because they must balance a treatment's benefit against exposure to other tissues. A radioactive nucleus cannot be made safe simply by cooling it or changing its chemical form. Its decay is a change in the nucleus, not a chemical reaction involving only electrons outside the nucleus.

3. Iodine-131 has a half-life of about eight days. After each eight-day interval, about half of the iodine-131 nuclei that were present at the start of that interval remain undecayed. Individual nuclei decay unpredictably, so a half-life describes a large group rather than a clock inside each atom. The amount does not suddenly fall to zero after one half-life. To limit exposure after treatment, patients may be asked to keep some distance from other people for a short time and follow instructions for handling bodily waste. These precautions matter because radioactive iodine can leave the body before all its nuclei have decayed.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does the nucleus formed by iodine-131 decay belong to a different element even though it still contains 131 protons and neutrons in total?

2. How does the thyroid's use of iodine help beta radiation treat an overactive thyroid?

3. A sample begins with 64 units of iodine-131. About how many units remain undecayed after 24 days? Explain your reasoning.

4. Why might a patient need to limit close contact with others even though much of the dose collects in the thyroid?

3 YOUR TURN

Your own words

Imagine a lab has a sealed sample of a beta-emitting isotope with a six-day half-life. Write a four-sentence note that predicts the undecayed fraction after 18 days, explains the nuclear change that produces a beta particle, and recommends one way to reduce exposure with a reason.

ANSWER KEY

Inside the Isotope

PART 1 · READ AND MARK

Underline each statement about a change inside an atomic nucleus. Circle each fact that helps explain either the treatment's effect or a safety precaution. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does the nucleus formed by iodine-131 decay belong to a different element even though it still contains 131 protons and neutrons in total?	**A neutron becomes a proton, raising the proton count from 53 to 54. Proton count determines the element, so the new nucleus is xenon-131.**
2	How does the thyroid's use of iodine help beta radiation treat an overactive thyroid?	**The thyroid absorbs iodine, concentrating iodine-131 near thyroid cells. Beta particles released there can damage those cells and reduce thyroid activity.**
3	A sample begins with 64 units of iodine-131. About how many units remain undecayed after 24 days? Explain your reasoning.	**About 8 units remain. Twenty-four days is three eight-day half-lives, so the amount halves three times: 64 to 32 to 16 to 8.**
4	Why might a patient need to limit close contact with others even though much of the dose collects in the thyroid?	**Some decays release gamma rays that can travel farther than beta particles, and radioactive iodine can leave the body before it decays.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

After 18 days, one-eighth of the original nuclei remain undecayed because three half-lives have passed. During beta emission, a neutron changes into a proton and the nucleus releases an electron. Keep the sample sealed so radioactive material cannot spread. This reduces the chance that someone will take the material into their body.

Accept equivalent half-life reasoning and safety measures with accurate explanations, such as using suitable shielding to reduce beta exposure. A response should distinguish nuclear decay from a chemical change.