What is an Atom?

(3 Class periods ~45 min each)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science
Grade Level: Middle School

Materials

- Phet Student worksheet for elaboration activity
- Computers
- Notebooks
- Pen/Pencil
- Paper plates
- Either colored cotton balls or colored stickers

STANDARDS

Next Generation Science Standards

- MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
- MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Mathematics Standards | Common Core State Standards

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems.
- 8.EE.A.3 Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

LESSON OBJECTIVE(S)

Students will be able to

1. Tell the basic compositions of an atom and the charges related with each particle. (Proton +, Neutron (No charge) and Electron (-))
2. Explain that atoms is the smallest part of all things that has a specific characteristic.
3. Identify the element based on the number of Protons present in each element.
4. Calculate the number of Neutrons in an element based on the Atomic mass of the element.
5. Calculate the number of electrons an element must have to be in its base state or for a positive and negative ions.

CAREER CONNECTION(S)

Mentor Background: Dr. James (Jeff) Carroll has 35 years experience in experimental nuclear physics, has published nearly 140 peer-reviewed journal articles on discoveries in physics, including two papers in Nature, and given over a hundred presentations around the world. Before joining ARL in 2010, he had been a Professor of Physics for 15 years and maintains a strong interest in outreach to educators and to the next generation of scientists and engineers. He has served numerous times as a Judge for the tri-service National Junior Science and Humanities Symposium and mentored numerous undergraduate and graduate students, and a RESET educator in 2022, during both shorter-term and long-term research experiences. Interacting with motivated and interested young scientists is truly one of the joys of his work.

STEM Careers: Physicists, Electrical Engineer, Energy Research, Mechanical Engineer and Chemical Engineer, Nuclear Engineer, Nuclear Fuel Chemist, Mathematician, Data Scientist, Computer Science, teachers, professors

ENGAGEMENT

Brief Description: Prior knowledge of atoms will be assessed by asking students to name the smallest object that they are familiar with.

Procedures:

Begin the lesson with the question, "What is the smallest object that you can think of?" Give the students 2-3 minutes to contemplate and submit their answers. Use Socrative.com to collect responses, displaying them to the class. As the answers come in, highlight smaller and smaller objects (bugs, germs, cells, etc) before emphasizing that all of these items are made up of smaller "building blocks." Ask the class if anyone has ever heard of "atoms" before, and what they know about them.

Technology Component: Students will submit their answers using Socrative.com, or a similar online tool that allows their responses to be displayed to the class without revealing student names.

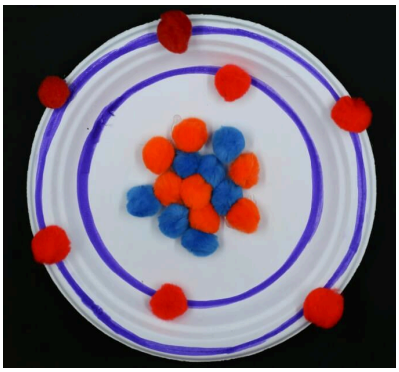
Time Frame: This portion of the lesson should take approximately 5-7 minutes, including the time for students to submit their answers, along with time for the teacher to highlight specific responses as an introduction to what atoms are.

EXPLORATION

Brief Description: Students will watch a video to learn the basic components of an atom.

Procedures:

Begin this portion of the lesson by displaying the following video: What's Inside an Atom? Protons, Electrons, and Neutrons!



As the video is playing, disperse paper plates to students, who should be placed into groups of 2-3. Assign each group a specific atom, and instruct them to use technology to research their assigned element. The group should use the paper plate to create a model of the atom, displaying the protons, neutrons, and electrons. Once complete, students will display their group's atom to the class, allowing the teacher the opportunity to highlight key differences in different types of atoms.

Technology Component: Projector to display the YouTube video. Chromebooks for group/individual research on the assigned atom.
Time Frame: This portion of the lesson should take approximately 10-15 minutes

EXPLANATION

Brief Description: The Explanation part of this activity is simply a slideshow to discuss what atoms are, including some background about matter and elements. There is also a video at the end to explain how we got to our current understanding of what the atom looks like.

Procedures:

Find the link to the What is an Atom Google Slides. In addition to the slides, the video about the history of the atom and our understanding of it is from TEDEd, and its resource page can be found here.

ELABORATION

Brief Description: Once students have been introduced to the structure of atoms, it is time for them to practice building their own. You will need a class set of computers/chromebooks. We will be utilizing a PhET Simulation for this activity, as well as a student worksheet for students to fill out as they work with the simulation. The worksheet is from the teacher resources tab on the simulation and it is by Emily Moore, Ariel Paul, Trish Loeblein, and Kathy Perkins.

Procedures:

In the PhET Simulation (link), students have the opportunity to build any atom from the periodic table. The simulation shows atom charges, and will allow students to modify the number of subatomic particles. The student resource provides scaffolding to middle school students to help them explore the composition and structure of atoms, as well as build their understanding of charged particles.

EVALUATION

Brief Description: The assessment part of this lesson includes one summative assessment and one final activity. Is up to the teacher to decide how they will use these assessments. The teacher can use both or just one of the assessments to measure learning. The first activity is a multiple choice assessment with 12 questions that measures the basic understanding of what an Atom is, the parts of the Atom and how they interact with each other. The second assessment is an online activity using the Build an Atom Phet app. Students have to use the app the answer questions about atoms.

Procedures:
The following activities/assessments can be printed out by the teacher or assigned as virtual work.

Assessment#1: What is an atom? (Google Form)
Assessment Form
(Make sure that you copy this form to your drive, then you will be able to make changes that the students will be able to see)

Test should take between 15 and 20 minutes depending on the students and their level.
Assessment#2: Build an Atom Phet (Time Frame: between 10 and 20 minutes depending on adaptations)
Go to: Phet Build an Atom Activity

Instructions Sheet:
What is an Atom Instruction Sheet

Submission Form:
Submission Form
(Make sure that you make a copy in your drive and then send the correct link to your students)

Adaptations:
For students that might require extended time or reduced questions, only assign the first two games instead of doing all four or chose the game that the teacher would like the students to do.

Reteaching:
Have the student watch the following video.
PBS Parts of an Atom

After watching the video have the students complete the following questions:
Reteaching Questions

(Allow the students to rewatch the video to answer the questions correctly, if necessary)
Extension:

For students that finish early, or find it easy, have them complete the following activity:
Bond Breaker Activity
Students that complete this work could be given bonus points, extra credits or some type of incentive if possible. (teacher discretion)

REFERENCES

https://phet.colorado.edu/
https://www.pbslearningmedia.org/resource/parts-of-an-atom-classifying-matter-teach-sci-nc/teach-sci-nc-animation/
https://static.pbslearningmedia.org/media/media_files/ba0820fe-b8c2-437d-af93-781822672834/f6c9f404-a80a-4aea-8deb-62eaf2fedb14.pdf
https://www.castl.uci.edu/games/bondbreaker
https://thestemlaboratory.com/stem-challenges/fun-stem-activity-for-kids-make-a-paper-plate-atom/
What's Inside an Atom? Protons, Electrons, and Neutrons!
Khan Academy
What is an Atom? Jefferson Lab Slides
Periodic Table
TED-Ed