

Activity 18: Nuclear Reactions: Is matter really conserved?

Protons, Neutrons, Electrons, and the Mass of an Atom: Is matter conserved?

Table 1: The Masses of Three Subatomic Particles^{*1}

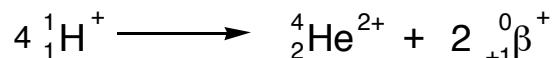
$$e^{-} = 0.000549 \text{ u} \quad {}_1^1\text{p} = 1.007276 \text{ u} \quad {}_0^1\text{n} = 1.008665 \text{ u}$$

"u" is the symbol for "atomic mass unit"

Table 2: The Masses of Four Elements

$${}_1^1\text{H} = 1.007825 \text{ u} \quad {}_1^2\text{H} = 2.0140 \text{ u} \quad {}_1^3\text{H} = 3.01605 \text{ u} \quad {}_2^4\text{He} = 4.00260 \text{ u}$$

In the sun, the following nuclear reaction occurs.



Typically, the charges, the superscripted numbers to the right, are not indicated in nuclear reactions.

1. a. Using the data tabulated in the model section determine the total mass of the reactants and the total mass of the products (a ${}_{+1}^0\beta$ particle has the mass of an electron and the charge of a proton).

¹ Masses obtained from the CRC Handbook of Chemistry and Physics (2000).

- b. Is the mass of the reactants the same as the mass of the products?
- c. Does the sun release or absorb energy?
- d. Considering Einstein's famous equation ($E = mc^2$) what do you think happens in the nuclear reaction that occurs in the sun?

2. Initiated by the collision with a neutron, the fission of ^{235}U (235.043933 amu), the fuel used in nuclear reactors, produces a variety of products. In one fission reaction, ^{90}Sr (89.907738), ^{143}Xe (139.9216 amu), and three neutrons are produced from ^{235}U and a neutron. (Since one neutron goes in and three come out, there is the net production of two neutrons.)



- a. Determine the total mass of the products.
- b. Is the mass of the reactants the same as the mass of the products?
- c. Does this reaction release or absorb energy.