



Chapter Fourteen: Changes in Matter

- **14.1 Chemical Reactions**
- **14.2 Types of Reactions**
- **14.3 Energy and Chemical Reactions**
- **14.4 Nuclear Reactions**

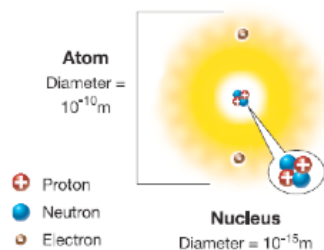


Chapter 14.4 Learning Goals

- **Compare and contrast chemical and nuclear reactions.**
- **Explain the significance of the strong nuclear force.**
- **Explore benefits and negative effects of nuclear reactions.**



14.4 Chemical vs. Nuclear Reactions

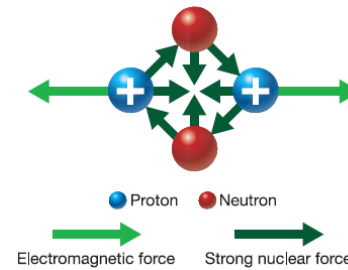


- The involvement of energy in chemical reactions has to do with the breaking and forming of chemical bonds.
- A nuclear reaction involves altering the number of protons and/or neutrons in an atom.



14.4 Chemical vs. Nuclear Reactions

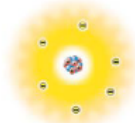
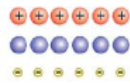
- For complex reasons, the nucleus of an atom becomes unstable if it contains too many or too few neutrons relative to the number of protons.
- The forces inside the atom result in it breaking apart or releasing particles.



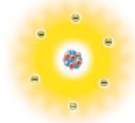


14.4 Radioactivity

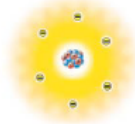
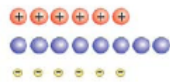
Carbon-12



Carbon-13



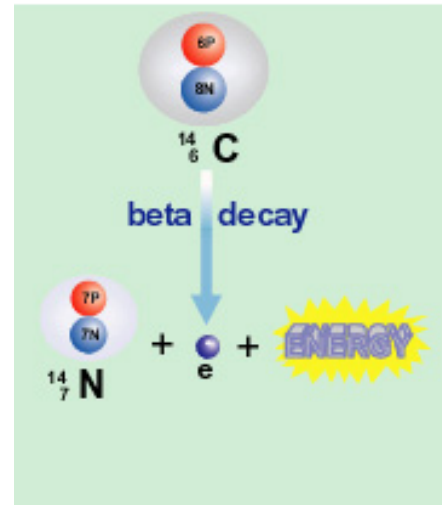
Carbon-14



- Almost all elements have one or more isotopes that are **stable**.
- “Stable” means the nucleus stays together.
- Carbon-14 is **radioactive** because it has an **unstable nucleus**.

14.4 Radioactive Decay

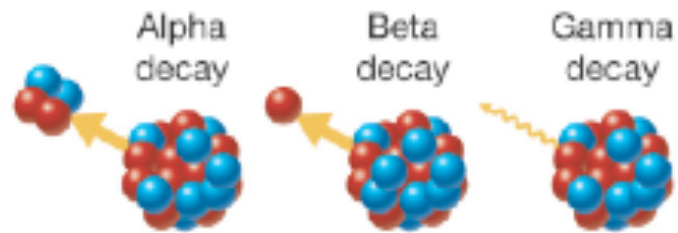
- This process of radioactive decay results in an unstable, radioactive isotope like carbon-14 becoming the more stable isotope nitrogen-14.





14.4 Radioactive Decay

● Electron ● Proton ● Neutron

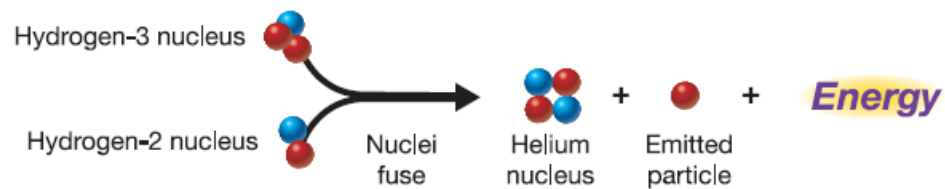


Protons	Decrease by 2	Increase by 1	Unchanged
Neutrons	Decrease by 2	Decrease by 1	Unchanged



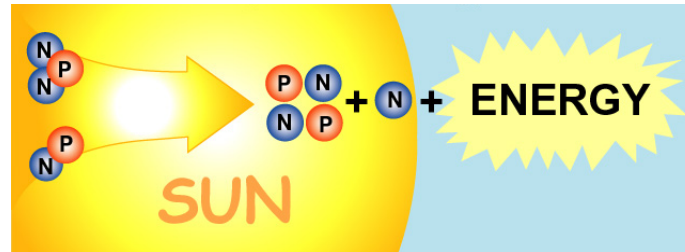
14.4 Two types of Nuclear Reactions

- There are two kinds of nuclear reactions: fusion and fission.
 - Nuclear fusion is the process of combining the nuclei of lighter atoms to make heavier atoms.



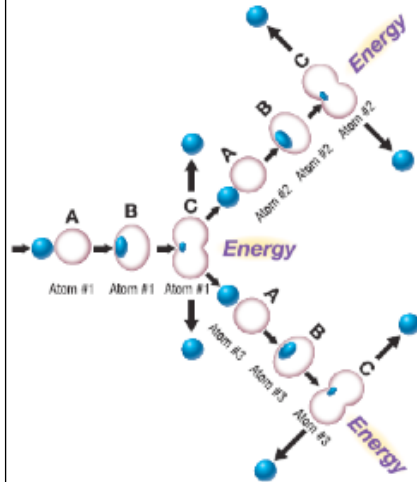
14.4 Fusion

- Nuclear fusion occurs in the Sun and the resulting energy released provides Earth with heat and light.





14.4 Types of Nuclear Reactions



- Nuclear fission is the process of splitting the nucleus of an atom.
- A fission reaction can be started when a neutron bombards a nucleus.



14.4 Using nuclear reactions in medicine and science

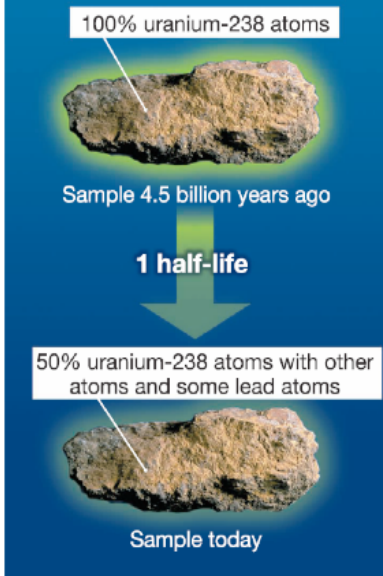
- A half-life is a certain length of time after which half of the amount of radioactive element has decayed.
- As a radioactive element decays, it emits harmful radiation such as alpha and beta particles and gamma rays.



14.4 Using nuclear reactions

- Radioactive dating is a process used to figure out the age of objects by measuring the amount of radioactive material in it and by knowing the half-life of that substance.
- Understanding radioactive decay of uranium-238 has allowed scientists to determine that the age of Earth is 4.6 billion years

Radioactive Decay of Uranium-238





14.4 Using nuclear reactions in medicine and science

- **Radioisotopes (also called radioactive isotopes) are commonly used as tracers in medicine and science.**
- **By adding a radioactive isotope into a system (such as the human body or an underground water supply), problems can be detected.**

Hydrogen Powered Cars

- **Scientists and engineers from government agencies, universities, and all of the major automobile manufacturers are designing, building, and testing hydrogen fuel cell vehicles, also known as FCVs.**

