The Magic of Science!

Experiments from Fandom Forward

While many of our favorite stories defy imagination – evil can be defeated with help from a volcano, superheroes can fly, and children can bend elements to their will – science brings magic to life in the real world! Try these fandom-themed experiments to add a little magic to your explorations in science, technology, engineering, art, and math. Each experiment also includes a call to action: a way for you to help make information and education more accessible for everyone!

This toolkit was created by Fandom Forward, a 501(c)(3) nonprofit that turns fans into heroes. We have engaged millions of fans of every age in our work for equality, human rights, literacy, and much more. Become a member today: visit fandomforward.org for resources, trainings, curriculums, and ways to take action or send us a message at info@fandomforward.org.

EXPLODING MOUNT DOOM

Adapted from: https://www.playosmo.com/kids-learning/how-to-make-a-volcano-for-kids/

In *The Lord of the Rings*, our hero Frodo spends many months traveling to Mount Doom with a single mission in mind: destroy the One Ring and eliminate evil from Middle Earth. Have you ever wondered what Frodo experienced after he threw the ring into Mount Doom and the volcano erupted around him? You can find out by creating your own volcanic explosion!

Time required: 10 minutes

Materials needed:

- 100 ml of warm water
- 10 ml of dish soap
- 400 ml of white vinegar
- Empty 2-liter soda bottle
- 2 drops of red food coloring
- Baking soda slurry (½ cup baking soda and ½ cup water)

Exploding Mount Doom Instructions:

1. Mix the dish soap, water, white vinegar, and food coloring and pour it into the empty soda bottle.

Exploding Mount Doom Instructions Continued:

2. Make a baking soda slurry with ½ cup baking soda and ½ cup water. Mix it thoroughly with a spoon, until it's completely dissolved.

3. Now, it's eruption time! Quickly but carefully pour this slurry into the bottle and step back. Now, watch the volcano erupt and spill out red lava!

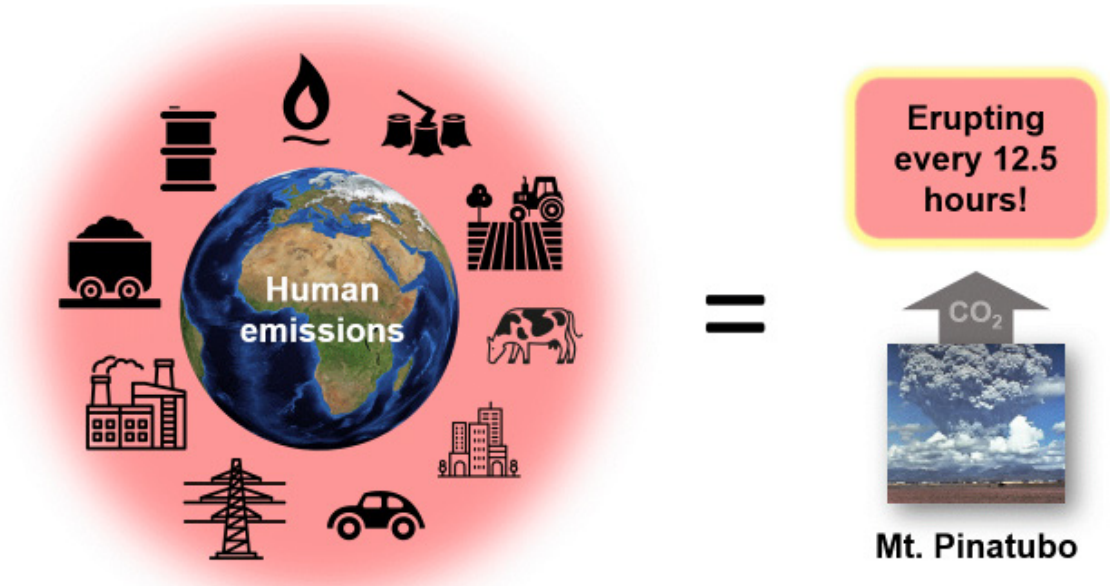
Talk it out:

- Why do you think the liquid in the soda bottle erupted when you added the baking soda slurry to it? How does the volcano science project work?
  - *Answer: The homemade volcano erupts because of a chemical reaction between an acid and a base. The acetic acid present in the vinegar reacts with the sodium hydrogen carbonate in the baking soda and produces carbon dioxide. The base (sodium hydrogen carbonate) undergoes a decomposing reaction when it is exposed to the acid. This produces a gas called carbon dioxide, which causes the homemade volcano to "erupt!" The dish soap becomes foamy and the bubbles spill out like lava.*

TAKE ACTION

If you had to guess, what do you think has more of an impact on climate change: human emissions or volcanic eruptions?

If you guessed human emissions, you're correct! Consider, for example, the eruption of Mt. Pinatubo in 1991, which was one of the three largest volcanic eruptions of the 20th century. Scientists estimate that Pinatubo's eruption released about 50 million tons of CO2 into the atmosphere in 9 hours. To match human emissions over a year, the planet would have to experience a volcanic eruption like Mt. Pinatubo's every 12.5 hours! (Source)



Source: Gerlach, T. (2011). Volcanic versus anthropogenic carbon dioxide. *EOS*, 92(24), 201–202.

In light of this information, **research and brainstorm some ways that you can personally lower your carbon emissions.**

GROW YOUR OWN INFINITY STONES

Adapted from: https://learning-center.homesciencetools.com/article/crystal-growing-science/

In the Marvel Cinematic Universe, the Infinity Stones were created at the very beginning of the universe and could lend immense power to those strong enough to wield them. If you've ever thought about how it would feel to hold some of this power, try making a stone (or two) of your own!

Time required: 15 minutes of prep time; Several days to grow

Materials needed:

- Alum (look for this in the spice aisle of your grocery store)
- Clean 250 ml beaker or jar
- 3/4 cup of very hot tap water, split
- Saucer or shallow dish
- Pencil
- Fishing line
- Food coloring

Grow Your Own Infinity Stones Instructions:

(Parental Supervision needed - this recipe deals with very hot liquids and could be dangerous)

1. In your jar or beaker, slowly add alum to 1/4 cup of very hot tap water, stirring to dissolve. Keep adding the alum until no more will dissolve: this is a saturated solution.

2. Pour a little bit of this solution into a shallow dish or saucer and let it sit undisturbed overnight.

Note: Make sure you only pour the clear solution, not any of the undissolved material. You can pour it through a coffee filter if necessary.

3. The next day you should see small crystals growing in the dish. When they look to be a good size, carefully pour off the solution and remove the biggest and best-looking one to use as your seed crystal.

4. Get someone to help you tie the fishing line to the seed crystal. This can be tricky; a pair of tweezers will help! If you need to, you can score a groove in the crystal to hold the line in place. Tie the other end of the fishing line to a pencil and set aside.

5. Prepare your jar or beaker again by cleaning it and adding several drops of food coloring to the bottom. Your Infinity Stone will take on whatever color you add in this step:

- Purple = Power Stone
- Blue = Space Stone
- Red = Reality Stone
- Orange = Soul Stone
- Green = Time Stone
- Yellow = Mind Stone

6. Make another saturated alum solution with about 1/2 cup of hot water. Add the solution to your prepared jar or beaker; avoid pouring any undissolved material.

7. Set the pencil across the top of the jar so the seed crystal is suspended in the alum solution without touching the sides or bottom of the jar. (You may need to adjust the length of the fishing line: just wrap it around the pencil until it is the right length.)

Note: if your seed crystal starts to dissolve, that means your solution isn't saturated enough. Remove the seed quickly and add more alum to the solution, filtering off any undissolved particles.

8. Cover the jar with a paper towel to keep out the dust and let your crystal grow until you are happy with its size. When you take it out of the solution, set it on some plastic wrap to dry.

Talk it out:

- Where do you think the Infinity Stones you grew came from? Why do you think the Stones had to grow in two steps?
  - *Answer: The small crystals that formed in the saucer grew because of nucleation. A few alum molecules found each other in the solution and joined together in a crystal pattern. Other alum molecules continued to join them until enough molecules gathered to become a visible crystalline solid. (Chemists call that a crystal "falling out of" the solution.) If you left these crystals in the solution they would continue to grow, but they wouldn't get very big because they would all be competing for the remaining alum molecules in the solution. Instead, you took one crystal and used it as the only nucleation site in the solution. It was the primary site for the alum molecules to join together, so the crystal could grow quite large!*

TAKE ACTION

Infinity Stones hold great power, and so do those who possess them. Although your Stones may not contain the power of the universe, you still have the power to make a positive impact in your community. Here are a few suggestions for how to wield your power:

- **Get involved at your local library.** Many libraries have volunteer programs specifically for teens. If yours doesn't, checking out a book or movie about your favorite superhero can help!
- **Learn about your city's officials.** Even if you're not yet old enough to vote, take some time to research what positions make up your local government and what each person is responsible for.
- **Get to know your neighbors.** Impacting your community can start on your street. Have some conversations with your neighbors and ask what improvements they would like to see in your neighborhood that you could work toward together. Make sure to bring a trusted adult for safety!

CAMP HALF-BLOOD: CALL FOR CODE

Adapted from: https://littlebinsforlittlehands.com/superhero-computer-coding-game-without-a-computer

Percy Jackson is lost on the grounds of Camp Half-Blood and he needs your help! Practice the basic concepts of computer coding and explore the Cabins, the North Woods, the Strawberry Fields, and more as you work to find Percy and bring him back to The Big House. Technology can attract monsters, so this activity requires no computer.

Time required: 20 – 60 minutes

Materials needed:

- See the end of this toolkit for the following:
  - Camp Half-Blood grid (one per person)
  - Character cutouts
  - Command cutouts or Post-It Notes (3 colors)
- Toy bricks or other obstacles

Camp Half-Blood: Call for Code Instructions:

1. Set up your obstacles, start, and goal (Percy) on the Camp Half-Blood grid.

2. Cut out your commands and your characters.

   Note: you may need multiple copies of the commands to complete the task

3. Set the Camp Half-Blood grid in the middle of a table.

4. Start the game! Write the code using the commands (Forward, Turn Right, and Turn Left) by laying each command on the table in front of you one at a time. Your character should navigate (one square at a time) from the starting point to Percy, and lead him safely back to The Big House while avoiding all obstacles. Move your character one command at a time as you write the code. (You cannot turn and move forward in one command. They are two separate commands.)

5. When you return Percy safely to The Big House, you win! Celebrate your victory!

6. Once you've mastered navigating Camp Half-Blood one command at a time, challenge yourself by writing a longer piece of code. Do not move your character as you go. Plan the commands out in your head and place them all out on the table. Then, move your character through the series of commands and see if you got it right!

Talk it out:

- What did you enjoy about writing your Camp Half-Blood code? What was challenging?
- Why could your character only move one command and one square at a time?
  - *Answer: The code you have written with the commands is an algorithm. An algorithm is a detailed, step-by-step instruction set or formula for solving a problem or completing a task. In computing, programmers write algorithms that instruct the computer how to perform a task. Even though the computer works very quickly, it still only reads and executes one command at a time – just like your character can only follow one command at a time.*

TAKE ACTION

Learning to code can open up lots of possibilities for future projects and careers! Does your school have a coding class or club? If not, talk to a teacher about what steps you can take to get your school to start one! You can also check out codecademy.com and codewars.com to get started on your own!

Beyond your school, there are other important steps you can take! Like all things, technology is better when we have a diverse team of people working on it! Check out organizations like Girls Who Code (girlswhocode.com) and Black Girls Code (blackgirlscode.com) and find out how you can become a participant or a supporter.

CREATE YOUR OWN KYBER CRYSTAL

Adapted from:
Quick Version: https://cooktilyummy.com/how-to-make-sugar-crystals-fast/
Standard Version: https://www.growingajeweledrose.com/2015/02/rock-candy-experiment.html

In Star Wars, the Jedi build their lightsabers using kyber crystals that they personally found in the Crystal Caves on Ilum when they were younglings. The younglings go through a trial where they have to face challenges that at first feel impossible, but once completed, they find the crystal that is speaking to them. Have you ever dreamed of having your own kyber crystal? Well, you can grow your own!

Time required:

Quick Version: 30 minutes active; 4 - 12 hours for rock candy to form
Standard Version: 15 - 20 minutes active; 7 days for rock candy to form

Materials needed:

- Granulated Sugar
- Water
- Jars (two needed for each cup of water)
- Wooden skewers (one or two skewers per jar)
- Clothes pins
- **Quick Version:** candy thermometer
- Optional: food coloring and/or flavoring

Create Your Own Kyber Crystal Instructions:

(Parental Supervision needed - this recipe deals with very hot liquids and could be dangerous)

Quick Version:

1. You need a ratio of 1 part water to 4 parts sugar.
   - For each cup of water, you can fill two jars with syrup and each jar should be able to hold two skewers.

2. Wet skewers and cover with granulated sugar, allow to dry while continuing.

3. Combine water and sugar in a saucepan and bring to a boil over medium-high heat.

4. Using the thermometer, bring the sugar syrup up to 230^{0} F (110^{0} C). If the syrup begins to boil up too much, drop the heat to low.
   Be very careful at this stage, as the syrup can boil up quickly, and this could be potentially dangerous.

5. Remove from heat and let the syrup cool to 220^{0} F before the next step and adding flavoring and coloring.

6. Very carefully pour the syrup into the jars. Add coloring and/or flavoring to jars and stir. Submerge the skewers, making sure they don't touch the bottom or sides. Use the clothes pins to hold the skewers over the top of the jars.

7. Sugar crystals should start forming quickly. Let the skewers stay in the liquid and leave the jars undisturbed until the crystals reach the desired size.

8. Once removed from the liquid let the candy dry completely before eating. Can be stored in an airtight container for a year.

Standard Version:

1. You need a ratio of 1 part water to three parts sugar.
   - For each cup of water, you can fill two jars with syrup and each jar should be able to hold two skewers.

2. Wet skewers and cover with granulated sugar, allow to dry while continuing.

3. Combine water and sugar in a saucepan and heat over medium-high heat.

4. Stir until sugar is dissolved, the syrup might appear cloudy, but that is okay.

5. Very carefully pour the syrup into the jars. Add coloring and/or flavoring to jars and stir. Submerge the skewers, making sure they don't touch the bottom or sides. Use the clothes pins to hold the skewers over the top of the jars.

6. Sugar crystals should start forming by the next day and should be fully formed after one week. Leave the skewers in the syrup and leave the jars undisturbed until the crystals reach the desired size.

7. Once removed from the liquid let the candy dry completely before eating. Can be stored in an airtight container for a year.

Talk it out:

- Why do you think the crystals grow? Why do crystals form, and grow so large on the submerged skewer?
  - *Answer: The crystals form because you created a supersaturated sugar syrup, which means that we dissolved more sugar in the water than it can hold at room temperature. This was achieved by heating the water to dissolve the sugar, and then when the syrup returned to room temperature, the sugar crystals precipitated (which means the sugar became solid again) out of the liquid.*
- Why did they primarily form on the skewer?
  - *Answer: They formed on the skewer because we "seeded" it with sugar, which gave the sugar a site to stick to and grow, this is called a nucleation site. You probably noticed that crystals also formed in other places in the jar, but because we gave our crystals a specific site, the largest ones grew there.*

- What is the difference between the quick version and the standard version?
    - *Answer: By heating the syrup to a higher temperature, we were able to dissolve even more sugar into the liquid. Because there is so much sugar dissolved in the liquid, it precipitates out much quicker as the temperature drops once it is removed from the heat.*

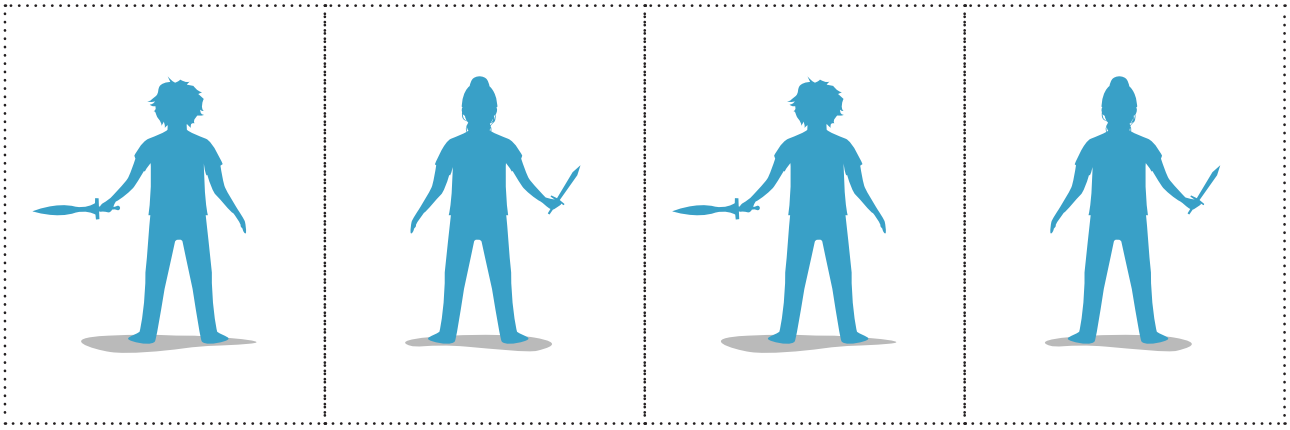
TAKE ACTION

Knowledge is one way we can face our fears and books are a great way to learn something new and acquire knowledge about a subject that interests you or one you're wanting to learn more about. Libraries are a place of community and learning that help all sorts of people come together and embrace new ideas and experience different views. Like Ahsoka and Yoda in the caves of Ilum, you too can help children to face their fears and acquire new knowledge by volunteering at your local library (maybe ask them about volunteering while wearing a costume from your favorite fandom!) or youth literacy group.

Another way you can fight against the dark side is fighting against banned books. Here are some actions you can take:

- **Read a banned book!** The most straightforward action is simply to read them, buy them from a local bookstore or get them from your local library. If your local library doesn't have copies, request that they buy them, this is one easy way to make sure that banned books stay available for all to read.
- **Start a Banned Books book club.** Get your friends involved in reading banned books, maybe expand it to your larger community. You can hold your meetings in a library and engage the library staff in a discussion, if they're available.
- If you know of a book being banned, report it through the American Library Association, that way awareness is raised when a book is banned, and it doesn't go unnoticed.

Camp Half-Blood: Call for Code Materials:



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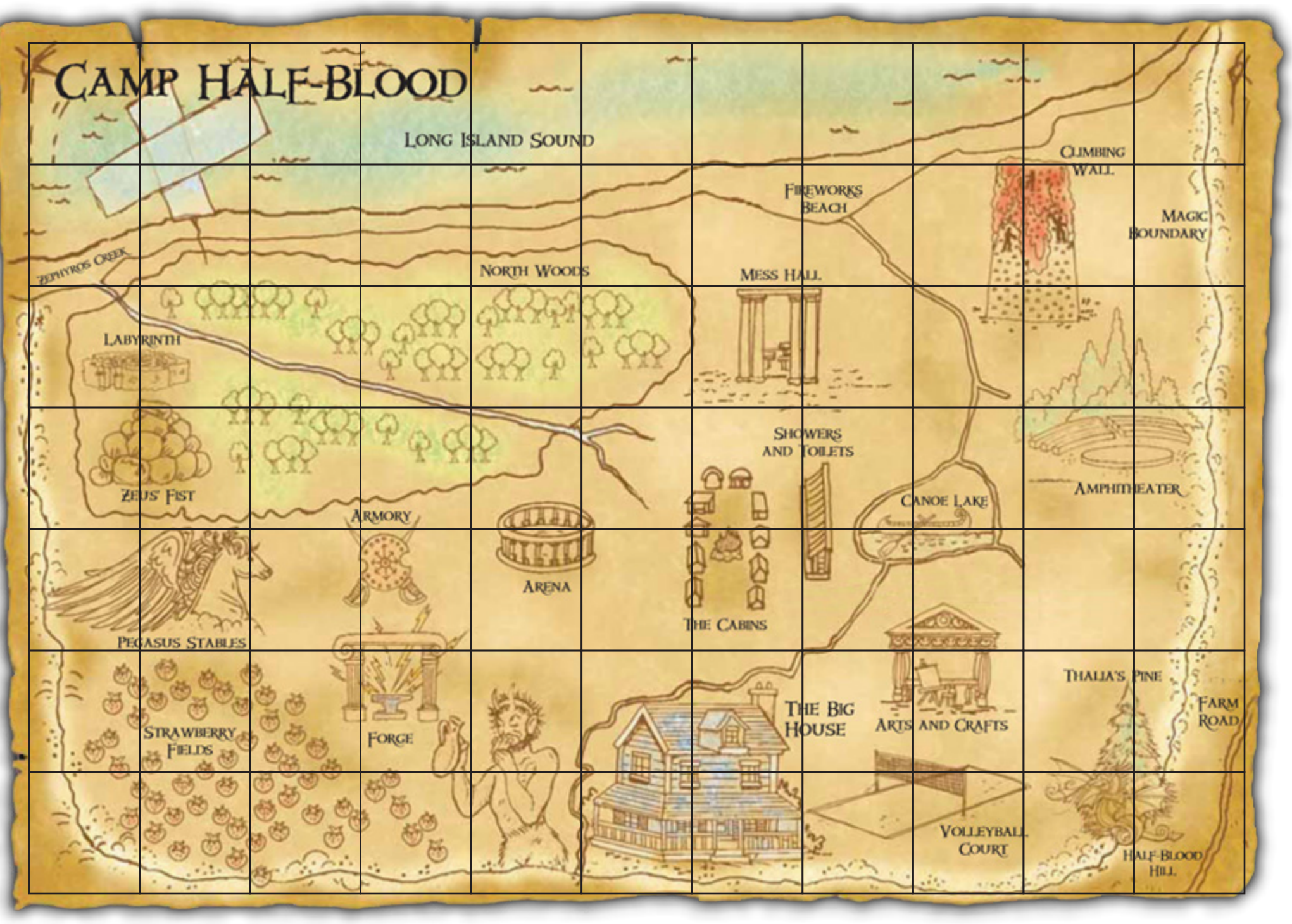

Source: https://rickriordan.com/extra/a-map-of-camp/