CRYSTAL CHOTTUT

SCIENCE EXPERIMENTS

FOR KIDS

FUN AND FANTASTIC PROJECTS TO IMPROVE CHILDREN'S CREATIVITY

(ACTIVITY BOOKS FOR KIDS)

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Introduction

What does it take to be a great scientist?

It is asking the right question and since it is only the first step toward being a great scientist, this book will also guide you in completing the second step: the experiment. Following each question there will be an experiment that will help you discover for yourself some of the mystery and magic of science. There are three different types of experiments offered in this book — simple activities you can do quickly, larger and more complex experiments, and science fair projects.

She wanted to draw some conclusions!

Scientists have used this method for hundreds of years to understand their world. Now it's your turn!

One of the most important steps in doing any experiment is thinking about any possible safety risks and making plans to stay safe. Read and follow the cautions for each experiment. An experiment might require adult help, goggles, or other special safety precautions. Here are some basic safety rules to follow when doing science:

follow directions carefully; 2) tell an adult which experiment you are doing, even if the experiment does not require adult help; 3) follow all cautions given in the experiment; 4) dress appropriately by wearing clothing and shoes that help you stay safe. Pull back long hair and wear closed-toe shoes; and 5) ask an adult for help if you feel unsure or unsafe about any part of an experiment.

When you find an experiment you want to do, read through the instructions completely. Make sure the level of difficulty matches your skill level and confidence. Also, check to make sure that you have enough time to complete the experiment. Many of the experiments can be completed in less than an hour, but a few take a lot more time from start to finish. Carefully look over the materials list and gather everything you will need for the experiment.

Read "The Question." This section gives you a peek at the experiment, but most importantly, it asks you to form a hypothesis to write in your notebook. A hypothesis is a temporary and testable suggested answer to a question. The experiment should give you information to help prove or disprove your hypothesis. For example, one of the experiments in this book investigates the strength of different glues. Your hypothesis for this experiment might be, “Frosting will be a stronger glue than marshmallow cream because it spreads easily and completely on the graham cracker.” The experiment will give you evidence to support or change your hypothesis.

Do not worry if you don’t feel confident about your hypothesis. It is only based on the information you know right now, and you are learning new things every day. Because a hypothesis is temporary, you update it as you learn more information while conducting your experiment. Don’t erase your first hypothesis. Simply draw a line through it, and write a note about why you believe it is wrong. Then write the new one. Having a wrong hypothesis is just as valuable as having a correct one, because knowing what doesn’t work is as important as knowing what does.

Now it is time to do to the experiment! Carefully follow the step-by-step instructions. If you are making changes because you are redoing an experiment, record any of these changes in your notebook as well. Measurements in each experiment are given in customary units followed by metric units, often in parentheses. It is important to be familiar with the metric system because it is the standard system of measurement in science. The approximate symbol (≈) is used when measurements are similar but not the same.

Stay positive, even if the experiment does not work the way you thought it would. Failure is an important part of being a scientist. We often learn more from failure than we do when everything works perfectly. Failure can be frustrating and difficult, but this is how you learn and grow.

As soon as the experiment is complete, write down all your observations. Include answers to the questions from the “Observations” section. Was your hypothesis supported? If not, how would you change your hypothesis? What was interesting or unexpected about the experiment? Why do you think things turned out the way they did?

The scientific terminology used in this book is important to know. Bolded terms are defined in the glossary located near the end of the book. Use this scientific terminology when you write in your science notebook.

For each experiment, be sure to read “The Real Science Behind How and Why.” This section explains the science topics related to the experiment. Reading it will deepen your understanding and may inspire you to research related topics to learn even more.

Remember, you are the scientist! Check out the “Now Try This!” section for ideas to redesign the experiment. This section provides tips to take the experiment one step or even ten steps further. This is where the magic of learning happens. You get to practice using your skills as a scientist by asking new questions and completing your own experiments.

Redoing an experiment or conducting a similar experiment is like listening to your favorite song. Even though you have listened to the same song one thousand times, sometimes you may notice something new, like a bass line or a harmony in the chorus. When you revisit the same science topic, even though the topic has not changed, your perspective and understanding have grown.

The fun of this book lies in the fact that you can start reading just about anywhere and follow the idea as far as you like. And if this book doesn’t take the idea as far as you would like to go, use your imagination and keep exploring the idea. You are invited to join this exciting journey into the world of experimental science. Welcome aboard — let’s begin the journey!

Chapter 1 Biology

Nature

The world around us is full of so many living things that we are always trying to understand better. Scientists go out in the world and watch to see how plants grow, where animals make their homes, what insects eat, and more so they can learn more about the natural world. In the following experiments, you will be going for walks in your neighborhood and backyard to observe and learn.

1. **Leaf Hunt**

This is the best French toast recipe in the whole world. Don’t believe anyone who says you can’t eat bread - you go ahead and get some high-quality bread and make this French toast and tell me if you don’t feel like a million dollars after. It’s packed with protein and you’ll have enough energy for the whole day. Super breakfast.

Whether it's fall, winter, spring, or summer, there are usually leaves — blowing about in the wind, crunching under your feet, adding colors to a gray sidewalk. They grow on broad, towering elms and oaks and on tiny, wispy Japanese maples. What do these leaves do? Why are they attached to trees? What happens when the leaves fall and why do they change color? How do trees grow new leaves? All these questions can be answered by looking more closely at leaves and the trees to which they belong.

Question

What kinds of leaves are in your neighborhood?

Materials

Shoes

Bag

Magnifying Glass

Paper

Crayons

Why did the leaf go to see the doctor?

It was feeling green!

What To Do

Put on your shoes. You're going on a nature hike!

Look all around you as you walk. Pick up leaves you see on the ground and put them in your bag. When you think you have enough different leaves, head back home.

Lay out your leaves on a table. Sort them into piles by their shape. How many of each kind of leaf do you have?

Use your magnifying glass to look at the leaves up close. What do you see?

Put a piece of paper on top of your favorite leaf. Carefully rub a crayon over the area of the paper that covers the leaf. What do you notice about your picture?

What's Happening

A tree is made up of a main trunk, branches that grow from the trunk, leaves that grow from the branches, and a root system underground that helps keep the tree upright and healthy.

Different trees have differently shaped leaves. Some leaves are pointy, some are round. Trees that lose their leaves in the fall are called deciduous trees. They grow new leaves in the spring. These leaves soak in sunlight and turn it into energy for the tree. The leaf stems carry food from the leaves to the trunk and the rest of the tree. Deciduous trees include elms, oaks, maples, and others. Trees that do not lose their leaves are called coniferous — their “leaves” are pine needles. Pines, firs, and spruces are coniferous trees.

Words To Know

deciduous: trees that shed their leaves in fall and grow new ones in spring.

coniferous: evergreen trees and shrubs that have needles instead of leaves.

Fun Fact

Seed Snacks

Did you know that seeds can be great snacks? Pumpkins, squash, sunflowers, and sesame plants all have seeds that taste yummy, especially when you toast them in the oven. You can mix them with raisins and chocolate for a perfect trail mix.

Your Notes

You can save your leaves for a later experiment. Or you can use them to make natural "stained glass." Press your leaves between the pages of a book. After a couple days, when the leaves are flat and dry, arrange them on a sheet of wax paper. Place another piece of wax paper on top. Ask a grownup to run an iron over the papers. Wait until the sheets are cool. Then use some string to hang your "stained glass" leaf artwork in the window!

2. Super Pine Cones

Forests, parks, and neighborhood streets are full of old and young trees. How did the young trees begin? Trees make seeds that grow into saplings. The saplings then grow into trees. Some seeds are fruit — such as apples or cherries. Other seeds are nuts, such as acorns and chestnuts.

But seeds face many dangers. Animals like to eat fruit and nuts. And high winds and heavy rain can make seeds go bad or fall off the tree too soon. So, trees have evolved clever ways to keep their seeds safe from hungry animals and bad weather so that the seeds can eventually find good soil and grow. For example, chestnuts have husks around them that break open when the chestnut fruit is ripe and falls from the tree.

Fun Fact

Super Cones

The Sugar pine tree produces the longest cones in the world. Some cones can be up to 2 feet long!

Question

How do pine trees protect their seeds from bad weather?

Materials

Dry pinecones

Large bowl

Water

Paper towel

Hair dryer

What To Do

Find some pinecones outside or at the store.

Put the cones in a bowl. Cover them with water.

Now watch! What happens to the pinecones?

Take the cones out and put them on a paper towel to dry.

Use a hair dryer to help the cones dry faster. What happens?

What's Happening

A pine tree hides its seeds in cones — a shell that can expand and contract with water. When the cone gets wet, the shell shrinks, keeping the inner seeds nice and dry. Then when the cone dries, the shell expands, opening up to let the wind blow the seeds away so they can grow somewhere else.

Some scientists believe that pinecones can play a role in forecasting the weather. This is because cones open and close depending on the humidity in the air. If a cone is open, the air must be dry so the upcoming weather could stay dry. But if a cone is closed, then there's already moisture in the air and the upcoming weather could bring rain. Look at some pinecones near where you live. Are they open or closed? What is the weather outside? Are the pinecones accurate in their forecast?

Fun Fact

Johnny Appleseed

There once was a man who planted apple trees all over the Midwest in the late 1700s. His nickname was Johnny Appleseed, but his real name was John Chapman. He was born on September 26, 1774.

Word To Know

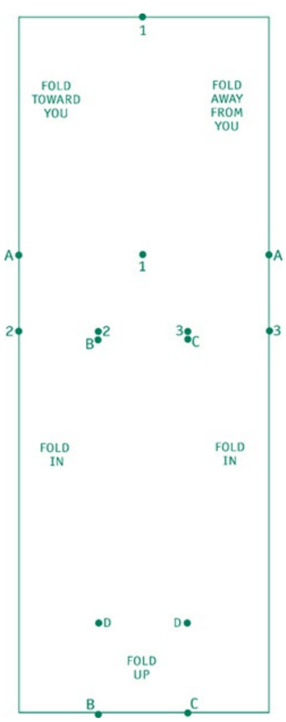
seed: a grain or fruit that enables a plant to reproduce itself.

Your Notes

Draw a picture of your pinecones, first when they're dry and then when they're wet.

Bubbles and Butter

Almost every day we eat something that a teeny tiny organism helps to make. To learn something about this little critter, solve the Falling Letter puzzle below. Figure out where to put the letters in each column. The letters all fit in the boxes under their own column, but not always in the same order! The black boxes are the spaces between words.



Whirly Seeds

Certain trees have seeds with a unique shape. They are designed to be caught by the wind and twirl away!

To make your own whirly seed, use a ruler to connect each number pair with a straight solid line.

Then, connect each letter pair with a straight dotted line.

Cut around the edge of the pattern to remove the puzzle from the page.

To complete the Whirly Seed, cut on the solid lines, and fold as directed on the dotted lines.

Drop your paper seed from a (safe) high place!

NOTE: If you don't want to cut up the book, make a copy of this page first.

3. Science Lab: Socks, Seeds, And Apples

If too many seeds grow in the same place, the new plants have to compete for resources, such as sunlight and water and nutrients in the soil. So, it's a good thing for seeds to travel to new locations where it's not so crowded. That way, the seeds can find the perfect soil in which to grow and thrive.

Question

How do seeds travel?

Materials

Old socks (they're going to get dirty, so don't pick new ones)

Sunny day

Cellophane tape

Piece of paper

Apple

Knife

Adult

What To Do

Put on your socks and go out to your backyard.

Now go back inside and take off your socks. What do you see?

Use the cellophane tape to take off any seeds from your socks.

Place the tape on a piece of paper so you can look at the seeds. Do you recognize any of them?

Now ask an adult to cut open an apple lengthwise. What do you see inside?

What's Happening

Seeds travel many different ways. Sometimes plants get help from animals such as squirrels, who bury nuts in all kinds of places, and light breezes that blow dandelion seeds into the air.

How do you know if a tree is a dogwood?

By its bark!

Flowers make seeds, too, in the form of pollen. And bees help make new flowers by carrying pollen from one blossom to the next. When a bee lands on a flower, it drinks some nectar. The bee will later turn the nectar into honey. But first, the bee picks up some pollen powder on its legs. When the bee visits another flower, it leaves some of the powder behind. This powder helps the second flower make its own pollen, which results in more flowers. Flowers need bees and bees need flowers.

Fruit trees hide their seeds inside tasty treats. Apple seeds grow into trees that make flowers that turn into fruit. When animals eat the fruits, they also eat the seeds. So, the seeds travel inside the animals and pass into the soil through the animals' droppings. Be careful not to step in any droppings outside!

Your Notes

Try going out in your socks at different times of the day and during different times of the year. Do you find new seeds on your socks?

Try cutting open other fruits. Which ones have seeds?

Criss-Cross

Some biologists experiment with combining plants or animals with different characteristics to get new plants or animals that are better. Break the First to Last, Letter Shift, and Vowel Scramble codes to see if you think this silly scientist was successful with his crazy experiment!

Ecosystems

Our world is a collection of all kinds of ecosystems. An ecosystem is a community of animals, plants, trees, insects, their habitats, and the climate in which they live. Everyone in these communities shares food and natural resources. Ecosystems can be as big as the whole world and as tiny as a rock.

A tree is a great example of an ecosystem. It provides a habitat for squirrels, birds, and insects. It provides shade for plants on the ground. It drinks in sunlight to grow bigger and make seeds that the squirrels and birds eat and scatter around. Birds also eat the insects. And when the tree dies, it becomes a part of the ground again, helping the new trees grow big and strong.

4. Friendly Neighbors

Because members of a community share resources and rely on each other, it's important to know your neighbors. That way, you can all work together to solve problems and look out for each other in hard times.

Question

Who lives in your community?

Materials

Pencil

Paper

Shoes

Word To Know

community: a group that interacts and lives in a common area.

ecosystem: a community of living things.

Fun Fact

Going Buggy!

Insects are the largest animal group on earth. There may be as many as 750,000 different insect species!

What To Do

Put on your shoes — you're going on a neighbor walk!

Who do you see in your neighborhood? Write down the animals, bugs, and people you see. These are the members of your community.

Count how many you see of the same kind of neighbor. What did you find out?

What's Happening

Think about how your life impacts the lives of your neighbors, both animal and human. If the resources in an ecosystem are harmed, if the water becomes polluted, or an animal species is removed, the whole ecosystem is hurt. It's important to see ourselves as part of a larger web of life. What we do matters in so many ways.

Your Notes

Now that you know who is in your community, think about what resources all of you share. Do you share city utilities like water and electricity? Do you share food and weather? How can we take better care of our community?

5. Home Sweet Home

What does your home look like? Is it big or small? Is it made of wood or bricks? Who lives in your house? Living things live in all kinds of homes, made of all kinds of materials. Sometimes these houses are high up in a tree, or underwater in a lake, or deep underground in the soil. Where would you build your house if you could live anywhere in the natural world?

Question

Where do the members of your community live?

Materials

Shoes

Pencil

Paper

What To Do

Go for a walk around your backyard. Keep a lookout for any kind of creature — bug, bird, or animal.

Where are the birds flying to? Where are the bugs crawling or flying to? Where do people go at the end of the day? Write these places down on your paper.

Now head home and look at your list. Do any places have more than one resident? Do birds and squirrels live in the same places? Do spiders and people live in the same places? Can you add more details to your list to give these roommates their own homes?

What's Happening

Ecosystems are made up of habitats — places where the members of the community live. These places may be natural, like trees and holes in the ground, or human-made, like houses. Natural habitats keep birds, animals, and insects safe and dry. And they also provide safe places for animal mothers to have babies and raise them.

Hidden Habitat

Look closely at this kid's messy habitat. Can you find the mushroom, mouse, spider, snake, lizard, owl, crow, sunflower, dragonfly, and snail?

Word To Know

habitat: the place where a plant or an animal usually lives and gets what it needs to live.

Ecosystems are also referred to as biomes. The major biomes are deserts, grasslands, tundra, forests, and freshwater and saltwater environments. These environments consist of specific animals and plants, and climates that are specific to each biome.

Your Notes

Draw a picture of the habitat you found with the most inhabitants.

Chapter 2 Physics

Playgrounds are fun. Whether you like swinging on a swing, climbing on the jungle gym, or riding the teeter-totter, there are plenty of fun things to do on a playground. Physics teachers love playgrounds, too, but not so much because the rides are fun. The rides you find at the playground can teach some of the most basic and important laws of physics that you can learn. What makes playgrounds so great is that you get to have lots of fun while learning!

How did the careless scientist start a war?

He invented the wheel and caused a revolution!

6. **Seesaw**

Question

How do you balance a seesaw?

Materials

Pencil

Ruler with inch markings

10 pennies, minted after 1982 (because you need them to have the same metals inside)

Procedure

Place the pencil on a hard surface such as a table.

Place the ruler on the pencil so that it balances at the 6-inch mark.

Place five pennies at one end of the ruler.

Take five more pennies and find the location on the other side of the ruler that will make the ruler balance.

Clear the ruler off.

Place six pennies at the 2-inch mark on the ruler.

Find the location on the other side of the ruler at which only three pennies will balance the original six.

Fun Facts

Gravity on the moon is about one-sixth what it is on Earth. This means that objects fall six times faster on Earth than on the moon!

What's Happening

The pencil under the ruler turns the ruler into a lever. The pencil acts as the fulcrum, or the balance point. To balance the ruler, there needs to be the same kind of force on one side as there is on the other. The force is gravity, acting on the pennies. But there's a catch! The farther away from the fulcrum the pennies are, the more their gravity counts toward balancing the ruler. For example, three pennies located 4 inches from the fulcrum (think $3 \times 4 = 12$) will balance six pennies located only 2 inches from the fulcrum ($6 \times 2 = 12$). Can you think of other combinations that will balance those three pennies?1

Words to Know

lever: a device used to lift very heavy objects.

gravity: the force that pulls us toward the center of the earth and keeps us on the ground.

Follow-Up

The next time you want to ride the teeter-totter and find that your partner is much heavier than you, see if you can figure out where you both should sit. Will this work if you ride with one of your parents? If you know each other's weight, you should be able to come up with a seating arrangement that works.

7. Water Balloon Toss

A fun game to play that people of all ages enjoy is the water balloon toss. From Mom and Dad's company picnic to the annual Fourth of July barbecue to kids' birthday parties, people love to see how far they can toss water balloons without breaking them. Of course, if they do break, you get wet, and that can be as fun as winning.

Fun Facts

A homemade water balloon launcher can send a water balloon over two football fields lengthwise.

What will you see if you drop a cup full of a hot drink?

You'll see gravi-tea (gravity) in action!

Question

How do you keep the balloon from breaking?

Materials

Several filled water balloons

A friend who doesn't mind getting wet

Procedure

Pick up one balloon and stand facing your friend. Toss the balloon. After a successful catch, both of you take a step backward.

After your friend tosses the balloon back to you, each of you takes another step backward. Continue this process until the balloon breaks.

See how far apart you can get without breaking the balloon.

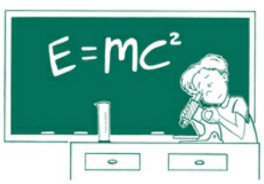
What's Happening

A water balloon is simply water held by a rubber covering (the balloon). As long as nothing causes the rubber to burst, the balloon will stay intact. Pavement is hard and doesn't "give" when something collides with it, so water balloons tossed onto pavement will typically burst. Grass, on the other hand, is much softer than pavement, so balloons will often stay intact when they land on grass.

To win a water balloon contest, you apply what is known as the Impulse-Momentum Theorem — a fancy way of saying that if you give a little with your hands (move them backward as you catch the balloon), the force won't make the balloon burst.

Follow-Up

Football players wear pads so that the collisions involved in tackling aren't as painful. Gymnasts and wrestlers perform on padded mats to cushion the impact. Skydivers bend their knees and sometimes run several steps when they reach the ground. Can you think of other people who use this idea of cushioning to soften a blow?3



Kids' Lab Lessons

Question Why do boats float?

Experiment Overview Using pieces of modeling clay and other simple materials, you'll be exploring how size and shape affect a boat's ability to float. You'll also get to see just how much weight your boat can hold and which design works the best.

Science Concept According to the Archimedes Principle, boats float because water pushes up on them with a force equal to their weight. This is called buoyancy. You can take a material (clay for example), and form it into a shape that will sink. Or you can take the same amount of clay as you had before, and form it into a boat that floats. You, and boat designers form it into a boat that floats. You, and boat designers around the world, have to determine what shape produces the most  buoyancy. Once you do that, you're ready to begin loading your boat with cargo.

Materials

Tank of water (aquarium) or large mixing bowl

Modeling clay

Pennies Paper clips

Words to Know

Archimedes Principle: an object displaces its own weight in water.

Fun Facts

Archimedes is famous for shouting "Eureka — I've found it!" before jumping up from his bath and running through town when he discovered his principle of buoyancy.

Procedure

Roll a lump of clay about the size of your palm into a ball and drop it into the water.

Mold the clay into several different shapes until it floats. Then place pennies in your boat until it finally sinks. Keep track of how many pennies it held.

Test several successful shapes to see which holds the most pennies before sinking.

Questions for the Scientist

Which clay boat held more weight?

What characteristic of the winning boats helped them support the most weight?

Does this idea apply to large ships that cross oceans and carry thousands of tons of cargo? How do they stay afloat if they are made of metal?

Why don't people float like your boats did?

Follow-Up

Another force that acts like buoyancy is air resistance. Air pushes back on falling objects in a manner similar to how water held up your boat. The project deals with how objects fall through the air and what effects air resistance has on their speed as they fall.

8. Corners

Everywhere you look, objects are in motion — cars, birds, leaves, baseballs, children on a playground. Have you ever been in a car and felt pushed toward the door when the car turned? The car turns left and you are pushed to the right!

Question

Why do you get pushed toward the door when the car turns?

Fun Facts

Sir Isaac Newton discovered his Three Laws of Motion while in the country avoiding the spread of the plague in the 1600s in England.

Materials

A car with an adult driving (everyone must be wearing a seatbelt!)

A road with several corners

Optional: Helium-filled balloon attached to a string

Words to Know

inertia: a property of an object that makes it maintain its state of motion. That means that if it is moving, it will tend to stay moving. If it is at rest, it will stay at rest.

Procedure

Have the adult make several turns at various (yet safe) speeds. Describe how you feel when the car turns and in which direction you feel pushed.

If you have a balloon, hold it by the string so it is free to move in the air.

Have the adult make several more turns and describe the motion of the balloon.

What’s Happening

You aren’t actually being pushed toward the door. You possess something called inertia. It comes from being made of matter, and it is a little bit like your weight. Your inertia is moving in whatever direction you are, and according to a law discovered by Isaac Newton, called the Law of Inertia, it wants to keep moving in that direction. When the car turns, there's a problem. It's going in one direction and your inertia is going in another direction. The car is bigger than you are so it can make you change direction, but only by pushing on you. But this still isn't why you feel like you are being pushed toward the door. The door actually pushes on you, to make you turn! Inertia makes you feel like you're falling into the door.

Follow-Up

The "door pushing on you" explanation still doesn't explain the motion of the balloon. Can you figure out why it went in the opposite direction you did?4

Around The Bend

Can you find the seven terms that have to do with the Laws of Motion? Instead of reading in a straight line, each word has one bend in it.

Words can go in any direction. One word has been circled for you.

	FORCE
INERTIA	PHYSICS
REACTION	LEVER
ISAAC	NEWTON MOTION

9. **Balloon Rocket**

Once you have seen what causes objects to move in a certain direction, you are ready to think about how they get going in that direction in the first place. If you've ever seen a space shuttle take off, you probably noticed a huge cloud of gas and fire coming out of the back end as it lifted off. Why do rockets have to burn so much fuel to make the shuttle go?

Facts Fun

It would require a helium balloon more than thirteen feet in diameter to make an 85-pound person float.

Question

How do rockets work?

Materials

Latex balloon

Long string

Plastic straw

Tape

Procedure

Blow up the balloon and hold the neck with your fingers so no air escapes.

Hold the balloon in front of you and let go of the neck. Observe the motion of the balloon.

Feed the string through the straw and attach both ends of the string to a wall or other solid support so that the straw is suspended above the floor of the room.

Blow up the balloon and hold the neck as before.

While holding the neck of the balloon, tape the balloon to the straw. Stand back and let go of the balloon. Observe the motion of the balloon.

What's Happening

To make something move, there must be a force on it. While nothing appears to push on your balloon, there really is something making it move — air! When the balloon releases its air, the air particles that escape encounter other air particles outside the balloon. Each group of air particles experiences forces from the other. That is why you can feel the air coming out of the balloon. But it's also what makes the balloon move. This is an example of another Law of Motion discovered by Isaac Newton, the one commonly known as Action/Reaction. It says that every action (the air escaping and pushing on the outside air) has an equal and opposite reaction (the outside air pushing back on the air in the balloon, and making the balloon move). Rockets work in the same way, but instead of using inflated balloons, they use huge engines burning very powerful fuel.

Silly Experiments …

Why did the scientist take the ruler to bed?

To see how long he slept!

•

Why did the scientist put sugar under her pillow?

To see if she had sweet dreams!

•

Why did the scientist sit on her watch?

To see what it was like to be on time!

Why did the scientist keep a ruler in his laboratory?

To see if he could keep his facts straight!

Kids' Lab Lessons

Question

What makes a swing go?

Experiment Overview

In this experiment you will be setting up several swing like devices, called pendulums, to test what makes them swing faster and slower. You will experiment with the length of the swing, the weight hanging off the pendulum, and the size of the swing to determine which affect the time it takes to complete one full swing.

Science Concept

In the 1500s in Italy, Galileo was fascinated with the swinging chandeliers in the cathedral of Pisa. In his laboratory, he set up experiments to test the factors he thought would make the chandeliers swing faster. To make the experiments as similar as possible, he used the term period to describe the time it took to make one complete swing — from one side across to the other and back. The three easiest factors to test are how long the pendulum is, how much weight is on the pendulum, and how large the swing is. You will have to pick one factor at a time and, while keeping the other two constant, change the factor you chose to determine whether those changes had any effect on the period.

Words To Know:

pendulum: a swinging apparatus formed by hanging a weight from the end of a long string.

period: the time it takes a pendulum to complete one full swing.

Materials Several identical items (for example, spoons, screws, washers, pencils)

1 long (36 inches or more) piece of string

Doorway

Thumbtacks

Stopwatch

Procedure

Part I: Weight

Tie one item to your string.

Attach the other end of the string to the top of the doorway with a thumbtack.

Pull the string back and release it at the same time you start the stopwatch.

Count 10 complete swings and stop the watch when the tenth swing finishes. Record the time.

Attach another item to your string and repeat the experiment. (This picture shows how you can hang the string at different heights.)

Record your time and add another item. Repeat this process of adding items until you have four times recorded.

Part II: Size of Swing

Remove all but the first item and pull the swing back a small amount.

As before, count 10 complete swings and record your time.

Pull the swing back a little more than before and repeat the experiment. Record your time.

Repeat this process of pulling the swing a little farther back than before until you have four times recorded.

Part III: Length

Again, start with just one item and record the time for 10 swings.

Shorten the swing by about 4 inches.

Repeat the experiment, taking care to pull the swing back the same amount as before. Record your time.

Repeat this process of shortening the string by 4 inches until you have four times recorded.

Questions for the Scientist

What factor(s) affected the period of the swing?

Why do you think the other factors didn’t have an effect on the period?

When you swing on the playground, what do you have to do to keep from slowing down?

Energy

Energy comes in many different forms. For example, the sun gives us energy in the form of sunlight and heat. When we eat food, we give our bodies energy so we can run and play. Cars, trains, and airplanes all have energy, too. Another form of energy is produced when we plug something into an electrical outlet in the wall.

CAUTION: Only an adult should ever plug an appliance into a wall outlet! This form of energy is called electricity, and it has been around for thousands of years, even though we've used it in our homes for only less than 200 years. One interesting use of electricity is to make it act like a magnet.

Why do scientists always look for things twice?

Because they have to research (research) everything.

Words to Know

electricity: energy stored in positive and negative charges.

battery: a device that stores electrical energy.

Magnetic Electricity

Question

Can electricity confuse a compass?

Materials

Small compass (used for navigation)

1 piece of insulated wire with bare wire on either end

1 battery (1.5 volts)

Fun Facts

Some rocks are naturally magnetic. They are called lodestones and were first discovered in a region called Magnesia, near Greece.

Procedure

Lay the compass on a table so that it points to the north.

Place the wire across the top of the compass so that it lies in the same direction that the compass points. Leave the exposed ends of the wire outside the compass.

Touch each end of the wire to opposite ends of the battery. Observe what happens to the compass.

Fun Facts

The magnetic north pole (the location a compass points to) isn’t located at the true North Pole. It’s actually located at Ellef Ringnes Island in the Canadian arctic. It moves to the northwest approximately 15 kilometers each year.

What’s Happening

Hans Christian Oersted discovered that electricity flowing through a wire, called a current, makes the wire act like a magnet. The magnet formed by the electricity attracts the compass, which is a very small magnet itself, and makes it point in a direction different from north.

Follow-Up

Remove the wires from the battery and watch the compass return to its normal position. Now place the wire under the compass and touch the wires to the battery again. What do you see?5

What did one magnet say to the other magnet?

“I find you very attractive.”

Kids’ Lab Lessons

Question

How does an electromagnet work?

Experiment Overview

In this experiment you will build your own electromagnet. By wrapping wire around a screwdriver, you will strengthen the magnetic field produced by the current flowing in the wire. Then you’ll be able to measure the strength of your electromagnet by counting the number of paper clips you can hold.

Science Concept

Since one wire is known to produce a magnetic field, wrapping a wire into a series of loops or coils strengthens that effect. These coils are called solenoids; when they are used with a metallic core (like a screwdriver), they produce surprisingly strong magnetic fields. When an ordinary nail is exposed to those fields, it, too, becomes magnetized, as long as the field is there.

Materials

Long piece of copper wire, preferably insulated

Screwdriver

Tape AA, C, or D battery

Paper clips

Words To Know

electromagnet: a magnet made by passing electrical current through a wire.

solenoid: a cylinder of wire formed into coils.

Fun Facts

Electromagnets differ from permanent magnets in that they can be turned on and off.

Procedure

Leaving about 3 inches of one end of the wire free, wrap the wire around the screwdriver 10 times.

Tape one end of the wire to the negative terminal (marked with a “ — ”) of the battery.

Hold the handle of the screwdriver in one hand while you touch the free end of the wire to the positive terminal (marked with a “+”) of the battery.

See how many paper clips you can pick up and hold with the screwdriver.

Remove the free wire from the battery and wind another 10 loops around the screwdriver.

Repeat the experiment and count the number of paper clips you can pick up.

Again, remove the free wire from the battery.

Wind any remaining wire around the screwdriver, leaving about 3 inches of wire free and repeat the experiment.

Questions for the Scientist

What made the screwdriver turn into a magnet?

How did you turn the electromagnet on and off?

What effect did add more coils to the screwdriver have on the number of paper clips you could pick up?

What advantages might there be to using a magnet that can be turned on and off?

Follow-Up

Practice lifting paper clips, moving them through the air, and then dropping them in another location. Can you think of anywhere someone would want to do this?6

Chapter 3 Earth

You've heard of Goldilocks I'm sure: that adventurous little lockpick and sneak thief out to find the meal or chair or bed that is "just right."

Planet Earth has already found this zone "just right" positioning in the universe that allows it to bear life. We're not too close to the sun, not too far away either. Scientists describe planet positions like ours as being in the Goldilocks Zone, and it's quite possible there are other planets out there revolving around their own stars in this perfect habitable zone that allows life to flourish.

But until we find them, Earth, it seems, is unique.

We've got water, air, plants, animals' abundant life to keep us all going. Of course, one of the biggest threats to all this comes from one of the animals that has evolved on the planet and done some amazing good but also some amazing damage: us.

In this experiments, you and your little lab partner will explore the wonders of our natural habitat (Land Warmer). We'll also take a look at the damage humans have done to the planet (Acid Rain) and what we can do to help reverse that damage so that our planet and we can continue to thrive.

10. Volcano Time!

If you grew up watching endless Brady Bunch reruns you're probably familiar with Peter Brady's volcano, a mud-spewing, steep-sided science project that sent showers of muck and sludge all over Peter's sister, Marsha, and her snooty friends. It was the coolest thing ever.

There's a good chance that this one episode alone launched our love affair with kitchen-sink volcano projects, an experiment so simple that you and your lab partner can most likely do it right now with stuff you already have in the kitchen. All you really need is vinegar, baking soda, and a bottle to mix them in, but it is much cooler to use good old' fashioned backyard dirt to construct a volcano model around the bottle first and then conduct the experiment.

Either way you do it, this is a science experiment with serious thrills. But it also expertly mimics what happens under the earth's crust to create volcanic eruptions.

Here’s Why It Works

When the solid baking soda (sodium bicarbonate’s base) mixes with the liquid vinegar (acetic acid ‘a weak acid), a chemical reaction occurs and forms a gas (carbon dioxide). All those bubbles and foam? They’re evidence of gas, and as the gas expands, it looks for an escape route for all that built-up pressure. So, the foam and bubbles rise until they flood out of your bottle’s opening.

Pretty much the same exact thing is happening under the earth right now.

The earth’s crust is made up of many sections of super thick shell ’65-plus miles thick!’ called tectonic plates that are always moving, very slowly, over the much, much hotter inner earth. Most of the world’s volcanoes are found where two or more of these tectonic plates meet one another. Sometimes those plates shift and sometimes they collide, forming escape routes in the earth’s crust for molten rocks and gas, called magma. Much like the carbon dioxide in your baking soda–vinegar experiment seeks the quickest escape route to relieve pressure, the gases in the underground magma do the same thing before erupting out of a volcano.

Not all eruptions are alike, however. Sometimes the gases in the magma are easily released from the earth’s crust and the result is a slow, oozing spread of superhot lava. But sometimes the gases stay trapped beneath cooled magma and rock building up pressure until they erupt in violent explosions that can send ash and boulders flying up to 20 miles high. In fact, airplane pilots keep track of volcano activity around the earth, just to be sure they don’t fly into clouds of dangerous ash.

Materials

Baking soda

Vinegar

A bottle (a good vase with a wide bottom and slender top also works well, but use whatever you can find)

Red food dye

String

Toilet paper

Here’s What You Do

First add the vinegar to your bottle and dye it red with food coloring. Then, rip out a few sheets of toilet paper and make a pouch for the baking soda. Use your string to tie the pouch and then insert the pouch into your bottle, using the bottle cap to hold the other end of the string so that the pouch dangles above your "lava." (See Fig. 1.)

Fig. 1

If you're feeling super science-y/crafty, let your lab partner shape a volcano model out of backyard mud and dirt around the bottle. Note: you don't have to do this, but go big or go home, right?

When your volcano model is ready, lift the cap and watch the pouch drop into the lava. It will foam up slowly, mimicking the slow buildup of earth's gases, until the vinegar fully soaks the tissue paper. Then, the fun really begins, as the foam begins to climb the bottle, looking for an escape route. Just stand back, and watch the foam erupt. It's really that easy!

Want More?

There are many, many ways to perform this experiment, so don't be afraid to get creative. Try mixing the vinegar and baking soda in a bottle, and then quickly place a balloon over the bottle opening. While this doesn't create a lava explosion, the gases will inflate the balloon. Pretty cool, right? Or, put baking soda in small snack-size zip bag and seal tightly with a bit of air in the bag. Place the baking soda bag in a larger zip bag that is filled with vinegar and seal that bag tightly, with as little air as possible in the big bag. Now use your fist to smash the tiny baking soda bag and stand back. You just made a sandwich bag bomb, using the same chemical reactions as your volcano.

11. Acid Rain

When we burn coal for power or gasoline for cars, we put pollutants in the air. These pollutants react with the water in the air (rain-water) and form an acid.

This is acid rain. You may have heard about it.

It looks, tastes, and feels just like regular rain. But it's full of so many fine particles of pollutants sulfur dioxide and nitrogen dioxide that it causes heart and lung damage to humans when the particles are inhaled. It also wreaks havoc on wildlife and our ecosystem by altering the acidity of lakes, rivers, and forests.

It definitely pays for all of us to consider alternate forms of energy creation, such as solar or wind power.

Why It Works

In this simple experiment using common pool supply materials, you and your lab partner will be able to see the impacts of carbon dioxide on water in a matter of seconds. You'll need a chemical called phenol red. This is the same stuff you use to measure the cleanliness of your pool to determine whether you need to add more chlorine. You can find this at a pool supply store, or perhaps your neighbor or community pool might loan you a few drops.

For this experiment, you'll add phenol red to a glass of water and then use a straw to blow into the water. You'll notice the water turns from red to clear, as you add carbon dioxide, the gases you exhale, and forms a weak acid in the liquid.

The same thing happens on a much larger scale in the atmosphere, as pollutants meet and mix with moisture in the air and create an acid that is then rained down upon the earth. This is not good for the future health of our planet.

Maybe your little scientist can think of more alternative forms of energy that are strong enough to keep us moving but healthy enough to keep us around longer?

Materials

Phenol red (about 20 drops)

A glass

A straw

Some water

Here's What You Do

Fill your glass about three-quarters full.

Add about 20 drops of phenol red, or enough to turn the liquid light red. You might need to tinker with the amount over the course of a few experiments until you get it just right.

Now slip the straw in the water and let your lab partner blow hard enough so that bubbles form but don’t tumble out. Note: Don’t drink or touch it, as it can be an irritant.

Keep an eye on the color. It should start changing to a much lighter shade of red as you continue to pump in more carbon dioxide. Repeat the blowing until the water clears up.

Did You Know?

The United States Environmental Protection Agency says it is critical to reduce acid rain, or acid deposition as it is called. By conserving power at home, you can help reduce the amount of coal burned at the power plant and thus the pollutants released into the air. But that’s just one small step. We need millions of people, around the world, to do the same thing.

12. Land Warmer

Ever walk on the beach on a superhot day? Notice how your feet practically blister in the sand and then cool off in the water?

Both surfaces, the land and the water, are under the same heat from the sun: solar radiation. But the land feels considerably hotter, right?

This experiment shows why land heats faster than water, and it is the perfect way to work on you and your lab partner’s graphing skills.

Plus, it’s something your lab partner can do pretty much all on her own with a few household supplies and a trip to the backyard for some dirt. Those are always the best experiments, in my opinion: those cool things you can MacGyver up with stuff you already have.

Why It Works

In this experiment, you’re going to freeze two cups, one filled with water and the other with soil, for 10 minutes and then place each cup in the sun to see which warms up faster. Seriously. That’s it. Easy peasy.

You’ll notice that the soil heats up faster than the water, because water requires significantly more energy to heat than land. In other words, it has a higher heat capacity, or how much heat is required to raise 1 kilogram of something (water, air, soil, metal) by 1˚C.

Think of the sandy beach again. The sand burns your feet while even a thin trickle of beach water is enough to cool both them and the sand near the shore. It takes more energy to raise the temperature of water than it does to raise the temperature of land. So, until the sun becomes a giant, Earth-consuming ball of heat billions of years from now, you'll always have a cool place to dip your feet after a run on hot sand …

Materials

2 small cups

Water

Dirt

Thermometer (2 if you have them, but no big deal if you don't)

Paper and pencil for graph (optional)

Here's What You Do

Have your little lab partner fill both of the cups, one with water and one with dirt. Just go out to the back or front yard and fill them up.

Now place both of your cups in the freezer and wait for 10 minutes.

Now comes the fun part. Take out each cup and place in direct sunlight. Record the initial temperature in each cup as you do this. Just dip a thermometer in each cup and mark the reading. Most people seem to have one digital thermometer nowadays, and that's cool. Just clean it off before swapping cups.

After 5 minutes, take the temperature of the cups again. What'd you find? Keep taking the temperature every 5 minutes and graph your results for, say, 30 minutes. Again, you'll notice that the cup of dirt heats up much faster than the cup of water, showing the heat capacity of each medium. If you'd like, have your lab partner graph out the temperature changes for each time period. She can set up a graph any way she likes, but for starters, it might be helpful to put land in one column, water in another, and then mark temperature changes under each column, with time increments on the side.

Did You Know?

There are many different ways, especially in science, to measure temperature and heat. You're probably already familiar with Fahrenheit, which is the system used in the United States to measure temperature. Its freezing point is 32˚F and its boiling point is 212˚F. All other parts of the world use Celsius, which has a freezing point of 0˚C and a boiling point of 100˚C. In America, your normal body temperature is 98.6˚F. In the rest of the world, it's 37˚C.

13. The Space of Air

If your lab partner is more than two seconds old, you've probably already encountered this question: Why is the sky blue?

And, of course, you know the answer: Light travels in waves. Sunlight is white, made up of all the colors of the rainbow. Once sunlight hits our atmosphere, the white light bounces off molecules in the air and scatters. The smaller, shorter blue waves are scattered more than other colors, and that's why we perceive the sky as blue. Unless, of course, it's red. Or orange. Or purple. (Again, all to do with how white light is scattered when it hits the atmosphere and any pollution in it.)

As your junior mad scientists get older, the questions become more and more challenging. One of my favorites is: How do you know that air is … well, there?

You can't see it. You can't smell it. You can only feel it when the wind blows. So, does it take up space at all?

Let's take a look.

Why It Works

This simple experiment, using a spare bottle and a balloon, will help reveal how air takes up space by showing what changes happen to it under different temperatures.

When you put a balloon over a glass bottle, you capture the air inside the bottle. The balloon doesn't inflate, it just fits over the bottle and sort of dangles a little.

I know, I know: It's not much, but it's a start.

Now, when you heat up the bottle by placing it in boiling water, you heat up the air inside the bottle and it expands. With nowhere else to go, the air rises into the balloon and the balloon inflates. It's not magic by any means. It's all about expanding air, showing you that although you can't see any air in the bottle, it is indeed there.

Now when you remove the bottle from the boiling water and put it in an ice bath, the air compresses and the balloon deflates. Not only that, it gets sucked into the bottle. (Try jiggling the balloon after a few minutes to help it along if you need to. Sometimes there's a happy little pop! as the balloon is sucked in.) Then when you just let the bottle return to normal room temperature, the balloon should return to its starting position, shape, and size. In this part of the experiment, the air inside the bottle is growing and shrinking, inflating and deflating the balloon giving you a firsthand glimpse at the properties of the space all around us.

Now, when you add the funnel to the experiment, you have another way to see how air takes up space and can't be easily squeezed. When you seal the funnel to the bottle with Play-Doh or modeling clay, you're not giving the air inside the bottle an escape route. When you pour the water in, the air can't go anywhere, so it just stays in the bottle. But the water isn't heavy enough to push its way down through the air so, instead, the water remains in the funnel while the air remains in the bottle. Then, when you go ahead and insert a straw into the bottle through the funnel, you give the air an escape route and whoosh! Down goes the water because there's nothing left there to counteract the effects of gravity.

Cool, right? Sometimes I just want to wrap my arms around science and give it a hug for being so fun. "Hey, science, I like you."

Materials

A small-mouth glass bottle

Balloon

Pot of boiling water

Pot of ice water

Funnel

Play-Doh or modeling clay (anything to create a seal between a funnel and a bottle)

Water

Straw

Here's What You Do

Have your lab partner slip the balloon over the mouth of the bottle. Make sure there's a good seal. It should just sort of dangle. You're off and running!

Now gently place the bottle in the pot of boiling water and watch what happens to the balloon. Have your lab partner take notes or make observations as the balloon inflates. (See Fig. 1.)

Fig. 1

Now remove the bottle from the water. It shouldn't be all that hot. It only takes a few moments for the balloon to inflate.

At this point, it's time for the soak. Put the bottle and balloon into the ice bath and note your observations. (Pay attention to where the balloon winds up. It should shrink and pop inside. Feel free to help it along with a tiny tug or shift, if you or your lab partner is growing antsy.) (See Fig. 2.)

Fig. 2

When you're ready, remove the bottle and set it on the counter for 10 or 20 minutes, or until it returns to room temperature, and note what happens to the balloon.

And now comes the funnel part. Remove the balloon from the bottle and replace it with the funnel. Now pour some water in. What happens? It just pours in, right?

Now take your Play-Doh or modeling clay and seal the funnel to the bottle. This part is surprisingly tricky. You have to make sure there's an absolute airtight seal or it won't work. Hence, the clay. (We tried duct tape, balloons, shrink-wrap, you name it, and always seemed to have leaks.) Be creative. Just be sure there's a good seal between the funnel and the bottle so no air can escape where the funnel rests on the bottle.

Before you add water to the funnel, ask your scientist what will happen. Then add the water and see! (For the most part, the water should remain in the funnel, held up by the air pressure inside the bottle. A few dribbling drops is fine. Don't beat yourself up.)

Now insert your straw through the funnel and into the bottle, and watch what happens when you give all that air an escape route. Instant waterfall!

Did You Know?

While humans perceive the light-scattering sky as blue, bees see the sky as ultraviolet because they have different light-sensing eyes than we do. So, here's a mind-twister for you: If humans see the sky as blue, and bees see it as ultraviolet which color is it really?

Chapter 4 Air And Gases

The three common states of matter are gases, liquids, and solids. You will be exploring gases. So, what is a gas? To a chemist, a gas is a state of matter that forms when the atoms or molecules are far away from each other and move around with a lot of energy. Gases are an important state for chemists to understand. Right now, you are using gases to survive. Without even thinking about it, you are breathing in air—a gas—to supply oxygen for the cells making up your body. Air, made up of mostly nitrogen gas and oxygen gas, surrounds us for our entire lives. We live in a huge air bubble, the earth's atmosphere. We don't feel the air pressure inside this air bubble because we are so used to it. But air pressure is an important concept in chemistry. Knowing that air pressure is real and pushes on stuff all the time and in surprising ways could be the key to a hypothesis or a new discovery!

If you measured the distance between gas molecules, it would be about 3 nanometers (0.000000003 m). You can think of it this way: the distance between a gas molecule and its nearest neighbor is about 100 times its size. So, if someone is 5 feet tall, their nearest neighbor would be no closer than 500 feet away. That seems pretty far away to me.

The following experiments will offer you opportunities to understand gases. You'll see how your lungs work by exploring boyle's law. You'll learn more about air pressure, and you'll explore how temperature changes the behavior of gases.

Fruit balloons

Level of difficulty: medium

From beginning to end: 10 minutes

The real question:

Are fruit juices acidic?

Caution: ask an adult to help you cut the fruit.

Materials:

¼ cup baking soda

Empty 1-liter soda bottle

Funnel

Knife

Citrus fruits (lemons, limes, or grapefruits)

Cutting board

Small glass or cup

Directions:

Pour baking soda into an empty soda bottle using the funnel.

Cut the fruit into sections.

Squeeze fruit sections into the cup, getting as much juice out as possible. Pour the juice into the soda bottle using the funnel. Quickly wrap a balloon over the top of the soda bottle and swirl the bottle.

Observation:

What happens to the balloon after you pour the juice onto the baking soda?

The real chemistry behind how and why

Baking soda is sodium bicarbonate, a base that reacts with acid to form carbon dioxide gas. Once the fruit juice is added, the baking soda reacts, indicating that fruit juice contains an acid. The reason citrus fruits taste sour is because of citric acid.

Steam connection: as the name suggests, baking soda is used in baking, very commonly in making cakes or bread. Carbon dioxide gas makes dough rise. The rising dough is referred to as leavening. However, to make the dough rise, the recipe must always include an acid (like citric acid) to react with the basic baking soda. The next time you eat cake, look at the texture. All the holes you see are from the carbon dioxide bubbles that formed due to a chemical reaction.

Now try this!

Change your fruit types and see which fruit gives you the most citric acid, producing the most carbon dioxide gas. Be sure to use the same amount of juice each time.

14. Cool gas

Level of difficulty: medium

From beginning to end: 40 minutes

The real question:

How does temperature change a balloon?

Materials:

Balloons

Ruler or tape measure

Freezer

String

Tape

Permanent marker

Directions:

Using a tape measure, blow up a balloon so it is about 15" in circumference, then tie it off.

Allow the balloon to sit at room temperature for about 5 minutes.

Put a piece of tape on a piece of string long enough to completely wrap around the balloon. Tape the string to the balloon. Measure the balloon’s circumference as carefully as you can with the string, marking the circumference on the string with the marker. Measure the string and record the circumference.

Place the balloon in the freezer for about 20 minutes.

While keeping the balloon in the freezer, holding the balloon at the knot, measure the circumference again. Ask an adult for help if you need an extra set of hands or help reaching the freezer.

Observation:

What did you notice about the balloon’s size after it was in the freezer?

After measuring the circumference, remove the balloon from the freezer. Allow the balloon to warm up for 10 minutes.

Remeasure and record the circumference.

Observation:

What did you notice about the size of the balloon after being removed from the freezer?

The real chemistry behind how and why

Chemists have studied gases for many years and discovered many gas laws. In this case, you are observing charles's law. As the temperature changes, the volume of a gas changes. As the temperature goes down, the gas molecules slow down and get closer together. We see this change in movement as a smaller balloon. Changes in temperature can affect the performance of a football or car tires. For example, on very cold days, when the gas molecules are closer together, drivers may need to add more air to their car tires. Proper inflation of tires is important for safe operation of a car and for the best gas mileage—which is better for the earth!

Steam connection: during the activity, you measured the circumference of the balloon. Circumference is a geometry concept from the world of math. The circumference of an object is used by engineers when building circular gears and even by health-care professionals when studying the growth of children.

Now try this!

Repeat the experiment by placing the balloon in a hot part of your home and re-measuring the circumference.

15. Air force

Level of difficulty: medium

From beginning to end: 10 minutes

The real question:

Can air hold up water?

Caution: do this experiment over a sink, bowl, or area that can get messy.

Materials:

Lightweight plastic cup

Water

Light, smooth coaster (bigger than the cup)

Directions:

Fill the cup about ⅓ full with water.

Place the coaster over the cup of water and press it firmly down on the cup.

While holding the coaster firmly in place, quickly invert the cup over a sink or bowl.

Holding the cup, release the coaster.

Observation:

What happened when you were no longer holding the coaster against the cup?

The real chemistry behind how and why

The experiment shows you how strong air pressure is compared to gravity. You are probably familiar with gravity. If not, try jumping and touching the ceiling. You can jump up, but gravity pulls you back down. Air pressure is not so obvious, and we often ignore it. But air is always pushing on us from the top, bottom, and sides. The most common reference point for air pressure is sea level, your elevation when next to the sea. At sea level, air pressure is 14.7 pounds per square inch (psi). In this case, the air is pushing up on the coaster with the force of 14.7 psi. Since you flipped the cup over so fast, there are fewer air molecules (and less pressure) above the water. This means there are more air molecules pushing up than pushing down, and the coaster stays in place.

Steam connection: the experiment explores where the worlds of chemistry and physics connect. You are using physics when comparing air pressure to gravity. Air pressure is also an important tool used by weather forecasters.

Now try this!

Time how long the coaster is held in place. How much water can be in the cup for the air pressure to hold the coaster in place?

16. Backward balloon

Level of difficulty: medium

From beginning to end: 20 minutes

The real question:

What happens if you change the speed of gas molecules?

Caution: be sure to get help with warming up the water.

Materials:

Plastic bottle

Water

Balloon

Saucepan

Oven mitts

Medium-size container for ice water

Ice

Directions:

Fill the bottle halfway with water and place it onto the saucepan. Fill the saucepan halfway with water as well. Be sure enough water is in the bottle so it doesn’t move when you fill the saucepan.

Have an adult help you bring the water in the saucepan to a boil.

While the water boils, fill a medium-size container with water and ice.

Using the oven mitt, remove the bottle from the saucepan.

Place a balloon over the mouth of the bottle.

Place the bottle with balloon into a container of ice water.

Write down your observations.

Observation:

What happens to the balloon when you cool the bottle?

After cooling for 10 minutes, put the bottle with balloon back into the saucepan and reheat.

Write down your observations.

Observation:

What happens to the balloon when the bottle is reheated?

The real chemistry behind how and why

Remember, gases are the state of matter where there are few molecules in a large space. When the gas molecules are hot, they move very fast. We feel the fast-moving molecules as air pressure. When you heated the water, you made the gaseous oxygen, nitrogen, and water molecules move very fast. Once you removed the bottle with water from the heat and cooled it, the gas molecules slowed down, decreasing the pressure. The air pressure in the room was now greater than the air pressure sealed in the bottle. The greater air pressure pushed the balloon back into the bottle! When you reheated the gases in the bottle, the gases moved faster, increasing pressure, and pushed the balloon up and out.

When you see the technology of a hot air balloon, you are seeing the chemistry principles you just observed. As molecules move faster and provide more pressure, they also rise. The lifting ability of hot gases lifts the basket of a hot air balloon.

Now try this!

when you reheat the container, put a few pennies in the balloon. See how many pennies are needed  on the balloon to keep it from pushing back out of the container.

17. Left-handed molecules?

Level of difficulty: medium

From beginning to end: 15 minutes

Chemistry category: organic

The real question:

Does the shape of a molecule change the odor?

Materials:

Caraway seeds

Spearmint gum

Multicolored gummy candies—5 different colored candies (2 of each)

Toothpicks

Directions:

Test odors

Smell the caraway seeds.

Smell the spearmint gum.

Observation:

How do the odors of the caraway seeds and spearmint compare?

Build the model for the molecule

Take one gummy bear and two toothpicks. Stick the toothpicks into the gummy candy so that the candy is at the point of the v.

Rotate the candy 90° and repeat step 3 with two more toothpicks. The vs need to be perpendicular to each other.

Make a second model using the same colored candy for the center.

Place the two models side by side.

On the free end of one toothpick, stick a gummy candy. On the second model, attach a candy of the same color in the mirror-image location.

Repeat until all four toothpicks on a model have a candy attached to it.

Observation:

Can you perfectly overlay the two models?

The real chemistry behind how and why

Examine your hands. You have one left hand, one right hand. They are identical, yet you cannot superimpose (overlay) one hand on the next. The thumbs end up pointing in different directions. Many molecules in our world are also left-handed or right-handed, and our bodies have developed to use these different-handed molecules. They have the same number of carbon atoms, hydrogen atoms, oxygen atoms, and so on, but they are geometrically arranged in different ways. Caraway and spearmint are mirror images of each other, just like your left hand and right hand. Our body detects the gases differently and we smell them as different. The models you made are mirror images of each other. They are made entirely of the same candies, but the connecting order can make a very large difference in how our body recognizes and uses them.

Are you left-handed or right-handed? We are used to our biology affecting how we play sports or write. Mathematics (geometry), biology, and chemistry come together to make us either left- or right-handed.

Now try this!

Build two models of methane, also called natural gas. It is made up of one carbon in the center attached to four hydrogen atoms. You can superimpose (overlay) these two molecules, illustrating not all molecules are left-handed or right-handed.

18. portable lungs

Level of difficulty: medium

From beginning to end: 40 minutes

Chemistry category: physical

The real question:

How do lungs work?

Caution: be careful cutting the plastic cup or ask an adult for help.

Materials:

Clear plastic cup

Scissors

2 small balloons (both smaller than the clear plastic cup)

Tape

2 straws

1 large balloon

Molding clay

Directions:

Cut a hole into the bottom of the cup.

Tape one of the small balloons to one of the straws. Wrap the clay around the outside of the balloon and straw to make an airtight seal between them. Repeat with the other small balloon and straw.

One at a time, slide the straws through the opening in the clear plastic cup, so that the ends with the balloons are inside the cup. Use the clay to make an airtight seal between the straws and the cup. You can also wrap tape around the clay for a tighter seal.

Cut the neck off of the large balloon. Discard the neck and place the remaining piece of the balloon over the open end of the cup.

Pinch the middle of the large balloon membrane and pull down.

Observations:

What do you see when you pull the membrane down?

What happens to the volume of the balloons when you push the membrane up?

The real chemistry behind how and why

You are seeing the effects of boyle’s law. The law states as the pressure on a gas increases, the volume of the gas decreases. Remember, air is always surrounding us and pushing down on us. When you pulled down on the membrane, there was more space for the balloons inside the cup and less pressure on the gases inside them. With less pressure on the gases, the regular air pressure was higher and forced its way into the balloons inside the cup. We see this change as the balloons expand.

While completing the activity, you were also using boyle’s law for gases while you were breathing. I hope you agree that it is an important biological function! When you breathe in, you are actually pulling down on your diaphragm, and the air pressure forces air into your lungs, making your lungs larger. When we exhale, we push the diaphragm upward, making our lungs smaller.

Now try this!

Try blowing up one of the small balloons while the large balloon membrane is over the cup. Remove the membrane and try again.

19. lava lamp

Level of difficulty: easy

From beginning to end: 10 minutes

Chemistry category: physical

The real question:

Is the density of a gas greater or less than a liquid?

Caution: wash your hands after touching the effervescent tablets.

Materials:

Tall, thin, clear container

Vegetable oil

Water

Effervescent antacid pain-relief tablets

Directions:

Fill the container ¾ full with vegetable oil.

Add water to the container but leave enough space so the liquids won't spill.

Break the effervescent tablets into small pieces and drop them into the container.

Observations:

Where does the water go when you add it to the oil?

What happens to the oil and water when you add the effervescent tablets?

Do you see evidence of a chemical reaction?

The real chemistry behind how and why

As you learned in the oily oceans activity, oil and water don't mix, since oil is non-polar while water is polar. Did you also see that water is denser than oil and sank to the bottom of the container? The lava lamp effect is observed because the tablets are water-soluble but not oil-soluble. When the tablet pieces are dropped into water, the tablet starts to dissolve, allowing two different chemicals, citric acid and sodium bicarbonate, to come into contact and react. This reaction creates carbon dioxide gas, co2. Co2 is less dense than both liquids and rises to the top of the container. Notice that the co2 carries the water with it to the top. Once the gas escapes out of the container, the water returns to the bottom.

You used an antacid pain-relief tablet for the activity, a material used in the health-care industry. These tablets contain aspirin for pain relief, but the bubbling is caused by citric acid reacting with sodium bicarbonate (a base). The acid-base reaction forms the co2 gas. The chemical reaction helps to dissolve the aspirin so the sick person gets pain relief faster.

Now try this!

Add red food coloring to your water to make the “lava” easier to see.

20. big mini marshmallows

Level of difficulty: hard

From beginning to end: 30 minutes

Chemistry category: physical

The real question:

Does a vacuum cleaner really create a vacuum?

Caution: work with an adult while cutting up the balloon.

Materials:

5 mini marshmallows

Hard plastic reusable water bottle with screw top

Scissors

Balloons

Kitchen knife

Handheld vacuum cleaner with hose

Tape

Directions:

Place the marshmallows into the water bottle.

Using the scissors, cut the neck off the balloon. Stretch the larger piece tightly over the narrow opening of the water bottle.

Using a kitchen knife, poke a small hole through the balloon. The hole should be over the bottle opening.

Tape the balloon to the water bottle.

Firmly press the vacuum cleaner hose over the opening. Turn on the vacuum cleaner.

Observation:

What happened to the marshmallows when the vacuum cleaner was attached to the water bottle?

The real chemistry behind how and why

When you turn on the vacuum cleaner, you are removing the gases from the water bottle. By removing the gases, you are on the way to creating a vacuum. This reduces the air pressure, meaning there is less force pushing down on the marshmallows. With less force pushing down on the marshmallows, they expand.

You are using a number of important engineering tools for the activity, such as scissors, a knife, and a vacuum cleaner. A vacuum cleaner uses an electric motor to move gases, creating a low-pressure area (a partial vacuum) to pick up dirt.

Now try this!

After observing the marshmallows, blow up a small balloon and tie it off. Place the small balloon inside the water bottle and repeat the experiment. What happens to the balloon while under a partial vacuum?

Chapter 5 Water And Liquids

Did you know that approximately 70 percent of Earth's surface is covered in water? And yet, less than one-tenth of one percent of all that water is drinkable. In fact, if you were to fill a gallon jug of water, and thought of that gallon as being all the world's water, less than one teaspoon of that water would be drinkable. Water is a precious commodity in our world, and it also provides a great starting place for seeing some amazing science take place.

You will get to explore the mysterious nature of water, and see some of its magical characteristics. You'll float paper clips, conjure up a magical water genie, make water disappear, and watch water change color.

The Amazing Leaking Bottle

There's nothing worse than opening up a bottle of water, starting to drink, and finding a hole in the side that has caused the water to spill out onto your face and shirt. Luckily, most water bottles, though made of plastic, don't have holes in them so that you can enjoy the water inside without worry about a leak. However, in this experiment you'll see how you can actually poke holes in a plastic container without the water spilling out.

Question

When does a hole not leak?

Materials

Plastic bag, preferably the kind found in produce sections at the grocery store

Sharpened pencil

Rubber band or twist-tie

Water

Shallow baking pan

Procedure

To begin, fill the plastic bag with water until it is at least half full. Make sure there are no holes in the bag.

Tie off the top of the bag so there is still some air left between the water and the top of the bag.

Carefully poke the pencil through the bag so it goes in one side of the bag and out the other.

Set the bag in the pan and look for any leaks.

Where Is the Water?

Use the directions to cross words out of the grid. When you are finished, read the remaining words from top to bottom and left to right. As if by magic, you will find the answer to this silly science riddle!

Cross out all the…

…two-letter words without N

…5th, 9th, and 15th letters

…words that rhyme with HOP

The Science Behind the Magic

This experiment demonstrates as much about the properties of plastic as it does about water. You see, plastic is made from polymers, which are molecules that are chained together. These polymers give plastic its strength. In the case of plastic bags from the produce department, the polymers that are used actually shrink when cut. As a result, when you poked the pencil through the side of the bag, the plastic molecules shrank, and acted as a seal around the pencil. This is what kept the water from leaking.

Follow-Up

Can you think of a place where this sort of behavior could be useful? Where might someone want to have a material that reacts to a puncture by closing down and forming a seal?

One place this technology is being used is in automobile tires. Some new tires react to a puncture by forming an automatic seal over the hole. In some cases, this is done by releasing a filler material inside the tire, but in others, the material the tire is made out of simply shrinks and seals the hole, at least until the owner can get to a repair shop.

Floating Metal

Question

Does metal float?

Materials

A cup of tap water

Paper clips

Liquid dish soap or a bar of soap

Procedure

Bend one paper clip into a flat hook shape so that a second paper clip can be placed on the flat surface.

Try to place a paper clip on the surface of the water so that it does not sink.

Carefully place a second paper clip on the flat part of the unfolded paper clip and slowly lower it into the water. The paper clip should float.

Place a few drops of soap in the water, or touch the bar of soap to the water's surface and watch what happens to the paper clip.

The Science Behind the Magic

The paper clip floats because of the surface tension of the water. If you were to place the paper clip in the water at an angle or drop it from a height, the force would break the surface tension and it would sink. But gently lowering the paper clip onto the water allows the surface tension to stay intact and the paper clip floats. Adding the soap breaks the tension and the paper clip sinks to the bottom of the glass.

Did You Know?

More than 80 billion gallons of water are wasted each year in America by people waiting for water from their faucets to get warm.

Science Quote

“Water is H2O, hydrogen two parts, oxygen one, but there is also a third thing, that makes it water and nobody knows what that is.” —D. H. Lawrence, British novelist

Follow-Up

You can extend this experiment by testing different objects, such as a needle or a small nail to see which ones float and which do not. Try to find out what shapes, sizes, and weights seem to work the best. Does soap always cause these other items to sink?

SURFACE TENSION: A result of water molecules squeezing together to produce a sort of lid on the surface of the water.

Did You Know?

It's true—metal does float! Large ships are often made out of steel or other kinds of metal and they float due to their shape. If a ship's metal were made into a ball of metal, it would sink, but because of its shape, it easily floats in water.

Abracadabra

Is it magic? Is it science? Or is it just silly?! To find the answer to this riddle, use a bright colored marker to highlight all the letters in the puzzle grid. Ignore the symbols, dollar signs, etc. Read the letters from left to right, and top to bottom.

Sinking Oranges

Question

What makes an orange float or sink in water?

Experiment Overview

When first exploring water, many children wear water wings, life jackets, or other aids to help them stay afloat. But what does a piece of fruit wear in the water if it wants to keep from sinking? In this experiment, you will place fruits in water with and without their peels and decide which peels help keep their fruits high and dry.

Science Concept

The Greek scientist Archimedes once famously shouted "Eureka—I've found it!" when he discovered the concept of buoyancy and ran through the streets of town announcing his discovery. Unfortunately, this realization came to him while he was bathing in his bathtub…wearing no clothes. What Archimedes figured out is that objects have to move water out of the way in order to be placed in it. That water has weight. He found that the weight of that displaced water is the same as the force that lifts up the object in the water. If that force is enough, the object can float. A block of wood is an example of something that experiences a buoyant force equal to its weight. A bowling ball, however, doesn't experience a large enough buoyant force, and so it sinks.

Materials

Several pieces of fruit

Large bowl of water

Adult helper

Knife, for peeling the fruit

Procedure

Select a fruit and predict whether or not it will float when placed in the water.

Place the fruit in the water and observe whether or not it floats.

Ask your adult helper to assist you as you peel the fruit.

Once you have completely removed the peel, place the fruit in the water again and observe whether or not it floats.

Select another fruit and repeat steps 2–4. Do this for each fruit that you have selected for the experiment.

Questions for the Scientist

Which fruits floated when they still had their peels?

For the fruits that floated with their peels, what about their peels made them float?

Which fruits floated even without their peels?

Was there something those floating fruits had in common that made them float, even without their peels?

Using what you observed in this experiment, describe an outfit you could wear that would help keep you afloat in a swimming pool.

Follow-Up

Oranges tend to produce very specific results in experiments such as this one. That is because of the way their peels are made. On the surface of orange peels are hundreds of tiny pits that collect air. Collectively, these air pockets act like a sort of life preserver for the orange, and keep it afloat. When the peel is removed, the inside of the orange is heavier than the water, and it sinks to the bottom of the bowl. Other fruits that do not have these pits in their peels tend not to float as well as the oranges do. As a follow-up experiment, try other liquids such as salt water (which tends to be more dense than fresh water) or fruit juice to see if the same fruits produce the same results in these other liquids.

Water Genie

Question

Does Colored Water Rise?

Materials

2 identical small-mouthed bottles

Food coloring

Cold water

Hot water

3″ × 5″ note card

Procedure

Fill one bottle with cold water.

Fill the other bottle with hot water from the tap.

Add food coloring to the hot water until its color is dark.

Place the note card over the top of the bottle containing the cold water.

Invert the bottle of cold water and place its mouth directly on top of the bottle containing the colored hot water.

Carefully remove the note card from between the two bottles.

The Science Behind the Magic

When you remove the note card, you should begin to see wisps of colored water rising into the upper bottle. It's not a magic water genie. Instead, it's the hot water trading places with the cold water. You see, hot water is less dense than cold water. So, when the two are placed together, the cold water falls to the bottom while the hot water rises. If all the water were clear, you might not see this exchange happen. But because you colored the hot water, you can see it rise, even while the cold water falls into the lower bottle.

Follow-Up

Water is not the only substance that behaves in this way. You may have noticed in the summer that the upper floors of your house tend to be warmer and the lower floors tend to be cooler. This is because, like water, hot air is less dense than cold air, so it rises to the top of the building. If you have a ceiling fan in your house, check to see if it has a direction switch on it. Those that do are designed to circulate cool air up from the ground during hot weather, and warm air down from the ceiling during cool weather.

Try This: Disappearing Water

Every house with small children living in it has at one time or another experienced the unfortunate results of a spilled glass of water, juice, or milk. It happens, and while it's usually quickly cleaned up, it's not typically one of the happiest activities for a parent. But just imagine if there were something a parent could use that would make a spilled drink completely disappear. Imagine further that this magic material were already in the homes of many families with small children. Wouldn't that be something?

Dizzy Drops

Strings of molecules bond together to form plastic, but in this puzzle strings of letters bond together to give you the silly answer to a riddle! Use the clues to fill in the drops. The last letter of one word is the first letter of the next! HINT: Fill the drops in order, even though it sometimes looks as if you are spelling backward.

Question

Can you make water disappear?

Materials

A few disposable diapers

Water

Measuring cups

Procedure

Open a disposable diaper and lay it flat on a table.

Pour one cup of water into the thick part of the diaper and watch what happens.

Repeat step 2 until no more water can be absorbed. Keep track of how many cups of water the diaper held.

The Science Behind the Magic

The water doesn't actually disappear, of course. It's absorbed by the material in the diaper. This material is another kind of polymer, called sodium polyacrylate, particles of which are about the size of regular table salt when dry. When the particles get wet, however, they absorb water until they swell to nearly four times their original size. What's more, these particles don't stick together, but remain separate. This provides extra comfort for babies with wet diapers and offers you an interesting extension activity.

Follow-Up

Take another diaper and with an adult's help, cut it open so you can see the materials inside. Pour these materials into an empty cup, preferably a clear one. Now slowly pour water into the cup and watch how the particles absorb water and grow. Keep pouring water into the cup until all the dry particles are wet. Can you turn the cup upside down without any water falling out? Depending on how much water you poured and how much of the absorbent diaper material you used, you may find that nothing comes out at all. Then, try adding some table salt and mixing with a spoon. You should see the water come back, as the salt reacts with the gel you produced to release the water.

Did You Know?

The first disposable diaper can be traced back to the year 1950. Today, nearly 20 billion disposable diapers are used each year in the United States.

Chapter 6 Color

Color Rainbow Coloring

Level of Difficulty: Easy

From Beginning to End: 15 minutes

Can you create a rainbow in your own home? Learn how rainbows are made in nature and then capture one for yourself.

Materials

Glass triangular or teardrop prism

White paper

Colored pencils

Directions

On a sunny day, set the prism in a window that receives a lot of light.

Experiment with the angle of the prism to project a rainbow around the room.

Angle the rainbow onto a piece of white paper. Use colored pencils to color over the rainbow from the prism.

Observations

How does the size and shape of the rainbow change with the angle of the prism?

Now Try This!

Take a flashlight, a prism, and a black piece of paper into a dark room. Set the prism on the black paper and shine the light through the prism at different angles. How is it different from sunlight? How is it the same?

The How's and Whys

Nature's prism is a raindrop. Raindrops work the same way a triangular prism does by dispersing white light from the sun, or breaking the light into its visible colors: red, orange, yellow, green, blue, and purple. Each color is refracted at a different angle, creating a rainbow.

21. Ice Color Mixing

Level of Difficulty: Easy

From Beginning to End: 6 hours

Can you make new colors from 2 existing ones? Create interesting colors and patterns while learning about freezing, melting, and color mixing.

Materials

Ice cube tray

Water

Food coloring

White plates

Spoons

Directions

Fill the ice cube tray with water. Make different-colored ice cubes by dripping about 5 drops of food coloring into each compartment. (Be sure you make a few ice cubes of each of the primary colors: red, yellow, and blue.)

Leave the ice cube tray in the freezer for several hours.

Once the colored ice cubes are frozen, take them out of the freezer.

Place 2 different-colored ice cubes on each plate.

Have fun pushing the melting colored ice around the plate with a spoon to make different patterns.

Observations

What new color is produced when 2 colored ice cubes melt together?

Now Try This!

Experiment to see what happens when 2 primary colors are mixed together. What happens when all 3 primary colors are mixed together? What color is made when 2 secondary colors are mixed?

The How's and Whys

The ice melts into colored water. When the colored water mixes, a new color is produced.

22. Magic Milk

Level of Difficulty: Easy


From Beginning to End: 20 minutes

Can you turn a plate of milk into a gorgeous art canvas? Use food coloring and a drop of science magic to create beautiful swirling colors and firework patterns.

Materials

Plate or baking dish

Milk

Food coloring

Liquid dish soap

Directions

Pour a thin layer of milk onto a plate.

Drip a few drops of food coloring into the milk.

Carefully drip one drop of liquid dish soap into the milk.

Observations

What kinds of patterns do the colors make? How do the colors move through the milk?

Now Try This!

Experiment to see if the type of milk makes a difference in how the colors burst. Does whole milk work better than skim milk? How about heavy cream or soy milk?

The How's and Whys

The molecules at the surface of liquid bond tightly together. This is called surface tension. When dish soap is dripped onto the surface of the milk, the soap breaks the surface tension and the molecules on the surface spread out. Of course, the milk molecules take the food coloring with them, making them look like exploding fireworks!

Another interaction that puts the magic into magic milk is the bond between soap molecules and fat and protein molecules. With millions of soap molecules pairing up with millions of fat and protein molecules in the milk, the mixture gets all stirred up. This creates little eruptions in the milk that keep going for several seconds, making a dynamic work of science and art.

23. Oil and Watercolor Resistant Painting

Level of Difficulty: Easy

From Beginning to End: 30 minutes

Can you create interesting textured art using oil and water? Experiment with mixing oil and watercolors while producing a gorgeous masterpiece.

Materials

Baking sheet

White card stock

Paintbrush

Cooking oil

Liquid watercolors

Directions

Place the card stock on a baking sheet to catch any mess.

Use a paintbrush to paint a design on the paper using the cooking oil. For best results, make it a strong, thick layer.

Finish the painting using watercolors.

Observations

What do you notice when you paint with watercolors over the oil design? What happens when the painting dries?

Now Try This!

What happens if you let the oil dry on the paper first and then paint over it with watercolors? Is it different from trying to paint over fresh oil? Why?

The How's and Whys

Oil and water do not mix because they are made of different kinds of chemical bonds. Oil is made of nonpolar bonds, while water is held together with polar bonds. In this painting, oil repels watercolors. This prevents the watercolors from soaking into the paper and creates a very interesting result.

24. Icy Art

Level of Difficulty: Easy

From Beginning to End: 20 minutes

What happens when salt is sprinkled onto ice? Not only will you discover the answer to this question, but you will also use the interaction between salt and ice to create interesting and colorful textured art.

Materials

Bowl full of ice cubes

Salt

Liquid watercolors

Paintbrush

Directions

Sprinkle salt onto the ice cubes in the bowl.

Wait a few moments and watch how the salt melts tiny tunnels into the ice.

Use a paintbrush to color the ice cubes with watercolors.

Add more salt to different sides of the ice cubes to create gorgeous textured ice cube art.

Observations

Can you see tiny tunnels inside the ice cubes?

Now Try This!

Freeze water in large plastic storage containers to start with an even bigger canvas.

The How's and Whys

Under normal conditions, ice melts at 32 degrees Fahrenheit. However, when salt is added, the melting point of ice decreases several degrees. This means that the tiny grains of salt melt tunnels and tracks into the ice. Painting over the texture illuminates these tunnels, creating a unique and beautiful masterpiece.

Chapter 7 Sound And Music

If I asked you to imagine the sounds of an amusement park, which ones would you think of? Amusement parks can be noisy places, with the screaming of riders on roller coasters, carousel music tinging away, and bells and whistles from games and booths. The reason you can differentiate all these sounds is that they each have different pitch, loudness, and amplitude. However, they also have something in common: Each sound is produced by an object that vibrates. This property of sound is very important to understand because it’s the basic principle behind the following activities on sound.

Although we can’t see or touch sound, we still have to use caution when doing physics experiments with sound. The reason for this is that all those vibrating objects create sound waves, which are gathered by the outer part of the ear and sent to the eardrum. Once inside the ear, those sound vibrations travel through the middle of it, where tiny bones multiply the force and pressure of the sound wave, amplifying the sound. The amplified sound hits 20,000 to 30,000 tiny hair cells in the inner ear. When vibrations reach those hair cells, electrical impulses send messages to the auditory center of the brain, and we are able to identify the vibrations as music, pots clanging, or a car driving past.

It’s important to note how the ear works, because our ears are not meant to withstand very loud sounds. If a sound is too loud, like when headphones are set at an extremely high volume, the hair cells are damaged and may not grow back, resulting in hearing loss. While the following activities will not produce damaging vibrations, be careful if you dive into future sound investigations that require ear protection.

Ready to investigate some good vibrations? I’m sure your family will be all ears when you share what you have done.

25. Phone Speakers

How can you make your phone louder if it’s already turned all the way up?

Level of Difficulty: Easy

Time Suggestion: 20 minutes

Materials

Smartphone or music-playing device with some good songs

Sturdy gift wrap tube, cut to about 25 centimeters long

Marker

Box cutter

2 plastic cups

Hot glue gun

Directions

Stand the phone on the middle of the tube and carefully trace its width and depth using a marker. With the help of an adult, use the box cutter to carefully cut out a slot that the phone can slide into.

Trace one end of the tube onto one side of each cup. Carefully cut out each circle with the box cutter.

Slide a cup onto each end of the tube with the tops of the cups facing you. Adjust the position of the tube so that the phone slot is almost directly on the top but slightly angled toward the back. Use the hot glue gun to secure the cups to the tube.

Start playing your tunes, then insert your phone into the slot. Let the dance party begin!

Now Try This!

Use different lengths of tube or use paper cups to see what combination gives your music the best amplified sound.

The How's And Whys*:*

Music is sound being sent to your ear by waves. Usually when the sound comes from your phone speaker, the waves move out in all directions away from the phone. When you place the phone inside the tube, the sound waves vibrate down the tube into the cups, which reflect the sound waves that would normally go away from you toward you, making the sound amplified in the front and not as loud in back.

26. Buzzing Bee Flyer

How can you produce a sound like a swarm of bees?

Level of Difficulty: Easy

Time Suggestion: 20 minutes

Materials

Play-Doh

Large craft stick

Scissors

Index card

Duct tape

60-centimeter-long string

Wide rubber band long enough to stretch the length of the craft stick

Directions

Attach a marble-size piece of Play-Doh to each end of a craft stick.

Use scissors to trim an index card so it fits between the Play-Doh pieces. Tape it in place with duct tape.

Tie the string to one end of the craft stick as close as possible to the Play-Doh.

Stretch the rubber band around the craft stick lengthwise and make sure it's secure in the Play-Doh. Be sure that the knot in your string is not touching the rubber band.

Find a clear area and swing your buzzing bee flyer overhead. Record your observations.

Now Try This!

Cut the index card into different shapes or use a thicker piece of paper to see if there is a difference in the sound you hear. Try changing the length of the string, which can also make you swing the flyer faster or slower. Now how does the sound change?

The How's And Whys*:*

As the flyer moves through the air, the rubber band begins to vibrate. The sound produced by the vibration is amplified by the index card, sounding like a swarm of bees.

27. Phonograph

How does a record produce sound?

Level of Difficulty: Easy

Time Suggestion: 15 minutes

Materials

Paper

Tape

Straight pin

Record (make sure you have permission to use it)

Record player

Directions

Take a piece of paper and, starting in one corner, roll it up to form a cone. The pointy end of the cone should be closed. Tape the edge of the cone to secure it and keep it from unrolling.

Push the straight pin at an angle through the cone about 1 centimeter from the tip. Make sure the pin is through both sides of the cone and points down at roughly a 45-degree angle.

Tape the head of the pin to the cone to secure it in place.

Place the record on the record player and turn it on.

Lightly hold the outer edge of the cone so that the pin is pointed down. Rest the pin in the grooves of the record and listen. Record your observations of what you hear.

Now Try This!

Try making different-size cones or use different materials to make a cone and see if there are changes in the results.

The How's And Whys*:*

Records have undulations, or bumps and bends, in the grooves that correspond to a specific song. When the pin travels along the groove, it vibrates back and forth in accordance with these bumps. The vibrations of the needle are amplified, or increased, by the cone and travel to your ear, which your brain translates as music.

28. Upcycled Wind Chime Challenge

Can you design and build a wind chime that plays four different notes using discarded items?

Level of Difficulty: Medium

Time Suggestion: 1 hour and 3 minutes

Materials

Discarded items that can chime, such as old silverware, old keys, empty soup cans, shells, PVC pipe scraps, and metal bottle caps

Drill (optional)

Materials to decorate your wind chime, such as paint or markers

Scissors

String

Ruler

Tape

Hot glue gun

Embroidery hoop (or other circular hoop)

Fan

Directions

Research parts of a classic wind chime, noting different lengths of tubes, how materials are suspended, and spacing of objects (see Resources). Next, gather materials from around your home that could be used for an upcycled wind chime. Have an adult drill a hole in the objects that don't already have one.

Decorate the parts of your wind chime with paint, markers, or anything crafty to make them look colorful and worthy of hanging outside your home.

Use scissors, string, a ruler, tape, and a hot glue gun to construct your wind chime so that all the parts are securely fastened to an embroidery hoop. Test your wind chime in front of a fan to make sure that it operates continuously without getting tangled and makes sounds pleasing to the listener.

Hang it for all to enjoy!

Now Try This!

Evaluate your wind chime and record all the dimensions, such as length of objects, object placement, and so on. How is the quality of sound? Can you modify, or make changes to, your original design for a different sound? You can even add a sail, which will catch the wind to help move the wind chime.

The How's And Whys

A wind chime usually makes its signature sound because of the metal tubes that are suspended from the top. The lengths of the tubes determine if high-pitched or low-pitched sounds are produced. Shorter tubes produce higher tones than longer tubes. Other wind chimes mix elements of metal and wood to produce different sounds that appeal to different listeners. No matter which material you use, wind is the driving force that makes your wind chime components collide to produce sound.

29. Make It Rain

What causes the sound of falling rain in a rain stick?

Level of Difficulty: Medium

Time Suggestion: 30 minutes

Materials

Scissors

Ruler

Aluminum foil

Pencil

Long cardboard tube, such as a wrapping paper tube

2 index cards

Masking tape

1 cup uncooked rice

Directions

Using scissors and a ruler, cut sheets of aluminum foil into 10-centimeter strips so when they are laid end to end, you have enough to equal a length and a half of a cardboard tube.

Attach the end of one aluminum foil strip to the end of another by loosely scrunching them together, making sort of a foil snake. Repeat until you have one long, continuous aluminum foil snake.

Starting at one end, wrap the foil around a pencil to form a spiral. Continue until the entire length is coiled. Insert the coiled aluminum foil into the cardboard tube. Secure the foil to each end of the tube with masking tape.

Cut the index cards large enough to cover the tube openings. Secure one index card with tape to one end of the tube.

Pour the rice into the tube through the open end. Cover the other end of the tube with the second index card and secure it with tape.

Tip the tube upside down and listen to the sound until all the rice has fallen.

Now Try This!

Instead of rice, try using other materials, such as dried pinto beans or sesame seeds, to see if they produce a different sound. Also, try changing the length of the tube to see if it makes a difference in sound.

The How’s And Whys

When a grain of rice bumps into the aluminum foil as it falls down the tube, the collision causes a vibration from the foil to the cardboard tube, sending the sound through the air, which our ears hear as a soft click. When many pieces of rice fall at once, the clicks happen randomly, producing a white-noise sound similar to a rain shower.

Chapter 8 Art

Pull out your paintbrush and get ready to create amazing art with the power of science!

You will see sound waves, create a rainbow with dissolving candy, produce fizzy patterns with a pendulum, and engineer your own coloring robot!

Art is so much more than just drawing on a piece of paper. Art is using your imagination to create, build, and design something unique. It is dreaming up new ways to express yourself by experimenting with mediums and canvases that haven't been used before.

Science and art are intimately connected. Both a scientist and an artist have to possess a wild imagination to help them creatively solve problems. They both experiment through trial and error to push the boundaries of what is possible and to shatter those boundaries with creative breakthroughs.

Here, you will use the principles of science to create art.

Always begin with a question: What happens if I mix these colors? How can I make different patterns? What materials can I use to make the ideas I imagine a reality?

Next, formulate a hypothesis using the same sentence you use when doing a science experiment: "I think . . . because . . ." This will help you discover new knowledge that sparks new ideas and more questions.

The really fun part comes next: experimenting. Find out what you can create, figure out the constraints you have, and then use your knowledge and creativity to fabricate something completely new. Experiment with patterns, colors, sounds, and light. Use the ideas and activities in this book to come up with your own scientific art experiments and projects.

After you are done experimenting and creating, state some conclusions. Remember the things you learned through your observations and creations.

Have a ton of fun experimenting with vibrant colors, unique patterns, new mediums, and unexpected canvases to produce something only you can create.

30. Bubble Painting

Level of Difficulty: Easy

From Beginning to End: 10 Minutes

Can you paint with bubbles? Sure, you can! Blow bubbles to your heart's content, learn what bubbles are made of, and create interesting, colorful patterns in the process.

Caution: Bubble painting can be very fun and messy. Wear clothes that you don't mind getting paint on.

Materials

Small cup

2 tablespoons tempera paint

1 tablespoon water

2 tablespoons liquid dish soap

Plate

Drinking straw

White paper

Measuring spoons

Directions

Mix the paint, water, and dish soap together in a cup.

Place the cup on a plate to catch the bubble overflow.

Place a drinking straw into the cup and blow through it to create bubbles being careful not to inhale or sip up any liquid.

Blow bubbles until the cup overflows.

Remove the straw, and carefully lay a piece of paper on top of the bubbles in the cup to make bubble prints.

Observations

What kinds of patterns are created on the paper?

Now Try This!

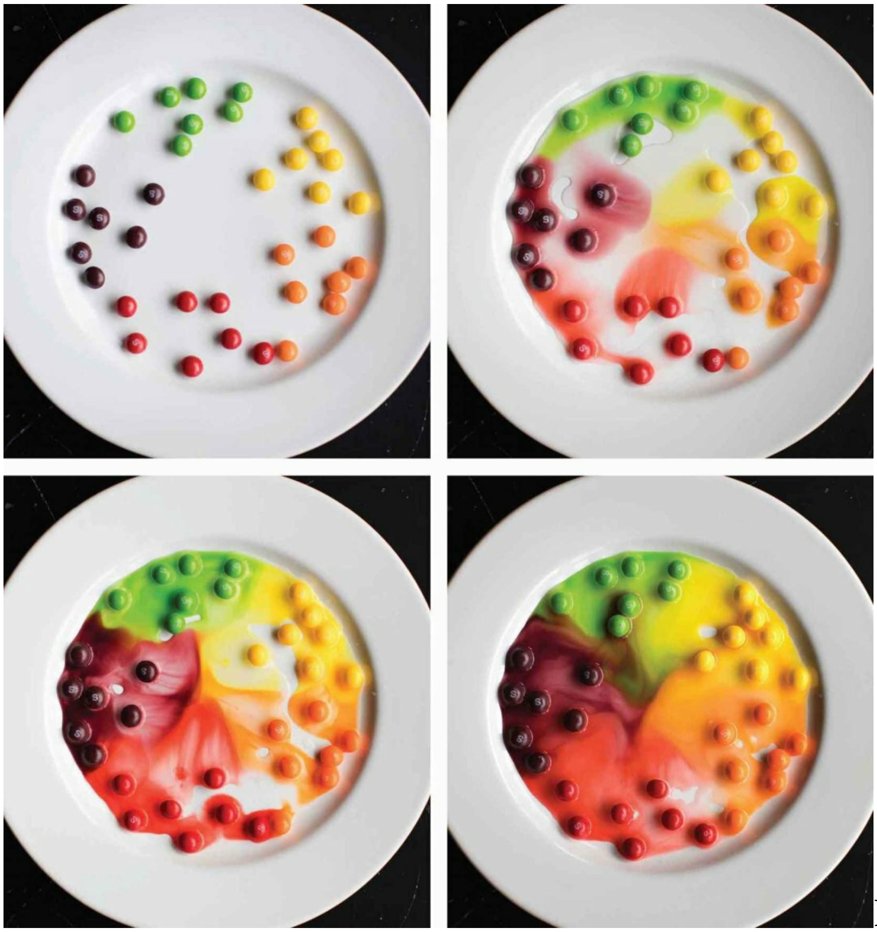
Use different sizes of straws to blow bubbles in the paint solution. Does a jumbo straw make different bubble prints than a coffee stirrer does?

The How's and Whys

The membrane of the actual bubbles is clear and can't be colored. However, when the bubbles pop, there is water and paint inside them that gets transferred to your paper. This creates unique bubble prints that you can layer with different colors and patterns.

31. Candy Rainbow

Level of Difficulty: Easy



From Beginning to End: 10 minutes

Can you create art using candy and water? Experiment with color mixing, vary the water temperature, and enjoy a sweet treat at the end.

Materials

Skittles candy

White plate

Hot tap water

Directions

Arrange several Skittles on the plate. You can arrange them in a pattern or just place them randomly on the plate to see what happens.

Carefully pour hot water onto the center of the plate. Add just enough to cover the bottoms of the candies.

Wait a couple of minutes for your masterpiece to develop.

Observe your creation and then create another one. Vary the temperature of the water each time to see how the water temperature affects the speed of the reaction.

Observations

What happened to the Skittles after the water was added? What patterns were produced? What new colors appeared?

Now Try This!

Experiment with other candies to see if they react the same way that Skittles do in hot water. Candies to try include Nerds, M&M’s, peppermints, jelly beans, gummy bears, or gobstoppers.

The How’s and Whys

The colored coating on Skittles is made of sugar, which dissolves in water. As the water moves around the plate, the colored sugar moves along with it, creating brilliant patterns and rainbows. Notice how the primary colors mix to create new colors.

32. Fizzy Pendulum Swing

Level of Difficulty: Easy

From Beginning to End: 60 minutes

Can you build a pendulum and use it to create beautiful textured art? Add a fizzy chemical reaction and you're set to have some real fun!

Caution: This fun experiment definitely gets messy! Be sure to do it outside where you can wash it away easily when you are done.

Materials

Paper or plastic cup

Hole puncher

Pushpin

String

Scissors

2 chairs

Broom

Baking soda

Tape

Vinegar

Food coloring

Directions

Use a hole puncher to punch 3 equidistant holes about an inch below the rim of a cup.

Use a pushpin to poke a small hole in the center of the bottom of the cup.

Use scissors to cut 3 pieces of string about 8 inches long. Thread 1 piece through each of the holes you punched around the cup. Tie all the ends of the strings together in the center.

Head outside to a level piece of sidewalk or driveway. Set up the chairs about 4 feet apart with the backs facing each other.

Slide the broom through the backs of the chairs.

Cut another piece of string and attach it from the middle of the broom handle to the strings on the cup. The cup should be hanging about 12 inches off the ground.

Sprinkle a few cups of baking soda on the ground directly under and around the suspended cup.

Place a piece of tape on the outside of the cup over the hole in the bottom.

Fill the cup about halfway full of vinegar. Add a few drops of food coloring.

Pull the cup back, remove the tape from the bottom, and let it swing freely over the baking soda.

When the cup stops swinging, pull it back again to create a new pattern. Continue to refill it with colored vinegar until your masterpiece is complete!

Observations

What happens as the cup swings over the baking soda? What do you notice about the reaction between baking soda and vinegar?

Now Try This!

Add a little bit of liquid dish soap to the colored vinegar. How does this affect the reaction between baking soda and vinegar?

The How's and Whys

Without any friction, a pendulum will continue swinging exactly the same distance back and forth forever. However, since this simple pendulum creates lots of friction between the string and the broom handle, it slows down quickly. As it slows, the distance it swings decreases, producing really beautiful orbit-like patterns.

33. Dancing Paper

Level of Difficulty: Easy

From Beginning to End: 15 minutes

Can you see sound waves? Most of the time the answer is probably no, but in this artistic science experiment, you will get actually to see how sound waves move through the air.

Materials

Glass bowl

Plastic wrap

Tape or rubber band

Tissue paper

Any speaker you have access to, such as a TV speaker, the speaker in a laptop, or a wireless speaker

Directions

Stretch plastic wrap tightly over the bowl. Secure it with tape or a rubber band.

Wad up a few small pieces of tissue paper and place them on the plastic wrap.

Set the bowl next to a speaker on a hard surface. The bigger the speaker, the better.

Turn some music on. Start with the volume down and gradually turn it up.

Observations

What happens to the tissue paper as you increase the music volume? What style of music produces the best results?

Now Try This!

Fill the bowl up with water and place it next to the speaker. Turn up the volume and play songs with a strong bass beat. What happens to the water?

The How's and Whys

Sound is a type of energy produced by vibrating particles in the air. Sound travels through the air in waves, which get stronger as the volume is turned up. When the music is loud enough, it causes the plastic wrap to vibrate, which you can observe as the little pieces of paper dance around on the surface.

34. Marker Chromatography

Level Of Difficulty: Easy

From Beginning To End: 20 Minutes

How many different dyes combine to make black ink? This artistic science experiment uses chromatography to separate marker ink into each of its individual dyes. Chromatography is not only used every day in professional chemistry and biology labs, it is also a great way to create cool art.

Materials

Coffee filter

Washable markers

Craft stick

Binder clip

Pint-size jar with a couple of inches of water in the bottom

Paper towel

Directions

Use markers to draw a design on a coffee filter. It can be circular or asymmetrical—whatever you feel inspired to draw.

Fold the coffee filter in half and then in half again.

Attach a craft stick to the top of the coffee filter with a binder clip.

Place the coffee filter in the jar of water (suspended by the craft stick) so that the bottom tip is touching the water. Leave it there for a couple of minutes and observe what happens.

When the water line reaches the top of the coffee filter, pull it out of the water, unfold it, and let it dry on a paper towel.

Observations

What changes did you notice while the coffee filter was suspended in water?

Now Try This!

Compare the different bands each marker produces through chromatography. Which marker ink contains the most colors?

The How's and Whys

Marker inks are made from many different colored dyes. This is most obvious with dark colors, such as black and purple. Each dye is made up of different chemicals, some heavier and some lighter, that travel at different rates with the water as it moves them up the paper. The heavier dyes will separate out first and move more slowly, while the lighter dyes keep moving faster up the paper, creating a tie-dyed or washed-out effect.

35. Magnet Painting

Level of Difficulty: Easy

From Beginning to End: 20 minutes

What kind of art can you create with magnets? Experiment with magnetic movement and patterns to


design a one-of-a-kind masterpiece.

Materials

Plastic container

Paper

Scissors

Tempera paint

Small metal objects from around the house, such as washers, springs, safety pins, screws, and ball bearings

Magnet

Directions

Trim a piece of paper with scissors so that it fits into a plastic container.

Dip each metal object into paint and then place it on the paper.

Use the magnet to move the metal objects around the paper from underneath the plastic container.

Observations

What kinds of patterns does each object produce as it moves around the paper?

Now Try This!

Dip other magnets into paint and place them on the paper in the plastic container. Move them around with the magnet underneath the plastic container to create more interesting art. Experiment with the attractive and repulsive forces between magnets.

The How's and Whys

Magnets are strong enough to attract metal objects, even though paper and plastic. Dipping those objects into paint first enables you to see how the objects move with the motion of the magnet.

36. Scribble Bot

Level of Difficulty: Medium

From Beginning to End: 30 minutes

Can you design and build a robot that colors all by itself? You'll be using a mechanical toothbrush, markers, and your own creativity to make your very own scribble bot.

Materials

Mechanical toothbrush (the inexpensive models from the dollar store work the best)

3 washable markers

Clear tape

Large piece of white paper

Directions

Use clear tape to attach all 3 markers to the motorized end of the mechanical toothbrush. Make sure that the scribble bot stands up on the marker tips like a 3-legged stool.

Remove the caps from the markers, set the scribble bot on the paper, and turn on the motor.

Watch as your robot draws and skips around the paper, leaving unique patterns behind!

Observations

Why does the scribble bot draw the patterns the way that it does? Can you alter that pattern?

Now Try This!

You can modify the pattern by adding more markers or changing the height of the markers. Experiment with your robot and see what interesting patterns you can create.

The How's and Whys

When a mechanical toothbrush is turned on, the motor rotates. The rotation creates a force that translates into vibrations you can feel with your hand. Attaching markers to the robot makes it easy to see the patterns the vibrating motion creates.

Chapter 9 Plants And Seeds

Plants are living organisms. This means they grow, breathe, eat, and reproduce. Plants use carbon dioxide and sunlight to make their own food through a process called photosynthesis. As a result, they release oxygen. This makes plants very important to us, since humans need oxygen to breathe. Learning to grow your own plants can help make the world a healthier place.

37. Breathing Tree

As you now know, a tree is a living thing. Although living things breathe, trees and plants don't breathe the same way we do, by using our lungs. Instead, they breathe through their stomata. These are tiny pores, or openings, that allow plant leaves to take in carbon dioxide and let out oxygen. Have you ever seen a tree breathe? Although we can't actually watch a tree breathe, we can do a fun experiment that will allow us to see a leaf's stomata in action.

Materials

Large glass jar or bowl

Water

Leaf

Rock

Magnifying glass

Procedure

Fill a large glass jar or bowl with water. The glass will allow you to see the process from all angles.

Collect a living leaf directly from a tree.

Place your leaf in your jar or bowl.

Anchor your leaf to the bottom by placing a small rock on top of it.

Place your glass container in a sunny area (preferably outside). The leaf will use energy from the sun to complete the process of photosynthesis.

Let your leaf sit for several hours before observing its changes. If you have a magnifying glass, use it to take a closer look. Do you see the tiny oxygen bubbles forming around the edges of your leaf? Your leaf is breathing. Reach in and gently shake your leaf. Watch the oxygen bubbles quickly rise. This is similar to when you go underwater and let out air, creating bubbles!

Did You Know?

During the cooler months, trees prepare for their winter's rest. With less sunshine and warmth, the leaves close their veins and stop creating the chlorophyll they need to stay green. Without chlorophyll, leaves will show their natural colors. The beautiful autumn colors of red, orange, yellow, and deep purple have been hiding underneath all year long.

38. Seasonal Bookmarks

I am always amazed at the plant life that changes with the seasons right outside my door. A surprise dandelion growing toward the end of autumn, new buds reaching out of the winter snow, unfurling ferns growing by the woods—each season brings something new. Many naturalists and artists enjoy collecting nature items like these to use for their creations.

Materials

Nature items

Basket or bag

Card stock or brown grocery bag

Scissors

Glue stick

Clear packing tape

Single hole punch

Contact paper or laminating machine

Twine or yarn

Procedure

Collect nature items around your yard, in the woods, or in a nearby park or field. Flat, thin items will work best. Look for small wildflowers, clovers, ferns, tiny leaves (no stems), and more. Collect them in your basket or bag.

Once home, cut your card stock or recycled brown bag into a rectangular shape (about 2½ by 7 inches).

Gently glue your nature items onto the paper.

Cover the front and back of the paper with packing tape or contact paper. If using tape, make sure it extends wider than the paper. Cut the tape around your paper so you have a ½-inch border of tape around the edge. If using contact paper, cut around your bookmark, leaving a ½-inch border of contact paper.

Use a hole punch to make a hole at the top of your bookmark.

Add string or twine through the hole and tie to secure.

Create a bookmark for each season, and observe what nature items grow year-round, and which ones only grow at certain times of the year.

Use your bookmarks in a book, display them, or give them as gifts!

Did You Know?

Antarctica has only two seasons, winter and summer. The South Pole never gets above freezing temperature, even in summer.

There are some important guidelines to remember when collecting. First, remember the safety rules here. Second, only collect flowers and plant pieces from your own yard or places where they are growing wild, such as fields or woods. Lastly, when collecting fresh flowers, ferns, or leaves, don't pull up the roots, so the plant can continue to grow, and take only a few, leaving the rest for others to enjoy.

39. Flower Press

Flowers are beautiful art growing outside. Their many colors, shapes, sizes, textures, and smells make flowers a great material for arts and crafts! For many years, people have been pressing flowers between the pages of books in order to preserve them, or keep them looking new and fresh. Today you will learn to make a flower press, allowing you to save colorful leaves, four-leaf clovers, and beautiful flowers.

Materials

6 pieces of printer paper

Scissors

Cardboard box

3 thin rubber bands and 2 thick rubber bands

Flowers and leaves, for pressing

Procedure

Fold all six pieces of printer paper in half, top to bottom.

Use one of the folded pieces of paper as a guide, and cut out three small rectangles of cardboard from your box. Ask for an adult's help if you have trouble.

Take the three thin rubber bands and wrap them around the center of one piece of cardboard. Wrap them as many times as necessary for a snug fit. This will be the top piece.

Now, make a cardboard and paper sandwich. Place another piece of cardboard on the bottom, followed by three folded pieces of paper, the last piece of cardboard, three more folded pieces of paper. Top this with the rubber band cardboard piece.

Add a thick rubber band at the top end and another around the bottom end to hold it all together.

Are you ready to explore? Bring along your flower press and collect items as you go. Remember not to pull up any plants from their roots so that they can grow back. You can pick flowers right beneath the bloom or include a few inches of the stem. When collecting flowers, look for ones that are naturally flat, such as violets and daisies. Thicker blooms will not flatten well. The folded inside pages are where you will store your leaves and flowers for drying. Place them inside as you go, or hold them in the rubber bands on the front cover and press them at home.

Let your leaves and flowers dry for several weeks before removing. To speed up the drying process, you can store your flower press under something heavy, such as a pile of books. Now they are ready to be used for crafts or homemade cards.

Try This at Home

Once you have enough pressed flowers and leaves, you can use them to decorate your nature press. You will need clear packing tape and a glue stick. Remove the front or back cardboard piece of your flower press, and glue down your pressed pieces. Once the glue is dry, cover the cardboard in clear packing tape.

40. Help Your Garden Grow

A wildflower grows without being intentionally planted. Wildflowers are planted with the help of nature (animals, wind, water) and taken care of by the sun and rain. They grow in fields, woods, yards, hillsides, mountains, and on the coast. You can find a variety of wildflowers everywhere! Growing your own flowers makes them a little less wild, but it is great to have your own flowers to cut and display in a vase, give as gifts, or use in crafts. Your wildflowers will also provide food for butterflies, bees, and hummingbirds. For this project, you'll need to visit a garden center.

Materials

Packet of wildflower seeds

Nature journal or paper

Pencil

Colored pencils or other art supplies

Patch of dirt outside or several flowerpots filled with potting soil

Water

Procedure

Visit a garden center with an adult. Bring along your nature journal and write down the names of flowers and plants you like. Talk to a garden specialist about what wildflowers grow well in your area.

Purchase a mixed packet of wildflower seeds or individual packets of flower seeds you like.

When you get home, draw out a flower garden design in your journal. This can be a picture of the actual flower garden you are planting, or a dream garden that you hope to plant one day. Use your art supplies to make it colorful.

Talk to your parent or guardian and together decide on a place to plant your flowers. A patch of dirt in your garden, yard, or the woods works great. You can also plant them in flowerpots or simply sprinkle them around the edge of your yard. You will want to choose a location that doesn't get mowed and that gets plenty of sun.

In the spring, sprinkle your seeds in your chosen location. You may want to step on the seeds to push them into the dirt a bit or cover them with a thin layer of soil.

Water your seeds regularly and wait for your new garden to bloom. It could take many months to see the flowers grow.

Once your flowers bloom, sit back and watch as bees, butterflies, and hummingbirds enjoy the special treat you have grown!

Try This at Home

Here are some fun ideas for your collected wildflowers.

Mix them into pretend soup or use as sprinkles on your mud pies.

Cut the petals into tiny pieces for a natural glitter or mix up a magical fairy potion.

Often grocery stores throw away bouquets at the first signs of wilting. Stores are usually happy to donate expired flowers to families for crafts or educational purposes. Ask the manager at your store about this possibility.

Inside A Flower

Birds, bats, and insects help transfer male pollen grains to the female part of the flower, allowing the flower to create seeds. Without this pollination, plants could not produce the seeds necessary to grow.

41. Edible Garden

Learning to grow your own food is a wonderful skill. Imagine being able to pick your own tomatoes, basil, oregano, thyme, and parsley for homemade spaghetti sauce; or gathering your own green beans straight from your backyard garden. It is a lot of work to take care of a garden, but also a lot of fun! The first step is starting your seeds. Some vegetables are best planted straight into the soil after the last frost, while other plants do best start in containers inside a sunny window.

Materials

Hanging jewelry organizer or over-the-door shoe holder with clear pockets

Small hand shovel

Potting soil

Water

Vegetable or flower seeds (a few of my favorites: green bean, chive, mint, oregano, lemon balm, and marigold)

Permanent marker

Spray bottle of water

Ruler

Nature journal or paper

Pencil

Procedure

Hang the organizer outside on a low branch or fence to make for more natural filling.

Use your shovel or hands to add soil to each pocket; fill half to three-quarters full.

Pour enough water into each pocket to thoroughly dampen the soil.

Add your seeds by pushing them into the soil. Read each packet for information on how deep to plant each type. You can plant something different in each row or have a random mix throughout, but I recommend using a permanent marker to label each pocket with the seed type as you go.

Bring your plants inside and hang your organizer on a curtain rod in front of the window or in a sunny area.

Water your plants regularly by spraying the soil and new sprouts as the soil becomes dry.

After 7 days, measure your tallest sprout, draw the plant in your nature journal, and write down its name and measurement. Measure the same plant again on day 15. How many more inches did it grow?

When your plants are several inches tall, transplant them to larger containers or an outside garden bed.

Try This at Home

Try starting seeds in a recycled container. Here are some ideas:

egg shells or egg cartons

hollowed-out orange halves

old shoes or boots

empty yogurt containers

42. A Dishful of Dandelions

A weed is a plant that grows where it is not wanted. Weeds usually overgrow, often taking over other plants and using up the nutrients in the soil. Most of the time, weeds are thought of as a bad thing, but there are many good things about weeds, too! Weeds can help stop soil erosion and add beauty to our world, as many weeds are flowers. Some weeds are healthy to eat, and others can be used for healing. Plantain, white clove, burdock, chickweed, and dandelion are a few useful weeds. Dandelions are common and easy to identify. Let’s take a look at how this weed can be used.

Safety Note

Only forage (pick plants) in areas you are sure have not been treated with pesticides or herbicides and always be sure to wash what you harvest.

Materials

Basket or bag for collecting

Dandelions

Store-bought dandelion tea

Procedure

Find some dandelions growing and collect them in your basket or bag. Pick 2 to 5 yellow dandelion tops and 1 or 2 young dandelion plants that are just beginning to bloom. You will only need the leaves from these.

Wash your dandelions and leaves in warm water.

Now it's time to taste-test your weeds! All parts of a dandelion are edible, even its roots. Try making a salad, mixing in a few dandelion leaves, and topping with petals from the yellow bud on top, or just sprinkle the petals onto your favorite dessert. Yum!

If you want to taste dandelions, but don't have any growing nearby, you can purchase dandelion tea from your local grocery store. Add some honey or perhaps sugar and a splash of milk, and enjoy!

Did You Know?

The yellow bud of a dandelion dries up and soon reveals the seed head underneath. This seed head opens into a round, white, fluffy ball. Pick a dried white flower, make a wish, and blow off the fluffy seed pieces. Every wish made this way scatters hundreds of seeds, many of which will turn into new

dandelion plants the next spring!

43. Fun With Fungus

All fungi begin as tiny spores and then grow on their food source. This could be mold on an old piece of bread, a bright red-and-white mushroom among a pile of decomposing leaves, or a splash of blue-green color beneath the bark of a rotting log. Fungus comes in many shapes and colors. Can you find fungi growing in your neighborhood or woods?

Safety Note

Some mushrooms are poisonous. Do not touch, pick, or eat any mushrooms.

Materials

This book

Nature journal or paper

Pencil

Colored pencils and other art materials

Procedure

Head out on a fungus-hunting adventure. Be sure to pack this book into your nature bag so you can check off your fungus as you find it! It may take months or even years to check them all off, so don’t get discouraged. Just remember to explore often and have fun.

Here is your fungus scavenger hunt:

Mushroom with red gills (the ribs under the cap)

Mushroom with an orange cap

Mushroom that is taller than 5 inches

A row of mushrooms growing on a log

Green fungus growing on a tree base

Mushroom with spots

Gooey Jell-O-like fungus

Crunchy fungus

Half-circle fungus

Coral-shaped fungus

Mushroom containing yellow

A mushroom with two colors

An oval-shaped mushroom head

An umbrella-shaped mushroom head

A fairy ring of mushrooms (mushrooms that create a circle)

A rotting log with orange fungus

Draw a picture in your nature journal of the coolest fungus you find. Can you identify what type of fungus it is?

Try This at Home

Use Play-Doh to create a mushroom fairyland. Add gills underneath the mushroom cap, add a stem, and be sure to use lots of fun colors! Fairies and gnomes will love their new village.

44. Seed Study Tic-Tac-Toe

Seeds sometimes travel to new locations with the help of animals, wind, and water. Some seeds stick to animal fur, while others are eaten by animals and grow from their scat. Wind carries fluffy lightweight seeds, and water carries many floating seeds. Some seedpods even burst open on their own, dispersing seeds. Seedpods that fall from trees are a helpful way to identify those trees.

Materials

Basket or bag for collecting nature items

4 sticks of similar size

10 tree seedpods, 5 of each type

Tic-tac-toe partner

Procedure

Today you will be looking for seedpods to use in a game of tic-tac-toe. Bring along a friend, sibling, or parent to play the game with. Head to an area with lots of trees for the most variety. A park with nature trails would be an excellent seedpod hunting spot.

Use your basket or bag to collect four small sticks of about the same size.

Search the ground for seedpods that have fallen off of the trees above. Once you find one, you will likely find many of the same type nearby. Examine the seedpod and nearby trees. Can you tell what tree it came from? Can you identify it? Collect as many seedpods as you can, but be sure to find at least two different sets of five that match for a game of tic-tac-toe.

Find a spot on the ground or bring your basket back home and play inside. Place your sticks into this shape: #

You and your partner will each need five matching seedpod game pieces.

Take turns placing your game pieces in one of the squares. The first person to get three in a row wins!

Try This at Home

My absolute favorite seedpods to explore are cattail and milkweed. Cattails are most often found near ponds, while milkweed can be found in pastures, fields, and on hillsides. If you can't find either of these, consider purchasing them online or finding a friend or family member who can send you a bagful. When you have the seedpods, make sure to open them in an outside area, because these will make a giant fluffball mess! Both seedpods are very satisfying to open, as the fluff unfolds and then blows away with the wind.

45. Growing Birdseed

In the last activity we mentioned that some plants grow from animal scat. How wonderful it is that something icky, like animal poop, is used to grow beautiful things like flowers, grass, and trees! Birds are one of the many animals that help spread seeds. Some plants contain seeds that are eaten by birds. Birds then fly to a new area and disperse the seeds in their droppings. Did you know that the birdseed you buy at the store can grow, too? By providing birds with seeds, you could be helping new plants grow!

Materials

Small potting container or hollowed-out orange half

Potting soil

Bag of mixed birdseed (with variety of seed types, like corn, sunflower seeds, and more)

Water

Scissors

Markers and other decorating tools

Procedure

Fill the container with potting soil. Sprinkle the top of the soil with birdseed and cover with a thin layer of soil.

Water your seeds right away, and continue watering, as needed, when the first few inches of soil are dry.

If you have leftover birdseed, sprinkle it outside for the birds to enjoy.

Store your plant by a sunny window inside and check its growth daily. You should see small sprouts by the end of the week. Once your sprouts (or plant hair) is long enough, you can cut and style your birdseed hair. Use markers or other craft materials to decorate your pot as you see fit!

You may want to move your planter outdoors, and regularly sprinkle new birdseed on the soil's surface. You never know what bird visitors you may get, or where the seeds will travel as a result.

Try This at Home

Sunflowers are a beautiful plant to grow for the birds. There are many varieties of sunflowers you can purchase. Mammoth sunflowers will grow more significant than you! In the spring, try planting some of the sunflower seeds from your birdseed pack, or purchase sunflower seed packets of your choice at your local garden center. After your flowers bloom and begin to dry, birds will enjoy the feast of seeds left over. Remaining seeds can be saved for next spring or, with the help of an adult, cooked in the oven and eaten.

Conclusion

You made it! You have explored the fields of Science, Technology, Engineering, Art, and Math, and you have completed experiments in each one. What new things have you learned and discovered?

Use the activities in this book as a launching pad to a lifelong habit of following the scientific method to discover new things. Ask lots of questions. Wonder why and how and what and when. Learn to love the process of discovery.

By now you are familiar with how the STEAM fields overlap and interconnect. By doing the experiments, you learned that you can’t have one field without many others. They enhance one another and build on one another.

There are hundreds of educational and vocational fields that need innovative people who will discover, create, build, and develop the next generation of amazing technological inventions. If you use the skills you have learned in this book, you can be one of those people.

Maybe you will be a scientist. You could work in a biochemistry lab to find a cure for cancer, or you could be the scientist who discovers life on Mars. You could be a field biologist who studies rare jungle animals or a volcanologist who travels the world to study volcanoes.

Maybe you will be a programmer or a hardware engineer. You could develop a new app that helps people or a new game that is fun to play. You could be on a team that invents a new electronic device or improves an old one. Maybe you will develop a new electrical panel for a fighter jet or produce a medical device that saves thousands of lives.

Maybe you will be an engineer. Perhaps you will make a streamlined rocket ship or a hovering car. You could end world hunger by developing a new, inexpensive process to make nutritious food, or you could build secure buildings and bridges that will withstand the forces of nature.

Whatever inventions you develop, you will need to think about how to design them so that they are intuitive, user-friendly, and visually appealing. You will use your creativity, your imagination, and your artistic talents to make sure that people can use your discoveries in the way they are meant to be used.

Perhaps your path will lead you away from the STEAM fields and into the humanities, politics, or music. You could be a teacher, a writer, a rock star, or a lawyer. Whatever your passion, knowing how to question, knowing how to discover, and loving to learn will set you up for success.

Keep exploring. Keep experimenting. Use the ideas in this book to think of ideas of your own. Never stop learning!

Want more exciting activities to do? Check out my other books: “Kitchen Lab for Kids: Edible Kitchen Experiments and Recipes to Improve the Children’s Creativity” and “Young Chef Cookbook: Fantastic Healthy and Tested Recipes for the New Kid Chef and Essential Culinary Skills” also available in Amazon!