LESSON MAKER PRO

Nuclear Change Tracker

Balance nuclei and compare nuclear energy changes.

HIGH SCHOOL · HS-PS1-8

HS-PS1-8 "Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay..."

NAME _____ DATE _____

BALANCE THE NUCLEUS

In a nuclear change, track the mass number and atomic number. An alpha particle lowers the daughter mass number by 4 and atomic number by 2, a beta-minus particle keeps the mass number the same and raises the daughter atomic number by 1, and gamma emission changes neither number. In this worksheet, beta means beta-minus.

WORKED EXAMPLE

Complete the equation: 35/16 S -> ____ + beta particle

1. The mass number stays 35 after beta-minus emission.
2. The atomic number rises from 16 to 17.
3. Atomic number 17 is chlorine, Cl.

Answer: 35/17 Cl + beta particle

PRACTICE 6 problems

1 Complete the equation: 226/88 Ra -> ___ + alpha particle

ANSWER _____

2 Complete the equation: 14/6 C -> ___ + beta particle

ANSWER _____

3 99m/43 Tc, where m means an excited nucleus, emits gamma radiation. Complete the equation: 99m/43 Tc -> ___ + gamma ray

ANSWER _____

4 A 131/53 I nucleus emits a beta particle. What are the daughter isotope's mass number, atomic number, and element?

ANSWER _____

5 A 235/92 U nucleus absorbs one neutron and splits into 141/56 Ba and 92/36 Kr. How many neutrons must be released to balance the mass numbers?

ANSWER _____

6 A grill burns propane, while a nuclear reactor splits uranium nuclei. Which process releases more energy per atom?

ANSWER _____

APPLY IT Show your work

1 A student is making a museum display about carbon dating. A carbon-14 nucleus has 6 protons and 8 neutrons, then it emits a beta particle. Name the daughter isotope, state its new numbers of protons and neutrons, and compare the energy released with an ordinary chemical reaction.

WORK SPACE

ANSWER _____

2 A school climate club reads about a fusion reactor using deuterium and tritium. Complete the model: 2/1 H + 3/1 H -> 4/2 He + ___. Then explain why energy can be released even though the total mass number is conserved.

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

A 219/86 Rn nucleus emits an alpha particle and then a beta particle. What final isotope forms? Explain the change in proton and neutron counts from the starting nucleus to the final nucleus.

_____

_____

ANSWER KEY

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Complete the equation: 226/88 Ra -> ___ + alpha particle	**222/86 Rn + alpha particle**
2	Complete the equation: 14/6 C -> ___ + beta particle	**14/7 N + beta particle**
3	99m/43 Tc, where m means an excited nucleus, emits gamma radiation. Complete the equation: 99m/43 Tc -> ___ + gamma ray	**99/43 Tc + gamma ray**
4	A 131/53 I nucleus emits a beta particle. What are the daughter isotope's mass number, atomic number, and element?	**Mass number 131, atomic number 54, xenon, 131/54 Xe**
5	A 235/92 U nucleus absorbs one neutron and splits into 141/56 Ba and 92/36 Kr. How many neutrons must be released to balance the mass numbers?	**3 neutrons**
6	A grill burns propane, while a nuclear reactor splits uranium nuclei. Which process releases more energy per atom?	**Nuclear fission releases much more energy per atom than burning propane.**

PART 2 · APPLY IT

1. **14/7 N; 7 protons and 7 neutrons; the nuclear decay releases much more energy per atom than an ordinary chemical reaction.** Beta-minus emission changes one neutron into one proton, so the mass number stays 14 and the atomic number rises from 6 to 7. Nuclear changes release far more energy per atom than chemical changes.
2. **1/0 n; energy is released because the fusion products have a different nuclear binding energy, and a small amount of mass is converted to energy.** The mass numbers total 5 before fusion and 4 in the helium nucleus, so a neutron with mass number 1 is needed. Fusion can release nuclear energy when the products are more tightly bound.

CHALLENGE

215/85 At. The starting nucleus has 86 protons and 133 neutrons. Alpha emission leaves 84 protons and 131 neutrons, then beta-minus emission changes one neutron into a proton, leaving 85 protons and 130 neutrons.

Accept isotope names or mass-number and atomic-number notation. For beta-minus items, accept electron for beta particle, and do not require neutrinos in these simplified equations.