



# NAME THAT MOLECULE CHALLENGE



## SCIENCE LESSON MOLECULAR STRUCTURES

Everything around us is made up of molecules. A molecule is a group of two or more atoms of the same or different element bonded together. We can't see molecules without a powerful microscope, so scientists use a variety of models to showcase their properties.

### FOR THE CLASSROOM

POSSIBLE APPROACH  
FOR THE CLASSROOM



LESSON LENGTH  
50-60 MINUTES



OBJECTIVE  
LEARN ABOUT MOLECULES &  
MOLECULAR STRUCTURES



MATERIALS  
SEE BELOW

## VOCABULARY:

- Element
- Atom
- Molecule
- Bond
- Compound
- Molecular Formula
- Structural Formula
- Ball and Stick Model
- Perspective Drawing
- Space Filled Model



### MATERIALS

Worksheet, Computer, Internet, Toothpicks + Colored Mini Marshmallows or Ball & Stick Model Kit



### PROCEDURE

1. Download and teach the [MOLECULAR STRUCTURES SLIDE DECK](#). Feel free to customize it to suit your teaching needs.
2. Optional Student Activity #1:  
Have your students complete the [DECODING MOLECULAR FORMULAS WORKSHEET](#) and follow the steps below.
  - a. Take a look at the molecular formulas listed in your worksheet and use a periodic table and the steps below to decode what they are made of.
  - b. Step 1: Underline the Capital Letters. This will tell you how many elements are in your molecule.
  - c. Step 2: Symbols-Write the symbols the molecule has in the symbol column.
  - d. Step 3: Element Name-Use the periodic table to identify what elements the symbol represents and write the down in the element column.
  - e. Step 4: How many atoms? - Write the number of atoms of each element in the How many atoms column. If there is a small number beside the symbol, this indicates how many atoms of this element there are in the molecule. If there is NO small number beside the Atomic Symbol, it has 1 atom.
3. Optional Student Activity #2:  
Have your students complete the [BUILDING SIMPLE MOLECULES WORKSHEET](#) and follow the steps below.  
Students can work individually or in groups to build simple molecules out of molecular model sets or marshmallows and toothpicks.  
Take a look at the molecular formulas listed in your worksheet and use a periodic table and the steps on the following page to



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## LESSON PLAN CONTINUED MOLECULAR STRUCTURES



### PROCEDURE (Continued)

#### 3. Optional Student Activity #2 (Continued):

decode what they are made of.

- If using marshmallows, Oxygen is orange, Carbon is green, and Hydrogen is pink.
- Pass out a piece of paper to each student/group. Students/group should write the following key at the top of the paper "Orange=Oxygen Green=Carbon and Pink=Hydrogen"
- Students should fold the paper into 4 sections and label the sections with the following molecules: O<sub>2</sub> (Oxygen), H<sub>2</sub>O (Water), CO<sub>2</sub> (Carbon Dioxide), and CH<sub>4</sub> (Methane)
- Pass out 20 colored marshmallows and 15 toothpicks to each group.
- Have the students use their worksheets as a guide to build each of the 4 molecules in the section designated section.
- If time allots, challenge them to reuse their supplies to build other molecular structures of your choice.



### BACKGROUND INFORMATION

#### ATOMS AND ELEMENTS

Atoms are found in everything around us and are the building blocks of matter. The word "atom" comes from the Greek word "atomos" which means uncuttable or undividable. Atoms are made up of particles called protons, neutrons and electrons. The protons and neutrons make up the nucleus and the electrons buzz around the nucleus. Atoms differ from one another by the number of protons (atomic number) in the nucleus. This number tells us what element the atoms is. For example, atoms with the atomic number 1 are Hydrogen atoms.

All substances are made up of elements. There are currently 118 known elements and they can be found listed in the Periodic Table of Elements. The Periodic Table tells us the name of an element, atomic symbol, the atomic number and its properties. Hydrogen (atomic number 1) has one proton and Oganesson (atomic number 118) has 118 protons respectively.

#### MOLECULES

Even though there are 118 elements, there are over 50 million chemical substances registered with the American Chemical Society. These chemicals are molecules formed from a combination of the 118 elements. Molecules can be made from two or more atoms of the same element or different elements. For example, the oxygen (O<sub>2</sub>) molecule is made up of 2 oxygen atoms while water (H<sub>2</sub>O) molecule is made up an Oxygen and two Hydrogen atoms. When a molecule is made up of 2 or more different types of atoms, it is called a compound.

How do atoms combine to form molecules? Atoms combine by gaining, losing or sharing electrons. When atoms combine, they form bonds.

Generally speaking, we refer to molecules by their common names (ex. carbon dioxide) or their molecular formula (ex.CO<sub>2</sub>). One of the most practical ways to refer to molecules is by using their molecular formulas. Molecular formulas list the atomic symbol and numbers to show how many atoms are in a molecule. For instance, CO<sub>2</sub> has one Carbon atom and two Oxygen atoms..





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## LESSON PLAN CONTINUED MOLECULAR STRUCTURES

### BACKGROUND INFORMATION CONTINUED

#### WAYS TO VISUALIZE MOLECULES

Molecular structures consist of two or more atoms and can get pretty complex. There are many different ways we visualize them but let's take a look at the most common ways.

#### Structural Formula

The structural formula of a molecule shows how the atoms are arranged. The chemical bonding can also be shown.

#### Perspective Drawing

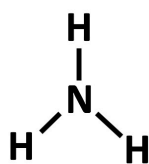
A drawing that shows the bonds to atoms going into (bolded wedge) the viewer and away (hash wedge).

#### Ball and Stick Model

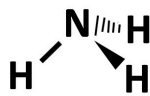
A ball and stick model of a chemical substance shows the 3D positions of the atoms and the bonds between them. The atoms are represented by spheres connected by sticks or rods representing the bond/s.

#### Space Fill Model

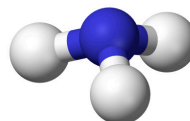
The space fill or calotte model is a 3D model where atoms and the space they take up are represented by spheres. The sphere size is typically proportionate to the size of the atom.



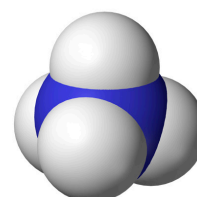
Structural  
Formula



Perspective  
Drawing



Ball and Stick  
Model



Space Fill  
Model

### ADDITIONAL MOLECULAR STRUCTURE TEACHING RESOURCES:

- What is an atom and how do we know? : <https://www.youtube.com/watch?v=LhveTGbIGHY>
- NASA Gummy Greenhouse Gas Molecules: <https://spaceplace.nasa.gov/gumdrops/en/>





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### LESSON PLAN CONTINUED

## MOLECULAR STRUCTURES



#### NEXT GENERATION SCIENCE STANDARDS

[MS-PS1-1](#) Matter and its Interactions Develop models to describe the atomic composition of simple molecules and extended structures. Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.

- **PS1.A Structure and Properties of Matter** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g. Crystals)
- **Crosscutting Concepts: Scale, Proportion, and Quantity:** Time, space and energy phenomena can be observed at various scales using models to study systems that are too small.





## SCIENCE LESSON WORKSHEET DECODING MOLECULAR FORMULAS

Molecular formulas tell us what elements and atoms are in a molecule. Learn how to decode them with help from the Periodic Table of Elements.

### HOW TO DECODE A MOLECULAR FORMULA

Use these steps to figure out what each molecules below are made of.

Take a look at the CO<sub>2</sub> sample below, then move on to the next page.

Step 1: Underline the Capital Letters. This will tell you how many elements are in your molecule.

Step 2: Symbols-Write the symbols the molecule has in the symbol column.

Step 3: Element Name-Use the periodic table to identify what elements the symbol represents and write the down in the element column.

Step 4: How many atoms? - Write the number of atoms of each element in the How many atoms column. If there is a small number beside the symbol, this indicates how many atoms of this element there are in the molecule. If there is NO small

### Molecular Formula: CO<sub>2</sub> (Carbon Dioxide)

Symbol	Element Name	How many atoms?
C	Carbon	1
O	Oxygen	2





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Use the Periodic Table of Elements to decode the following molecules.

### Molecular Formula: NH<sub>3</sub> (Ammonia)

Symbol	Element Name	How many atoms?

### Molecular Formula: CH<sub>4</sub> (Methane)

Symbol	Element Name	How many atoms?

### Molecular Formula: H<sub>2</sub>SO<sub>4</sub> (Sulfuric Acid)

Symbol	Element Name	How many atoms?





## NAME THAT MOLECULE CHALLENGE



### SCIENCE LESSON WORKSHEET BUILDING SIMPLE MOLECULES

There are more than 50 million different types of molecules. Molecules consist of two or more atoms bonded together. Scientists use a variety of different ways to visualize them including structural formulas, perspective drawings, ball and stick and space fill models.

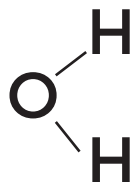
#### BUILDING SIMPLE MOLECULES

Use colored mini marshmallows and toothpicks or ball and stick model kits to build the molecules listed below. The lines represent which atoms are bonded.

1) O<sub>2</sub> (Oxygen)



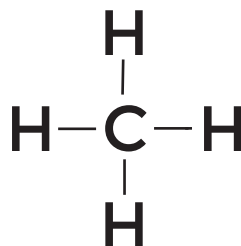
2) H<sub>2</sub>O (Water)



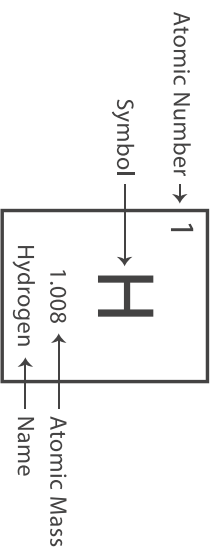
3) CO<sub>2</sub> (Carbon Dioxide)



4) CH<sub>4</sub> (Methane)



1	H Hydrogen 1.008	2	He Helium 4.002602
3	Li Lithium 6.94	4	Be Beryllium 9.0121831
11	Na Sodium 22.98976928	12	Mg Magnesium 24.305
19	K Potassium 39.0983	20	Ca Calcium 40.078
37	Rb Rubidium 85.4678	38	Sr Strontium 87.62
55	Cs Cesium 132.90545196	56	Ba Barium 137.327
87	Fr Francium 223	88	Ra Radium 226
103	Uuo Ununoctium 284	104	Rf Rutherfordium 267
109	Uue Ununennium 288	110	Ds Darmstadtium 281
115	Uup Ununpentium 289	116	Lv Livermorium 293
117	Uus Ununseptium 294	118	Rn Radon 222
118	Uuo Ununoctium 294		



21	Sc Scandium 44.955908	22	Ti Titanium 47.867	23	V Vanadium 50.9415	24	Cr Chromium 51.9961	25	Mn Manganese 54.938044	26	Fe Iron 55.845	27	Co Cobalt 58.933194	28	Ni Nickel 58.6934	29	Cu Copper 63.546	30	Zn Zinc 65.38	31	Ga Gallium 69.723	32	Ge Germanium 72.630	33	As Arsenic 74.921595	34	Se Selenium 78.971	35	Br Bromine 79.904	36	Kr Krypton 83.798		
39	Y Yttrium 88.90584	40	Zr Zirconium 91.224	41	Nb Niobium 92.90637	42	Mo Molybdenum 95.95	43	Tc Technetium 98	44	Ru Ruthenium 101.07	45	Rh Rhodium 102.90550	46	Pd Palladium 106.42	47	Ag Silver 107.8682	48	Cd Cadmium 112.414	49	In Indium 114.818	50	Sn Tin 118.710	51	Sb Antimony 121.760	52	Te Tellurium 127.60	53	I Iodine 126.90447	54	Xe Xenon 131.293		
57	La Lanthanum 138.90547	58	Ce Cerium 140.116	59	Pr Praseodymium 140.90766	60	Nd Neodymium 144.242	61	Pm Promethium 145	62	Sm Samarium 150.36	63	Eu Europium 151.964	64	Gd Gadolinium 157.25	65	Tb Terbium 158.92535	66	Dy Dysprosium 162.500	67	Ho Holmium 164.93033	68	Er Erbium 167.259	69	Tm Thulium 168.93422	70	Yb Ytterbium 173.054	71	Lu Lutetium 174.9668				
89	Ac Actinium 227	90	Th Thorium 232.037	91	Pa Protactinium 231.03588	92	U Uranium 238.02891	93	Np Neptunium 237	94	Pu Plutonium 244	95	Am Americium 243	96	Cm Curium 247	97	Bk Berkelium 247	98	Cf Californium 251	99	Es Einsteinium 252	100	Fm Fermium 257	101	Md Mendelevium 288	102	No Nobelium 259	103	Lr Lawrencium 266				

Lanthanide Series

Actinide Series

