Lesson 1-4: 3-D Shapes: VSEPR	
Curriculum Expectations	C2.3predict the shapes using the valence shell electron pair repulsion (VSEPR) model, and draw diagrams to represent their molecular shapes [AI, C] C2.4 predict the polarity of various chemical com- pounds, based on their molecular shapes and the difference in the electronegativity values of the atoms [AI] C3.5 describe a Canadian contribution to the field of atomic and molecular theory (e.g., the work of Richard F.W. Bader of McMaster University on electronic density in small molecules; the work of Robert J. LeRoy of the University of Waterloo on the mathematical technique to determine the atomic radius of molecules known as the LeRoy Radius; the work of Ronald J. Gillespie of McMaster University on the VSEPR model)
Learning Goals	**Learning Goals:** By the end of this lesson you will: • Understand how electrons behave within different bonds • How to draw Lewis structures • Understand VSEPR theory • Be able to predict molecular shapes based on bonds, atoms and electron configurations
Success Criteria	**Success Criteria:** I know I have achieved the learning goals when I: • Can produce lewis structures for atoms and molecules • Can explain the concepts underlying VSEPR theory • Can predict the shapes and bond angles within molecules
Teacher Prep	• Print out worksheets if you intend to have students complete them as you progress through the class. • Print out Gridlock activity pages. • Check to make sure videos from activity 1-4A & B work. • Check that the VSEPR simulator from PHET works. • Check to make sure interactive periodic table from the Graphing the periodic table group activity works.

	• Print out handout if you want students to fill it out as they progress through the lesson.

Minds On

Goal: This is an opportunity to enforce the idea that atoms and their electrons can be represented in numerous ways. This is meant as a review and will lead into Lewis structures and molecular shapes.

1. <u>Bohr Diagrams Review Game</u>

Instructions:

1. Open the embedded presentation and use the slides to review how to draw Bohr Diagrams with the whole class (Slides 1-7)
2. Break the students up into teams of 2 - 4.
3. Explain that as a team they will have to complete a series of Bohr diagrams. The first team to accurately complete them all wins the game.
4. Put slide 8 up on the projector for the whole class to see. The group will have to accurately draw all of the structures represented. Have the students begin drawing the structures. The first group to finish raises their hand.
5. Check the work of the group to make sure the drawings are accurate.

Emphasize the Bohr diagrams are just one tool that chemists can use to represent the structure and components of an atom. These are tools that help us understand how atoms and molecules might behave and interact with each. Other tools such as Lewis structures are another example, which can help us predict how molecules will form.

Action

****Refer to the Differentiation Resources link for additional practice worksheets, and to enrich your classroom teaching using different tools throughout the lesson. ****

1. Chemical Bonding & Lewis Structure Handout

Have students complete the handout as they work their way through the lesson *or* you can assign the handout as homework to completed after class and taken up in the next session.

2. 1-4A: Lewis Structures

- Have students read sections A & B on their own.
- Review with the class valence electrons and how to use the periodic table to quickly determine the number of valence electrons in each neutral atom.

- Play the video from section C for the whole class.
- Review and clear up any questions.
- Have students read sections D and E on their own.
- Students should answer the embedded question on their own.
- Teacher will take up the answer to the embedded questions.
- Use the additional resources at the bottom of the page to differentiate the instruction and offer additional review opportunities for the students.

3. 1-4B: VSEPR Theory

1. Begin by introducing the concept of VSEPR theory, emphasizing that its function is to help predict the shape of molecules.
2. Explore the findings of Ronald J. Gilespie (use embedded link). Point of emphasis here is the Canadian connection to the development of VSEPR theory.
3. Play the VSEPR theory video.
4. Review with the class after, answer any questions and clear up any misconceptions.

    - This first video explores the concepts underlying the theory.
    - Emphasize the repulsive effect of same-charge particles.

5. Have students read section B and then watch video for section C.

    - After the video review the concepts, you may choose to rewatch parts of the video.
    - Answer any questions and clear up any misconceptions.

6. Have students complete the interactive at the bottom of the activity page on their own or you may choose to display this for the whole class to see and have the students help you progress through the simulator.

4. 1-4C: VSEPR Shapes

1. Use the simulator from PHET, embedded at the top of the activity to help guide the instruction through this activity.
2. You may choose to lead a class lecture on the topic, showing how the addition of atoms and lone pairs of electrons produces the different common VSEPR shapes.
3. Emphasize that students are expected to know how to use Lewis structures to:

    - produce the shapes
    - the names of the different shapes
    - the bond angles associated with the different shapes.

4. Have students answer the embedded question on their own.
5. Take up the answer as a class.

6. Use the video at the bottom of the page as a review.
7. Ask questions to ensure student understanding.
    - **1. Serve the question.** Raise a question to the class and choose a student to answer.
        - "What is the purpose of predicting VSEPR shapes?"
    - **2. Volley the question.** Choose several other students to answer the same question. You may choose to write some of the answers on the board to help keep track of the points mentioned.
    - **3. Keep the game going.** At this stage there are several options, but the ultimate goal is to keep the conversation going and have students think critically about the topic. Do not ask any new questions. You will only repeat what the 3 students answered.
        - You could "serve" follow-up question such as: "How is molecule geometry and electron geometry different?"
        - You could ask whether any of the students agree or disagree with one of the points previously mentioned.
        - You could offer your own perspective and have students respond to it.
        - You could ask one of the students who previously responded to elaborate on their opinion.
        - You could ask students to give examples and or justifications.
        - You could comment on some of the previous points mentioned and then ask whether any other students have comments.

5. Molecular Shapes Gridlock Activity

In groups, individually or with the whole class. Click on the link for the online version of the gridlocks activity or if in groups or individually, give printouts for the students to complete. 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.

Consolidation

1. **1-4D: Lewis Dot Review & Practice.** This activity allows students to review and practice drawing Lewis Structures. This can be done in class or as homework. Answers should be reviewed as a whole class.

2. **1-4E: VSEPR Practice Activity** – To be completed individually, in class or at home. Take up the answers together the following day.

3. **1-4F: Lewis Structures & VSEPR Practice Problems** Students complete the quiz individually on their own in class (put the activity up on a projector) or at home. Once all students have completed activity, take up the answers as a class.

4. **1-4G: Simulator.** This is a tool that students can use to test their understanding of VSEPR and also to explore how the addition and subtraction of atoms/lone pairs affects the shapes and bond angles of different molecules.

****Refer to 1-4 Differentiation Resources for additional practice worksheets, and to enrich your classroom teaching using different tools. ****