

# THE SEVENTEENTH

# UBC PHYSICS OLYMPICS

## RULE BOOK

### MARCH 5, 1994

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Financial sponsorship is provided by the Rex Boughton Memorial Fund.

The UBC Physics Olympics is organized by the Department of Mathematics and Science Education and the Department of Physics

#### **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 which may require special room conditions and/or measurement equipment.

## **General Rules**

Each school may enter one official team made up of a maximum of five members. 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.

ONE of the events requires a pre-built structure. This entry must be checked in at the time of registration on the morning of the competition at which time it will be stored in a safe place until the time of the event.

## **Further Information**

For official clarification and further information about event rules call Kristin Schleich at (604) 822-6286 or e-mail [olympics@noether.physics.ubc.ca](mailto:olympics@noether.physics.ubc.ca)

## **Our Special Thanks to the Event Designers:**

May Chiao, James Nikkel, Erica Bird, Kim Callaghan, Louie van de Lagemaat, Jeff Vavasour, Alex Dickenson, Glenn Wells, Mark Allen, Irene Lees, Isaac Leung, Gary Lim, Rob McDuff, Tiago De Jesus

## **and to**

Dr. Brian Turrell, Head UBC Department of Physics and all students of the Physics and Engineering Physics program who assisted in this Physics Olympics.

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# The Amazing Electrical Circuit

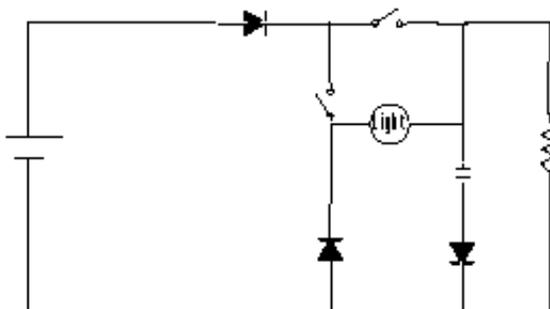
This event will require teams to race to solve an electrical maze.

**Materials:** The following equipment will be provided:

- digital multimeters
- paper
- ruler

## 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.
2. Teams will be given a fixed circuit consisting of a DC power supply, a small circuit containing one or more light emitting diodes and some or all of the following components: resistors, capacitors, switches and diodes. The components may not necessarily be visually identifiable to the contestants; it may be necessary to identify them using their properties and the provided equipment. Recall that a diode is a component which allows the passage of current in only one direction. It is represented in a circuit diagram by  where the arrow indicates the allowed direction. A capacitor is a charge storage device with the property that it does not allow the passage of DC current. It is represented in a circuit diagram by . A switch is a device that allows current to pass in both directions when closed, and does not allow current to pass when open. It is represented by . A resistor changes the voltage across itself according to Ohm's law and is represented by . Finally, a DC power supply is represented by  where the current flows from the negative to positive plate and larger plate is positive.
3. Each team will be expected to find a path through the circuit that will provide a specified voltage and current to the small circuit. Successful completion of this task will cause the light emitting diode or diodes to perform in some specified manner, such as flashing on and off. This path will be made by opening and closing switches. Each team will also be expected to draw a circuit diagram of the entire maze. These diagrams will be turned in when the team has successfully solved the maze and will be used in the scoring.
4. Each team will be awarded a time based on the time that their circuit diagram is turned in to the event organizers. The winners of the event will be determined by the least time taken in finding a correct solution to the maze that passes through the least number of components. In the unlikely event of a tie, the clarity and completeness of the circuit diagram will be a deciding factor in determining a winner.



*An example of a simple maze*

# Rubber Band Powered Boat Race

The object of this event is to construct a polystyrene boat powered by elastic bands that covers the racecourse described below in the shortest amount of time.

**Materials :** Contestants are required to bring:

- A pair of scissors.
- A stapler with staples.
- Manual cutting tools appropriate for work on polystyrene (no power tools)
- One 8.5" by 11" piece of paper for notes/blueprints.
- A pencil sharpener.

No other supplies may be brought.

Teams will be supplied with the following materials by the event organizers:

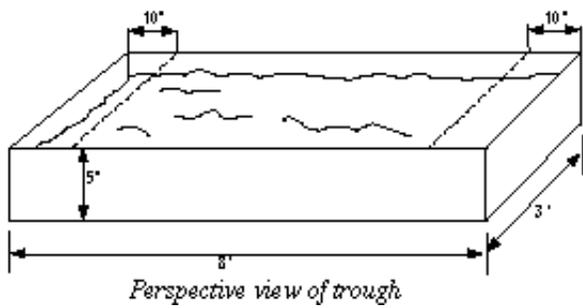
- Two 4" by 8" sheets of 1" thick pink Polystyrene.
- One standard wooden pencil with flag attached. Flag is 1.5" by 1.5" and is located at the top of the pencil.
- Four 3.5" by 2.5" pieces of rigid cardboard each consisting of two playing cards glued together.
- Two rubber bands each approximately 8" in circumference.

No other materials except for staples may be part of the boat.

## **Rules for construction of the boat:**

1. The boat must be constructed during a ten minute period during the beginning of the event from the four materials supplied by the event organizers and staples. An unlimited number of staples may be used. The polystyrene may be cut into any shape and as many pieces as desired.
2. The boat must have a width of 4" at its widest point, and a length of 8" at its longest point.
3. The pencil may be modified or cut into pieces, but the flag must not be. The flag must be positioned such that its centre is 4" from the water and it flies parallel to the direction of motion of the boat. This positioning is important as the flag is used in timing the boat.

**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.

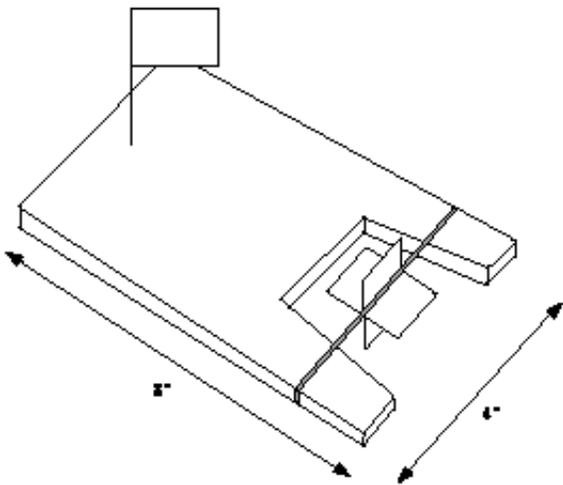


### Racing and Scoring:

1. The boat will be released by one member of the school team from the end of the trough nearest the starting gate. 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 force.
2. The timer will start when the flag crosses the starting line and ends when the flag crosses the finish line.
3. The boat may hit the sides of the trough or take on water without disqualification, but all parts of the boat must finish together.
4. The boat must remain in contact with the water at all times.
5. The winning boat will be the one that finishes the course in the shortest time. In the event of a tie, another set of time trials will be run using the same boats to break the tie. No repairs or modifications will be allowed for re-trials.

**Note:** 2 by 8 foot 1" thick sheets of pink polystyrene foam are used for insulation and are available at hardware stores and building supply stores such as Irly Bird Hardware in Vancouver.

Below is a simplified diagram of an acceptable boat. However, this is only one of many possible configurations, and certainly not the most efficient!

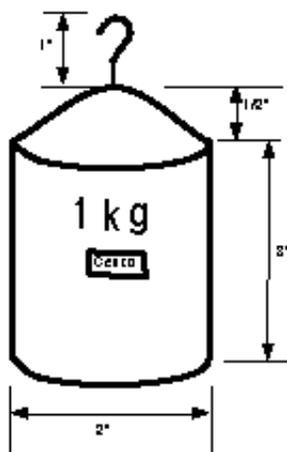


## The Incredible Wheeled Swamp Buggy

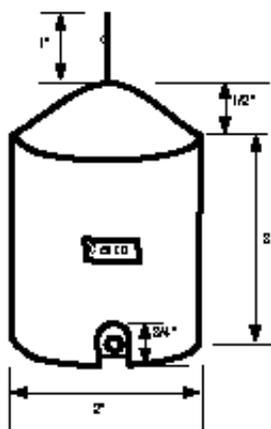
A fan-powered cart will be constructed to run on a linoleum floor.

**Apparatus:** The part of the apparatus that will be timed is called the cart. The entire apparatus can be the cart itself, or may consist of a cart and other components. The cart must be designated by the contestants before the beginning of the trial.

1. The total energy for powering the fan can only come from the energy produced by a one kilogram mass falling a maximum vertical distance of one meter. This energy can be stored or converted into other forms by the apparatus for use in powering the fan.
2. Movement of air by the fan must provide the only source of propulsion for the cart. Specifically, the energy of the falling mass cannot be directly used to propel the cart.
3. The fan must be carried by the cart at all times.
4. The one kilogram mass will be supplied by the event organizers. It must be mounted on or utilized by the apparatus without altering it in any way and returned undamaged at the end of the event. Teams not returning the mass will be disqualified.
5. The cart 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. This flag must be directly attached to a rigid vertical flagpole or other rigid vertical piece of the cart. This flag must remain attached in this manner at all times. Note that flag placement is important as it is used to time the cart.
6. The apparatus must be constructed by the contestants themselves and should not consist mainly or exclusively of any sort of pre-purchased model kit or device.



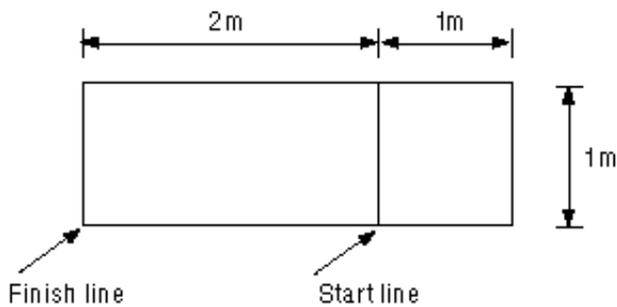
*Front View of 1 Kilogram Mass*



*Side View of 1 Kilogram Mass*

**Rules:** The rules for the event are as follows:

1. The cart will have to move on a linoleum floor and will be required to travel on a drag strip approximately 1 meter wide and 2 meters long. Carts exiting this drag strip through the sides will be disqualified. The starting line will be at one end of the drag strip and the finish line at the other. There will be an approximately 1 meter square area behind the starting line for set-up of the apparatus.



*Schematic of track*

2. No part of either the apparatus or the cart can be in front of the starting line before the mass is dropped. No external intervention is allowed after the release of the mass, with the only exception as given below.
3. The cart must remain in contact with the ground at all times and the wheels of the cart should not slip.
4. The timer will start when the flag on the cart crosses the starting line and will stop when the flag crosses the finish line. The winning score will be obtained by the cart that traverses the drag strip in the fastest time. External intervention is permitted to stop the cart after it completely exits the drag strip to prevent undue damage. The recommended form of this external intervention is a person or persons; positioning must be well clear of the finish line and is left to the discretion of the judges..
5. If the cart does not cross the finish line, a score inversely proportional to the distance travelled will be awarded. This score will be higher than that of any finishing cart; that is all carts that finish will place above a cart that does not. This distance will be the shortest distance from the front edge of the flag to the starting line.
6. Teams will be allowed two trials. A total time of 10 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, both scores will be used to resolve the tie.

## **Mystery Event**

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

## **Intuitive Physics Problems**

Each team will be presented with a set of 5-10 problems. These problems can be solved either by using basic principles of physics or by the application of simple logic. Some problems may require a minimal amount of calculations. A team leader will be responsible for recording the answers arrived at by the group. Solving all the problems correctly should be your main objective (no team has yet scored 100%).

### **Rules for tie breaking:**

1. Should two or more teams tie with a scores less than 100%, incorrect answers will be used as a basis for tie breaking.
2. Should two or more teams tie with a score of 100% then time will be used as a basis for tie breaking.

## **Jeopardy!**

Teams will compete against each other to demonstrate general physics knowledge in a quiz show format based on the television show Jeopardy! In Jeopardy!, recall that the questions are phrased in terms of answers and contestants responses must be phrased in terms of a question. For example,

A: He won the Nobel Prize in 1918 for his discovery of energy quanta.

Q: Who was Max Planck?

Four teams will compete against each other in each game. Each game will consist of three rounds, Jeopardy, Double Jeopardy and Final Jeopardy.

The first two rounds, Jeopardy and Double Jeopardy, will each last 5 minutes. Each will consist of six categories with each with five answers. The categories will cover physics topics ranging from famous physicists to quantum physics. The five answers in each category will have point values worth 100, 200, 300, 400, 500 points in Jeopardy, and 200, 400, 600, 800, 1000 points in Double Jeopardy. The more an answer is worth, the more challenging it will be. The team selecting the first category and value will be chosen by random draw in Jeopardy and by highest score in Double Jeopardy.

Once the answer is revealed, teams will have five seconds to "buzz-in" to provide the correct question. The first team to "buzz-in" has five seconds to do so. If the correct question is not provided is the remaining eligible teams have an additional three seconds to "buzz-in". A correct question will add the answer's value to the team's score, and an incorrect one will take its value from the team's score. The team with the last correct response chooses the next category and value.

After each correct question, all teams will be required to rotate their team members to ensure that all team members participate in this event.

In Final Jeopardy, a category will be given, and the teams will have fifteen seconds to record how many points they wish to wager on the final answer. This number can be between zero and their score, inclusive. Only teams with a score greater than zero are allowed to compete in Final Jeopardy. Once the final answer is revealed, the teams will have one minute to write their question. The winner of the game is the team with the most points.

Game winners will be ranked according to their final point scores. The four top scoring game winners will compete in a final game of Jeopardy! to determine first through fourth place. The remaining places will be awarded first to remaining game winners according to point scores, then to all other teams according to point scores.

## **Ballistic Egg Event**

This event involves the construction of a protective capsule which safely protects an egg during a ballistic flight and landing on a target. The capsule is to be constructed at the time of the event from the materials supplied by the event organizers. The package will be tested with a launcher supplied by the organizers. The contestants will need to do calculations based on uniformly accelerated motion in order to determine how to adjust the launcher so that their capsule hit the target. For example, what initial velocity do you need in order to hit the target.

**Materials:** The capsule and any supplements to the launcher must be made from the following materials that will be provided at time of the contest:

- 1 garbage bag (26 inch by 36 inch)
- 2 meters of zinc alloy wire (16 gauge; approximately 2 mm diameter)
- 3 meters of duct tape
- 2 styrofoam coffee cups (195 ml)
- 20 meters of unwaxed dental floss

**Equipment:** Teams will be provided with the following tools to calculate adjustments to launcher:

- Calculator
- Paper
- Timing Device

The contestants will be allowed to use the tools they brought for the Rubber Band Boat Race to build their package.

**Rules:**

1. Contestants will have 12 minutes from the beginning of the event period to assemble the capsule from the materials provided and to calculate the adjustments of the launcher. The craft must carry 1 raw egg, which will be supplied by the event organizers at time of construction. The egg can be placed anywhere in the capsule; however it must be readily possible to determine the condition of the egg by inspecting it at time of landing. All, some or none of each provided material may be used in the construction of the craft.
2. At the end of the 12 minute period, contestants must line up for the first launch attempt. Each team will be given a total of two launch attempts; the best score out of the two attempts will be counted as the team score. The order of launch will be randomly chosen by the organizers; however teams will receive their first and second launch attempts in the same order. Teams will have the time between their first and second launch attempts to readjust the launcher or modify their capsule to improve their score. Only one set of materials may be used, although in case of breakage of the first egg, a second egg will be supplied.
3. The capsule and supplemental materials if any must be placed on the launch surface within a span of 90 seconds from the time the team is called to the launcher.
4. No form of external power or assistance of any kind may be given to the craft other than that provided by the launcher.
5. Interference from anyone on the team or the team's school with the craft at any point after its launch will be judged as a failed attempt and awarded a score of 0. External interference from other unanticipated sources may be judged as grounds for a re-launch as decided by the event judge. However, hitting walls or other fixed obstructions will not be grounds for a re-launch.

6. Score is based on how close to target and the condition of the egg. If the egg cannot be easily removed from the craft for inspection, the judge may disassemble or tear apart as much of the craft as necessary to determine the condition of the egg. Contestants are not given replacement materials to repair or replace any damage caused by making this

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