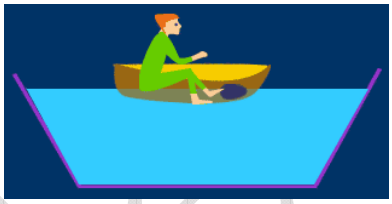
Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

1. Raft Rally

GOAL

The goal of raft rally contest is to understand the concept of buoyancy and apply it to the design of a mini boat that can hold the maximum load.

BACKGROUND



Buoyancy forms when an object is placed in a medium with a lower density. How the buoyancy works for a boat floating in water as shown? A large boat is usually made of metals, much denser than water. It nevertheless floats because its submerged part is mostly hollow and its total density gets lower than that of the surrounding water. The greater volume of water is pushed out underneath the ship, the stronger the buoyant force becomes.

DESCRIPTION

In this contest, you will build a boat using aluminum foil. Remember what we have learned in the above about the buoyant force, and, based on it, design your boat so that it can hold the maximum weight until it sinks.

Use the materials listed below to build a raft. The raft will be tested by floating the raft and adding the mass. Your score is given by the maximum number of pennies that your raft supports.

MATERIALS

To be specified at the time of contest.

DESIGN RULE AND TIPS

- You will be allowed 20 minutes to build your raft.
- If you need another piece of foil, you will be allowed one replacement only.
- Do not cut the aluminum foil. Keep it mind that you do not have any glue or tape.
- Remember that aluminum foil is not as hard as it sustain the shape when loaded.

EVALUATION

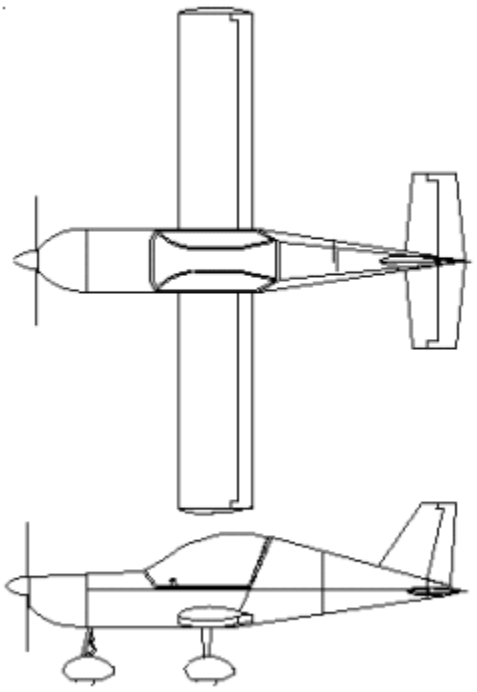
- Before testing, all rafts will be collected and no change will be allowed after that.
- At the beginning of the test, you have to load a bag of 100 or initial number of pennies on your raft. You can load it any position you want on your raft.
- After that, you may add pennies one by one at a time in any pattern you want.
- When it appears that the raft is nearing its maximum load, you may be asked to wait a few seconds between adding pennies.
- At the point that any amount of water enters the raft, your turn is done.
- You cannot dump pennies in the raft at the last minute-the violation will disqualify your score!
- You will receive one point for each penny held up to that point. The last penny added to the boat (the one that made it sink) is not counted.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

2. Airplane Flying (Rubber Band Powered)

OBJECTIVE

Design a rubber band-powered airplane to fly as far as possible.



DESCRIPTION

Each contestant builds a hand-launched, rubber band-powered airplane using only the materials listed below. Students will hand-launch their airplanes and will be evaluated based on the flight distance.

RULES

- Build an airplane (any shape) within 60 minutes.
- The length of your plane body must be ranged from 30 cm to 50 cm (from the front to the tail).
- Your plane must have at least two major wings with a main body. No problem in design with more than 2 wings.
- No rocket design: The length of the two major wings must be more than two third (2/3) of the main body (Example: If the length of the main body is 30 cm, the sum of the two major wings must be more than 20 cm in the length from the one side end to the other side end.).
- You don't have to use all of the materials.
- Any cheating (talking, copying, fixing after construction period, etc.) will disqualify students from competition.
- No questions will be answered for the sake of fairness.
- Don't forget to write down your name and registration number on your plane.

MATERIALS & TOOLS

To be specified at the time of contest.

EVALUATION

- Each student has two chances to get his or her best distance. The best result out of two (2) attempts will be counted as your score.
- Airplanes that reached the farthest distance will win the prize.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

3. Airplane Flying (Hand Powered)

OBJECTIVE
Design a hand-launched airplane to fly as far as possible.

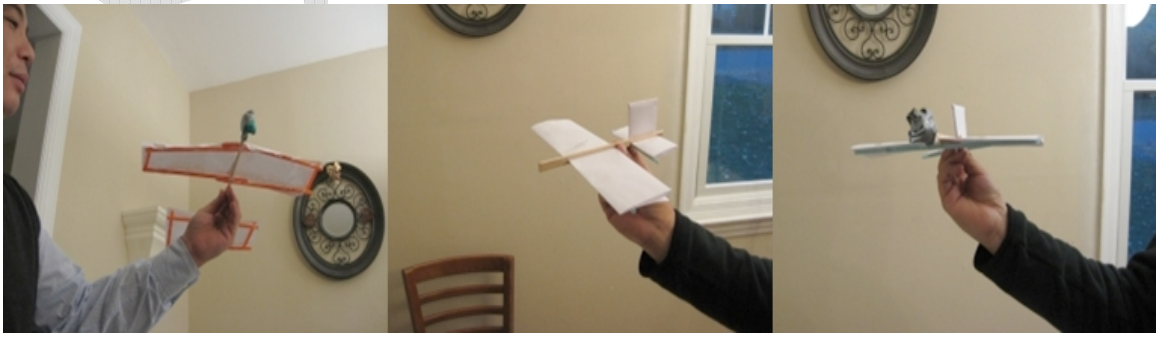
DESCRIPTION
Each contestant builds a hand-launched, using only the materials listed below. Students will hand-launch their airplanes and will be evaluated based on the flight distance.

MATERIALS & TOOLS
To be specified at the time of contest.

DESIGN RULE AND TIPS
1. Build an airplane (any shape) within 50 minutes.
2. Your plane must have at least two major wings with a main body. No problem in design with more than 2 wings.
3. No rocket design: The length of the two major wings must be more than two third (2/3) of the main body (Example: If the length of the main body is 30 cm, the sum of the two major wings must be more than 20 cm in the length from the one side end to the other side end.).
4. You don't have to use all of the materials.
5. Any cheating (talking, copying, fixing after construction period, etc.) will disqualify students from competition.
6. No questions will be answered for the sake of fairness.
7. Don't forget to write down your name and registration number on your plane.

EVALUATION
1. Each student has two chances to get his or her best distance.
2. The best result out of two (2) attempts will be counted as your score.
3. Airplanes that reached the farthest distance will win the prize.

SAMPLES



TIP
To have a good flight performance, the nose of the airplane should have adequate amount of weight.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

4. Egg Drop

GOAL

You will construct a device to hold an egg and drop it from a certain height toward a target on the ground. You don't want the egg to break, but the device should have the least amount of mass and shortest dimension, and land as close to the target as possible.

MATERIALS & TOOLS

To be specified at the time of contest.

RULES

- Devices may be of any shape. See, however, our guide for design in the below.
- Briefly describe your design concept within 100 words, on the back of this sheet, possibly including your own drawings.
- Judges will check the survival of the egg (E=1 if unbroken or E=0 if broken) and measure the length (L), weight (W) of the device, and the distance (D) of the egg to the target. The score will be given according to

$$\text{score} = \frac{100\,\text{gm}}{W} \times \frac{30\,\text{cm}}{L} \times \frac{3\,\text{ft}}{D} \times E$$

where W excludes the mass of egg and L is the maximum dimension of the device in any direction measured after the drop. D is measured in reference to the egg.

DESIGN GUIDE

Contestants can freely choose *any* style of design. Three types are described in the below only for the purpose of guidance. Remember, however, that the most spectacular design can also win one of the prizes regardless of the egg integrity factor. Either any combinations of these or other extreme variations (e.g., cushion or UFO style) will also be welcome.

Type	Box 	Dart 	Parachute 
Pro	-Simple to build -Light & compact	-Target pointing -The tip absorbs impact of landing	-Best protection for eggs -Light, although not compact
Con	-Poor egg-protection -May bounce away from the target if too compact	-Can be very long -Amount of materials and time	-Lengthy -Poor pointing -Possible risk of folding

EVALUATION

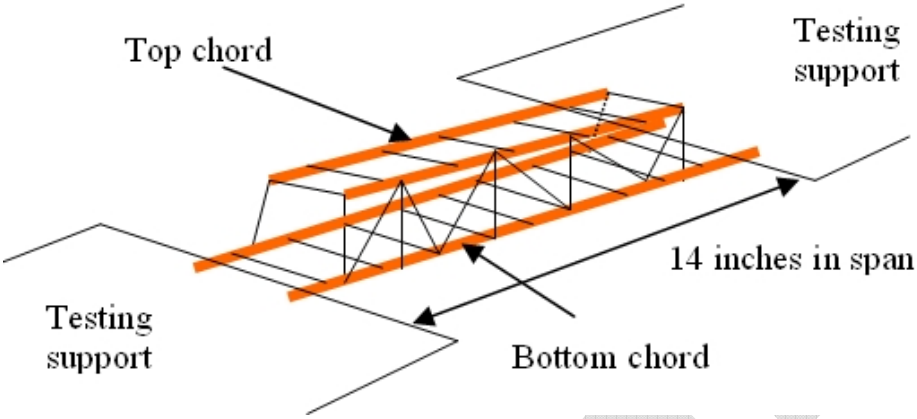
The devices with the top three highest scores will win the 1st -2nd -3rd prizes. Besides, the most innovative device in each grade, as determined by the judges, will win the incentive prize regardless of E.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

5. Bridge Building

OBJECTIVE

Design and build a bridge as light as possible and capable of holding the greatest weight, while complying with the specific rules listed below.



RULES

- Finish within 90 minutes.
- You can use given materials any way you want: bending, cutting, bundling together, connecting, etc.
- No restriction on bridge height.
- The width of the deck (inside measurement) should be greater than 3 inches.
- The length of the bridge (span) should be greater than 14 inches so that the bridge shall lie flat on the testing supports, which are 14 inches apart.
- The bridge must allow a tennis ball to pass from one end to another end.
- The bridge should have an unobstructed opening at mid-span (in the middle) to allow the loading mechanism access to the bridge deck for the testing.
- You do not have to use all the materials provided.
- You must build both top and bottom chords for your bridge.

EVALUATION

- The bridge will be placed in the test apparatus with both ends of the bridge resting on a horizontal support, and a load block (about 1.5” x 6” x 0.75” in dimension) will be placed at mid-span to apply the load with sand and others.
- The maximum load will be recorded.
- The bridge that passes all specifications and supports the largest load will win the contest.

MATERIALS & TOOL

To be specified at the time of contest.

NOTE

Describe and draw your idea how you designed it on this sheet and return it along with all materials left over. The description will be used to break the tie scores.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

6. Tower Building

GOAL

Design and build the highest tower that supports a standard load (2.5lb) under certain constraints on material and geometry.

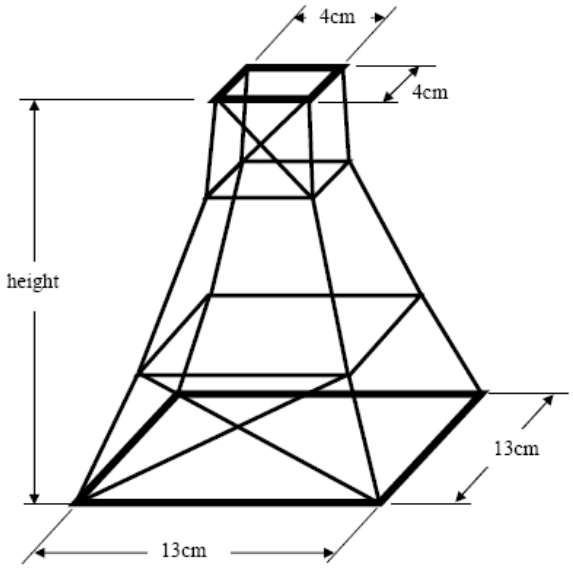
MATERIALS & TOOLS

To be specified at the time of contest.

RULES AND EVALUATION

1. You will be allowed 50 minutes to build your tower.
2. The shape of base can be either triangle or square. The length of each side should be at least 13- cm.
3. The shape of tower top also can be either triangle or square and the length of each side should be at least 4-cm.
4. Submit the tower and this sheet showing your design concept.
5. The highest tower that sustains the imposed weight will win.

DESIGN ISSUES



1. Design is important. First of all you should think of a design and draw it out. An example is shown to the left.

2. A four-legged tower is easier to build but may not be as efficient. A three-legged tower is efficient but difficult to build, as the angles aren't nice and neat.

3. The bracing is the part that towers are won and lost by. It depends on the type of leg design you use. In the three-legged design, a bracing strip needs to be angled two ways, whereas in a four-legged design it's only one.

4. Also, with the bracing, equality is of high importance. If balance is off and the weight is not distributed equally it may fail to support a heavy load.

EVALUATION

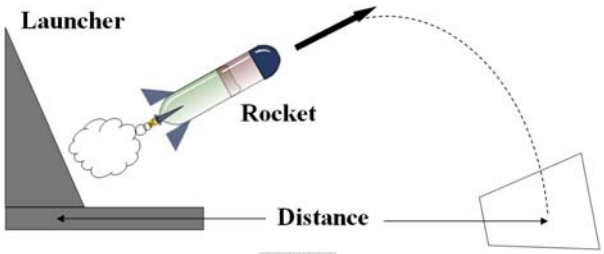
- Upper and lower opening should meet the given constraints.
- Height will be measured while the tower sustains the imposed weight.
- All towers will be photo-taken for design evaluation.
- Criteria for design winner include symmetry, straightness, and tidiness, etc.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

7. Water Rocket

OBJECTIVE

Design and construct a rocket using a plastic soda bottle as pressure chamber and supplied materials for nose and fins. The maximum flight distance will win this contest. However, the rocket must not deviate from a designated area. This means that the rocket should have both maximum propulsion and a good guidance system.



MATERIALS

To be specified at the time of contest.

TIPS

Water rockets consist of four major parts: nose, body, fins, and nozzle. You can design, build, and attach ***the nose and fins only*** without altering the body. The nose and fins are the guidance system for your rocket that can increase aerodynamic stability to achieve better flight. Don't be afraid to be creative in designing the nose and fins. Finally the design and the amount of water of your choice will determine the performance of your rocket flight. Be sure to take some time thinking out the design of your rocket before committing to a plan of action.

DESIGN RULES

1. Finish building the rocket within 50 min.
2. The body (including the bottle neck) should not be modified. Especially don't poke a hole or make a crack in the bottle for safety.
3. Build the nose and fins using the material supplied. Use scissors to cut out the boards.
4. Any fins or other attachments must not extend too low from the mouth, so that we can fit it in our launcher.
5. Finally attach the name tag to the rocket body.
6. The initial acceleration is great enough to rip off casually attached articles. So please, in the interest of safety, make sure all attachments (e.g. fins) are securely affixed to the rocket. Use of duct tape is highly recommended as the main type of fastener.
7. Try to make the design durable enough for two or three launches to allow a re-shoot in case of a tie.

LAUNCH RULES

1. Submit the finished rocket and this exam sheet to instructors. Don't forget to put your name tag firmly. The tag should show your name, ID, and the water amount percentage.
2. Once a rocket has been presented and approved for competition, nobody should be stand near the launcher. Lower your body whenever rockets launch.

Korean-American Scientists and Engineers Association
National Mathematics and Science Competition

8. Water Rocket with Parachute

GOAL

Construct a bottle rocket with parachute that can be aloft for the maximum time.

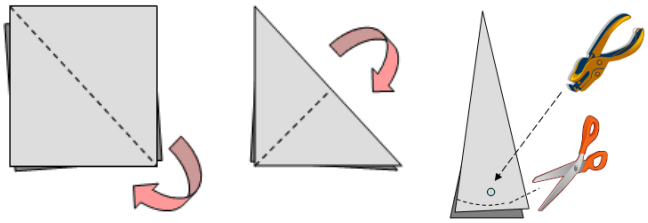
MATERIALS & TOOLS

To be specified at the time of contest.

PROCEDURE

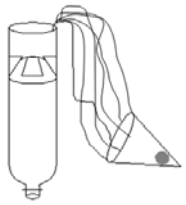
1. Design your rocket.
2. Make the parachute deployment system and attach it to the rocket.
3. Attach nose and fins to the bottle. Finish all these within 50 min.
4. Put a name tag that shows your name and the amount of water.
5. Submit it to instructor and watch the performance of your rocket.

A. Make the parachute



Lay down the vinyl sheet on a flat surface and smooth it out. > Fold it in half along the diagonal axis. > Continue to fold it a few times more. > Cut the base of the triangle to the desired chute size (radius). > Punch holes through the parachute and tie the shroud lines to the holes.(*Tip*: A good parachute has shroud lines that are at least as long as the diameter of the canopy.)

B. Attach the parachute to the rocket body

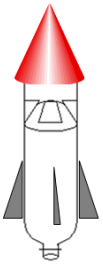


Create a fuselage (a place to store the parachute).

Attach the completed chute inside the fuselage.

Tip: Pack the parachute loosely so that it can be easily deployed at the highest point of the rocket trajectory.

C. Finish rocket by attaching the nose and fins



Build the nose and fins using the material supplied.

Any fins or other attachments must not extend too low from the mouth, so that it can fit into our launcher.

Neither alter the bottle neck nor poke a hole or make a crack in the bottle for safety.

EVALUATION

Same as #7 except that this is a maximum time aloft contest. The parachute deployment will be an important factor for your rocket's performance.