THE THIRTY-EIGHTH UBC PHYSICS OLYMPICS RULE BOOK

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Department of Curriculum and Pedagogy (Science Education Group)
Department of Physics and Astronomy

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General Rules

Each school may enter one team of students, which participates in all 6 events. A team may have a maximum of 15 registered students, of which at most 5 can participate in a given event. Events are designed so undersized teams are not penalized. Each event is run in 6 heats lasting about 1 hour each. There is a break for lunch (not provided, but the Student Union Building is across the street from the Hennings Building). Gold, Silver, and Bronze medals will be awarded to the members of the top teams in each event. Plaques will be awarded to the schools with the top 6 combined scores, and a traveling trophy will be awarded to the top school.

The combined score of a team is the sum of their decibel scores in the 6 events. The schools are ranked by their score in each event, and the decibel score for the event is $\mathrm{dB} = 10 \times \log_{10}(\mathrm{rank})$. Thus a first place ranking in an event is 0 dB, second is 3.01 dB, fifth is 6.99 dB, tenth is 10 dB, twentieth is 13.01 dB. The overall winner is the school with the lowest total decibel score.

Interpretation of Rules

Normal physics interpretations will be applied to all the terminology used in defining the challenges. Those solutions which, in the opinion of the event judges, do not comply with the spirit and intent of the rules will be disqualified from the event (and thus ranked last for the event). The ruling of the event judges is final.

Pre-Build Events

There are two events which require the teams to design and build devices before the event. Pre-built devices will be checked into a storage room until required for a heat. Modifications are not allowed after arrival, except for repairs of damage sustained in transit.

The pre-built events are intended to be learning experiences for the students, so we ask that team coaches resist the urge to overly involve themselves in the design and construction.

Winning solutions will typically push up against the limits of the rules, but violating the rules will result in disqualification. To avoid this disappointment, teams are encouraged to contact the Physics Olympics organizers for a preliminary evaluation about whether their design is within the rules. However, the ruling of the event judge about the legality of a pre-built device at the time of the competition is final, and overrides any preliminary evaluation.

Please direct inquiries about the rules to Prof. Thomas Mattison, preferably by email to mattison@physics.ubc.ca or by telephone 604-822-9690.

1. Elastomer-Powered Aircraft

Your goal is to construct the heaviest aircraft that can remain airborne for at least 15 seconds, powered exclusively by the elastic energy stored in an elastomer (e.g., rubber).

Your aircraft must be constructed using only elastomer, wood, tissue, paper, cardboard, drinking or stirring straws, paper clips, crafting beads, clothing buttons, glue, and adhesive tape. You may lubricate your elastomer with Armor-All etc. You may not use an aircraft kit, or parts from a kit.

Your aircraft must be delivered to our storage area in a box with dimensions not exceeding 80 x 80 x 80 cm. Just before your heat, you will pick up the box and carry it to the Hebb Theatre Aerodrome.

We will weigh your aircraft just before your flight. After the weigh-in, you will have 3 minutes to prepare your aircraft for launch. You may assemble, adjust, and/or wind up your aircraft during this time. Pre-winding is allowed, but failures of your locking mechanism or elastomer are your responsibility. You may not push your aircraft. No external launch-assist devices are allowed. Your aircraft may not intentionally jettison any components during launch or flight.

You will release your aircraft from rest on a 105 cm by 240 cm table, aimed in the direction of your choice. There is a row of desktops on the sides of the launch table, 45 cm below the top. There is a row of desktops from 28 to 66 cm forward of the launch table front and 76 cm below the launch table top. The next row of desktops is from 113 to 150 cm forward of the launch table front and 101 cm below the launch table top. The next row is 189 to 226 cm forward and 127 cm below. The desk rows curve around the front podium area. The front wall is about 13.5 meters from the launch table, and the side walls are about 8.5 meters from the launch table, converging toward the front.

Your air time starts when the aircraft becomes airborne, and ends when the aircraft touches the ground, ceiling, or any obstruction. The winning aircraft is the heaviest one that remains airborne for at least 15 seconds. Aircraft that do not remain airborne for 15 seconds will be ranked by duration (longer is better), below all aircraft that do remain airborne for 15 seconds. There is no penalty (but no advantage) for durations longer than 15 seconds.

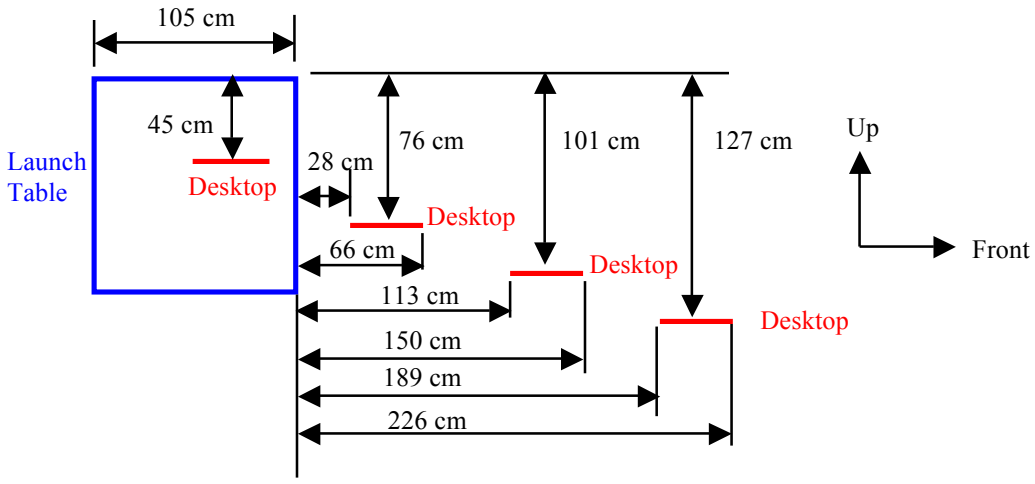

Figure 1: Side View of Launch Table and Desktops

Figure 2: View of Launch Table from Front of Aerodrome

2. Mousetrap Rice Harvester

Your goal is to build a device that can collect the maximum amount of rice, using the energy from a mousetrap.

The rice field is a 75 cm square area bounded by 38 mm (1.5 inch) walls and filled with dry white rice to a depth of 10 mm.

Your device must fit inside the 75 cm by 75 cm field, and be no more than 75 cm high. Your device may not exceed 5 kg in mass before harvesting. Your device must have a hook on top for weighing and for placement into the rice field. You may not anchor your device to the rice field. Your device may not damage the rice field or contaminate the rice. The harvested rice must be recoverable from your device and uncontaminated.

Your device will be driven exclusively by one Victor-brand mousetrap (46x98 mm, available at Safeway and other stores), with the original spring. No additional mechanical, potential, pneumatic, hydraulic, electrical, chemical, nuclear, zero-point, dark, or other energy source may be used, including extracting energy from the action of being lowered into the rice field or being raised out of the rice field.

We will attach a string to your hook and lower your device vertically into the rice field. You will trigger the mousetrap, and your device will harvest rice and store it internally. When activity ends, we will raise your device vertically with the string, and weigh it again to determine the amount of rice that was harvested. Rice that spills out during the removal and weighing process does not count as having been harvested.

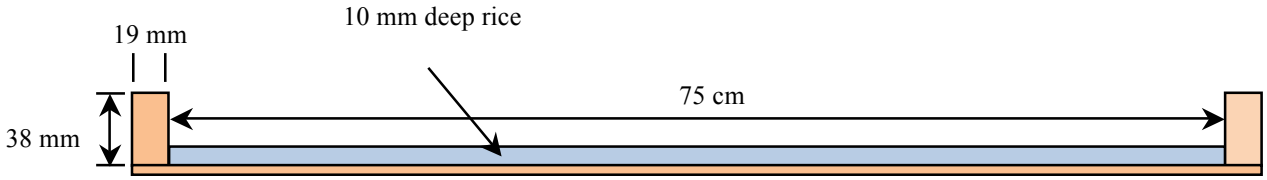

Figure 3: Cross Section of Rice Field

Figure 4: Victor-brand mousetraps.

3. Pulleys Lab

A laboratory-based event involving pulleys. Heats (except the last) will be closed to all persons except the participants.

4. Mystery Lab

A laboratory-based event. To preserve the mystery, heats (except the last) will be closed to all persons except the participants.

5. Quizzics!

Team members will work together to answer questions about physics and astronomy. Questions may involve mechanics, waves, electricity and magnetism, optics, fluids, "modern" physics, famous scientists, or the history of science. Some questions may involve short calculations. Use of cellphones or other wireless devices will result in disqualification.

All teams will participate in the preliminary Quizzics! heats. Questions are in multiple-choice format and each team will answer using an electronic "clicker." Consultation between team members is allowed. The same questions will be used in each preliminary heat, so these heats (except the last) are closed to all except the participants.

The teams with the highest scores in the preliminary heats will meet in the public round of Final Quizzics! using a buzzer system. Each question will be answered by the first team to buzz. The correct answer (indicated by holding up a letter card) is worth 1 points, an incorrect answer (or failing to hold up a card within 5 seconds) loses 2 points, for the first question. For the second question, a correct answer is worth 2 points, and an incorrect answer loses 3 points. For question N, a correct answer is worth N points, and an incorrect answer loses N+1 points. The winner is the team with the maximum number of Final Quizzics points.

6. Fermi Questions

The great twentieth century physicist Enrico Fermi was famous for being able to estimate anything to within a factor of ten. Examples of "Fermi Questions" are:

- What is the total mass of the students competing in the Physics Olympics today?
- How many litres of gasoline are consumed in Greater Vancouver each year?
- How many molecules of air are there in this room?

For more examples, look on the web. These were taken from
http://www.physics.uwo.ca/science_olympics/events/puzzles/fermi_questions.html

Answering a Fermi question in physics requires common sense understanding, knowing the order of magnitude of key constants of nature and physical parameters, and the ability to do approximate calculations quickly.

Your team will be given a number of Fermi Questions to answer using only pencil and paper and your own knowledge. No notes, tables, or books are allowed. No calculators, computers, tablets, cellphones, or other wireless devices are allowed. Since there will be a substantial number of questions to answer and only a limited time to answer them, speed and teamwork will be important. Your written answers will be graded for accuracy appropriate to the questions. Your answers must include appropriate units, in the SI (MKS) system. The same questions will be used in each heat, so these heats (except the last) are closed to all except the participants.

Many physicists pride themselves on knowing various constants of nature and physical parameters to at least one decimal place. Parameters that may be needed, to this accuracy, include but are not limited to:

the speed of light
Planck's constant
Boltzmann's constant
Avogadro's number
the mass of the electron
the mass of the proton
the charge of the electron
the constant in Coulomb's Law
the constant in Newton's Law of Gravity
the acceleration of gravity on Earth
the radius of the Earth
the distance to the Sun

Addendum

In order to prevent damage to pre-build devices, no contestants or coaches will be allowed into the device storage area. Your devices must be in boxes displaying your school name.

1. Elastomer-Powered Aircraft

A. The phrase "You may not use an aircraft kit, or parts from a kit" prohibits use of commercially fabricated parts, e.g., propellers, from any source whatsoever, of any material.

B. Lighter than air gases are not on the allowed materials list, and would in any case result in a negative weight, contrary to the goal of the largest weight that can stay airborne for 15 seconds.

C. Your aircraft may not propel itself using the edges of the launch table.

D. It is permissible to unfold or assemble your aircraft from components that fit into the box, as part of the 3 minute launch preparation time.

2. Mousetrap Rice Harvester

A. In order to be sure that only mousetrap energy is used to harvest rice, and not energy from lifting your device from the field, the mousetrap energy must be fully expended before your device is lifted. You are responsible for making sure that your harvester does not "jam."

B. You should allow for up to 20° of rotation while being lowered into the rice field.