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STEM AT HOME ACTIVITY GUIDE:

Archimedes' Screw Challenge

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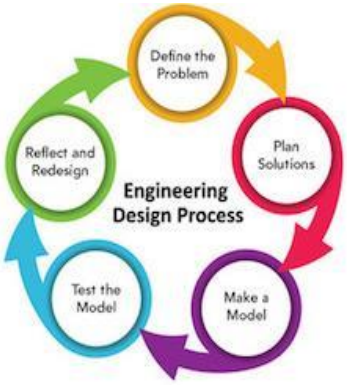
STEM AT HOME GUIDE: Archimedes Screw Challenge
Background Knowledge

Aim: Design functioning Archimedes screw made from the different simple machines designed with household materials to pump liquids and solids.

Problem & Career Focus: Who doesn't love a historic invention that is still being used today? Did you know that an ancient way of transporting water, called the Archimedes screw, is still so effective it's even used in waterpark and amusement park rides? It is made from several simple machines. Using the engineering design process, your task is to work with your team of hydrological engineers, robotics engineers, and 3D designers to design, model, and prototype a working Archimedes screw using several simple machines.

Educational Standards Correlations: Engineering Design, Motion, Energy, Simple Machines, Physics, Mathematics

Engineering Design Process: STEM professionals use the engineering design process as steps to help solve real-world problems. With your team: define the problem, discuss solutions, design, build, test, and improve a prototype of your solution. One of the most important steps of the engineering design process is reflect and redesign- if your team notices your playground equipment prototypes aren't working- improve the design! Use the engineering design process steps to guide your exploration during the Archimedes screw Challenge.



Investigating Questions

- Does the direction of the designed screw affect the water distribution process? Does the spin direction of the screw affect how the water is transferred?
- How does the length of the overall design how much water is transferred? Can the rate of water distribution be increased or decreased?
- Other than water, what other kinds of materials could be moved by using an Archimedes' screw?

Materials

- A bowl
- A glass
- Piece of PVC pipe (1.5 inch wide; 14 inches long)
- Clear plastic tubing (1/4 inch inside diameter)
- Clear packing tape
- Water
- Food coloring
- Any other household item you desire!

***Materials can be found at Lowe's or Home Depot

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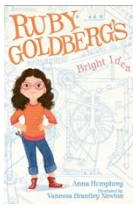
Vocabulary:

Simple Machines: mechanical devices that help people do work; there are 6 simple machines (wedge, lever, pulley, inclined plane, screw, and wheel and axle)
Inclined Plane: help move heavy objects, such as a ramp (examples: bathtub or wheelbarrow)
Screw: a slender, sharp-pointed metal pin with an inclined plane thread (examples: picture screw, jar lid, light bulb)

STEM Career Connections:

Hydrological Engineer	Robotic Engineer	3D Designer
Are professionals that control natural water sources such as rivers, lakes, and beaches. **They**: measure water properties, examine water test samples, evaluate environmental impacts and work for the government, construction companies, and organizations.	Are professionals that design, build, and test machines, and maintain the software that controls them. **They**: build, configure and test robots for different manufacturing companies and industries.	Are professionals that create three-dimensional models, animations, and visual effects using hand-drawing techniques and computer software. **They**: need to have knowledge of mathematics, computer software, and overall design skills.

Literacy Connections:

Ruby Goldberg's Bright Idea	How Do Seesaws Go Up and Down? A Book About Simple Machines	Iggy Gizmo and the Invention Convention
by Anna Humphrey	by Jennifer Shand	by Pip Jones
		

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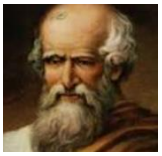
Background Knowledge

Real World Applications

The Archimedes screw was used to transport water from low-lying areas to irrigation ditches and is still being used today. Water treatment plants and amusement parks still use the original design. Take a trip to your nearest water park to research and see for yourself or watch the video links provided to see engineering in action.

Engineering New Ideas from Ancient Inventions



Archimedes, a Greek scientist, lived between the years 287 B.C. and 212 B.C. He was known as a mathematician, engineer, inventor, and astronomer. He became famous for his discovery of the relation between the surface and volume of a sphere and circular rotating cylinder, known as the Archimedes screw, 200 years after the invention. His ancient invention continues to be important in the modern world.

The Archimedes' Screw

Simple machines help us make work and play more enjoyable! They have few or no moving parts which help us do work by changing the direction of force needed to do something. The simple machines in the Archimedes screw are the inclined plane wrapped around a cylinder (which is the actual definition of a screw). This tool has many historical uses. It was used to empty water out of leaking ships and flooded mines. The screw was used to water fields of crops by pulling water from lakes and rivers.

Everyday Science: Archimedes Screw

This ancient invention can be seen in our lives today. To use the Archimedes screw to life water, the pipe must sit on an angle with one end in a body of water. Then, the screw must be turned with a hand crank or motor. As the bottom of the screw turns, it will scoop out the water. The shape of the screw will trap it, the water will be carried to the top of the pipe and spill it out. Water parks, water treatment plants, and pumping stations use the Archimedes screw to make transporting water easier!

Fun Facts!

- Archimedes also invented a variety of mechanical devices to fight off a Roman army invasion.
- Archimedes discovered the theory for water buoyancy.
- Archimedes was so far ahead of his time in mathematics, it took 1,800 years later until his work was finally understood by Sir Isaac Newton.

Check out these video links!

Graphic Design Career
https://youtu.be/0JeCrMqDwbY

Archimedes: More than Just a Screw!
https://www.youtube.com/watch?v=55_QQRDXlW0

Archimedes Screw In Action!
https://www.youtube.com/watch?v=8EECNgK_Cv0

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Activity Directions

Aim: Design functioning Archimedes screw made from the different simple machines designed with household materials to pump liquids and solids.

Investigating Questions

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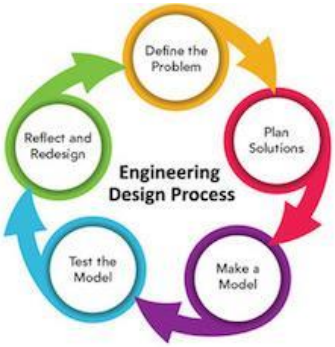

Materials

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Clear plastic tubing (1/4 inch inside diameter)
Food coloring
A glass
Clear packing tape
Water
Any other household item you desire!

***Materials can be found at Lowe's or Home Depot

Criteria & Constraints:

Engineering design challenges (EDCs) are great opportunities for open-ended activities to grow critical thinking and problem-solving skills. EDCs do not use a list of directions to build a specific design, rather suggest a framework of designing a solution based on the problem and goal. How your team chooses to address the problem and goal is entirely up to you.

- Discuss as a family how screws make work easier. Take two jugs of water (one closed with a screw lid; and another closed with a pop-top lid). Outside throw the jugs of water- what happened? Which lid helped keep the water in the jug? (*Define the Problem*)

- Lay out all materials and items available for the challenge. Plan to give time for your team to discuss the problem relating to your background knowledge. How will you use the materials provided to make your Archimedes screw based on what you've learned from the video links and background information? (*Define the Problem*)

- Discuss, sketch, and determine what order you will use the materials to build your Archimedes screw (*Plan Solutions*).

- Using your sketches and discussions, begin creating the screw from your model from materials available. Family adults: allow your child(ren) to experiment with the materials and help them build problem-solving skills (*Make a Model*).

- As you are building your model, test out the prototype to make sure they can move/work. (*Test the Model*)

- With your team, continue to discuss and work through problems with your designed models along the way. What adjustments can your team make to improve your design? If you were to make a new Archimedes screw with different equipment, what materials would you use or how would your model be different? (*Reflect and Redesign*)

Ideas to Increase Difficulty:

-Change the materials to transport pieces of cereal instead of water!

-Limit the number of materials that will be used!

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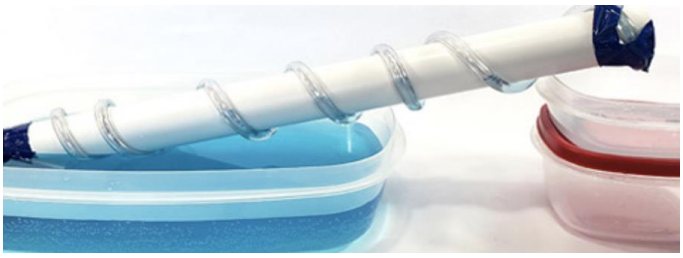
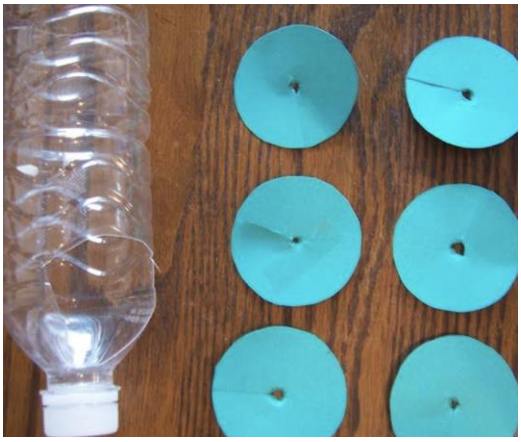
Sample Ideas





Photo's courtesy of: Liliana Murphy, Highhill Education, Frugal Fun 4 Boys

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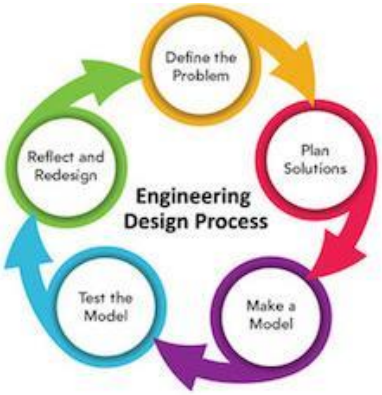
Extension Activity

Hoverboard Challenge

Materials:

CD	Hot glue/tape	Balloons
Water bottle cap	Scissors	



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-In this challenge you are designing a balloon-propelled hovercraft that will transport small toys from one point in a room to another.
-To increase level of complexity- try and add more balloons to your hovercraft

- Research and brainstorm designs of hoverboards. How do they work? *Define the Problem*)
- Sketch your prototype and design of key aspects of your hoverboard (*Plan Solutions*).
- Use research and the sketches to start brainstorming your prototype (*Plan Solutions and Make a Model*)
- Plan your prototype: draw or sketch the design. Watch some videos on zipline mechanics! (*Plan Solutions and Make a Model*).
- Using a CD, cover the hole in the center with a piece of packing tape. Poke small holes in the tape with a pin (this controls the airflow). Next, hot glue a pop-top soap cap or water bottle cap to the center of the disc—be sure to create a good seal to keep air from escaping. *(Make a Model)*
- Have an adult blow up the balloon all the way and pinch the neck to keep the air inside (don't tie it). Next, make sure the pop-top is closed and fit the neck of the balloon over the pop-up portion of the cap, and then place it on a smooth surface and pop the top open. *(Make a Model)*
- Test your design! Will you have to modify? Talk with your team about ways you could improve the design of your model (*Reflect and Redesign*).