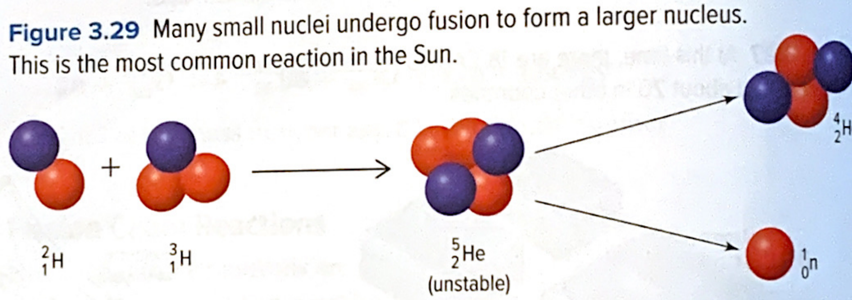
nuclear fusion a process in which two very small nuclei combine, or fuse, to form a slightly larger nucleus

Nuclear Fusion

In **nuclear fusion**, two very small nuclei combine, or fuse, to form a slightly larger nucleus. For nuclei to fuse, they must collide with a tremendous amount of force. Thus, fusion requires very fast-moving particles to begin. This means it needs to occur at extremely high temperatures. However, once the nuclei fuse, they themselves generate the energy needed for fusion reactions to continue. Scientists have been trying to find a way to control fusion to produce energy, but they haven't been successful. However, fusion reactions occur in the Sun and other stars, like those in Figure 3.28. The reaction that occurs most frequently in the Sun is the fusion of two isotopes of hydrogen. These are called deuterium, $^{2}_{1}H$, and tritium, $^{3}_{1}H$. This fusion reaction forms the very unstable isotope, helium-5. Helium-5 immediately breaks down into helium-4 and a neutron. The reaction is shown in Figure 3.29. The helium-4 that is produced is stable. Thus, fusion does not produce radioactive materials.

Figure 3.28 Nuclear fusion occurs in all stars.

Figure 3.29 Many small nuclei undergo fusion to form a larger nucleus. This is the most common reaction in the Sun.



$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{5}_{2}He \rightarrow ^{4}_{2}He + ^{1}_{0}n + \text{energy}$$

Connect to Investigation 3-D on page 240

The amount of energy released in a fusion reaction is about 10 times less than the amount transformed by the fission of uranium-235. However, the sum of the masses of deuterium and tritium is about 47 times smaller than the mass of uranium-235. Therefore, the energy released per unit mass is much larger for nuclear fusion than for nuclear fission. As well, the products produced by fusion are not radioactive isotopes, so no radioactive nuclear waste products result.

Before you leave this page . . .

1. Compare chemical reactions and nuclear reactions in terms of how much energy they transform.
2. a) What is a radioactive isotope?
   b) How do these isotopes get rid of their extra energy?
3. How is alpha decay different from beta decay?
4. Why does gamma decay occur?
5. How are nuclear fission and fusion similar? How do they differ?
6. At a glance, it appears like the law of conservation of energy does not apply to nuclear reactions. Explain why it does.