THE THIRTY-THIRD UBC PHYSICS OLYMPICS RULE BOOK

March 12, 2011

Financial sponsorship is provided by the Rex Boughton Memorial Fund.

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

Version 2, 22 February 2011

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 ranked by 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 decibels.

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 teams to design and build devices before the event. Pre-built devices will be checked in to 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 telephone 604-822-9690.

1. Gravity Golf

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

Your device will be suspended from a 100 cm x 100 cm "ceiling". The ceiling has 36 closed-loop screw eyes on a 20 cm grid. The bottoms of the closed-loop screw eyes are 150 cm from the "tee surface," and the wire is 3.5 mm in diameter. You may use any number of strings and hooks to attach your device to the "ceiling." 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 store gravitational potential energy by raising your device to a point of your choice, but no point on your device may be more than 150 cm above the floor. You will hold it at the chosen point by a single string, then release the stored energy by releasing the string. You may not push your device.

You will also supply a "tee" to hold the golf ball above the "tee surface." The "tee" may not itself impart any kinetic energy to the ball, or guide the direction of the ball.

Your ball must land in a "sand trap" target (actually filled with birdseed) that is 100 cm x 100 cm square. There is a 10.8 cm diameter hole in the centre of the sand trap. There is a backboard and sideboards on the sand trap.

The score for a shot is

$$S = \frac{D_{\text{tee-hole}}}{1\text{ m} + D_{\text{ball-hole}} + P_{\text{floor}} + P_{\text{back-sides}}}$$

where $D_{\text{tee-hole}}$ is the initial distance from the tee to the hole, $D_{\text{ball-hole}}$ is the distance from the final ball position to the hole (zero if inside the hole), P_{floor} is a one meter penalty if the ball bounces one or more times before the sand trap, and $P_{\text{back-sides}}$ is a one meter penalty if the ball hits the backboard or sideboards one or more times. The score for the shot is zero if the ball does not stop in the sand trap.

The score for your team will be the maximum score obtained in 3 shots (including shots that do not stop in the sand trap). You may rest your tee at any point on the 100 cm x 100 cm area of floor vertically below the ceiling. You may choose the initial location of the sand trap relative to the tee, up to a maximum of 10 meters between the tee and the hole. You may relocate the sand trap one time. You may not relocate the tee position.

You will have 3 minutes to attach your device to the "ceiling," make your shots, and remove your device. We strongly encourage you to use hooks to attach to the screw eyes, rather than knots.

Neither your device nor your tee may damage the setup in any way.

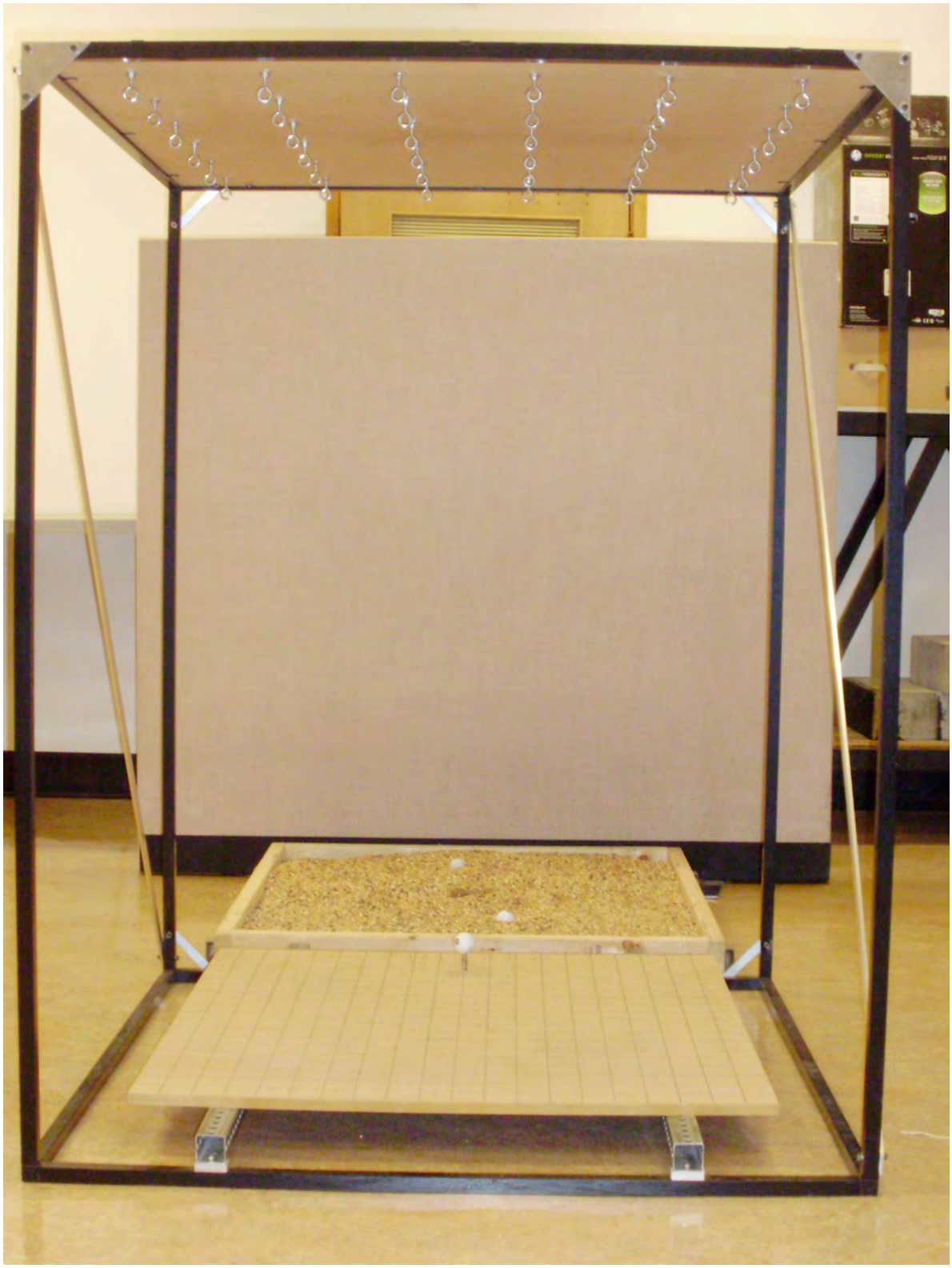

Figure 1: Gravity Golf setup. The sideboards and backboards of the "sand trap" have not yet been installed.

2. Mousetrap Dragster

The goal is to make a car driven by the energy of a mousetrap that traverses a drag strip in the shortest time.

The car must be propelled exclusively by wheels made from standard CDs or DVDs. The wheels must be driven exclusively by one Victor-brand mousetrap (46x98 mm, available at Safeway and other stores). The mousetrap trigger mechanism must be used to start the vehicle, and the mousetrap must not be disassembled or modified except as required for mounting to the car. The car must be a single unit no more than 40 cm long before, during, and after the race.

The drive wheel CD/DVDs may not be reduced in diameter, but modifications to increase traction are allowed provided the diameter is increased no more than 4 mm and the thickness no more than 2 mm. Non-drive wheels need not be made from CDs or DVDs. The car may not be constructed from a commercial kit.

The track is 4 meters long plus 40 cm long start and finish areas. It has a painted plywood surface and is 1 meter wide with 2x4 side walls. The start and finish times will be measured electronically by light beams close to the track surface. Cars which may damage the track will be disqualified.

Your score will be the fastest time obtained in two trials. You will have 3 minutes to do your trials. Cars which do not finish the race in either trial will be ranked by distance traveled.

Figure 2: Victor-brand mousetraps.

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:

- 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 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. Light Ray Ricochet

Students will be required to apply their knowledge of reflection and refraction in order to direct a laser beam onto a target. Heats will be closed except to participating schools.

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 teams with the highest scores in the preliminary heats will meet in the public medal-round of Final Quizzics! using a buzzer system. The first team to buzz must answer the question. An incorrect answer (or failing to answer within 30 seconds) loses 5 points, and allows the other teams a chance to buzz to answer the same question. A correct answer is worth 5 points, plus a chance to answer a bonus question for 10 points.