STEM Outreach Presents:

STEM Every Day Keeps the Boredom Away

Art Edition

Always ask a trusted adult before starting a Science or Engineering project.

String Art

DIFFICULTY LEVEL: NOVICE

PURPOSE

Explore algorithms, number theory, and geometric shapes through string.

MATERIALS

1 Recycled plastic bowl (ex: washed yogurt cup)
1 Hole punch (1/4 inch)
1 String Art Template
1 Marker
1 Pair of scissors
Tape
String or yarn

INSTRUCTIONS

1. Cut out the string art template along the dotted line (see page 4).
2. Tape the template to the bottom of the cup.
3. Use the ruler and marker to extend the lines on the template out to the edges of the cup.
4. Use the hole punch to cut a hole close to the edge of the cup on each line. You may need a trusted adult to help with this step.
5. Write the number from the template below each hole.
6. Cut a long length of string and tie it through the hole numbered "0".

Tip: You can also use a paper plate for this activity, by punching holes on the edge of the plate so that the holes are open on one side.

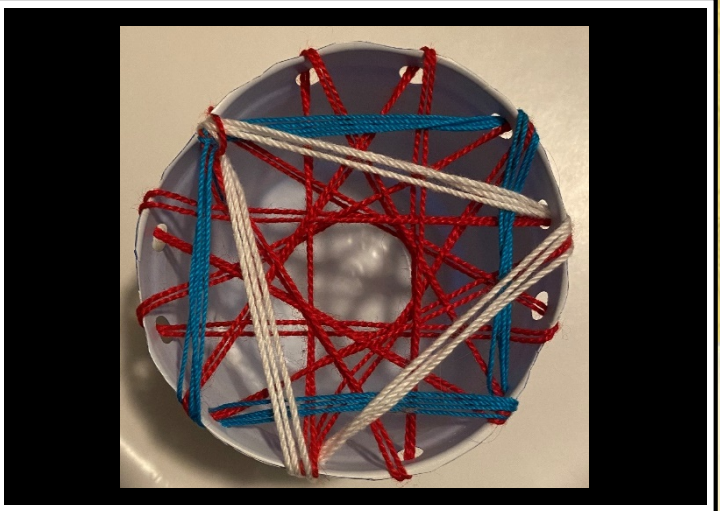
CONCEPT #1

Algorithm

An algorithm is a detailed set of instructions to perform a specific task. Algorithms are used by both people and computers to complete tasks.

For example, a child's bedtime algorithm might be to:

1. **Change into pajamas**
2. **Brush their teeth**
3. **Climb into bed**
4. **Listen to a bedtime story**
5. **Close their eyes and fall asleep**



Radial string art featuring a triangle, a square, and a 12-point star.

String Art

Algorithms

Example Algorithm:

1. Start at hole "0".
2. Count __**4**__ holes **clockwise** and thread the string through that hole from the **inside** of the bowl to the outside.
3. Repeat Step 2 until you have threaded the string back through hole "0".
4. Tie the end of the string in hole "0".

How many sides does this shape have? _____

Create Your Own Algorithm

1. Start at hole "0".
2. Count ____ holes **clockwise** and thread the string through that hole from the **inside** of the bowl to the outside.
3. Repeat Step 2 until you have threaded the string back through hole "0".
4. Tie the end of the string in hole "0".

What shape did your algorithm create? _____

Challenges

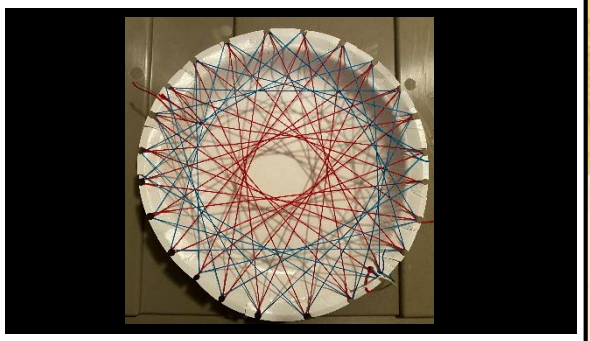
- Create an algorithm that will produce a **square**.
- Create an algorithm that will produce a **hexagon**.
- Create an algorithm that will produce a **12 point star**.

CONCEPT #2

Number Theory

Number theory is an area of study in mathematics. Number theorists study whole numbers: what properties they have, and ways they can be useful.

In this activity, the circle has 12 holes. Factors of 12 (1, 2, 3, 4, and 6) put into the example algorithm will produce polygons (or a line in the case of 6). Can you figure out the relationship between the number put into the algorithm and the number of sides on the polygon produced? What happens when you use a number that is not a factor of 12?



Radial string art.

String Art

Algorithms

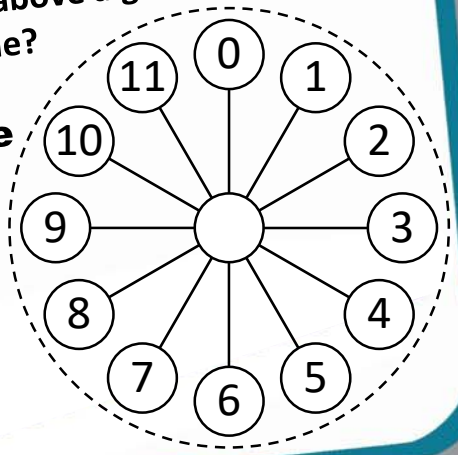
Advanced Algorithm:

1. Start at hole "0".
2. Count __**4**__ holes **clockwise** and thread the string through that hole from the **inside** of the bowl to the outside.
3. Count __**1**__ hole **counterclockwise** and thread the string through that hole from the **outside** of the bowl to the inside.
4. Count __**4**__ holes **counterclockwise** thread the string through that hole from the **inside** of the bowl to the outside.
5. Repeat Steps 2- 4 until you have threaded the string back through hole "0".
6. Tie the end of the string in hole "0".

You should see a circular shape in the center of the art.

What can you change about the above algorithm to create a larger circle in the middle?

String Art Template

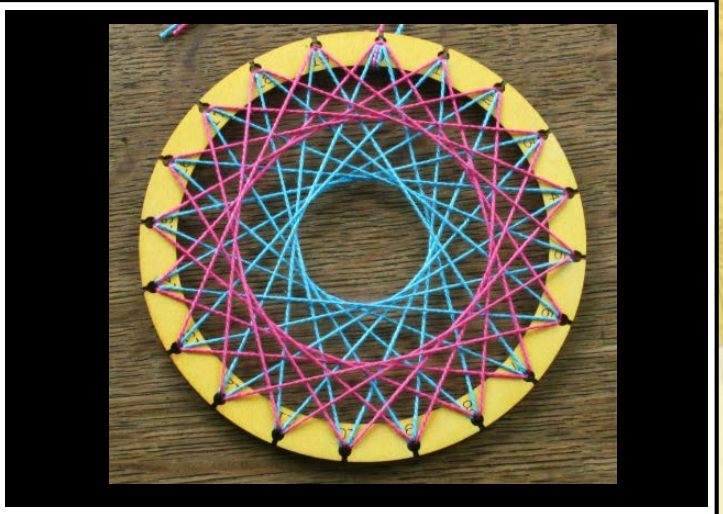


CONCEPT #3

Computer Algorithms

Programmers can design algorithms to instruct computers how to complete a specific task or solve a specific problem.

For example, Google developers designed a search algorithm to sort through billions of webpages to deliver a list of the most relevant pages in less than a second.



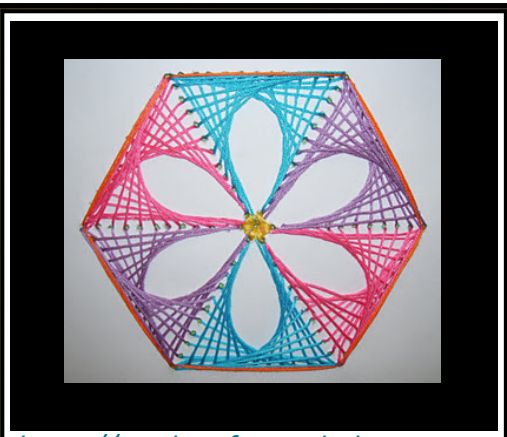
https://makingmathvisible.com/String-Rings/String-Rings.html

CONCEPT #4

History of String Art

Mary Everest Boole, a self-taught mathematician from the late 1800s, invented string art to make mathematical ideas more accessible to children. The craft she invented illustrated how a series of straight lines gives the appearance of curves. A modern version of these types of curves are called "Bézier Curves" and are used in creating computer graphics. Learn to create amazing string art like the ones shown here by visiting:

- **https://mathcraft.wonderhowto.com/how-to/create-parabolic-curves-using-straight-lines-0131301/**
- **https://babbledabbledo.com/math-art-idea-explore-geometry-string-art/**
- **https://makingmathvisible.com/String-Rings/String-Rings.html**



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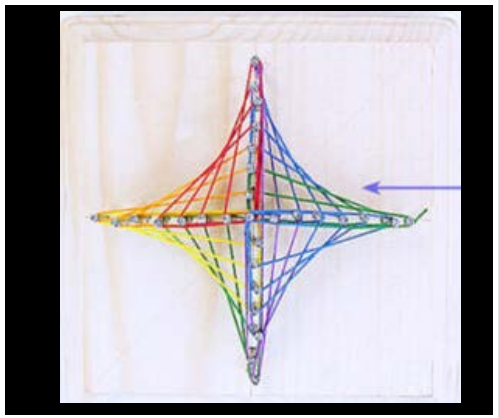

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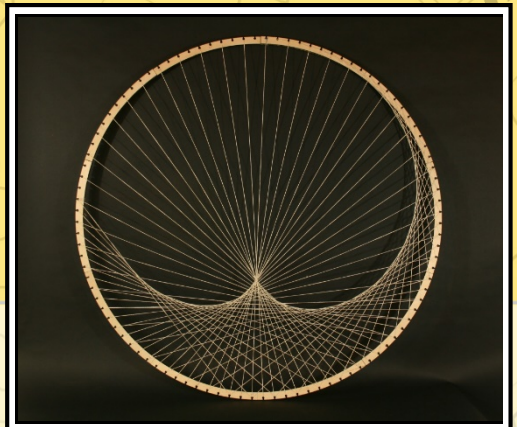

https://makingmathvisible.com/String-Rings/String-Rings.html

EXTENSIONS

https://www.geogebra.org/m/uUwwq8zS

REFERENCES

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https://makingmathvisible.com/String-Rings/String-Rings.html

Pixelated Images

DIFFICULTY LEVEL: INTERMEDIATE

PURPOSE

Explore how pixels use a pattern of data (1's and 0's) to create images!

MATERIALS

1 Picture you want to pixelate
- simple images with 1-3 colors work best (emoji work well)

1 Sheet of graph paper (grids)
3 Different colored markers
1 Pencil (with a good eraser)

INSTRUCTIONS

Tip: Use a very simple image (❤, ☺, 🏈, ☼, etc.) on your first attempt. A complicated image will be more difficult to pixelate.

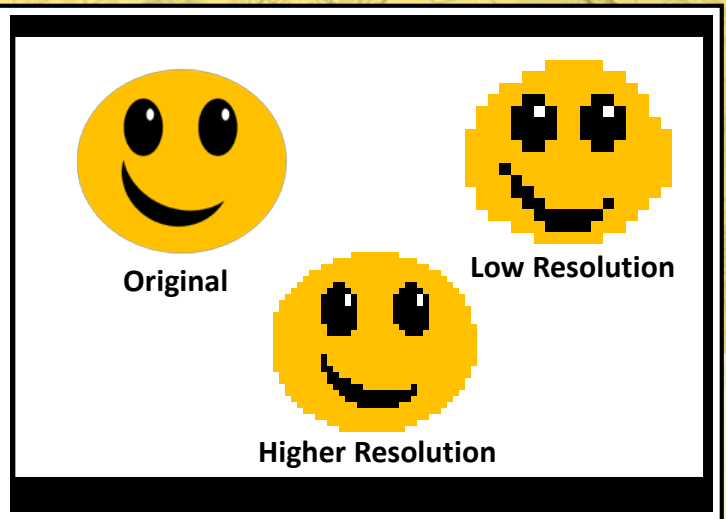
1. Place the graph paper and photo side by side.
2. Using the photo for reference, write a 1 in any of the squares that will be filled in.
   Tip: You can place the graph paper on top of the image to determine what pixel to use.
3. Create a code for the other colors.
   For example: 1 = Black; 11 =Red; 111= Blue
4. Add 1's to your image to show where different colors will go.
   Tip: Watch the video below for a detailed explanation: https://www.generationgenius.com/activities/information-transfer-activity-for-kids/
5. Using your color key, fill in the colors to reveal the pixelated image.

CONCEPT #1

Pixels

The images on many screens, like TVs and computers, are made of thousands (or even millions) of small colorful points, called "pixels". "Pixel" is short for "picture element".

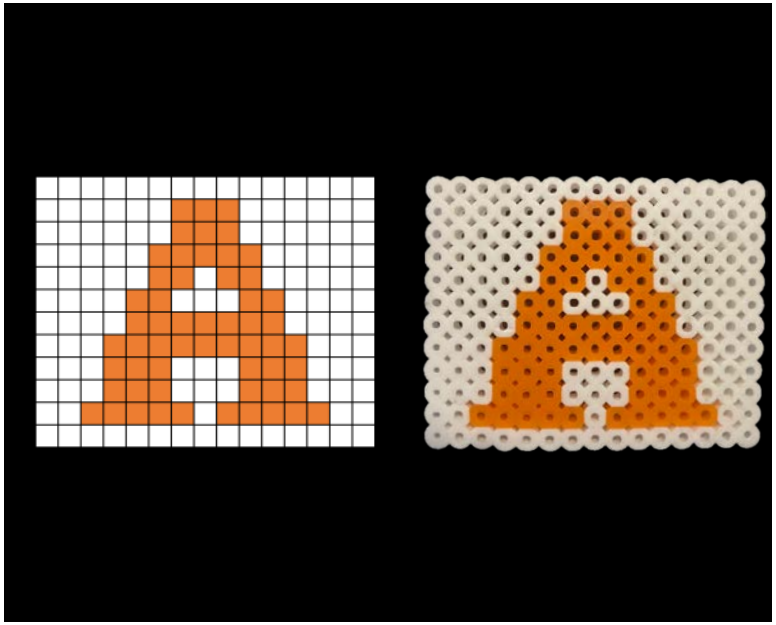
One way a computer can store the information of each pixel's color is in a bitmap. In a bitmap, each color is assigned a value, and those values are listed for each pixel.



CONCEPT #2

Resolution

The number of pixels in an images is called “resolution”. The more pixels used to create an image, the clearer the image will be. Images can have millions of pixels, so we can rewrite this information in a shorter way, this is called “compression”. One way we can compress the information is by listing the information in groups of the same color.



Pixelated image of the letter A, digitally (on the left) and made with fuse beads (on the right).

https://www.generationgenius.com/activities/information-transfer-activity-for-kids/

EXTENSIONS

- Use plastic fuse beads to create a long-lasting work of art! (Ask a trusted adult to operate the clothes iron to fuse (melt) your masterpiece.

REFERENCES

Adapted from:
https://www.generationgenius.com/activities/information-transfer-activity-for-kids/

ADULT ASSISTANCE REQUIRED

Engineering Art

DIFFICULTY LEVEL: ADVANCED

PURPOSE

To design and build a pendulum and explore the patterns produced by a swinging pendulum.

MATERIALS

Tools

- **1** Pair of scissors
- **1** Hole punch (1/4 inch)
- **1** Sieve
- **1** Measuring cup

Art Supplies

- Tempera paint
- Water
- **1** Large piece of paper

Building supplies

- **1** Empty school glue bottle with twist nozzle
- **1** Large paper clip
- Yarn or string
- Sturdy household materials*: (cardboard, wooden dowels, plastic building blocks, pvc pipe, rulers/yardsticks, etc.)
- Strong tape (duct tape, packing tape, etc.)

INSTRUCTIONS

With the help of a trusted adult:

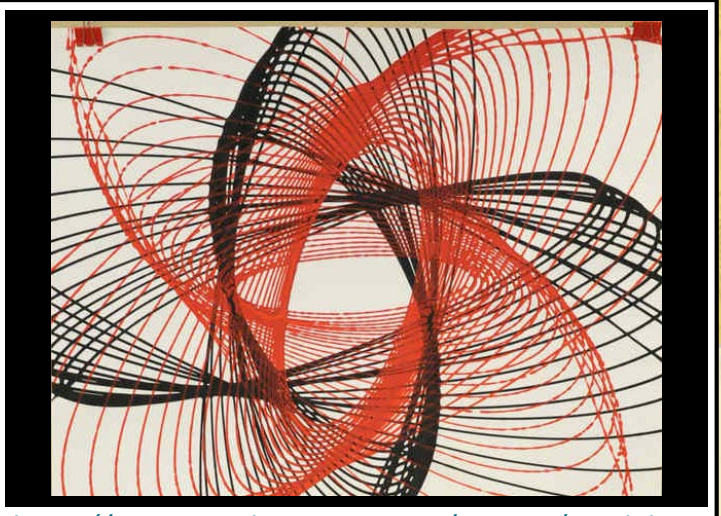
1. Use a craft knife or scissors to cut off the bottom 1/2 inch of the empty (clean) school glue bottle.
2. Using the hole punch, create a hole in the center of each side of the bottle near the bottom of the bottle.
3. Tie each end of a long piece of string or yarn to the bottle using the holes.
4. Thread loop onto a large paper clip.

This will be your pendulum (see picture on next page). Set aside for now.

CONCEPT #1

Pendulums

A *pendulum* is a weight (called a "bob") that swings from a fixed point, like a swing on a swing set. it always takes the bob the same amount of time to return to its starting point. The bob will travel a shorter distance each swing, but the bob still takes the same amount of time to return to complete a swing. The length of the string determines how long each swing takes (longer string = longer swing).



https://www.marthastewart.com/894554/pendulum-painting

Engineering Art (cont.)

INSTRUCTIONS (cont.)

5. Use the house hold materials to design and build a sturdy structure to support the pendulum.

Tip: Research types of structures that support weight (bridges, tripods, tables, etc.)

Requirements:

- Must have a string in the center of the structure to attach the pendulum (by tying to the paper clip) so that it hangs down in the center.
- The nozzle of the pendulum should be at least 1 inch away from the paper when hanging from the structure.
- The pendulum must have space to swing freely.
- The structure must be able to support the weight of the pendulum (including the paint that will be inside).
- The structure must also be sturdy enough to remain still as the weighted pendulum swings.

Tip: You can fill the pendulum up ½-way with water and test the height, strength, and stability of your structure.

CONCEPT #2

Engineering Design Process

Engineers use the *Engineering Design Process* to develop and refine their solutions:

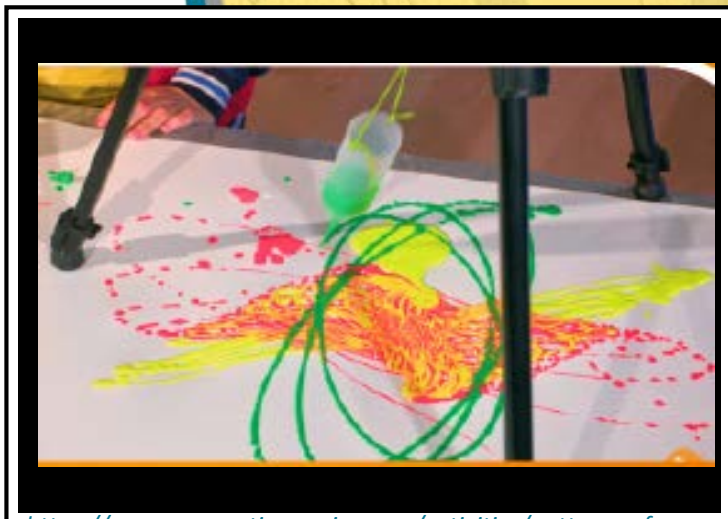
1. **Identify the need or challenge (requirements)**
2. **Research and develop possible solutions**
3. **Draw a possible solution**
4. **Build and test the solution**
5. **Modify and retest the device**

https://www.generationgenius.com/activities/patterns-of-motion-and-friction-activity-for-kids/

Engineering Art (cont.)

INSTRUCTIONS (cont.)

6. Mix one part tempera paint with one part water. Paint should run freely but should not be too watery. Add more paint or water if necessary.
7. Use the sieve to strain the paint and water mixture. This will remove any lumps to prevent the pendulum nozzle from clogging.
8. Place paper under your pendulum structure.
9. Make sure nozzle is closed and carefully add paint to pendulum.
10. Pull pendulum off to side of paper, open nozzle and allow paint to run freely. With paint flowing, let pendulum swing over paper, changing direction as desired.
11. To stop flow of paint, place finger under paint nozzle and twist to close. Allow artwork to dry flat.



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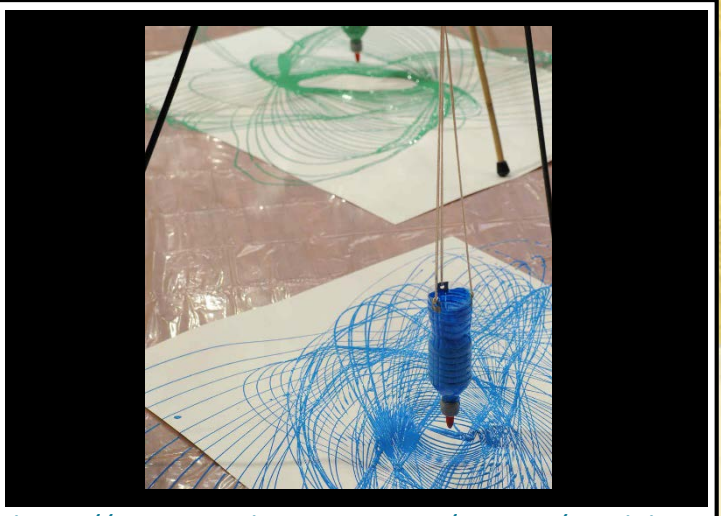

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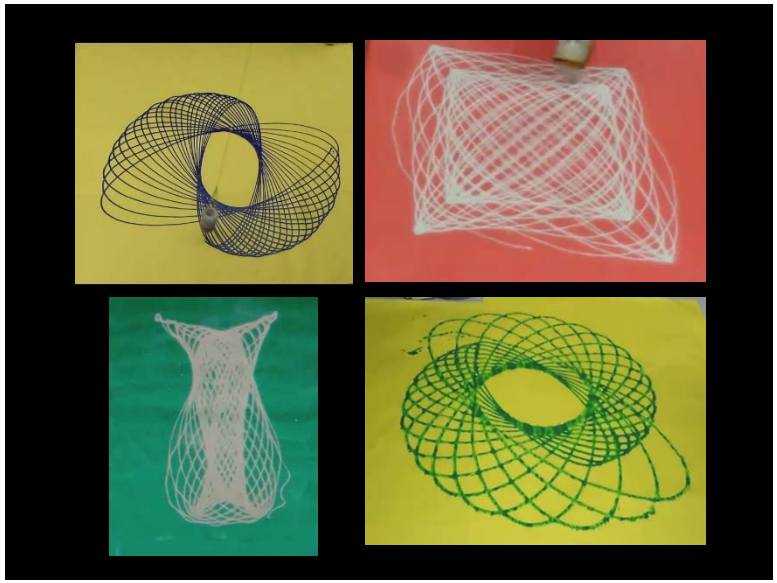
CONCEPT #3

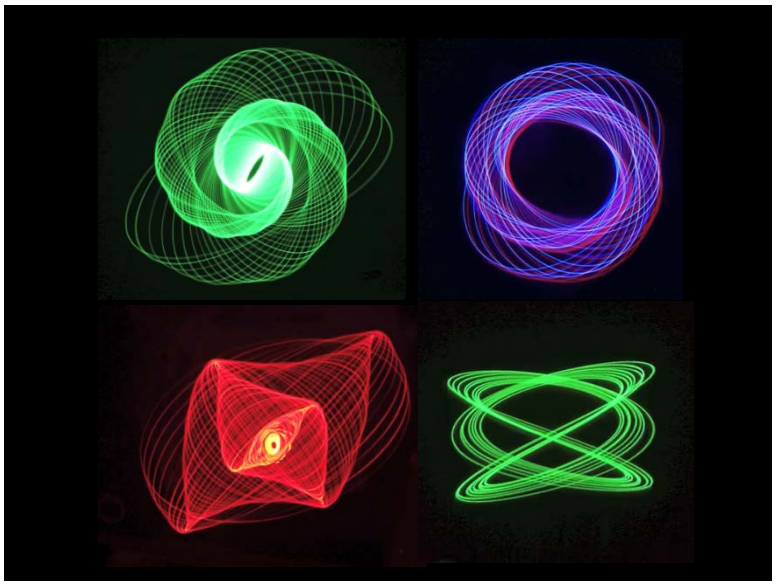
Lissajous Patterns

Jules Antoine Lissajous, a French physicist from the mid-1800's, studied patterns that can be made with compound pendulums. These types of patterns are now called "Lissajous Patterns". Watch the videos by Bruce Yeany (listed below) to learn how to adjust your design to create amazing Lissajous patterns like the ones pictured on this page.

- https://youtu.be/uPbzhxYTioM
- https://youtu.be/7RHanp1Xjsc



https://youtu.be/7RHanp1Xjsc
Bruce Yeany



https://youtu.be/7RHanp1Xjsc
Bruce Yeany

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https://www.generationgenius.com/activities/patterns-of-motion-and-friction-activity-for-kids/
https://www.youtube.com/channel/UCNk3CeLpCA0qIZsuzGl09cw

More Art-Related STEM Activities

Moss Art
https://www.stevespanglerscience.com/lab/experiments/moss-graffiti-sick-science/

Geometric Math Art With Circles
https://teachbesideme.com/geometric-math-art-circles/

Rhombicuboctahedron
https://teachbesideme.com/3d-shape-template-rhombicuboctahedron/

Slime Drawings
https://leftbraincraftbrain.com/five-minute-crafts-slime-drawings/

Mobile
https://www.sciencebuddies.org/stem-activities/mobile

STEM Spa
https://goalgirl.blog/stem-spa-day/

Wood Bending Bracelets
https://figmentcreativelabs.com/2018/02/wood-bending-bracelet-craft-magic-or-science/

Art Edition