

**THE THIRTIETH
UBC PHYSICS OLYMPICS
RULE BOOK**

March 8, 2008

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, preferably via email to schleich@noether.physics.ubc.ca or by phone to (604) 822-6286. 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.

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The Looney Car (BC's Best Driver)

This is a pre-built event which involves the design of a car that utilises the energy stored in three rubber bands to cover a 5.0 m course as quickly as possible while completing a legal right turn and then parking.

Apparatus:

1. The total energy for moving the car can only come from the elastic potential energy stored in at most three size #32 rubber bands 3" x 1/8" (76 mm x 3.2 mm x 1.1mm). The three rubber bands will be supplied by the event organisers. They can be utilised in any way and do not have to remain in original condition. They do not need to be returned to event organisers.
2. The car must be constructed by the contestants themselves and may not consist mainly or exclusively of any sort of pre-purchased model kit or device. The car's mass must be less than or equal to 2 kg and its length in any direction must be no more than 0.50 m at all times.
3. The car 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 and whose front edge is even with the foremost part of the car. This flag must be directly attached to a rigid vertical flagpole or other rigid vertical piece of the car. This flag must remain attached in this manner at all times. Note that flag placement is important as it is used to time the car.

The Event

The car will move on an "L" shaped track marked on a linoleum floor. This track will be 5.0 meters long as measured along the inner edge of the L, and the bend in the L will be at 3.0 meters. The track will have three marked lanes, each 30 cm wide.

Behind the starting line there will be an area of about 1 meter in length for set-up of the car.

Immediately beyond the finish line there will be a parking area consisting of three stalls, each 30 cm wide and 50 cm long.

A successful car will start from rest at the starting line, travel down the track, turn 90 degrees, and stop in the parking area.

Rules: The rules for the event are as follows:

1. To begin a run, the car must be placed at the starting line with no part extending beyond this line. When the event organizers indicate to do so, a team member releases the car. No external intervention is allowed after the release of the car.
2. The car must remain in contact with the ground at all times. All parts of the car must remain on the track at all times. All parts of the car must cross the finish line and subsequently park in

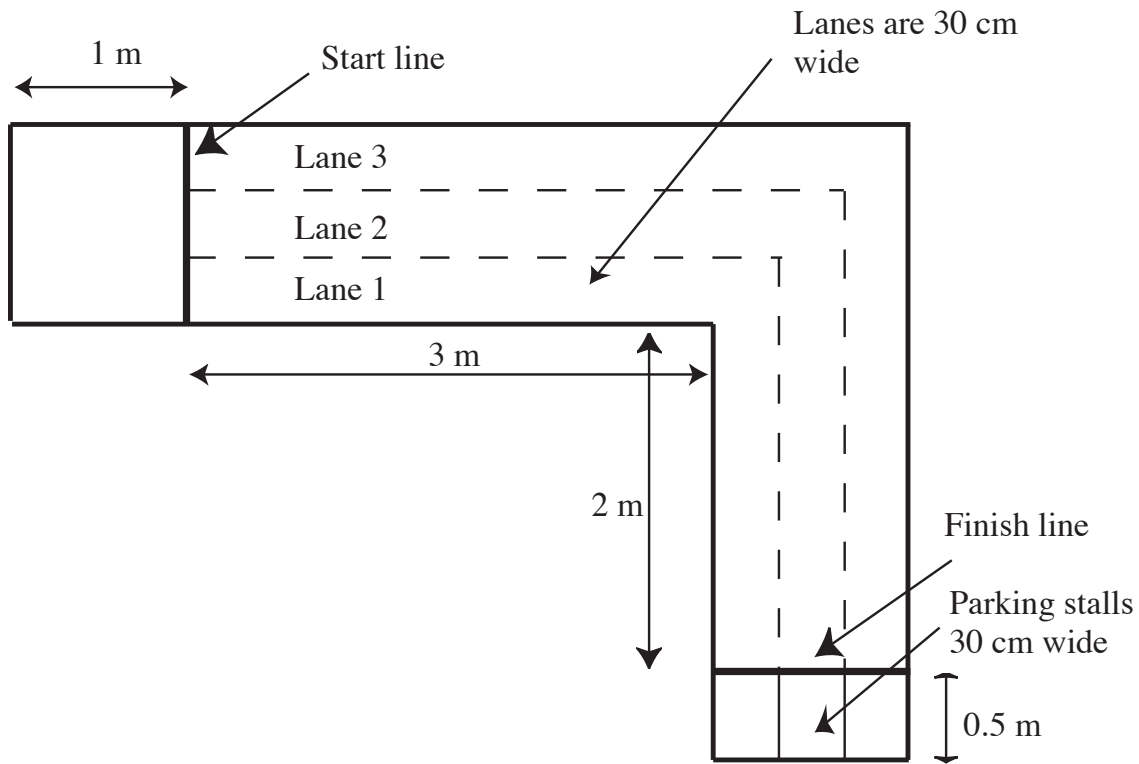


Figure 1: Diagram of the Race Track

the parking area. In particular, note that no material or substance can be left behind the car at any point during the run.

3. The timer will start when the flag on the car crosses the starting line and will stop when the flag crosses the finish line. If the car does not cross the finish line in 30 seconds, the run will be declared over (See rule 5). The car must then park (come to a complete stop in a parking stall) within an additional 15 seconds. A team member may stop a car that completely overshoots the parking stalls.

4. The score for a trial run is given by the formula $\text{Score} = Lx(T + (D-50)/10)$ where T is the time taken for your car to traverse the track from the starting line to the finish line, L is the lane number of the lane farthest from the inner edge of the track that your car either partially or fully entered during the run and D is the distance from the frontmost point of your car to the front of the parking stall in centimeters. A car that partially crosses the finish line is penalized by this scoring formula; as long as the clock is stopped by the car, this formula will be used to calculate the score. The winning car will be the car with the lowest score.

5. If the car does not cross the finish line in 30 seconds, a time $T = 10 + 150 / x$ (x is the distance in meters traveled by the car) and a D of 100 will be used in calculating the score. The distance x will be the shortest distance from the front edge of the flag to the starting line. The score

calculated in this manner will be higher than that of any finishing car; that is, all cars that cross the finish line will place above a car that does not.

6. If any part of the car exits the track before crossing the finish line, the score will be calculated as in rule 5, where x will now be the shortest distance from the exit point to the starting line. If a car crosses the finish line but does not park in the additional 15 seconds or if a car fully exits the parking area without stopping, the score will be calculated using a D of 100.

7. Teams will be allowed two trials. A total time of 6 minutes is allowed for the setup and running of the two trials. The best score attained in the two trials will be used as the team score. In the event of a tie, the second score will be used to resolve the tie.

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:
 - a. 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.
 - b. 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.
 - c. Teams found to be communicating answers between members during the first round will be disqualified.
3. Second round:
 - a. Questions will be in both multiple-choice and single-answer format and may require simple calculations or more detailed knowledge.
 - b. 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.

Intuitive Physics

Each team will be presented with simple experiments or simulations based on basic principles of mechanics, electricity and/or magnetism. Teams will be required to provide answers to questions based on these experiments or simulations. Answers to questions may involve simple calculations. The team with the most correct answers will win. Quality of answers involving explanations will be used to resolve ties.

Boat Race

The object of this in-house event is to construct a boat out of mystery materials provided by the event organizers on the day of the event to sail on the racecourse described below.

1. The boat must be constructed only from the mystery materials supplied on the day of the event by the event organizers.
2. The boat must have a maximum width of 4" at its widest point, and a maximum length of 8" at its longest point. The boat must be designed to carry out all tasks (such as carrying provided cargo) that will be specified by the event organizers.
3. Contestants will have 15 minutes to design and build their boat. Contestants will be able to test their designs using the Racecourse during this period.

Racecourse:

The course will consist of an 8 foot long by 3 feet wide by five inch deep trough filled with water. The starting gate will be placed 10 inches from one end of the trough and the finish gate will be placed 10 inches from the other end.

Racing and Scoring:

1. The boat will be released from the end of the trough nearest the starting gate. The boat may not push off from the sides, back or bottom of the trough or from the person launching it. The person launching it must release the boat without providing it any force.
2. The boat may hit the sides of the trough or take on water without disqualification, but all parts of the boat must finish together.
3. The winning boat will be the one that finishes the course in the manner specified by the organizers on race day.

Mystery Event

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

Multimeter Project

This is a pre-built event in which participants must design and build a multimeter with which to measure DC current, voltage and resistance.

Materials:

The only materials that may be used in construction of the multimeter are:

- * wood
- * nails
- * wire
- * magnets
- * resistors
- * potentiometers
- * batteries
- * common household materials

Note: scavenged meter movements, transistors and integrated circuits are specifically excluded.

The multimeter should be able to measure current up to 100 mA, voltages to 20 V and resistance to 10 k Ω .

The meter must be constructed by the contestants themselves and may not consist mainly or exclusively of any sort of pre-purchased model kit or device.

Event:

Each team will be provided with

- (a) a complete circuit consisting of resistors and a battery and,
- (b) two resistors.

The team will have 10 minutes in which to measure one current and one voltage for the circuit and to determine the resistances of the two resistors.

Rules:

1. The multimeter must be equipped with test leads that may use alligator clips or bare wire ends to connect the meter to the circuit or to the resistors.

2. The multimeter (excluding test leads) must be able to fit into a bounding box of dimensions 30 cm by 30 cm by 30 cm at all times during the event.
3. Each team will have ten minutes (the trial period) to complete their measurements. Prior to the trial period, judges will distribute circuits and resistors to all the competing teams. The trial period will begin at the time indicated by the judge.
4. Teams are to record their results on the form provided.
5. The score will be based on the accuracy of the results. In the event of a tie, the time required to make the measurements will determine the winner.
6. After the trial has ended, the team must quickly return the circuit and resistors to the judges. The circuit and resistors must be in their original condition. If either the circuit or resistors are damaged, the team will be disqualified. If your multimeter design potentially places a current through the circuit during the voltage or current measurement, please contact the event organizers for further specifications.