Urban Inventors

Ten Science and Engineering Themed Activities

Suggested Morning Activities:

- **Balloon Rockets**

This activity allows kids to experiment with making rockets, both in traditional and then nontraditional ways. See which method works best, and then encourage the kids to experiment on their own. How far does the balloon travel? Can you find a different method to make a rocket that makes the balloon travel even farther?

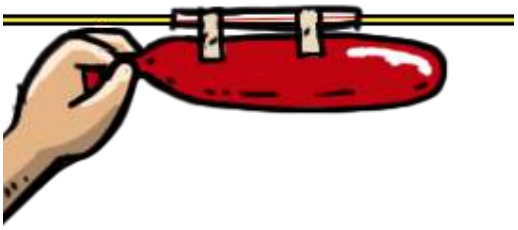
You Will Need:

- Yarn (about 6 feet per rocket)
- Balloon
- Straws
- Tape
- Scissors
- Timer

To Begin:

1. Begin by dividing up into small groups of at least 4. There will be two people on either end holding the string, and the person in the middle holding the balloon. If there are more than three per group they can take turns doing the various jobs.
2. Hand out a copy of the instructions and the materials
3. Begin by having kids thread a straw onto the string, and add two pieces of tape to the top of the straw. Have one kid hold the string on either side.

4. Inflate the balloon (DON'T TIE IT!) and tape it underneath the straw, carefully holding the end so it doesn't deflate. The person holding the balloon should keep holding until the rocket is ready to launch.



5. The 4th person should have a timer ready. They will time how quickly the balloon travel to the other side?

6. Have the balloon holder stand at one end of the string, and on the count of three, have them let go. The time keeper will keep track of how quickly the balloon traveled.

7. Here are some follow up questions and experiments to continue the project:
    - Does the shape of the balloon affect how far (or fast) the rocket travels?
    - Does the length of the straw affect how far (or fast) the rocket travels?
    - Does the type of string affect how far (or fast) the rocket travels? (try fishing line, nylon string, cotton string, etc.)
    - Does the angle of the string affect how far (or fast) the rocket travels?

• Marshmallow Launchers

You Will Need:

- Paper cups
- Balloons
- Marshmallows
- Pom Poms
- Scissors

- Tape

To Begin:

1. Give each kid a cup, balloon, and a pair of scissors.

2. Have everyone cut off the bottom of the cup.

3. Knot the end of the balloon. Then cut off the end of the other end of the balloon, and pull it over the top of the cup. It should look like the picture on the right:

4. To launch, stick a marshmallow in the middle of the cup, pull the balloon end back, and launch! How far can the marshmallow fly? Whose can fly the furthest?

5. To extend to project, make a target and see if you can shoot your marshmallow into the middle. Put a little paint on the end of your marshmallow so you know where it lands on the target.

• Rube Goldberg Inspired Inventions

Rube Goldberg was an American inventor and cartoonist who came up with complicated inventions for very simple tasks. For example, an invention to turn on a light switch would begin by hitting a marble that knocked a domino which pulls a level which leads to something eventually hitting the switch. Give examples of different Rube Goldberg machines, and then send groups off to make their own machines.

You Will Need:

- Worksheet on Rube Goldberg invention ideas
- Any materials you can find that will be useful for the machines

- Paper and pencil

To Begin:

1. Pass out paper, pencils, and worksheet of ideas. Brainstorm a list of simple inventions you think you could make. His inventions were simple tasks, and the invention focused on the process rather than the end result. Ideas for inventions include:
    - Crushing something
    - Dropping something
    - Watering a plant
    - Filling a balloon
    - Drawing on something
    - Popping a balloon
2. Divide into small groups and have each group pick a problem to solve. Pass out worksheet of examples for inspiration.
3. Give groups 10 minutes to sketch their machines and planning out the steps before they begin.
4. When groups are done sketching send them to the collect the supplies they need to assemble their inventions.
5. When groups are ready to begin give them 30 minutes (you can increase the time if you need) to solve their problem. Try to have each group come up with at least 3 steps along the way.
6. At the end of the activity have everyone come together and show each other what was made. Did it solve the problem? If it didn't, is there anything you would change next time?

- **Kite Making**

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Making kites is a great activity for kids to use measurements to create their kites, and then figure out the angle that works best for flying. Let kids experiment making different models, and having different lengths of string or ribbon, to see which design works best. This activity should be done on a day with some wind.

You Will Need:

- Paper
- String
- Ribbon
- Scissors
- Tape

To Begin:

1. Pass out paper, markers, tape, and a ruler
2. Have each kid decorate the paper on both sides
3. Fold paper in half
4. Measure and mark at 3.5 inches on the folded half of the paper. Then measure and mark at 2.5 inches on the edges of the page.
5. Curl (don't fold) down the edges down to the 2.5 inch mark and tape them in place.
6. Make a hole at the 3.5 inch mark and cut a long piece of string and tie it to the kite. Wrap the end of the string around a popsicle stick.

- **Bubbles**

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This simple experiment allows kids to make an activity they have encountered numerous times. Explain that these bubbles are better and stronger than the traditional bubble mixture because of the glycerin. Every bubble actually has three layers: soap, water, and another layer of soap. The bubble pops when the water stuck between the layers of soap evaporates. The glycerin helps make the layers of soap thicker, making the bubbles bigger and last longer.

You Will Need:

- 1 gallon of water
- 2-3 tablespoons of glycerin
- 2/3 of a cup of dishwashing liquid
- Cups for measuring
- Spoons to measure drops
- Bucket for mixing

To Begin:

1. Mix everything together in a large container and set aside for the afternoon. The longer the glycerin sits, the better the bubbles will be. Try making it in the morning and then coming back to it in the afternoon.
2. In the mean time experiment making different wands. You can use string, popsicle sticks, cups, or anything you think you can use to blow bubbles with.

To Make a Wand:

1. **Start with two straws**. If they're too long you can shorten them to about 6 inches.
2. **Thread a length of string through the straws**, end to end, as though you were stringing beads. The length of your string determines the size of your bubbles. Mine was about 30" long and was a nice, manageable size for the kids. (TIP: If you're having problems threading the string through the straw,

insert the string into one end and suck on the other end. You might end up with a mouthful of string, but it pulls it right through!)

3. **Tie the ends** of the string to form a large loop. Then, move the knot so it's inside one of the straws.
4. **Take two more straws** and insert them to form handles. (I actually had two different sized straws, but if you pinch the ends, you can still push in the straws for handles.)
5. **Pour your bubble solution into the shallow container**. Submerge the string and straws, then slowly lift up by the handles. Gently pull apart the handles until the strings are taut and then let the wind or your movement help a big bubble take shape. It took a few tries to get the hang of it, but the kids loved perfecting their techniques.
6. At the end of the day come back to the bubbles, dip your wand in, and blow. How do they work? Try making differently shaped wands, and see if they all work blowing bubbles. Is there a shape that works best?

Suggested Afternoon Activities:

- ## Tallest Tower

This task mirrors the challenges that engineers face in the real world. The activity works with constraints such as material limitations and deadlines. This challenge is to design and construct a model tower using only paper, tape, and scissors. Each team will be provided with materials and given a limited amount of time. The tower must be as tall as possible while still able to hold up to wind. It also must be freestanding, meaning participants cannot tape it to the ground, or any other object. The objective of this activity is to understand the structural aspects of skyscrapers; participants will then discuss why some designs worked while others fell.

You Will Need:

- Newspaper
- Tape
- Scissors
- Yardstick

To Begin:

1. Encourage participants to think about the skyscrapers they have seen and discuss their shapes and foundations. Which shapes form the tallest towers? If needed, suggest to the participants different structures to focus on: cylinder shape to allow wind to move around the building, tripod design to create a foundation against wind, and others.
2. Divide the participants into groups of 4 or 5
3. Distribute scissors for groups to share, and give each group 12 inches of tape and three full sheets of newspaper
4. Give teams ten minutes to brainstorm and discuss ideas WITHOUT building
5. Allow twenty minutes for building
6. When time is up, ask all participants to stop building.
7. One by one, measure each tower's height
8. Measure the wind resistance, but standing an arm's length away and blowing on the tower
9. In turn, let each group share with the rest of the participants why they chose their structure and why they think it worked/didn't work. Share what they have learned through this activity.

• Earthquake Testing

This allows kids to see what happens to buildings in an earthquake, and has them try to come up with designs that they think will withstand a shake. This project allows kids to work together to plan and design a building they believe will withstand the quake. Use the handout in the back on earthquakes and seismic testing to provide the kids with background knowledge on their designs. Begin this activity by asking the kids what they know about earthquakes, and then discuss different types of structures that may be best. Try to relate this back to bridge making during the engineering week, and see if anyone remembers a structure that worked well. At the end of the activity kids will test their towers on a "shake table."

The shake table will be used to test all of the towers. Because these usually require complex materials, you will build a modified version. The goal is simply to have a platform with something round underneath, so the shaker can gently shake a platform which will easily move back and forth.

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You can test out various designs to come up with the best one. One kid or staff member should be responsible for shaking each tower. They should try to shake consistently, so each tower experiences a similar "earthquake."

You Will Need:

- Shake Table:
  - Something sturdy for the base (a few pieces of cardstock fortified with popsicle sticks)
  - Something round underneath (glue sticks, markers, crayons- need the base to roll back and forth)
- Tower:
  - 15 toothpicks
  - 15 straws
  - 15 marshmallows
  - 5 popsicle sticks
  - 1 foot of yarn

To Begin:

1. Participants will work in groups to create their own building out of the materials they are given. Give everyone the same amount of materials, and set a time limit for the groups to create their structures (30 minutes suggested time).
2. Split participants into groups
3. Distribute materials
4. Groups will have 30 minutes to design their own buildings.
5. After the groups build their buildings have them test them one by one on the shake table. Construct the shake table by putting the platform on a base that rolls. There should be one person designated as a shaker (neutral party who will fairly shake each tower the same way) and a time keeper to see how long each tower stays up.

6. After everyone has tested their tower discuss whose stayed up the longest. What kind of design did they use, and why? Compare which designs worked best, and which ones fell quickly.

• Paper Planes and Ring Gliders

Participants will choose if they would like to make a ring glider or a paper plane, and then test them out to see whose went the further. Who predicted correctly? Is there a design that works best? After the initial test run see if kids can refine their design.

You Will Need:

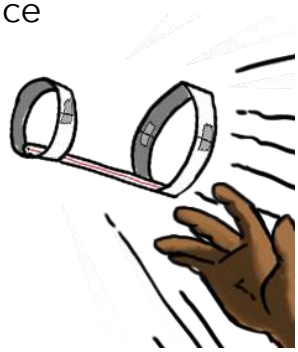
- "Paper Plane Ideas" worksheet
- Plastic straws
- Index card or card stock
- Tape
- Scissors
- Paper
- Paper clips

To Begin:

1. Have participants choose to make either a paper plane or ring glider to start. Tell them that they will be testing out their creations to see whose can go the furthest.
2. Split up into groups of those making planes and those making ring gliders, so a staff member can explain to each group how to make the basic version. Give everyone 30 minutes of time to experiment making their own glider or airplane. At the end of the 30 minutes they will pick which one they would like to enter into the competition.

- Hand out worksheets to those making paper planes
- For the ring glider:

1. Cut out three 5 inch long, 1 inch wide strips of paper
2. Tape two of the pieces of paper together to make a circle, overlapping the edges at each end so the hoop stays round.
3. Fold the third strip into a smaller circle, edges overlapping once again so the shape remains a circle.
4. Line up the hoops along the straw, taping the straw on the inside of each hoop.
5. To throw it hold the straw in the middle, with the two hoops pointed up.



3. After everyone has made their planes or gliders, have them pick one to enter into the competition. Give everyone a 5-10 minute test run, so they can figure out the best throw or angle that they feel helps their creation go the furthest.
4. When everyone is ready have them line up at the "start" and on the count of three, throw their planes and gliders. Whose went the farthest? What was the design?
5. Try the race again. Did the same creation win? Try as many times as needed, and discuss which type works best, and why they think that may be.

• Making Polymers

Polymers are solids that we use as the base for most objects. This activity allows kids to make their own bouncy balls, a form of polymers, using glue, borax, water, and corn starch. This activity may be a bit messy so put something down on the table before getting started. ***You will also need a cup of lukewarm water, so leave it out in the sun at least an hour before you begin.***

You Will Need:

- Cups
- Borax
- Corn starch
- Glue

- Stirring spoons or popsicle sticks
- Measuring cup

To Begin:

1. Label one cup "borax solution" and the other "ball mixture."
2. Pour 4 ounces of water and 1 teaspoon of borax powder into the "borax" cup. Stir the mixture until the borax has dissolved.
3. In a separate cup pour one spoonful of glue.
4. Add ½ a teaspoon of the borax solution and 1 tablespoon of cornstarch to the glue. Do not stir! Let the ingredients mix on their own for 10-15 seconds. Wait 15 seconds before stirring to fully mix everything together. If you do not wait the 15 seconds the ingredients will not have time to interact correctly.
5. Once the mixture is impossible to stir, take it out of the cup with your hands and begin to roll it into a ball. It will start off sticky, and then continue to become more solid as you keep rolling it into a ball.
6. Keep rolling until the ball is solid. Try bouncing it on a flat solid surface.

• 100 Toothpick Challenge

Participants will learn about different bridges and then work together to construct a bridge that they think will hold the most weight. This activity has participants working together in small groups to solve a problem, while also thinking about geometry and how this affects the bridge's design and function. After the bridges are built, students will then test out the bridges to see whose will hold the most weight. (Lesson adapted from BEAM UCLA, written by Anjali Mulchandani)

You Will Need:

- Worksheet on bridges
- 100 toothpicks per group
- 50 marshmallows per group
- Books on the different types of bridges

- Timer

To Begin:

1. Pass out the worksheet on the different types of bridges and their different functions. Ask if anyone can identify any famous bridges, and which type of bridge it is. There are five types of bridges, and each design serves a different purpose. Have them guess which designs they think are the most stable, and why.
2. Next, split into small groups (depending on how many kids, groups should be between 3-6 people) and hand out materials.
3. Let them know that the most successful method is to assemble the sides first, and then build the middle. The simplest bridges to build are the truss and beam bridges. There are examples of planning sheets below, if they would like to use them.
4. Give each group about 30 minutes to build their bridges.
5. Come back together as a group to test each bridge. To test the bridge let it hang in between two books, chairs, or any other materials you have (if using books you will need two even stacks, or put two chairs next to each other, with the edges of the bridge on either side, hanging down in the middle).
6. Have one group member SLOWLY push down on the bridge. As soon as it collapses have a group member investigate where it broke. Did it come apart at a joint (where the toothpick and marshmallow meet) or did a toothpick snap? Allow each group to experiment.
7. After each group has tested their bridge come back together as a group and talk about what happened. Look at which bridges broke at the joints, and which ones had toothpicks snap. Was there a design that worked best? Whose prediction was correct?