



**30<sup>th</sup> Annual  
Engineering Competition**

South Florida Science Center and Aquarium

# 2016 Competition Information & Rules

In Partnership with the Florida Engineering Society &  
the South Florida Science Center and Aquarium



SOUTH FLORIDA  
SCIENCE  
CENTER  
AND AQUARIUM

FOUNDED 1916



Florida  
Engineering  
Society



## Table of Contents

---

<b>General Competition Information</b>	<b>3</b>
<b>Summary of Rule Changes</b>	<b>4</b>
<b>Drop It</b>	<b>5</b>
<i>Engineering Design Challenge</i>	6
<i>Construction Specifications</i>	6
<i>Testing and Judging</i>	6
<b>Thrill It</b>	<b>7</b>
<i>Engineering Design Challenge</i>	8
<i>Construction Specifications</i>	8
<i>Testing and Judging</i>	9
<b>Float It</b>	<b>12</b>
<i>Engineering Design Challenge</i>	13
<i>Construction Specifications</i>	13
<i>Testing and Judging</i>	14
<b>Launch It</b>	<b>15</b>
<i>Engineering Design Challenge</i>	16
<i>Construction Specifications</i>	16
<i>Testing and Judging</i>	16
<i>Diagram 1 – Rocket</i>	17
<i>Diagram 2 – Nose Cone Diagram</i>	18
<i>Diagram 3 – Fin Diagram</i>	18
<b>Clean It</b>	<b>19</b>
<i>Engineering Design Challenge</i>	20
<i>Construction Specifications</i>	20
<i>Testing and Judging</i>	21
<i>Diagram 1 – Chamber Diagram</i>	23
<i>Diagram 2 – Filter Diagram</i>	23

## General Competition Information

Drop it, Thrill it, Float it, Launch it, Clean it is an annual engineering design competition jointly presented to all students by the **South Florida Science Center (SFSC)** and the **Florida Engineering Society (FES)**.

The following are the competition details:

**Date:** Saturday, April 16, 2016

**Time:** 7:00 am – 9:00 am Registration

9:00 am – 4:00 pm Competition and Awards Ceremony

**Location:** South Florida Science Center and Aquarium  
4801 Dreher Trail North  
West Palm Beach, FL 33405

**Website:** <https://www.sfsciencecenter.org/>

**For questions regarding the event details**, please contact the following staff member from the South Florida Science Center:

Carla Duhaney  
[CDuhaney@sfsciencecenter.org](mailto:CDuhaney@sfsciencecenter.org)

**For questions regarding the rules of the competition**, please contact one of the following engineers from the Florida Engineering Society Palm Beach Chapter:

Krystin Berntsen, PE  
[KBerntsen@pbcwater.com](mailto:KBerntsen@pbcwater.com)

Jimmy Richie, PE  
[Jimmy.Richie@WantmanGroup.com](mailto:Jimmy.Richie@WantmanGroup.com)

### GENERAL COMPETITION RULES:

1. The competition is open to students individually or in teams (maximum of 2 students per team and max. of 4 students for Thrill It), from elementary to high school students.
2. Students register online at <https://www.sfsciencecenter.org/>.
3. Entrants and their egg drop containers, rockets and roller coasters must be complete and present at the Science Museum before 9:00 am sharp on Saturday, April 16, 2016 for registration.
4. Rockets and crates must be clearly marked with the name(s) of the entrant(s). Rockets and crates must meet construction specifications.
5. All questions and disputes must be brought to the attention of FES/SFSC staff the day of the event and will not be considered thereafter.
6. **All decisions of the judges are final.**

## Summary of Rule Changes

**\*All egg drop containers, rockets and roller coasters are to be completed at home and brought to the competition. The water filter pre-cut 2-liter bottles and filter media are to be brought to the competition for assembly. ONLY boats will be made at the event.\***

### **Drop It**

- All containers will be dropped once from 50 feet ONLY.
- The following items are allowed: packing peanuts, Styrofoam, and pool noodles.

### **Thrill It**

- The width of the coasters has been reduced to 30 cm.

### **Float It**

No changes

### **Launch It**

No changes

### **Clean It - NEW EVENT!**

- pre-cut 2-liter bottles and filter media are to be brought to the competition for assembly



**Drop it**

# **DROP IT**

---

## **ENGINEERING DESIGN CHALLENGE**

Design and build a shipping container that will prevent an uncooked egg from breaking when dropped from a height of 50 feet.

## **CONSTRUCTION SPECIFICATIONS**

All egg crates must meet the following specifications:

### 1. MATERIALS

- A. Parachutes, balloons, helium balloons, propellers (of any type) or inflatable material (i.e. inflatable foam, bubble wrap, air pillow packing material, inflated ziploc bag, etc.) of any kind are **NOT** permitted. The following items are allowed: packing peanuts, Styrofoam, and pool noodles.
  
- B. Eggs will be supplied (Grade A Large chicken eggs).

### 2. CONSTRUCTION

- A. The maximum dimensions of the crates shall be 8" x 8" x 8".
  
- B. The entire egg crate must be able to pass through a square aperture of 8 inches by 8 inches (8" x 8") in all three axes (8" cubed dimension) to be eligible for competition.

## **TESTING AND JUDGING**

- A. Only one (1) entry (egg crate) per person/team will be accepted. A maximum of two people per team will be accepted.
  
- B. Only one (1) crate may be used. Only one (1) attempt will be allowed for each entry.
  
- C. Each egg crate will be visually inspected and measured for compliance with all of the rules. Once the crate is checked in, no further adjustments will be permitted. An egg will be provided to each contestant.
  
- D. The egg crate will be drop tested from a height of 50 feet. After the drop, the contestant will remove the egg from the crate for inspection by the judge. Only the judge determines whether the egg survived the drop test.
  
- E. Each egg crate that passes the drop test will be weighed, without the egg.
  
- F. The winning entry will be determined by the egg crate that weighs the least and successfully completes the drop, without the egg breaking.



**Thrill it**

# THRILL IT

---

## ENGINEERING DESIGN CHALLENGE

Roller coasters are called "gravity rides" for a good reason: once the coaster has been dragged to the top of the first hill and released, it is the force of gravity that keeps the coaster going all the way back to the station platform at the end of the ride. As the coaster goes through its twists, turns, rolls, and loops, it gains and loses its initial potential energy (supplied by dragging it up the first hill). Energy changes from potential into kinetic energy and back into potential energy. Since some of this initial energy is lost due to friction, the roller coaster can never rise as high as the first hill. The roller coaster you will design is also a "gravity ride".

In the "Spirit of the Competition," the key ingredients are creativity and application of science principles. Doing a great job is encouraged over spending lots of money to complete the project.

### Documentation

- (1) Each team must attach a 3" x 5" index card to the ride. The front of the card should include:

**Name of the Roller Coaster**

**Grade Level (K-5, 6-8 or 9-12)**

The back of the card (not showing) should include:

**Team Name**

**Members of the Team with grade level and School Name (if applicable)**

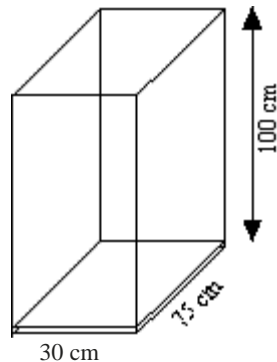
Each team will be provided with a scoring card on the day of competition.

## CONSTRUCTION SPECIFICATIONS

1. MATERIALS
  - A. Materials that seem logical include wood, wire, string, twine, doweling, toothpicks, cardboard, construction paper, glue, tape or other low cost items.
  - B. Design teams using **commercially available** roller coaster kits, including paper kits, will result in up to a **25 point deduction**.
  - C. Each team must supply their own steel ball or glass marble.
2. COASTER MODEL RULES



- A. Size restrictions - the base must fit within a rectangle footprint that is 30 cm x 75 cm. The overall track must fit within a rectangular box 30 cm x 75 cm x 100 cm high, including all decorations.



- B. The model will be designed for a steel ball or glass marble. This means that the steel ball or glass marble when released from the top of the first hill by the judge will travel through the entire ride, and arrive at the bottom loading platform. (Note: for this contest, you will raise the steel ball or glass marble by hand from the loading platform to the top of the first hill to start the "ride".)
- C. A ball must be provided by the team so that it can be tested on judging day. The ball must be either a glass marble or a steel ball that is 1 cm (1/2") in diameter or greater.
- D. Magnets, electricity, springs and other forms of energy may not be used - this is a "gravity ride" only. These other sources of energy can be used for esthetics (i.e., background lighting). No electricity is provided in the contest area.
- E. The starting position at the top of the first hill **must** be clearly marked. The ending position **must** be clearly marked.
- F. Each competing team can have a maximum of 4 students.
- G. **The decision of the judges is final. Any coaster that violates the rules above or the spirit of the competition will be disqualified.**

## TESTING AND JUDGING

Roller coasters will be judged based on the categories below:

- A. Run Time
- B. Technical Merit
- C. Theme
- D. Bonus – Vertical Loops
- E. Deductions

**A. Run Time**

Each model will be entitled to three runs. The longest time to go from the Start position to the Finish will be the official time for that model. The time of a run that fails to make it from the start position to the finish position will not be recorded, and will count as one of the three attempts (runs) allowed. (50 points maximum) A calculation example of points awarded for finish time is given below.

The points awarded for time will be based on the maximum time taken within the grade level (K-5, 6-8 or 9-12). Assume the maximum time was 15 seconds and your coaster took 9 seconds:

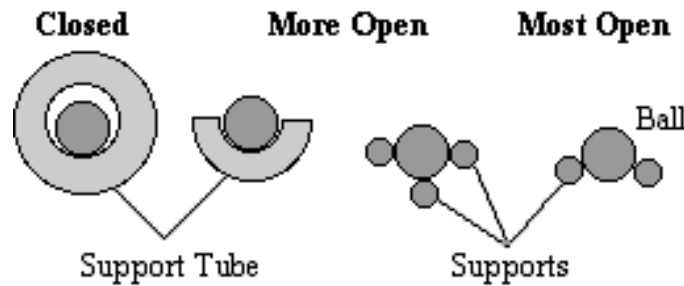
Points = 50 points x (your time / maximum time)

Points = 50 points x (9 sec / 15 sec) = **30 points**

**B. Technical Merit**

**Track Openness**

0-15 points may be awarded for degree of openness of track.



**Performance**

0-10 points may be awarded based on the performance of the roller coaster with the steel ball or glass marble ending in a designated area or container during each run.

Technical merit points will be awarded based on the following rubric:

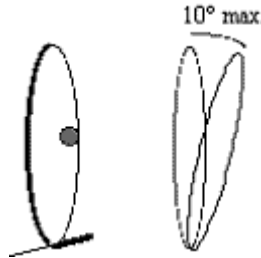
<b>Track Openness</b>	Mostly closed = 0	>25% open = 5 pts	>50% open = 10 pts	>80% open = 15 pts
<b>Performance</b>	Ball does not end in designated area=0	Ball ends in designated area during 1 run=3 pts	Ball ends in designated area during 2 runs=6 pts	Ball ends in designated area during all 3 runs=10 pts

**C. Theme (creativity)**

0-10 points may be awarded based on the theme of the roller coaster.

<b>Theme</b>	No theme = 0	Theme but little follow through = 3 pts	Theme throughout ride = 6 pts	Theme well done throughout = 10 pts
--------------	--------------	---	-------------------------------	-------------------------------------

**D. Bonus points** for technical merit will be awarded for the following:  
**5 points per vertical loop.** Vertical loop is defined as any time the "rider" is upside down on a loop of track that is within 10° of vertical (see illustration). If the vertical loop is a portion of a corkscrew (helix), it counts as a vertical loop. Horizontal loops do not add bonus points.



Bonus Points for technical merit will be awarded based on the following rubric:

<b>Vertical Loops</b>	1 = 5 pts	2 = 10 pts	3 = 15 pts	4 = 20 pts
-----------------------	-----------	------------	------------	------------

**E. Deductions**

**Use of commercially available roller coaster kits, including paper coaster kits, will result in a deduction according to the following rubric:**

<b>Use of Commercial or Paper Kits</b>	Elementary = -15 pts	Middle = -20 pts	High = -25 pts
--	----------------------	------------------	----------------



**Float it**

## FLOAT IT

---

### ENGINEERING DESIGN CHALLENGE

Design and build a boat that travels across a container of water a distance of at least 7 (seven) feet without sinking or capsizing (tipping over).

### CONSTRUCTION SPECIFICATIONS

#### 1. MATERIALS

- A. Each entrant (individual or 2 person team) will receive the following:
  - a. black electrical tape
  - b. 2 wooden paint stirrers
  - c. 2 playing cards
  - d. 2 drinking straws
  - e. 2 rubber bands
  - f. 2 paper clips
- B. Only the specified materials and quantity of materials provided are to be used (EX: the bag the materials are stored in may NOT be used, 3 playing cards may NOT be used, and so on).
- C. The boat **MUST** be made at the event.
- D. No staples, adhesives or tape (except the supplied electrical tape) can be used.
- E. Upon inspection, if the boat is found to be in violation of any of the Construction Specifications the boat will be disqualified and prohibited from racing and the student(s) will forfeit their entry in this event.

#### 2. CONSTRUCTION

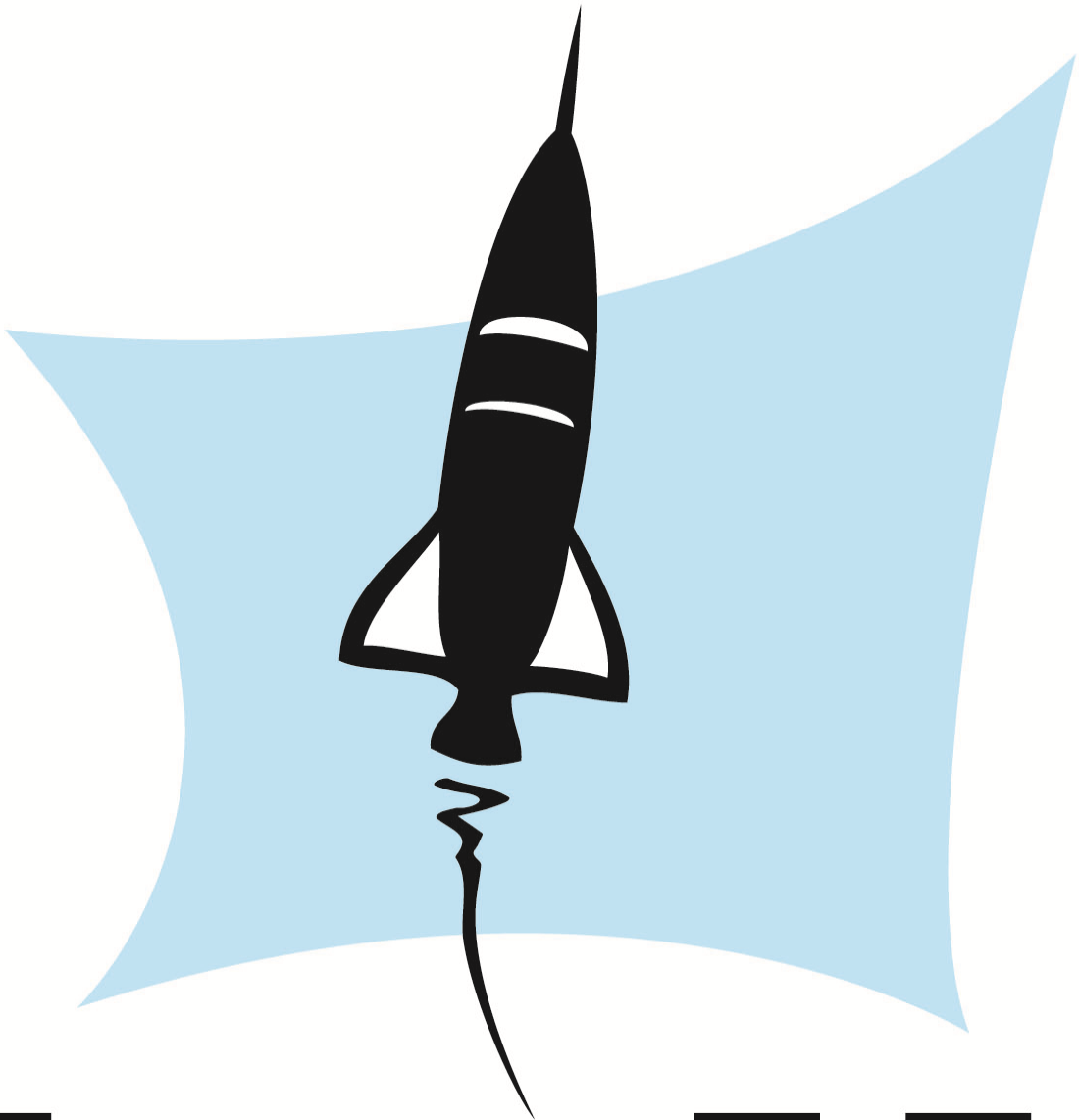
- A. When the group arrives to the Float It event area, each entrant will receive a kit of materials. Upon receiving the kit, the entrants must build their boat within the allotted period of time, have it inspected for qualification by the judges and then wait in line for their regatta race. Changes may not be made after inspection.
- B. All boats must be ready for inspection at the start of each group's regatta race.
- C. The materials may be altered to construct the desired shape. Cuts, holes, rolls, tears, are allowed. Please use caution when breaking wood and using scissors. Tools are not provided, and the Organizers will not assume any liability for personal injury or damage.
- D. The width of the boat must not exceed a maximum of 4 inches (10.1 cm) wide. The length of the boat must not exceed a maximum of 28 inches (71.0 cm, or two 14" paint stirrers end to end) long.
- E. The underwater depth of the boat must not exceed a maximum of 2 inches.

**No test runs are allowed.** Boat buoyancy may be tested in the bins provided.

- F. Entrants are asked to be considerate and clean up after themselves. Please return tape and scissors after construction. Please throw away your garbage in trash cans.

### **TESTING AND JUDGING**

- A. Only one (1) entry (boat) per person/team will be accepted. A maximum of two people per team will be accepted.
- B. Only one (1) attempt to race will be allowed by each contestant.
- C. The boats will be raced in a standard rain gutter that is ten feet long, 4.5 inches (11 cm) wide, and 2.5 inches (6 cm) deep, placed on saw horses or tables, and filled to near the top with water.
- D. Boats will be handed to the judge(s) who will help place them behind the start line and command "Get on your mark, Get set, and Go!"
- E. On the "Go!" command the judge(s) will let go of the boat. The judge(s) will record the travel time for each boat.
- F. Boats will be propelled by 12" desk fans (or comparable) blowing on the sail; **NO** other form of propulsion is allowed.
- G. **NO** direct contact with the boat is allowed after it is released; and will disqualify the boat and individual(s). Boat cannot be touched by hands or similar (EX: blowing on the sail) until the race is over.
- H. A crew has finished the race when the bow of its boat has crossed the finish line between the uprights and over the crossbar.
- I. The judge(s) will record the *travel time for each boat*, which will then be used to calculate the final score. The winning entry will be determined as the boat with the fastest time.  
  
The *travel time* is defined as the time from the moment the boat is released until the bow of the boat crosses the plane of the finish line (between the uprights and over the crossbar).
- J. The judge(s) reserve the right to declare a boat dead in the water after 15 (fifteen) seconds.
- K. The decision of the judges is final. Any boat that violates the rules above or the spirit of the competition will be disqualified.**



**Launch it**

# LAUNCH IT

---

## ENGINEERING DESIGN CHALLENGE

The objective of the contest is to construct a rocket propelled by “fuel” (12 ounces of water) and air compressed to 60 psi that will be launched at a predetermined angle to reach the maximum flight time possible.

## CONSTRUCTION SPECIFICATIONS

### 1. MATERIALS

- A. The pressure vessel **MUST** be one (1) clear 2-liter bottle, see Diagram 1.
- B. **DO NOT** USE metal, glass, or spikes to construct the rocket. **\*USE OF THESE MATERIALS WILL RESULT IN AUTOMATIC DISQUALIFICATION OF YOUR TEAM FROM THE COMPETITION.**
- C. The use of a parachute is **NOT** allowed.

### 2. CONSTRUCTION (Please note, **the construction rules for this competition differ from the rules for the SECME Rocket**)

- A. On the bottom of the rocket, leave 7.5 cm from the throat of the exit plane clear of any covering (fins, markings, drawings, etc.) See Diagram 1.
- B. Maximum total height of the rocket is 76.0 cm. See Diagram 1.
- C. Nose-cone tip must have a minimum radius of 1.5 cm. See Diagram 2.
- D. **Fins must end 7.5 cm from the throat of the exit plane.** See Diagram 1. No forward swept types of fins are allowed to be used on the rocket. The quantity of fins used is up to the design team.
- E. The maximum fin width distance from the bottle is 10.0 cm (or 16.5 cm from center of bottle axis). See Diagram 3. The minimum fin width is up to the design team.

## TESTING AND JUDGING

- A. Teams of maximum of two (2) students and individual student entries are permitted.
- B. Each entry must pass a visual inspection and height requirement in order to be eligible to compete. Entries that fail this inspection will not be permitted to enter the competition.
- C. Only one (1) student per team is permitted to be at the launching pad.
- D. The judge(s) will record the *flight time for each rocket*, which will then be used to calculate the final score.

The *flight time* is defined as the time from the moment the launch button is pressed until the instant the rocket lands on the ground or an object on the ground. This measurement must be taken by at least three qualified judges and the average flight time is the final record. The final score will be calculated as a percentage of the greatest flight time recorded during the competition using the following formula:

$$\text{Final Score} = (\text{Flight time} \div \text{Max flight time}) \times 100\%$$



Diagram 1 – Rocket

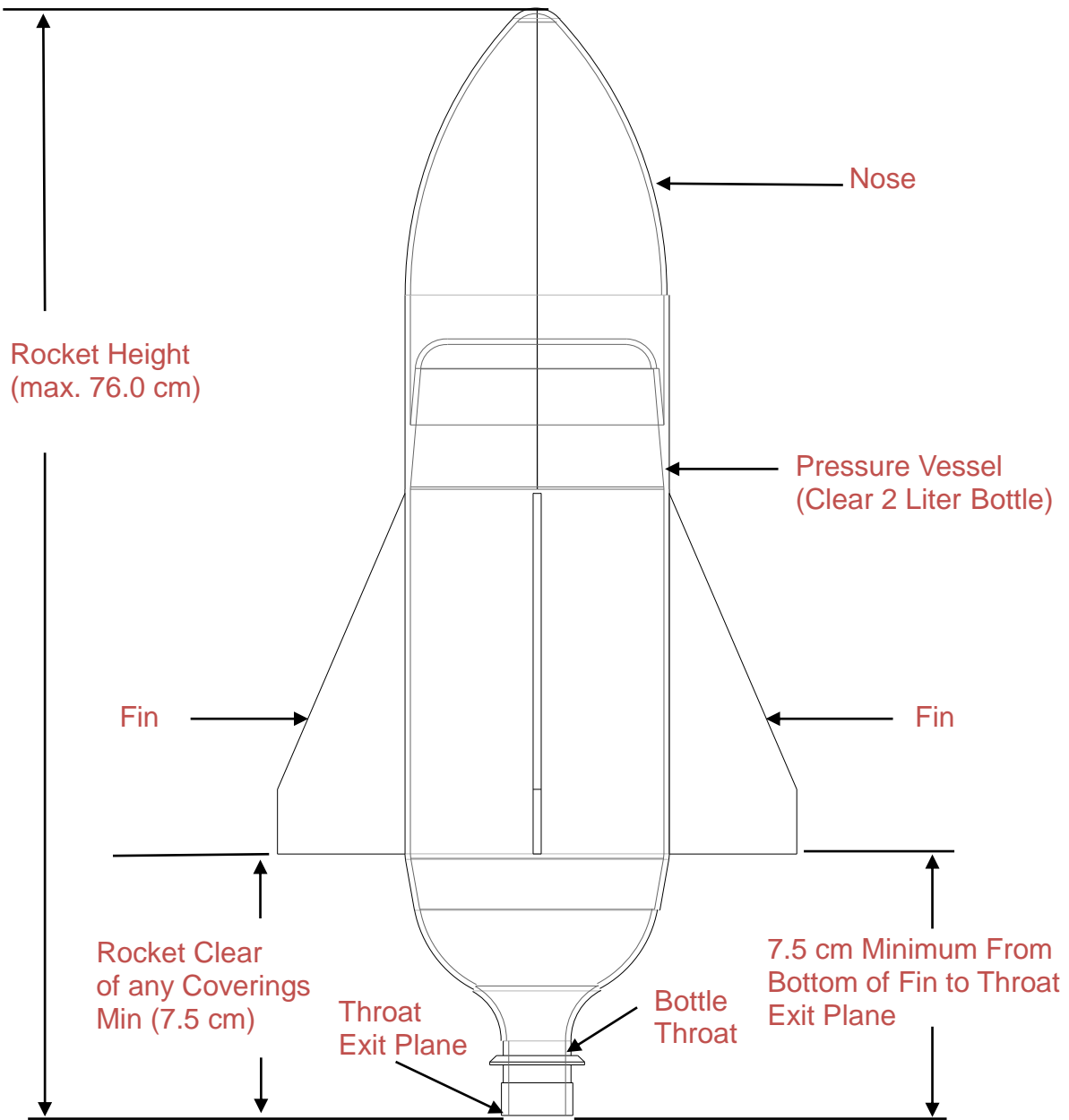


Diagram 2 – Nose Cone Diagram

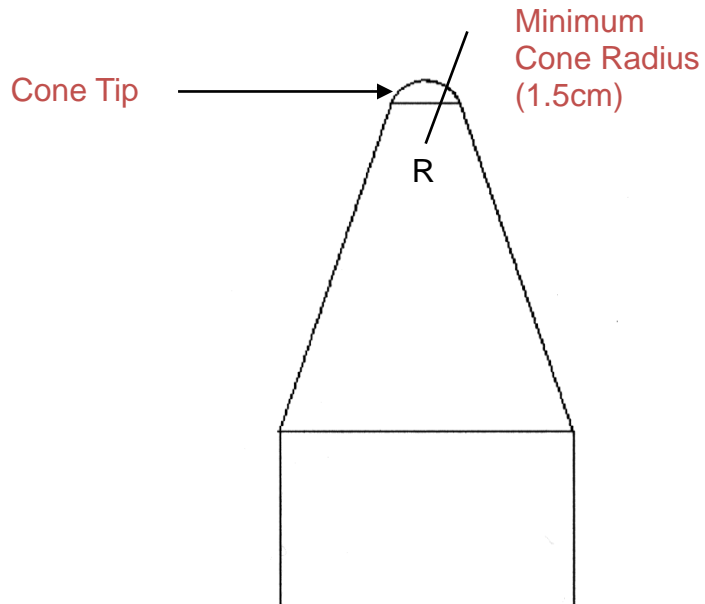
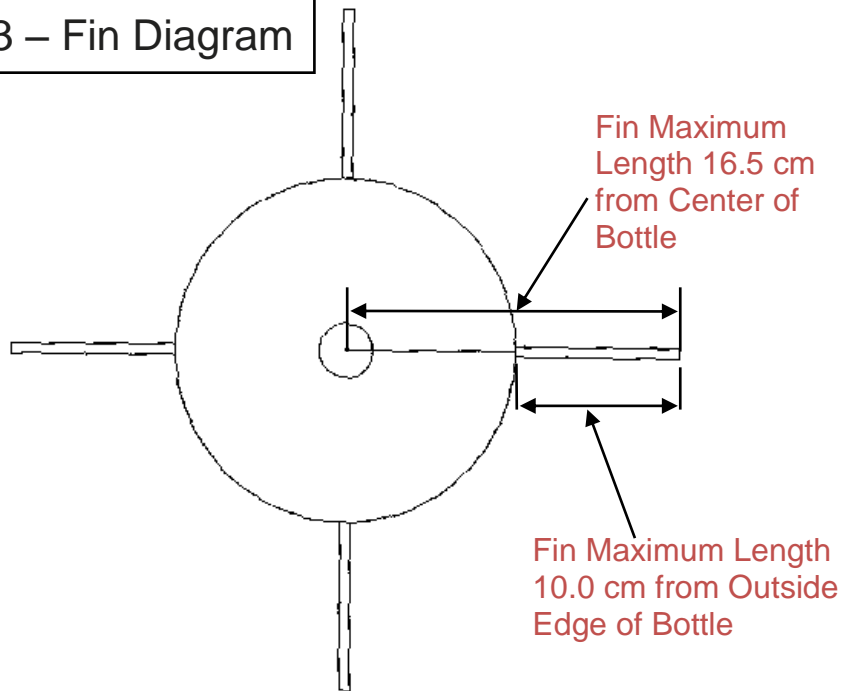


Diagram 3 – Fin Diagram





**Clean it**

## **CLEAN IT**

---

**IMPORTANT: Please note that water filtered by contestants, while it may look clean, is not for safe for human consumption. DO NOT DRINK!**

### **ENGINEERING DESIGN CHALLENGE**

Design, build, and test a water filter to clean non-toxic contaminated water (water that has been mixed with potting soil) and produce the lowest reading of turbidity (measure of how clear or cloudy a fluid is).

### **CONSTRUCTION SPECIFICATIONS**

#### **1. MATERIALS**

- A. The filter must consist of two chambers: the Sump (where clean filtered water collects) and Filter Bed. Each chamber shall be built from a 2-liter, clear plastic soda bottle (see Diagram 1). Both the Sump and Filter Bed must be clear (no tinted 2 liter plastic soda bottle allowed) and be clearly visible. All beverage labels must be removed.
- B. Each separate filtering layer is made up of a different household material, such as food-grade (e.g., bread, rice, oatmeal, crackers, etc.), sand, rock (less than 0.5 inches in diameter), fish tank rock, marbles, charcoal, straw, wood chips, cotton, clay, and silt. Contestants are allowed to use materials not on the list, provided it they are not commercial materials such as chemicals or press made filters.
- C. Each entrant (individual or 2 person team) will receive the following:
  - a. one (1) paper coffee filter, basket style
  - b. one (1) rubber band
  - c. one (1) collection cup (Solo clear 9-ounce cup or similar)
  - d. one (1) 16-ounce bottle of water mixed with 1/3 cup of potting soil
- D. Each entrant **MUST** bring the following:
  - a. pre-cut 2 liter, clear plastic soda bottles
  - b. filter media
- E. The filter **MUST** be made at the event.

#### **2. CONSTRUCTION**

- A. When the group arrives to the Clean It event area, each entrant will receive one paper coffee filter, rubber band, collection cup, and 16-ounce bottle of non-toxic contaminated water to be filtered.
- B. The filter must consist of two chambers: the Sump (where clean filtered water collects) and Filter Bed. Each chamber shall be built from a 2-liter, clear plastic soda bottle (see Diagram 1).

- a. Precut 2-liter, clear plastic soda bottles in advance. Please use caution when using scissors and knives. Tools are not provided, and the Organizers will not assume any liability for personal injury or damage. Also, **DO NOT DRINK THE WATER!**
  - b. To build the Sump, cut the top off of a 2-liter, clear plastic soda bottle.
  - c. To build the filter bed, cut off the bottom of a 2-liter, clear plastic soda bottle and attach a coffee filter on the cap end with a rubber band.
  - d. Insert the filter chamber (cap end) into the sump. Sump and filter chamber should be free standing and need no outside support to remain upright in operation (see Diagram 2).
- C. The filter bed chamber can be made of up to four (4) filtering layers; four maximum, no minimum.
  - D. The total depth of the filter must be a maximum of five (5) inches, with each layer at least one (1) inch deep.
  - E. Each filter layer in the Sump must be clearly labeled with the type of material (IE: "SAND") printed in black Sharpie marker. Both the Sump and Filter Bed must be clear 2-liter bottles (all labels removed, except contestant's name).
  - F. **The Filter Bed and Sump must be labeled with the contestant's full name printed in black Sharpie marker.**
  - G. Entrants are asked to be considerate and clean up after themselves. Please dispose of garbage and filters properly in trash cans.

## TESTING AND JUDGING

- A. Only one (1) entry per person/team will be accepted. A maximum of two people per team will be accepted.
- B. Contestants will present their filter materials to the judges for inspection and approval prior to beginning assembly of the filter. Materials which are not suitable (see MATERIALS, Section B) may not be used.
- C. Contestants will have 5 minutes to assemble the filter in front of the judges. Contestants will hear "Ready, Set, Go!" and on the "Go!" command the judge(s) will start the time and give a time remaining warning. At the end of 5 minutes judge(s) will call out "Stop!" where all contestants must take their hands off the filters.
- D. Contestants will have 10 minutes to produce at least 3 ounces of treated water to be tested. Contestants will hear "Ready, Set, Go!" and on the "Go!" command the judge(s) will start the time and give a time remaining warning.
- E. Multiple filtration passes are allowed. Contestant may attempt as many passes as 10 minutes allows, but must produce sufficient filtered water in the collection

cup for testing (minimum 2 inches in collection cup, or 3 ounces). Please hold sump over filter while pouring sump water back into filter. Only contents of sump may be returned to filter before filter is securely nested back in sump. No spillage may be added.

- F. At the end of 10 minutes judge(s) will call out "Stop!" where all contestants remove their filters from the sump and take their hands off the filters. No direct contact with the filtered water in the collection cup is allowed after time is called; and will disqualify the filter and individual(s).
- G. TEST #1 Hach 2100P Portable Turbidity meter, or similar equipment.
- H. The judges(s) will record the turbidity for each filter. The winning entry will be determined as the filter with the lowest turbidity reading (measure of how clear or cloudy a fluid is). In the event of a tie, the filter that produces the largest volume of water wins.
- I. **The decision of the judges is final.**

**HINTS:**

The following links may provide useful information regarding water filtration:

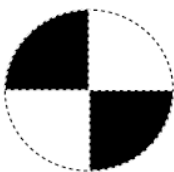
- [http://www.epa.gov/ogwdw000/kids/flash/flash\\_filtration.html](http://www.epa.gov/ogwdw000/kids/flash/flash_filtration.html)

-

[https://www.ideo.columbia.edu/edu/k12/snapshotday/activities/Turbidity\\_small\\_tube\\_final.pdf](https://www.ideo.columbia.edu/edu/k12/snapshotday/activities/Turbidity_small_tube_final.pdf)

Newspaper Test: Place the collection cup in front of or on top of a newspaper article, and look down. If the large black print letters of the headline can be read, the water is less than 30 JTU (Jackson Turbidity Units).

Secchi Disk Test: Water turbidity test with Secchi Disks: Place the collection cup in front of the turbidity chart, and look horizontally through. Match the circle seen through the water to one of the surrounding secchi disks (black and white circles).



0 JTU



20 JTU



40 JTU



60 JTU



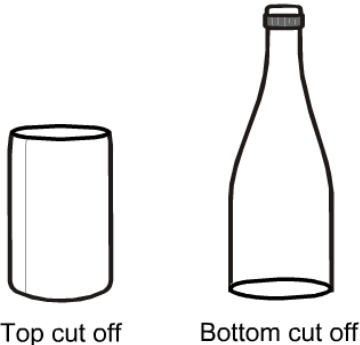
80 JTU



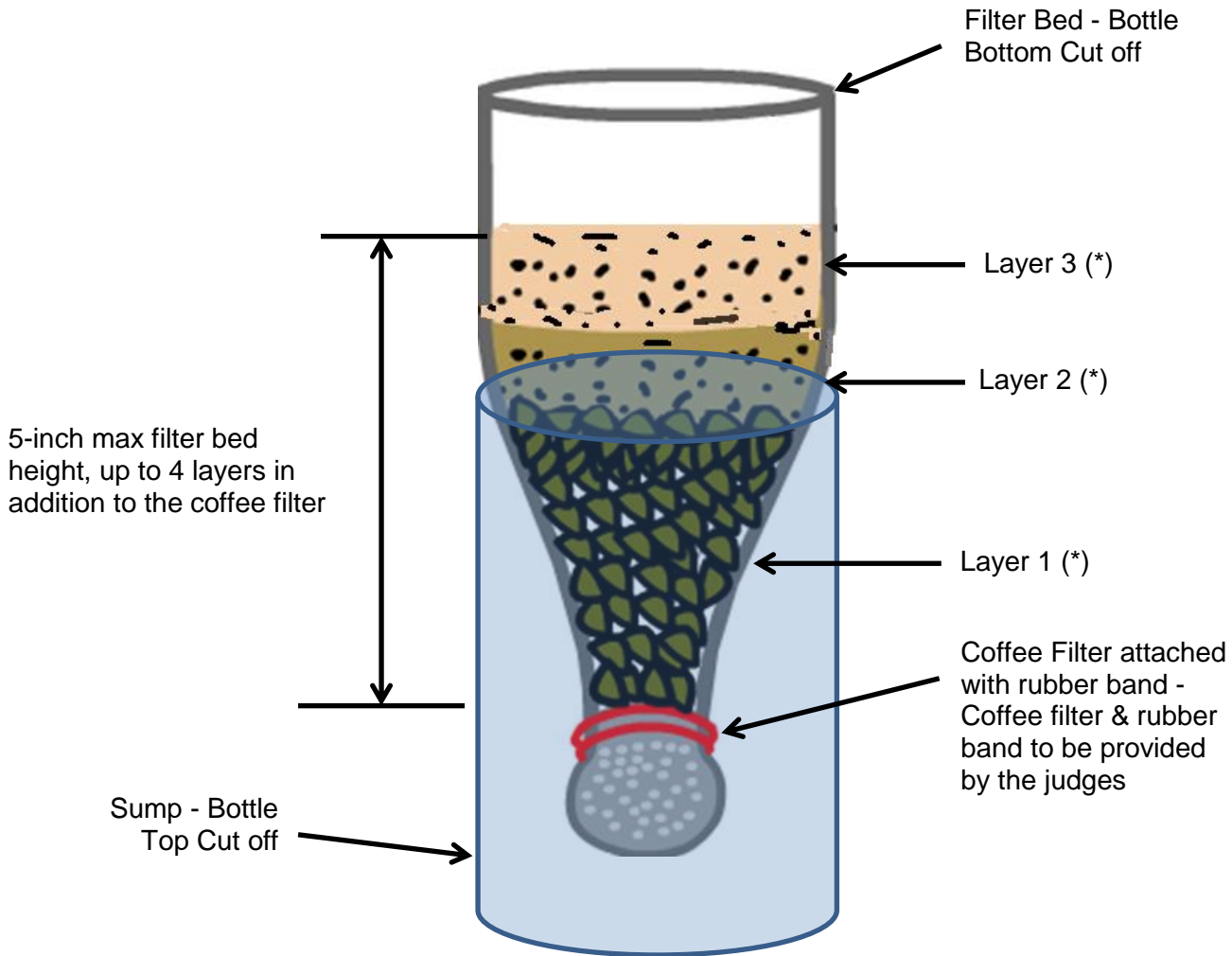
100 JTU

## Diagram 1- Chamber Diagram

Two 2 liter, clear plastic soda bottles, one with its top cut off (sump) and one with the bottom cut off (filter bed).



## Diagram 2- Filter Diagram



(\*) Each layer must be labeled (e.g., sand) . Minimum layer depth = 1 inch.