Lesson on the Structure of the Atom

The following lesson would be part of a larger chemistry unit on the atomic model and the periodic table of the elements. Learning outcomes below are from the new 2006 Michigan Content Expectations for Science.

Content Expectations

Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.

C4.8A Identify the location, relative mass, and charge for electrons, protons, and neutrons.

C4.8B Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.

C4.8C Recognize that protons repel each other and that a strong force needs to be present to keep the nucleus intact.

A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.

C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope.

C4.10B Recognize that an element always contains the same number of protons.

Big Idea

All matter is made up of three universal particles. (Higher understanding advances this concept to be six fundamental particles)

Enduring Understandings/Theme for the Unit

If the building blocks of the universe are all the same, then it is simply the organization of these universal particles that makes all the difference.

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Universal Design for Learning
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Essential Questions

- What is matter?
- If the atom is mostly space, why can I sit on a chair?
- If positive protons repel each other, why does the nucleus stay together?
- How many different ways are there to organize subatomic particles?

Key Knowledge

Terms and Vocabulary

- Protons
- Neutrons
- Electrons
- Ions
- Isotopes
- Quarks
- Charge
- Atom
- Molecule
- Element
- Nucleus

Students will be able to:

- Draw models of the elements
- Determine charge on various atoms and ions
- Analyze element data on the periodic table

Student Assessment

Students will create a model of one element from the periodic table. This model can be created in a variety of ways and the selection of medium will be left up to each student. A detailed explanation must accompany the model and include characteristic data regarding the element. Additional information on this performance assessment can be found on the website.

Online Resources

- **Tom Lehrer Song (Song about the elements found in the periodic table)**
  http://www.privatehand.com/flash/elements.html

- **Various Interactive Periodic Tables of the Elements**

  Instructions on Reading the Periodic Table

  http://www.classzone.com/books/earth_science/terc/content/investigations/es0501/es0501page06.cfm

  Basic Interactive Tables with Clickable Links to Information on Each Element

  http://www.webelements.com/
  http://periodic.lanl.gov/default.htm
  http://www.touchspin.com/chem/DisplayTable.html
  http://www.chemicool.com/

  Tables with Unique Element Features or Graphics

  http://www.popsci.com/popsci/periodictable/
  http://www.chemsoc.org/visElements/pages/pertable_fla.htm

- **Structure of the Atom Sites**

  Beginner

  A very simple visual with text of one element, carbon. Good place to start if confused.
  http://www.vtaide.com/png/atom.htm

  This page describes and shows the basics of the atom
  http://web.jjay.cuny.edu/~acarpi/NSC/3-atoms.htm

  **Interactive atom building site
  http://www.classzone.com/books/earth_science/terc/content/investigations/es0501/es0501page05.cfm

  Intermediate

  **Information on structure of the atom and an interactive atom builder.
  http://www.pbs.org/wgbh/aso/tryit/atom/

  Older "retro" video on the atom. (About 15 minutes)
  http://www.teachertube.com/view_video.php?viewkey=e84cd1d4c85c2cbb84fc

  Advanced

  A complete PowerPoint primer on the structure of the atom.
  http://www.particleadventure.org/frameless/modern_atom.html

  A very complete look at many aspects of the atom.
  http://www.howstuffworks.com/atom.htm

- **Glossary of Scientific Terms**

  An online glossary of science vocabulary.
  http://www.spartechsoftware.com/reeko/Glossary.htm#P

Lesson Outline
Structure of the Atom Lesson

Engagement

1) Coin exploration activity (5-10 min)
    a. Students explore various US and Canadian coins using magnets, electrical circuits and various liquids.
    b. Allow minimal class discussion, but ask directed questions looking for similarities and differences between coins.
    c. All coins are metal and will conduct electricity, but Canadian coins are magnetic and US coins are not. The US Mint uses primarily zinc cores where Canada uses nickel. Zinc is not magnetic and nickel is magnetic.

2) Tom Lehrer Elements Song *(Online Resource)*
    a. Play song for whole class
    b. Engage in discussion as to what the song is referring to
    c. Pose questions to class, leading to the discussion of elements

Exploration

3) Introduce Periodic Table of the Elements *(Online Resource)*
    a. Very brief exploration of how the elements are arranged.
    b. Possible leading questions
        i. What elements might the various symbols represent?
        ii. What is the number on the top? Any pattern with that number?
        iii. Is water on the table? Why or why not?

4) Sticky Note Atom Activity
    a. Distribute three different colored post-it notes randomly to the students. Each student should have at least one and the colors should be fairly evenly represented. Colors represent protons, neutrons and electrons.
    b. Prepare a white board for the sticky notes (with a key for which colors are protons, neutrons and electrons) and ask them to come up and place their notes where they think they should be.
    c. Do sticky note atom for one element as whole group.
    d. Develop structure rules during class demo
        i. Protons and neutrons in center
        ii. Protons spaced by neutrons, protons as far as possible
        iii. As much space as possible to electrons

Co-Teaching Notes

Begin diagram of atom on the white board. Add notes to the diagram about the big ideas as they are covered in the lesson. Interject questions for clarification of big ideas or comment to highlight them within the discussion.

Interject questions when it appears students need a slower pace.

List vocabulary important to the lesson as the come up. Repeat definitions discussed conversationally. Ask about definitions not clearly defined.

iv. Same number of protons and electrons for neutral atom
v. Electrons around outside with appropriate number of electrons in each energy level. (2, 8, 18)

e. Break into groups of four and assign to various locations with two or more elements to build.
f. Early finishers can come to challenge pile for more difficult atoms, ions, isotopes, etc…

Add to class vocabulary list. Interject brief discussion

5) Clicker Check for Understanding
   a. Identify results,
      i. If 80% or more, move on (re-teaching for struggling 20% will occur in independent online time see co-teaching notes).
      ii. If less than 80% of class is ready to move on, introduce Human Atom Activity to the struggling students
   b. Human Atom Activity (for whole group or small groups based upon the above results)
      i. Create various atoms using students and chairs to represent subatomic particles.
      ii. One option is: Girls – Protons, Boys – Electrons, Chairs – Neutrons. This model is built on opposites (boy/girl, +/- charge)
      iii. Be sure that students address spacing, location, placement, charge of overall atom.
      iv. Look for strengths and weaknesses of this (and any) model.
      v. Show enormous spacing between electrons and the nucleus in hall if time
      vi. Repeat check for understanding

As needed throughout class period, provide instruction for groups needing re-teaching. Repeat activity with slower pace and extra emphasis on big ideas or provide alternate activity. Note the types of difficulty by the students and accommodate accordingly.

Circulate during independent work, monitoring all students' understanding with teacher. Help students using various strategies or student pairings.

<u>Explanation</u>

6) Return to Periodic Table *(Online Resource)*
   a. Discuss site on reading the periodic table
      i. Need to lead through atomic number, symbol and atomic weight
   b. Allow time to explore various interactive tables
   c. What are some similarities between elements?
   d. What are some differences?

7) Online Learning – Structure of the Atom Sites *(Online Resource)*
   a. The sites listed will continue developing student understanding of the structure of the atom.
   b. Students can choose which level of understanding is appropriate, but must do one of the interactive sites

Throughout the class period increase opportunities for students on IEPs to practice their IEP objectives. This occurs during class discussions, group work, and/or individual work. (This may be facilitated by having students write their goals and objectives in their own words inside the cover of their folder.)

with an asterisk.

c. Students will need time to look at various sites and attempt to cross over to higher levels of information.

Evaluation

8) Clicker Check for Understanding
    a. Again, based on results of assessment, can re-teach or move on.
    b. Re-teaching could include returning to sticky model or the interactive sites with more direct teacher involvement.

9) Introduce Culminating Assessment, Element Model Project
    a. Students will create their own model of the atom for one element.
    b. An explanation of the model and the history and characteristics of the element must accompany the final product.
    c. Details for the project are in the assignment on the website.

Build an Atom Assignment

1. Build a model of an atom with 6 or more protons. Show proper placement and labeling of the protons, neutrons, ad electrons.
2. Develop an explanation of the model that includes the parts and definitions, as well
    - Examples of how this element appears in the real world and why you chose it.
    - The history of the element's discovery.
    - Natural sources of the element.
    - Characteristics / physical properties.
        - Temperature at which it melts (melting point)
        - Temperature at which it boils (boiling point)

The model may be made from the materials of your choice such as using:
Legos, K'nex, beads in wearable jewelry, digital model, or clay/claymation.

The explanation may take the form of your choice such as a:
Podcast, videocast, digital story, song/rap, or a written paper.

It is suggested that your selected element relate to an area of your interest. For example, if you like sports investigate the elements in a piece of equipment such as a baseball bat or skateboard wheels, if you like Nascar – look into the elements in racing fuel, or if you are a movie fan, research the elements used in film.

Be creative! Relate your model and explanation back to the real world object and topic of your interest.

CHALLENGE:
Show of model of a nucleus with placement of quarks within protons and neutrons and define quarks.
Consider the question, "Why do protons in a nucleus stay together?"