Lesson Title	Build your own atom
Length of Lesson	1 hour 15 min
Created By	Chris Ruhs
Subject	Chemistry
Grade Level	10-12th Grade
State Standards	Chemistry 1: 3b and c. (Unifying Concepts and Processes, Science as Inquiry, Science and Technology, History and Nature of Science)
DOK Level	DOK 2
DOK Application	Infer, collect and display, identify patterns, cause/effect, compare, relate, organize, make observations, summarize
National Standards	9-12: A (Inquiry); B (Physical Science)
Graduate Research Element	An understanding of how atoms and molecules behave is necessary to interpret environmental and biogeochemical research, to formulate hypotheses on chemical mechanisms, and to understand oxidation/reduction, chemical fate, and pH.

Student Learning Goal:

MS 9-12th Grade:

3(b) Identify the three fundamental particles of an atom when given the charge, mass, and location of the particle. *Students will build their own atoms using the three fundamental particles of an atom.* (c) Determine the number of protons, electrons, or neutrons in an element when given the atomic number and the atomic mass of the element, or vice versa. *Students will build their own atoms by using the correct number of protons, electrons, and neutrons to make an element.*

National Science Education Standards of Content 9-12:

A: Inquiry: Formulate and revise scientific explanation and models using logic and evidence. *Students will be introduced to the idea that the online 2D model used is not accurate to real life.*

B: Physical Science: Structure of atoms. *Students will learn what makes up an atom and how atoms of different elements differ.*

Materials Needed (supplies, hand-outs, resources):

Hand-out and computer lab with computer that can access and run the atom builder program found at http://www.classzone.com/books/earth_science/terc/content/investigations/es0501/es0501page04.cfm.

Lesson Performance Task/Assessment:
Students will follow and complete a hand-out and then conduct independent research on an element.

Lesson Relevance to Performance Task and Students:
By building their own atoms using the flash program found at http://www.classzone.com/books/earth_science/terc/content/investigations/es0501/es0501page04.cfm, students will be able visualize rudimentary atoms in order to become familiar with an atom's layout, the three subatomic particles, how these subatomic particles affect the mass of the whole atom, how electrons fill the atomic orbitals and maintain their distance from one another, how uncharged atoms need equal numbers of protons and electrons, and how isotopes are formed by varying the number of neutrons. The program is basic, and does not include all isotopes, nor does it allow for atoms above Neon, but its simplicity along with guidance and inquiry can be used to the teacher's and students' advantage to introduce these ideas clearly and visually.

Anticipatory Set/Capture Interest:
A brief discussion of the nature of matter will be used to get students' attention and cause them to ponder why matter behaves the way it does.
"If the nucleus of an atom were the size of a basketball, the nearest electron orbital would be 8 miles away! Matter is mostly made of nothing at all."
"If matter is mostly made of nothing at all, why can't we put our hands into solid objects? Particles of matter exhibit different forces, and these forces are very strong. At the atomic level, gravity is the weakest of these forces, and think how strong gravity is! In order for your hand to pass into a solid object, you would have to overcome all of these very strong forces simultaneously, before the solid object could break apart."

Guided Practice:
The program will guide the students through an initial tutorial, and then the instructor will guide the students to use the program to build a hydrogen atom followed by a helium atom, while filling out the appropriate sections on the hand-out.

Independent Practice:
Students will finish the hand-out independently and answer follow-up questions regarding the three subatomic particles and their role inside the atom.

After the student has completed the hand-out, each student will be assigned an element to research. Each student must report what his/her element is, when it was discovered, where it is found in nature (on Earth), what is it used for today, how much it weighs (grams/mole), what isotopes it has, what the abundances of those isotopes are in nature (on Earth), the number of each of the three subatomic particles in the main isotope, and what sources were used in the research.

Remediation and/or Enrichment:
Remediation:
Individual IEP.

Enrichment:
Discussion of the actual shapes of orbitals, instead of using the Bohr model.
Discussion of isotope abundances.
Implement 3D models (simulated or real) for students who understand the pattern in the 2D models found in this lesson plan.

Check(s) for Understanding:
How is the atom organized?
Why does an atom stay in this configuration?
Are there smaller particles that make up subatomic particles?
Observation and dialogue with students throughout activity; finished hand-out; summary discussion; independent research report.

Closure:
Summary discussion allowing students to lead discussion on the particles that make up atoms, where they are, how they behave and why.

Possible Alternate Subject Integrations:
Physics needs a discussion on subatomic particles, however, this lesson plan is not geared toward discussion of quarks, hadrons, all atomic forces, etc, though it may serve as a introduction for physics students or as a way to tie what they're learning in physics to what they're learning in chemistry.

Teacher Notes:
The Bohr model is not a very good representation of reality, but is useful for teaching certain concepts. Our visualization of subatomic particles as "concrete little spheres" that follow prescribed orbital pathways is false—in reality, the movement of electrons is currently described as probabilistic volumes (most are familiar with the s, p, d, and f orbitals), and the nucleus is made of nucleons (protons and neutrons) which are themselves each made of three smaller particles, called quarks. The specific combination of these three quarks dictates whether the nucleon will be a neutron or a proton. The reality of matter is foreign and bizarre, or at least difficult to visualize. The entire atomic structure is described as being held together by interacting forces which are carried by particles separated relatively far apart: the atom is, after all, made mostly of empty space. And since most of space is empty of matter, and matter itself is made mostly of empty space—one begins to lose the view that the universe is filled with "stuff" or "material", and gains the view that the universe is filled, instead, with various attractive and repulsive *forces*.