

**THE TWENTY SEVENTH  
UBC PHYSICS OLYMPICS  
RULE BOOK**

**March 5, 2005**

Financial sponsorship is provided by the Rex Boughton Memorial Fund.

The UBC Physics Olympics is organized by the Department of Curriculum Studies (Mathematics and Science Education) and the Department of Physics and Astronomy.

## *In the Spirit of Physics*

The wording of each challenge in this year's rule book has been carefully prepared to define each task as precisely as possible. It is expected that all participants will produce solutions which comply with the task as defined. Normal physical interpretations will be applied to all the terminology used in defining the tasks. Those solutions which, in the opinion of the judges, do not comply with the spirit and intent of the challenge, will be disqualified. General questions regarding the challenges may be directed to the coordinators of the Olympics. The coordinators will accept inquiries which may help them to prepare for unusually good solutions to the problem.

**Please direct all inquiries regarding the rules to K. Schleich or D. Witt at preferably via email to [schleich@noether.physics.ubc.ca](mailto:schleich@noether.physics.ubc.ca) or by phone to (604) 822-6286. Phone will be unavailable Feb. 14-19 due to construction: call (604) 454-8611 during this time. This rule book and any clarifications will also be available on the world wide web at <http://noether.physics.ubc.ca/>.**

## *General Rules*

Each school may enter one official team made up of a maximum of 10 members, of which a maximum of 5 participate in each event. Gold, silver and bronze medals will be awarded to the official teams scoring the highest, second highest and third highest aggregate scores. In addition, gold, silver and bronze medals will be awarded to the official teams scoring the highest, second highest and third highest aggregate scores. All teams must enter all events. The events are scheduled so that it is possible for all teams to enter all events. All ties will be broken. A trophy will be awarded to the school sponsoring the official team achieving the highest aggregate score.

TWO of the events require a pre-built structure. These entries must be checked in at the time of registration on the morning of the competition at which time they will be stored in a safe place until the time of the event.

## *Our Special Thanks to*

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and to

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and all students of the Physics and Physics Engineering program who assist in the design organization and running of this Physics Olympics.

## **Rescue Me**

Students will build a simple model hovercraft that will sail a racecourse carrying the maximum possible load.

### **Apparatus:**

Contestants will provide a hovercraft, the load it carries and, if desired, one 12V AC to DC power adapter (wall wart) with sufficient wire for running the race. The load must be separate and removable from the hovercraft.

1. The hovercraft and load must be constructed by the contestants themselves and should not consist mainly or exclusively of any sort of pre-purchased model kit or device.
2. The sole source of lift for the hovercraft must be no more than 2 computer cooling fans, either case fans or CPU fans. These fans must be ones sold for use in personal computers capable of running Microsoft Windows 98 or XP or MacOS. Contact the organizers if you need further information or wish to check if your fan is allowed.
3. The hovercraft must hover; it must ride on a cushion of air produced by the operation of the cooling fan(s) at all times during the race. It must visibly rise when powered on and not move under application of force when not powered. For example, it cannot move when unpowered from the wind provided by the race course fan at various settings. Supplemental wheels, bearings or other devices that reduce the effects of friction are not allowed and will result in disqualification.
4. The hovercraft engine can use either one 12V AC to DC power adapter (wall wart) OR a completely self contained power supply (i.e. batteries). If you use an adapter, you must ensure that the wire connecting it to the hovercraft remains less than 8 cm from the floor at all times to prevent spurious triggering of the timing gates. Note a hovercraft with a completely self contained power supply will obtain a scoring bonus.
5. The hovercraft carrying its load (but excluding the adapter and connecting wire) must be able to fit into a 50cm length by 50cm width by 30 cm height box at all times during the event. All parts of the hovercraft and load must finish the race together.
6. The hovercraft must have a 5 cm by 5 cm square rigid flag placed parallel to the direction of travel whose bottom edge is situated at a height of 10 cm from the floor when the craft is in operation. Note that flag placement is important as it is used to ensure triggering of the timing gates.
7. Propulsion of the hovercraft can come only from the computer cooling fans or wind from the box fan provided by the organizers.
8. The load must be transported solely by the hovercraft. Loads that self-transport will result in disqualification.

### **Racecourse**

The hovercraft will race on a drag strip approximately 1 meter wide and 2 meters long laid out on linoleum floor. A power bar will be provided on one side of this strip at the center. There will be an approximately 1 meter square area behind the starting line for setup of the hovercraft. An optional source of energy for propulsion of the hovercraft is provided by a standard 22 inch by 22 inch box

fan at low speed 2-3 meters behind the start line. This fan is provided by the event organizers. Organizers will turn off the fan for duration of the race by request of contestants.

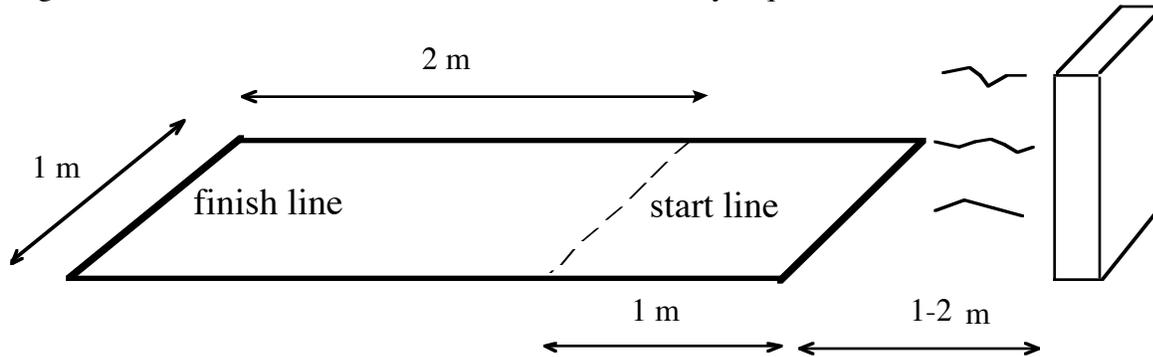


Figure 1: Illustration of the drag strip.

**Rules:**

- 9. Teams will have a total of 5 minutes to set up and run their race. Only one trial will be allowed.
- 10. No part of the hovercraft can be in front of the starting line before the start of the trial. No external intervention is allowed after the start of the trial.
- 11. The hovercraft must stay in bounds during the entire race to receive a time. The timer will start when the hovercraft crosses the starting line and triggers the timing gate and will stop when the hovercraft crosses the finish line and triggers the timing gate.

**Scoring:**

- 12. If the hovercraft completes the race, the final score will be given by the formula

$$\text{Score} = 2 * B * (L + .1) / T$$

L = the weight of the load (in Newtons), T = the time (in seconds) and B = 4 if the hovercraft has a self contained power supply and 1 otherwise.

- 13. If the hovercraft does not cross the finish line, the final score will be modified to

$$\text{Score} = D * B * L / 300$$

where D = distance (in meters). The distance will be the shortest distance from the front edge of the hovercraft to the starting line. If the hovercraft goes out of bounds at any time before crossing the finish line the shortest distance from the point at which the hovercraft exits to the starting line will be used.

**Mystery Event**

This event will involve solving a simple experimentally oriented problem or problems using logic and knowledge of basic principles of physics.

## Quizzics

A game show in which teams compete against each other to demonstrate general physics and astronomy knowledge.

### Rules:

1. Each game will consist of two rounds of competition. Each team member will receive a PRS clicker (An electronic entry device similar to a TV remote) for use in answering the questions.
2. First round:
  1. Teams will be tested on a set of randomly chosen questions. Questions will be in multiple-choice format, testing general knowledge of physics and astronomy ranging from famous physicists and discoveries to mechanics, waves, fluids, electromagnetism and quantum physics.
  2. All 5 team members will be required to answer each of these questions individually. Each team member will input his/her own answer using the PRS clicker. The team score will be the sum of the number of correct answers made by all team members.
  3. Teams found to be communicating answers between members during the first round will be disqualified.
3. Second round:
  1. Questions will be in both multiple-choice and single-answer format and may require simple calculations or more detailed knowledge.
  2. The 5 team members are allowed to consult with each other during the second round. Only one answer will be submitted per team in the second round. The team score for this round will be 5 times the number of correct answers.
4. The total score will be given by the sum of the team scores from both rounds. Ties will be broken by short set of extra challenge questions.
5. The top 6 teams overall will meet in a final game of Quizzics to determine first through sixth place. The other places will be awarded in accordance with the total scores.

## Resistance is Futile

The goal of this event is to solve a problem using resistors, diodes and light emitting diodes in a DC electrical circuit. To prepare for this event, contestants should know Ohm's law and understand circuits involving series and parallel resistors and properties of diodes.

### Rules:

1. Contestants are not allowed to bring or use any materials or equipment other than those provided with the exception of pens or pencils for writing and a videotape (not DVD!) of any episode of Star Trek: The Next Generation involving the Borg as a good luck charm.
2. The teams are expected to identify various components of an electrical circuit using the equipment provided. This equipment will include a digital multimeter. Armed with this knowledge, students will be required to construct or modify a circuit that utilizes these components so that it will satisfy certain criteria.
3. The winning team will be the team correctly carrying out all parts of the task assigned. Part marks will be awarded to teams with partially correct answers. If two or more teams receive the

same score, the time they took to determine the correct solution will be used to break this tie.

## Optical Obstacle Course

The goal of this event is to direct a laser beam or beams through an optical obstacle course. The optical obstacle course will contain optical objects such as prisms, plane mirrors and other transparent objects. Some course elements will be fixed and some will be movable.

To prepare for this event, contestants should be able to use Snell's law and the law of reflection. Contestants should bring a non-programmable calculator, pencil, protractor, and a ruler.

### Rules:

1. No laser pointers or other collimated light sources are permitted, other than those provided by the event organizers. Teams found possessing these will be disqualified.
2. Students may not move any of the fixed course components. One fixed course component will be the laser. Other components that are fixed will be specified at the time of the event.
3. The beam or beams may be required to pass through certain fixed course components for a successful completion of the obstacle course. These components will be specified at the time of the event.
4. A maximum of fifteen minutes will be allowed for each team to set up the movable objects in the course. No movable course objects may be placed outside of the designated course boundaries. Only the equipment provided may be used.
5. No trial runs are permitted. The laser will be turned on by one of the event coordinators after the students' setup is complete. (Alternately, at the end of the allotted time if this comes before the contestants have fully completed their setup). After the laser has been turned on by the coordinator, no course objects may be moved.
6. Score will be based on accuracy on carrying out the required task. Time spent in solving the course will be used to resolve any ties with shorter time being better.

## The Mechanical Timer

The object of this event is to build an adjustable mechanical timer which can time two different time intervals. The two times will be given to your team on the day of the event in your round. One time interval will lie in the range of 10sec-60sec and the other time interval in the range 1min-3min.

**Apparatus:** The entire apparatus provided by the each team consists of two parts; a timer and a glass marble dropped to indicate that time is up.

1. Teams are allowed to bring one timer to use in this event.
2. The timer must be built without any metal parts with the exception of paper clips (length before unfolding of 3 cm or smaller), sewing pins (length 3 cm or smaller), tiny nails or screws (length 4 cm or smaller) and staples (standard desk stapler size or smaller).
3. The timer must be constructed entirely by the contestants themselves and not consist entirely or partially of any manufactured device or kit. For example, no clock or commercially made timer parts

may be used in the construction.

4. The only sources of energy allowed to run the timer are mechanical forms of potential energy. No electrical power or other electrical or chemical source of energy is allowed.
5. The timer must be able to fit into a box of 40cm by 40cm by 40cm at all times during the event and must be designed to sit unsupported on a flat surface.
6. The timer must be constructed so that when time is up, it drops a marble into the stop time apparatus. The stop time apparatus is provided by event organizers.

### The Stop Time Apparatus:

The stop time apparatus will be provided by event organizers. It consists of a funnel (Norge Nunc International 100 mm powder funnel, height 10.4 cm, top inner diameter 9.9 cm, length of tube 3.4 cm, smallest inner diameter of tube 1.7 cm) whose top is mounted 18 cm above the surface of table and a stop gate positioned immediately below the funnel. The contestants' timer may extend over the funnel at a height over 20 cm from the surface. No part of the contestants' timer can enter the space at or below the top of the funnel or touch the funnel at any time to ensure correct functioning of the stop gate.

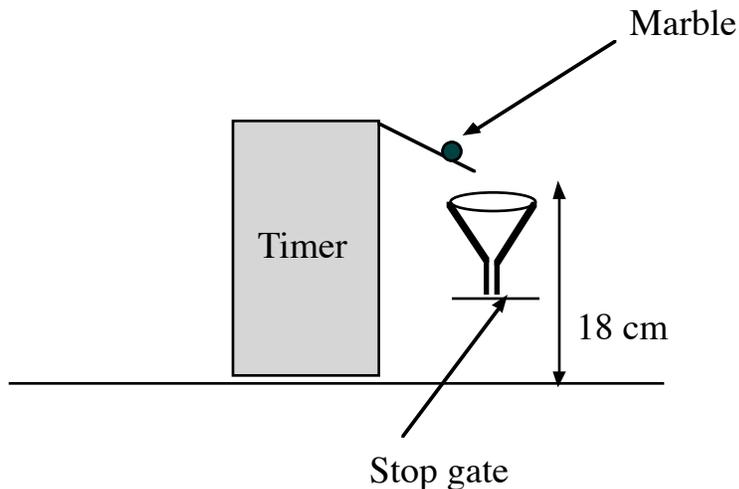


Figure 2: Diagram of Timer Setup.

### Rules:

7. At the start of the trials, two randomly selected times will be chosen and told to the team. One time will lie in the range of 10-60 seconds and the other time in the range 1 - 3 minutes. Teams will have 2 minutes to get their timer set up for each trial.
8. Contestants must demonstrate that their marble will trigger our stop gate or else must use a marble provided by the event organizers.
9. Contestants must **not** bring a watch, stop watch or any other timing device into this event. **Teams found to possess such a device during the event will be disqualified.**
10. At the start of a trial, the team will start their timer when directed to by the event organizers. Failure to start the timer within 1/2 second will result in scoring penalty described below. At the end of each trial, the timer will drop the marble into the funnel indicating that it has finished timing. The stop time will be measured at the instant when the marble drops out of the funnel.

11. No external human intervention is allowed after starting the timer during each trial.

**Scoring:**

12. The score for each trial will be given by

$$\text{Score} = 1000 |T_m - T_s| / T_s$$

where  $T_m$  is the time interval of the timer as measured by the judges and  $T_s$  is the time interval as specified by the judges at the start of the event. Note the score depends on the absolute value of the difference of these times. If a team fails to start their timer within 1/2 second of the start time, they will receive a score of 1000 for that trial. The total score for the event will be the sum of the scores for each time. The team with the lowest score will win. Any ties will be broken by the judge's assessment of creativity of design.

# The Seventh Annual Physics Olympics Open Event

This year, we are again pleased to announce a completely optional event designed for the participation of those people who accompany the official teams to the Physics Olympics. This event **is not** an official Physics Olympics event and is intended for teacher teams, informal B teams (those not participating in the regular Physics Olympics events) and any other informal teams who wish to try it. No trophies will be awarded in this event, but the names of the top finishers will be announced at the awards ceremony. This event will be run at announced periods all day; anyone who wishes to participate can do so by showing up at one of these times. This year, our event is

## Stress Test

The goal of this event is to construct a structure entirely out of 8.5 by 11 inch copy paper that will withstand the maximum stress or strain.

### Rules:

1. Contestants are not allowed to bring or use any materials or equipment other than those provided.
2. Contestants will be provided 8.5 by 11 inch copy paper to construct a structure during a 10 minute period to carry up to a maximum specified stress or strain. The actual challenge will be revealed only on the day of the event.
3. The winning team will be the team whose design best carries out the task.