THE THIRTY-SECOND UBC PHYSICS OLYMPICS RULE BOOK

March 6, 2010

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The UBC Physics Olympics is organized by the Department of Physics and Astronomy with assistance from the Department of Curriculum & Pedagogy (Science Education).

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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 10 registered students, of which at most 5 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, with approximately 10 schools participating in each heat. There is a break for lunch (not provided, but the Student Union Building is across the street from Hennings). Gold, Silver, and Bronze medals will be awarded to the members of the top teams in each event. A trophy will be awarded to the school sponsoring the team with the best combined score.

The combined score of a team is the sum of their decibel scores in the 6 events. The schools are sorted by score in each event, and the decibel score of each school 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 decibels.

Interpretation of Rules

Normal physical 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 challenge will be disqualified from the event (and thus ranked last). The ruling of the event judges is final.

Pre-Build Events

There are two events which require teams to design and build structures before the event. It is the responsibility of each team to package their structure for transportation to the competition without damage. Pre-built structures will be checked in on arrival and safely stored 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 at any time 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 structure at the time of the competition is final, and overrides any preliminary evaluation.

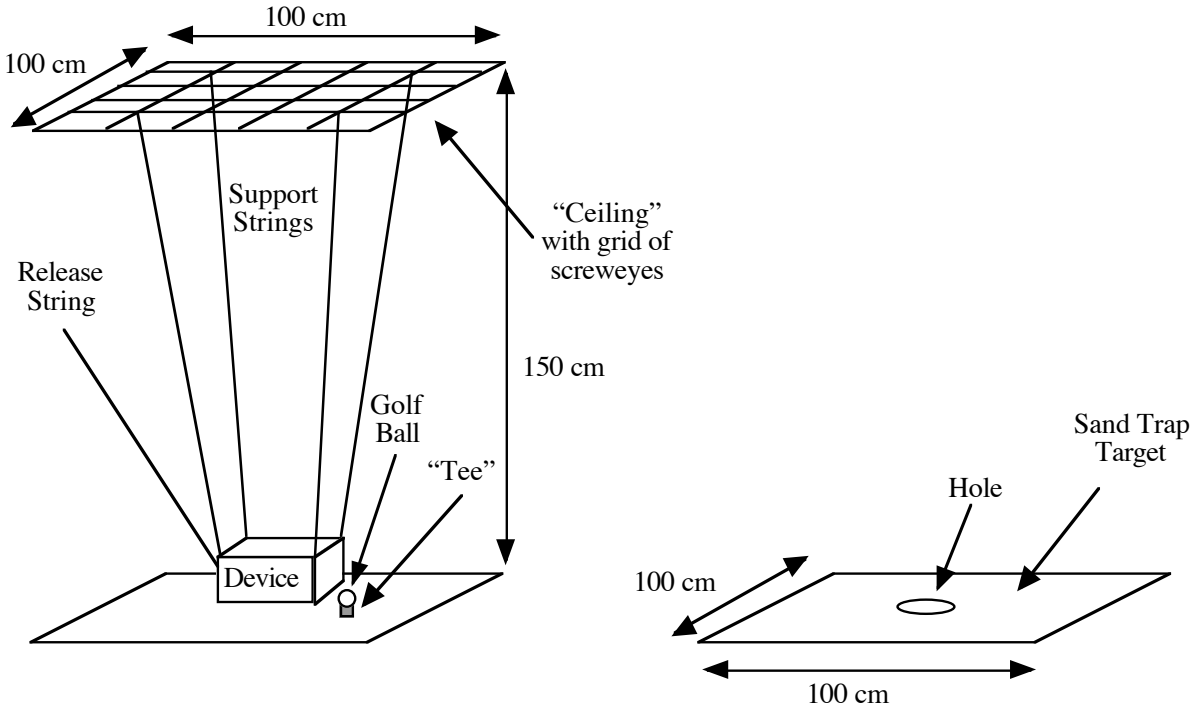
Please direct inquiries about the rules to Prof. Thomas Mattison, preferably by email to mattison@physics.ubc.ca or telephone 604-822-9690 (day) 604-224-3049 (evening).

1. Pendulum Golf

The goal is to build a pendulum device to drive a golf ball toward a hole, using only gravitational potential energy from the weight of your device.

Your pendulum device will be suspended from a 100 cm x 100 cm "ceiling" located 1.5 m above the "floor". The ceiling has 36 screw eyes on a 20 cm grid. You may use any number of strings and hooks to attach your device to the ceiling. Use of elastic strings will result in disqualification. Your device may have a mass of no more than 5 kg and must fit inside a rectangular volume of 150 cm x 15 cm x 15 cm. You will supply a "tee" to hold the golf ball above the floor. You may place your tee at any point on the 100 cm x 100 cm area of impenetrable floor vertically below the ceiling. The tee may not itself impart any kinetic energy to the ball, or guide the direction of the ball. You will store gravitational potential energy by raising your device to a point of your choice, but no point on your device may be more than 2 meters above the floor. You will hold it at the chosen point by a single string, then release the stored energy by releasing the string.

Your ball must land in a sand trap target that is 100 cm x 100 cm square, without rolling or bouncing first, and without bouncing or rolling out. There is a 10.8 cm diameter hole in the centre of the sand trap. You may choose the location of the sand trap relative to the tee, up to a maximum of 10 meters between the tee and the hole. The score for a shot is the distance in meters from the tee to the stopping point of the ball, divided by (1 meter plus the distance of the ball from the center of the hole in meters). The score is thus the distance from the tee to the hole if the ball ends up in the hole, and half the distance from the tee to the hole if the ball stops in the sand trap 1 meter from the hole. The score for your team will be the maximum score obtained in four shots. You will be allowed one "mulligan" for missing or rolling out of the sand trap. Between shots, the sand trap may be relocated, and minor adjustments to your device may be made, with the permission of the judge. The attachment of your device to the "ceiling," your four shots, and the complete removal of your device from the "ceiling," and removal of your "tee," must be accomplished in 4 minutes. We encourage you to use hooks to attach to the screw eyes, rather than knots.

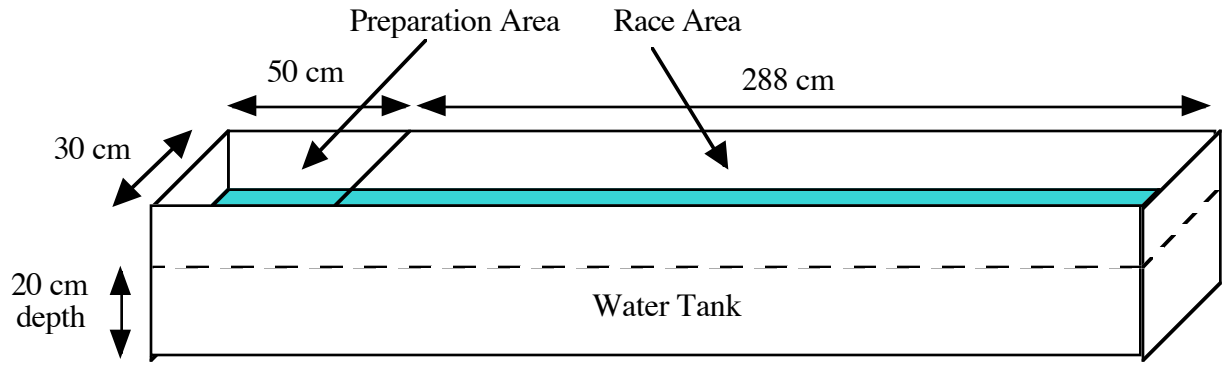


2. Water Power Boat Race

Your goal is to construct a racing boat, powered only by the gravitational potential energy of water. There is no limit on how much water "fuel" you may use, except that your boat must float stably throughout the race. Your boat may discharge water during the race, but no water may be added during the race. You may not use air or steam pressure, or any other form of stored energy, in your propulsion mechanism.

Your boat must fit within a rectangular region 25 cm wide, 40 cm long, and 100 cm high, at all times during the race. Your boat may not contact the bottom of the tank, which will be filled with water to a depth of 20 cm. Your boat may incidentally contact the walls of the tank, but you may not utilize the walls of the tank for propulsion.

The race course is 30 cm wide and 288 cm long, plus a 50 cm long preparation area. Your boat will be held the preparation area while you "fuel" it with water and otherwise prepare it to race. You will tell us when to release your boat, and we will measure the time it takes to reach the finish line. Your rank will be determined by the shortest time to complete the race. Boats not completing the race will rank behind those that do finish, with greatest distance traveled ranking highest. You will have 1 trial, which must be completed in less than 4 minutes including preparation time.



3. 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:

- How much energy does a horse consume in its lifetime?
- How big does a seed on the ground have to be to justify a bird flying off a tree branch to eat it?
- What is the typical molecular binding energy?
- How small can a 1 GB memory be?

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 calculators, computers, books, or notes 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.

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
Avagadro'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

4. Inukshuk Construction

Your team will compete to construct Inukshuks that maximize some specified properties, using sets of wooden blocks which will be provided. Your Inukshuks must balance and be free-standing, so a good understanding of Centre of Mass will be essential.

There will be 3 different projects to be constructed, and the blocks used will vary in size and mass distribution from project to project. Your team's score will be a weighted sum of the values of the specified properties for the 3 projects. Any ties will be broken using the minimum value of the total construction time.

5. Mystery Event

Teams will solve a problem using knowledge of physics principles, logic, and/or experiment. Details of the problem and scoring scheme will be announced at the time of competition. To preserve the mystery, the heats will be closed to all persons except the participants.

6. Quizzics!

Team members will work together to answer questions about physics and astronomy. Questions may involve famous scientists, history of science, mechanics, waves, electricity and magnetism, fluids, and "modern" physics. Some questions may involve short calculations.

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 are closed to all except participants. The three teams with the highest scores in the preliminary heats will meet in the public medal-round of Final Quizzics!

In Final Quizzics! the first person to buzz must answer for her team without consultation. An incorrect answer (or failing to promptly answer after buzzing) loses 5 team points, and allows the next team to buzz a chance to answer the same question (also without consultation). Correct answers score 5 team points, and a chance for the team to answer a 10 point bonus question (with 1 minute for consultation).