Investigating Stars Name:____Block:____________

How is Energy Produced in Stars? **E1:A4**

The sun has been producing vast amounts of energy for about 4.6 billion years. Instead of burning in the chemical sense, atoms of hydrogen are fused together, resulting in the creation of new elements and the release of energy. The elements and energy formed in these starry furnaces are the foundation of life on a planet like Earth. In this activity, you will examine how nuclear fusion produces the elements and energy on which all life depends.

1. As a class, discuss the fusion reaction shown on the *Forming Elements with Nuclear Fusion* worksheet, and work through the example showing one of the reactions that commonly occurs inside a star when a new element is formed.

2. Complete the *Forming Elements with Nuclear Fusion* handout.

   • When you finish, compare your answers with a classmate.

3. As you saw in Steps 1 and 2, nuclear fusion inside a star can fuse light elements to make heavier ones.

   • Can this same process also be a source of energy?

4. Complete the worksheet *Producing Energy with Nuclear Fusion*, which shows several nuclear fusion reactions that commonly occur inside stars.

   Calculate the total mass of the input elements (the elements before the arrow sign) and enter this mass into the "Mass of Input" column.

   Find the total mass of the output elements (the elements after the arrow sign) and enter the mass into the "Mass of Output" column.

   Calculate the mass difference between the Input and Output columns.

5. Read both FYI: *Nuclear Fusion* and FYI: *Conservation of Mass and Energy* and Complete the reading guide and questions after reading.

Forming Elements with Nuclear Fusion

Investigating Stars: Exploration One: Activity 4

Below are some reactions that commonly occur inside stars to form new elements. The reactions occur when two or more lighter elements fuse to create a heavier element. For example, to make a ${}^{4}_{1}He$ atom, you can fuse together four ${}^{1}_{1}H$ atoms, giving you the two protons*, two neutrons, two positrons, and energy.

$${}^{1}_{1}\mathbf{H} + {}^{1}_{1}\mathbf{H} + {}^{1}_{1}\mathbf{H} + {}^{1}_{1}\mathbf{H} \longrightarrow {}^{4}_{2}\mathbf{He} + 2\,{}^{1}_{0}\mathbf{e}^{+} + \mathbf{E}$$

Fill in the blanks with the appropriate information. To do this, (a) read the element symbols in the equation, (b) complete the boxes below each symbol, and then (c) determine what new element has resulted. For simplicity, assume that there are the same number of protons and neutrons on each side of an equation.

$${}^{4}_{2}He + {}^{4}_{2}He + {}^{4}_{2}He \longrightarrow \qquad\qquad + E$$

Protons: _____	Protons: _____	Protons: _____	Protons: _____
Neutrons: _____	Neutrons: _____	Neutrons: _____	Newtrons: _____

$${}^{4}_{2}He + {}^{12}_{6}C \longrightarrow \qquad\qquad + E$$

Protons: _____	Protons: _____	Protons: _____
Neutrons: _____	Neutrons: _____	Neutrons: _____

$${}^{12}_{6}C + {}^{4}_{2}He \longrightarrow \qquad\qquad + E$$

Protons: _____	Protons: _____	Protons: _____
Neutrons: _____	Neutrons: _____	Neutrons: _____

$${}^{16}_{8}O + 2\,{}^{4}_{2}He \longrightarrow \qquad\qquad + E$$

Protons: _____	Protons: _____	Protons: _____
Neutrons: _____	Neutrons: _____	Neutrons: _____

 Name:______________________________ Block:__________

Producing Energy with Nuclear Fusion

Investigating Stars: Exploration One: Activity 4

Atomic Mass of the Elements Commonly Involved in Nuclear Fusion Reactions Inside Stars	
Element Name or Particle Type	**Atomic Mass (mass of protons plus mass of neutrons)**
neutron	1.0087
${}^{4}_{2}He$	4.0026
${}^{12}_{6}C$	12.0000
${}^{16}_{8}O$	15.9949
${}^{24}_{12}Mg$	23.9850
${}^{31}_{16}S$	30.9796

Common Reactions in Stars

Common Reactions in Stars	Mass of Input	Mass of Output	Difference Between Input and Output Mass	How Does Mass of Input Compare to Mass of Output? (equal to, greater than, or less than)
a. ${}^{4}_{2}He + {}^{4}_{2}He + {}^{4}_{2}He \rightarrow {}^{12}_{6}C$				
b. ${}^{4}_{2}He + {}^{12}_{6}C \rightarrow {}^{16}_{8}O$				
c. ${}^{12}_{6}C + {}^{12}_{6}C \rightarrow {}^{24}_{12}Mg$				
d. ${}^{16}_{8}O + {}^{16}_{8}O \rightarrow {}^{31}_{16}S$ + 1 neutron				