

Happy Atoms

Welcome!

Happy Atoms is a physical and digital chemistry teaching tool that allows students to learn, see, and explore the world of chemistry.

Getting Started

Before you can use Happy Atoms with a tablet device, you will need to complete the following steps:

1. Download the Happy Atoms app
2. Calibrate the app
 - a. When you open the app for the first time, you will be asked which Happy Atoms modeling set you have
 - i. Introductory Set? Or Complete Set?
 - b. You will then have to calibrate the app using atoms contained in the set you have.
 - c. Follow the instructions on the screen to calibrate your app.
 - d. This step should only take a few minutes, and will only need to be done once. After this, your Happy Atoms app is ready to be used.
3. Having your students complete this step will be a great way to help familiarize students to the features of the app.

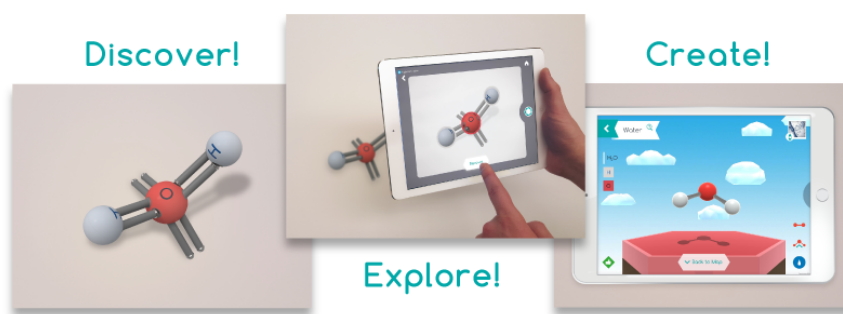
Play

The Happy Atoms app is set up as an open inquiry tool to work together with guided instruction. When you first show the app to students, give them time to make a few molecules, snap their picture, and learn about the intuitive features of the app.

Allow students to use this initial exposure to the app to read through the instructions from Harper and Andee.

Have Fun!

Enjoy the rest of your school year using the Happy Atoms app!



happyatoms.com



Big Idea

Atoms consist of a nucleus with protons and neutrons and electrons around the nucleus. The configuration of electrons in the outermost shell of an atom determines chemical properties of elements.

Learning Objectives

Students will be able to:

1. Understand that orbitals that are not yet stable contain valence electrons by counting the valence electrons on the physical Happy Atoms elements.
2. Observe that valence electrons determine how many bonds an atom can make by making molecules using all the atoms in a group.
3. Understand that electron configuration is one way of identifying an element, as well as showing which elements are “related” to each other (i.e., share similar chemical properties) by comparing the molecular bonding patterns of atoms across groups and periods.

Standards Addressed

1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
2. Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
3. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)
4. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3)
5. Science and Engineering Practice: Developing and Using Models: Use a model to predict the relationships between systems or between components of a system.
6. Crosscutting Concept: Systems and System Models: Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models
7. Crosscutting Concept: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Vocabulary, Content and Misconceptions

Proton

Neutron

Electron

Valence electron- magnets

Stability

The physical atoms only show valence electrons, while the Periodic Table within the app shows all electrons circling the nucleus of each atom. For example, students may wonder why both the Carbon and Silicon atoms have 6 magnets (representing valence electrons) when C has 6 electrons total, and Silicon has 14.

Atomic Structure Lesson Guide

Materials

- Happy Atoms modeling set
- Happy Atoms app
- Atomic Structure Student Worksheet

Advance Preparation

Provide to each student:

- Atomic Structure Worksheet (double sided)

Provide to each lab station group:

- Happy Atoms app downloaded onto tablet device
- Happy Atoms modeling set

Expected Activity Time: One class period (50 minutes)

Description of Lesson

Introduction to a Happy Atoms atom (5-10 minutes)

1. Distribute worksheet to students, and have them go to a station with their group.
2. Have every student take an atom (any atom) from the Happy Atoms set to hold on to during this demonstration.
3. Review the following terminology, as it related to the Happy Atoms set. While reviewing these terms, have students share with their partner or group how the term relates to the atom they are holding.
 - a. Element symbol
 - b. Valence Electrons
 - c. Nucleus (protons and neutrons)
 - d. Bonding Site

Part I: Identifying Elements (15-20 minutes)

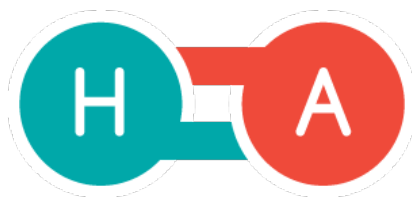
1. Assign each station a group of elements to work with: Period 1 or Period 2 (plus He and H). If you have not reviewed the organization of the Periodic Table with your students, you can tell them which elements to work with:
 - a. Period 1: H, He, Li, Be, C, N, O, F, Ne
 - b. Period 2: H, He, Na, Mg, Si, P, S, Cl, Ar
2. Instruct students to complete the Atomic Structure Worksheet, using the Happy Atoms modeling set and app.

Part II: Patterns and Questions (15-20 minutes)

1. Partner groups who completed the table for different elements.
2. Instruct students to share their observations and looks for patterns across their data table
3. Instruct student to work together to complete the *Part II Patterns and Questions* section of the worksheet.

Wrap Up and Closing Discussion (5-10 minutes)

1. Review the worksheet with your students, making sure to include examples from both Periods in your discussion.
2. Most importantly, review some of the patterns in valence electrons across a period and down a group in the Periodic Table.
 - a. Examples may include: valence shell electron patterns, total number of electron patterns, stable outer shell patterns.
 - b. You can refer to the images in the Happy Atoms Periodic Table as an additional resource.



Atomic Structure Worksheet

Name: _____

Period #: _____

Date: _____

Background:

- Valence electrons are the outer most electrons around the nucleus of an atom that determine many of the element's chemical characteristics.
- Total electrons refers to the total number of electrons around the nucleus of an atom, including the outermost valence electrons.
- Happy Atoms elements have bonding sites, or spots on the nucleus that represent the number of bonds that can form around the element.
- Elements are considered to be stable when they have a full outer shell of electrons. This can easily be seen using the Periodic Table in the Happy Atoms app.

Atomic Structure Worksheet

Part I: Identifying Elements

Complete this table using the Happy Atoms modeling kit. You can also use the Periodic Table in the Happy Atoms app for additional information.

Element Name	Chemical Symbol	Atomic Number	Nucleus		Total number of electrons	Number of valence shell electrons	Total number of electrons needed around nucleus to be stable	Number of electrons atoms <u>gives up</u> or <u>needs</u> to be stable
			Protons	Neutrons				
Hydrogen								
		2						

Atomic Structure Worksheet

Part II: Patterns and Questions

1. Explain the difference between the valence electrons, and the total number of electrons for any given element.
Valence electron-

Total electrons-

Ex. Describe the difference between total and valence electrons for the element Silicon.

2. Your teacher will pair you with a group that completed the table using different elements. List two (2) similarities and two (2) differences between Oxygen and Sulfur, using the information in your table, and the other groups' table. You can also use your physical atoms and the Periodic Table in the app as a reference.

Similarities

1.

2.

Differences

1.

2.

3. What patterns do you notice about the total number of electrons and the number of valence electrons? You can list patterns across the Periodic Table, or relationships between the total and valence shell electrons. Provide evidence from the Happy Atoms modeling app or set that allows you to come to this conclusion.

1.

2.

3.

4. What do you notice about Argon and Neon? Provide evidence from the Happy Atoms modeling app or set that allows you to come to this conclusion.

Big Idea

The periodic table is organized in rows by increasing atomic number, such that elements with similar atomic structure and chemical properties are grouped as vertical columns. Increasing or decreasing trends, such as atomic size, number of valence electrons, or electronegativity, can be observed in the periodic table across a period or down a group.

Learning Objectives

Students will be able to:

1. Understand how atomic size changes down a group by visually drawing the trend when provided with a blank periodic table.
2. Understand that elements within the same group have similar chemical properties and atomic structure, and demonstrate that understanding by identifying that elements with the same number of valence electrons also reside in the same group.
3. Understand that elements from different groups have different chemical properties and atomic structure by identifying the difference in the number of valence electrons across a period in the periodic table.

Standards Addressed

1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1.)
2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (HS-PS1-2.)
3. Science and Engineering Practice: Developing and using models
4. Crosscutting Concept: Structure and Function

Vocabulary, Content and Misconceptions

Group

Period

Atomic size

Atomic size across a period is not well represented in the Happy Atoms set and app. Students often don't understand that the Noble Gases are larger compared to the Halogens because atomic size generally decreases as you move from left to right in a period. Students sometimes think it is a mistake in their book or ask if this is a mistake in the models. A discussion of the properties of Noble Gases and the Octet rule would help with this. Noble gases have a complete outer shell of electrons. The size of each atom is larger because there is more electron repulsion. Because Noble Gases have all the valence electrons they need, they are very stable and don't participate in many chemical reactions.

The models can be used to discuss the misconception that the valence electrons do not represent all the electrons of an atom. You can note that the noble gases do not have any valence electrons: it might seem like it would be just a free floating nucleus, but rather they have full octet of electrons. Use this to guide students, along with the use of the Happy Atoms application, to show that the magnets are just showing the valence electrons and not the total number of electrons in an atom.

Materials

- Happy Atoms modeling set
- Happy Atoms app
- Atomic Structure Student Worksheet

Advance Preparation

Provide to each student:

- Atomic Structure Worksheet (double sided)

Provide to each lab station group:

- Happy Atoms app downloaded onto tablet device
- Happy Atoms modeling set
- Happy Atoms modeling set white mat

Periodic Trends Lesson Guide

Expected Activity Time: One class period (50 minutes)

Description of Lesson

Introduction to a Happy Atoms atom (5-10 minutes)

1. Distribute worksheet to students, and have them go to a station with their group.
2. Demonstrate to students where they can find the Periodic Table in the app.
 - a. It is important to point out the differences between the Periodic Table in the app, and the real Periodic Table of Elements, to avoid any confusion.

Part I: Identifying Different Types of Elements (5-10 minutes)

1. Students will complete their worksheet, filling out the different types of element classifications (from app) in each box.

Part II: Identifying Valence Electrons (10-15 minutes)

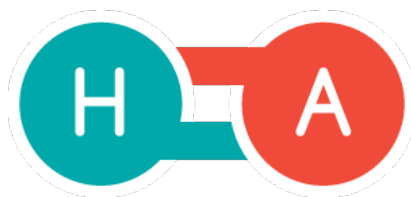
1. Students will use the Happy Atoms Periodic Table mat to physically lay out all of the elements. After they have done this, and have answered the questions, you can suggest that each group find another group to discuss the patterns that they noticed across and down the Periodic Table.
2. You may want to consider having a discussion about the periodic trends as a class before having students visually represent their trends at the end of Part II.

Part III: Electronegativity (10-15 minutes)

1. Students will complete the table about inner electrons, valence electrons, and electronegativity. Explain to students the difference in electronegativities of O and F. You can use the physical atoms to demonstrate this.

Wrap Up and Closing Discussion (5-10 minutes)

1. Review the worksheet with your students, making sure to review the electronegativity table, as this will be new.
2. Summarize the different trends that groups notices in the Periodic Table.
3. Most importantly, review some of the patterns in valence electrons across a period and down a group in the Periodic Table.
 - a. Examples may include: valence shell electron patterns, total number of electron patterns, stable outer shell patterns.
 - b. You can refer to the images in the Happy Atoms Periodic Table as an additional resource.



Periodic Trends Worksheet

Name: _____

Period #: _____

Date: _____

Background:

- Elements are organized in a Periodic Table of Elements. The Periodic Table also guides you in identifying patterns and information about each element depending on its position in the table.
- Electronegativity is the relative tendency of an atom to attract electrons to itself in a chemical bond. The greater an atom's electronegativity, the greater its ability to attract electrons to itself.

Part I: Identifying Different Types of Elements

Use the Periodic Table in the app to classify each type of element in the Happy Atoms Periodic Table.

Group 1A	
H	Group 2A
Li	
Na	

				Group 2A
				He
Group 4A	Group 5A	Group 6A	Group 7A	
C	N	O	F	Ne
Si	P	S	Cl	Ar

1. What patterns do you notice about the metals and nonmetals? Where is each category of elements located on the Periodic Table?

Periodic Trends Worksheet

Part II: Identifying Valence Electrons

Use the Periodic Table Mat to lay out one of each atom on the mat. Make sure you have enough space.

1. What patterns do you notice as you move down periods in the Periodic Table? What is your evidence? How can you summarize the pattern of valence electrons as you move down periods in the Periodic Table?
2. What patterns do you notice as you move across groups in the Periodic Table? What is your evidence? How can you summarize the pattern of valence electrons as you move across groups in the Periodic Table?

Use the space below to visually summarize these patterns. You can write in your patterns on the arrows.

The diagram illustrates the periodic table with trends in electronegativity. A horizontal arrow at the top points from left to right, indicating that electronegativity increases across a period. A vertical arrow on the left points from top to bottom, indicating that electronegativity decreases down a group.

Group 1A						Group 2A
H	Group 2A	Group 4A	Group 5A	Group 6A	Group 7A	He
Li	Be	C	N	O	F	Ne
Na	Mg	Si	P	S	Cl	Ar

Part III: Electronegativity

Periodic Trends Worksheet

Except for hydrogen and helium, most elements want to fill their orbitals so that they have a stable Octet (8 electrons in their outermost shell). Atoms do this by bonding to other atoms. Review the Happy Atoms app or physical models for each atom listed below to determine how many valence electrons each atom has and how many it needs.

Chemical Symbol	Number of Inner Electrons	Number of Valence Electrons	The number of electrons an element will donate or lose in order to achieve stability	Total Number of Valence Electrons in a Stable Configuration
H		1		
He		2	Stable	
Li	2	1		
Be				
C				
N				
O			Needs 2 more electrons	
F		7		
Ne				
Na				
Mg	10			
Si				
P				
S				
Cl				
Ar				

1. Write one sentence below describing how electronegativity changes as you move from left to right on the periodic table.
2. Write one sentence below describing how electronegativity changes as you move down a group on the periodic table.

Big Idea

An element's atomic structure and chemical properties determine the types of bonds that element will form with other elements. Different numbers of valence electrons will cause elements in the same period to have different properties. Elements in the same group will have similar chemical properties because they have the same number of valence electrons.

Learning Objectives

Students will be able to:

1. Visualize that the chemical properties of ionic and covalent compounds are caused by their bond types. Students will demonstrate an understanding by identifying similarities in compounds with ionic bonds, and differences when contrasting ionic and covalent compounds.
2. Understand that elements in a period will have different chemical properties and bonding types by identifying that elements across a period contain differing numbers of valence electrons.
3. Understand that elements in a group will have similar chemical properties and bonding types by identifying that elements within a group have the same number of valence electrons.

Standards Addressed

1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1.)
2. Science and Engineering Practice: Developing and using models
3. Crosscutting Concept: Structure and Function

Vocabulary, Content and Misconceptions

Ionic compound

Covalent compound

Cation

Anion

Students may try to break the octet rule with a group 5A, 6A, or 7A element because there are many magnetic connectors with the Happy Atoms modeling set.

Single bonds modeled using Happy Atoms can be mistaken by students as double bonds because there are two flexible arms involved. Since each atom is sharing one valence electron (present at the end of each flexible arm), the atoms are only sharing one **pair** of electrons, which is the definition of a single covalent bond.

There is a misconception that hydrogen will always make a covalent bond in a compound because it is a nonmetal. Hydrogen, if acting as a hydride anion when paired with a metal cation, will make an ionic bond.

Students may think that hydrogen can make more than a single bond. Students have tried to create double or triple bonds to a hydrogen atom in a compound.

Ionic and Covalent Bonding

In the Happy Atoms physical models, ionic bonds and covalent bonds are modeled similarly. Students may be confused that elements like Na or Li are not giving up their electron because it is still attached to the element when modeling the ionic bond with Happy atoms. Teachers can clarify this by explaining that Group 1A and 2A elements do not have magnetic bonding sites, and cannot participate in a covalent bond.

Materials

- Happy Atoms modeling set
- Happy Atoms app
- Chemical Formulas and Bonding Worksheet

Advance Preparation

Provide to each student:

- Chemical Formulas and Bonding Worksheet (double sided)

Provide to each lab station group:

- Happy Atoms app downloaded onto tablet device
- Happy Atoms modeling set

Expected Activity Time: One class period (50 minutes)

Description of Lesson

Introduction to Bonding (5-10 minutes)

1. Distribute worksheet to students, and have them go to a station with their group.
2. Have every student take two Hydrogen atoms (there should be enough in each set for 7 students to follow along) and have them follow along as you demonstrate bonding.
3. Review the following terminology, as it related to the Happy Atoms set.
 - a. Valence Electrons
 - b. Bonding Site

Part One: All About Hydrogen Compounds (15-20 minutes)

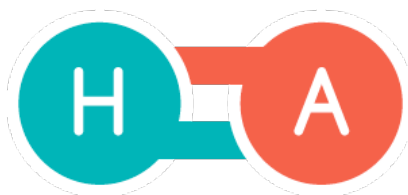
1. Assign a period in the Periodic Table to each group of students. They will complete the first part of their worksheet with these elements.
 - a. Period 2: Li, Be, C, N, O, F
 - b. Period 3: Na, Mg, Si, P, S, Cl
2. Students will use the Happy Atoms physical modeling set to make molecules with hydrogen. Students will then take a picture of their molecules, and identify it's name, and identify whether it is ionic or covalent. Happy Atoms differentiates between ionic and covalent bonds in both the physical models, and in the app.
 - a. Period 2 groups will make: LiH, BeH₂, CH₄, NH₃, H₂O, HF
 - b. Period 3 students will make: NaH, MgH₂, SiH₄, PH₃, H₂S, HCl
3. When students are finished with the first table, have them partner with a group that worked with different elements. Together, they will determine the trends in bonding with Hydrogen, and answer the questions in Part I.

Part Two: Ionic or Covalent? (15-20 minutes)

1. Instruct students to continue working on the table in Part II. For each listed molecule, students will be identifying the chemical name and bond type, chemical properties of the molecule, and providing a sketch of the compound.

Wrap Up and Closing Discussion (5-10 minutes)

1. Review the worksheet with your students, making sure to include examples from both Periods in your discussion.
2. Most importantly, review the concepts of ionic and covalent bonding, as it refers to the Happy Atoms physical models. You can demonstrate using NaCl, and CH₄, for example, to show the ionic vs. a covalent bond.



Ionic and Covalent Bonding Worksheet

Name: _____

Period #: _____

Date: _____

Part One: All About Hydrogen Compounds

Your group will examine either Period 2 or Period 3 elements. Find the atoms from the Happy Atoms model kit for all the elements in that period. Bond one atom of each element in that period to the maximum number of hydrogen atoms possible to make each compound. After making the compound, use the Happy Atoms app to complete the rest of the table.

Period 2: Li, Be, C, N, O, F

Period 3: Na, Mg, Si, P, S, Cl

Element						
Molecule Formed when bonded with Hydrogen						
Compound Name						
Ionic or Covalent						

1. What do you observe that leads you to determine whether a molecule is ionic or covalent? Write down your evidence.
2. Partner with a group that completed the table for the other Period of elements. Work together to recognize patterns about molecular bonding in different group of elements in the table below.

Ionic and Covalent Bonding Worksheet

Use the first column as a guide. X= any element in the group

Any Element From Group	Group IA	Group IIA	Group IVA	Group VA	Group VIA	Group VIIA
Molecule Formed when bonded with Hydrogen	X-H					
Example of a Compound that follows this pattern	LiH					
Ionic or Covalent	ionic					

1. What patterns do you notice from your tables?

2. Are the chemical properties of each compound similar or drastically different? Based on your modeling, what is the cause of the similarity or difference?

3. Compare your results with a group that examined compounds from a different period (for example, if you examined Period 2 compounds, compare your results with a group that examined Period 3). Are the chemical properties of compounds **in the same periodic table group** similar or drastically different? Based on your modeling, what is the cause of this similarity or difference?

Ionic and Covalent Bonding Worksheet

Part Two: Ionic or Covalent? Complete this table using the Happy Atoms modeling set. After making the compound, use the Happy Atoms app to complete the rest of the table.

Chemical Formula	Chemical Name	Bond Type (Ionic or Covalent)	Sketch compound (from app or physical model)	If ionic, what is the cation (positive charge) and anion (negative charge)?	If covalent, what type of bond (single, double, triple)?	One interesting fact about the compound
NaCl						
NaF						
CH ₄						

Ionic and Covalent Bonding Worksheet

Chemical Formula	Chemical Name	Bond Type (Ionic or Covalent)	Sketch compound (from app or physical model)	If ionic, what is the cation (positive charge) and anion (negative charge)?	If covalent, what type of bond (single, double, triple)?	One interesting fact about the compound
Mg(OH) ₂						
SiO ₂						
NH ₃						

1. Ionic compounds are made of a _____ and a _____.
2. Covalent compounds are made of a _____ and a _____.
3. Is magnesium oxide an ionic compound or a covalent compound? Provide at least 3 pieces of evidence (from the periodic table, from each atom's electron configuration, and from actually modeling the compound) to support your answer.

4. Is butane an ionic compound or a covalent compound? Provide at least 3 pieces of evidence (from the periodic table, from each atom's electron configuration, and from actually modeling the compound) to support your answer.

5. Why are He, Ne, and Ar missing from compounds in this activity? Provide at least 3 pieces of evidence (from the periodic table, from each atom's electron configuration, and from actually modeling the compound) to support your answer.

Big Idea

Molecules can be represented using a Lewis Structure drawing. This representation of a molecule can be used to determine the geometry and shape of a molecule.

Learning Objectives

Students will be able to:

1. Draw a Lewis structure of a molecule based on the number of valence electrons of each atom.
2. Predict the molecular shape (geometry) in relation to the central atom's group on the Period table based on VSEPT theory. Students build molecules where the central atom has different numbers of valence electrons.

Standards Addressed

1. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (HS-PS1-2.)
2. Science and Engineering Practice: Developing and Using Models: Use a model to predict the relationships between systems or between components of a system.
3. Crosscutting Concept: Systems and System Models: Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models

Vocabulary, Content and Misconceptions

Lone pair (unshared pair) of electrons

Bonding pair of electrons

Ligand

Steric number

Student misconceptions for VSEPR might include:

- That a double bond counts as 2 ligands. (Remember, it really counts as 1 ligand in VSEPR.)
- When drawing Lewis structures, students often get so caught up in drawing the Lewis dots correctly that they will write the chemical symbol incorrectly ("CL" instead of Cl", for example). It is important to check their Lewis symbols frequently.
- Sometimes, students are unclear as to an atom gaining/losing electrons, so be sure to check for this while circulating. Watch this especially in the metals, as the bonding using metals is different with the Happy Atoms model set. There is only one "arm" from the metal connecting to the other atom, and this is not reciprocated.

The models sometimes do not connect all the way for certain molecules (for example, in SiO₂ the rubber arms do not reach all the way; however, a bond forms). You can tell the students that this might be a limitation of the models, or even ask students to come up with limitations of the models, but they can see there is a bonding placeholder (magnet) with which, if the arm could reach, would represent the double bond.

Lewis Structures and Molecular Shape

Materials

- Happy Atoms modeling set
- Happy Atoms app
- Lewis Structures and Molecular Shape Student Worksheet

Advance Preparation

Provide to each student:

- Lewis Structures and Molecular Shape Worksheet (double sided)

Provide to each lab station group:

- Happy Atoms app downloaded onto tablet device
- Happy Atoms modeling set

Expected Activity Time: One class period (50 minutes)

Description of Lesson

Introduction (5-10 minutes)

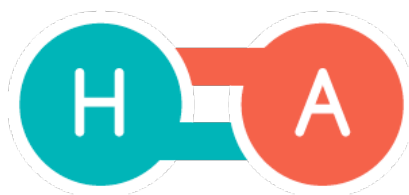
1. The Valence Shell Electron Pair Repulsion (VSEPR) Theory helps us to predict the shape (or molecular geometry) of molecules. 3-D models are helpful representations to visualize what these molecules look like. A molecule's shape will often influence its function and use.
2. Use an oxygen and two hydrogen atoms to model how to make a water molecule and to complete the same tasks students will do in their worksheet. Students can follow along in their worksheet.
 - a. Demonstrate how to draw a Lewis Structure for this molecule.
 - b. Make the water molecule. Use the water molecule to describe the number of ligands (2) and lone pairs (2) on the central oxygen atom to the students.
 - c. Take a picture using the Happy Atoms app, image the molecule, and show students where to find the information about molecular geometry on the app.
 - d. Select the molecular angle button in the app to determine the molecular geometry of the molecule.

Part I: Lewis Structures and Shapes (2-30 minutes)

1. Instruct students to make all the molecules on their worksheets, and to complete table.

Wrap Up and Closing Discussion (5-10 minutes)

1. Briefly review the worksheet information with students, and answer any clarifying questions.
2. Guide the discussion to get students to recognize the trends between steric number and the geometry and bond angles.
3. Review the steric number table with students. You can use this step as a check for understanding.
4. Most importantly, review the trends in molecular shape, and how Lewis Structure can help determine this.



Lewis Structures and Molecular Shape Worksheet

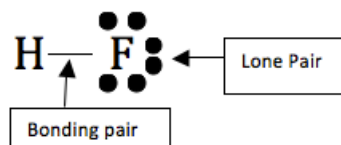
Name: _____

Period #: _____

Date: _____

Background:

- The Valence Shell Electron Pair Repulsion (VSEPR) Theory helps us to predict the shape (or molecular geometry) of molecules. 3-D models are helpful representations in seeing what these molecules really look like. A molecule's shape will often determine its function and use.
- Lewis structures show bonding in molecules: a straight line shows a bonding pair (shared pair) of electrons, and two dots represent a lone pair, or non-bonding pairs of electrons.



- Molecules can be arranged in the following molecular shapes:

Molecular Geometry Linear		Molecular Geometry Tetrahedral	
Molecular Geometry Bent		Molecular Geometry Trigonal Pyramidal	
Molecular Geometry Trigonal Planar			

Lewis Structures and Molecular Shape Worksheet

Part I: Lewis Structures and Shapes

Complete this table using the Happy Atoms modeling kit. You can also use the Periodic Table in the Happy Atoms app for additional information. Use the last two rows to make a molecule not found in this table.

Chemical Formula	Compound Name	Lewis Structure	Number of Ligands	Number of Lone Pairs	Molecular Geometry	Special Characteristics
H ₂ O						
CCl ₂ F ₂						
PH ₃						
SiH ₄						
CS ₂						

Lewis Structures and Molecular Shape Worksheet

Chemical Formula	Compound Name	Lewis Structure	Number of Ligands	Number of Lone Pairs	Molecular Geometry	Special Characteristics
H ₂ S						

Part II: Patterns and Questions

1. Give two examples of molecules with bent geometry. How many elements are bound to the central atom? How many lone pairs are around the central atom?
2. Give two examples of molecules with tetrahedral geometry. How many elements are bound to the central atom? How many lone pairs are around the central atom?

Lewis Structures and Molecular Shape Worksheet

3. Name 1 pattern you notice in your data that would be helpful to understanding VSEPR. Cite evidence from your data.

4. The number of ligands added to the number of lone pairs on an atom is equal to the steric number. Use this information to complete the following table

Steric Number	Geometry- 0 lone pairs	Geometry 1 lone pair	Geometry 2 lone pairs
2			
3			
4			

Big Idea

There are different patterns in chemical reaction types. One key feature of all chemical reactions is that atoms in molecules rearrange to form the products, thus providing the basis for balancing reactions.

Learning Objectives

Students will be able to:

1. Physically model the products and reactants of a chemical reaction using the Happy Atoms set, and observe how bonds break and reform to make new compounds.
2. Build a compound if they know its chemical formula, and use it to build the products of a reaction using the same atoms present in the reactants
3. Demonstrate an understanding of balancing chemical equations using physical models of the products and reactants.

Standards Addressed

1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (HS-PS1-2)
3. Use mathematical explanations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (HS-PS1-7)
4. The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (PS1.B.3)

Vocabulary, Content and Misconceptions

Reactant

Product

Balanced Equation

Visualizing the number of atoms present in the reactants and products of a reaction will help students gain a conceptual understanding of balancing equations. However, some students may only make one molecule of each product and reactant. Be sure to remind students that number of atoms on both sides of the equation must be equal, therefore they might need to make more than one of each molecule.

Remind students that once you write the chemical formulas to not touch the subscripts in the chemical formulas when balancing a chemical equation – use coefficients only to balance the chemical equation.

Note that at the combustion reaction station, groups may construct a model of the reaction using different starting hydrocarbon compounds. Use this as a teaching point to explain the unique trend in combustion reactions

Chemical Reaction Types Lesson Guide

Materials

- Happy Atoms modeling set
- Happy Atoms app
- Chemical Reaction Types Student Worksheet

Advance Preparation

Provide to each student:

- Chemical Reaction Types Worksheet (double sided)

Provide to each lab station group:

- Happy Atoms app downloaded onto tablet device
- Happy Atoms modeling set.

For this lesson, it may be easier to have students rotate through stations of reactions. If this is the case, combine the same atoms from different Happy Atom sets in order to have enough of each atom at each station to create models of the reactions. Before the lesson, you will need to sort the atoms into the appropriate sets.

- Station 1: Nitrogen, hydrogen (3:1 ratio)
- Station 2: Carbon, oxygen (2:1 ratio)
- Station 3: Magnesium, lithium, hydrogen (1:2:2)
- Station 4: Magnesium, sulfur, oxygen, hydrogen (1:1:1:1)
- Station 5: Remaining carbon, hydrogen, oxygen

Chemical Reaction Types Lesson Guide

Expected Activity Time: One class period (50 minutes)

Description of Lesson

Introduction (5-10 minutes)

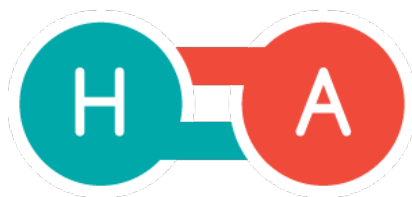
1. Distribute worksheet to students, and provide information about each of the stations.
2. Have students follow along in the first row of the table as you demonstrate how to model the first reaction. (NH_3)
 - a. Demonstrate how to use the search feature and search for ammonia in the app
 - b. Build the molecule
 - c. Build the products based on the given chemical equation
 - d. Build enough of each product and reactant to model a balanced equation for your students.

Worksheet Activity (35 minutes)

1. Students start at one of the 5 different stations (one station will be the NH_3 reaction), depending on class size and classroom management, you can allow students to move freely from station to station, or use a timer to ensure each student gets time at each station.

Wrap Up and Closing Discussion (5-10 minutes)

1. Review the worksheet with students and ask if there were any questions.
2. Ask different groups what “Challenge Molecule” they used, and have the entire class try to complete the table for these molecules.
3. Most importantly, review that the total number of each elements on the reactants and products side of a balance equation should have the same number of atoms, just arranged differently among molecules.



Chemical Reaction Types Worksheet

Name: _____

Period #: _____

Date: _____

Background:

During chemical reactions, bonds break and new bonds form in order to make new stable molecules. The number of each molecule needed for any reaction to proceed will depend on the molecule. Generally, the total number of each element on the reactants and products side of a reaction must be equal. You can build each reactant and product, and build enough until there are the same number of atoms on each side of the equation. That will help you determine how to balance the equation.

Part I: Identifying Elements

Complete this table using the Happy Atoms modeling kit and Happy Atoms app.

You can search for molecules by Chemical Formula OR by Common Name. If you aren't sure how to build a molecule, Happy Atoms will help you.

Reactant(s)					Product(s)				Balanced Chemical Equation
Chemical Formula		Common Name			Chemical Formula		Common Name		
		Ammonia		→				Nitrogen gas	$2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$
C	O ₂			→					
		Magnesium hydride	Lithium	→					
				→			Magnesium sulfide	Water	
				→			Carbon dioxide	Water	

Chemical Reaction Types Worksheet

Challenge Question:

Complete the following challenge reactions. Remember to use the Happy App to find the molecule, and learn how to make it.

Reactant(s)					Product(s)				
Chemical Formula		Common Name			Chemical Formula		Common Name		
		Carbonic Acid		→					
		Ethanol		→					
HCl				→				Sodium Chloride	