

Content: Students relate lines representing bonds in structural formulas to dots representing valence electrons in Lewis dot structures.

Time Required: 45 minutes

Target student audience: Year 1

College prep chemistry

ChemSense User Level: Beginning

ChemSense Tools used: Drawing tools

Text notes - summarize

Context: Students have relied on the HONC 1234 rule to make sense of the bonding patterns for common elements in the structural formulas of small organic molecules. This lesson serves as a transition to students' using a understanding of valence electrons and the octet rule to correctly predict bonding patterns.

Chemistry Concepts in Activity (linked to CA stds, NSES, Benchmarks, ChemSense 5 themes):

Electron pairs in covalent bonds: part of NSES Content Standard A/Structure and Properties of Matter

Pre-requisite Chemistry Concepts: Bonding patterns of hydrogen, oxygen, nitrogen and carbon

Inquiry Skills

Identify questions and concepts that guide scientific investigations (NSES)

Formulate and revise scientific explanations and models using logic and evidence (NSES)

Communicate and defend a scientific argument (NSES)

ACTIVITY Summary:

1. ChemCatalyst: Students investigate what is a chemical bond.
2. Concept introduction: Covalent bond defined, Lewis dot structures introduced
3. Activity: Relationship between element group number and number of dots in Lewis symbol, extension to bonding in molecules

4. Discussion: Introduction of lone pairs and bonded pairs
5. Check-in: Application to new element

ACTIVITY

1. ChemCatalyst

This is a drawing of the structural formula of a methane molecule. The lines represent bonds. Explain what you think a bond is.

Use this discussion to get a sense of students' initial ideas.

2. Concept introduction

Define covalent bond as a link between two atoms, consisting of shared pairs of electrons.

Introduce Lewis dot structures by drawing methane with dots representing electrons.

Model use of terms "electron pair" and "unpaired electron."

3. Activity

Purpose: to investigate the question, "How can Lewis dot structures help us understand and predict bonding?"

Part 1: Draw Lewis dot structures for the following elements and answer the questions.

C	N	O	F	Ne
Si	P	S	Cl	Ar

- Do you notice any patterns?
- Predict the Lewis dot symbol for arsenic, As, and antimony, Sb.
- How many bonds do you think silicon will make? Germanium?
- How many bonds do you think chlorine will make? Bromine?
- Determine how many bonds each group of elements will make with other elements.
- Summarize with ChemSense text object: What relationship do you notice between the group number and the number of valence electrons? Review at least two other students' summaries and comment if you would like.
- Explain why nitrogen, N, in Group 5, does not make five bonds if it has five valence electrons.
- Why do you think we have not considered the elements in Groups 1, 2, and 3?

Part 2: The ChemSense drawing tool contains an example that illustrates the formation of methane Lewis dot structure from four hydrogen and one carbon Lewis dot symbols.

- Create a ChemSense drawing object that represents three hydrogen atoms combining with one nitrogen atom to create an ammonia molecule.
- Create a ChemSense drawing object that represents two hydrogen atoms combining with one oxygen atom to create a water molecule.
- Based on what you've learned in this lesson, explain why the HONC 1234 rule works. Create a ChemSense text object that contains your explanation.

4. Discussion

Review relationship between HONC 1234 and electrons in Lewis dot structures.

Review activity questions with groups of students.

Distinguish bonded pairs and lone pairs of electrons.

5. Check-in

Draw the Lewis dot symbol for the element I, iodine. Explain how you arrived at your particular drawing. How many covalent bonds does iodine make?

Rubric/s for scoring:

Activity part 1

Insufficient mastery	Incorrect numbers of electrons are shown around each element. No patterns are found.
Basic mastery	Correct numbers of electrons are shown around each element. The relationship between group number and number of valence electrons is identified. Nitrogen is expected to form five bonds.
Exceptional mastery	Correct numbers of electrons are shown around each element. The relationship between group number and number of valence electrons is identified. Nitrogen is expected to form three bonds, and the existence of one bonded pair of electrons is used to justify this answer.

Activity part 2

Insufficient mastery	Incorrect structures are drawn for ammonia and water, or lines are used to represent bonds instead of dots.
Basic mastery	Correct Lewis dot structures are drawn for ammonia and water. The availability of single, unbonded electrons is used to explain the relationship between HONC 1234 and the number of valence electrons.
Exceptional mastery	Correct Lewis dot structures are drawn for ammonia and water.

	The availability of single, unbonded electrons is used to explain the relationship between HONC 1234 and the number of valence electrons. Reference is made to the octet rule.
--	--

Check-in

Insufficient mastery	Iodine is represented with an incorrect number of valence electrons or an incorrect number of bonds.
Basic mastery	Iodine is represented with the correct number of valence electrons and number of bonds. Student's explanation includes reference to the three lone electron pairs and one unbonded electron in iodine.
Exceptional mastery	Iodine is represented with the correct number of valence electrons and number of bonds. Student's explanation includes reference to the three lone electron pairs and one unbonded electron in iodine. Reference is made to the octet rule.

Links: Living By Chemistry, Lawrence Hall of Science, Unit 2 Investigation II, Lesson 3

Integrated Uses: possible link to beginning organic chemistry or biochemistry.