



Level A Investigations

A-1 The Periodic Table

What is the periodic table?

Students define atom, element, molecule, and compound; build a periodic table using the periodic puzzle blocks, and become familiar with the element names and symbols through the Element Bingo game.

A-2 Groups of Elements

How are the elements arranged in the periodic table?

Students are introduced to atomic structure, ions, and chemical bonds. They learn to recognize groups in the periodic table, and use the periodic table to predict chemical formulas.

A-3 Chemical Reactions

What is a chemical reaction?

In this Investigation, students learn to identify reactants and products in a chemical reaction and practice balancing simple chemical equations using the periodic puzzle blocks.

Level B Investigations

B-1 Chemical Formulas

Why do atoms combine in certain ratios?

In this Investigation, students are introduced to energy levels and oxidation numbers. They use oxidation numbers to predict chemical formulas, learn naming conventions for ionic compounds, recognize groups in the periodic table, and play the Molecular Crossword game.

B-2 A Tour of the Periodic Table

How is the periodic table organized?

Students further explore the organization of the periodic table. They build each group of elements with the periodic puzzle blocks while they read about the properties of elements in that group. They practice forming molecules made from elements of two different groups while they read interesting facts about different elements and compounds. They are also introduced to the transition metals, lanthanides, and actinides.

B-3 Chemical Equations

How do you balance chemical equations?

In this Investigation, students learn to identify reactants and products and to write chemical equations. They practice balancing chemical equations using the periodic puzzle blocks.

Level C Investigations

C-1 Electrons and the Periodic Table

What electrons have to do with the periodic table?

Students learn how electrons are organized in the energy levels. They build the periodic table out of periodic puzzle blocks and write the electron configurations of all of the elements. They discover that the groups of the periodic table are arranged according to the number of valence electrons. They practice predicting and writing chemical formulas based on an understanding of the octet rule.

C-2 Challenging Chemical Equations

How do you balance difficult chemical equations?

In this Investigation, students learn to identify reactants and products and to write chemical equations. They practice balancing challenging chemical equations using the periodic puzzle blocks.

C-3 Classifying Reactions

How can you predict the products of a chemical reaction?

Students learn to identify five types of reactions, predict the products of a reaction given the reactants. They use the puzzle blocks to predict the products in reactions, given only the reactants, and to write the balanced chemical equation for each reaction.



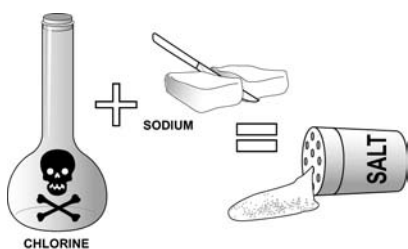
Question: What is a chemical reaction?

In this Investigation, you will:

1. Define reactant, product, and chemical reaction.
2. Learn to balance chemical equations.

In the previous Investigation, you learned that atoms combine to form molecules. Now we will investigate how those combinations take place through **chemical reactions**.

1 What is a chemical reaction?



Sodium and chlorine combine to form sodium chloride, or table salt. We call this process a **chemical reaction** because the atoms that we start with rearrange themselves and form new bonds with other atoms. It is important to remember that the numbers and kinds of atoms don't change; instead they are just rearranged.

We call the ingredients that go into the reaction the **reactants**. The material or materials that we end up with are called the **products**.

- a. What are the reactants in the chemical reaction above?
- b. What are the products?

2 Identifying reactants and products of chemical reactions

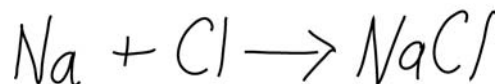


- a. Octane is a major component of gasoline. When octane is burned in the presence of oxygen, carbon dioxide and water are formed. What are the reactants in this chemical reaction?
- b. What are the products of the octane-burning reaction?

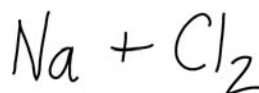
Writing chemical equations

We can show what happens during a chemical reaction by writing a **chemical equation**. Writing chemical equations is a lot like writing mathematical equations. To write a chemical equation, we use the symbols for the elements and compounds involved in the reaction. The reactants are shown on the left side of the equation, followed by an arrow, and then the products on the right side.

Remember that sodium reacts with chlorine to form sodium chloride, or table salt. We *might* write the chemical reaction for table salt like this:



to show that we started with sodium (Na) and chlorine (Cl) and ended up with salt (NaCl). The only problem with this equation is that chlorine is not available in the atomic state. Pure chlorine exists in pairs of atoms that we call **diatomic molecules**. The formula for diatomic chlorine is Cl_2 . Therefore we write the left side of the chemical equation like this:



Take three periodic puzzle blocks to represent the reactants above: One sodium block and two chlorines joined together to represent a molecule. Rearrange them to make salt. What is the happens?



The rule for chemical equations is that you have to use all the atoms you start with, and you cannot add extras or have leftovers at the end. In other words, chemical equations must always *balance*.

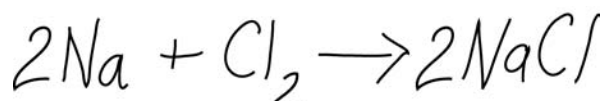
Since chlorine comes in molecules containing two atoms, we need to have two sodium atoms to match up with the two chlorine atoms in the diatomic molecule.

Now add another sodium block to the three blocks you already have. Let the chemicals react! Does your equation balance now?



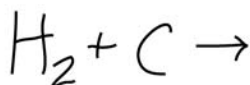
- a. How many sodium atoms do you need to complete the equation?
- b. How many molecules of sodium chloride are formed in the equation?

To write the complete, balanced equation for this reaction, we place numbers in front of the reactants and products to show how many of each are required. These numbers are called coefficients. If the number of reactants or products is one, we do not use a coefficient (or write the 1). The complete, balanced equation for the formation of sodium chloride is:

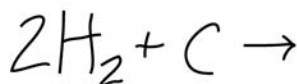
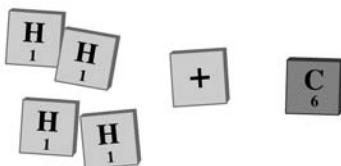


Balancing chemical equations

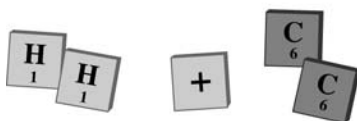
Let's try another reaction. Combine hydrogen gas (which is also a diatomic molecule, H_2) with carbon (C) to make methane (CH_4). First pick out some hydrogen and carbon blocks, and then try setting up the reactants. Remember that you must be able to rearrange all the reactant atoms to get complete products. Which of these reactant combinations works?



or



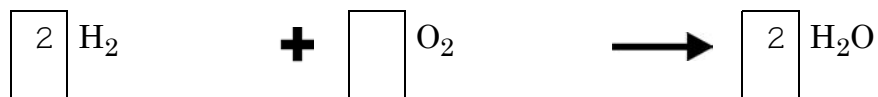
or



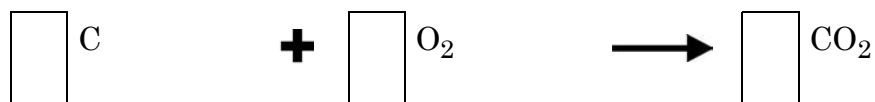
Write the balanced chemical equation for making methane from hydrogen gas and carbon.

Let's balance some other chemical equations. The following equations have the proper reactants and products. First assemble the reactants out of blocks, then rearrange them to make products. Figure out the right number of each reactant and product to make the chemical equation balance. Fill in the numbers in the boxes below. If there is only one reactant or product required, do not write the 1. The first one is done for you.

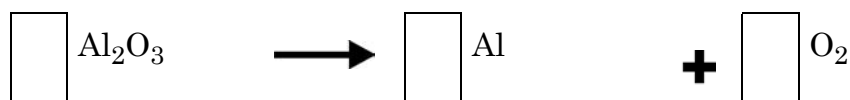
Hydrogen reacts with oxygen to produce water:



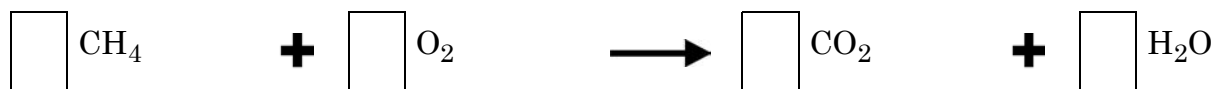
Carbon reacts with oxygen to produce carbon dioxide:



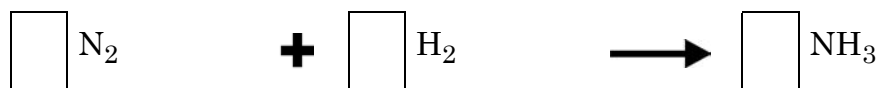
Aluminum ore is heated to produce aluminum metal and oxygen gas:



Methane (natural gas) burns in oxygen to produce carbon dioxide and water:



Nitrogen gas reacts with hydrogen gas to produce ammonia:



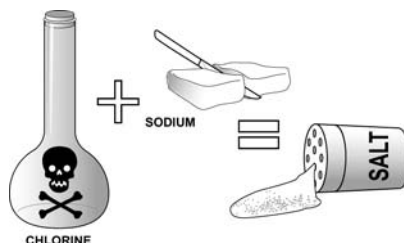
Carbonic acid in soda pop breaks down to produce water and carbon dioxide (the bubbles in your soda!):





Question: What is a chemical reaction?

1 What is a chemical reaction?



a. What are the reactants in the chemical reaction above?

b. What are the products?

2 Identifying the reactants and products of chemical reactions

a. Octane is a major component of gasoline. When octane is burned in the presence of oxygen, carbon dioxide and water are formed. What are the reactants in this chemical reaction?

b. What are the products of the octane-burning reaction?

3 Writing chemical equations

a. How many sodium atoms do you need to complete the equation?

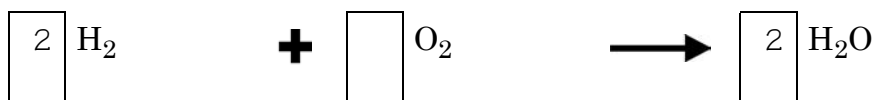
b. How many molecules of sodium chloride are formed in the equation?

4 Balancing reactions

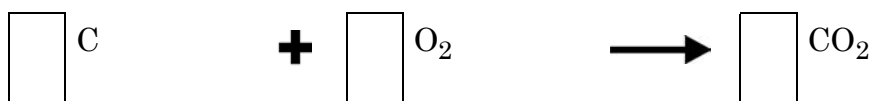
- a. Write down the equation for making methane from hydrogen gas and carbon.

5 More equations to balance

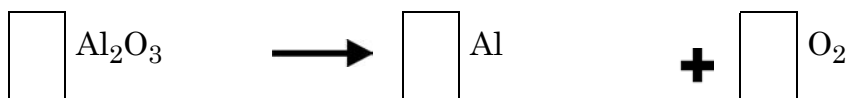
Hydrogen reacts with oxygen to produce water:



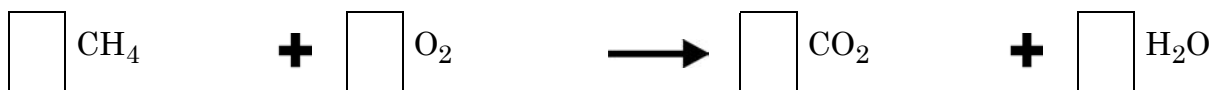
Carbon reacts with oxygen to produce carbon dioxide:



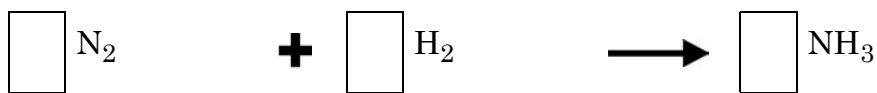
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Questions

1. Hydrochloric acid (HCl) is a substance produced by your stomach to help break down food. Sometimes, if you eat spicy foods or worry too much about your upcoming science test, your stomach produces too much hydrochloric acid and you get heartburn. Many people take antacids to relieve this painful condition. Antacids commonly contain calcium carbonate (CaCO_3) which neutralizes the hydrochloric acid. The products formed are calcium chloride (CaCl_2), carbon dioxide (CO_2), and water (H_2O).

a. What are the reactants in this chemical reaction? What are the products?

b. Write the chemical equation for the heartburn reaction in words.

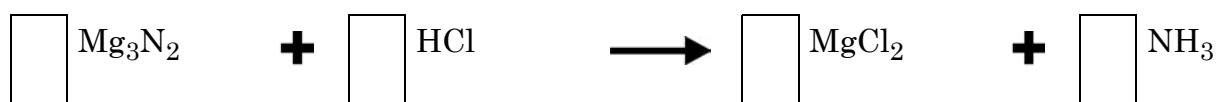
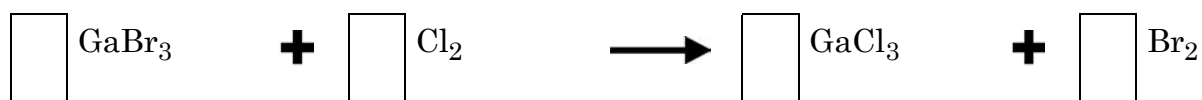
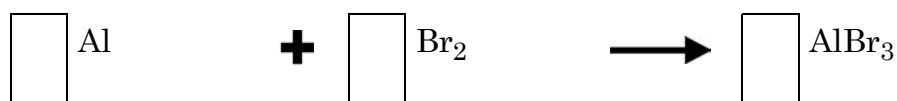
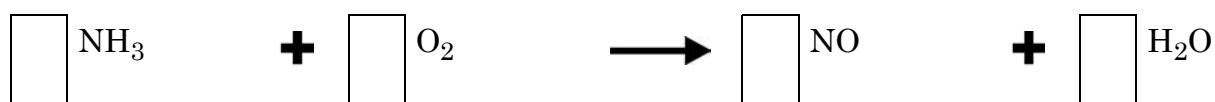
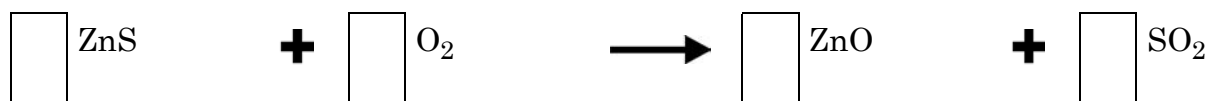
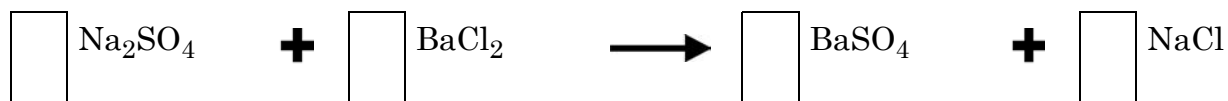
c. Now write the equation again, using the chemical symbols for each molecule in the reaction. Use an arrow to represent the words “to produce.”

d. Fill out the table below to determine the number of each type of atom on the reactant and on the product side. Hydrogen is done for you.

atom	reactants	products
H	1	2
Cl		
Ca		
C		
O		

e. Use the chart above to help you balance the equation. Remember, you can change the coefficients in front of a molecule, but you can't change the subscripts. Write the balanced equation for the heartburn reaction.

2. Balance the following equations. Make your own charts like the one in step 1e to help you.



Curriculum Resource Guide: Periodic Puzzle

Credits

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