Lesson Plan (55 min): Subatomic Particles and Isotopes (Nuclides)
Massachusetts State Standard 2.2: Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.

Course: Honors Chemistry

Essential Question(s): What are the basic building blocks of all matter? How does matter change based on the type of building blocks used? Where do subatomic particles fit in with the definition of fundamental particles?

Objective: At the end of the session, students will be able to distinguish between fundamental particles and subatomic particles, to build isotope structures of atoms, and to predict the number of protons, neutrons and electrons in given isotopes or ions.

Activator: (5 min) Split the class into 3 groups (at most, 11 per group) and give each group 10 slips with the following terms written on the slips: quark, lepton, force carrier particle, electron, positron, muon, proton, neutron, atom, DNA, red blood cell
Have each group independently rank these items from least complex to most complex in terms of fundamental particles i.e. have them identify the particles that they think can not be broken down any further and place them at the top of the list. Some particles may be considered to have the same complexity, so they would occupy the same "rung" on the fundamental particle ladder. It is okay if they are unsure, this is assessing current knowledge content.

Activator Debrief/Notes: (15 min) Go over the correct ranking for all the particles listed and highlight for students that protons and neutrons can be broken down further into quarks but electrons can't! Talk about what we consider to be subatomic particles. Then, do a quick dipstick of the class to see who remembers where each subatomic particle is located in our model of the atom and their relative masses. Then, ask the following
Q: What happens if only the number of protons is changed in an atom?
A: The identity of the atom changes.
Q: What happens if only the number of neutrons changes in an atom?
A: The identity stays the same but now we have an isotope.
Q: What happens if only the number of electrons changes in an atom?
A: The atom has formed an ion, a charged species.

Marble Nuclei: (10 min) Hand out one carbon-12 nucleus marble set-up to each student. Allow them to play with the marbles for 2 min. Then, direct the students to make 4 different atoms with 2 isotopes each. They may combine their nucleus with a neighbor to have more protons and neutrons available to build. They must keep track of the isotopes that they build using the Nuclide Symbol (introduce this to them prior to the activity). They must compare their nuclides to the chart of the

nuclides for the elements up to oxygen. Did they make any isotopes of atoms that are not on the chart? What could that mean?
Worksheet (10 min): Go over what each column means in the chart below and have students try to fill it in during class. Spot check every student and walk around to answer questions.

Atomic number / Mass number worksheet Complete the chart below.

	Element symbol	Atomic number	Mass number	Protons	Electrons	Neutrons	Isotope hyphen notation	Nuclear symbol
1	Pu		244					
2		30	65					
3	Cl		35					
4			137		56			
5	Ag		108					
6							Cobalt-59	
7				26		30		
8	Br		80					
9							Tungsten-184	
10					13	14		
11		88	226					
12			133		55			
13	H		1					
14							Manganese-55	
15			75	33				

Wrap-Up (15 min): Have students identify the areas of the lesson that were clear, unclear, and what further questions that they might have. Write these on the board (or newsprint hanging). Take time to go over further questions and anything that is unclear.

HW: More practice by finishing with the Atomic number/Mass number worksheet and additional pages

Additional info about the fundamental particles
http://particleadventure.org/eternal-questions.html

Great resource for teachers and students!