WEEK 2

Vol. 14 Issue 1
First Quarter

All About Matter

Science Studies Weekly
Challenger

SCIENCE 5 STUDIES

All About Matter!

Has anyone ever asked you, "What's the matter?" The next time someone asks that, try answering, "Well, actually, everything is matter!" You see, the universe is made up of lots of different things! Stars, planets, toothpaste, your toenails, gum, trees and . . . well, everything that takes up space—like a bacon, lettuce and tomato sandwich or pocket lint—is matter. But you wouldn't want a BLT with lint on it, so yep, it all matters how it's put together.

Can you think of how some things are similar or different—like a rock and a feather, for example? Some things are hard, others soft. Some things are smooth like glass, and others are rough like tree bark. Other things are colorful like flowers. Some things are cold like ice while others are hot like molten lava. When we talk about shape, size, color or texture (how it feels), we are describing properties of matter. What properties can you use to describe matter around you? What about this newspaper? Is it smooth or rough? What shape is it?

More than 2,000 years ago, a Greek thinker first guessed that everything must be made of tiny particles that could not be cut or divided into smaller particles. He called them atomos, which means "indivisible."

Nowadays, we call these tiny particles atoms. There are a limited number of different kinds of atoms that make up all matter! When the atoms in a chunk of matter are all the same, we call it an element. There are more than 100 basic materials called elements that make up everything we know of in the universe. Some of these elements you can see in their pure form, like gold or iron metals. But they can be combined to make anything. It is how atoms are put together that makes everything the way it is. So what's the matter? Turn the page to learn more.

Biography *Dr. Patricia Bath*

Patricia Era Bath was born in Harlem, New York, in 1942. As an African American girl, she faced a childhood of stereotypes. To overcome these challenges, Patricia carved her own path and was quickly inspired to study science. The National Science Foundation scholarship that she was awarded in high school was the first of many honors to come. During her career as an ophthalmologist (a physician who treats eyes), Dr. Bath broke barriers in the field, both as a woman and as an African American. After attending Howard University College of Medicine, Bath worked to provide eye care for those in poor neighborhoods. Together with three other physicians, Dr. Bath founded the American Institute for the Prevention of Blindness; she was the institute's first president. She also patented a device to help remove cataracts from the clouded lenses of an eye. This device uses a fiber optic laser called a Laserphaco Probe. The laser tube is inserted in the eye through a tiny cut. It then vaporizes the cataract within moments. It was a revolution in eye care, especially for patients faced with possible blindness from cataracts. Dr. Bath's procedure and invention made eye surgeries easier, safer and faster. It also made her the first African American female doctor to patent a medical device. Since then she has continued to develop and refine her eye-saving techniques, and she educates people about eye health. Dr. Bath believes that eyesight is a basic right!

Understanding Matter

Everything's Made of Atoms

As we were saying—all matter in the known universe is made of only about 100 different kinds of atoms or elements. Everything else is just a combination of those different atoms. Water, as you probably know, is a combination of two hydrogen atoms and one oxygen atom—called H2O. Carbon dioxide, the stuff we exhale from our lungs, is a combination of carbon and oxygen atoms. In carbon dioxide, there are two oxygen atoms and one carbon atom. It's also known as CO2.

In this lesson, let's take a look at the basic structure of atoms and how they combine with each other to form all kinds of different matter.

Elements

Elements are made of molecules that have all the same atoms. Elements cannot be broken down into simpler substances. For example, gold is an element. It is made of only gold atoms. There are about 100 elements. Ninety-two occur in nature without our help. The number of protons in the nucleus determines what element it is. This is called the atomic number.

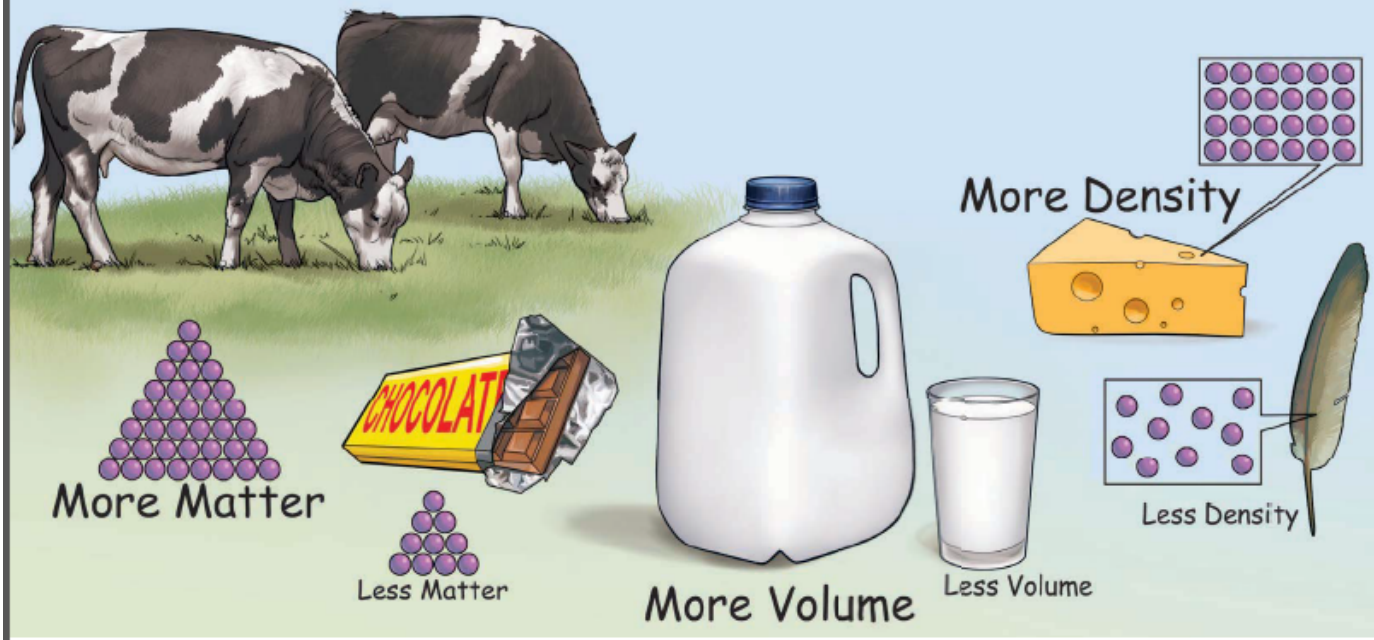
Molecules

When two or more atoms link together, they make a molecule. A molecule can be made up of atoms from the same element or a combination of different atom types.

Mass, Volume, Density and Weight

Mass is the amount of matter in an object. Volume is a measure of how much space matter takes up, like a gallon of milk or a two-liter bottle of soda pop. Density is a measure of how much mass is in a specific volume. You can measure things by their volume or their mass.

Gravity pulls on objects here on Earth because they have mass. Because of gravity, objects have weight. The mass of an object stays the same, but weight depends on gravitational force. The same object in outer space has the same mass as it does here, but the weight changes due to changes in gravity. An object that weighs 100 pounds on the Earth will weigh about 17 pounds on the moon because the moon's gravity doesn't pull as hard. There is one more thing you should know about the weight of matter: The weight of an object or substance is always equal to the sum of the weight of its parts.



Technology & Science

High-Tech Ink!

You probably know a lot of people who would rather read a newspaper or a book than a computer screen. Papers and books are easier to read and carry around than most laptops. People continue to buy millions of newspapers and books every day. But now people have a choice. Have you heard about Electronic Paper Displays? EPDs can be read from any angle just like paper, and you can read them even in bright sunlight. They also have a long battery life, because they only use power when the image changes.

A company called E Ink developed the EPDs. They use technology called an "active matrix ink display." The technology uses black-and-white ink in tiny micro-capsules that can be controlled by electric fields. The electric fields determine which part (top or bottom) of the capsule the white and black inks move to. If they want black letters, they "zap" the black ink to the top, and they have readable print! This process can be used to form letters and pictures on a "page" that looks like the ones you're reading right now! The ink capsules are

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Book Science

Transfiguration: 'Harry Potter' series by J. K. Rowling

If you've read the "Harry Potter" books you know Harry, Ron and Hermione take a class called transfiguration. In transfiguration, they change one item into another, like a matchstick into a needle, or a rat into a goblet. Professor McGonagall can even change herself into a cat! Is that really possible?

Well, matter is constantly changing, but not in the magical ways you read about in Harry Potter. Physical changes to matter happen all the time. For example, ice melts into water, and water can be heated into a gas. But it's all still good old H2O.

Chemical changes happen a lot, too. Chemical changes turn one substance into another. When you burn your toast in the morning, that's a chemical change. When the milk in the refrigerator goes sour, that's a chemical change. You can't reverse chemical changes.

But what they do in the "Harry Potter" books isn't a physical or chemical change. They're taking elements and molecules and changing them into different elements and molecules. They're changing the metal in the needle into wood, and the flesh and bone of the rat into glass! We know changes like that aren't possible because these things are made of different

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Three Main Parts of an Atom

Atoms are made of three main parts: protons, neutrons and electrons.

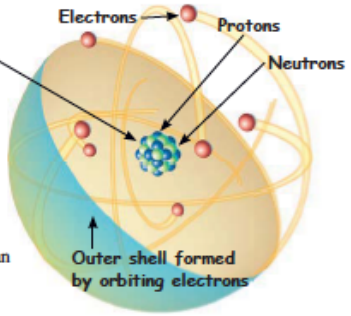
Nucleus

The nucleus, or center of an atom, is where the neutrons and protons exist.

Check It Out!

Look very closely at this tiny atom. →

Actually, you can't! It is too small to see. Atoms are millions of times smaller than a speck of dust.



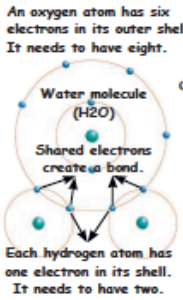
Electrons

Spinning around the nucleus of an atom are the electrons. Different types of matter have different numbers of electrons. Hydrogen only has one electron. Some atoms have many electrons like the uranium atom, which has 92!

Chemical Bonding

Shells

Can you see the rings around the nucleus in these illustrations? Each ring is called a shell. The first ring nearest the nucleus needs two electrons to fill the shell. Different atoms have various layers of shells.



Mixtures

The next time you drink lemonade, think of it as a mixture. Mixtures are different materials that are mixed together but do not bond, or change into a new molecule. For instance, if you mix some salt in water, you can boil the water out, and the salt will still be there because it did not bond.

Bonds

A bond happens when atoms come together and share electrons. If an atom has only one electron instead of two, like hydrogen, then it is attracted to other atoms like oxygen, which lacks two electrons in its outer shell. Two hydrogen atoms bond with the oxygen atom forming H2O, or water.

Compounds

Compounds are molecules that are made up of different types of atoms. For instance, when oxygen combines with hydrogen, water molecules are formed.

Democritus

Ancient Greek thinkers such as Democritus noticed that things could be broken down into smaller pieces. He thought that everything could be built out of atoms, or the tiniest particles of matter that cannot be cut. He thought that these atoms moved around and flowed.

Actually, atoms can be split. Scientists discovered how to split atoms and release massive amounts of energy. This is known as nuclear fission and is what makes an atomic bomb.

In the Lab

Chemical Density

Purpose: To show that, in chemistry, one plus one does not always equal two.

Materials

- a two-quart jar
- some tape
- a one-cup measuring cup
- a funnel
- one cup of water
- one cup of rubbing alcohol

Directions

1. Put a piece of masking tape down the side of the two-quart jar.
2. Carefully fill a measuring cup with one cup of water. Make sure it's exactly one cup. Use the funnel to be sure every drop is poured into the jar.
3. Repeat step two.
4. Precisely mark the level of two cups of water on the masking tape on the side of the jar.
5. Empty the jar and dry it out.
6. Repeat step two again.
7. Carefully fill a measuring cup with one cup of alcohol. (Keep it away from your mouth and eyes.) Use the funnel to be sure every drop is poured into the jar.

Notice that the volume of two cups of water is greater than one cup of water plus one cup of alcohol. Why is that? The density of the mixture of water and alcohol is greater than the density of plain water. The alcohol molecules fit into the spaces, or pockets, that are between water molecules.

This Week's Question

How do scientists know atoms exist if atoms are so small?

Scientists have many ways to detect atoms. In the early days, Greek thinkers believed atoms existed just because it seemed to be the most obvious theory. But because of amazing scientific inventions, we can now actually see individual atoms! Scientists use the new Scanning Tunneling Microscope (STM) and scanning probe microscopes to see single atoms. They take "pictures" of atoms using a tiny needle that sends electrons over atoms on a surface. The device detects when there is an atom, and the needle moves up and down. The movement of the needle lets scientists use computers to make a picture of the shape of the surface of the atom.

How do they keep atoms from flying away? Well, they have to cool them to freezing temperatures so that they don't move on their own. Recently, they also discovered how to control atom movement at higher temperatures.

Even more amazing, scientists at Oxford University used the tip of the STM to move 37 atoms to spell the letters IBM, thanking the IBM company for their help with the project. You may have heard the saying, "Always read the fine print," but that's ridiculous!

Spotlight

Marie Curie

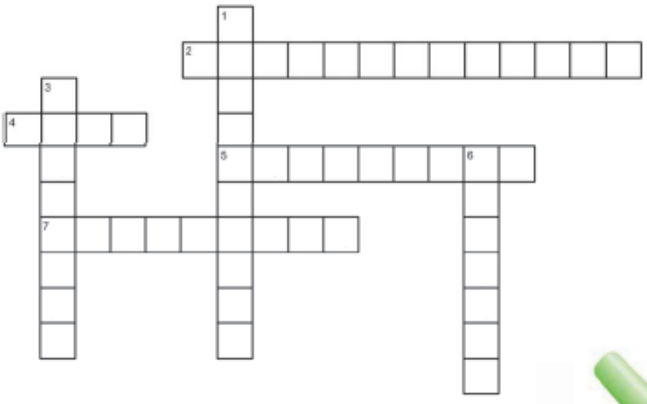
1867-1934

Marie Curie was a great scientist! Like many scientists of her day, she wondered about X-rays. She wanted to know why an element called uranium fogged up photographic film when it was nearby. She thought there must be some sort of energy coming from it. So, she got permission to use a university storage room to do experiments. Marie and her husband, Pierre, studied radioactivity, the energy that fogged up the film. Radioactivity is a form of energy that comes from very special elements. They were the first to discover two radioactive elements called radium and polonium.

The Curies won the Nobel Prize in 1903 for their discovery. The Nobel Prize is considered by many to be the highest award for people who make a big contribution to the world. Marie Curie became the first person to win two Nobel Prizes! In 1911, she won another Nobel Prize for her continued research in radioactivity.

Back then, people did not know that too much exposure to radiation energy increases the risk of some cancers. Sadly, Marie Curie died of cancer at age 67. Her research was very important in helping us understand radioactivity, and many scientists used her findings to make even more discoveries and uses for radioactive elements.

Name _____



ACROSS

2. a combination of one carbon atom and two oxygen atoms (CO_2)
4. A _____ is formed when two atoms come together and share electrons.
5. What spins around the nucleus of an atom?
7. molecules that are made up of different atoms

DOWN

1. she discovered radioactive elements and won a Nobel Prize for the discovery
3. When two or more atoms link together, they make a _____.
6. the center of an atom where the neutrons and protons exist

As you read this week's lesson, circle or highlight all proper nouns with any color pen or highlighter. This will help you find some of the crossword answers and get ready for this week's test.

Matter

Create your own chemical bond. Make carbon dioxide gas!

Materials

- cork and bottle
- skewer
- two flexible straws
- drinking glass
- scissors
- food dye
- baking soda
- vinegar
- paper

Directions

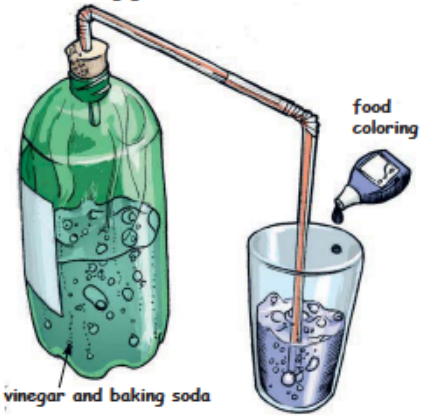
1. Put a hole in the cork with the skewer. Then push the short end of the straw into the hole you created.
2. Cut a small slit in the other end of the straw. Slide it inside the second straw. The two should fit together.
3. Fill the drinking glass with water. Color the water with the food dye. Don't make it too dark.
4. Put a teaspoon of baking soda into the bottle. Add enough vinegar in to fill the bottle about half full.

Mini-Lab

5. Quickly put the cork on the bottle. Put the end of the second straw into the water glass.
6. Record what happens.

Why?

The vinegar and baking soda make carbon dioxide gas. The gas escapes through the straw. It makes the water in the drinking glass bubble.



High-Tech Ink!

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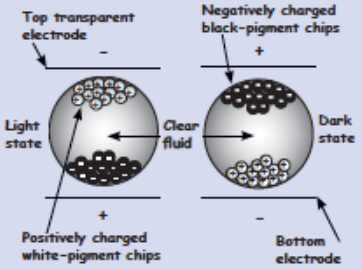
imbedded inside plastic film, which has a layer of electronic circuits attached to it.

E Ink makes electronic-ink books and screens for computers, cellular phones, digital cameras-even wearable images. Imagine wearing a T-shirt that flashes the current time and temperature throughout the day. The screens really do look a lot like a newspaper. Hey, maybe someday soon you'll be reading Science Studies Weekly on an EPD. Now that is smart technology! Check out www.eink.com to learn more.



Transfiguration

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elements. Some people used to believe that it was possible to change one element into another, like turning lead into gold. But scientists haven't found a reliable way to do that. So for now, the magic in the "Harry Potter" books is just that—magic!

If you'd like to make any editorial comments about our paper, please write to us at feedback@studiesweekly.com.

Let's Investigate

Welcome back to Let's Investigate, science detectives. This week we're going to talk about the steps in doing a science investigation correctly. Did someone say, "Where do I start?" You just did! Asking questions is the first step in an investigation. Here's a step-by-step list of what to do:

- Ask a question.
- Think of a possible answer. Scientists call this a hypothesis.
- Make a plan to test your hypothesis.
- Test your hypothesis.
- Record the results of the test.
- Share your results with others.

It's a good idea to write these steps in your science journal or cut out this article and save it. You'll need to know these steps many times this year. Next week we'll work together to plan an investigation!