

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

March 8, 2003

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 822-6286 or via email to schleich@noether.physics.ubc.ca. This rule book 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. If space permits, each school may enter one additional, unofficial team in all events. Gold, silver and bronze medals will be awarded to the official teams scoring the highest, second highest and third highest aggregate scores. Both official and unofficial teams are eligible for these medals. In addition, gold, silver and bronze medals will be awarded to the official teams scoring the highest, second highest and third highest aggregate scores. The official teams must be designated at registration. 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. Points scored by unofficial teams will not be included in the school championship aggregate.

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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Milk Jug Support Event

This is a pre-built event in which participants must design and build a structure to support one or more 4-litre plastic milk jugs filled with water over a table. The jug or jugs must hang from a single support point.

Materials:

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

- Wooden Popsicle sticks
- White glue (no glue guns)
- Wooden toothpicks
- Natural fiber string of less than 3 mm diameter. The string must not have any metal component in it, and must be non-mono-filament – i.e. no fishing line or monofilament dental floss.

The structure will support:

- A team specified number of 4-litre milk jugs containing only water. The milk jugs must not be altered in any way from their standard shape as purchased.

Teams are required to bring as many 4-litre milk jugs as they intend to support. In contrast to the natural fiber string used in the construction, any type of string or wire may be used to attach the milk jug(s) to the support point on the structure, and must also be supplied by the team.

Apparatus:

1. The structure must be designed to support one or more 4-litre plastic milk jugs filled with water for one minute. The team can choose how much water to use so long as the filled milk jug(s) exceed a minimum mass of 1 kg.
2. The structure must be able to fit into a bounding box of dimensions 30 cm by 45 cm by 60 cm at all times during the event.
3. The structure must sit within a 15 cm square section of the horizontal surface of a tabletop adjacent to the edge of the table as illustrated in figure 2. The structure must only come into contact with the tabletop in the designated area. No part of the structure can extend below the plane defined by the tabletop.
4. The milk jug(s) must all hang freely from the structure from one single support point, attached only by a loop of string or wire through the handle(s). They may not otherwise come in contact with any part of the structure, table or floor at any time during the trial.
5. The support point for the milk jug(s) must be over the tabletop and a horizontal distance of at least 250mm in from the table edge and at least 30 cm above the tabletop.
6. The structure can be attached to the table with a maximum of two C-clamps. The C-clamps are to be provided by the team. They each must be smaller than 20 cm in length and must have a contact area of their jaw of less than 8.5 cm^2 (See figure 1). The C-clamps must only touch wooden parts of the structure.
7. Any string used in the construction of the structure must terminate on wooden pieces a minimum distance of 10 mm from both the support point and the C-clamps.



Figure 1: Left: C-Clamps next to a meter stick. Right: Table next to a meter stick.

Table:

The tabletop has dimensions of 60 cm by 75 cm and is 77 cm from the floor. The thickness of the tabletop is approximately 2 cm. The table has a metal support underneath approximately 5.5 cm from its edge. The surface will be covered with one 150 mm by 150 mm sheet of 80 grit garnet paper backed sandpaper secured with masking tape. The sandpaper will extend to the edge of the table as illustrated in figure 2.

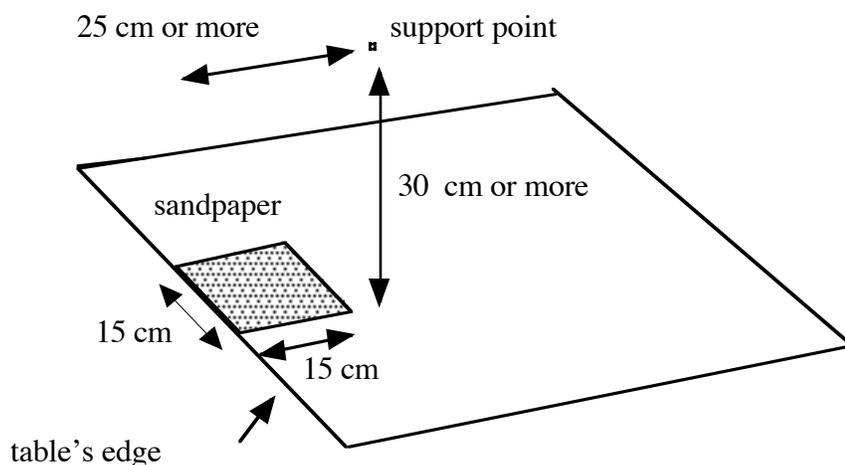


Figure 2. Diagram of the tabletop illustrating the sandpaper and position of support point. Note support point must remain within bounding box (not illustrated) for structure to satisfy rule 2.

Rules:

1. Each team will be allowed one trial. Teams will be given a total time of 10 minutes to set up and run the trial. When the team is ready to begin a trial, they must inform a judge, who will time the trial.
2. The trial begins when the judges indicate that they are ready and after all external support of the jug and structure is removed. The structure must support the freely hanging milk jug(s) without collapsing for a trial period of one minute.

3. During the trial, no external intervention is allowed to adjust, steady or support either the structure or the milk jug(s). A collapse of the structure or intervention before the trial is over will result in disqualification.
4. After the trial has ended, the team must quickly detach the milk jug(s) for weighing to determine the score.
5. The score will be given by the following formula: $s = M_{\text{jug(s)}}/M_{\text{structure}}$ where M is mass. The largest score wins.
6. Ties will be broken by the mass of the structure with the least massive structure winning.

Crash Scene Investigation, Vancouver

In this event teams will use their knowledge of the principles of basic physics to analyze a traffic accident scene.

Rules:

1. Teams should bring a non-programmable calculator, pencil or pen, protractor, ruler and a carpenter's tape measure.
2. Teams are not allowed to bring or use any materials or equipment other than the above with the exception of equipment provided by the event organizers.
3. Teams will be judged on their collection of data and the correctness of their assessment of that data. Ties will be resolved by answers to a set of bonus questions.
4. Teams are permitted to bring blue glowing lights as lucky talismans.

Good Clean Fun

This event will explore properties of soap bubbles.

Rules:

1. You are not allowed to bring or use any materials or equipment other than those provided with the exception of pens or pencils for writing.
2. Materials will be provided for constructing and studying soap bubbles.
3. You will be expected to do an experiment to determine a property or properties of soap bubbles. Your score will be based on the accuracy of these measurements and the description of the experiment.
4. Don't worry, more specific directions and information will be given at the time of the event. With these directions you will be able to figure out what to do. In addition, there will be friendly, helpful invigilators at the event to make sure you have no trouble blowing bubbles.

To prepare for this event, you should familiarize yourself with the basic physics of soap bubbles.

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.

The Concentrator

The object of this pre-built event is to construct an energy-collecting apparatus to concentrate as much energy from a provided 250-Watt heat lamp as possible. This energy is to be used to heat a mass of water.

The Energy Source:

1. One 250-Watt R40 infrared heat lamp will be provided. It will be positioned so that the face of its bulb is parallel to the floor at a vertical distance of 1.2 m centered above a 1-m by 1-m square on the floor.
2. The concentrator can be placed on the floor anywhere in this square.
3. The heat lamp must be the ONLY energy source used to heat the water.

The Concentrator:

1. The concentrator consists of two parts: the apparatus and the water container.
2. The concentrator must be able to fit into a 1 m by 1 m by 0.9 m bounding box at all times during the event.
3. No part of the concentrator can be more than 0.9 m above the floor at any time during the event.
4. The apparatus can be made of any material. It must be designed so that the water container is heated only by electromagnetic radiation from the heat lamp.
5. The concentrator is to be designed so that the water container is easily separable from the apparatus. In particular, a judge must be able to easily insert the water container into the apparatus.

The Water Container:

1. The water container will be a black, 35-mm film canister without lid provided by the event organizers.
2. It will be provided at the beginning of the trial filled with a fixed amount of water at a uniform temperature between 0 and 40 degrees C. The amount and temperature will be the same for all contestants but will be set on the day of the event.
3. Teams cannot bring their own water or their own film canister. Teams must not modify the water container, i.e. the film canister and water it contains, in any way except by the action of their concentrator during the trial.

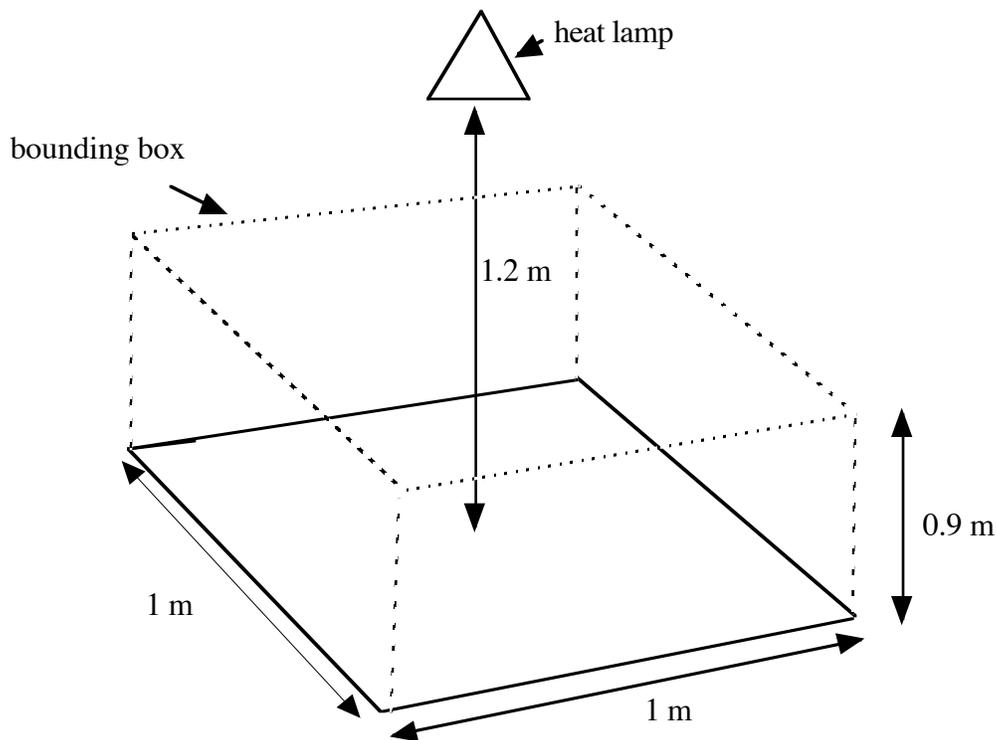


Figure 3. Diagram of the concentrator set-up.

Rules:

1. At the start of the event, teams are allowed 5 minutes to set up their apparatus. The heat lamp will be on during this time.
2. Teams will notify the judges when they are ready for the insertion of the water container. An event organizer will place the water container into the apparatus. At this point, the 12 minute trial period will begin. The concentrator must remain undisturbed for the entire 12 minute period.
3. At the end of the 12-minute trial the water container will be removed from the apparatus and the temperature of the water will be taken. The water container will be weighed on a scale.
4. The score will be given by: $\text{Score} = m(\Delta T)d^{2.5}$ where m is the mass of water measured in grams, ΔT is the change in temperature measured in kelvin, and d is the vertical distance from the film can to the heat lamp measured in centimeters. The concentrator with the highest score wins the event.
5. In the unlikely event of a tie, the tied teams must present their calculations and design plans to the judges. The winner will then be determined by the thoroughness and physical accuracy of the presentation.

There will also be an award for the most innovative design as judged by the event organizers.

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Clarification

March 8, 2003

The Concentrator (2 clarifications)

1. Rule clarification

Rule number 1 states: “1. ... teams are allowed 5 minutes to set up their apparatus. The heat lamp will be on during this time.”

The reason the lamp is on in this rule is so that you can adjust your apparatus to be appropriately aligned etc. This does not mean you can be storing energy in it during setup to be used later. In particular, you can not store energy from the heat lamp before the 12 minute run time to be used during the run. This follows from number 4 under the Concentrator which states:

“4. ...water container is heated only by electromagnetic radiation from the heat lamp.”

2. Score clarification

The formula for the score is $\text{Score} = m(DT)d^{2.5}$ based on a 12 minute run.

If you are within 5 cm of maximum distance and can boil water in less than 12 minutes, we will calculate your score based on the time taken to bring the water to boiling. The shortest time to boil the water (assuming more than 1 team does so) will win.

