

**Kingsborough Community College  
The City University of New York  
The Science of Nutrition Laboratory  
SCI 7000**

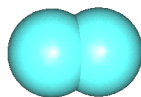
## **Building Molecules**

Elements are substances that cannot be separated into simpler substances. Salt is made up of the elements sodium and chloride. Water is made up of the elements hydrogen and oxygen.

The smallest particles of matter are called atoms. If you continually cut up a piece of aluminum, you will reach a point that you could no longer divide it. These are aluminum atoms. An atom is the smallest particle of an element that has the properties of that element. Some properties of aluminum are: shiny, silver colored, fragile, and thin. Each element has its own type of properties.

Chemists use symbols to represent elements. A symbol is a letter or picture used to represent something. Chemists use one or two letters to represent elements. The symbol for calcium is Ca. The symbol for oxygen is O.

A model of an oxygen molecule:



The symbol for oxygen is O. "O" stands for one atom of oxygen. Oxygen atoms are joined in pairs. To write a pair of oxygen atoms using symbols, we use the symbol O and the number 2. Oxygen would be (O<sub>2</sub>). The 2 is a subscript. "Sub" means "below". The 2 is written to the right of and below the O. A pair of oxygen atoms is a molecule of oxygen. A molecule is the smallest particle of a substance that exists independently. Molecules of most elements are made up of only one of atom of that element. Oxygen, along with nitrogen, hydrogen, and chlorine are made up of two atoms. Look at the model of oxygen above. The two balls represents the two oxygen molecules. The oxygen molecules are bonded or stuck together.

### **Compounds**

A compound is a substance formed when two or more elements are chemically joined. Water, salt, and sugar are examples of compounds. When the elements are joined, the atoms lose their individual properties and have different properties from the elements they are composed of. A chemical formula is used a quick way to show the composition of compounds. Letters, numbers, and symbols are used to represent elements and the number of elements in each compound.

*Source: <http://www.nyu.edu/pages/mathmol/textbook/compounds.html>*

## The Periodic Table of the Elements

|  |   |  |  |   |   |   |  |   |  |                                       |                                       |  |                                       |   |  |   |                                     |
|--|---|--|--|---|---|---|--|---|--|---------------------------------------|---------------------------------------|--|---------------------------------------|---|--|---|-------------------------------------|
| 1<br><b>H</b><br>Hydrogen<br>1.00794   |   |  |  |   |   |   |  |   |  |                                       |                                       |  |                                       |   |  |   | 2<br><b>He</b><br>Helium<br>4.003   |
| 3<br><b>Li</b><br>Lithium<br>6.941     | 4<br><b>Be</b><br>Beryllium<br>9.012182 |  |  |   |   |   |  |   |  |                                       |                                       | 5<br><b>B</b><br>Boron<br>10.811         | 6<br><b>C</b><br>Carbon<br>12.0107    | 7<br><b>N</b><br>Nitrogen<br>14.00674     | 8<br><b>O</b><br>Oxygen<br>15.9994     | 9<br><b>F</b><br>Fluorine<br>18.9984032 | 10<br><b>Ne</b><br>Neon<br>20.1797  |
| 11<br><b>Na</b><br>Sodium<br>22.989770 | 12<br><b>Mg</b><br>Magnesium<br>24.3050 |  |  |   |   |   |  |   |  |                                       |                                       | 13<br><b>Al</b><br>Aluminum<br>26.981538 | 14<br><b>Si</b><br>Silicon<br>28.0855 | 15<br><b>P</b><br>Phosphorus<br>30.973762 | 16<br><b>S</b><br>Sulfur<br>32.066     | 17<br><b>Cl</b><br>Chlorine<br>35.452   | 18<br><b>Ar</b><br>Argon<br>39.948  |
| 19<br><b>K</b><br>Potassium<br>39.0983 | 20<br><b>Ca</b><br>Calcium<br>40.078    | 21<br><b>Sc</b><br>Scandium<br>44.955910 | 22<br><b>Ti</b><br>Titanium<br>47.867      | 23<br><b>V</b><br>Vanadium<br>50.9415   | 24<br><b>Cr</b><br>Chromium<br>51.9961  | 25<br><b>Mn</b><br>Manganese<br>54.938049 | 26<br><b>Fe</b><br>Iron<br>55.845      | 27<br><b>Co</b><br>Cobalt<br>58.933200  | 28<br><b>Ni</b><br>Nickel<br>58.6934   | 29<br><b>Cu</b><br>Copper<br>63.546   | 30<br><b>Zn</b><br>Zinc<br>65.39      | 31<br><b>Ga</b><br>Gallium<br>69.723     | 32<br><b>Ge</b><br>Germanium<br>72.61 | 33<br><b>As</b><br>Arsenic<br>74.92160    | 34<br><b>Se</b><br>Selenium<br>78.96   | 35<br><b>Br</b><br>Bromine<br>79.904    | 36<br><b>Kr</b><br>Krypton<br>83.80 |
| 37<br><b>Rb</b><br>Rubidium<br>85.4678 | 38<br><b>Sr</b><br>Strontium<br>87.62   | 39<br><b>Y</b><br>Yttrium<br>88.90585    | 40<br><b>Zr</b><br>Zirconium<br>91.224     | 41<br><b>Nb</b><br>Niobium<br>92.90638  | 42<br><b>Mo</b><br>Molybdenum<br>95.94  | 43<br><b>Tc</b><br>Technetium<br>(98)     | 44<br><b>Ru</b><br>Ruthenium<br>101.07 | 45<br><b>Rh</b><br>Rhodium<br>102.90550 | 46<br><b>Pd</b><br>Palladium<br>106.42 | 47<br><b>Ag</b><br>Silver<br>107.8682 | 48<br><b>Cd</b><br>Cadmium<br>112.411 | 49<br><b>In</b><br>Indium<br>114.818     | 50<br><b>Sn</b><br>Tin<br>118.710     | 51<br><b>Sb</b><br>Antimony<br>121.760    | 52<br><b>Te</b><br>Tellurium<br>127.60 | 53<br><b>I</b><br>Iodine<br>126.90447   | 54<br><b>Xe</b><br>Xenon<br>131.29  |
| 55<br><b>Cs</b><br>Cesium<br>132.90545 | 56<br><b>Ba</b><br>Barium<br>137.327    | 57<br><b>La</b><br>Lanthanum<br>138.9055 | 72<br><b>Hf</b><br>Hafnium<br>178.49       | 73<br><b>Ta</b><br>Tantalum<br>180.9479 | 74<br><b>W</b><br>Tungsten<br>183.84    | 75<br><b>Re</b><br>Rhenium<br>186.207     | 76<br><b>Os</b><br>Osmium<br>190.23    | 77<br><b>Ir</b><br>Iridium<br>192.217   | 78<br><b>Pt</b><br>Platinum<br>195.078 | 79<br><b>Au</b><br>Gold<br>196.96655  | 80<br><b>Hg</b><br>Mercury<br>200.59  | 81<br><b>Tl</b><br>Thallium<br>204.3833  | 82<br><b>Pb</b><br>Lead<br>207.2      | 83<br><b>Bi</b><br>Bismuth<br>208.98038   | 84<br><b>Po</b><br>Polonium<br>(209)   | 85<br><b>At</b><br>Astatine<br>(210)    | 86<br><b>Rn</b><br>Radon<br>(222)   |
| 87<br><b>Fr</b><br>Francium<br>(223)   | 88<br><b>Ra</b><br>Radium<br>(226)      | 89<br><b>Ac</b><br>Actinium<br>(227)     | 104<br><b>Rf</b><br>Rutherfordium<br>(261) | 105<br><b>Db</b><br>Dubnium<br>(262)    | 106<br><b>Sg</b><br>Seaborgium<br>(263) | 107<br><b>Bh</b><br>Bohrium<br>(262)      | 108<br><b>Hs</b><br>Hassium<br>(265)   | 109<br><b>Mt</b><br>Meitnerium<br>(266) | 110<br>(269)                           | 111<br>(272)                          | 112<br>(277)                          | 113<br>(284)                             | 114<br>(285)                          | 115<br>(288)                              | 116<br>(289)                           | 117<br>(290)                            | 118<br>(291)                        |

|  |  |  |  |                                       |  |   |   |   |   |                                      |  |  |   |
|--|--|--|--|---------------------------------------|--|---|---|---|---|--------------------------------------|--|--|---|
| 58<br><b>Ce</b><br>Cerium<br>140.116   | 59<br><b>Pr</b><br>Praseodymium<br>140.90765 | 60<br><b>Nd</b><br>Neodymium<br>144.24 | 61<br><b>Pm</b><br>Promethium<br>(145) | 62<br><b>Sm</b><br>Samarium<br>150.36 | 63<br><b>Eu</b><br>Europium<br>151.964 | 64<br><b>Gd</b><br>Gadolinium<br>157.25 | 65<br><b>Tb</b><br>Terbium<br>158.92534 | 66<br><b>Dy</b><br>Dysprosium<br>162.50 | 67<br><b>Ho</b><br>Holmium<br>164.93032 | 68<br><b>Er</b><br>Erbium<br>167.26  | 69<br><b>Tm</b><br>Thulium<br>168.93421  | 70<br><b>Yb</b><br>Ytterbium<br>173.04 | 71<br><b>Lu</b><br>Lutetium<br>174.967  |
| 90<br><b>Th</b><br>Thorium<br>232.0381 | 91<br><b>Pa</b><br>Protactinium<br>231.03588 | 92<br><b>U</b><br>Uranium<br>238.0289  | 93<br><b>Np</b><br>Neptunium<br>(237)  | 94<br><b>Pu</b><br>Plutonium<br>(244) | 95<br><b>Am</b><br>Americium<br>(243)  | 96<br><b>Cm</b><br>Curium<br>(247)      | 97<br><b>Bk</b><br>Berkelium<br>(247)   | 98<br><b>Cf</b><br>Californium<br>(251) | 99<br><b>Es</b><br>Einsteinium<br>(252) | 100<br><b>Fm</b><br>Fermium<br>(257) | 101<br><b>Md</b><br>Mendelevium<br>(258) | 102<br><b>No</b><br>Nobelium<br>(259)  | 103<br><b>Lr</b><br>Lawrencium<br>(262) |

Just 6 elements account for 99% of body weight in humans.

| Element  | Atomic Symbol | % of Human Weight | Functions in Life                          |
|----------|---------------|-------------------|--|
| Oxygen   | O             | 65                | Found in water and other organic molecules |
| Carbon   | C             | 18                | Found in all organic molecules             |
| Hydrogen | H             | 10                | Found in all organic molecules and water   |
| Nitrogen | N             | 3                 | Component of proteins                      |
| Calcium  | Ca            | 2                 | Component of bones, teeth, and body fluids |

|            |   |   |   |
|------------|---|---|---|
| Phosphorus | P | 1 | Found in cell membranes and bone matrix |
|------------|---|---|---|

Procedure:

1. Open the simulation at <http://phet.colorado.edu/en/simulation/build-a-molecule>
2. Stay in the “Make Molecule” Tab
3. Explore how to make bonds by dragging the atoms and placing them together.
4. Click on the 3D button to view ball & stick and solid sphere (aka space filled) models.
5. Once the bond is formed, you can break the bond by placing the cursor between the atoms. Once you build a structure, you can break all bonds (atomize the particle) by clicking on the blue square, next to the green “3d” toggle.
6. Once you have built the molecule(s), place it in the right column by dragging it into the black space and move to the next kit in the collection by clicking on the yellow arrow-head.

**Collection 1 -**

**Kit #1**

One molecule can be built with Kit #1. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

1. What is the name of the compound?
2. What elements make up the compound?
3. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection 1 - Kit #2**

Two molecules can be built with Kit #2. Each of these molecules consists of only one element. Build the molecules and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

4. What are the names of the 2 compounds?
5. What elements make up each of the compounds?
6. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model for each of the 2 molecules.

### **Collection 1 - Kit #3**

Two molecules can be built with Kit #3. Build the molecules and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

7. What are the names of the 2 compounds?
8. What elements make up each of the compounds?
9. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model for each of the 2 molecules.

### **Collection #2 – Kit #1**

One molecule can be built with Kit #1. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

10. What is the name of the compound?

11. What elements make up the compound?

12. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #2 – Kit #2**

One molecule can be built with Kit #2. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

13. What is the name of the compound?

14. What elements make up the compound?

15. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

**Collection #2 – Kit #3**

One molecule can be built with Kit #3. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

16. What is the name of the compound?

17. What elements make up the compound?

18. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

**Collection #2 – Kit #4**

One molecule can be built with Kit #4. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

19. What is the name of the compound?

20. What elements make up the compound?

21. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #2 – Kit #5**

One molecule can be built with Kit #5. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

22. What is the name of the compound?

23. What elements make up the compound?

24. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #3 – Kit #1**

One molecule can be built with Kit #1. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

25. What is the name of the compound?

26. What elements make up the compound?

27. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #3 – Kit #2**

One molecule can be built with Kit #2. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

28. What is the name of the compound?

29. What elements make up the compound?

30. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #3 – Kit #3**

One molecule can be built with Kit #3. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

31. What is the name of the compound?

32. What elements make up the compound?

33. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.



### **Collection #3 – Kit #4**

One molecule can be built with Kit #4. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

34. What is the name of the compound?

35. What elements make up the compound?

36. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.

### **Collection #3 – Kit #5**

One molecule can be built with Kit #5. Build it and view the solid sphere (aka space-filling) and ball and stick models by clicking the green “3D” toggle.

37. What is the name of the compound?

38. What elements make up the compound?

39. Draw the solid sphere (aka space filling) model, ball & stick model and structural formula model of the molecule.