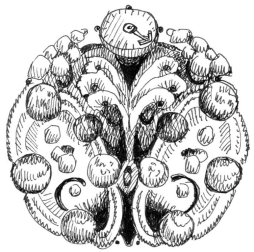
Fairy Experiments

Activities for Thinkers *'n'* Tinkerers



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Experiments conducted by

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For Gamy and Marilyn,
who have always loved everything I've ever written.

Typeset in Alex Brush, Carlito, Century Schoolbook, Merienda, and MoolBoran.

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Fairy Land Palace

Dearest reader,

Well met! My name is Morganis, and I am the queen of the Fairy Land and all its inhabitants. Mine is the gentle hand that guides all fairies to be curious and inquisitive, as well as responsible and honest.

I welcome you to enter my realm for a bit of fairy fun. Within these pages, you will discover that a fairy's favorite pastime is experimenting in the many fields of science. You may be a little surprised, but you shouldn't be. The fair folk are just as curious of their surroundings as you humans, if not more so. And yet, even the best scientists in my lands do not have the power of perseverance that you hold within you, dear friend. While they are easily discouraged, you know well that if you think hard enough, tweak your process this way or that, and try again, you'll find the answer soon enough.

As such, I will share with you the most treasured and well-kept fairy secret: the research and experiments conducted by my esteemed fairy scientists are what replenish our supply of fairy magic. You may know our

methods as magic, and our scientific tools as magic wands and fairy dust, but no matter the names, the only power we really have is through doing what you call science experiments. Unfortunately, my fairy scientists are unlike you humans; fairies are driven to perfection, and when a problem arises with an experiment, our scientists immediately quit and abandon their projects without a second glance. Now, our magic is in danger of being lost forever.

With my fairies fast running out of curiosity, science, and magic, I must ask for the help of a resourceful human for the first time in fairy history. In order to restore our magic, I need a human with the courage to see our experiments through to the end and to pursue answers in the face of doubt. I need someone who isn't afraid to make a mess, take a guess, or get the wrong answer, or many wrong answers. I need someone like you.

Now, my scientists will need to know that they are able to trust you as they would one of their own. As a token of my quest, I will bestow upon you an honorary badge that you may wear with pride as you discover wonderful scientific and magical powers yet to be explored. By royal decree, you are hereby forevermore a member of my royal science guard known as the Thinkers'n'Tinkerers, or TNTs for short. If you know some other curious humans who may be of assistance to you, like a friend or a caregiver, please share with them our dire circumstances, especially when the science gets a bit risky.

Take heart and take notes, pay close attention to your mistakes, and most of all, I implore you to have lots of fun! You'll have the eternal gratitude of every fairy in my lands, and the unshakable confidence that you can do anything you put your mind to.

Gracefully yours,

Queen Morganis

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How to Use This Book

Oh, you surprised me! Hello there, new friend. I'm known to the TNTs as the Alchemist, and I'm Fairy Land's lead scientist. Queen Morganis has informed me of your induction into Fairy Land's very first human branch of the TNTs, and I'm so excited to be your research guide throughout this book!

In each chapter, you will find several experiments designed to direct the magic you create to that particular fairy tribe, though not all experiments are complete. Some of these unfinished fairy studies will require you to problem solve and make adjustments as you work, so I have provided pages for you to take notes, draw conclusions, and make sketches of your steps or results. You will need (or want!) to conduct some experiments several times as you think and tinker. You may color the fairy pictures provided, and, of course, use all these boring margins for extra notes and sketches. For the best science requires creativity, so best not limit yourself only to the lines someone else has drawn for you!

Speaking of scientific ingenuity, the Miaj chapter (meaning "mine" or "my" in the human language Esperanto) features space for you to create and test your very own experiments. Take heart, be confident and remember that, no matter your initial results, you have succeeded in science when you've learned something.

When you have finished tinkering with an experiment, you and a grown-up can check your research against mine at my website:

www.FairyExperiments.com

If you made a mistake, write about something you can change in your notes and try again! Even if you didn't make a mistake, you can still try making a change to some part, or variable, of the experiment, and see if you get different results. Changing one part at a time will give you more useful results, or data, than if you change more than one. You may get unexpected results, or something may be overlooked, but there are no wrong answers in science, and that's what makes it beautiful.

If you take photos of your experiments, you and your grown-up can post them online (to my own site or any of my social media pages) and tell me how it went. While you're there, you can swap tips and results with other TNTs around the world.

Finally, you can conduct further research and discover resources for more magical science in the Continued Research chapter. You'll also find many more interesting activities and information on the website, as well as places to purchase experiment materials, especially the ones that are harder to find.

So color and cut out your badge on page 103 (or from my website) so you can **wear it and your safety glasses while you work**. A grown-up can also print extras from my website. Your badge will let everyone know that you are acting under the full authority of the fairy queen herself to bring back the fairies' magic with science!

Alchemy Experiments

Alchemical Fairies like to mix things up! They put together all kinds of ordinary ingredients to create extraordinary substances. What happens when I add a bit of toadstool to two bits of beauty berry? These are the kinds of things we Alchemy Fairies are thinking all day and all night. You'll want to steer clear of an Alchemist's workspace; you never know when something unexpected might fly your way!

But when an Alchemy fairy works with foodstuff, oh, the results are just delectable. You see, cooking and baking are an every-day kind of chemistry. You have to have all the ingredients and you have to follow each step very carefully, or your food might not come out very tasty. But once you've worked with one type of ingredient enough, you start to learn its attributes and you'll just know when it'll be useful. That, my friend, is science, and you eat it everyday!

Some of the experiments in this section are edible and are clearly marked. **DO NOT EAT OR DRINK** anything in this book unless the directions say you may. **Do not** ingest anything you have an allergy to.

Attach your TNT badge, put your safety glasses on, and let's get started!

Invisible Ink

Making invisible ink is very simple, and making it reappear might be even easier! You can try the whole experiment for yourself. Once you are comfortable with it, you can pass a secret invisible note to a friend and tell her how to decode it when she gets home.

Materials

- baking soda
- water
- paper
- thin paintbrush or a cotton swab
- small cup
- grape juice

Directions

1. Mix together 2 teaspoons of baking soda and one teaspoon of water
2. Dip a cotton swab or a thin paintbrush in your ink and write a message on the paper
3. Set aside and rinse your paintbrush
4. When the paper is dry, pour some grape juice in the cup, then hold the paper over a sink and quickly pour the juice over the paper
5. Observe and take notes

Fairy Messy

A forgetful fairy came up with this cool stuff when she tried to make gravy but forgot the drippings! It won't hurt you to taste it, but there's not much flavor. You might want to put down some newspaper or an old sheet before you get started, but don't worry. The goop will come off in the wash.

Materials

- cornstarch
- water

Directions

1. Mix together equal parts cornstarch and water in a large mixing bowl
2. Observe and take notes

Lava Lamp

Fairies love bubbles. They like soap bubbles, soda pop bubbles, aquarium bubbles, ALL the bubbles! Wouldn't it be cool to make bubbles in your favorite color? Let's see if we can do it with a lava lamp.

Materials

- 1 empty water bottle with label removed
- funnel
- vegetable oil
- water
- 5 drops liquid food coloring
- Effervescent antacid tablets with anhydrolic acid

Directions

1. Using the funnel, fill the bottle about 60% with oil
2. Fill the remainder with water, leaving a gap of 1-2 inches at the top
3. Add 5 drops of food coloring
4. Break the antacid tablet in half, and drop the pieces in one at a time
5. Observe and take notes
6. When you are finished, you can put the lid on your bottle and save it for another day

Drink It! Limonada

Speaking of soda bubbles, why not try whipping up one of these on a hot day? It's an Alchemy fairy's favorite beverage. (*You may need help from a grown-up with this tool.)

Materials

- 7 lemons
- *knife
- 1 large drinking glass or pitcher
- 1 cup water
- 1 teaspoon baking soda
- sweetener to taste

Directions

1. Squeeze all the juice you can out of the lemons into the glass
2. Remove seeds from the juice
3. Add water and baking soda to the juice
4. Add sweetener until it tastes yummy
5. Observe and take notes

Sticky Fountain

I know you TNTs love explosions too! Here's a controlled explosion that also involves bubbles, and lots of them!

Materials

- 2-liter bottle of cola
- 2-liter bottle of diet cola
- 4 mint-flavored scotch candies (like Mentos)

Directions

1. Place the bottles of cola and diet cola outside on a flat surface away from cars or bystanders so they are both within arms reach
2. Open both bottles
3. Take two candies in each hand, drop them into each bottle, then quickly move out of the way
4. Observe and take notes

Startler

Alchemy fairies can be mischievous little pranksters. They use this quick experiment to startle and surprise their friends with a little bang, though it's much louder to a fairy with small ears.

Materials

- ½ cup vinegar
- ¼ cup warm water
- 1 quart-sized zip-top freezer bag
- 1 half sheet paper towel
- 1 ½ Tablespoons baking soda

Directions

1. Pour the vinegar and water in the freezer bag
2. Place baking soda in the center of the paper towel and fold the sides inward to make a packet
3. Take the bag and paper towel packet to a clear area outside
4. Working quickly, drop the packet into the bag and seal it
5. Shake it up a bit, then stand back
6. Observe and take notes

Milky Whirls

Wield a tiny wand to see what beautiful magic you can unleash with the power of science. You are turning out to be quite the TNT!

Materials

- 2% or whole milk
- large plate
- 4 liquid food colors
- 1 cotton swab
- 1 drop dish soap

Directions

1. Slowly pour the milk onto the plate
2. Drop 1 drop of each food coloring into the milk
3. Place 1 drop of dish soap onto one end of the cotton swab
4. Touch the swab to the milk
5. Observe and take notes

Rock Farm

Have you ever seen a geode? They are rocks that look normal on the outside, but when you break them open, the inside is filled with beautiful fairy crystals! Let's see if we can grow some fairy crystals of our own. (*You may need some help from a grown-up with these steps.)

Materials

- Day 1
  - *half an eggshell, clean and intact (or plastic eggshell)
  - school glue
  - thin paintbrush
  - potassium aluminum sulfate (alum powder)
- Day 2
  - small plastic container
  - *5 tablespoons very hot water
  - 4 tablespoons alum powder
- Day 3
  - spoon
  - paper towels for drying

Directions

1. Using your paintbrush, coat the inside of the eggshell with glue
2. Sprinkle with alum powder
3. Let dry **overnight**

4. *On the next day, stir together a solution of hot water and alum in the plastic container until the alum is completely dissolved
5. Remove any extra alum powder with a spoon
6. Place the eggshell in the container with the inside facing up
7. Let sit for **24 hours**
8. Remove the eggshell from solution with slotted spoon and let dry completely. Do not throw out the solution.
9. Observe and take notes

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Fauna Experiments

Fauna fairies are in charge of the animal and microscopic life of the world. They love every creature, from the cuddly to the frightening, the cute to the ugly, and everything in between. They help the animals find food, build homes, and take care of their families. They teach the birds to sing and the bees to make honey. There is magic in helping animals, and the Fauna fairies are grateful for the kindness you offer to an animal in need.

Did you know that you are an animal too? It's true! Maybe you have a secret fairy helper yourself. Do you feel a special connection with one of your pets, or maybe you're drawn to a certain type of animal? I'd bet a Fauna fairy helped create that bond with her magic. She will help guide you through this set of experiments too.

While Fauna fairies are experts in all critters wild and tame, you are not. **NEVER** approach an animal you don't personally know or any wild animals. If you notice a new animal around, tell an adult. Similarly, **NEVER** feed a wild animal. The Fauna fairies make sure they get the food they need. You don't want to spoil their dinner, after all! If you're ready to get started, grab your TNT badge and we'll begin!

Yummy in Your Tummy

Ever wonder what happens to your food after you swallow it? Digestion is how your body breaks down big pieces of food to feed your trillions of microscopic cells. Every animal has to digest its food before it can be used for energy, and it starts in the stomach. Let's get a sneak peek into a stomach that just had breakfast.

Materials

- 1 quart-sized zip-top freezer bag
- 3 crackers or 1 piece of bread
- ½ cup orange or pineapple juice

Directions

1. Break the crackers or bread into bite-sized pieces and put in the bag
2. Add the juice
3. Seal bag tightly, getting most of the air out
4. Squeeze and mush the bag in your hands for a minute or two
5. Observe and take notes

Preserve-a-Critter

Sometimes when an animal dies, its body gets buried and pressed under many layers of dirt and water. After many years, minerals in those layers replace the animal's bones, turning it into a rock. We call those rocks fossils, and they help us learn about the animals that roamed the Earth many, many years ago. Let's make a model of one now.

Materials

- 2 oz modeling clay
- 2 disposable cups
- shell
- 8 tablespoons plaster of paris
- 6 tablespoons water
- disposable wooden stick

Directions

1. Press the modeling clay down into the bottom of one of the cups
2. Press the shell into the clay, texture side down
3. Remove the shell and set aside
4. In the other cup, pour water, then sprinkle in plaster, stirring with the stick until completely smooth (or according to included package directions)
5. Pour plaster on top of the clay, being careful not to touch it as it will warm as it sets.
6. Once the plaster is dry (**1 hour, or according to package directions**), tear away the cup and clay
7. Observe and take notes

Bug Snacks

Part of being a fairy is being intimately familiar with the circle of life. Bugs eat fruit. Birds and frogs eat bugs. Snakes eat birds and frogs. To help this cycle along, the fairies want to know which fruit attracts the most insects so they can keep the rest of the food chain happy too.

Materials

- 2 different fruits
- 1 paper plate for each fruit

Directions

1. Cut, or have an adult cut, a couple small pieces of each fruit you want to use
2. Place each fruit on its own plate
3. Take the plates outside to a place that usually has bugs and set them
4. Observe and take notes **every 4 hours**
5. You can compare your observations to the Creepy Crawly Identification chart

Life Source Code

Fairies use DNA to tell a cell what to do. Everything about your body is written in your DNA. It tells your eyes what color to be and how many spots a ladybug should have. Wanna see it?

Materials

- Day 1
  - rubbing alcohol (preferably 91%)
- Day 2
  - clear electrolyte drink
  - small cup
  - 1 clean, empty spice jar with lid
  - colorless liquid dish soap
  - pineapple juice or meat tenderizer solution
  - 1 drinking straw, toothpick, cotton swab, or pipette

Directions

1. Place alcohol in freezer **overnight**
2. Swish a mouthful of electrolyte drink around for two minutes, lightly scraping your cheeks with your teeth
3. Spit all the liquid into the cup, then pour some of it into the spice jar until it is 1/3 full
4. Add enough dish soap until the jar is half full and seal the lid
5. Gently swirl the mixture around to mix the contents together **without** creating bubbles
6. Add 3 drops pineapple juice, and repeat Step 5

7. Open both your jar and the rubbing alcohol
8. Tilt the jar in one hand and use your other hand to slowly trickle a little alcohol down the side of the jar into the solution so that there is a layer of alcohol floating on top of the solution
9. Slowly turn jar upright and let sit **10 minutes**
10. Insert the straw until the white stringy stuff is on the inside. Cover the top of the straw with your thumb to create a seal and gently remove from jar. *Or instead*, you can gently swirl a toothpick in a single direction to gather the strands and lift them out. A cotton swab or pipette may also be helpful at this step.
11. You can place the strands on a slide and look at them under a microscope if one is available to you, or on a darkly colored surface
12. Observe and take notes

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Built-In Blanket

Some animals live in very cold places all year round. What do you think these animals do to stay warm? Polar bears have fur, but that's not enough to protect them from constant freezing temperatures. And some seals don't have any fur at all! The fairies will let you in on a little wintery secret.

Materials

- small bowl
- ice or ice pack
- timer that measures seconds
- 2 quart-sized zip-top freezer bags
- about 1 cup shortening, margarine, or butter
- heavy duty tape

Directions

1. Make an ice bath in the bowl by filling it with half with water and adding your ice or ice pack
2. Put your hand in the ice bath and time how long you can keep it there (DO NOT leave your hand for longer than 20 seconds)
3. Record your results
4. Scoop the shortening into one freezer bag
5. Place your hand inside the second bag, then place your bag-covered hand in the bag with the shortening
6. Squish the shortening around until it's evenly distributed between the bags

7. Tape the seams of the bags together
8. Place your bag-covered hand in the ice bath, being careful that the water doesn't get in
9. Observe and take notes

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Meeting the Locals

Fairies of all kinds work together in everything they do. For example, if a Fauna fairy knows a certain kind of bird lives in oak trees, she will ask a Flora fairy to grow more oak trees for them. You can help them out by recording what critters stop by your neck of the woods.

Materials

- large cookie sheet with a lip (ask for permission first, or buy one from a thrift store just for this purpose)
- clean sand or dirt without clumps or rocks
- ruler
- seeds and/or nuts (premixed bird see will work too)

Directions

1. First, scout out a place on your property that is flat and is as far away from your house as possible
2. When you've found a location, lay the cookie sheet down and pour in some sand or dirt
3. Add just enough water to make it damp, stirring until evenly moistened
4. Spread the wet sand around the pan and level it with a ruler
5. Carefully place the pan of sand in your chosen location
6. Drop a few seeds and nuts in the center
7. Observe from your house, taking care to not go near the tray, and take notes

8. Examine the track box **24 hours** later and take notes
9. Compare your notes to the Animal Track Identification chart

Bacteria Farm

The Fauna fairies also look after the smallest life forms in nature. Bacteria, fungi, and viruses are everywhere: on every surface, in the air around you, and even living in and on your body! You've probably heard of an ant farm before. Well this is a bacteria farm!

Materials

- prepared agar plates (or agar and several petri dishes)
- cotton swabs

Directions

1. If you are preparing your own plates, prepare according to the instructions
2. Swab a surface with a cotton swab
3. Gently rub the agar with the same swab
4. Cover and let sit in a warm area for **24 hours**
5. Observe and take notes several times
6. Repeat Steps 2-4 with all kinds of surfaces. Try these to get started
    - your bellybutton
    - dirt
    - a doorknob
    - a cell phone
    - your toothbrush
7. Observe and take notes
8. When you are finished, throw away the petri dishes without opening the lids

Radiant Experiments

Radiant fairies are the brightest fairies of all. Literally. They warm the Earth with the rays of the sun, guide travelers with the twinkle of the night-stars, and bounce sunlight off the moon to brighten the dark night sky. But don't make them angry, for they spark lightning in the sky and in your laundry!

The most fascinating part about Radiant fairies is that you don't see most of their work. Light has another name: electromagnetic radiation. The funny thing about electromagnetic radiation, or EMR, is that it also includes things like UV radiation and radio waves and microwaves. So when you cover up with sunscreen, you are protecting yourself from a type of light you can't see but can do you harm. When you dial in to your radio in the car, the sounds you hear are traveling from the radio station to your car over another type of light you can't see. And when you reheat leftovers in the microwave, it is yet another type of light that warms up the molecules in your food.

To make it easy on us, the fairies decided to only give you experiments about the light you can see. When you are older and are an expert TNT, you'll have to try your hand at the more challenging aspects of playing with light!

Black and White

It's important to know what kind of clothes to wear when you're working all day in the hot sun like many of the Radiant fairies do. You don't want to overheat!

Materials

- 2 small, identical drinking glasses or glass jars
- 1 piece black paper
- 1 piece white paper
- tape
- water
- thermometer

Directions

1. Wrap one piece of paper around each glass, and secure with tape
2. Fill each glass ¾ full with water
3. Measure the temperature of the water with the thermometer, and record the measurements
4. Put both glasses in a place where they will be in direct sunlight for at least **3 hours**, folding the tops of the each paper down to block the light from reaching the water directly
5. Measure the temperature of the water in both glasses and take notes

Prism Power

A Radiant fairy's favorite pastime is painting rainbows of all shapes and sizes. You can reuse the materials from the previous experiment to see one of the smaller kinds.

Materials

- clear drinking glass or glass jar
- water
- 1 piece of white paper

Directions

1. Fill the jar ¾ full of water
2. In a sunny place, lay the paper on the ground and hold the jar above the paper at different angles and heights
3. Observe and take notes

Pencil Diffraction

The light the Radiant fairies create is actually made up of tiny little specks or particles flowing very fast, and they move up and down, like a wave. Looking at a fire or light bulb is a lot like looking at a whole ocean or river of light. This experiment will let you see the tiny waves one at a time.

Materials

- 2 pencils
- 1 candle
- 1 hair from your head

Directions

1. Place the candle 3 feet away from you
2. With help from an adult, light the candle with a match or lighter.
3. Holding your pencils upright and close to one eye, close the other eye and look at the flame through the tiny space between your pencils
4. Try pinching the pencils together while you look
5. Observe and take notes
6. Try turning them on their side
7. Observe and take notes
8. Set the pencils down, and stretch the hair across your view of the candle
9. Observe and take notes
10. Safely snuff out the candle with help from an adult

Disappearing Rainbow

Radiant fairies make rainbows, it's true, but they also have to erase them when they're finished playing. You probably have to clean up your toys when you're finished with them too. Let's find an easy way to erase a rainbow. (*You may need some help from a grown-up for this step.)

Materials

- 1 paper plate
- scissors
- ruler
- markers or crayons in red, orange, yellow, green, blue, and purple
- pencil with eraser
- 1 pushpin

Directions

1. Cut a flat circle out of the middle of the paper plate
2. Use the ruler to divide the circle into six equal pie slices
3. Color each slice with one of your markers or crayons, using each one once
4. Pin the center of the plate to the center of the pencil eraser
5. *Spin the plate as fast as you can
6. Observe and take notes

Magic Wand

Every fairy uses a magic wand. They use wands to convert Fairy Land's science discoveries into magic. Although only fairies can use real magic wands, you can make a model of one with some simple materials.

Materials

- penlight, or smartphone flashlight
- 3 hot glue gun glue sticks
- clear tape

Directions

1. In a darkened room, shine the penlight into one end of a glue stick
2. Hold the other end about a half inch away from the wall
3. Observe and take notes
4. Tape two sticks together end-to-end and repeat Steps 1-3

Fountain of Light

This magical contraption was how fairies first discovered that light could be bent in unexpected ways. There are all sorts of ways that optical fibers are used in your world, but this is a more recreational version that the fairies prefer.

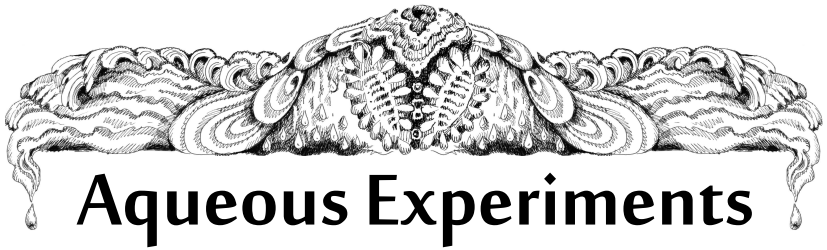
Materials

- 1 clean 2-liter bottle
- pushpin
- tape
- water
- flashlight
- screw

Directions

1. About 4 inches up from the bottom of the bottle, carefully press the pin into the bottle to make a small hole, and remove the pin
2. Place a piece of tape over the hole and press it down firmly so it is sealed
3. Fill the bottle with water
4. In a dark room with a sink, turn the flashlight on and the lights off
5. Place the bottle on the edge of the sink
6. Place the flashlight against the bottle so that it is resting on the opposite side and shining through to the tape
7. Remove the tape

8. Observe and take notes
9. When the water is finished draining, use the screw to open up the hole a little wider and repeat Steps 3-8, observing and taking more notes

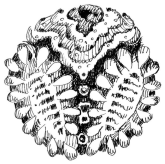


Aqueous Experiments

Aqueous fairies have the power to manipulate water. They can be fun to play with, but watch out when they're angry. A hurricane might blow ashore! But they're mostly friendly little fairies. After all, they always wave to the beach! The Aqueous fairies call the rain to fall and streams to flow. They are in charge of the water cycle, which is why you can only find it here on Earth.

The water cycle is how the fairies make the rain. When the Radiant fairies heat up the earth, the Aqueous fairies send tiny molecules of water up to the clouds. Clouds are like sponges. When they get full of water, it drips out and that's the rain. The rain flows into rivers that then flow into the oceans. The rain also seeps down into underground aquifers where people can drill a well to drink the water. So you see the Aqueous fairies are very important to all lifeforms.

Come learn more about the magical world of water with us! Got your badge? Let's go!



Gauging Rainfall

This is an easy way to tell how many Aqueous fairies are in your area. The more rain that falls, the more fairies there are. (*You may need some help from a grown-up with these steps.)

Materials

- 1 pushpin
- 1 clean, 2-liter bottle
- scissors
- 1 cup of gravel or pebbles
- heavy duty tape
- permanent marker
- ruler

Directions

1. *About 4 inches from the top of the bottle, use the pushpin to perforate a line in the bottle with 4-5 holes.
2. *Carefully insert your scissors into this line, then proceed to cut off the top 4 inches of the bottle in a smooth straight line, leaving it as intact as possible, and set aside
3. Pour the pebbles into the bottom of the bottle
4. Turn the top piece upside down, place it inside the bottle so the edges line up, and tape it in place
5. Use the ruler to mark the bottle in inches or centimeters, placing 0 at the top of the pebble line
6. Pour in enough water to reach the 0 line

7. Place the bottle outside on a flat, level surface with open sky above it on a rainy day
8. When it stops raining, or anytime before, observe and take notes

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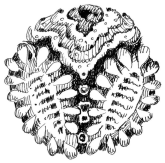


Under Pressure

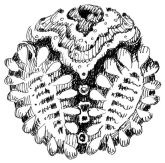
Practice being an Aqueous fairy by making water defy gravity with the help of air pressure, or lack thereof.

Materials

- small cup
- sink
- piece of cardboard large enough to completely cover the opening of the cup

Directions

1. Completely fill the cup with water at the sink
2. Place the cardboard on top of the cup
3. Place your hand over the cardboard to hold it in place, then turn the cup upside-down
4. Remove your hand
5. Observe and take notes



Radiant Water

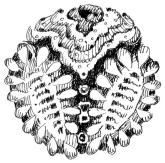
You can do this experiment to see how fairies make fun lighting for their fairy feasts. But don't be fooled. There's science in everything fairies do!

Materials

- black light
- tonic water
- highlighter
- 1 drinking glass or glass jar
- water

Directions

1. Carefully break open the highlighter and remove the felt
2. Place it in a jar of water to soak for a few minutes
3. Place the tonic water and highlighter jar on a table or counter top
4. Turn on the black light so it is near the waters
5. Turn out the lights in the room
6. Observe and take notes



Magical Music

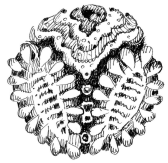
Speaking of fairy feasts, a fairy host needs more than just fancy lighting to throw the party of the season. There has to be music too!

Materials

- 4 identical drinking glasses or glass jars
- water
- 1 pencil

Directions

1. Fill each glass with a different amount of water
2. Arrange them from least full to most full in a line
3. Observe and take notes
4. Try changing the water levels and repeat



Go with the Flow

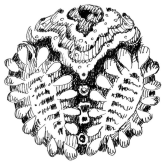
Aqueous fairies know that temperature can affect the speed of water molecules. Do you think cold water or hot water moves faster? Let's uncover this secret knowledge with the help of some color.

Materials

- 2 identical glass jars or drinking glasses
- 1 ice cube
- sink
- red and blue liquid food coloring

Directions

1. Fill one glass with cold water and add the ice
2. Fill the other glass with hot water
3. Open the bottles of food coloring, and squeeze in one or two drops into each glass at the same time
4. Observe and take notes



Water Power

If you believe in fairies and their magic, if you believe that science can reveal the magic and the beauty in both the Fairy Land and the human world, the Aqueous fairies will grant you a bit of their power to keep you dry.

Materials

- sturdy bucket with a strong handle
- water
- 10 square feet of solid ground, cleared of innocent bystanders or debris you might trip on

Directions

1. Fill the bucket halfway full of water
2. Stand clear of people and make sure your area is clear of anything you might trip on or hit with the bucket
3. Hold the bucket with the handle and start spinning
4. Lift the bucket higher as you spin
5. Lower the bucket as you slow down
6. Observe and take notes

Flora Experiments

Flora fairies love getting dirty. They spend all their time germinating seeds, making flowers bloom, and ripening fruit and vegetables. They keep the balance of plants in a certain area just right so that no one plant takes over the others. They even grow the weeds in your garden. Some plants need lots of nutrients, others need less, and each plant needs a different mix. It helps keep the soil fertile, and makes the Flora fairy's job much easier, if the plants can help each other out as they grow. It's the reason you might see corn in a farmer's field one year, but soybeans the next. Farmers helped the Flora fairies by taking such good care of their plants that the fairies decided to share their secret of crop rotation.

There are lots of things to be learned from plants, and from the Flora fairies themselves. We still don't know everything there is to know, but I bet you could help out. Grab your TNT badge and we'll get started!

Colorful Bouquet

Flowers are different colors because of how the Flora fairies write their DNA, but there's a magical way to turn a plain white flower into one with vibrant color after it's already bloomed.

Materials

- 2 cups
- water
- 2 liquid food colors
- 3 white carnations or daisies, or stalks of celery

Directions

1. Fill each cup half full of very warm water
2. Add about 30 drops of one food coloring to one cup, and put 30 drops of the second color in the other
3. Place the cups next to each other and put one flower or celery stalk in each cup
4. Split the bottom of the stem of the third flower in two and place one half in each cup
5. Check every **24 hours** until the plants wilt
6. Observe and take notes

Eat it! Ripe for the Taking

A big part of the Flora fairies' job is ripening fruit and vegetables so they are ready to be eaten by animals. Let's see if we can uncover the secrets to their process.

Materials

- 1 banana
- 3 hard, unripe avocados, peaches, or plums of the same size
- 1 paper bag
- tape

Directions

1. Place the banana and one fruit inside the paper bag together
2. Fold the top over and tape it shut
3. Place a second fruit in a place that is room temperature and where it won't be eaten
4. Place the third fruit in the refrigerator
5. Observe and take notes **every 12 hours until one of the fruits is ripe enough to eat**
6. Enjoy the fruit of your labor!

Terrarium

Flora fairies work very hard to create the perfect environments for their plants. Try your hand at a mini plant habitat. (*You may need some help from a grown-up with these steps.)

Materials

- clean 2-liter bottle
- *scissors
- 1 cup of gravel or pebbles
- 4 cups potting soil
- pea or marigold seeds
- ¼ cup filtered water
- plastic wrap
- rubber band

Directions

1. *Carefully cut the top 4 inches off the bottle and recycle it
2. Wash the bottle out thoroughly with soap and water
3. Pour the gravel into the bottom of the bottle
4. Pour the potting soil on top of the gravel
5. Spread the seeds around the top of the soil, then press down about ¼ inch
6. Smooth the dirt over and add water
7. Cover the top of the bottle with plastic wrap and hold in place with the rubber band
8. Place terrarium in a location that receives indirect sunlight

9. Observe and take notes
10. Care for your terrarium every day. Tend to anything that seems out of balance.

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Veggie Races

One of the ways Flora fairies like to unwind after a hard day's grow is to race vegetable boats. But they need help. The last time they tried to race, half the boats sank! Maybe a TNT can figure out the best veggies for the race, but be careful. This is an experiment that requires a steady hand and precise measurements.

Materials

- 4 different fruits or vegetables
- scale that measures grams
- 2-quart (or larger) graduated pitcher that measures milliliters (ounces can be used, but will need to be converted at Step 8)
- water
- measuring cup
- pencil
- calculator

Directions

1. Weigh each produce item in grams and record the measurement
2. Fill your pitcher about ¾ full of water, and make a note of the measurement
3. Gently place your first produce in the bowl
4. Note if it sinks or floats
5. If it floats, slowly push it down to the bottom of the bowl with a pencil
6. Make a note of the measurement of the water line

7. Remove the produce from the pitcher, and repeat Steps 3-7 until you have measured each item
8. Calculate each item's volume: subtract the water line measurement of each item from the starting water line. (If you used ounces, convert your final number to milliliters by multiplying by 29.6, because there are 29.6 mL in each ounce of water.)
9. Use your calculator to divide each item's weight (in grams) by its volume (in milliliters). This is its density [g ÷ mL = D]
10. Observe any patterns and take notes

Cabbage Clone

Cloning sounds like it belongs in a laboratory rather than a garden, but cloning can be found in just about any proficient gardener's bounty. It simply means you're growing a plant whose DNA is identical to its parent. Let's give it a shot! (*You may need some help from a grown-up with these steps.)

Materials

- 1 leaf from a Napa cabbage
- scissors
- 2 paper towels
- 2 quart-sized zip-top freezer bags
- permanent marker

Directions

1. Make a horizontal cut near the bottom of the cabbage leaf to separate it into a leaf and a stem
2. Wet the paper towels and wring out so they are only damp
3. Fold the leaf into the damp paper towel and slip it into one of the bags
4. Label it with the marker
5. Repeat Steps 3-4 with the stem
6. Seal the bags and set aside
7. Observe and take notes **now**, on **Day 3**, and again on **Day 7**

Zephyr Experiments

Zephyr fairies are in charge of the earth's winds. They are temperamental little creatures. They can blow a cool, soothing breeze through your hair on a hot summer day, but they can also move big, sometimes destructive thunderstorms around where they want them. They make soft breezes and howling winds in the same way: by changing the pressure around them. The more the pressure changes, the more wind is made.

One of the coolest parts about wind is that it's invisible! That's because it's made of the same air that you breathe and stand in. You can only see the wind cause change around you, like when it hits a tree and the leaves are rustled and shaken off. The wind is very important to Earth's many climates. When you watch the weather report on TV or on a computer, you are really learning about the predictions scientists are making about the wind that day.

Ready? Alright, let's go make some predictions of our own!

Hidden Air

The Zephyr fairies are experts at squeezing air into the smallest little spaces, even in places where you don't think it is. Don't believe me? You will soon! (*You may need some help from a grown-up with this step.)

Materials

- 1 raw egg
- 1 glass jar
- *very hot water
- magnifying glass

Directions

1. Gently place the egg in the jar
2. *Carefully pour in very hot water until the egg is covered by about a half inch
3. Use your magnifying glass to help you observe, then take notes

Pressure in the Air

Zephyr fairies make wind by creating pressure differences in the atmosphere. You can create and see the effects of uneven air pressure in this experiment. (*You may need some help from a grown-up with these steps.)

Materials

- 1 egg *(or use a pre-boiled egg from the store and skip Steps 1-2)*
- 1 jar, with an opening diameter slightly smaller than the egg
- index card
- *lighter

Directions

1. Hard boil your egg and let it cool
2. Completely peel the shell off
3. *Light the index card and quickly slide it into the bottle
4. Place the egg on the mouth of the bottle
5. Observe and take notes

Tornado Maker

The Zephyr fairies are normally mellow and sweet, but on the rare occasions their tempers flare, tornadoes are born. You can give it a whirl too, but this way is much safer. (*You may need help from a grown-up for this step.)

Materials

- clean 2-liter bottle
- water
- glitter or paper confetti

Directions

1. Fill the bottle about ¾ full of water
2. Add glitter, or cut up colorful construction paper to make confetti
3. Tightly replace the cap
4. *Turn the bottle upside down and spin it around in small, fast circles
5. Stop spinning the bottle and look inside
6. Observe and take notes

Breath Saver

Zephyr fairies like to throw parties as much as the Aqueous fairies. The Zephyr fairies are always in charge of the decorations, but blowing up balloons is hard on your cheeks. Help the fairies with the experiment below. (*You may need some help from a grown-up with these steps.)

Materials

- 1 latex balloon
- 1 empty water bottle
- water

Directions

1. Stretch the balloon opening around the top of the bottle
2. *Heat the water in the microwave or on the stove
3. *Carefully submerge the bottle in the hot water while firmly holding it from the top
4. Observe and take notes

Weather Vane

This is the best way to find out where the fairies are aiming their wind. You've probably seen weather vanes on top of barns or other buildings, but this one is perfect for your garden at home.

Materials

- 1 index card
- pencil
- scissors
- 1 drinking straw
- tape
- 1 pushpin
- 1 disposable cup
- modeling clay or a few heavy rocks

Directions

1. Draw an equilateral triangle and a square of about the same size on the index card and cut them out
2. Cut a slit into each end of the straw and slide the paper shapes onto them to make an arrow, securing with tape
3. Carefully use the pushpin to poke a hole in the center of the bottom of the cup, then use the scissors to widen it just enough for the pencil
4. Carefully push the pin through the center of the straw and into the top of the pencil eraser. Make sure the straw can rotate freely in the wind.

5. Turn the cup upside down and push the pencil through the hole to make a stand
6. Put your weather vane outside on a level surface
7. Place the clay or a few rocks on top of the cup to hold it in place
8. Observe and take notes

Weather Predictions

When the fairies change the weather, you can measure the changes in the air to predict what they will do. You'll be able to detect fairy weather magic even before you see the change with your eyes!

Materials

- 1 latex balloon
- scissors
- 1 jar or can of any material
- 1 rubber band
- tape
- 1 drinking straw
- 1 index card or sheet of paper
- pen or permanent marker

Directions

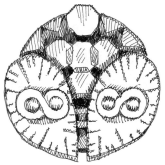
1. Cut off the mouth of the balloon
2. Stretch the balloon bulb across the top of the jar so it's tight like a drum and wrap the rubber band around the edge to hold it in place
3. Tape one end of the straw to the center of the balloon. The straw will act as the pointer.
4. Place the barometer on a flat surface and near a wall
5. Tape the index card on the wall behind the straw pointer
6. When you notice a change in the weather, make a mark on the index card where the straw is pointing
7. Observe and take notes

Visionary Experiments

Visionary fairies are those who anticipate the needs of the rest of the fairy population and invent solutions to their problems. They are remarkable at constructing new, cool things from a random pile of stuff. How does this twig fit into that seed? What is the angle between this branch and that tree trunk? Visionary fairies work with what humans boringly call mathematics, but the fairies call it Numericonjury.

Numericonjury was one of the first Visionary fairy inventions many years ago, and they use it every time they experiment. Why, even YOU have been using Numericonjury throughout this book! Every measurement comes from Numericonjury, every calculation, addition, subtraction, every division and multiplication! (Although the fairies call your “addition” sumcrafting.)

Get your tools, get your creativity, and get excited! Are you excited? Well, what are you waiting for? Get your TNT badge and get started!

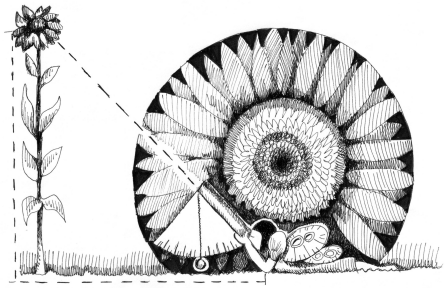


Magical Angles

The mariner's quadrant is a very important tool for travel across large bodies of water. A human sailor stole this invention from the Visionary fairies long ago, and humans have been using it ever since. You can make yours colorful and use a pretty bead like the fairies do!

Materials

- quadrant pattern (on page 104 or from my website)
- crayons, markers, or colored pencils
- glue stick
- 1 piece of cardboard
- scissors
- hole punch
- 1 drinking straw
- clear tape
- string
- 1 bead
- tape measure



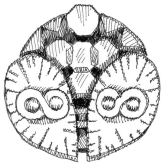
Directions

1. Cut out the pattern on page 181. Cut along the outer edge, leaving as much of the black border as you can.
2. Glue the quadrant pattern to the cardboard, smoothing out any wrinkles
3. Cut the reinforced quadrant out, leaving a little margin on both straight edges
4. Color and decorate it if you wish
5. Carefully use a hole punch to make a small hole through the circle in the corner

6. Cut the straw to the length of the quadrant, and tape it to the 90° edge
7. Measure and cut a length of string that's about 1.5 times the length of the quadrant
8. Tie one end of the string to the hole in the cardboard and tie the bead to the other end, leaving enough string to hang past the edge of the quadrant

Measuring Height

1. Grab the tape measure and your quadrant
2. Find an object that stands at a 90° angle to the ground
3. Sight the top through the straw with the curved side facing you, hold the string in place, and check the angle. You want it to be right at 45°. If it's greater than 45°, move further away. If it's less than 45°, move closer. STAY OUT OF ROADS AND ALL OTHER DANGEROUS AREAS. DO NOT TRESPASS ONTO ANY PROPERTY. Find a different object to measure if you can't measure safely!
4. Once you have found your 45° angle, lay the quadrant on the ground to mark your place, and use your measuring tape to measure the distance between the quadrant and the object.
5. This measurement is the height of your object. You created a 45°-45°-90° triangle with the endpoints being you, the base of the object, and the top of the object. In a 45°-45°-90° triangle, two of the sides are always the same length.



Protractor Contractor

You probably have a special stick that measures inches and centimeters called a ruler. Another tool of Numericonjury is the protractor. It measures the angle between two lines, or between an object and the ground, like the angle of the roof of your dollhouse. It will also be very useful for the next experiment.

Materials

- 1 paper plate
- scissors
- pen
- 2 crayons or colored pencils

Directions

1. Cut your plate in half
2. Using the pen, write *0°* on the curve of the left edge and write *180°* on the right
3. Fold the plate in half and unfold, making a crease in the halfway point
4. Trace the crease with the pen, and write *90°* and *right* along the line
5. Write the word *acute* between the 0º and 90º lines, and write *obtuse* on the other side
6. Fold the plate from the 0º edge to the 90º line, making another crease in the center, and mark this new line *45°*
7. Repeat Step 6 from 0º to 45º and mark this line *22.5°*

8. Repeat Step 6 from 180º to 90º and mark this line *135°*
9. Continue to mark the obtuse side in this same way, marking *112.5°* and *157.5°*
10. Color the acute side one color and the obtuse side another
11. Check out the angles around you to determine if they are acute, right, or obtuse. Line up one edge with 0º, then see where the adjacent edge hits your protractor to determine the type of angle.
12. Take notes on your discoveries

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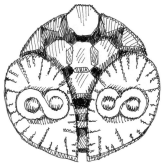


Confection Construction

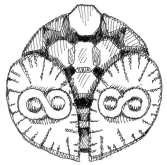
We fairies are so much smaller than you humans, so our Visionaries have to use smaller building materials to build all the infrastructure for Fairy Land. Of course, this means the materials is yummier than the big stuff. After you build something, use your Numericonjury instruments to take different measurements of your creation.

Materials

- 1 bag mini marshmallows
- 1 bag large marshmallows
- 1 bag matchstick pretzels
- 1 box toothpicks
- 1 box coffee stirrer straws
- scissors

Directions

1. Build something
2. Measure the angles between the sticks with your protractor and take notes
3. When you are finished, eat your pretzels and marshmallows!



Not for the Faint of Heart

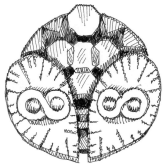
Your doctor uses a stethoscope to listen to your heart when you go in for a visit. It looks really fancy, but you can make one of you own very easily. Fairy medicine has never been the same since the Visionary fairies invented it.

Materials

- 1 latex balloon
- scissors
- funnel
- tape
- timer that measures seconds
- calculator

Directions

1. Cut off the mouth of the balloon
2. Stretch the balloon tight across the large end of the funnel like a drum, and secure with tape
3. Ask a friend for their consent to listen to their heartbeat, or ask someone to listen to yours
4. Using the timer, count how many times your friend's heart beats over the course of 10 seconds, then multiply the number by 6. That is their heart rate.
5. Have them jump up and down for 30 seconds, then measure again
6. Repeat Steps 3-4 with several people, always getting consent first
7. Observe and take notes



Bottled Rainbow

The kaleidoscope was invented as a gift to a Radiant fairy on her birthday. She loved it because a kaleidoscope lets you have a rainbow in your pocket that you can look at anytime, even at night! It's a big help to cheer you up when you're feeling down.

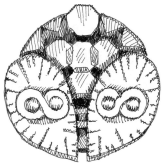
Materials

- 1 clear plastic report cover or page protector
- ruler
- pen
- scissors
- clear tape
- 1 empty paper towel roll
- 1 sheet black construction paper
- plastic wrap
- glitter, confetti, or tiny beads
- wax or parchment paper
- 1 rubber band
- heavy duty tape

Directions

1. On the report cover, draw a rectangle 8 inches by 4 inches
2. Divide the rectangle into long columns: three columns that measure 8" x 1.25" each, and the remaining flap that measures 8" x 0.25"

3. Cut out the large rectangle and fold along the lines to create a triangular prism with the ¼ inch flap on the outside
4. Tape the flap in place with clear tape and set aside
5. Measure and trim the paper towel roll down to 8 inches
6. Stand the roll on its end on top of the construction paper and trace it to make a circle
7. Cut the circle out of the paper
8. Fold the circle in half and cut out a small semi-circle so you have a doughnut shape when you unfold it
9. Place the plastic triangle into the roll and tape the black circle over one end of the roll
10. Cut a 4 inch by 4 inch square of plastic wrap and place it over the other end
11. Push the center into the triangle a little to form a pouch
12. Tape the plastic wrap in place
13. Put your pretty shiny things into the pouch
14. Cut a 4 inch by 4 inch square of wax paper and cover the pouch
15. Secure the wax paper with the rubber band so it stays in place while you tape the ends down with heavy duty tape
16. Look through the tube, observe and take notes
17. Decorate the outside of the kaleidoscope with art supplies, if you wish



Periscope

With the advancement of human technology and the increase in human construction, the fairies have needed a way to get around in secret. A periscope is the perfect tool for a fairy to examine her surroundings without being spotted! (*You may need some help from a grown-up for these steps.)

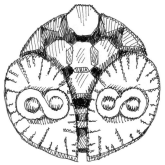
Materials

- 2 milk or cream cartons, 1-quart sized
- scissors
- 2 pieces cardboard
- 2 small pocket mirrors
- protractor (use the one you made in Protractor Contractor!)
- pencil
- heavy duty tape

Directions

1. Use the scissors to cut off the triangular top of one of the cartons
2. Cut a viewing hole in the bottom front of the carton, leaving about ¼ inch on each side
3. Turn the carton on its side with viewing hole facing you
4. Use your protractor to measure a 45° angle that starts at the corner between the base of the carton, the top side you can see, and the viewing hole side.

5. *Cut along this line according to how long your mirror is, as this is the place you will insert it
6. Slide the mirror into the slot, widening it as necessary. If your mirror is the wrong shape or size, first tape it to a piece of cardboard that does fit, then widen the hole as necessary and slide it in.
7. Sit the carton upright on the table and verify that you can see the ceiling. Adjust the mirror as necessary, then tape in place.
8. Repeat Steps 1-7 for the second carton
9. Stand one carton with the viewing hole facing you
10. Turn the other upside-down and face the hole away from you
11. Slide one carton onto the other
12. Adjust the height of your periscope and tape the two cartons in place
13. Observe your environment and take notes



Look Out Below

When fairies are busy picking leaves, seeds, and berries, they don't have time to fly back and forth between the treetops and the ground. The Visionary fairies discovered this easy parachute that helps keep things from bruising or breaking on their way down. (*You may need some help from a grown-up with these steps.)

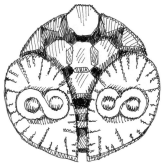
Materials

- 1 plastic grocery bag
- scissors
- string
- a small object to parachute

Directions

1. Cut a large square out of the grocery bag, then cut the corners off to make an octagon.
2. *Carefully poke a hole at each corner of the octagon with the scissors
3. Cut 8 pieces of sting that are equal in length
4. Tie one string tightly into each hole
5. Tie the other end of each string to your object
6. *Find a *SAFE*, high place to drop your parachute from. Only choose a place with a railing, like a tree house, a tall jungle gym, or a balcony. ***If you can't find a SAFE place***, have an adult help you climb a step ladder, and drop it from there.
7. Observe and take notes
8. Please don't pollute! Remember to pick up your parachute, along with any other plastic bits, and take

them home when you're finished so the fairies don't get trapped! Recycle your unused plastic bags at a grocery store.



Liquid Layers

When Visionary fairies find something they've never seen before, they have to identify it before doin anything else. An easy way to do this is to test its density, which is how many molecules you can fit into a certain measurement of it. In fact, playing with density is a young Visionary's favorite game. Here is a version of the fairy density game.(Note: It's okay if you don't use all the liquids; even two will work.)

Materials

- 2 clean, empty water bottles
- ½ cup of each of the following:
  - 100% real maple syrup
  - vegetable oil
  - milk
  - water
  - rubbing alcohol
  - honey
  - corn syrup
  - dish soap

Directions

1. In the first bottle, pour half of each liquid into the bottle in any order you choose
2. Observe and take notes
3. In the second bottle, pour in the other half of each liquid in this order: honey, corn syrup, maple syrup, milk, dish soap, water, vegetable oil, and rubbing alcohol
4. Observe and take notes

Rime Experiments

Rime fairies are in charge of all things frosty. They make snowflakes, icicles, and icebergs. They turn the wind cold and turn rain into sleet. Most of the time they live in the polar regions, but once a year, they take a vacation from their usual stomping grounds.

There are only two Rime fairy habitats in the world, the Arctic Circle at the north pole and the Antarctic Circle at the south pole. It's always cold at the poles, but when the earth and the sun line up just right, winter stretches down from the north pole and the Arctic fairies go to work for a few months. When summer returns, the Arctic fairies return north, but that's when winter begins for the Antarctic fairies, who fly north from the south pole to spread winter there.

A little Rime fairy secret: the seasons change, and are opposite in the northern and southern hemispheres, because the earth doesn't rotate at a perfectly vertical 90º. The earth tilts 23º! Can you find 23º on your protractor? That's quite the angle!

If icy experiments sound up your alley, grab your badge and we'll get started!

Ice Slice

Rime fairies live on large sheets of ice floating on top of the Arctic Ocean. Sometimes they need to cut the ice into smaller pieces to use when they travel south for winter. Let's see if you can do it too.

Materials

- 1 tall plastic cup
- 1 paper plate
- 1 ice cube
- fishing line
- scissors
- 2 hammers, mallets, or other heavy tools with handles

Directions

1. Place the cup upside-down on the plate
2. Tie one end of the fishing line to one of the hammers
3. Measure and cut the fishing line at about 15" away from the first hammer
4. Tie the other end to the second hammer, making sure the tools can dangle freely on each side of the cup
5. Place the ice cube on top of the cup
6. Lay the center of the fishing line over the top of the ice cube for about **5 minutes**
7. Hold one hammer in each hand and move the line back and forth along the center of the ice cube
8. Observe and take notes

Melt Magic

Water and ice have very strange properties as far as matter is concerned, but you'd have to be pretty strange to live on the polar caps for most of the year too! For example, when most liquids become solid, they become more dense, but water actually becomes *less* dense. The Rime fairies use these properties to their advantage, as you can see in this experiment.

Materials

- measuring cup
- 1 ice cube
- water

Directions

1. Place the ice cube into the measuring cup
2. Add water until you reach a line, and note what the measurement is
3. Watch the ice melt for a few minutes until it's gone, or come back in about **10 minutes**
4. Observe the water line and take notes

Enchanted Ice

Antarctic fairies play many games at the South Pole to pass the time before their winter work begins, and they've decided to share this one with you. They thought you would especially appreciate the little rhyme they sing as they play. It's a little like your human game of Ring-Around-the Rosie.

Materials

- small cup
- water
- 1 ice cube
- 1 paper plate
- 8 inch length of yarn
- a sprinkle of salt

Directions

- *The first day of spring still had quite a shiver*
  when a fairy was strolling 'long old Onyx River...
  1. Fill a cup with cold water
- *When what did she see floating on down the stream*
  but the most beautiful block of ice ever seen...
  2. Dip the ice in the water, then place on the plate
- *"Come to me, rime! Ye shall surely be mine!"...*
  3. Dunk the yarn in the water, then place it on top of the ice for **2 minutes**
- *But the ice was too wild, altogether unmild...*
  4. Lift up the yarn
- *The fairy just laughed, then began the old craft.*
  "Hark, ye old rascal! Heed me, else see
  what a fine little pet you turn out to be!"...
  5. Sprinkle salt onto the ice, then press the yarn on top
- *For two long minutes, the ice struggled to win,*
  but the magic dust did pull through in the end...
  6. Let sit for **2 minutes**
- *"Saltus!" said the fairy, as she hoisted her band,*
  and the little ice block jumped into her hand...
  7. Pull up the string again
- *Take notes, and this lesson, please do emboss*
  Lest you ever think wise a fairy to cross!
  8. Take notes on your observations

Grow a Snowflake

Have you ever wanted to examine a snowflake up close? It's almost impossible. Snowflakes are so small, and they melt as soon as they touch your hand. But you can grow a magic one that won't melt. (*You may need some help from a grown-up with these steps.)

Materials

- 1 pipe cleaner
- string
- pencil or stick
- water
- 1 cup or jar
- plain borax (**not** borax soap)

Directions

1. Cut the pipe cleaner into three equal parts
2. Twist all three pipe cleaners together at their centers to create a 6-point star-shaped frame
3. Make sure the frame will fit into the jar without touching the sides. Trim as needed.
4. Tightly tie one end of a piece of string to the snowflake frame and tie the other around the middle of the pencil
5. *Boil some water, and pour it into the jar until it is mostly full
6. Stir in 3 Tablespoons of borax for every 1 cup of water in the jar. The borax may not completely

dissolve, but stir for a couple minutes until most of it is.
7. Lower the frame into the jar, resting the pencil across the top to hold the frame in place
8. Adjust the string as needed to make sure the pipe cleaners don't touch the bottom or sides of the jar
9. Leave it sit undisturbed **overnight**
10. Observe and take notes

Eat it! Creamy Ice

Why, of course a Rime fairy's favorite treat is ice cream. And they can whip it up in five minutes or less! (If you are lactose intolerant, try using a fruit juice instead of milk, sugar, and vanilla.)

Materials

- ½ cup half and half (that's half milk and half cream, which you can substitute instead)
- 1 tablespoon sugar
- 1 teaspoon vanilla extract
- 1 quart-sized zip-top freezer bag
- 1 gallon-sized zip-top storage bag
- ice
- 1/2 cup salt
- oven mitts

Directions

1. Pour the milk, sugar, and vanilla into the quart-size bag
2. Let out as much air out of the quart bag as possible and seal completely shut
3. Add two handfuls of ice to the gallon-size bag, and sprinkle on half the salt
4. Place the quart bag into the gallon bag, then add two or three more handfuls of ice and the rest of the salt
5. Let out as much air out of the gallon bag as possible, then seal shut

6. Put on your oven mitts and vigorously shake the bag for 5 minutes
7. Remove the small bag from the large bag and rinse off the salt water
8. Observe, take notes, and enjoy!

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Crystal Clear

The Rime fairies need your help. Every year, when winter comes, the Antarctic fairies build vacation homes in the north. At the end of winter, the little houses melt along with the rest of the snow. But this year, there is a shortage of the clear ice they use to make their windows, mirrors, and chandeliers. Maybe you could make some more? (*You may need some help from a grown-up with these steps.)

Materials

- 1 plastic food container with tight-fitting lid
- 2-quart or smaller glass baking dish (or ceramic coffee mug)
- water
- masking tape or label stickers
- pen

Directions

1. Fill the plastic food container halfway full of water, and label it “shaken water”
2. Tightly close the lid and vigorously shake the container for **30 seconds**
3. Place the container in the freezer
4. Fill the glass baking dish (or ceramic coffee mug) halfway full of water, and microwave it for **1-2 minutes**
5. Let the boiled water cool, undisturbed, for **1 hour**
6. Add a label to the dish or mug that says “boiled water”, and gently place it in the freezer
7. Check your containers after **5 hours**

8. Observe and take notes

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Miaj Experiments

Alright, Thinkers 'n' Tinkerers! You've done it! You've completed your mission to restore the fairy magic! Queen Morganis is most delighted. To thank you for your help, she has granted you unlimited access to the Fairy Land and all the magic and science it holds. Miaj experiments have yet to be invented by you, dear magic-maker. They are all your own, so act wisely and confidently with the knowledge you have gathered from your experimenting.

Go! Explore your world, think, tinker, make messes (then clean them up), figure out your mistakes, and never ever stop learning.

Fairily yours,

The Alchemist

_____

About my experiment: _____

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Materials

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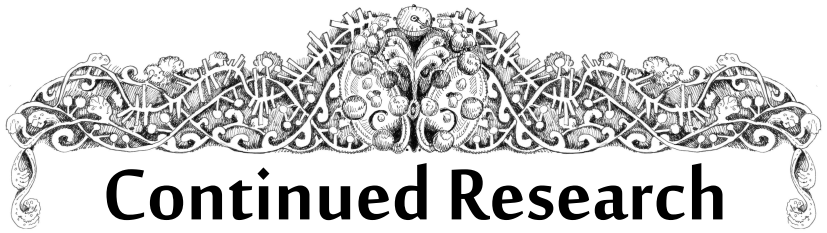
Directions



Continued Research

Don't limit your new powerful skills to the fairy realm alone. Spread your knowledge and enjoyment to your friends, siblings, cousins, and neighbors. The only thing better than science, after all, is science with a friend!

In this section, you will find a collection of varied information to help further your research and experimentation. There are lists of people and subjects that can be a springboard for you to explore online (with a parent's permission, of course) and inspire you to experiment. There are also some field guides to help you identify the organisms you encounter in your journey. Observe your surroundings, think about things critically, and you'll be surprised at what you'll find.

Important Thinkers 'n' Tinkerers

Selected women who have changed the modern world. Highlight or circle those who inspire you and learn more about them on my website.

Abigail Adams
Jane Addams
Maria Agnesi
Agnodice of Athens
Elizabeth Garrett Anderson
Mary Anderson
Maya Angelou
Mary Anning
Susan B. Anthony
Anyte of Tegea
Virginia Apgar
Frances Arnold
Anna Atkins
Tabitha Babbitt
June Bacon-Bercey
Florence Bailey
Jeanne Baret
Françoise Barré-Sinoussi
Clara Barton
Florence Bascom
Charlotta A. Bass
Laura Bassi
Daisy Gatson Bates
Patricia Era Bath
Ruth Howard Beckham
Aphra Behn
Ruth Benedict
Ruth Benerito
Mary McLeod Bethune
Elizabeth Blackwell
Katharine Blodgett
Margaret Brent
Ruby Bridges
Charlotte Bridgwood
Elizabeth Britton
Harriet Brooks
Beth A. Brown
Margaret Bourke-White
Jocelyn Bell Burnell
Annie Jump Cannon
Rachel Carson
Émilie du Châtelet
Kalpana Chawla
Katherine Sui Fun Cheung
May Edward Chinn
Shirley Chisholm
Mamie Phipps Clark
Elizabeth Cochran (Nellie Bly)
Josephine Cochrane
Bessie Coleman
Eileen Collins
Margaret Collins
France Córdova
Gerty T. Cori
Martha Coston
Eva Crane
Marie Curie
Marie Maynard Daly
Mary A. Delaney
Anna Dickinson
Marion Donovan
Marie Dorian
Amelia Earhart
Annie Easley
Rosa Smith Eigenmann
Mileva Marić Einstein
Gertrude Elion
Alice Evans
Sandra Faber
Fannie Farmer

Evelyn J. Fields
Dian Fossey
Rosalind Franklin
Elizebeth Friedman
Birutė Galdikas
Indira Gandhi
Mary Elizabeth Garrett
Ina May Gaskin
Marthe Gautier
Sophie Germain
Fabiola Gianotti
Lillian Gilbreth
Alessandra Giliani
Ruth Bader Ginsburg
Winifred Goldring
Jane Goodall
Sarah E. Goode
Bette Nesmith Graham
Evelyn Boyd Granville
Charlotte Forten Grimke
Sarah and Angelina Grimke
Sarah Guppy
Alice Hamilton
Margaret Hamilton
Anna Jane Harrison
Lene Hau
Euphemia Haynes
Caroline Herschel
Jane Hinton
Ruby Hirose
Dorothy Crowfoot Hodgkin
Helen Sawyer Hogg
Marie Emilie Holmes
Grace Murray Hopper
Sarah Blaffer Hrdy
Sayyida al Hurra
Zora Neale Hurston
Libbie Hyman
Hypatia of Alexandria
Mary Jackson
Shirley Ann Jackson
Mae Jemison
Qiu Jin
Katherine Johnson
Nancy M. Johnson
Doris F. Jonas
Diann Jordan
Elena Kagan
Florynce Kennedy
Mary Kies
Mary-Claire King
Coretta Scott King
Angie Turner King
Flemme Kittrell
Margaret Knight
Anna Komnene
Sofia Kovalevskaya
Stephanie Kwolek
Raymonde de Laroche
Mary Leakey
Esther Lederberg
Inge Lehmann
Leizu
Hedy Lemarr
Rita Levi-Montalcini
Maya Lin
Ruth Smith Lloyd
Ada Lovelace
Wangari Maathai
Elizabeth Magie
Vivienne Malone-Mayes
Audrey F. Manley
Lynn Margulis
Maria the Jewess
Eleanor Mariano
Biddy Mason
Sarah Mather
Matoaka (Pocahontas)
Barbara McClintock
Paulette McCrae
Kyla McMullen
Margaret Mead
Lise Meitner
Maria Sibylla Merian

Betsey Metcalf
Maria Mitchell
Ruth E. Moore
Toni Morrison
May-Britt Moser
Florence Nightingale
Emmy Noether
Antonia Novello
Annie Oakley
Ellen Ochoa
Sandra Day O'Connor
Rosa Parks
Cecilia Payne-Gaposchkin
Annie Smith Peck
Frances Perkins
Rózsa Péter
Elena Cornaro Piscopia
Harriet Powers
Betsy Hagar Pratt
Jessie Isabelle Price
Margaret Profet
Jeannette Rankin
Eleanor Raymond
Judy W. Reed
Sarah Remond
Sally Ride
Nancy Roman
Eleanor Roosevelt
Ernestine Rose
Esther Ross
Vera Rubin
Florence Sabin
Sacajawea
Margaret Sanger
Sophie Scholl
Mary Seacole
Irena Sendler
Cheryl L. Shavers
Patsy Sherman
Dolores Cooper Shockley
Carolyn Shoemaker
Gwynne Shotwell
Muriel Siebert
Lillian Smith
Mary Somerville
Sonia Sotomayor
Sarah Hackett Stevenson
Alicia Boole Stott
Harriet Beecher Stowe
Quincy Symonds
Helen Taussig
Kateri Tekakwitha
Maria Telkes
Valentina Tereshkova
Lucy Terry
Margaret Thatcher
Sheila Tobias
Trota of Salerno
Sojourner Truth
Harriet Tubman
Dorothy Vaughan
Lydia Villa-Komaroff
Sara Volz
Phyllis Wallace
Lucy Walker
Barbara Walters
Mary Walton
Ida B. Wells
Phillis Wheatley
Lucille Whipper
Grace Olive Wiley
Marguerite Williams
Mary Wollstonecraft
Victoria Woodhull
Fanny Bullock Workman
Chien-Shiung Wu
Rosalyn Yalow
Roger Arliner Young

Fields of Study

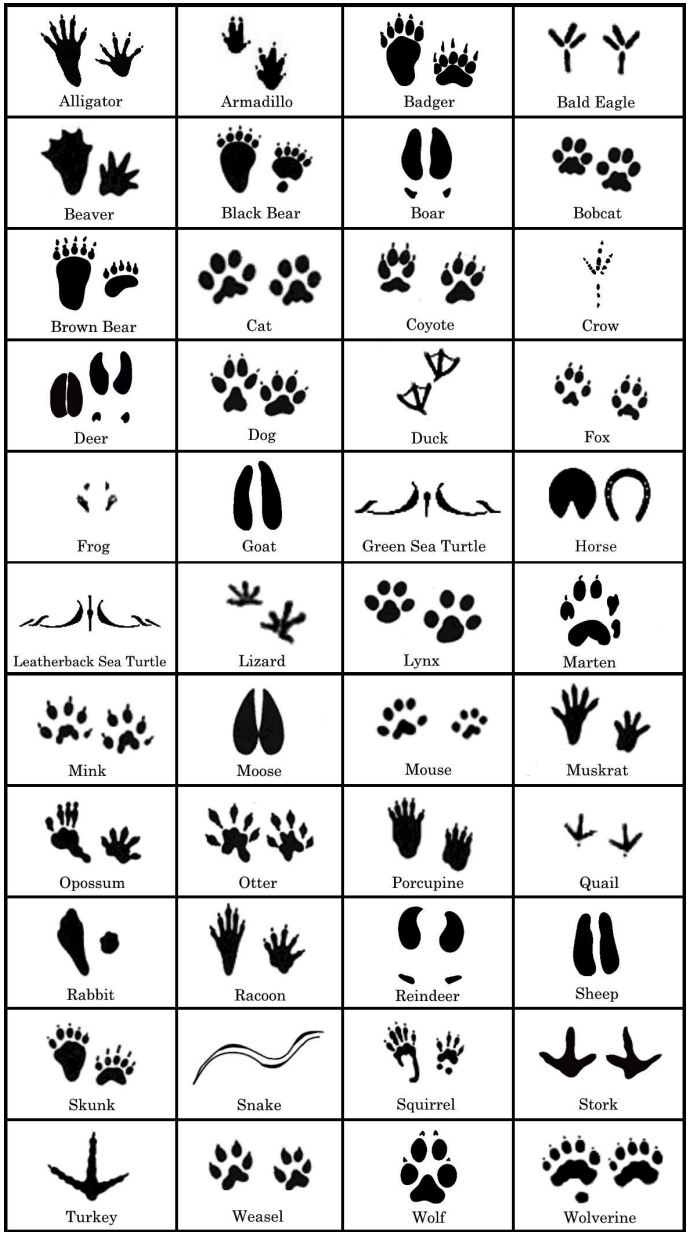
Note that some of these are in-between, or interdisciplinary, fields that encompass more than one larger field. Highlight or circle the fields that interest you and learn more about them on my website.

- Aeronautics
  - Aviation
- Archaeology
- Architecture
- Astronomy
- Atmospheric science
  - Climatology
  - Meteorology
  - Planetary atmospheric science
- Biology
  - Anatomy
  - Botany
  - Ecology
  - Evolutionary biology
  - Microbiology
  - Neurobiology
  - Systems biology
- Chemistry
  - Culinary arts
  - Forensic science
  - Metallurgy
- Computer science
  - Artificial intelligence
  - Software development
- Cryptography
- Engineering
  - Aerospace engineering
  - Agricultural engineering
  - Biological engineering
  - Chemical engineering
  - Civil engineering
  - Computer engineering
  - Electrical engineering
  - Industrial engineering
  - Mechanical engineering
  - Robotics
  - Software engineering
- Genetics
- Geography
  - Cartography
- Geology
  - Environmental science
  - Glaciology
  - Hydrology
  - Oceanography
  - Paleontology
  - Seismology
  - Volcanology
- Mathematics
  - Algebra
  - Arithmetic
  - Calculus
  - Geometry
  - Recreational
  - Trigonometry
- Materials Science
- Medicine

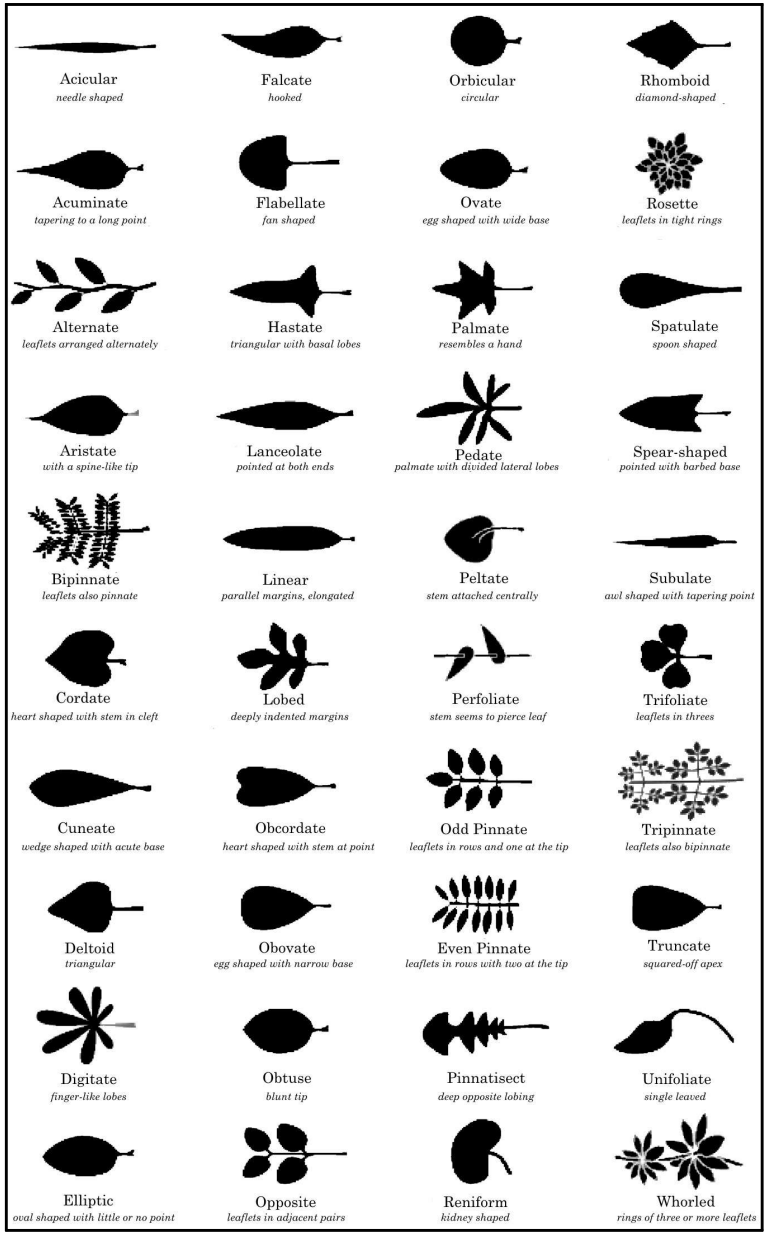
- Anesthesiology
- Audiology
- Epidemiology
- Gynecology
- Immunology
- Neurology
- Optometry
- Pathology
- Pediatrics
- Pharmacology
- Radiology
- Surgery
- Toxicology
- Veterinary medicine

- Physics
  - Astrophysics
  - Biophysics
  - Classical mechanics
  - Crystallography
  - Electromagnetism
  - Nuclear physics
  - Optics
  - Quantum mechanics
  - Relativistic mechanics
  - Thermodynamics
- Psychology
  - Biological psychology
  - Clinical psychology
  - Cognitive psychology
  - Developmental psychology
  - Neuropsychology
  - Positive psychology
- Social Science
  - Anthropology
  - Education
  - Journalism
  - Linguistics
  - Politics
  - Sociology
- Technology
  - Biotechnology
  - Nanotechnology
- Telecommunications
- Trade
  - Artisans
  - Assistants
  - Construction
  - Mechanics
  - Service providers
- Zoology
  - Ethology
  - Entomology
  - Herpetology
  - Ichthyology
  - Mammalogy
  - Marine biology
  - Ornithology
  - Primatology

Animal Track Identification

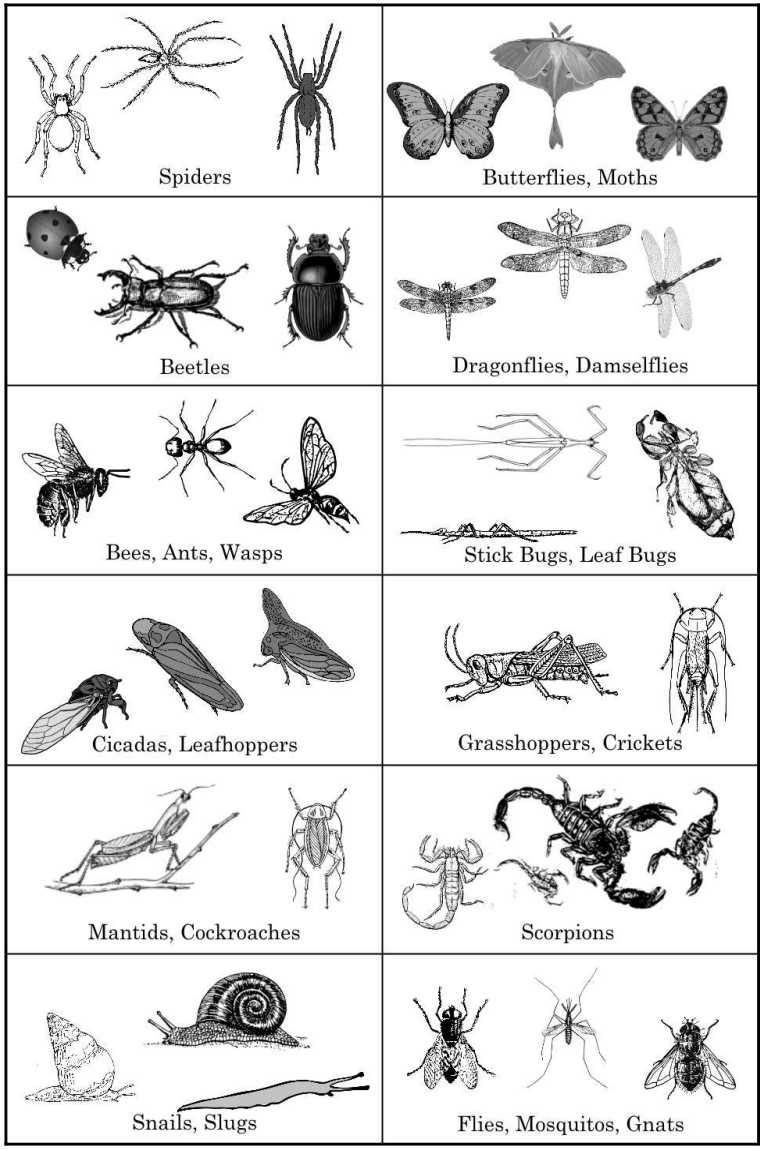


Leaf Identification



Creepy Crawly Identification

(Arachnids, insects, & gastropods)



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About this Project

Fairy Experiments was inspired by Disney's Tinker Bell® movie series. Or rather, it was inspired by what I, feminist mom that I am, determined to be the lack of appropriate merchandise available to impressionable Tinker Bell fans and their parents.

Tinker Bell, in her movie series, is an engineer. Her friend Zarina is a chemist. Rosetta is a botanist. Iridessa works with optics, Fawn is an ethnologist, and Vidia works with aerodynamics. Silvermist works with the water cycle. None of this is explicitly mentioned in the movies, and yet, it doesn't take a Ph.D. to see the incredibly lucrative and at-the-time completely untapped market available to Disney® that would have extracted all of my dollars, and those of moms like me, one by one, for the chance to provide my kids with a unique line of fairy toys. (All those fairy names are registered trademarks of Disney.)

So naturally, when I began my shopping for my daughter's birthday that year, I hopped online with an elated sense of anticipation for Zarina's Chemistry Set!, Tinker Bell's Tool Set, with Real Working Thorn Hammer!, and Rosetta's Garden Tool Set! (Garden Starter Kit sold separately!). Okay, okay, so maybe Iridessa's Laser Lab was a bit unlikely, but you get the idea. I expected to find toys that were relevant to the plot lines of the movies. When what I found instead was jewelry. makeup. dress-up clothes. fashion dolls. décor... my record proverbially scratched.

Now, don't get me wrong. I grew up with girly toys. I understand the draw to and the unique play elicited by those kinds of toys. My kids have some of their own. But, this was it? For such a groundbreaking series featuring strong and skilled young women with actual personalities geared toward kids with girly style, the disappointment that I felt when I realized that the marketing encompassed the same old gendered B.S. is still palpable as I write this five years later. (In all fairness, the series

is now finished and I still can't buy my daughters a freakin' thorn hammer.)

My first course of action was to buy my kid a small and pink, yet very real and working, tool set and Tinker Bell change purses to hold her bolts and nuts. Then I turned a small TV stand into a fairy workbench with light green paint and Tinker Bell wall stickers. Eventually, I began to think, and then started to announce randomly to people (protip: they *really* love that kind of thing), that if Disney wouldn't bring their fairies to the world of science, doggone it, "someone" should bring science to the world of fairies. I became the last to realize that that "someone" was going to be me. I wrote out the first draft of this book over the course of a couple weeks in the fall of 2014 as my oldest child alternatively watched Tinker Bell and Microcosmos (a movie of bugs in HD!) and I nursed my second child on the couch. But life has a tendency to take interesting turns, and now, in the fall of 2019, almost every aspect of my life had radically changed. The circumstances that put me in touch with Päivi Eerola this summer alone would have been completely incomprehensible to me five years ago, when I was making Paint edits to public domain clipart.

Once I had set my mind on doing it, the goal with which I went into writing this book was to create the kind of exploration of science that I needed as a child who was smart, liked fairy tales, and didn't have hands-on science support at home. One that didn't write out the "right" answer and science principles on the same page as the experiment itself, because then I found I was unmotivated to actually do the activity. One that encouraged tinkering and mistakes, because it is truly the best way to learn… still occasionally to my chagrin. A scientific book that had beautiful and exciting illustrations, because art and beauty are important and compelling, and no one should have to choose between the two. A book that asked me to contribute to it, because I needed to know that my way of thinking was valuable. One that was marketed to me, a pink-loving girl, because girls

are scientists. One that I could mostly do by myself with things I could obtain, because I enjoyed a fair amount of time by myself as a kid.

As much fun and passion as I've brought to the Fairy Experiments project, I could never have undertaken, much less accomplished this enormous dream without a supporting cast. Steven is the amazing father to our three beautiful daughters, as well as the remarkable talent behind the Fairy Experiments website. His inimitable tech support is the foundation for this to *be* a project, rather than just another science activity book.

Our girls. The whole reason this came together. When Steven and I talked about having kids all those years ago, I explained my wish for at least one daughter. For one, I felt sorrowfully jealous of my younger sisters, the three of whom were lucky enough to be born within 6 years of each other. Me? I'm the oldest in my family, and after myself, three boys arrived on my scene. I remain to this day, interminably, "one of the guys". More affirmatively, I wanted to pass on my own third-generation middle name to a fourth generation. It seemed unlikely for us though, since the previous two decades had resulted in a sturdy crop of boys in his extended family. When I think back to those conversations, I cannot describe how much gratitude I feel at my lot in life. It is terrific fun to have three little girls run about your house and your life, and it's an unspeakable joy to share this life with Steven. I couldn't ask for a better dad for my kids.

Alex, my pleasant surprise, is the person who inspired me to resurrect this labor of love last spring, so no matter what he says, you wouldn't be reading this without him. I am so grateful to have him in my life.

I was so nervous to ask Päivi to create the beautiful, original illustrations you'll have no doubt enjoyed. I found her portfolio on Hire an Illustrator after a friend's offer to illustrate it fell through, and I instantly fell in love with her blend of hard industrial objects with softer natural elements. She instantly fell in love with the blend of science and femininity I wanted to

create with this book. She has been supportive and helpful to me in so many ways beyond drawing my fairies. This was a fun collaboration. Find her fantastic portfolio and art lessons at PeonyAndParakeet.com.

To everyone who has promised to buy my book or made suggestions to promote it before even seeing it! Your kind words and faith have stayed with me and have kept me going when I've hit the inevitable roadblocks. Cheryl Hooper, Kim Sprouse, Laura Latourette, Susan Hunt, Laurie Hummel, Julie Boswell, Tess McFarland-Porter, Michael Scott, Shirley Bond.

To the TNTs, I hope this book helps you build resiliency and critical thinking skills. I hope it teaches you to trust your instincts and your ability to tackle tough problems. I hope it helps you to ask important questions and provide your own answers without fear. Finally, I hope it contributes to your own lifelong love of all things scientific.

Fairily yours,
C. L. Hunt

TNT BADGE

QUADRANT PATTERN