Engineer It Day 1: High Winds Engineering

Materials:

Straws (wrapped) or Sticks	20
Wooden Blocks	20
Legos	20
Fan (Box or Oscillating)	1+ (ideally 4)
Plate, Cutting Board, or Tray	3

Video Link: https://youtu.be/rU9hKilxk0M

Background:

- The International Residential Code & Standards, set by the American Society of Civil Engineers, requires corrosion-resistant clamps or nails to hold down roofs. These protect buildings against winds caused by thunderstorms.
- Some engineers have been studying ways to improve these codes, trying to take tornado damage into account. Some engineers are even building tornado simulators so they can study how storms destroy homes, and how homebuilders can use certain materials that will make homes safer in extreme weather.

Vocabulary:

Weather	what is going on in the air outside; the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time.
Severe Thunderstorm	(as defined by the National Weather Service) a thunderstorm that produces a tornado, winds of at least 58 mph, and/or hail at least 1" in diameter.

Preparation:

This experiment can be done outside on a windy day or can be conducted inside with multiple fans.

Instructions:

1. If you are conducting this experiment with multiple fans, be sure they are facing each other. You can set this up with just one fan. If you have two, make sure they are facing each other.

2. Build your structures. Take some time to build the strongest structures possible, using only the listed challenge materials.
    - On a flat surface, like a plate or tray, build a structure with your straws or sticks.
    - Repeat this step with your wooden blocks, and again with your legos.

3. Once you have built all of your structures, move them individually to the open space in the middle of your fans, or if you are using one fan, place the building in front of your fan.

4. Turn your fan on, and see what happens to the building! Turn off the fans before gathering your materials.
    - Repeat this step with all of your structures.

5. After testing the strength of your structures, you can return to engineering the structures; use the material or structure that was the strongest and test how long you can get it to withstand the power of high winds.

Evaluation:

- Would you feel safe in a tornado or thunderstorm in the structure you made? Why or why not?
- What material worked the best when you put it in the middle of the fans?
- What would you recommend to engineers and homebuilders when they are thinking of ways to best engineer buildings against severe weather like thunderstorms and tornadoes?

Further Exploration:

Visit...

- https://resources.pitsco.com/stemathome to find engineering challenges that you can complete with activities at your own house.

Read...

- Rosie Revere, Engineer, written by Andrea Beaty and illustrated by David Roberts.

Engineer It Day 2: Catapults

Materials:

Rubber Bands	10
Small Recyclables	2-3
Play Dough	Small ball
Paper or Plastic Cups	1 - 12
Ping Pong Ball or Paper Ball	1 - 2
Cotton Ball or Marshmallow	1 -2
Spoon	1
Popsicle Sticks	10+

Video Link: https://youtu.be/5zDRtvupSgQ

Background:

- Physics is the branch of science that is concerned with nature and properties of matter and energy.
- Newton's Laws:
  1. If an object is not moving, it will not start moving by itself. If an object is moving, it will not stop or change direction unless something pushes it.
  2. Objects will move farther and faster when they are pushed harder.
  3. When an object is pushed in one direction, there is always a resistance of the same size in the opposite direction.
- Projectile Motion is the form of motion experienced by an object that is thrown, and moves along a curved path, or parabolic arc, under the action of gravity only.
- Storing Energy: Potential energy is energy that is stored. For example, a spring that is pressed down has potential energy, and when it moves, that becomes kinetic energy!
- Energy is never created or destroyed; it just changes from one type of energy to another. For example, chemical energy turns from food that we eat into kinetic energy when we move.

Vocabulary:

Potential Energy	the energy that something has because of its position or the way its parts are arranged.
Kinetic Energy	the energy that something has due to its motion.

Preparation:

Set up a work space that gives you at least 2 feet of clearance for launching your projectiles.

Instructions:

1. You will need to build a wedge for your catapult. A wedge is something used as a separating or holding device.
   - Using a rubber band on each end, attach 10 popsicle sticks together. You will do this by stacking them on top of each other, and then wrapping the rubber bands around until they are secure.
   - If you don't have that many popsicle sticks, something like a thick marker could also work. If you use an alternate material, you won't need to use rubber bands in this step.

2. Use rubber bands to attach one end of two more popsicle sticks. When you are wrapping your rubber band or rubber bands around the sticks, be sure to keep them 1 inch from the ends.

3. Attach the pieces that were made in the last two steps. Take the secured stack of popsicle sticks (your wedge) and place it between the other two sticks at a perpendicular angle.
   - This means it will be a right, or square angle – like a plus sign.
   - You may have to use some force to separate the two sticks, depending how tightly you wrapped your rubber band.

4. Now that the wedge has been placed, we will need to secure the pieces of the catapult together. You will need to wrap a rubber band around the pieces in both directions, creating an X.

5. Attach your spoon, or the basket of the catapult. Taking the handle of the spoon, overlap it with your popsicle stick, so that only the spoon is hanging off the end. Secure this with a rubber band.

6. When you press down on the top popsicle stick, where the spoon is attached, you create tension in the rubber bands. As long as the spoon is pressed down, the catapult has potential energy – stored energy.
   - As soon as I release the spoon, you will see the spoon fling forward in a rapid motion, exerting kinetic energy – energy in motion.

7. To test your catapult, stack a few cups into a pyramid, or one on top of the other to form a tower, at the other end of the table, or 2 feet away from your catapult.
   - Place the ball in the spoon, and pull down. When you are ready, release the catapult. Repeat this until you have successfully knocked down your tower of cups.

Evaluation:

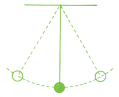
- Where is potential energy stored in this activity? When did you observe kinetic energy during this activity?
- Projectile motion is the motion experienced by the ball, and it moves along a curved path. What determines this path?

Further Exploration:

Visit...
- https://www.engineergirl.org/ to meet women that are working on amazing engineering projects.

Read...
- Awesome Engineering Activities for Kids, by Christina Schul

Engineer It Day 3: Paint Pendulum



Materials:

Foam or Paper Cup	1
Scissors	1
String	2+ feet
Small Nail	1
Tape	1 small piece
Chairs	2
Broom	1
Large Paper or Poster Board	1+
Drop Cloth or Tablecloth	1
Water	

Video Link: https://youtu.be/VhrcsBii8n4

Background:

- A Pendulum is a weight that is suspended from a point so that it swings freely.
- When a pendulum is directly below where it's attached, it is in its equilibrium position. When it moves from that position, it swings constantly back and forth.
- The amount of time it takes for it to complete one full swing is called the period. Depending on Earth's gravitational pull in the geographical location where it is pulled, the period will either be slower or faster.

Vocabulary:

Gravity	the force that attracts a body toward the center of the earth, or toward any other physical body having mass.
Motion	the action or process of an object moving or being moved.
Pendulum	a weight, or object, hung from a fixed point so that it can swing freely backward and forward.
Potential Energy	the energy that something has because of its position or the way its parts are arranged.
Kinetic Energy	the energy that something has due to its motion.

Preparation:

Prepare the workspace by covering the floor with a drop cloth of some sort.

Instructions:

1. Prepare the water pendulum by poking a hole in the middle of the bottom of the foam or paper cup. Also, poke one hole on each side of the cup underneath the rim.

2. Tie a piece of string through the two holes on the side of the cup creating a handle.

3. Place a broom horizontally between two chairs and slide the string-tied cup to the middle of the broom.

4. Before adding water to the cup, place a piece of tape over the hole on the bottom of the cup.

5. Place your paper underneath the pendulum, on top of the drop cloth, and add water to the cup; remove the tape and swing the cup.
    - Observe what patterns the pendulum creates on the paper.

6. Experiment with different timing of swinging the cup, different lengths of string, or lowering and raising the height of the cup.

Evaluation:

- What pattern is the pendulum making with the water?
- What happens if you swing the pendulum gently or swing it more forcefully?
- What does the water image look like or remind you of?

Further Exploration:

Visit...

- http://theyounginventors.org/online/ to spark ideas for inventions!

Read...

- Oscar and the Cricket: A Book about Moving and Rolling, by Geoff Waring

Engineer It Day 4: Flood Barrier Engineering

Materials:

Medium/Large container	1
Water	To fill container
Rectangular Blocks	3+
Sand, Dirt, or Rice	1/3 of container
Sponge	1

Building Materials: Toothpicks, popsicle sticks, playdough, rocks, sticks, etc.

Video Link: https://youtu.be/wqpP4EiRG8w

Background:

- Floods happen when weather-related events cause in influx of water to a specific area.
    - Floods can be caused by hurricanes, thunderstorms, melting snow, dams breakings, multiple rainy days, and more.
- During a flood, the ground becomes saturated with water, and the water rises beyond its normal levels. Often, the water extends to dry land.
- Flash floods are floods that happen incredibly quickly.
- Due to topographic and climate factors, Tulsa is an area that is prone to flooding, specifically seasonal flash flooding.

Vocabulary:

Flood	an overflowing of a large amount of water beyond its normal ability; sometimes, the water flows over normally dry land.
Barrier	a fence or obstacle that prevents movement; in this case, prevents the movement of water to dry land.

Preparation:

Place a paper towel on your work area to minimize messes.

Instructions:

1. Create your environment for the flood simulation. To do this:
    - Gather a medium or large container.
    - Fill 1/3 of the container with sand, dirt, or rice; compact it to one side of the container.
    - Place three rectangular blocks in the sand, dirt, or rice, to represent three buildings in the ground.
    - Fill another bowl or large measuring cup with enough water to fill the container. Do not pour it into the container. Set it aside for testing.

2. Your goal is for your barrier to not collapse, and for your buildings to not fall into the water.

3. Before building, draw what you would like your barrier to look like.

4. Build your barrier with rocks, sticks, toothpicks, etc. Be sure to press your barrier into your sand so that you have an area for your 'river' to flow, but not flood.

5. To test your barrier:
    - Soak your sponge in the water.
    - Raise your sponge over your tub, and squeeze the water out of the the sponge, simulating rainfall over your river. Continue to do this until the water overflows or knocks your barrier over.
    - Once you have tested your barrier, you can rebuild and test it with different materials.

Evaluation:

- Did your barrier protect the buildings from the flood?
- How much water did it take before your barrier flooded?
- What are some things that you did to keep your barrier strong?
- What are some ways that you could alter your barrier?

Further Exploration:

Visit...

- https://www.sciencebuddies.org/science-engineering-careers/engineering/environmental-engineer#projectideas to learn about the job of an Environmental Engineer and explore activities that simulate the career.

Read...

- Engineered! Engineering Design at Work, written by Shannon Hunt and illustrated by James Gulliver Hancock

Engineer It Day 5: Egg-Stronauts

Materials:

Tape	1 roll
Newspaper, Tissue	1+
Scissors	1 pair
Recyclables (small boxes)	3+, assortment
Eggs (plastic or real)	1 plastic, 3 real
Ziploc bag	1, if using real egg
Pennies or small weights	6
Measuring Tape / Yard Stick	1
Paper	1
Pencil	1

Video Link: https://youtu.be/WTwmKyNbGJY

Background:

- Physics is the branch of science that is concerned with nature and properties of matter and energy.
- Gravity is a force of attraction that pulls together all matter (anything you can physically touch). The more matter something has, the greater the force of its gravity.
- On Earth, gravity pulls objects toward the center of Earth. This is what makes objects fall. It is also what gives an object weight.
- Weight is a measurement of the force of gravity between an object and the surface it stands on. If a person stands on a scale, gravity pulls the person against the scale. The scale shows the strength of this force, or the person's weight.
- The Engineering Design Process is the process of designing, building, testing, and making edits based on what you have learned.

Vocabulary:

Gravity	force of attraction that pulls together all matter
Engineering Design Process	an iterative design strategy is based on the cyclic process of developing an initial design or prototype, testing that prototype, analyzing its performance against specific metrics, learning what worked and what did not work, designing a new prototype based on what was learned, and completing the cycle again.

Preparation:

Plan to do this experiment on a surface that is easily cleaned in case of spills.

Instructions:

1. We will build a 'space suit' for our egg-stronauts and test it by dropping it from a height of two feet.

2. If you are using real eggs, put them inside of a ziploc bag and seal tightly, in case your egg cracks.
   - If you are using a plastic egg, you will want to put pennies or weights inside. If you skip this step, the egg will not have enough weight. It will still fall, but will have less impact.

3. Using your recyclables, create a suit that will protect your egg.
   - The newspaper or tissue will provide cushion to your egg. Experiment with packing it tightly, or crumpling it slightly and resting the egg within.

4. Once you have completed building your the protective barrier for your egg, place the egg within and prepare to drop.

5. Using your measuring tape or yard stick, measure a height of 2 feet. Raise your egg-stronaut so that its starting point is where you have measured.

6. Drop your egg. Carefully disassemble your suit and check your egg for cracks. Repeat this step as many times as you would like. Use the Engineering Design Process to make adjustments to your suit so that it protects your egg.

Evaluation:

- What do you think kept your egg from breaking?
- Can your egg withstand a fall from a taller height? 3 feet? 4 feet?

Further Exploration:

Visit...

- https://www.acs.org/content/acs/en/education/whatischemistry/adventures-in-chemistry.html to find chemistry activities for children, written by the American Chemical Society.

Read...

- Astrophysics for Young People in a Hurry, by Neil deGrasse Tyson
- Out of the Box: 25 Cardboard Engineering Projects for Makers, by Jemma Westing