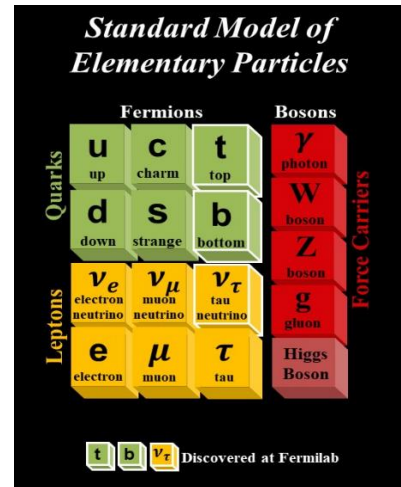


## Can you build the Standard Model chart?

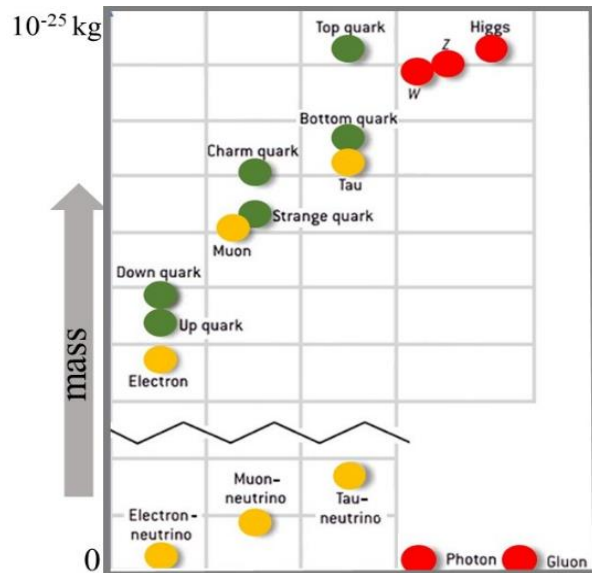
The Standard Model is a kind of periodic table of the elements for particle physics. But instead of listing the chemical elements, it lists the fundamental particles (that make up the atoms that make up the chemical elements), along with any other particles that cannot be broken down into any smaller pieces.

There are 17 fundamental particles in the Standard Model, and it took a long time to build it. Physicist J. J. Thomson discovered the electron in 1897, and scientists at the Large Hadron Collider found the final piece of the puzzle, the Higgs boson, in 2012. Three out of the 17 fundamental particles were discovered at Fermilab.



**Materials:** Pool color balls, sand, small funnel, balance, tape, glue

**Activity:** Pick six green, six yellow and seven red balls. Make a small hole in each ball and fill it with sand using a small funnel. The mass chart below will tell you how particle masses compare to each other. Use balance and make sure you follow this order. Use a tape and/or glue to close the holes. Label each ball as particles are labeled in the Standard Model chart.



**Questions to ask:** What are the heaviest and the lightest fundamental particles? Which particles are massless (have zero rest mass)? Which is heavier? (Bottom quark or up quark?)

**Useful links:** [https://ed.fnal.gov/lsc\\_exhibits/list.html](https://ed.fnal.gov/lsc_exhibits/list.html)  
<https://www.symmetrymagazine.org/standard-model/>  
<https://www.liveworksheets.com/id/uc39939cd>