

<b>Lesson 1-1: Atomic Structure</b>	
<b>Curriculum Expectations</b>	<p>C2.1: use appropriate terminology related to structure and properties of matter, including, but not limited to: <i>orbital, emission spectrum, energy level, photon, and dipole</i> [C]</p> <p>C3.1: explain how experimental observations and inferences made by Ernest Rutherford and Niels Bohr contributed to the development of the planetary model of the hydrogen atom</p> <p>C3.2: describe the electron configurations of a variety of elements in the periodic table, using the concept of energy levels in shells and subshells, as well as the Pauli exclusion principle, Hund's rule, and the Aufbau principle</p>
<b>Learning Goals</b>	<p>By the end of this lesson you will:</p> <ul style="list-style-type: none"> <li>• Understand how the model of the atom has developed over time</li> <li>• Describe the experiments and conclusions that contributed to the evolution of the model of the atom</li> <li>• Be able to describe the structure of an atom in terms of the nucleus, electrons and orbitals</li> </ul>
<b>Success Criteria</b>	<p>I know I have achieved the learning goals when I:</p> <ul style="list-style-type: none"> <li>• can explain the plum pudding, Rutherford and Bohr models of the atom</li> <li>• can describe the experiments of Rutherford and Bohr and how they contributed to the current structural model of the atom</li> </ul>
<b>Teacher Prep</b>	<ul style="list-style-type: none"> <li>• Materials for build a tower exercise: paper, scissors, tape</li> <li>• Print out gridlocks for atomic structure gridlock game if you are choosing to run this as a small group or individual activity instead of a whole class activity</li> <li>• Check to make sure Rutherford simulator is working</li> </ul>

<b>Minds On</b>
<p>Goal: To get students and teacher to get to know each other and to activate previous knowledge and ideas about chemistry.</p> <p><b>1. <u>Build a Tower Group Activity</u></b></p> <p><b>Teacher's notes:</b> this activity is meant as a team building exercise to be used on the first or second day with a class. It encourages communication, critical thinking, problem solving and is a fun way for students to interact with each other while performing an enjoyable task. To relate the activity to chemistry you can ask the students to reflect on how the strategies that</p>

worked and didn't in building a tall tower may apply to large molecules or you can also make connections between building the tower with the formation of polymers.

**Instructions:** divide the class into groups of 2-4 depending on class size. Post the instructions for the whole class to see or print and handout the instructions to each group.

The discussion component is key for this assignment. Students should map out or create a blueprint of their structure before building. You can also encourage students to take pictures of their structures and share them with other groups, friends, etc.

**Reflective Questions:** Have students answer these individually, then their answers within the group. Finally, open up a whole class discussion using the reflective questions as a guide.

1. What were some of the critical elements in building the tower?
2. How did you make your choices to prove your structure would be the 'best'?
3. What is one additional material that you could use that would increase the height of the tower in the most effective way possible?
4. Seeing as this is a chemistry course, how does the building of a tower relate to the "building" of large molecules?

## Action

Have students complete the pre-assessments for this course. This is an opportunity for students to refresh their knowledge of chemistry as well as an opportunity for the teacher to gauge the level of understanding of the students in the course.

1. **Activity 1-1A – Pre-Skills Quiz.** Students will complete this individually online. After completion, take up the answers as a class and allow time and room for students to ask questions.
2. **Gridlock Activity – Atomic Structure** – Groups or Whole class. Click on the link for the online version of the gridlocks activity. Explain the rules.

### Teacher information:

Gridlock Puzzles are designed to do 3 major things:

1. They give the students a problem solving context for the activity – students like solving problems and there is a sense of satisfaction in completing the gridlock. There can be an aspect of competition as well: who solved the most, who was quickest or who made the least mistakes. In the online versions the students are trying to beat the clock.

2. The students need to engage with the factual information the gridlock is based on. In order to solve the puzzle they need to recall the relationships between the data established in the first part of the activity. For example they need to recall that 3 electron pairs gives trigonal planar geometry or that sulfuric acid forms sulfate salts. Whilst they are solving the gridlocks they should find themselves referring to the initial data repeatedly so much so that they recall a fair bit of it by the end.

3. It develops some important thinking skills. The students have to survey the data given in the gridlock to find which squares can initially be filled in. They cannot simply choose a square at random and fill it in because there may not be enough information yet in the grid to narrow down the options to one possible answer. This thinking skill is sadly missing in the students who, given a titration calculation want to straight multiply a concentration by a volume to give the moles of the reactant asks for despite not having all the relevant information yet. Gridlocks also encourage logical reasoning e.g. 'it has to be x because it can't be w, y or z'.

#### **How they might be used:**

Gridlocks are suitable for an episode in a lesson or homework. They are designed to be follow up activities rather than an introduction to a topic. The students should have met at least some of the data the gridlocks are based on. The online gridlocks could be tackled by students working individually or a class using a projector. The paper based gridlocks are easy to set and readily peer or self assessed. Some gridlocks go beyond specifications and could be used as extension activities.

#### **The first time you use a gridlock:**

It is best to put up the gridlock on a screen and show the class how they work by talking through how to fill in the first few boxes on the first gridlock. Otherwise too many will say 'I don't get it'. Weaker groups may need this careful introduction several times.

### **3. Class Discussion/Review of Significant Digits**

Before completing the next activity, have a class discussion about significant digits and their relevance. Emphasize the need to maintain accuracy and that the number of significant digits are a reflection of the accuracy of the measurements of a quantity.

### **4. Activity 1-1A: Significant Digit Practice** – Students complete the activity individually, online.

Before the next activity, review the rules for calculating with significant digits. Emphasize that when calculating with significant digits, the final answer can never include more significant digits than the variables used to calculate it.

**5. Activity 1-1A: Calculating with Significant Digits** – Students complete the activity individually, online.

**6. Activity 1-1A: How small is an atom**

Watch the video “How small is an atom”.

Have a brief review of the video with a class discussion guiding the students to answer the following questions:

- “Describe the size and scale of an atom.”
- “Explain the relative size of the nucleus in relation to the size of the entire atom.”

Put students into groups of 2-4. Have each group come up with their own analogy for the size of an atom. Have them estimate some proportions to determine how they would use their analogy to describe how small an atom is. Have each group present their analogy to the class.

**7. Think-Pair-Share – Determining the Shape of an Unknown**

- Pair up students (or groups of 3-4) for a think-pair-share activity.

**Prompt 1:** “How would the rate of a reaction be measured (which units and tools could you use)?”

1. Have each person in each group carefully think about the prompt for **2 minutes**.
2. Then have each student record their answer on a sheet of paper.
3. Have students reflect on which connections they can make to previous knowledge.
4. Have the pairs (or groups) come together to share their ideas for 3-4 minutes and discuss the prompt. The students should ask questions to help clarify what each was thinking.
5. As the teacher, you should circulate around the room while this is going on, help facilitate the discussion and make sure students are staying on topic.
6. After sufficient time, groups will choose one member to share their ideas with the rest of the class.
7. Record responses and help guide the students to the fact that the rate of a chemical reaction can be measured by the amount of product produced over a period of time

**8. Activity 1-1B: Atomic Structure: Rutherford’s Gold Foil Experiment**

Have students read section A on their own.

Then have them try the Name that Shape game that mimic Rutherford’s gold foil experiment. After playing the game, link the game to the think-pair-share activity related to finding the

shape of an unknown object. Explain that Rutherford's experiment followed a similar logic, to help him determine the structure of an atom.

### **Rutherford's Gold Foil Experiment Simulator**

Have students open the instructions for the simulator and the simulator on their own computers. Students will complete the handout on their own, after which you can take up the answers as a class.

After taking up the handout have students read section D for an explanation. Follow up by having a class discussion to find out if there are any questions and to clear up any misconceptions.

### **9. 1-1C: Atomic Structure: Niels Bohr & Electron Orbits**

Put an image of the line spectra on the page up for the whole class to see and ask if they have any explanation for the patterns?

Students read through section A on their own.

**B. Bohr's Model of the atom.** As a class or individually watch the link to the animation that explains line spectra and how Bohr interpreted them. Following this, students should read through the rest of section B. Follow up by asking if there are any questions. Focus the discussion on the fact that the structure of the atom was unknown before these experiments and that Bohr and Rutherford based their understanding on their interpretation of the experimental results.

### **10. 1-1D: Canadian Contributions to Atomic & Molecular Theory**

#### **Teachers Notes:**

- For this activity, the task for students is to research a Canadian scientist who has made a contribution to atomic and/or molecular theory. You may have students do this individually or in groups.
- This is a good opportunity to talk about research assignments, expectations, plagiarism and how to effectively research a topic. Emphasize that they should not copy and paste information, but compile it, making note of the sources they used and then reconstructing the information in their own words and formats.
- This should take at least 1 hour of research and compilation.
- To make this a group activity you can have students in groups of 2-4 pair up, select a scientist to research and to present their own Canadian researcher to the whole class.
- Even if presenting, students should also post their results on the discussion page.

## Consolidation

### 1. 1-1F: Lesson 1-1 Quiz

- This is an online quiz that does not count towards their grade. Have students complete this in class or as homework.

### 2. 1-1G: Assessment

- This is a graded assignment. Students should complete this on their own, outside of class. Go over the assignment and general expectations with students before they attempt the assignment such as:
  - complete the assignment on their own, no copying off others.
  - answer in complete sentences, in your own words.
  - save files using the proper formatting.