Remote Learning Activities

Chemistry

Expect great things.
Pittsburgh Public Schools
High Chemistry Remote Learning Activities

Below is a list of activities that students can work on during the unexpected closure of schools. Activities are designed to reinforce the learning already facilitated to students during the 2019-2020 Academic School Year. This Remote Learning Activity Packet was created for a minimum of ten (10) days of independent practice.

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Khan Academy https://www.khanacademy.org/science/chemistry
A scientist in a white coat mixes two liquids in a test tube. The mixture bubbles and spews—definitely a chemical reaction. But labs and test tubes aren’t required for reactions to happen. They can happen anywhere—in the kitchen, in the washing machine, in the ocean, in hospitals, in our bodies. Chemists study reactions to learn what substances are made of and how they interact.

Every substance has both physical and chemical properties. Physical properties include texture, boiling and freezing points, taste, and appearance. Water freezes at 32°F (0°C) and boils at 212°F (100°C); lemon juice tastes sour. A chemical property tells us how one substance changes when it is mixed with another. If you mix vinegar and baking soda, carbon dioxide gas forms. You can see evidence of that gas in the bubbles that form.

But just combining substances doesn’t always result in a chemical change. Spreading mustard on a hot dog changes the way the hot dog looks and tastes, but a new substance is not formed. Adding a drop of ink to a glass of water changes the appearance of the water and the ink, but does not form a new substance.

Most reactions need a little push to get started; they must be activated by energy, which can take the form of heat, light, or electricity. Energy plays other roles in chemical reactions. Some reactions release energy. A burning log is undergoing a reaction that releases heat. In other reactions, more energy is used than released. A plant uses sunlight in a reaction that produces the food it needs.

Both chemical and physical changes are part of our everyday lives. You don’t have to look any farther than your own backyard to find examples of both.

### Chemical

When we digest food, pepsin and hydrochloric acid in our stomachs go to work on our food, changing it chemically before it passes to other organs where the conversion process continues.

### Physical

By adding sugar to lemonade, you change both the appearance of the sugar and the taste of the drink. You have made a solution—the sugar has broken down into tiny particles and mixed with the liquid, but it’s still there and so is the lemonade.

### Physical

Unless you shake it up, salad dressing has two separate layers—one oil and the other vinegar. Shake the bottle and the oil and vinegar form what's called an emulsion, a combination of liquids that don’t normally mix. The oil breaks down into minuscule particles in the vinegar, but after a while, the oil particles get back together and the two liquids separate again—the lighter oil floats on top of the vinegar.
CHEMICAL

Burning charcoal is a chemical reaction in which the carbon in the charcoal and oxygen in the air react to produce carbon dioxide and water vapor.

As burgers grill, many complicated chemical reactions are taking place. The heat breaks down cell walls in the meat and the contents of the cells (minerals, amino acids, fats, carbohydrates, and enzymes) mix and react. The visible result of the reaction between the carbohydrates and amino acids is the brown crust on the burgers.
Activity: Chemistry

After reading the article, Chemistry, list 3 facts stated in the article and create 2 questions you have about the content and 1 analogy.

Three facts:
1. 

2. 

3. 

Two Questions:
1. 

2. 

One Analogy


Classifying elements based on their properties can be done using basic observations. For example, gold is an unreactive, malleable element that conducts heat and electricity. Even without modern technology, scientists could observe elements and organize them according to their properties. This is how early versions of the periodic table were constructed.

Scientists eventually made enough observations of these trends to create early versions of the periodic table. The ancient Greeks were the first to try and arrange elements according to their properties. As the number of recognized elements grew, so did scientists’ ability to categorize elements.

In the late 1700s, Antoine Lavoisier organized about 33 elements into groups of metals and nonmetals. In the early 1800s, Johann Dobereiner grouped elements in groups of three based on their chemical and physical properties. Not too long after this, Alexander Chancourtois incorporated atomic weights and periodicity to the organization of the elements. His periodic table used what is called a telluric helix. This had the appearance of a graph wrapped around a cylinder.

John Newlands was the first to include groups in his design. The law of octaves, as Newlands proposed, described his observation that every eighth element repeated similar physical and chemical properties. His work appeared around the same time as Mendeleev’s.

Dmitri Mendeleev is often credited as the father of the periodic table. His version of the table, created around 1869, included about 63 elements and resembled the periodic table we have today. Mendeleev added numbered groups and periods and also included gaps where he thought new, undiscovered elements would fit. Based on periodic trends of atomic weight and valence structure he had observed in his table design. Mendeleev was able to predict the properties of the undiscovered elements.

Up until this time, scientists had not learned a lot about gases. William Ramsay is credited with the discovery of the noble gases around 1900. Ramsay experimentally removed water, carbon dioxide, oxygen, and nitrogen from an air sample. What remained was an unreactive gas that was about 19 times heavier than the known mass of hydrogen. This mystery gas also produced an unfamiliar emission spectrum. Ramsay decided to call this gas argon. Soon afterward, he discovered helium, neon, krypton, and xenon. He proposed that these elements, called the
noble gases, be placed in a new group in the periodic table. In 1904, Ramsay received the Nobel Prize for his work.

Around 1914, Henry Moseley determined the atomic number of each element known at the time. He also added to the periodic law, which states that elemental properties vary periodically with their atomic numbers. This resulted in some rearrangement of the elements and the confirmation that there were more unknown elements yet to be discovered. Scientists believed, however, that the total number of elements was 92.

Since then, additional elements have been discovered or created in the lab. These new elements have fit into the periodic table as predicted by Mendeleev and his peers. Today, there are 118 recognized elements that display properties related to periodic trends.
Activity 2: Filling in *The Periodic Table*

After reading the article, *Filling in The Periodic Table*, use evidence from the text to explain, how the periodic table was developed?
The chemist's most useful tool probably isn't the test tube or the bunsen burner. It's the periodic table of elements. It lists all the elements known in an order that tells us quite a few things about them. How did this table come to be?
Chemist Dmitri Mendeleev arranges the elements. This table had been in the works for a thousand years. Mendeleev refines it by arranging the elements by atomic number: the number of protons in an element's nucleus. Elements that have the same number of electrons in their outer shells are arranged in vertical columns.

Why are the electron shells so important? Elements combine with other elements by sharing, losing, or gaining electrons with one another. So the number of electrons in the outer shell determines how the element will behave with others. A helium atom, for example, has an outer shell of two electrons. It doesn’t want to combine with any other atoms. It won’t explode or react in some other dangerous way, which makes it a safe filler for a child’s balloon. Lithium, on the other hand, has an outer shell with just one electron. It always wants to lose that electron, or to pick up a few more from somewhere else. It is a very reactive metal. Lithium is never found in nature on its own but rather always as a compound.
Day 3: Stack 'Em UP

After reading the article, *Stack 'Em Up*, use evidence from the text to answer the following questions.

1. How did Dmitri Mendeleev arrange the periodic table?

2. Why are the electron shells of atoms so important?

3. Why is helium safe to fill a child’s balloon?

4. Why is lithium reactive?
Getting to Know: Atoms and Elements Review

The universe contains a vast number of different types of matter. On Earth, there is matter that exists most commonly as liquid and matter that is found almost always in solid form. There is matter that makes up organisms and matter that makes up nonliving things. There is matter that is considered valuable by humans and matter that is essential for our survival.

All of this matter seems very different at first glance. If we take a look at the atoms that make up matter, however, we see patterns that help us understand why different kinds of matter have different properties.

What is an atom?

An atom is the basic particle that makes up all matter. All atoms contain a nucleus. The nucleus is a small area near the center of the atom where protons and neutrons are located. All atoms also contain at least one electron. The electrons orbit the nucleus and are always in motion.

Some of the particles inside an atom carry an electrical charge. Protons are positively charged particles, electrons are negatively charged, and neutrons have no charge at all. These charges help determine how atoms combine with one another. When matter contains only one kind of atom, it is an element.

Misconception 1: Can I see an atom with a regular light microscope?

No, an atom is too small to be seen with a light microscope. However, a special kind of microscope can be used to create an image of an atom. Atomic Force Microscopy uses a special sensor and a computer to create a three-dimensional image of tiny particles like atoms.

What is an element?

An element is matter in which all of the atoms contain the same number of protons. For example, silver is an element. A piece of silver contains only silver atoms, each with 47 protons. If a substance is made of atoms with 48 protons in each nucleus, it is not silver.

Concept: Atoms and Elements Review
Getting to Know
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Since atoms contain charged particles, do atoms also have an electrical charge?

Atoms do not have to carry an electrical charge because there is always an equal number of electrons and protons. That means that the positive and negative charges balance to produce a neutral atom.

Remember that an oxygen atom has 8 protons. It must, therefore, also have 8 electrons. The 8 positively charged particles balance out the 8 negatively charged particles, so the entire oxygen atom is neutral.

If an atom does become electrically charged, it is then called an ion, instead.

What is an ion?

Although atoms of the same element always have the same number of protons in their nucleus, they can have a different number of electrons. As electrons move around an atom’s nucleus, some electrons can be gained or lost. An atom that has gained or lost electrons is called an ion.

The number of protons in an atom cannot change, so the positive charge on the atom does not change. However, when electrons are gained, the negative charge becomes stronger than the positive charge. On the other hand, when electrons are lost, the balance of charges is tipped in the other direction and the atom’s charge becomes positive. In either case, the positive and negative charges are not balanced. When the charges within a particle are not balanced, the particle—now called an ion—has a charge.

Misconception 2: Protons can be lost or gained from the nucleus to change the charge of an atom.

No, protons are never lost or gained from an atom. Remember, all the atoms of a certain element contain the same number of protons. If any protons were lost or gained, the atom would then be an entirely different element. The charge always depends on the number of electrons orbiting the nucleus.

A mathematical equation can help explain the imbalance of charges that exists in an ion. A neutral chlorine atom has 17 protons and 17 electrons. You can express this in an equation that shows that the difference between the charges is zero and the atom is neutral.

$$17 + (-17) = 0$$

If the chlorine atom gains 1 electron, however, the equation changes to reflect the additional electron. The difference between the charges is now 1, and the atom has become a negatively charged ion.

$$17 + (-18) = -1$$

Scientists have learned that the electrons, protons, and neutrons in atoms interact when chemical reactions occur. In the lesson, you will learn more about the role atoms and elements play in every activity that occurs on Earth.
Activity 4: Getting to Know: Atoms and Elements Review

After reading the article, *Getting to Know: Atoms and Elements Review*, use evidence from the text to answer the following questions.

1. What is an atom?

2. What is an element?

3. What is an ion?

4. Explain why it is not possible to see an atom with a regular light microscope?

5. Explain why protons are never lost or gained from the nucleus?
What do a diamond and a lump of coal have in common? Actually, they may look very different, but they are made of the same type of **atoms**. Atoms are the smallest pieces of matter. Atoms are very small—you cannot see them with your eyes alone. They make up everything that we can see and touch.

Both of these substances are made of pure carbon.

There are many different kinds of atoms. The different kinds of atoms are called **elements**. Diamonds and coal are made of an element called carbon. Diamonds do not have anything in them other than carbon, so all of the tiny atoms that make up a diamond are carbon atoms.

Oxygen is another element you may have heard of. Oxygen is found in the air, and your body uses it when you breathe. However, oxygen in the air is more than just single oxygen atoms. Pairs of oxygen atoms join together to make an oxygen **molecule**. A molecule is what forms when two or more atoms combine. The atoms in a molecule can be the same element, like oxygen, or they can be different elements. Most molecules have atoms of more than one element.

You cannot see the oxygen in this image, but it is there.

You may know that coal burns. When it burns, carbon atoms in the coal combine with oxygen molecules in the air to make a new molecule. This new molecule has one atom of carbon and two atoms of oxygen. You may have heard of this molecule. It is called carbon dioxide. Molecules such as carbon dioxide are still very small. Even the largest molecules are too small to be seen without special microscopes. The molecules in substances such as plastic can have thousands of atoms, but because those atoms are so tiny, it takes millions of molecules to make one plastic bottle!
Activity 5: Atoms and Molecules

After reading the article, *Atoms and Molecules*, use evidence from the text to answer the following questions.

1. Compare and contrast atoms, elements and molecules. Include how they are similar and how they are different.
The idea of an "atom" dates back to ancient times when philosophers believed that the world was composed of tiny, indivisible particles. This notion is called the atomic theory. While this idea has evolved through time, the basic idea that tiny particles compose the world around us is still believed by many scientists today. What follows is an exploration into the history of the atomic theory.

Approximately 400 BC: Democritus, an ancient Greek philosopher, was curious about the composition of materials in the world. He reasoned that all things were composed of miniscule particles, similar to how large buildings could be constructed with small stones. More importantly, he believed that these miniscule particles were indivisible. In other words, he thought these particles were the smallest possible objects in the Universe. He called these particles atomos, which translates as "indivisible." Ideas about the structure and composition of the natural world would remain purely philosophical until the 18th century when science experiments would provide more insight into these particles.

1803: John Dalton conducted experiments that would lead to the first atomic theory supported by experimental evidence. He proposed the law of multiple proportions. This stated that when substances combined together to form a compound, they seemed to combine together with specific proportions. Furthermore, these proportions were simple integer ratios. For example, when 100 g of tin combined with oxygen, it either combined with 13.5 g of oxygen or 27 g of oxygen. He noticed that 13.5 and 27 form a 1:2 ratio. He hypothesized that an atomic theory could explain this phenomenon. If tin and oxygen were actually tiny atoms with particular properties, then one atom of tin could combine with either one atom of oxygen or two atoms of oxygen. Dalton's experiments led him to propose a list of atomic masses for various substances.

1811: Amedeo Avogadro determined that any two gases held at the same temperature and pressure will contain the same number of molecules. In other words, the number of atoms in a volume of substance is unrelated to the mass of each atom. His research helped scientists to understand the number of atoms in particular substances. This allowed scientists to refine Dalton's calculations of atomic mass. It also allowed scientists to distinguish more clearly between atoms and molecules, which are groups of atoms.

1869: Dmitri Mendeleev organized elements into a chart known as the periodic table. An element was understood to be the smallest component of a substance that still retained the properties of that substance. In other words, elements were atoms with specific properties. Mendeleev noticed that different elements shared particular properties. He organized the periodic table according to these properties. In fact, Mendeleev was able to predict the existence of elements that had not yet been observed by scientists according to his arrangement of the periodic table.
1897: J.J. Thomson discovered the existence of electrons, which he thought to be negatively charged subatomic particles. Thomson believed that these particles existed inside of the atom. This was a controversial theory, because scientists had previously believed that the atom was the smallest unit of matter. He proposed the “Plum Pudding” model of the atom. He believed that atoms were positively charged objects with negatively charged electrons scattered throughout. It was called the “plum pudding” model because he thought electrons were scattered randomly throughout an atom just like raisins scattered throughout a plum pudding dessert.

1910: Ernest Rutherford determined that atoms seemed to have a concentrated of positive charge located at the center of the atom. This caused him to propose a new theory of the atom. In this model, the atom contained a small, positively charged nucleus orbited by negatively charged electrons. Rutherford would later propose the existence of neutrons, neutrally charged particles, in the nucleus.

1913: Niels Bohr proposed the Bohr model of the atom in which electrons orbit about the atomic nucleus at particular energy levels. In this model, a specific amount of electrons can orbit at each energy level. Electrons orbiting at the outermost energy level are called valence electrons. Valence electrons of an atom can interact with valence electrons from other atoms. The interactions of valence electrons determines the chemical properties of an atom.

**Modern Quantum Theory:** The present theory of the atom is Quantum Theory. It is similar to the theory proposed by Niels Bohr because it proposes that electrons orbit the nucleus of an atom at specific energy levels. These energy levels can be thought of as different energy shells around the nucleus. When atoms gain energy, electrons will “jump” up to a higher energy shell. When atoms lose energy, electrons will “fall down” to a lower energy shell.
Activity 6: The Atomic Theory

After reading the article, *The Atomic Theory*, use evidence from the text to answer the following questions.

1. Compare and contrast the different contributions to the atomic theory since 1897. Include how they are similar, how they are different, and how they build on each other.

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Subatomic Particles

You probably already know that atoms are extremely tiny particles. What you might not know is that atoms are made of even tinier particles, known as subatomic particles. Knowledge of subatomic particles is integral to understanding the form and function of atoms. The three subatomic particles are protons, neutrons, and electrons.

Before we explore those subatomic particles, let’s review some important ideas about the atom. First, remember that atoms are so small, you can’t see them with your eye or with most microscopes. Scientists have a special unit to measure and discuss the mass of atoms: the atomic mass unit, or amu. Curious about what an amu equates to? One atomic mass unit is equal to $1.7 \times 10^{-27}$ kilograms. In contrast, a DNA molecule is about $1 \times 10^{-18}$ kilograms, and a virus is about $1.5 \times 10^{-15}$ kilograms.

Atoms from different elements have different numbers of subatomic particles, and therefore different masses. Protons and neutrons each have an atomic mass of about 1 amu. Electrons have a very small mass (only about $0.00055$ amu). Looking at the periodic table can help us learn more about atomic mass. For example, the element oxygen (O) has 8 protons and 8 neutrons. What do you think is the atomic mass of oxygen? Its atomic mass is close to 16 amu (15.9994 amu to be precise).

Protons and neutrons are located in the nucleus, or center, of the atom. The number of protons in the nucleus determines the element. You read above that oxygen has eight protons. The element gold (Au) has 79 protons in its nucleus. Which element do you think has a greater atomic mass: gold or oxygen? If you guessed gold, you’re correct. All elements on the periodic table have an atomic number. Looking at this number can quickly tell you how many protons are located in the nucleus of an atom of that element.
Subatomic Particles

Neutrons are also located within the nucleus of the atom. While protons have a positive charge, neutrons don’t have any electrical charge. Still, neutrons are very important because they help hold the protons together. If the nucleus of an atom didn’t have neutrons, the protons would repel each other due to their like charges.

Sometimes, an atom has an even match of protons and neutrons. In other instances, there are more neutrons than protons. The same element can have atoms with different numbers of neutrons. (Remember, all atoms of an element have the same number of protons.) Atoms of an element with different numbers of neutrons are called isotopes. Carbon, for example, has 8 different isotopes. Because neutrons have an atomic mass of about 1 amu, each isotope of carbon has a slightly different atomic mass. The masses of the different isotopes of carbon can range from 7 amu to 15 amu. Though they have different masses, they’re all still considered carbon because they each have 6 protons.

Protons and neutrons are smaller parts of the larger atom. But did you know that subatomic particles also contain even smaller particles? These small particles are called quarks. Quarks have a fraction of an electrical charge. They are observed only in combination with other quarks. Quarks combine to form several types of particles, the most common of which are the proton and neutron.

The third type of subatomic particle is the electron. Electrons, as you already know, have a very tiny atomic mass. Electrons also have a negative charge. When an atom has the same number of protons and electrons, its charges are balanced. An atom with more protons than electrons has a net positive charge, and an atom with more electrons than protons has a net negative charge. These unbalanced atoms are called ions. Knowing about the subatomic particles in an atom is helpful when studying how atoms function.
Activity 7: Subatomic Particles

After reading the article, *Subatomic Particles*, use evidence from the text to answer the following questions.

1. What are subatomic particles?

2. What subatomic particles give the atom mass?

3. What causes an element to have different isotopes?

4. Where are protons, neutrons and electrons found in the atom?

5. How is an element’s atomic number determined?
Molecules That Matter

Did you know that all of the things around you are made of matter? Matter is anything that takes up space and has mass. So a desk, a chair, the food you eat, the water you drink, and even the air you breathe are made up of matter. You may not realize it, but your own body is composed of matter.

**Defining Matter**
So what exactly is matter made of? Matter is made up of atoms and molecules. Atoms are the smallest part of a substance that still retains the properties of the substance as a whole. In other words, if you took water and kept sorting it out piece by piece, eventually you would get down to one single molecule of water. If you took this molecule apart, then you would no longer have water. Examples of types of atoms are hydrogen and oxygen. Atoms are made up of electrons, protons, and neutrons. The specific structure of atoms allows them to combine with other atoms.

**Compounds and Molecules**
When atoms combine they form *compounds*. Two atoms combine by forming a bond that is made up of at least two electrons. When atoms are bonded together we call this a molecule. Water is an example of a common molecule that we encounter every day. A water molecule, H₂O, is made when two hydrogen atoms form a bond with one oxygen atom.

**Types of Bonds**
There are two different types of bonds between atoms, covalent bonds, and ionic bonds. In covalent bonds atoms are actually sharing at least 2 electrons. With ionic bonds however, electrons are moved from one atom to another. The result is the formation of positively charged ions (cations).
and negatively charged ions (anions) which are attracted to each other. Table salt or sodium chloride, NaCl, is an example of a compound formed by an ionic bond. The sodium and the chlorine atoms do not share electrons. Instead, the chlorine has taken an electron from the sodium atom. This gives the chlorine a negative charge and the chlorine a positive charge. This difference in charge leads to an attractive force between the atoms. This is similar to the way that rubbing a balloon on a sweater can make it stick to the sweater.

**Diatomic Molecules**
When you breathe in air and take in oxygen, you are not breathing in a bunch of single oxygen atoms. Breathable oxygen is actually a molecule! It is called a diatomic molecule because oxygen atoms tend to pair up in groups of two. So most breathable oxygen has pairs of oxygen atoms that are connected. That is why we call it \( O_2 \).

**Models of Molecules**
In our everyday lives it is easy to forget about atoms and molecules because atoms and molecules are too small for us to see. Because of this, scientists use models to represent atoms and molecules so that we can better understand molecules and how they are constructed. It is important to remember that models of atoms and molecules, while helpful, also have flaws. After what you've learned about bonds, can you think of some flaws in the common “Lewis Structure” model of water shown here?

![Lewis Model of Water Molecule](image)

**How is a Molecule different than an Atom?**
Molecules differ from the elements that make them. Think again about a cup of water. Water is a liquid at room temperature. You can pour it, drink it, boil eggs in it, and take a shower with it. Now, think about the two types of atoms that bind to form water molecules—oxygen and hydrogen. These atoms have very different properties than water! For
example, at room temperature, both oxygen and hydrogen are gases. You could ignite and burn pure oxygen and hydrogen gas very easily. These atoms are considered highly flammable and should be handled very carefully. Liquid water on the other hand is not flammable at all, and is often used to extinguish fires. The properties of a molecule can be very different from the properties of the atoms that make the molecule.

**Do Molecules Behave Differently in Different States?**
Yes, molecules and atoms behave differently depending on their state. This is a very important concept in science. In a solid, molecules are packed together tightly and only vibrate very slightly as they move back and forth. Solids also typically keep their shape even if they are not in a container. Molecules in a liquid state are closely packed too, but the particles can move around each other. Unlike solids, liquids take the shape of the container holding it. Gas molecules tend to spread out as far from each other as possible. These particles are in constant motion, colliding with each other and all other materials they come into contact with. There is empty space between the gas molecules.

Now that you know about molecules and atoms, you should start thinking about the molecules you encounter every day. Consider the gases, the liquids, and the solids you depend on. You may start to “see” how much of the matter on Earth is connected and how it is moving and changing.
Activity 8: Molecules that Matter

After reading the article, Molecules that Matter, use evidence from the text to answer the following questions.

1. What is matter?

2. How are compounds and molecules similar and different?

3. What are the two types bonds between elements? How are they similar? How are they different?

4. How is a molecule different than an atom?

5. Explain how molecules behave in a solid, a liquid and a gas.
What are chemical reactions?
Chemical reactions are changes that occur when atoms, ions, or molecules interact. Let's look at a simple example: rust. Rust forms when iron reacts with oxygen. Rust is a new substance that is different from either of the two substances that formed it. Think of a rusty object you've seen. Where was it? Most likely, the object was exposed to plenty of air, which contains oxygen. Iron reacted with this oxygen to form rust. This process is known as oxidation, and it's a very common chemical reaction.

Why do chemical reactions occur?
Chemical reactions occur because atoms can lose, gain, or share electrons. The outer shell of electrons, called the valence shell, has a tendency to fill with a total of eight electrons. If an atom has only seven electrons in its outer shell, it is likely to gain an electron. An atom with only one electron in its outer shell has a tendency to lose that electron. This tendency of atoms to fill their outer shells with eight electrons is called the octet rule. The octet rule demonstrates the trading of electrons that tends to occur between atoms.

In a chemical reaction, the starting substances (the reactants) are different than the ending substances (the products). In the example above, the reactants are iron and oxygen, and the product is rust.

Are there different types of chemical reactions?
The short answer is yes. But let's explain this topic a bit more. There are at least four different types of chemical reactions, although some scientists list more types. One type is a synthesis reaction. The rust example is a synthesis example. Two different reactants create one product. A second type of chemical reaction is a decomposition reaction. During a decomposition reaction, one reactant breaks down into two or more products. Water can undergo a reaction in which it breaks down into hydrogen gas and oxygen gas.
Getting to Know: Chemical Reactions

Consider the job of a chemist. Chemists work in a laboratory setting studying chemical reactions, or the rearrangement of atoms to form new molecules. In a chemical reaction, one or more substances, called reactants, react to form one or more different substances, called products.

Studying chemical reactions helps chemists find solutions to problems in the world around us. For example, acid rain is caused by atoms in the atmosphere reacting with rainwater to make it acidic. The acids then react with substances on Earth's surface, poisoning rivers and lakes, damaging plants, making animals ill, and damaging human-made buildings as well as natural landforms. Scientists are seeking ways to reduce acid rain and to minimize the damage it causes.

Chemical reactions also teach chemists about processes that occur in living things. Photosynthesis and digestion are just two examples of these types of chemical reactions, and there are many more. Medications are sometimes developed to support these natural chemical reactions.

A chemist may also develop products. Soaps and shampoos are formed by chemical reactions. Even the plastic bottles containing these substances are created using chemical reactions.

How are chemical reactions different from physical changes to matter?

All matter is made of atoms bonded together in a particular pattern. When matter is broken into smaller pieces or heated so that it changes from a solid to a liquid, it is a physical change. Physical changes do not cause a rearrangement of molecules. When matter is permanently changed on an atomic level, however, there is a chemical change.

What are some different types of chemical reactions?

A rusted car is an example of an oxidation reaction. Oxygen and iron in metals react chemically to form rust. Fire is a type of chemical reaction known as combustion. For a substance to combust, there must be oxygen present for the reaction. A spark from a match is the energy needed to start the reaction. Batteries are examples of electrochemical reactions that release electrical energy.

Misconception: Can physical and chemical changes occur together?

A chemical reaction usually causes a change in both the physical and chemical characteristics of a substance. Rust on a car changes the molecules of metal on an atomic level. The physical appearance of the car changes at the same time.
Misconception: Do some of the atoms go away during a chemical reaction?

During a chemical change, atoms are not gained or lost. The mass of the reactants equals the total mass of the resulting substance.

How does energy affect a chemical reaction?

In a chemical reaction, the bonds between the atoms break, releasing all the different kinds of atoms present so that they interact with one another. The reaction produces a new chemical compound. During the formation of the new compound, energy is either absorbed or released. Reactions that absorb thermal energy are endothermic reactions. Reactions that release heat energy are exothermic reactions. In an exothermic reaction, less energy is used to break bonds than is released when new bonds form. In an endothermic reaction, more energy is used to break bonds than is released when new bonds form.

What happens to the mass of the reactants in a chemical reaction?

There is no loss of mass during a chemical reaction. A fire is a good example. The reactants are completely consumed, but their atoms are still present in the ash, smoke, and gases that are produced. For this reason, the mass of these reactants equals the mass of wood, oxygen, and other reactants that were present before the reaction occurred.

Can anything increase or decrease the speed of a chemical reaction?

Reaction rates depend on several factors. Changing the amount of each reactant has an effect, because this also changes the number of molecules present. Temperature can affect chemical reactions; adding energy in the form of heat can speed things up. Finally, the surface area of each reactant is important. For example, acid rain can only react with the part of a rock that it touches. The outside surface of the rock may be broken down by the rain, but the material inside remains unchanged. If the rock is broken into many pieces, however, all of the pieces will be exposed to chemical reactants when it rains.

Chemical reactions happen all around us and inside our bodies all the time. In this lesson, you discover more about how these processes happen and how they can be controlled.
Activity 10: Getting to know Chemical Reactions

After reading the article, *Getting to know Chemical Reactions*, use evidence from the text to answer the following questions.

1. How are chemical reactions different from physical changes to matter?

2. What are some different types of chemical reactions?

3. How does energy affect a chemical reaction?

4. What happens to the mass of the reactants in a chemical reaction?

5. Can anything increase or decrease the speed of a chemical reaction?
Claim- Evidence-Reasoning

How would you know if a chemical reaction occurred? Develop a claim-evidence-reasoning to support that a chemical action occurred.

Claim:


Evidence:


Reason:


