micron STEM

Atoms and Molecules Activity Guide

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Objectives

These activities will enable students to:

- Describe how atoms are the building blocks of matter
- Build a model of an atom and a molecule
- Interpret element information from the Periodic Table
- Discuss the historical development of the study of matter, including contributions of notable scientists

Standards

This lesson aligns with the following National Science Content Standards (NGSS):

- MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.
- HS-PS1-1 Matter and its Interactions - 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..

Throughout this document, black text indicates optional talking points, green text indicates actions/tasks for the instructor that support the talking points for the instructor.

Level 1 & 2 Introduction

Q: What is everything made of? Every building, every person, every object?
A: Everything is made up of matter. Matter is anything that takes up space and has mass.

Anything that is **material** is made of **matter** – in fact both words come from the same Latin root 'mater' meaning 'mother' or 'root'. The Latin 'mater' derives from the Greek root 'hyle', which is a concept of hyle emphasizes originated by the Ancient Greek philosopher Aristotle, that everything physical is made of the same basic substance, which aligns well with modern scientific understanding.

Q: What is matter made of?
A: Matter is made up of molecules, and molecules are made up of atoms.

History lesson slide: Democritus
About 2400 years ago, a Greek philosopher named Democritus (460-370 B.C.) thought a lot about what things were made of. One day while slicing an apple, he wondered how small he could slice it. He figured that everything that could be touched could be divided again and again until there was a piece left that was so small it couldn't be cut. It turns out that he had the right idea, and that smallest piece we now know as the atom. The word **atom** comes from an ancient Greek word that means "uncuttable." Democritus could not see an atom (as we can today with super strong microscopes), but he had figured out something very important. His atom is what we talk about today as an **element.**

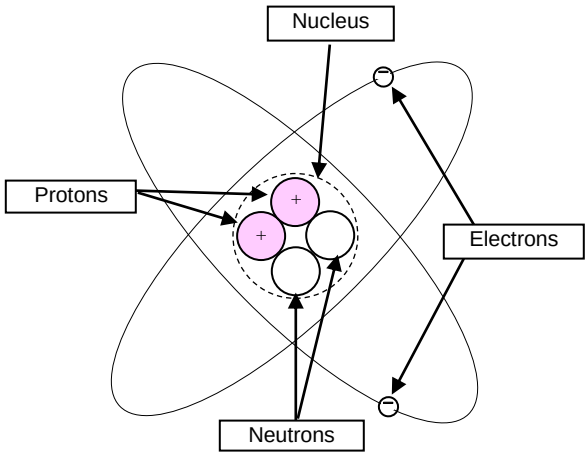
Q: What is an example of an element?
A*: Answers will vary;* Examples include hydrogen, oxygen, gold, etc.
Refer to a Periodic Table for additional elements.

In the mid 17th century, scientists began to prove the existence of specific elements, or pure substances that couldn't be "cut" into other pieces. This led scientists to discover the elements and atoms that make up all matter.

The types of scientists who study atoms are chemists and physicists. At the beginning of the 20th century, scientists found that Democritus' atom could be cut into smaller pieces, called **sub-atomic** particles.

Atom Model
Q: What are the parts of an atom?
A: Nucleus, electron, proton, neutron
The nucleus is at the center of the atom. It is made up of protons and neutrons. Moving around outside of the nucleus are the electrons. In 1915 a scientist named Niels Bohr proposed a model of the atom that illustrates the atomic structure, called the **planetary** model or the **Bohr** model.

Refer to the picture of the atom on the slide and explain how the electrons look like planets orbiting the nucleus "sun."



Proton comes from the Greek word for “first.”

Q: What type of charge does a proton have?
A: Protons have a positive charge.

Note: Typically, positively charged particles would repel each other, but they are held together in the nucleus with a force called the **strong atomic force**. This is the strongest force in the universe.

The other part of the nucleus is the neutron. Neutrons are about the same size as protons. The word **neutron** comes from the Latin word for “neutral.”

Q: What charge does a neutron have?
A: The neutron has no charge – it is neutral.

The third particle of an atom is the electron. Electrons are much smaller than the protons or the neutrons (almost 2000 times smaller). It is easy to illustrate them orbiting around the nucleus using the Bohr model, although they actually move in a cloud.

Q: What type of charge do electrons have?
A: Electrons are negative.

All atoms in the universe are made up of the same basic particles: the proton, the neutron and the electron. The different combinations of those particles combine to make different elements, which combine to make different molecules.

Periodic Table
All of the known elements are organized into a table called the **Periodic Table of Elements**. Each box on the Periodic Table represents an element, organized according to its atomic number and atomic mass. Each element is represented by a letter, or letters, which is its **atomic symbol**. Generally, the symbol is the first one or two letters of the element’s name, although several elements’ symbols come from their name in Latin. Some elements have names that relate to famous scientists or where it was discovered.

Point out some of the names of the elements, specifically:

- *Sodium (Na, #11) – name comes from the Latin “Natrium”*
- *Copper (Cu, #29) – name comes from the Latin “Cuprum”*
- *Einsteinium (Es, #99) – named after Albert Einstein*
- *Berkelium (Bk, #97) and Californium (Cf, #98) – named after the Berkeley, California lab where they were discovered.*

Elements have a specific atomic configuration and properties. Each element has an **atomic number**, equal to the number of protons in that atom. In fact, the number of protons in an atom determines what element it is.

Q: How is the Periodic Table arranged with respect to the number of protons an atom has?
A: The Periodic Table is arranged in increasing Atomic Number, which corresponds to an increasing number of protons in each element.

Q: How many elements are there?
A: As of 2024, there are 118 known elements. 90 of the elements occur naturally in appreciable amounts. 8 elements occur in trace amounts naturally. The remaining elements are known as ‘synthetic elements’ that have been created in laboratories.

History lesson: Dmitri Mendeleyev

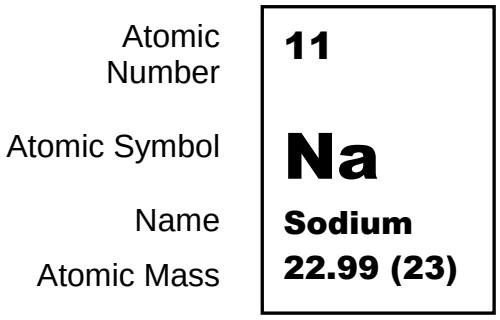
In 1869, Dmitri Mendeleyev was credited with putting together the Periodic Table of Elements. He listed all the known elements and grouped them together based on their properties. Mendeleyev was able to organize the table in its present form even though many of the elements hadn’t been discovered yet. Although Mendeleev is credited with developing the Periodic Table, many scientists contributed to its development. The organization was done in such a way that as new elements have been discovered, they fit right where they are supposed to on the Periodic Table. It is no coincidence that once the periodic table was arranged by atomic number, the elements that were close to one other ended up having very similar properties.

The elements in the Periodic Table are arranged according to their atomic structure. We can determine the number of protons, neutrons, and electrons in an atom by looking at the information given in the Periodic Table.

Sodium

Let’s look at a familiar element, sodium.
Q: What is the atomic number for sodium?
A: Sodium has an atomic number of 11.

Q: How many protons does it have?
A: Sodium has eleven protons; eleven is the Atomic Number, which is equal to the number of protons.



The number of protons plus the number of neutrons equals the Atomic Mass of an element, because each one is approximately equal to one Atomic Mass Unit (AMU). The mass of the electrons is negligible because they are so small.

Q: If the number of protons as well as the Atomic Mass of an element is known, how can the number of neutrons be determined?
A: The number of neutrons can be determined by subtracting the number of protons from the Atomic Mass (rounded to the nearest whole number).

Q: What is the atomic mass of sodium?
A: The atomic mass of sodium is 22.99 (whole number = 23)

Q: How many neutrons does the sodium atom have?
A: The sodium atom has twelve neutrons. Subtract the Atomic Number (11) from the Atomic Mass (23) to get 12.

Q: In order for the charge of the atom to be balanced, how many electrons does an atom have?
A: An atom must have the same number of electrons (negative charge) as protons (positive charge) in order for it to be balanced. The atom will have no overall charge.

Q: How many electrons does the sodium atom have?
A: The sodium atom has eleven electrons to balance the 11 protons.

Conclusion – Level 1

Everything in the world is made up of atoms.

Q: What determines how atoms and molecules are structured?
A: The arrangement of the sub-atomic particles in the atom; the electrons, protons, and neutrons.

Q: What cannot be changed about an atom?
A: The number of protons. Each atom has a unique and specific number of protons. The number of protons cannot be changed through any chemical reaction.

The arrangement of sub-atomic particles within each atom determines not only what type of element it is, but how it combines to form molecules and how it reacts in the physical world. The makeup of the entire world is dependent on the configuration of individual atoms. Understanding the chemistry and physics of the atom helps us understand our world.

This concludes information on the Slide Deck for Level 1. The next sections reference information contained in Slide Decks Level 2 & 3.

Orbitals – Level 2

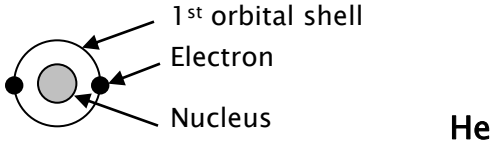
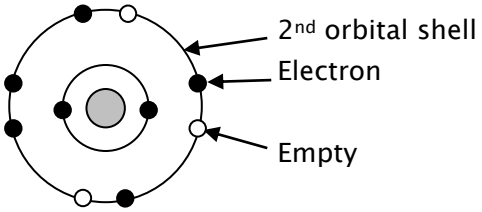
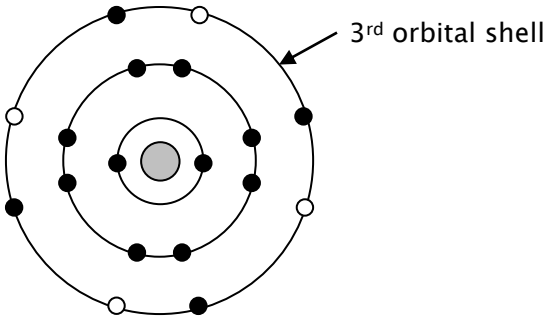
The following information involves a more in-depth explanation of Elements and the Periodic Table. Individual lesson objectives will determine if the following material is appropriate.

The rows of the Periodic Table are called **periods** and correspond to how the electrons are grouped for the elements in that row. *Point out the periods on the Periodic Table.*

Orbital Shells & Periods

The electrons are arranged in **orbital shells** around the nucleus, with specific patterns of electrons in each shell. This arrangement helps determine how different atoms and elements bond together to become molecules and compounds.

Elements in any one period are only similar because they have the same number of orbitals. They do not typically have other similar characteristics. The number of the period is the same as the number of orbitals for those elements.

Period 1 elements fill electrons in the 1st orbital shell.	
Period 2 elements fill electrons in the 2nd orbital shell. The 1st shell is full.	
Period 3 elements fill electrons in the 3rd orbital shell. The 1st & 2nd shells are full.	

Refer to the Periodic Table, pointing out lithium, carbon and oxygen.
Q: What Period are these elements in, and how many orbital shells would each atom have?
A: Each element in this group is in Period 2, and so each atom has two orbital shells.

Gold has the chemical symbol of Au. *Have the students find Au on the Periodic Table.*
Q: How many orbital shells does it have and why?
A: It has six orbital shells because it is in Period 6.

Groups

The columns of the Periodic Table are called **groups**.

Point out the groups on the Periodic Table.

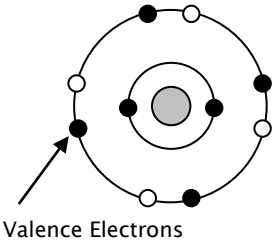
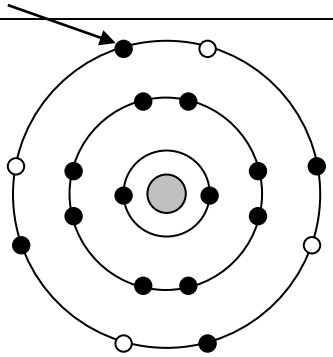
Elements in the same group typically have similar chemical properties, which has to do with the similar configuration of the electrons for those elements. Each element in a group has the same number of electrons in its outermost orbital, which makes them have similar bonding characteristics.

Some Periodic Tables have elements in different colors.
Q: Is there a pattern to the color arrangements of the elements on the Periodic Table?
A: Yes, in most cases the elements that are the same color are adjacent to each other. The most notable patterns are the two columns on the far right of the Periodic Table.
Q: What do you think this represents?
A: Elements in the same group have the most similar properties. The elements in the last two groups have very similar properties to each other, but properties that are very different than the rest of the elements.

Valence Electrons
The electrons in the outermost orbital are called **valence electrons.** The group number tells you how many valence electrons an element has. Each shell can only hold a certain number of electrons. The first shell only holds two electrons, and the next shells hold eight.

Refer to the Periodic Table.
Look at carbon and silicon on the Periodic Table.
Q: What group number are they in?
A: They are in group IV, or 4.

Q: How many valence electrons would each element have, since they are in group IV?
A: There are four valence electrons in the outermost orbital shell of those elements, and all other elements in that Group.

Element	Group IV
6 C Carbon	
14 Si Silicon	

Atoms are in their most stable state when they have a full outer shell. In order to maintain a full outer shell, atoms will gain or lose electrons. Since most of the outer shells hold eight electrons, this is called the **octet rule**, because the atom wants to have a full octet (eight) of electrons. This rule, or the potential to gain or lose an electron to maintain a full shell, is what governs how elements combine with one another.

Ions and Isotopes – Level 3

A neutral atom is an atom with an equal number of electrons and protons, which is equal to the atomic number. Atoms can be altered by changing the number of neutrons or electrons. The number of protons does not change. The number of protons is the identifying characteristic of each atom.

Ions

Ions are atoms with extra electrons or missing electrons. The atom's electron configuration determines if it is an ion. Two examples of elements that form ions are sodium (Na) and chlorine (Cl), which form an ionic bond to make Sodium Chloride, or table salt.

Q: Sodium loses an electron to bond with chlorine. Does it become a positive or a negative ion?
A: It becomes positive because it lost a negative charge and is noted Na+.

Q: What happens to chlorine with a bond to the sodium ion?
A: Chlorine gains an electron, becoming a negative ion noted as Cl-.

Isotopes

Some elements have **isotopes** of that element. An isotope of an element has the same number of protons (and electrons) as that element, but a different number of neutrons. If you change the number of **protons** an atom has, you change what element it is. If you change the number of **neutrons** an atom has, you make an isotope of that element. Carbon is an example of this. Carbon has an isotope called Carbon-14 (C-14), which is used to "carbon-date" organic objects.

Q: Based on the atomic number and atomic mass of carbon, how many neutrons does it have in its neutral state?
A: Carbon has 6 neutrons in its neutral state.

Carbon-14 has **8** neutrons, or 2 more than "regular" or **elemental** carbon.

Q: Why is it called **carbon-14**?
A: The **14** is the total number of protons **and** neutrons, or 6 + 8. Isotopes are noted in this way.

Molecules – Level 3

Atoms, Molecules, Matter

Atoms are the building blocks of molecules, and molecules are the building blocks of matter. Molecules are extremely small. In one spoonful of sugar there are approximately 300 billion, billion molecules of sugar! Molecules can be made up of atoms of the same element, or molecules can be made up of a combination of atoms of different elements.

Q: What is the name of a molecule that is made up of atoms of the same element?
A: There are a few: Hydrogen (H_2), oxygen (O_2) and nitrogen (N_2).

Single element molecules

A molecule is formed when two or more atoms join together chemically. Combinations of two or more elements are called **compounds**. All compounds are molecules but not all molecules are compounds. Molecules can also join together to form larger molecules.

Q: Name a molecule that is also a compound, or is made up of atoms of different elements.
A: The most familiar answers will be water (H_2O), carbon dioxide (CO_2) or salt (NaCl).

Compounds

Look at the model of the water molecule. It is noted as H_2O. Since it is made up of more than one element, it is also a compound.

Q: What does the “2” represent in the formula for water?
A: There are two hydrogen atoms for every one oxygen atom in a molecule of water.

The molecular formula for table sugar is $C_{12}H_{22}O_{11}$. *Write this compound formula on the board.*

Q: What are the different elements in this compound?
A: Carbon, hydrogen and oxygen.

Q: How many atoms of each element are in the compound?
A: There are 12 carbon atoms, 22 hydrogen atoms, and 11 oxygen atoms.

This is how combinations of elements are noted in compounds; the element symbols followed by the number of atoms of that element in that compound. The number of atoms in the combination is determined by how the atom is structured – but that is a future topic!

ATOMS ACTIVITIES

The remainder of this document contain the following for each activity:

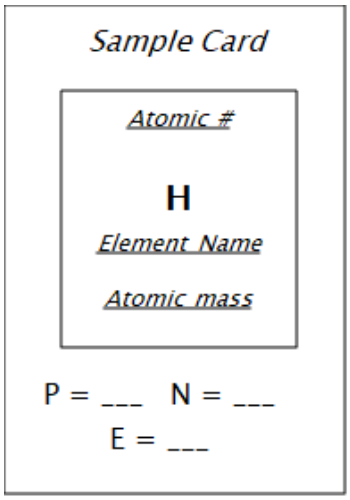
- instructions
- student papers
- answer keys

Activities:

- Level 1
  - Elements
  - Atoms
- Level 2
  - Orbitals
- Level 3
  - Molecules
  - Ions & Isotopes

NOTE: the individual printable Activity Papers can be found in the directory

Elements Activity – Level 1



Divide the students into groups of 4 or 5 and distribute the "Periodic Table" cards – Appendix E evenly to each group. Give each student a "Periodic Table" activity sheet – Appendix F. Write the color key and the card pattern (given below) on the board. Students will need a Periodic Table – Appendix I to do this activity.

Step 1: The card has an element box with a chemical symbol on it. Complete the information in the Element box by filling in the atomic number, element name & atomic mass.

Step 2: Determine the number of protons, neutrons and electrons for each element. Write it in the appropriate place on the card.

Step 3: Color the element box on the card according to the key:

White	Green	Pink	Blue	Purple	Orange	Red	Tan	Yellow
H	Li	O	Be	F	B	C	N	He
	Na	S	Mg	Cl	Al	Si	P	Ne
								Ar

Step 4: Arrange the cards in whatever pattern makes the most sense.

Discuss with the students their reasons for choosing the pattern they did. Then have them rearrange their cards in the following pattern and glue them on the construction paper. Have them notice how this is similar (or different from) the pattern on the Periodic Table.

H							**He**
Li	**Be**	**B**	**C**	**N**	**O**	**F**	**Ne**
Na	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**	**Ar**

Step 5: Answer the questions on the activity sheet using the information on your Periodic Table that you made. Discuss the answers to the questions with the students, asking different members of the group to explain a different question.

This activity is adapted from "Periodic Table Basics" taken from "The Science Spot" by T. Trimpe: http://www.sciencespot.net/

Periodic Table Cards

Sample Card *1* **H** *Hydrogen* *1.00* P = 1 N = 0 E= 1	___ **H** _____ _____ P = ___ N = ___ E=___	___ **He** _____ _____ P = ___ N = ___ E=___	___ **Li** _____ _____ P = ___ N = ___ E=___	___ **Be** _____ _____ P = ___ N = ___ E=___
___ **B** _____ _____ P = ___ N = ___ E=___	___ **C** _____ _____ P = ___ N = ___ E=___	___ **N** _____ _____ P = ___ N = ___ E=___	___ **O** _____ _____ P = ___ N = ___ E=___	___ **F** _____ _____ P = ___ N = ___ E=___

Periodic Table Cards

___ **Ne** _____ _____ P = ___ N = ___ E=___	___ **Na** _____ _____ P = ___ N = ___ E=___	___ **Mg** _____ _____ P = ___ N = ___ E=___	___ **Al** _____ _____ P = ___ N = ___ E=___	___ **Si** _____ _____ P = ___ N = ___ E=___
___ **P** _____ _____ P = ___ N = ___ E=___	___ **S** _____ _____ P = ___ N = ___ E=___	___ **Cl** _____ _____ P = ___ N = ___ E=___	___ **Ar** _____ _____ P = ___ N = ___ E=___	___ **H** _____ _____ P = ___ N = ___ E=___

Periodic Table Activity sheet

Use the periodic table you made to answer each question

1. How are the atomic numbers and the atomic masses of the elements related to how the elements are arranged on the Periodic Table?

2. How does the number of electrons relate to the arrangement? What is the difference in the number of electrons in a 3rd period element and the 2nd period element above it?

3. Do some elements next to each other have the same number of neutrons? How is that possible?

4. How are the colors arranged, and what conclusions can be drawn from this arrangement?

Referring to the table below, write the name and number of the group above each color group on the periodic table you made.

Green	**Blue**	**Orange**	**Red**	**Tan**	**Pink**	**Purple**	**Yellow**
Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Alkali Metals	Alkaline Earth Metals	Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halides	Noble Gases

1. Compare the location of the **Metals** groups in relation to the **Noble Gases** group. What is the significance of their locations on the Periodic Table?

2. Which groups have names that help you to remember where certain elements are located?

Atoms Activity – Level 1

Refer to the "Atom Models" picture – Appendix A and the Periodic Table – Appendix I for this activity. Review with the students the basics of the atomic structure, including the names of the parts of an atom and their charges, the basis of what makes an element (number of protons), and how to determine the number of sub-atomic elements in an element.

Pass out the "Atoms" activity sheets – Appendix B, one to each student. Have students fill out their activity sheets to determine the numbers of sub-atomic particles in each atom on the activity sheet.

Through this activity, we will be exploring the basic building blocks of atoms.

Step 1: Determine the number of sub-atomic particles in each atom and complete the activity sheet.

Next have the students use the marshmallows to choose one of the atoms to build a model of.

Step 2: Construct a helium atom model. Start with the nucleus. The large colored marshmallows are the protons, and the large white marshmallows are the neutrons. Connect the nucleus marshmallows together using toothpicks.

Step 3: Use small colored marshmallows for the electrons. Attach the proper number of electrons to the nucleus using the toothpicks.

Step 4: Construct additional atom models if there is time.

It will be required to build a Lithium or Beryllium atom to do the Ion/Isotope Extension activity.

When the students have completed their models, find two of the models that are of the same element, but look different. Point out to the students that although the models look quite different, it can be determined what atom is represented by counting the number of large colored marshmallows, because those represent the protons. Emphasize that no matter how many neutrons or electrons are on the model, it is the number of protons that determine what the atom is.

Ions & Isotopes Activity – Level 3

A neutral atom is an atom with an equal number of electrons and protons, which is equal to the atomic number. The atoms you constructed in the Level 1 activity with marshmallows are neutral atoms and have no net charge. Atoms can be altered by changing the number of neutrons or electrons.

Ions

Ions are atoms with extra electrons or missing electrons. The atom's electron configuration determines if it is an ion.

Step 1: Construct a lithium atom with the marshmallows. (see Level 1 Atoms Activity instructions)

Step 2: Turn it into an ion by removing (or adding) an electron.

Step 3: Record the information on the Atoms: Ions/Isotopes activity sheet.

Isotopes

Some elements have **isotopes** of that element. An isotope of an element has the same number of protons (and electrons) as that element, but a different number of neutrons. If you change the number of **protons** an atom has, you change what element it is. If you change the number of **neutrons** an atom has, you make an isotope of that element. Carbon is an example of this. Carbon has an isotope called Carbon-14 (C-14), which is used to "carbon-date" organic objects.

Step 1: Take either the lithium or the beryllium atom you made and add or subtract a neutron to make an isotope.

Step 2: Record the information on the "Atoms: Ions/Isotopes" activity sheet.

Beryllium, Be, Atomic number 9, has 4 protons and 5 neutrons. To make "Be-10," you need to add one neutron to the model of the Beryllium atom.

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ATOMS

Refer to a Periodic Table and the Key below to fill out this table for each element. Start with helium as your first atom to make.

1. Fill out the table below with the correct values.
2. Assemble the nucleus using the proper number of large colored and white marshmallows, sticking them together with toothpicks.
3. Select the proper number of small colored marshmallows (all one color) as your electrons. Attach them one at a time to the nucleus with toothpicks, away from the nucleus.

ATOM	**ATOMIC SYMBOL**	**ATOMIC NUMBER**	**NUMBER OF PROTONS** (see key)	**ATOMIC MASS (ROUNDED)**	**NUMBER OF NEUTRONS** (see key)	**NUMBER OF ELECTRONS** (see key)
Hydrogen	***H***	***1***	***1***	***1.00***	***0***	***1***
Helium						
Lithium						
Beryllium						

Atomic Number
Atomic Symbol
Name
Atomic Mass

1
H
Hydrogen
1.00794

KEY

Number of Protons = Atomic Number
(Use the large colored marshmallows for protons)
Number of Neutrons = Subtract Atomic Number from Atomic Mass
(Use the large white marshmallows for neutrons)
Number of Electrons = Number of Protons
(Use the small colored marshmallows for electrons**)**

Name: _____

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ATOMS: Ions & Isotopes

Refer to a Periodic Table and the Key below to fill out this table for each element.

3. Assemble the nucleus using the proper number of large colored and white marshmallows. Stick them together with toothpicks.
4. Select the proper number of small colored marshmallows (all one color) as your electrons. Attach them one at a time to the nucleus with toothpicks.
5. Turn the lithium atom into an ion and note the information.
6. Turn either the lithium atom or the beryllium atom into an isotope. Record what you did.

ATOM	**ATOMIC SYMBOL**	**ATOMIC NUMBER**	**NUMBER OF PROTONS** (see key)	**ATOMIC MASS**	**NUMBER OF NEUTRONS** (see key)	**NUMBER OF ELECTRONS** (see key)
Lithium						
Beryllium						
Lithium Ion						
Isotope: _____						

Atomic Number	**3**
Atomic Symbol	**Li**
Name	**Lithium**
Atomic Mass	**7**

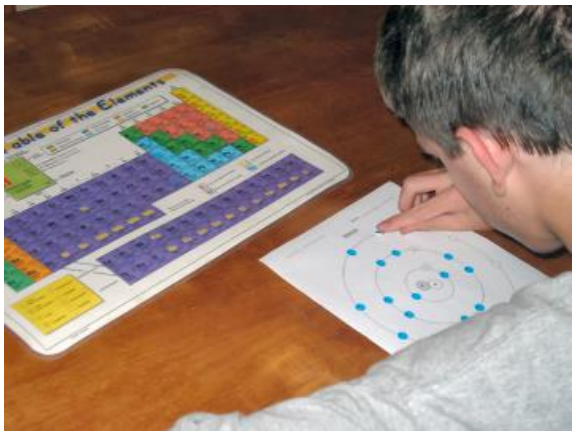
KEY

Number of Protons = Atomic Number
Number of Neutrons = Subtract Atomic Number from Atomic Mass
Number of Electrons = Number of Protons
Ions: Add or subtract an electron from the element
Isotope: Add or subtract a neutron from the element

Orbitals Activity – Level 2

Materials for this activity include "Orbitals" activity sheets – Appendix G and small round stickers divided by colors (or different colored markers), one color per group. You will need to refer to the Periodic Table for this activity.

Give each student an activity sheet and a sheet of sticker dots (all one color) or a colored marker. Assign each student one of the elements listed below.



Elements: Li, B, N, F, Mg, Si, S, Ar

If there are more than 8 students in the group, also assign He, Na, P, Cl.

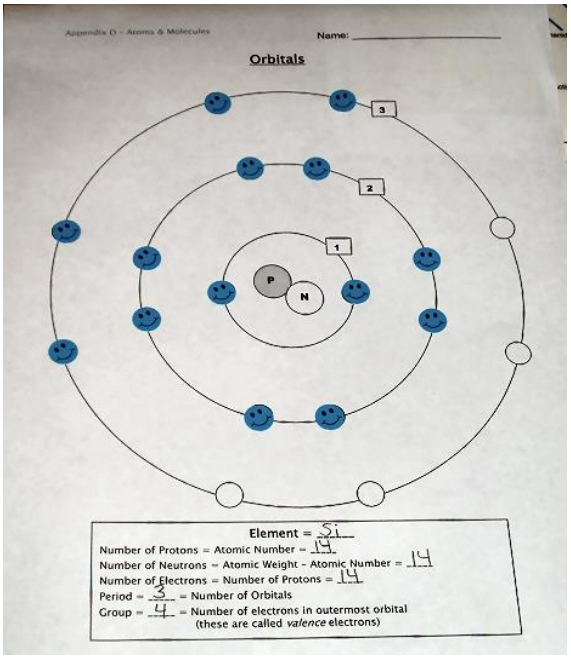
Step 1: Write down the name of the element you were assigned.

Step 2: Determine the Atomic number, Atomic mass (rounded), and the number of protons, neutrons and electrons for the element. Record it on your activity sheet.

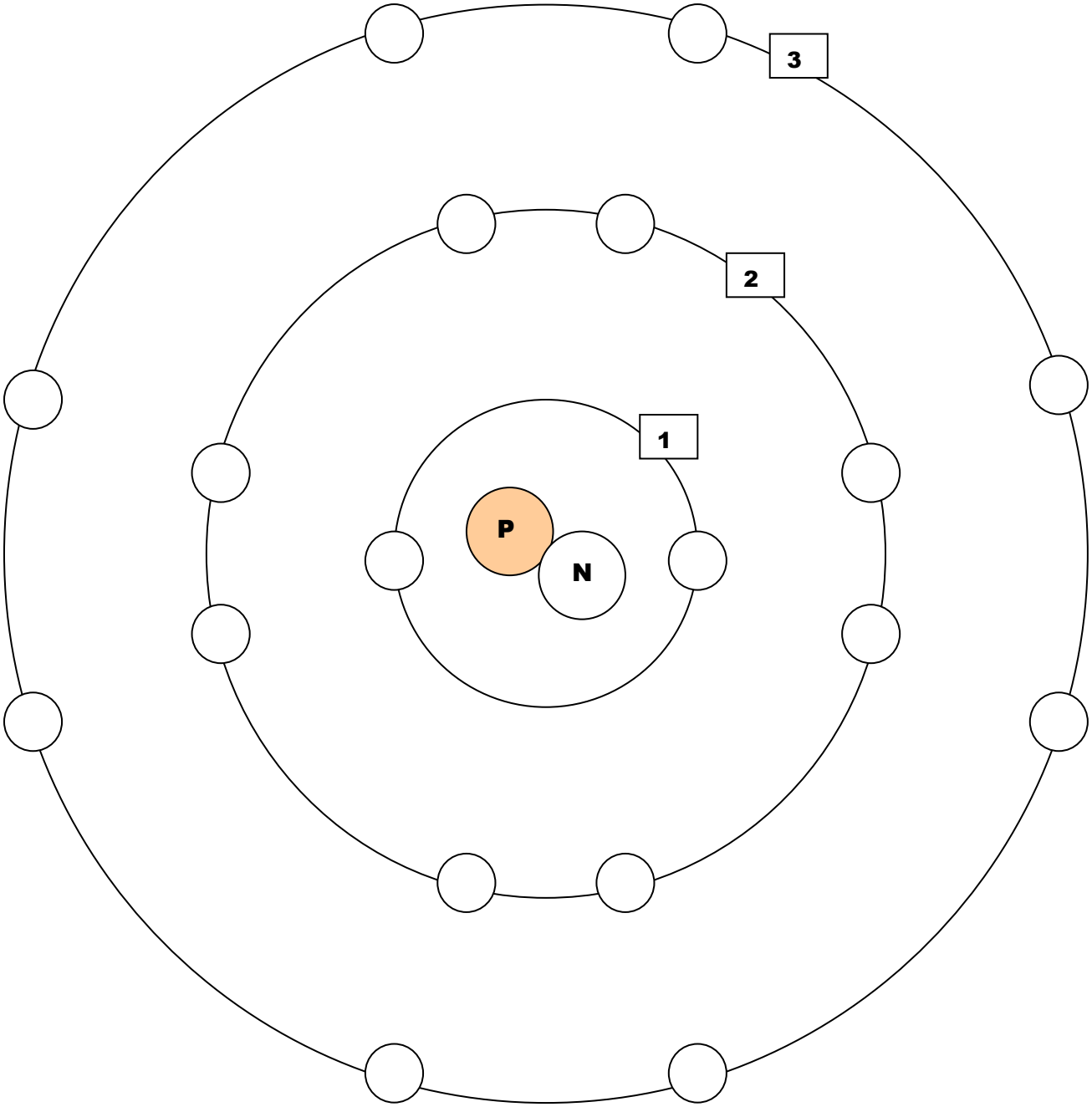
Step 3: Fill in the period number of the element. This is how many orbitals it has.

Step 4: Fill in the group number of the element. This is how many electrons are in the outermost orbital.

Step 5: Starting at the innermost orbital, put stickers on (or color in) the circles corresponding to the total number of electrons. You must fill up one orbital before moving to the next one.



Orbitals



Element = _____

Atomic Number = _____

Number of Protons = Atomic Number = _____

Atomic Mass (rounded to nearest whole number) = _____

Number of Neutrons = Atomic Mass – Atomic Number = _____

Number of Electrons = Number of Protons = _____

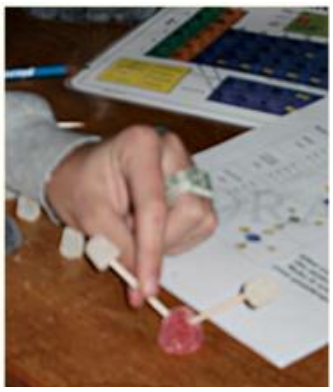
Period = _____ = Number of Orbitals

Group = _____ = Number of electrons in outermost orbital

(These are called *valence* electrons)

Molecules Activity – Level 3

Refer to the "Molecules" picture – Appendix D for this activity. Review with students the structure of molecules, noting the difference between same-element molecules, and multi-element molecules, or compounds.



Give each student a "Molecules" activity sheet. Guide the students through the activity according to the steps. When finished, compare the gumdrop models to pictures of molecules (Appendix D), or to models from a molecule kit made ahead of time.

Step 1: Color in the Molecule Color Key with colored pencils as indicated.

Step 2: Determine the number and type of elements in each molecule and write it down on the activity sheet.

Step 3: Draw the molecule models.

Step 4: Color the molecule models using the colored pencils that correspond to the Color Key.

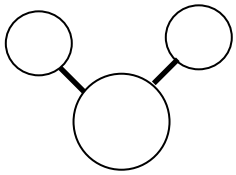
Step 5: Have each student make one of the molecule models using appropriately colored gumdrops and toothpicks.

Name: _____

micron STEM

Molecules

1. Color in the Molecule Color Key molecules with colored pencils as indicated.
2. Determine the number of elements in each molecule and write it down.
3. Draw and color the molecule with the correct number of elements.
4. Make each molecule model using appropriately colored gumdrops and toothpicks.

Molecule	Elements	Draw It!
Water **H_2O**	**H** = _____ **O** = _____ **N** = _____ **C** = _____	
Carbon Dioxide **CO_2**	**H** = _____ **O** = _____ **N** = _____ **C** = _____	
Ammonia **NH_3**	**H** = _____ **O** = _____ **N** = _____ **C** = _____	
Methane **CH_4**	**H** = _____ **O** = _____ **N** = _____ **C** = _____	

Molecule Color Key

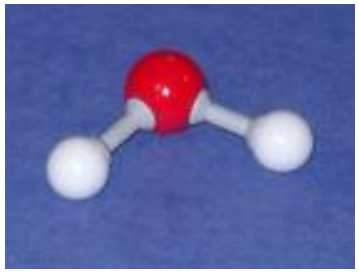
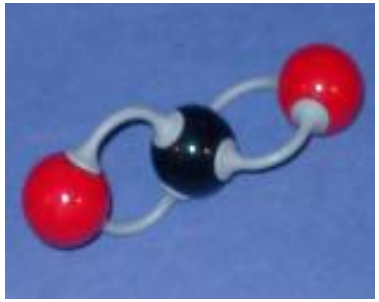
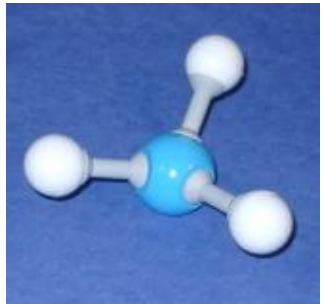
Hydrogen
(yellow)

Oxygen
(red)

Nitrogen
(green)

Carbon
(black)

Molecule Pictures

			
H_2 (Hydrogen)	O_2 (Oxygen)	N_2 (Nitrogen)	NaCl (Salt)
			
H_2O (Water)	CO_2 (Carbon Dioxide)	NH_3 (Ammonia)	CH_4 (Methane)

ATOMS – *Answer Key*

Refer to a Periodic Table and the Key below to fill out this table for each element. Start with helium as your first atom to make.

1. Fill out the table below with the correct values.
2. Assemble the nucleus using the proper number of large colored and white marshmallows. Stick them together with toothpicks.
3. Select the proper number of small colored marshmallows (all one color) as your electrons. Attach them one at a time to the nucleus with toothpicks.

ATOM	ATOMIC SYMBOL	ATOMIC NUMBER	NUMBER OF PROTONS	ATOMIC MASS (ROUNDED)	NUMBER OF NEUTRONS (MASS – ATOMIC NUMBER)	NUMBER OF ELECTRONS
Hydrogen	***H***	***1***	***1***	***1.00***	***0***	***1***
Helium	*He*	*2*	*2*	*4.00*	*2*	*2*
Lithium	*Li*	*3*	*3*	*7.00*	*4*	*3*
Beryllium	*Be*	*4*	*4*	*9.00*	*5*	*4*

Atomic Number
Atomic Symbol
Name
Atomic Mass

1

H

Hydrogen

1.00794 (1)

KEY

Number of Protons = Atomic Number
(Use the large colored marshmallows for protons)
Number of Neutrons = Atomic Mass – Atomic Number
(Use the large white marshmallows for neutrons)
Number of Electrons = Number of Protons
(Use the small colored marshmallows for electrons**)**

ATOMS: Ions & Isotopes – *Answer Key*

Refer to a Periodic Table and the Key below to fill out this table for each element.

1. Assemble the nucleus using the proper number of large colored and white marshmallows. Stick them together with toothpicks.
2. Select the proper number of small colored marshmallows (all one color) as your electrons. Attach them one at a time to the nucleus with toothpicks.
3. Turn the lithium atom into an ion, and note the information.
4. Turn either the lithium atom or the beryllium atom into an isotope. Record what you did.

ATOM	ATOMIC SYMBOL	ATOMIC NUMBER	# PROTONS	ATOMIC MASS	# NEUTRONS	# ELECTRONS
Lithium	*Li*	*3*	*3*	*7.00*	*4*	*3*
Beryllium	*Be*	*4*	*4*	*9.00*	*5*	*4*
Lithium Ion	*Li+*	*3*	*3*	*7.00*	*4*	*2*
Isotope: *Be*	*Be 10*	*4*	*4*	*---*	*6*	*4*

Atomic Number	**3**
Atomic Symbol	**Li**
Name	**Lithium**
Atomic Mass	**7**

KEY

Number of Protons = Atomic Number
Number of Neutrons = Atomic Mass – Atomic Number
Number of Electrons = Number of Protons
Ions: Add or subtract an electron from the element
Isotope: Add or subtract a neutron from the element

Periodic Table Cards – *ANSWER KEY*

Pg. 1 of 2

Sample Card *Atomic #* H *Element Name* *Atomic mass* P = ___ N = ___ E=___	1 H Hydrogen 1.00 P = 1 N = 0 E =1	2 He Helium 4.00 P = 2 N = 2 E = 2	3 Li Lithium 7.00 P = 3 N = 4 E = 3	4 Be Beryllium 9.00 P = 4 N = 5 E = 4
5 B Boron 11.00 P = 5 N = 6 E = 5	6 C Carbon 12.00 P = 6 N = 6 E = 6	7 N Nitrogen 14.00 P = 7 N = 7 E = 7	8 O Oxygen 16.00 P = 8 N = 8 E = 8	9 F Fluorine 19.00 P = 9 N = 10 E = 9

Periodic Table Cards – *ANSWER KEY*

10 **Ne** Neon 20.00 P = 10 N = 10 E = 10	11 **Na** Sodium 23.00 P = 11 N = 12 E = 11	12 **Mg** Magnesium 24.00 P = 12 N = 12 E = 12	13 **Al** Aluminum 27.00 P = 13 N = 14 E = 13	14 **Si** Silicon 28.00 P = 14 N = 14 E = 14
15 **P** Phosphorus 31.00 P = 15 N = 16 E = 15	16 **S** Sulfur 32.00 P = 16 N = 16 E = 16	17 **Cl** Chlorine 35.00 P = 17 N = 18 E = 17	18 **Ar** Argon 40.00 P = 18 N = 22 E = 18	1 **H** Hydrogen 1.00 P = 1 N = 0 E = 1

Periodic Table Activity sheet – *Answer key*

Use your periodic table to answer each question

1. How are the atomic numbers and the atomic masses of the elements related to how the elements are arranged on the Periodic Table?

The elements are arranged in increasing atomic number, which also corresponds to increasing atomic mass.

2. How does the number of electrons relate to the arrangement? What is the difference in the number of electrons in a 3rd period element and the 2nd period element above it?

The elements are arranged in increasing number of electrons. Each element in the 3rd row has eight more electrons than the element above it in the 2nd row.

3. Do some elements next to each other have the same number of neutrons? How is that possible?

Yes, some of the elements next to each other have the same number of neutrons, but they are different elements because they have a different number of protons.

4. How are the colors arranged, and what conclusions can be drawn from this arrangement?

The colors line up in columns. The elements in each column have similar properties. Elements are organized into families (groups) according to their physical and chemical properties. Notice that the elements that are the same color fall into the same group.

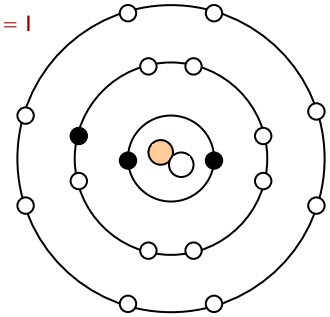
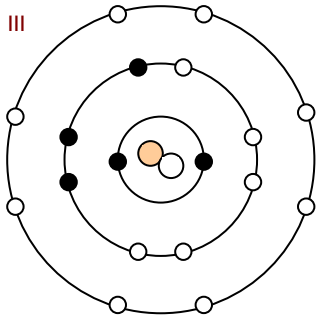
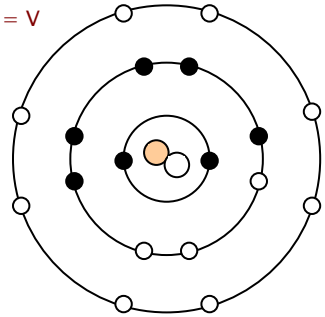
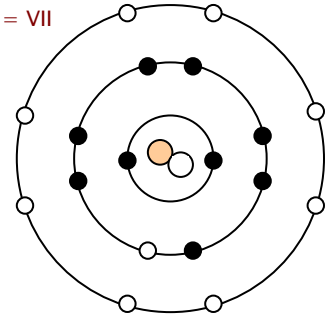
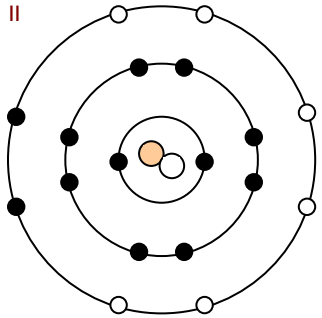
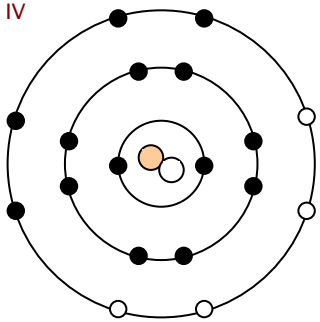
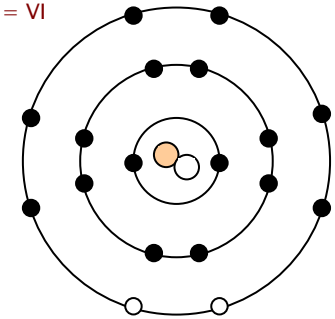
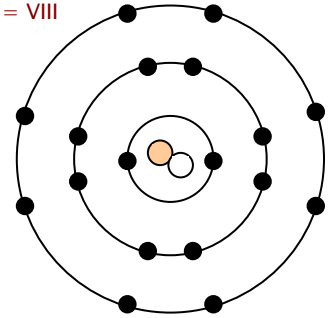
5. Compare the location of the **Metals** groups in relation to the **Noble Gases** group. What is the significance of their locations on the Periodic Table?

The Metals groups are on the far left of the Table, and the Noble Gases are on the far right. There is a very big difference in the structure of the elements from one side of the Table to the other.

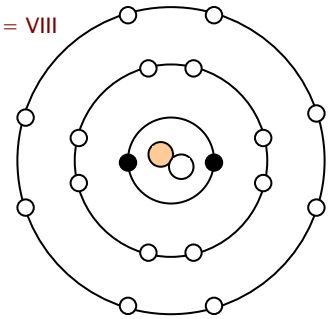
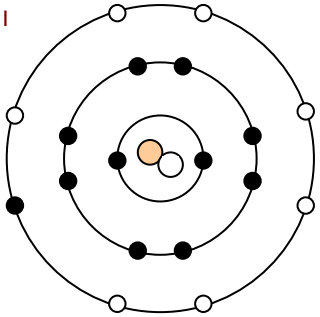
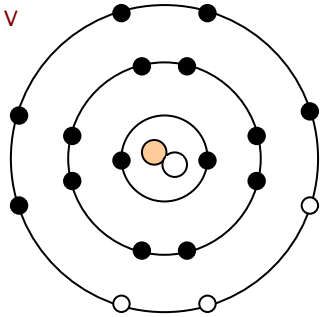
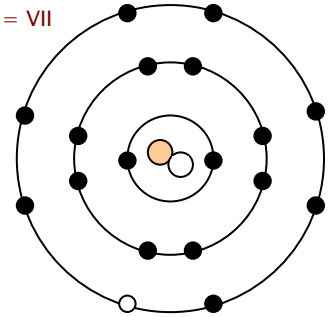
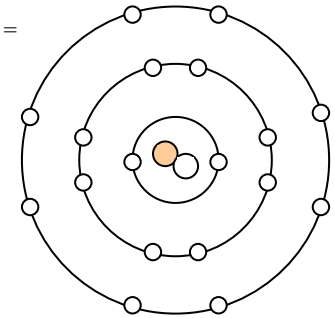
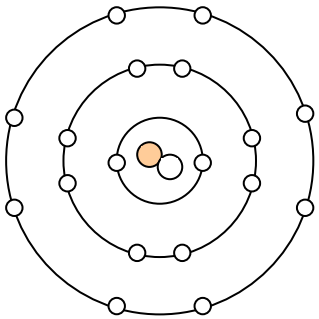
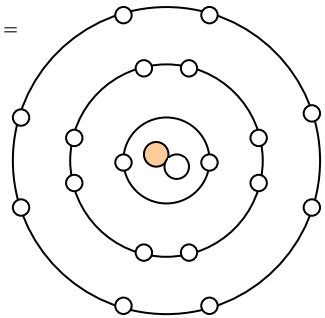
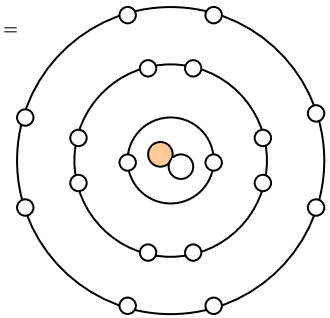
6. Which groups have names that help you to remember where certain elements are located?

Groups III, IV, V and VI are all named after the element at the top of the group. Knowing the names of these groups helps to locate where those elements are on the Periodic Table.

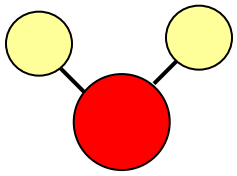
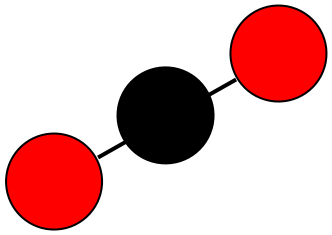
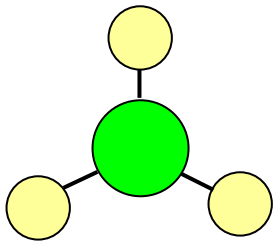
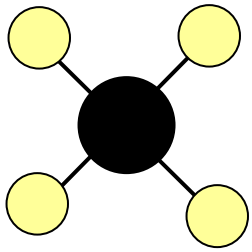
Orbital Shell Cards – Answer Key (pg. 1 of 2)

Element = Li (Lithium) Atomic Number = 3 Atomic Mass = 6.9 Number of Protons = 3 Number of Neutrons = 7 Number of Electrons = 3 Period = 2 Group = I 	**Element = B (Boron)** Atomic Number = 5 Atomic Mass = 10.8 Number of Protons = 5 Number of Neutrons = 6 Number of Electrons = 5 Period = 2 Group = III 	**Element = N (Nitrogen)** Atomic Number = 7 Atomic Mass = 14.4 Number of Protons = 7 Number of Neutrons = 7 Number of Electrons = 7 Period = 2 Group = V 	**Element = F (Fluorine)** Atomic Number = 9 Atomic Mass = 18.99 Number of Protons = 9 Number of Neutrons = 10 Number of Electrons = 9 Period = 2 Group = VII 
Element = Mg (Magnesium) Atomic Number = 12 Atomic Mass = 24.3 Number of Protons = 12 Number of Neutrons = 12 Number of Electrons = 12 Period = 3 Group = II 	**Element = Si (Silicon)** Atomic Number = 14 Atomic Mass = 28.1 Number of Protons = 14 Number of Neutrons = 14 Number of Electrons = 14 Period = 3 Group = IV 	**Element = S (Sulfur)** Atomic Number = 16 Atomic Mass = 32.1 Number of Protons = 16 Number of Neutrons = 16 Number of Electrons = 16 Period = 3 Group = VI 	**Element = Ar (Argon)** Atomic Number = 18 Atomic Mass = 39.9 Number of Protons = 18 Number of Neutrons = 22 Number of Electrons = 18 Period = 3 Group = VIII 

Orbital Shell Cards – Answer Key (pg. 2 of 2)

Element = He (Helium) Atomic Number = 2 Atomic Mass = 4.0 Number of Protons = 2 Number of Neutrons = 2 Number of Electrons = 2 Period = 1 Group = VIII 	**Element = Na (Sodium)** Atomic Number = 11 Atomic Mass = 22.99 Number of Protons = 11 Number of Neutrons = 12 Number of Electrons = 11 Period = 3 Group = I 	**Element = P (Phosphorus)** Atomic Number = 15 Atomic Mass = 30.99 Number of Protons = 15 Number of Neutrons = 16 Number of Electrons = 15 Period = 3 Group = V 	**Element = Cl (Chlorine)** Atomic Number = 17 Atomic Mass = 35.45 Number of Protons = 17 Number of Neutrons = 18 Number of Electrons = 17 Period = 3 Group = VII 
Element = Atomic Number = Atomic Mass = Number of Protons = Number of Neutrons = Number of Electrons = Period = Group = 	**Element =** Atomic Number = Atomic Mass = Number of Protons = Number of Neutrons = Number of Electrons = Period = Group = 	**Element =** Atomic Number = Atomic Mass = Number of Protons = Number of Neutrons = Number of Electrons = Period = Group = 	**Element =** Atomic Number = Atomic Mass = Number of Protons = Number of Neutrons = Number of Electrons = Period = Group = 

Molecules - Answer Key

Molecule	Elements	Draw It!
Water H_2O	H = 2 O = 1 N = 0 C = 0	
Carbon Dioxide CO_2	H = 0 O = 2 N = 0 C = 1	
Ammonia NH_3	H = 3 O = 0 N = 1 C = 0	
Methane CH_4	H = 4 O = 0 N = 0 C = 1	

Molecule Color Key

Hydrogen (yellow)

Oxygen (red)

Nitrogen (green)

Carbon (black)

Print a Periodic table of Elements. Some options below:

https://www.periodni.com/
https://www.acs.org/education/whatischemistry/periodictable.html

micron

STEM

micron