Focused Learning Lesson
Science
Grades 9-11
SI-H-A5

Overview: This lesson can be used to review the concepts of inquiry processes, the use of models in scientific investigations, and the use alternative explanations to those investigations when new technology arises. This lesson is also a review (timeline) of the history of atomic structure.

Approximate Duration: Two 45-minute class periods.

Benchmark:
SI-H-A5 recognizing and analyzing alternative explanations and models.
SI GLE: 8. Give an example of how new scientific data can cause an existing scientific explanation to be supported, revised, or rejected.
Benchmark:
SI-H-B2 communicating that scientists conduct investigations for a variety of reasons, such as exploration of new areas, discovery of new aspects of the natural world, confirmation of prior investigations, evaluation of current theories, and comparison of models and theories
SI GLE: 13. Identify scientific evidence that has caused modifications in previously accepted theories.

Objectives:
1. The learner will review the history and development of the atomic theory from Democritus to the Quantum model.
2. The learner will create a timeline based on the atomic theorists.
3. The learner will relate each theorist and the experiment performed to science inquiry processes.

Teacher Preparation:
- Assign students to groups of two or three prior to the beginning of the lesson.
- Photocopy and cut out enough sets of cards for groups of students.
- Mix each set of cards and place the set in an envelope.
- Markers, colors, or color pencils will be needed for activity 1.
- See Attachment 1 for activity 1.
- See Attachment 2 for card sort for students.
- See Attachment 3 for correct key of card sort theorists and pictures.
- See Attachment 4 for correct key of timeline of theorists.
- See Attachment 5 for teacher background information.
- See Attachment 6 for explanations of how each model changed from one to the next.
- Make a transparency of Attachment 7 for example drawings of models for assessment.
- See Attachment 8 for teacher answers of transparency, Attachment 7.

Materials/Equipment/Resources:

- Card sort
- Markers, colors, or colored pencils
- Unlined paper, construction paper, or loose leaf paper
- Tape
- Transparency film
- Overhead projector
- Chalk or dry erase board

Lesson Procedures:

Set or Opener:

- Explain to students that you have observed that some of your houseplants are dying and you don't know why.
- Ask students to give you some ideas on why they think your plant is dying. *(Possibilities: not enough water, food, sunlight, too much water, food, and sunlight.)*
- Ask students how would they test these possibilities. *(Possibilities: put more water, food, sunlight in one and not another, or take away water, food, sunlight from one and not the other.)*
- Once that is complete, ask the students if they recall the inquiry processes.
- Review scientific inquiry processes with students. (Observation/question, hypothesis, experimentation/investigation, collection of data, analysis of data, theorizing, conclusions, and communication of results)

Body of the Lesson:

1. Implement the card sort in Attachment 1. Students draw a model of an atom.
2. Hand out cards for the card sort. See Attachment 2 for card sort. Instruct students to match experiment with scientist.
   - Walk around to the room to check for understanding and probe for questions.
   - Allow 10 minutes for activity.
   - Once the students have completed the task, review correct responses for the card sort with students.
   - Refer to Attachment 3 for correct card sort.
3. Hand out blank sheets of 11 x 14 inch paper or rolls of adding machine tape. Instruct students to make a timeline with the theorists name and model of the atom. If timeline software is available, it may be used to create the timeline. Allow students to use the text and other references to obtain dates.
   - Walk around to the room to check for understanding and probe for questions.
   - Allow 15 - 20 minutes for activity.
   - Once the students have completed the task, review the timeline with students to ensure that they understand the development of the atomic structure.
   - Refer to Attachment 4 for correct timeline.

4. Review the six theorists and their discoveries. See Attachment 5 for teacher background information. If available, display illustrations or the theorists or technology used. Make historical connections to the times and culture in which each lived.
5. Discuss how each model has changed and the reasons why each has changed.
   - As new technology arises, scientists are able to alter the investigations by the previous scientists to further investigate the area.
   - See Attachment 6. In Attachment 6, mention a couple of examples technological advances used in developing later models.

Closure:

- Review all models with students. Use your own drawings on the board to ensure that students understand each.
- Then use the transparency created from Attachment 7 to assess the students' understanding of the models. Make this assessment a matching or fill in the blank. For matching, provide the names and have them match the name with the theory.

Attachments:

Attachment 1: Teacher Directions for Activity 1
Attachment 2: Card Sort (for students)
Attachment 3: Key of Card Sort
Attachment 4: Key for Timeline
Attachment 5: Teacher Background
Attachment 6: Examples (how new scientific data can cause existing explanations to be altered)
Attachment 7: Examples for Assessment
Attachment 8: Key for Attachment 7

Sample Assessment Items:

Use transparency of example drawings (Attachment 7) of models for each theorist as the summative assessment of student understanding. See Attachment 8 for teacher answers for example drawings of models for each theorist to be used as transparencies for assessment.

Reference Links and Technology Connections:

Davis, R., Metcalfe, H.C., Williams, J., and Castka, J. (2003). *Modern Chemistry*. (pp 31, 65-73, 91-98). Austin, TX; Holt, Reinhart, and Winston.

Pictures:

http://www.alphalink.com.au/~vmck/amain.htm
http://www.alphalink.com.au/~vmck/ruth.htm
http://www.ndeepak.info/stuff/qp/chap04.php

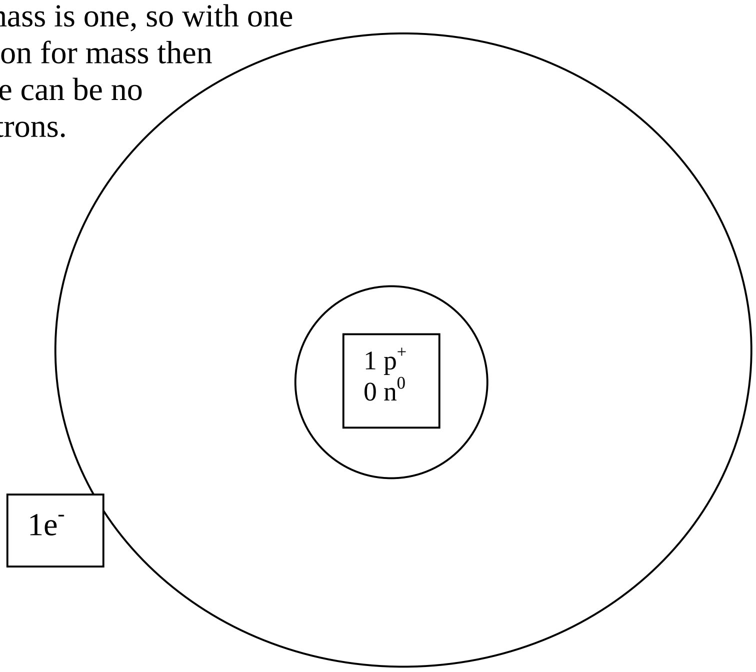
If the software *Timeliner* is available, use the software to construct the time lines.

Attachment 1
Teacher Directions for Activity 1

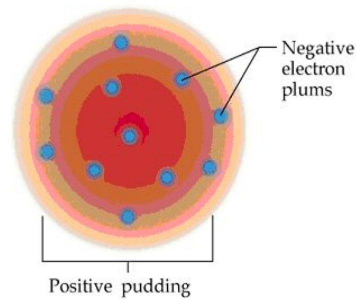
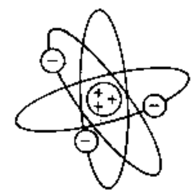
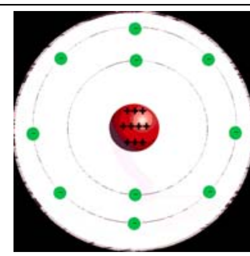
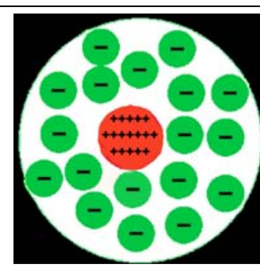
1. Instruct students to draw on paper what they think an atom of hydrogen looks like.
2. Walk around the room to ensure students are working.
3. Once all students have completed the assignment, approximately 5-7 minutes later, ask for volunteers to bring their model picture to the front of the classroom and explain the model.
4. Hopefully, students' drawings will have one proton and zero neutrons inside the nucleus and one electron outside the nucleus. See figure below for example.
5. Have two or three students present their models and hang them on the board with tape to refer to later in the lesson.
6. Then ask probing questions:
   - How do you think scientists came up with the model of an atom? *(Experiments)*
   - Can you see or touch an atom? (*No*)
   - What kind of evidence caused changes in atomic models? *(Answers will vary.)*
   - Then how can you perform an experiment on an atom? *(Students will probably be stumped.)*
   - Explain to students that when data from experiments show that predictions of hypothesis are successful, scientists try to explain the phenomena they are studying by constructing model.
     - A <u>model</u> in science is more than a physical object; it is often an explanation of how phenomena occur and how data or events are related.
     - Models can be changed once new information is available.
     - One of the most important models in chemistry is the atomic model of matter, which is what we will study today.

Example of model <u>hydrogen</u> atom - $^{1}_{1}H$
1 means 1proton and 1 electron,
The mass is one, so with one proton for mass then there can be no neutrons.

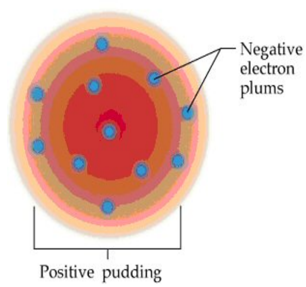
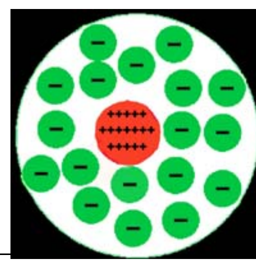
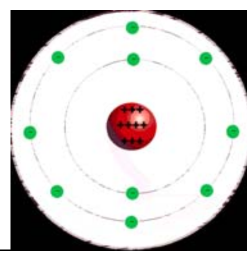
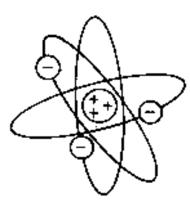
KEY
p^{+} = protons
n^{0} = neutrons
e^{-} = electrons
center circle = nucleus
large circle = energy level



Attachment 2 **Card Sort** **(for students)**

Democritus	
Dalton	
Thomson	
Rutherford	All matter is composed of tiny, indivisible particles called atoms.
Bohr	
Quantum theory	All matter is composed of extremely small particles called *atoms*. Atoms of a given element are the same; atoms of different elements are different. Atoms cannot be subdivided, created, nor destroyed. Atoms of different elements combine in simple whole-number ratios to form chemical compounds. In chemical reactions, atoms are combined, separated, or rearranged.

Attachment 3: Key for Card Sort

Democritus	All matter is composed of tiny, indivisible particles called atoms.
Dalton	All matter is composed of extremely small particles called *atoms*. Atoms of a given element are the same; atoms of different elements are different. Atoms cannot be subdivided, created, nor destroyed. Atoms of different elements combine in simple whole-number ratios to form chemical compounds. In chemical reactions, atoms are combined, separated, or rearranged.
Thomson	
Rutherford	
Bohr	
Quantum theory	

Attachment 4
Correct Timeline

Democritus

- 400 B.C.
- Belived that atoms were tiny indivisible particles.

John Dalton

- 1808
- All matter is composed of extremely small particles called atoms.
- Atoms of a given element are the same in size, mass, and other properties; atoms of different elements differ in size, mass, and other properties.
- Atoms cannot be subdivided, created, nor destroyed.
- Atoms of different elements combine in simple whole-number ratios to form chemical compounds.
- In chemical reactions, atoms are combined, separated, or rearranged.

J.J. Thomson

- 1897
- Cathode-ray tube experiments
- Discovered electrons

Ernest Rutherford

- 1911
- Gold-foil experiments with alpha particles
- Discovered positive core center of an atom

Neils Bohr

- 1913
- Electrons can circle the nucleus only in allowed paths, or orbits.

Quantum model

- 1924
- Electrons exhibit wave-like patterns, and the location of them can be mathematically determined.

Attachment 5
Teacher Background

Use what information you feel is necessary to relay the imporant information to the students.

Democritus

- Called nature's basic particle atom – Greek for *indivisible*
- Belived that atoms were tiny indivisible particles.

John Dalton

- All matter is composed of extremely small particles called *atoms*.
- Atoms of a given element are the same in size, mass, and other properties; atoms of different elements differ in size, mass, and other properties.
- Atoms cannot be subdivided, created, nor destroyed.
- Atoms of different elements combine in simple whole-number ratios to form chemical compounds.
- In chemical reactions, atoms are combined, separated, or rearranged.

J.J. Thomson

- Cathode-ray tube experiments
- Discovered electrons
- Because atoms are electrically neutral, they must contain a postive charge to balance the negative charge.
- Because electrons have so much less mass than atoms, atoms must contain other particles that account for most of their mass.

Ernest Rutherford

- Gold-foil experiments with alpha particles
- Discovered positive core center of an atom
- The volume of the nucleus is very small compared to the total volume of an atom.
- Electrons were located outside the nucleus.

Neils Bohr

- Proposed a model of the hydrogen atom is linked to the atom's electron with photon emission
- Electrons can circle the nucleus only in allowed paths, or orbits.

Quantum model

- Electrons exhibit wave-like patterns, and the location of them can be mathematically determined.

Attachment 6
Examples

Examples of how new scientific data can cause a existing explanations to be altered.

- Dalton altered Democritus – atoms can have different properties when compared to one another. All atoms are not the same; they differ depending on which element you are considering.

- Thomson altered Dalton – atoms can be further subdivided into subatomic particles. Dalton was altered by others – for a given element, it can have atoms with different masses (isotopes).

- Rutherford altered Thomson – Positive matrix is actually positive core of atom. Electrons are outside the nucleus.

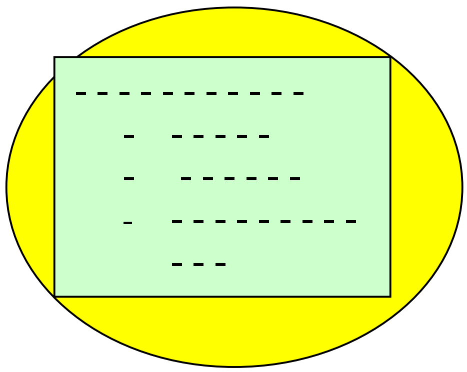
- Bohr altered Rutherford – electrons travel in fixed paths around the nucleus.

- The current quantum theory model altered Bohr – electrons behave like waves and their probable location is not fixed and can be determined mathematically.

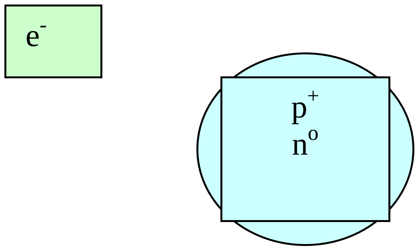
Attachment 7
Examples for Assessment

Use these to draw on the board or to evaluate student understanding.
Make a transparency of these for your assessment.

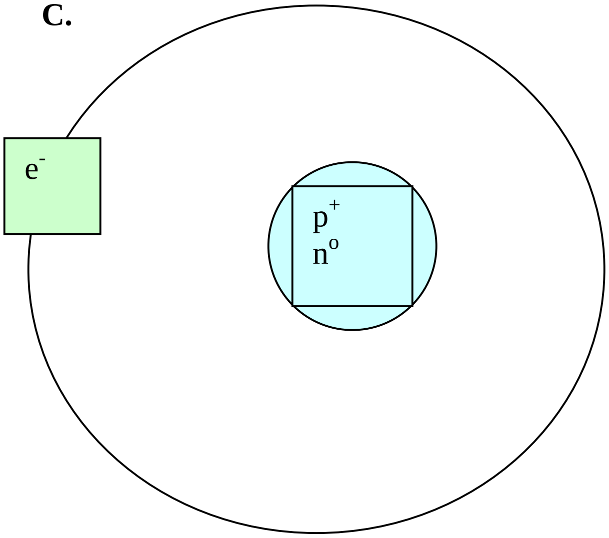
A.



B.



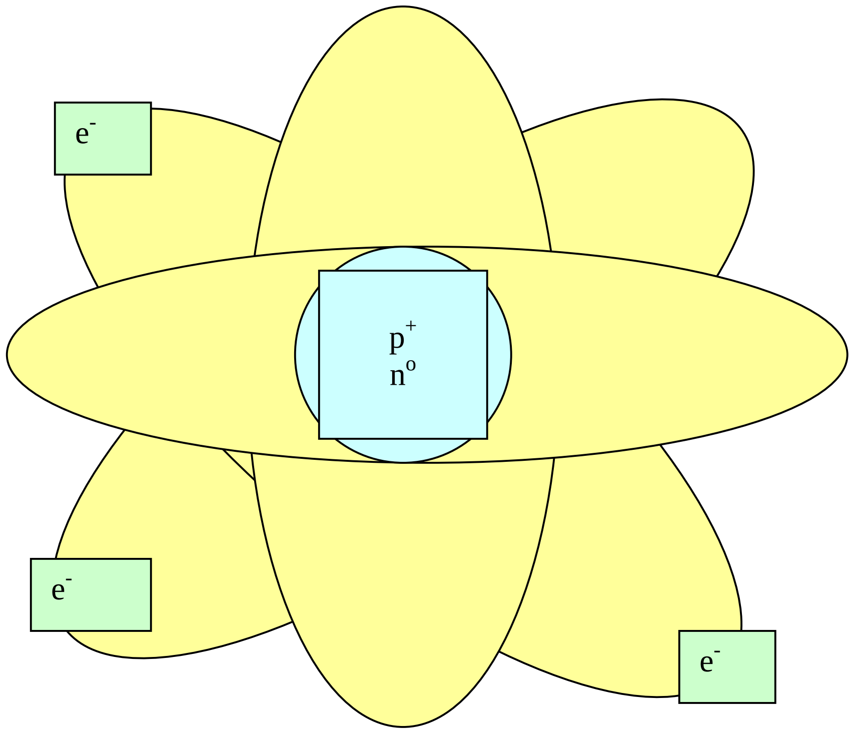
C.



D. No model, all matter is made of tiny, indivisible particles.

E. No model, all matter is composed of extremely small particles called *atoms*. Atoms of a given element are the same in size, mass, and other properties; atoms of different elements differ in size, mass, and other properties. Atoms cannot be subdivided, created, nor destroyed. Atoms of different elements combine in simple whole-number ratios to form chemical compounds. In chemical reactions, atoms are combined, separated, or rearranged.

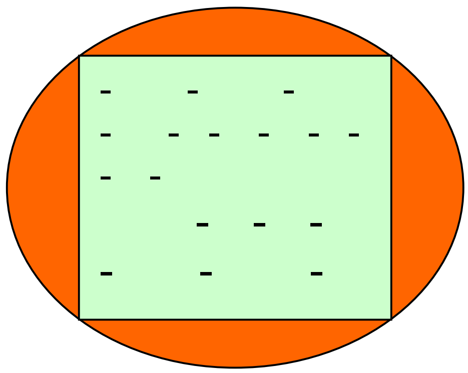
F.



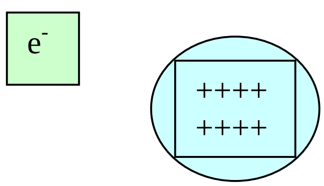
Attachment 8
Key for Attachment 7

- Democritus – no model, all things are made of atoms (small, tiny, indivisible particles) (*D*)
- Dalton – no model, all matter is composed of extremely small particles called *atoms*. Atoms of a given element are the same in size, mass, and other properties; atoms of different elements differ in size, mass, and other properties. Atoms cannot be subdivided, created, nor destroyed. Atoms of different elements combine in simple whole-number ratios to form chemical compounds. In chemical reactions, atoms are combined, separated, or rearranged.
- Thomson – plum pudding model (*A*)

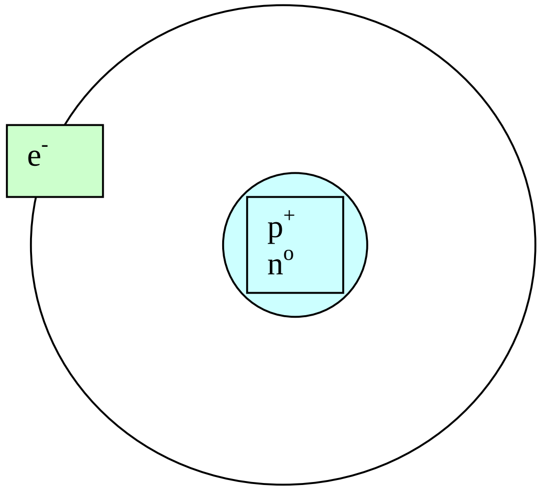
Gray matrix is positve
With negative particles
(electrons) throughout



- Rutherford – positive core (nucleus/blue) with negative electrons outside the nucleus. (*B*)



- Bohr- electrons travel in fixed paths around the nucleus like the planets rotate around the sun. (*C*)



- Quantum theory – electrons are not in fixed paths, but behave like waves and location can be predicted mathematically. (*F*)