THE THIRTY-SEVENTH 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 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. Mousetrap Elevator

Your task is to construct a device which elevates a golf ball by 50 cm in the minimum time, using only the energy stored in a mousetrap.

You will place your device on a tabletop, and insert a standard golf ball into it. The golf ball may be restrained in the device, but the device may not be restrained to the tabletop. When we trigger your mousetrap, your device must raise the golf ball through a light beam just above the initial position to start our timer, and elevate it by 50 cm to break another light beam to stop our timer. The golf ball must remain in the upper light beam for at least 10 seconds. The winner is the device that elevates the golf ball in the minimum length of time. Ties will be broken in favor of the smaller weight device. Devices which fail to reach the stop beam will be ranked by the height achieved.

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.

The top of the golf ball and any restraints on it must be no more than 5.5 cm above the tabletop initially, so it is below the start light beam. The center of the stop light beam will be 53.4 cm (55 cm minus golf ball radius) above the tabletop, and vertically above the start light beam. The golf ball must be insertable and removable from your device with no damage or alteration to it.

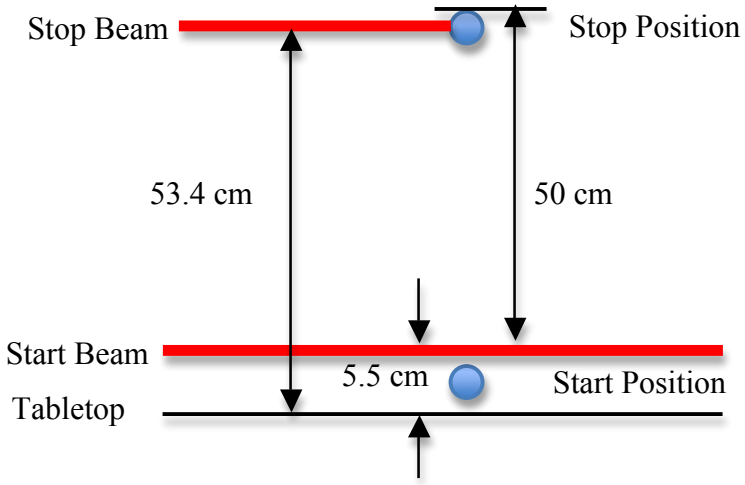

Figure 1: Start and Stop Beam Geometry

Figure 2: Victor-brand mousetraps.

2. Splashdown

Your task is to construct a device which removes the maximum amount of water when dropped into a filled bucket.

The bucket will be a 5-quart plastic utility pail, Canadian Tire product #49-5891-4. It is 20.5 cm inner diameter at the top, 18.5 cm diameter at the bottom, and 16.5 cm tall. It will be filled to initial depth of 14 cm and weighed. We will release your device from rest with its lowest point at a height of 1 meter above the water surface. Your device must remain in the bucket after splashdown. The bucket (including your device) will be weighed one minute after release. The winner is the device with the largest decrease (or smallest increase) from the initial filled bucket weight.

Your device must not tip the bucket over or damage the bucket. Your device may not contain moving parts or any source of mechanical, pneumatic, electrical, chemical, nuclear, zero-point, dark, or other form of energy. You may not interact with your device after it is released.

Figure 2: Bucket

3. Buoyancy Lab

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

4. Electrical Mystery Lab

A laboratory-based event involving electrical circuits. 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