

## Lesson overview

Subject:	Chemistry
Grade:	10 – 12
Topic:	History of Atomic Theory
Concepts:	Development of atomic theory, atomic structure
Essential questions:	<ol style="list-style-type: none"><li>1. How do scientific theories adapt over time?</li><li>2. What is the significance of the quantum model?</li><li>3. How did scientists use indirect means to develop the atomic theory?</li></ol>

## Objectives

✓ Students will know:

- 1) Historical scientific theories and corresponding experiments: Democritus, Dalton, Thomson, Rutherford, Millikin, Bohr, Heisenberg, Schrodinger
- 2) Electrons have little mass and negative charge, protons are positively charged, neutrons are not charged. Protons and neutrons are located in the nucleus.

✓ Students will understand:

- 1) scientific theories adapt over time
- 2) the significance of the quantum model
- 3) scientists use indirect means to develop the atomic theory

✓ Students will be able to do:

- 1) Describe the contributions of each of the scientists above to the development of atomic theory.
- 2) Identify the location of the protons, neutrons, electrons, and nucleus in various atomic models.
- 3) Explain how the experiments performed by the scientists listed above led to new knowledge of atomic structure.

*\*Checking points.*

- Do the “Know” objectives cover the essential information to be learned?
- Are the “Understand” objectives big and transferable ideas of the discipline?
- Are the “Do” objectives observable and measurable? Do they encompass essential skills?
- Do the KUDs “fit together”-in other words, will they come together coherently?

## Range or description of learner needs in your class related to this topic

*Some of the s. in the class enjoy history. Others enjoy learning about how ideas were created and how experiments work. This lesson is strictly knowledge-based and requires no significant math skills. Some of the information in these objectives has been covered in previous physical science classes and is review, while others are extensions of these ideas. Some students remember this prior content while others need a “refresher.”*

## Factors you’ll need to consider in developing the RAFT assignment

(related to time, students, space, materials, etc.)

*I envision this lesson would take 2 full class periods (90 min blocks) from introduction to closure, and some groups may finish their individual research and small group assimilation at different times, so I need to have an activity built in that relates to the topic that they can work on if they finish before other groups or individuals. In this respect, I would have to give them some general time constraints in terms of the maximum amount of time they'll have to do the lesson.*

*The two big things that will need happen to make this lesson successful since s. are finding then sharing knowledge is that there needs to be at least two s. choose each scientist (so that there can be at least 2 groups to share at the end of the jigsaw), but I think I could hi-lite interesting things about each of the scientists that, in knowing my students, I'll be able to flexibly achieve this goal.*

*Second, the students will need access to books and the internet to do research. I would sign out the laptop carts on the first day of this lesson.*

*Additionally, students will need space to work individually, in small groups of 2-3 and in 2-3 large groups of 6-8 s. (I would probably set up the lab benches in tables of 4 initially for the first two parts and then put these tables into bigger tables so 6-8 s. could sit around them in a circle for the last part.) This would also facilitate t. monitoring of s.*

### **Pre-assessment plans:**

*The preassessment for this lesson comes during the introduction to the lesson and would strictly assess for s. current conceptions about the structure of the atom, and generally anything else they know about atomic theory/ atomic structure. The t. could look over this quickly as students are beginning their RAFT task to determine which s. may need extra support in the task.*

### **Assessment plans :**

#### 1. how work will be graded

*Students will work independently to research their chosen scientist. For this component, they will be assessed on their participation, use of time, and completion of the task, but not on content.*

*Then, s. will work in groups to assimilate and develop one set of information about the scientist based on all of their individual findings. They will be assessed on use of time, their contribution to the group, and whether or not they have all of the information about their scientist that is identified on the "scientist" rubric.*

*Finally, they will work in large groups with students who have done research on different scientists to share information, synthesize it, and come up ideas of how they could develop the information into a study tool. S. will be turn in a product that conveys that they have the information required on the "scientist rubric" for all of the scientists. This product will be assessed using the "scientist rubric" for all of the scientists on the accuracy of content. S. can complete this individually or in groups of no more than three. Additionally, s. will individually turn in their responses to the two*

*questions: 1) how did scientific theories related to atomic theory change over time? 2) How did scientists use indirect means to develop the atomic theory? after discussing these questions in their groups.*

**2. Monitoring student work and progress:**

*t. will circulate as s. are working and assist s. or groups as necessary.*

**3. Checking work for accuracy, understanding, and quality:**

*Parts 1 and 2 require the s. to use a rubric to self assess for the information they need to find out about the scientist. Additionally, s. will be comparing their findings with others and collaborating. The t. would circulate throughout as s. work individually and in groups to ensure that they are referring to the rubric to obtain all of the required information. Finally, the “mixed scientist” groups will share their information with each other and use the “scientist rubric” to ensure they have the necessary information for all scientists. They will also discuss in their groups “1) how did scientific theories related to atomic theory change over time? 2) How did scientists use indirect means to develop the atomic theory?”*

**Day 1:**

***Introduction: (10 min)***

Hook (also preassessment): Give s. an index card. On the front: Draw an atom. Label the parts of the atom. On the back: write anything else you know about atoms, atomic structure, atomic theory, or how scientists figured out what an atom “looks” like.

Have some s. share their drawings with the class, explain, and describe them.

What is similar about the drawings? What is different?

Have you ever wondered how scientists determined the components of the atom? Have you ever wondered how scientists determined what an atom “looks” like?

T. collects index cards

T. today and tomorrow, you’ll have an opportunity to explore the different components of the atom and how theories about the atom’s structure developed over time.

You’ll pick a scientist using the RAFT and research what that scientist did, making sure to include the information on the “scientist rubric.” You can use books, computers, etc to research your scientist. (T. will have some websites pre-selected on her portaportal site that s. can use if they want. This will provide scaffolding for s. who have difficulty getting started with independent research.) T. goes over “scientist” rubric. You’ll be working individually on this part. Once you’ve completed your initial research, you’ll get into small groups with the others who had the same scientist as you chose. Your goal in this will be to make sure that you can corroborate the information you found with your peers and make sure each of you have all of the information required on the “scientist rubric.” You have until the end of class today to complete these two tasks.

Tomorrow, you’ll work in large groups with at least one s. representing each scientist on the RAFT. I’ll explain that task more tomorrow.

***Body: (75 min)***

Part 1: Individual research

**RAFT assignments**

Role	Audience	Format	Topic
Dalton	Peers	Paragraph and Picture or Diagram	Stealing other's ideas... making a name for myself
J.J. Thomson	Peers	Paragraph and Picture or Diagram	The name should be "little Jack Horner"
Millikin	Peers	Paragraph and Picture or Diagram	The essence of oil
Rutherford	Peers	Paragraph and Picture or Diagram	We like to shoot things
Bohr	Peers	Paragraph and Picture or Diagram	I'm an astronomer of atoms
Heisenburg/ Schrodinger	Peers	Paragraph and Picture or Diagram	You can't give me a speeding ticket cause I'm doin' the wave!

T. circulates to ensure all individuals are working. Targeted help for s. who need more scaffolding in terms of getting started with research (this would be info pre-identified by t. and having some websites already selected would be a great starting point for these s., some s. who know how to do research would not require this scaffolding.)

**Part 2:**

T. has all of the s. who worked with a particular scientist get together. Your goal in this will be to make sure that you can corroborate the information you found with your peers and make sure each of you have all of the information required on the "scientist rubric." Make sure everyone contributes and that the information you include is substantiated by the findings of at least one other member of your group. At the end of the period, you should have information to share with others tomorrow about your scientist.

Note: Timing on this can be flexible for groups. S. have other stuff to work on if they finish individual research before the rest of the people in their group are ready to get together. T. would guide such that all groups have at least 15 – 20 min to complete task 2.

***Closure: (5 min)***

T: Anyone want to share one thing you learned today that you didn't know at the beginning of class? (Take a couple of responses.)

Tomorrow, you'll work in groups with s. who didn't have the same scientist as you to share what you learned.

Total time: 90 min

**Day 2:**

***Introduction: (5 min)***

T: What did we do yesterday?

EA: Learned about scientists who contributed to atomic theory.

T: Today we're going to build on that. You're going to work in groups of 7-9 with s. who researched scientists other than yours. I'm going to assign these groups since different numbers of s. worked on each scientist.

***Body: (70 min)***

**Part 1: (approx. 45 - 55 min)**

You have three tasks in these groups.

- 1) share the information you learned about your scientist with the others in the group making sure you have the information on the "scientist rubric" for all of the different scientists your peers learned about,
- 2) brainstorm ways you could compile the information you learned into a useful study tool for yourself – examples might be a chart, timeline, flashcards, "Cornell-style" notes page, etc. You'll choose one of these and spend part of class making this tool. You can work individually or in groups of no more than 3 on this, but everyone in your group needs to have the tool.
- 3) Discuss the following questions as a group: a) how did scientific theories related to atomic theory change over time? b) How did scientists use indirect means to develop the atomic theory?

I suggest taking about 30 min to share information (roughly 5 min per scientist), 10 min to brainstorm ideas of how to compile the information, and 10 min to discuss the two questions.

**Part 2: (15 – 25 min)**

Work individually or in groups of no more than 3 to make your study tool. Make sure you check with me on your proposed "product" before you start.

If you complete this, individually answer the following questions in complete sentences. a) How did scientific theories related to atomic theory change over time? b) How did scientists use indirect means to develop an atomic theory? Use what you learned yesterday and today to help you answer these questions.

***Closure: (5 min)***


T: Anyone want to share one thing you learned today that you didn't know at the beginning of class? (Take a couple of responses.)

T: What is an example of how scientists used indirect means to develop an atomic theory? (EA: Rutherford's gold foil experiment – he couldn't see why the particles were being deflected but he knew they must have been bouncing off of something and thus the center of the atom is dense and the outside is mostly empty space.)

**Scientist Rubric**

As you research your scientist, make sure you can answer the following questions about your scientist. You will also use these questions to assess whether your group has a complete information on your scientist, and I will use these questions to assess your “study tool” to make sure you have included complete information about all of the scientists.

As an example, I have included Democritus, the first scientist to propose the existence of the atom.

<b>What was the full name of your scientist?</b>	Democritus
<b>Approximately when did your scientist live?</b>	400s BCE
<b>Of what nationality was your scientist?</b>	Greek
<b>If your scientist developed a model of the atom, what was the proposed model of the scientist called? Draw it and label the parts.</b> (Note: this may not be applicable for all RAFT scientists)	“Solid sphere model”, no parts 
<b>Describe this model. What subatomic particles were known to this scientist? Which ones that we know of today were yet to be discovered?</b>	Atoms are just spherical chunks of matter. (Didn't know about protons, neutrons, electrons, the nucleus, or the electron cloud)
<b>What experiment(s) did the scientist perform that led the scientist to develop his model or learn more about the structure of the atom?</b> (Note: this may not be applicable for all RAFT scientists) <b>Describe 1) what the experiment was, 2) what the outcomes of the experiment were, 3) the conclusions about atomic theory or structure that the scientist drew from the experiment</b>	No experiments, Democritus was a Greek philosopher. He basically came up with the idea of an atom based on thinking alone.
<b>Describe the major contribution(s) of this scientist to the development of atomic theory. (Make sure you description is complete and that we can tell what was already known about the atom and what wasn't known about the atom.)</b>	1) Described matter as being composed of indivisible homogenous chunks of matter of different shapes, which he called “atomos” or atoms. 2) He didn't know that there were subatomic particles in an atom.
<b>In what ways did this scientist's contribution represent a change from prior understandings about the atom?</b>	There weren't any previous understandings about the atom, so he's the guy who started it all!
<b>Two other facts about your scientist that you think are interesting?</b>	1) He wasn't even a scientist! 2) He said there were two types of substances “matter” and “the void” (everything that wasn't atoms)

## **Reflection**

In creating this differentiated lesson, I really wanted to create something that met the goals of 1) the differentiated task was incorporated into the body of the lesson instead of being product-oriented, 2) would result in a completely student-centered lesson. The RAFT is incorporated as the beginning component of a “jigsaw” style activity. I really like jigsaw style lessons because students are held accountable to each other and it changes the role of the teacher from the transmitter of knowledge to the facilitator of the gathering and dissemination of knowledge, giving the students more flexibility in how they explore and explain information to one another.

Students may choose whichever scientist (role) they want to explore and they have a rubric of information they need to find. While students will not meet all of the KUDs using the RAFT activity alone, by the end of the jigsaw, all students will have the information required to meet all of the KUDs. In terms of differentiation, this lesson as a whole differentiates based on student interest – they get to pick the scientist they want to study, learning profile – they are ultimately developing a study tool that will be useful for them, they can use words or words/ pictures/ diagrams to synthesize their information, and they will be working individually or in groups throughout the lesson – sometimes I choose this for them, and sometimes they get to pick.

I chose the history of atomic theory for my content because there are so many aspects of it that can be explored, experiments, models of the atom, and how atomic theory has changed through history. Typically this content is taught through direct instruction, where the teacher disseminates the information for each scientist to students and there is no real assimilation or synthesis of information by students. Also, this is

one topic that students at the school I taught in struggled with terms of the end of course tests. I think potentially it's because this is strictly knowledge that is taught at the beginning of the year and is never revisited. I would hope that in having students develop the knowledge and struggle with the essential questions with each other, they would come to more enduring understandings about the development of atomic theory that would facilitate them in retaining the required content.

In terms of assessment, I am using a pre-assessment so that I can target which students might need more assistance during the initial individual research phase. I would also need to be aware of which students I know need general help with research, but I would develop this knowledge earlier in the year and wouldn't need to preassess for it for this lesson in particular. Formative assessment would include circulating and asking students questions to ensure they have the required information (and that it is accurate) and students would be monitoring their own information gathering based on the rubric. That the information is "complete" relative to the rubric is one formative assessment. Their study tool and their answers to the essential questions would be other formative assessments, as I could use this information to see who get it and can move on with new content and who I need to work with in a small group to help further solidify the connections between the scientists work and their discoveries and what the implications are for the development of atomic theory.