Comparing Concepts: Nuclear Reactions (Fission vs. Fusion)
(Use the information on the following page to complete your diagram)

Definition of **Fission**: (include a diagram)		Definition of **Fusion**: (include a diagram)

How are they alike?

How are they different?

Nuclear Fission vs. Nuclear Fusion

- **The Similarities:**

Nuclear fusion and nuclear fission are two types of energy-releasing reactions in which energy is released from the nucleus of an atom. Both nuclear fusion and nuclear fission use the energy stored in atomic particles in the energy production process. Both fission and fusion are processes that produce energy. Both fission and fusion can occur naturally. Both fission and fusion reactions are suitable for making nuclear bombs.

- **The Differences:**

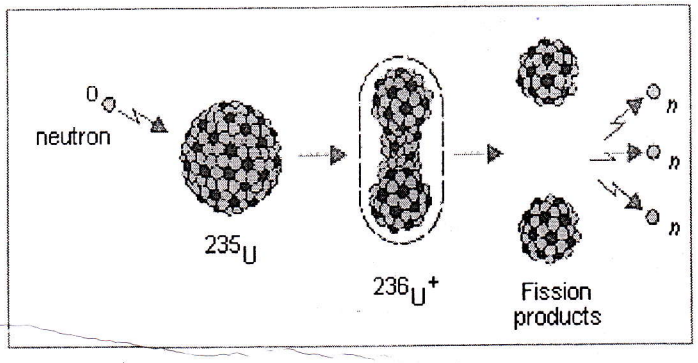
	Nuclear Fission	Nuclear Fusion
Definition	Fission is the splitting of a large particle into two or more smaller particles	Fusion is the fusing of two or more lighter particles into a larger one
Natural occurrence of the process	Fission can occur naturally but most often is human induced	Fusion occurs in stars (like the sun)
By-Products of the reaction	Fission produces many highly radioactive particles	Few radioactive particles are produced by fusion
Conditions	Critical mass of the substance and high-speed neutrons are required	High density, pressure, and temperature are required
Energy requirement	Takes little energy to split two atoms in a fission reaction	Extremely high energy is required to fuse protons together
Energy released	The energy released by fission is a far greater than that released by chemical reactions; but lower than the energy released by fusion	The energy released by fusion is three to four times greater than the energy released by fission
Nuclear weapon	One class of nuclear weapon is a fission bomb, also known as an atom bomb	One class of nuclear weapon is the hydrogen bomb, it uses a fission reaction to trigger a fusion reaction
Energy Production	Fission is used in nuclear power plants.	Fusion is an experimental technology for producing power.
Fuel	Uranium is the primary fuel used in power plants	Hydrogen isotopes (Deuterium and Tritium) are the primary fuel used in experimental fusion power generation.

Write Fission or Fusion next to each of the descriptions below…..

1. Generates a large volume of solid radioactive waste. _____.
2. Occurs in the core of the Earth _____.
3. The reaction occurs only at extremely high temperatures. _____.
4. Earth's source of internal energy. (Volcanoes, plate motion, geothermal). _____.
5. The products of this reaction are not radioactive. _____.
6. Occurs only in the core of the sun _____.
7. Earth's source of external energy (atmosphere, oceans, weather, plants) _____.
8. Also called radioactive decay. _____.
9. Responsible for providing heat for the convection in the interior of the Earth. _____.
10. A potential power source but we lack the technology to maintain the reactions so we are unable to perform these reactions on Earth for energy gain. _____.
11. The primary fuel is Uranium. _____.
12. The primary fuel is Hydrogen _____.
13. An experimental technology _____.
14. Used in nuclear power plants _____.

Nuclear Fission vs. Nuclear Fusion

Nuclear f "i" s s i o n (Spl"i"tting an atom into two new ones)

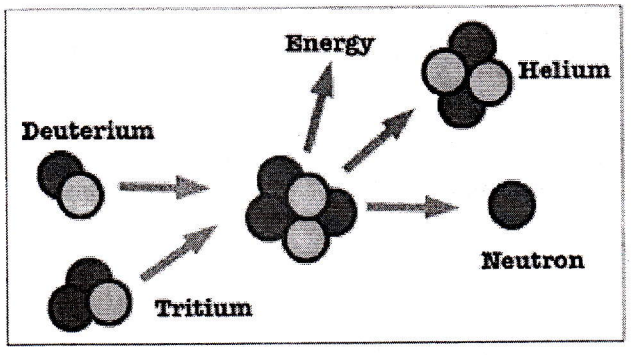


In nuclear fission reactions (also called radioactive decay), a neutron is aimed at the nucleus of a large, unstable atom, like uranium, thorium, or other radioactive elements. The extra mass of the neutron causes the radioactive nucleus to split apart, forming lighter elements, free neutrons, and great quantities of energy. This process causes convection currents that move Earth's tectonic plates, and generate earthquakes and volcanic eruptions.

*Nuclear **Fission**:*

- Source of energy in the core of the Earth that produces heat from the decay of radioactive elements.
- Produces vast quantities of energy.
- Does not produce particulate air pollution like fossil fuels and coal.
- Involves the splitting of harmful radioactive elements.
- Loss of control leads to harmful radiation exposure.
- Produces a radioactive waste product that will need to be stored.

Nuclear f "u" s i o n (combining/f"u"sing two atoms together into one new atom)

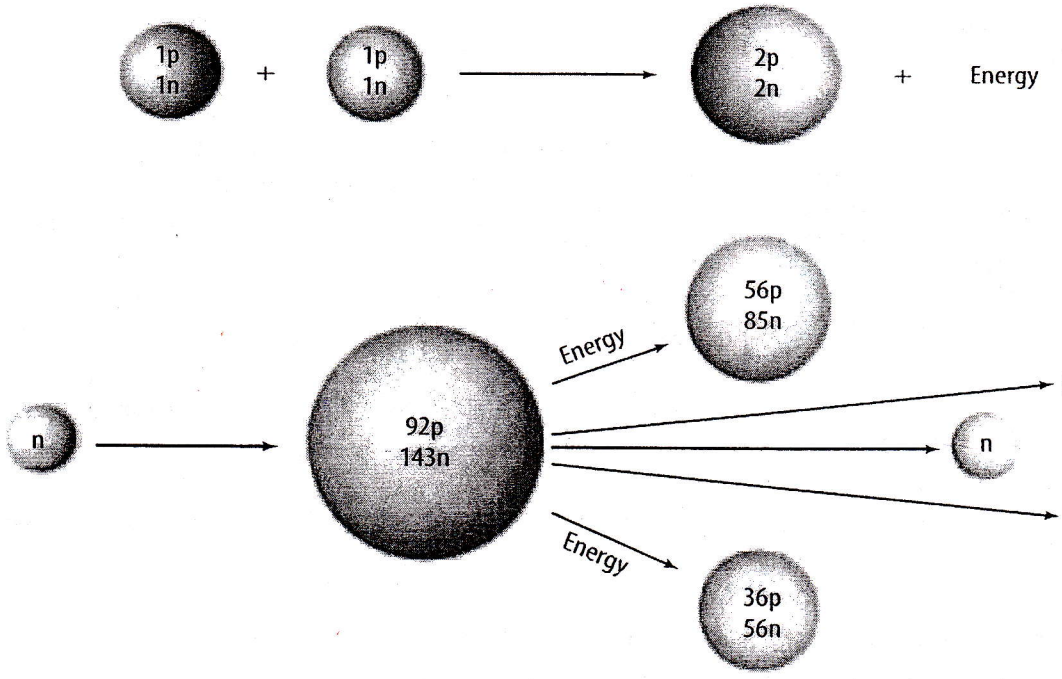


During fusion reactions, nuclei collide and fuse, eventually forming nuclei of heavier elements and producing *enormous* amounts of energy. Fusion of hydrogen to helium occurs in the sun and is the source for all external weather related events.

*Nuclear **Fusion**:*

- Source of energy in the Sun that produces heat from the fusing of elements like hydrogen.
- Produces unsurpassed quantities of energy.
- Does not produce particulate air pollution like fossil fuels and coal.
- Does not produce a radioactive waste product that will need to be stored.
- Currently, we lack the technology to maintain reactions as a viable energy source.

Directions: *Use the diagrams below to complete the following activities.*



1. The diagrams show two types of nuclear reactions: nuclear fission and nuclear fusion. Label the type of reaction shown in each diagram in the space provided.
2. Circle the letter of the equation that correctly explains the nuclear reaction shown in the top diagram.
   - **a.** H-2 + H-2 → H-4
   - **b.** H-2 + H-2 → He-4
   - **c.** H-1 + H-1 → H-2
   - **d.** H-1 + H-1 → He-2
3. Circle the letter of the equation that correctly explains the nuclear reaction shown in the bottom diagram.
   - **a.** 1 neutron + U-235 → Ba-141 + Kr-92 + 3 neutrons + energy
   - **b.** 1 neutron + U-238 → Ba-141 + Kr-92 + 4 neutrons
   - **c.** Ba-141 + Kr-92 → U-235 + 3 neutrons
   - **d.** Ba-141 + Kr-92 → U-238
4. What two elements are involved in the nuclear fusion reaction? _____
5. Label each atom in the fusion reaction with its correct symbol and isotope notation.
6. What three elements are involved in the fission reaction shown? _____
7. Label each atom in the nuclear fission reaction with its chemical symbol and its correct isotope notation.