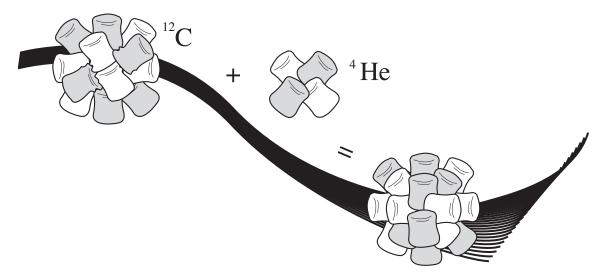
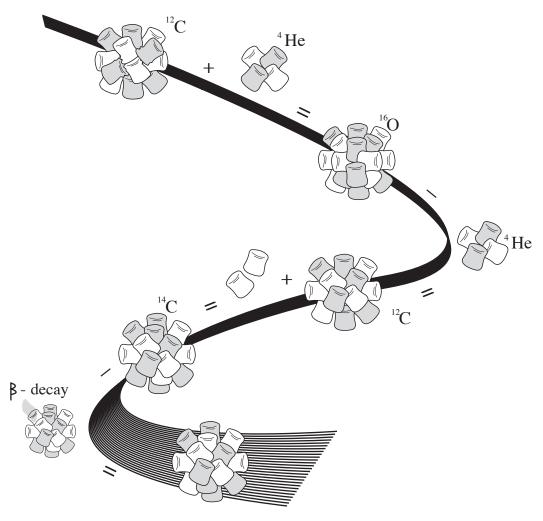
Using white marshmallows for **protons**, and colored marshmallows for **neutrons**. *Be courteous*, *use the spoon to take the marshmallows*.



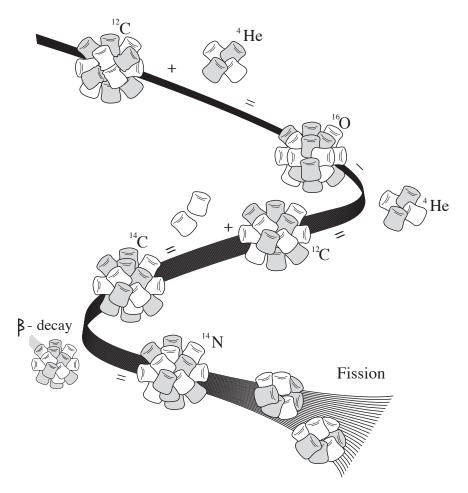
- Make the **nucleus** for Carbon-12 using six neutrons and six protons. Find Carbon on the **Periodic Table** of the Elements.
- Nuclear forces are short ranged. (Try licking the marsh-mallows to get them to stick together.
- Alpha particles are Helium nuclei make an alpha particle with two neutrons and two protons. Find Helium on the Periodic Table.
- New elements can be made by adding nuclei together. Add the alpha particle to the Carbon-12 particle What element have you made? Find it on the Periodic Table.



- Heavy elements like Uranium are **Radioactive.**The spontaneous emission of a alpha particle is called **Alpha decay**. Remove the alpha particle from Oxygen-16, (you may eat the alpha particle).
- Isotopes of an element have the same number of protons and different numbers of neutrons. Add two neutrons to your Carbon -12 nucleus. What isotope have you made?



- Carbon-14 undergoes radioactive **beta decay**. A high energy electron is emitted, the **beta particle**, and a neutron becomes a proton. Exchange a neutron for a proton in your carbon-14 nucleus. What element have you made and what isotope of that element?
- Each **nucleon** (proton or neutron) has a diameter of **2 Fermi**, (1 Fermi = 10^{-15} meters). What is the diameter of your Nitrogen-14 nucleus using the "Marshmallow Fermi" ruler below? If A is the number of nucleons in the nucleus then is the diameter of the nucleus equal to $2 \times A^{1/3}$?



- The radius of a Carbon-12 nucleus is about 3 Fermi. One **Fermi is 10** ⁻¹³ **cm**. If the most probable radius of the Carbon atom is about .3 Angstroms, (one **Angstrom is 10** ⁻⁸ **cm**). The ratio of the size of the atom to the size of the nucleus is 10,000.
- Heavy element nuclei such as Californium-252 will undergo spontaneous fission by separating into two almost equal parts. Fission your Nitrogen-14 nucleus.
- Note that your nucleus may not separate exactly in half. You may eat the **fission products**. In real life fission products such as strontium-90 or cesium-137 are harmful because they are radioactive beta particle emitters.