**Saturday Science– Spring 2016**

**Engineering | Grades 5-8**

Overview

Engineering is the bridge between science and technology. Students will be able to learn scientific knowledge while they are working on various engineering activities that include both the design and construction process. In this five-day class, students will explore engineering designs in relation to five different themes. The themes students will be exploring are: towers, bridges, roller coasters, flight, and parachutes.

Tower Day

**Learning Objectives:**

-Students will be able to understand how compression and tension affect the strength and stability of a structure

-Compare their model to others to understand why some models are stronger than others

-Students will be able to understand how to build a strong foundation and choose appropriate materials for building.

**Vocabulary:** Compression, tension

**Materials:**

|  |  |  |
| --- | --- | --- |
| Items | Usage | Quantity |
| Dixie bath cups | These items are used to build the tower body | 250 |
| Newspaper  | This item is used to build the tower body; magazines also work | -- |
| Spaghetti | This item is used to build the tower body. | 4 packs |
| Marshmallows | Used as a connector in tower building | 4 packs |
| Straws | These items are used to build tower body; Non-bendy (1000 count per pack) | 10 packs |
| Plastic cups  | To hold weights for strength testing (Red solo type, 16 oz.) | 6 |
| Weights | This item is used to see which can hold the most weight on top; starting with 10g.  | -- |
| Golf balls | Used for newspaper tower | 6 |
| Clay  | Used as a connector in tower building  | -- |
| Fake money  | Used to buy supplies  | -- |
| Masking Tape | Used as a connector in tower building  | 12 |

**Activities:**

9:30-9:40: Welcome, introduction, and icebreaker activity. Students will briefly introduce themselves and present an interesting fact about themselves to the class.

9:40-9:50: What is engineering?! The class will participate in a discussion on what engineering means to them and why it’s important.

9:50-10:00: Brief overview of what to expect and lecture about towers. This lecture highlights the most famous towers worldwide and also shows some of the greatest design mistakes. We will briefly discuss the main structural components of towers and why knowing them is important, in order to avoid these mistakes.

Activities: (10:00-11:45 am)

*Activity 1* Cup Tower (10:00-10:30am)

Each group will receive 50 Dixie cups and will have to work together to see how high they can build a tower with in limited time (10 min). More cups will be available if the group feels they can keep building higher. No specific instructions will be given. The students can experiment with all different types of shapes and ideas.

After the activity is completed, we will briefly discuss why some fell and which shape and foundation was the most supportive for the towers that were the highest.

*Activity 2:* Golf Tower (10:30-10:50am)

Each student will receive 10 pieces of newspaper, and 20 inches of masking tape. Instructions: Build a tower that can hold a golf ball. The tower cannot be taped to the table to help it stand. While the students are building, an instructor will go around the room with a golf ball and aid students in testing their various structure designs before their final test for stability.

*Activity 3:* Spaghetti Tower & Competition (11:00-11:45am)

Prior to students beginning this activity, the instructor will briefly remind them of the principles of tension and compression. Each group will receive a handout explaining the rules for this activity. They will receive $400 in fake money (30 tens and 20 fives per group) for ordering supplies. One group member should take the role of banker for the duration of the activity. One instructor will manage the store and sell the groups marshmallows ($10) and spaghetti ($5). Before students may go to the store to purchase supplies, they must draw up a design with their group that falls within their $400 budget. This activity highlights that engineers must sometimes work within financial constraints while still building a safe, sturdy structure. The goal for each group is to build the tower that can withstand the most amount of weight before breaking. When the tower is finalized, weights will be placed on top and the weight at which they broke will be recorded.

**References:**

<http://pbskids.org/zoom/activities/sci/supergolftower.html>

<https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_mechanics/cub_mechanics_lesson10_activity1.xml>

Bridge Day

**Learning Objectives:**

- Identify how geometry affects bridge design and function and apply that knowledge to the design and construction of a bridge

- Students will explore different design style and choose the best for a Strong foundation.

- Students will understand basic physical concepts.

**Vocabulary:** Truss bridge, moveable bridge, arch bridge, suspension bridge, beam bridge

**Materials:**

|  |  |  |
| --- | --- | --- |
| Items | Usage | Quantity |
| Popsicle sticks  | This item is used for the bridge body | 1200 count |
| Weights | This item is used to see which can hold the most weight on top; starting with 10g | -- |
| 8 ½ X 11 paper  | Used for bridge body | 50 pieces |
| Books | Used as weight | -- |
| Pennies  | Used as weight | 300 |
| Hot glue gun  | This item is used to connect the popsicle sticks | 6 |
| Straw | Used for the bridge body | 300 |

**Activities:**

Preparation:

9:15-9:40: Checking in. As soon as students are seated, they will be given a blank piece of paper, a pencil, and told to draw any bridge they can imagine.

9:40-9:50: The students will be given the opportunity to come up to the front of the room, share their bridge with the aid of a projector, and tell everyone about their design.

9:50-10:00: A brief lecture will be given, providing an overview of the variety of bridge designs. The instructor will also mention the functionality, design, and requirements of the various bridges.

Activities: (10:00-11:45 am)

*Activity 1* Popsicle Stick Bridge (10:00-10:30):

Each group will receive 200 Popsicle sticks and a glue gun. The instructors will provide four types of bridge designs and students may choose one to build. The students will also have the freedom to come up with their own design as long as they get it approved by the instructor.

When the students have finished building their bridges, the instructors will test them for strength. Each bridge will be placed on two stools, approximately 10” apart. Books will then be placed on top of the bridge one at a time to see which bridge can hold the most books before it breaks.

At the conclusion of the activity, the instructor will hold a discussion guided by the following questions:

* Which design held the most weight?
* What should we consider when making comparisons?
* What are the advantages of each type of bridge?

*Activity 2* Crazy Straw Bridge (10:40-11:10):

Each group will get 100 straws and masking tape to build a bridge that will span 14 inches with each end of the bridge being attached to individual stools. The students will receive no instructions on how to connect the straws but will come up with their own design methods. Pennies will then be placed on the straw bridge until it breaks or bends enough that all of the pennies fall onto the floor. Competition: which one will hold the most weight?

*Activity 3* Paper Bridge Challenge (11:10-11:45):

Each student will receive one piece of card-stock paper to design a paper bridge.

A testing station will be set up by the instructor that will span 6” between 2 book stacks of equal height. The bridge is successful if it can hold Mr. Snoopy with a basket. The instructor may keep increasing the weighted objects available (stuffed toys, pennies) until the bridge collapses.

Clean up: (11:45 am-12:00 pm)

**References:**

<https://www.educationfund.org/uploads/docs/Publications/Curriculum_Ideas_Packets/2013/Building%20Bridges%202013-14.pdf>

<http://www.scientistinresidence.ca/pdf/physical-science/Structures/SRP_Structures_Lesson%204%20WF.pdf>

Roller-coaster Day

**Learning Objectives:**

- Identify points in a roller coaster track where a car accelerates and decelerates.

- Explain why it is important for engineers to understand how roller coasters work.

- Identify points in a roller coaster track at which a car has maximum kinetic and potential energy.

**Vocabulary:** acceleration, potential energy, kinetic energy, critical velocity, friction

**Materials:**

|  |  |  |
| --- | --- | --- |
| Items | Usage | Quantity |
| Poster board | The body of the roller-coaster; large pieces | 10 |
| Cardboard tubes  | For the maze & roller coaster. Small and large sizes | 75 |
| Rulers | Roller coaster measurement | 6 |
| Fabric/emory boards | These are used for the maze activity | -- |
| Mask tape | This item is used to connect parts. | 12 rolls |
| Marbles | For testing the roller coaster. Varying weights & sizes | 12 |
|  cups  | To catch the marble at the end of the roller coaster  | 6 |
| Books | only to be used to prop up the roller coaster | -- |

**Activities:**

**Preparation:**

9:15-9:40: Checking in: Students will be provided with pencils and paper and told to design a roller coaster while waiting for class to begin. The instructor will also provide mazes for the students to complete or they may attempt to design their own.

9:40-10:00: During the lecture, brief videos of a variety of roller coasters will be shown. The class will discuss acceleration, critical velocity, and safety issues for each design. Mazes will also be discussed with a brief explanation of how to draw one and a few examples of mazes ranging from simple to extremely difficult.

Activities: (10:00-11:45 am)

*Activity 1* Roller Coaster (10:00-11:00):

 Each group will be told to design a roller coaster that can fit on their lab table. They will be provided with a guide booklet that shows how to make different roller coaster features out of poster board. Each group must get their design approved by the instructor before supplies will be handed out. There will also be contest where the roller coaster with the most design features will be the winner. However, this does not necessarily mean that it will be the best roller coaster. A simple one can work just as well. The overall goal is for each rollercoaster to successfully have a marble start at the beginning point and make it to the end point. Instructors will hold onto the marbles and aid the students in testing their roller coaster designs as they build.

*Activity 2* The Slow Maze (the backup activity) (11:00-11:45)

 Each table will be given one large piece of cardboard and the remaining paper towel rolls. The goal is to construct a maze that a small ball can travel down at the slowest speed. Each piece of cardboard will be propped up around the room at the same angle (approx. 16” from the wall at the base). Students will then attach their tubes to this piece of cardboard using glue guns or tape, and slow down their balls using Emory boards, pieces of fabric, or just by their designs. Each group will get one final trial that will be timed to see who made the slowest maze (using the principles of friction and acceleration). All teams will have access to the same amount of materials.

Clean up: (11:45 am-12:00 pm)

**References:**

[**https://www.teachengineering.org/view\_activity.php?url=collection/duk\_/activities/duk\_rollercoaster\_music\_act/duk\_rollercoaster\_music\_act.xml**](https://www.teachengineering.org/view_activity.php?url=collection/duk_/activities/duk_rollercoaster_music_act/duk_rollercoaster_music_act.xml)

[**http://pbskids.org/zoom/activities/sci/rollercoaster.html**](http://pbskids.org/zoom/activities/sci/rollercoaster.html)

[**http://pbskids.org/zoom/activities/sci/marblemaze.html**](http://pbskids.org/zoom/activities/sci/marblemaze.html)

Flying Day

**Learning Objectives:**

After this activity, students should be able to:

- Create a paper model of an airplane to use in experiments.

- Use observations of paper airplane flight to explain flight.

- Find the average distance of flight trials.

**Vocabulary:** aerodynamic, drag, flaps, rudder, lift, pitch, thrust

**Materials:**

|  |  |  |
| --- | --- | --- |
| Items | Usage | Quantity |
| Paper  | This item is used for plane body | 100 |
| Measuring tape | This item is used to measure distance (at least 50 feet) | 2 |
| Masking tape | Used for both plane and rocket  | 3 rolls  |
| Scissors | Used for both plane and rocket | 6 |
| Water Bottle  | 8 oz. Used for rocket body. | 24 |
| Popsicle sticks  | This item is used to join popsicle sticks | ~80 |
| Rubber stopper | Stop water bottle | 6 |
| Vinegar | Vinegar and Alka-Seltzer react to create carbon dioxide to launch the rocket.  | 1 L |
| Alka-Seltzer Tablet | 1 pack |

**Activities:**

Preparation:

9:15-9:40: Checking in. As soon as students get into our classroom, instructors will let them draw a plane on a piece of paper (this can be individual work or group work. They will be provided with drawing materials.) The theme of this drawing is: How can we fly in future?

9:40-9:45: Brief lecture on the main points of flight. What is drag? What is lift?

Activities: (9:50-11:50 am)

*Activity 1* Paper plane competition (10:00-10:50):

Each group will make at least two plane designs. They will fly their plane in the hall way three times, and then calculate the average length and flight time. They will then get three tickets for a competition. They will fly their plane at the competition site with one volunteer, write down flying time and distance on the ticket, and let the volunteer validate the information with her signature. Then, they will turn in their ticket. Meanwhile, they can turn in their planes for the best design award. Tickets and plane due by 10:50 am.

*Activity 2* Bottle Rocket (11:00-11:45):

Students will make a bottle rocket. If one group (4 to 5 students) finishes first, they may go out and test it with a volunteer. Then, they can come back and improve their design. The rocket may only be launched by the instructors or volunteers.

Clean up: (11:45 am-12:00 pm)

**References:**

<https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_airplanes/cub_airplanes_lesson06_activity1.xml>

Parachute Day

**Learning Objectives:**

After this activity, students should be able to:

- Design and construct parachute

- Test and refine their design

- Communicate their design process and results

**Vocabulary:** Canopy, lines, risers, gravity, round parachute, square parachuts, ram-air parachute, ribbon and ring parachute.

**Materials:**

|  |  |  |
| --- | --- | --- |
| Items | Usage | Quantity |
| Stopwatch | Measure the time to land | 12 |
| String  | Used to prepare parachute; Yarn is better if it is cheaper. |   |
| Weights | This item is used to see which can hold the most weight on top; starting with 10g | -- |
| Plastic garbage bag | Used to prepare body of parachute | 12 count |
| Masking tape | Tape string to the parachute body | 12 |
| Scissors |  | 24 |
| egg | used for testing parachute: Egg drop challenge | 1 dozen |
| Small cups | To hold eggs | 20 |
| Other supporting materials | Marshmallows; cotton; cloth; straws… | -- |
| Color pencils  | Used for design; prepare for 6 groups | 6 sets  |

**Activities:**

Preparation:

9:15-9:40: Checking in. Students will be given paper and pencils and told to design a parachute.

9:40-9:50: Brief lecture that will display some clips about parachutes, discuss purpose of parachutes, the history of parachutes, and parachute design principles.

Activities: (9:50-11:50 am)

*Activity 1* Exploring Parachute Shape(9:50-10:15, inside classroom):

Students will begin with the simplest design. Each group or individual will make a round, a square, and then a parachute with any other shape using plastic bags. The parachute will be tied to a penny and students will test it by throwing it up; they start timing when the parachute touch the ceiling and stop timing when it falls to the ground. They will measure the drop time and calculate the velocity and average velocity. Out of this activity, they need to choose the best shape.

*Activity 2* Exploring materials **(**10:15-10:40, inside classroom**)**

Students will try up to two different types of materials and choose the best one.

*Activity 3* Drop egg challenge (10:50-11:45):

Students will design and build a parachute that will carry a raw egg to the ground without breaking. They should test it with a weight first (two biggest washer), and then test eggs. The instructor will carry the egg around to aid students in testing the shape of their design apparatus. Once students have finalized their design, the egg will be placed in their parachute container and they will drop it from a height of one story.

Clean up: (11:45 am-11:50 am)

**References:**

<http://tryengineering.org/lessons/playingwithparachutes.pdf>

<https://www.teachengineering.org/view_activity.php?url=collection/wpi_/activities/wpi_design_a_parachute/design_a_parachute.xml>