

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

**March 6, 2004**

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 e-mail to [schleich@noether.physics.ubc.ca](mailto: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 prebuilt 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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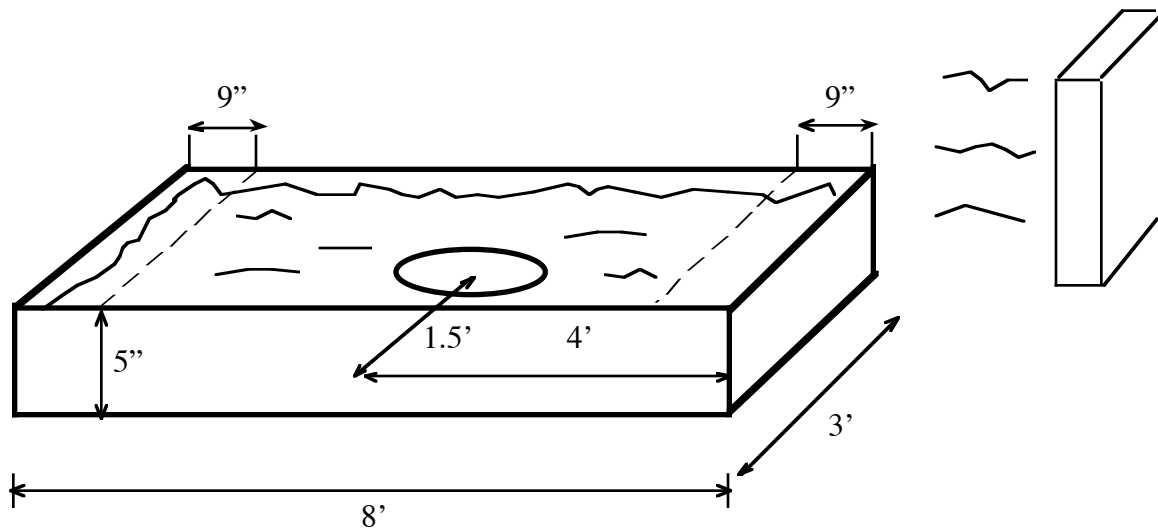
# Pirates of the Caribbean

The object of this event is to build a boat that will sail the racecourse described below in the fastest possible time that returns the most Aztec gold pieces (loonies) to the sunken city (target) to lift the dread curse of physics phobia.

Teams will bring a boat, optional treasure chest and Aztec gold pieces (1 Aztec gold piece = 1 loonie) to this event.

## Construction of boat:

1. The only source of energy used to move the boat must be supplied by wind power provided by a standard 22 inch by 22 inch box fan on medium speed. This fan is provided by the event organizers.
2. The boat must be designed to transport Aztec gold pieces optionally set inside one treasure chest. It should be designed to drop the Aztec gold pieces, possibly in the treasure chest, inside the target (the sunken city) marked on the floor of the trough.
3. The optional treasure chest is a single object of both length and width less than 9 inches at all times containing loonies.
4. Both the length and the width of the boat must be less than 9 inches at all times during the race. Both the length and the width of the boat together with the optional treasure chest must also be less than 9 inches at all times before the treasure chest is dropped.
5. The boat must have a part that is a minimum height of 4 inches above the water line flying a 5 cm by 5 cm square paper flag centered at a height of 4 inches.
6. The mechanism that controls where the Aztec gold pieces (loonies), and/or the optional treasure chest, is dropped must be contained entirely within the boat and/or treasure chest and must operate without any external intervention.



*Perspective view of trough*

**Racecourse:**

The course will consist of an 8 foot long by 3 foot wide by 5 inch deep trough filled with water. The start gate will be placed 9 inches from one end of the trough and the finish gate will be placed 9 inches from the other end of the trough. The fan will be placed 3 to 4 feet away from the starting edge of the trough.

**Target:**

The target (sunken city) consists of a 12 inch diameter circle painted on the bottom of the trough. Its center is 4 feet from the starting edge of the trough and 1.5 feet from the left wall.

**Rules for racing and scoring:**

7. Teams will have a maximum of 5 minutes to conduct one trial of their boat.
8. For the trial, the back end of the boat will be placed against the end of the trough nearest to the starting gate and released by a member of the school team. The boat may not push off from the sides or back of the trough or from the launching team member. The launcher must release the boat without providing it any momentum.
9. The boats are allowed to hit the sides of the trough and will not be disqualified if they take on water, assuming that they finish.
10. The timer will start when the boat triggers the start gate and stop when the boat triggers the finish gate. The boat must drop the Aztec gold pieces before crossing the finish gate.
11. After the race is complete, the number of Aztec gold pieces (loonies) in the target will be counted by event organizers. An Aztec gold piece will be considered to be in the target if all of it is within the target circle. Aztec gold pieces in a treasure chest will be considered to be in the target only if the entire treasure chest is inside the target.
12. The score will be computed by the formula

$$\text{Score} = (2n+1) / t$$

where t is the time in seconds and n is the number of Aztec gold pieces (loonies) in the target. The team with the highest score will win. Should there be a tie for the best score, the boat with the fastest time will win.

**Additional information:**

Note that wind, current and tide conditions on race day may vary from those encountered at your location - this is a part of sailing.

After the trials, all Aztec gold pieces will be fished out of the trough by event organizers and returned to the contestants. If the contestant choose, they can donate their Aztec gold pieces to the Johnny Depp Fan Club.

## 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.

## Motor Mayhem

In this event, teams will build a DC electrical motor optimized to perform a task or property specified by event organizers.

### Rules:

1. Teams should bring pens, pencils and non programmable calculators to the event. No other materials may be brought or used, other than those supplied by the event organizers.
2. Teams will be supplied with components used in constructing a DC motor such as batteries, paper clips, magnets and copper wire. Motors may be built using only the materials provided by the event organizers.
3. Teams will be scored on the performance of their motor on the task or property specified by event organizers and their understanding of the physics behind it.

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 getting started on your motor.

## Do You See what I See?

How did Galileo observe the planets? How do biology students see microorganisms? In this experiment you will have to demonstrate your theoretical and applied aptitude in optics and build a simple optical instrument.

To prepare for this event, you should know the thin lens equation and how to use it:

$$\frac{1}{i} + \frac{1}{o} = \frac{1}{f}$$

where  $i$  is the distance to the image from the lens,  $o$  is distance to the object from the lens and  $f$  is the focal length of the lens. You should understand focal lengths, magnification, virtual and real images, and know the characteristics of converging and diverging lenses.

### Rules:

1. You should bring a non-programmable calculator and pencil.
2. Assorted lenses, an optical bench and all other materials needed for this event will be provided by the invigilators. No other materials may be used.
3. You will be required to construct an optical instrument that has a specified property or properties. You will also be required to carry out calculations using the thin lens equation to aid the design of this instrument.
4. The score for this event will be based both on the correctness of the calculations and the success of the construction and design of the optical instrument.
5. This is not an impossible exercise. So don't despair if you do not know how to solve it before you get to the event. Also, the invigilators are a really fun bunch of people, so don't be afraid to ask questions.

## The Descrambler

This is a prebuilt event in which participants must design and build a structure to protect an egg from breaking when a mass is repeatedly dropped on it from a height of one meter.

Teams will bring an apparatus consisting of three parts: a guide, a scrambler and an egg protecting structure.

### Guide:

1. The guide will consist of a wood base and, if desired, a maximum of 4 thin wooden poles. The wood base must be 1 inch thick. It can be no smaller than 30 cm by 30 cm and no bigger than 50 cm by 50 cm.

2. The wooden poles are to be less than 3/4 inch in diameter. They are to be placed around the edges of the base. The wooden poles must extend up from the base a distance no less than 1.1 m or more than 1.4 m. They may be secured to the base by glue, nails and/or screws.

### **Scrambler:**

3. The scrambler must consist of a single rigid object composed of solid, completely rigid materials such as iron, lead, other metals, brick or hardened concrete.

4. The scrambler must be designed to fall freely with an acceleration approximately equal to  $g$  when dropped. It must have a flat bottom surface that must be downward during at all times when dropped. The maximum diameter of this bottom surface must be no more than 20 cm.

5. The scrambler must be designed to first impact the egg protecting structure without ever touching any part of the guide and must not use the guide poles (if used) to slow its fall in any way.

### **Egg Protecting Structure:**

6. The only materials that may be used in construction of the egg protecting structure are:

- Paper
- flat wooden toothpicks
- Natural fiber string of less than 1 mm diameter. The string must not have any metal component in it, and must be non-mono-filament – i.e. no fishing line or mono-filament dental floss.
- Small quantities of white glue to secure components together

7. The egg protecting structure must be designed so that it does not fully encase or otherwise attach to the egg. Specifically it sits freely over the egg and can be freely lifted up both before and after a trial for examination of the egg.

8. The egg protecting structure must fit in a 20 cm by 20 cm by 20 cm box.

9. The egg protecting structure must not touch the poles of the guide at any time during a trial. In particular, the guide poles cannot act to support the egg protecting structure at any time.

### **Rules:**

10. Each team will be allowed up to 5 trials. Teams will be given a total time of 10 minutes to set up and run the trials.

11. Teams will be given a single extra large grade A egg. The egg is to be placed directly on the wood base of the guide. The egg protecting structure is then placed over the egg.

12. The team's guide will be set on a piece of flat cardboard on top of the floor to protect the flooring.

13. Each trial begins when the judges indicate that they are ready. A team member will then drop the scrambler from a minimum height of 1 meter above the wood base of the guide onto the egg protecting structure. This team member will be required to do so from a sitting or kneeling position on a table positioned next to the guide. The tabletop has dimensions of 60 cm by 75 cm and is 77 cm from the floor.

14. The scrambler must freely fall with the flat bottom surface downward, approximately parallel to the wood base. The scrambler must hit the egg protecting structure first before touching any part of

the guide. The scrambler's center of mass must approximately hit the center of the egg protecting structure.

15. After the scrambler has come to rest, a team member will remove it, another team member will lift the egg protecting structure and show the judge the condition of the egg. The judge will evaluate the condition of the egg and place it in one of two categories - intact or broken.

16. The trial will be successful if the egg is intact and the fall of the scrambler satisfied rule 14 during the trial.

17. After each trial has ended, the team can choose to run another trial and if it does so, must quickly prepare for the subsequent trial by replacing the egg protecting structure over the same egg.

18. The score will be given by the following formula:

$$\text{score} = i * M_{\text{scrambler}} / (H * M_{\text{structure}})$$

where  $i$  is the number of successful trials,  $M_{\text{scrambler}}$  is the mass of the scrambler,  $M_{\text{structure}}$  is the mass of the egg protecting structure and  $H$  is the maximum height of the egg protecting structure, all as measured upon check-in to the event. The largest score wins. Ties will be broken by the mass of the egg protecting structure with the least massive structure winning.