

THE EIGHTEENTH

UBC PHYSICS OLYMPICS

RULE BOOK

March 11, 1995

The Rules

- [River Ferry Race](#)
- [Paper Bridge](#)
- [Mystery Event](#)
- [Jeopardy!](#)
- [Optical Obstacle Course](#)
- [Intuitive Physics](#)

Financial sponsorship is provided by the Rex Boughton Memorial Fund.

The UBC Physics Olympics is organised by the Department of Curriculum Studies (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.

Please direct all inquiries regarding the rules to K. Schleich or D. Witt at 822-6286 or via email to olympics@noether.physics.ubc.ca.

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.

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 the Event Designers:

Vikas Bhushan Glenn Wells Irfan Dhalla Paul Harrison

Steve Brown Jenny Riecken Elizabeth Nethery Jamila Fazal Karim

Don Witt Tiago De Jesus Alex Dickenson Andrew DeBenedictis

Darwin Hawes Louie Van De Lagemaat

and to

Dr. Brian Turrell, Head UBC Department of Physics

and all students of the Physics and Physics Engineering program who assisted in this Physics Olympics.

[Back to Olympics](#)

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River Ferry Race

The object of this event is to construct a ferry powered by a crosswind that covers the racecourse described below in the shortest amount of time. This ferry is to be prebuilt by the contestants.

Rules for Construction:

1) Ferries must be built by the contestants **only** of materials in the following list:

Paper, Cardboard, Aluminium Foil, Aluminium Soda Cans, Polystyrene Foam, Cloth, Pieces of wood less than 2 cm in diameter by 20 cm in length such as Match sticks, Popsicle sticks, Bamboo skewers and Balsa Wood sticks, Wire of equal or smaller gauge as that in metal coat hangers, Dental Floss, String, Staples, Paper Clips, Scotch Tape, Masking Tape, White Glue, Wood Glue, Rubber Bands, Pennies.

Materials can be cut, reshaped or carved in any manner by the contestants.

2) The energy utilised to propel the river ferry must come only from the crosswind produced by the fan bank. This energy may be stored or converted into other forms for use in moving the boat. Energy needed for any other ferry functions such as steering must also come only from the crosswind either directly or from a stored or converted form.

3) The ferry must have a length of no more than 22 cm at its longest point, a width of no more than 30 cm at its widest point and a height of no more than 40 cm at its highest point. These restrictions must be satisfied at all times during the race. The ferry must be completely self-contained; it must leave no part of itself behind while racing.

4) The ferry must be designed to carry two passengers consisting of one adult and one child *Playmobil* figurines. (See figure 1.) The figurines will be provided by event organisers on race day and must be returned undamaged at end of test runs. The passengers must be carried in a civilised manner, that is they must sit, lie or stand freely in or on the ferry. A simple test of this is that the passengers must fall out when ferry is turned upside down. Thus, for example, they cannot be tied, taped, glued or stapled to the ferry on race day. The adult figurine weighs approximately 13 gm and is approximately 7.5 cm tall by 3.5 cm wide by 2 cm deep while standing and 5 cm tall by 4 cm deep while sitting. The child figurine weighs approximately 7 gm and is approximately 5 cm tall by 3 cm wide by 2 cm deep while standing and 3.5 cm tall by 2.5 cm deep while sitting. Note that both the arms and legs of the figurines are positionable.



Figure 1: Playmobil adult and child figurines.

5) The ferry must be able to trigger the timing gates; that is it must contain some opaque part that is at least 5 cm in width at any height between 8 and 13 cm above the water. This opaque part must also be parallel to the length of the ferry. For example, this requirement can be satisfied by a 5 cm by 5 cm flag with its centre positioned 10.5 cm from the water flying parallel to the length of the ferry. It can also be satisfied by some

other part of the ferry such as its sail.

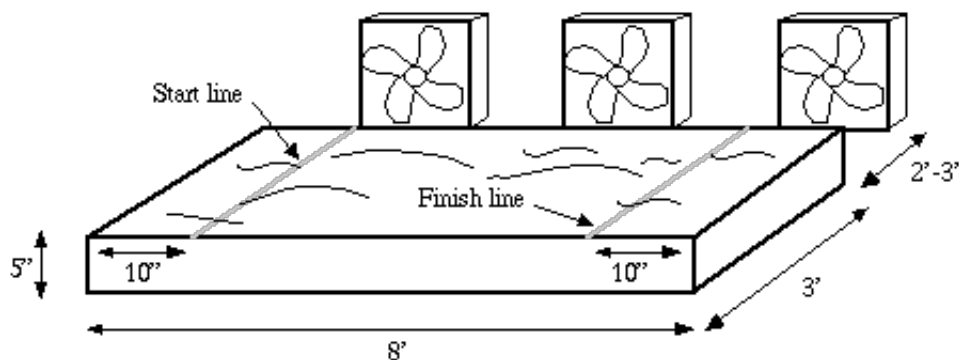


Figure 2: Trough for River Ferry Race:

Racecourse:

The course will consist of an 8 foot long by 3 foot wide by five inch deep trough filled with approximately four inches of water. The start line will be placed 10 inches from one end of the trough and the finish line will be placed 10 inches from the other end. Wind will be supplied by a fan bank consisting of three equally spaced standard 22 inch by 22 inch box fans on low setting. These fans will be placed parallel to the length of the course at a distance of between 2 and 3 feet from the trough. (See figure 2.) Contestants cannot move the fans.

Racing and Scoring:

6) Teams will have total of 5 minutes to set up and make a maximum of 3 ferry runs.

7) For each run, the ferry will be released by the team from the end of the trough nearest the starting gate. The ferry must be released without providing it any force. Ferry must not contain any stored energy at time of release. After release, *there must be no external intervention of any sort until run is completed.*

8) The timer will start when the flag or other opaque part of the ferry at the height specified in 5) crosses the starting line and will stop when it crosses the finish line. The ferry must remain in contact with the water at all times. The ferry may make contact with the sides of the trough or take on water without disqualification, but all parts of the ferry must finish together. In particular, any run on which a passenger falls overboard will be disqualified.

9) Teams can stop a run at any time by request to the event organisers. Note that a stopped run counts toward the maximum of 3, but is disqualified. Teams may perform adjustments on their ferry between runs.

10) The winning ferry will be the one that has the fastest single run. In the event of a tie, the total time of the fastest two runs will be used to resolve it. Any further ties will be broken by the judge's decision on most innovative design.

Advice: Note that the ferry will be sailing in a crosswind! Additionally observe that there may be irregularities in the crosswind due to the edges of the fans, though event organisers will make the wind as uniform as possible. As race conditions may vary from those at your high school, teams should plan to be able to make small adjustments to their ferries on race day. In particular, wind conditions may be slightly different and the water level in the trough may be slightly higher or lower. Finally, 2 foot by 8 foot 1" thick sheets of pink polystyrene foam are used for insulation and are available at hardware stores and building supply stores.

Paper Bridge

The object of this event is to build a paper bridge on site of the smallest amount of materials that supports the largest possible weight. Teams will supply their own prebuilt test weight.

Materials:

The contestants will be required to bring the following three supplies:

1. Standard paper staplers with standard staples
(Staples with 1/2" crown, 1/4" leg, chisel point.)

2. Scissors.

3. One test weight, henceforth referred to as a "truck".

The event organisers will provide each team with exactly fifteen 8.5 x 11 in. sheets of paper. Please note that you will only be allowed to use the paper that is given to you by the event organisers. Since you will receive only fifteen sheets of paper it is highly recommended that you practice before coming to the Olympics and bring a "blueprint".

Rules for Construction of Bridge:

1) The bridge must be constructed during a 10 minute period at the beginning of the event. It must be constructed from no more than fifteen 8.5 by 11 in. sheets of paper and staples only. This paper will be 20 lb. long grain white copy paper of type typically used in copiers and will be provided by event organisers. An unlimited number of staples are allowed, but every staple used in the bridge must pierce some piece of paper provided by event organisers. The paper may be cut into any shape and as many pieces as desired. Contestants may bring a "blueprint" of their bridge design to aid in the construction, but no piece of the blueprint may be incorporated into the bridge itself.

2) The bridge must have a minimum clear span of 36 cm and an overall length of no more than 80 cm. It must be constructed in such a way that it can be supported at both ends on a flat horizontal surface. It must have a roadway, i.e. a deck such that a toy car of width of 3 cm. can safely roll over the bridge from one horizontal surface to another. (See figure 3.)

3) Bridge must be strong enough to support the team supplied "truck" for 1 minute.

Rules for the "Truck":

4) The "truck" must have a length of less than 15 cm and a maximum width that is within 120% of the width of the roadway. It must be one unit. It may be made of any material and may be any shape that conforms with the previously specified dimensions. It must be designed such that it can be placed centred on the span on top of the roadway. When so placed, it must not have any part hanging below the roadway.

5) The "truck" must be checked-in as a prebuilt. Its weight at check-in time must be specified by the contestants.

Rules for Event:

6) The "truck" will be weighed by event organisers at beginning of event to obtain the official weight. The "truck" must have the weight specified at check-in.

7) Contestants will be provided with two horizontal surfaces set a distance of 36 cm apart. Each surface will be covered with one 228 mm by 279 mm sheet of 80 grit garnet paper backed sandpaper secured with masking tape. The sandpaper will extend to the edge of the surface. The bridge must sit freely on these surfaces; it cannot be secured to this surface by staples or any other means. Moreover, the horizontal surfaces must provide the sole source of support for the bridge; for example, the bridge cannot be supported by the floor, ceiling or vertical edges of the surfaces.

8) Contestants will have 5 minutes to set-up their bridge to traverse this required minimum span and demonstrate that it will hold the "truck" for one minute.

9) Contestants will notify event organisers when they are ready to place their "truck". Event organisers will then indicate that they are ready to judge the event. The "truck" will then be placed on bridge by contestants. It must be centred on the span on top of the roadway with no part hanging below the roadway. It must be supported only by the paper bridge; that is it must not be supported in whole or in part by the horizontal surfaces or any other support.

10) Bridges that collapse in under one minute result in disqualification. Score for bridges that support the "truck" for at least one minute are given by the following formula: $W/(P+2)$

where W is the weight of the "truck" and P is the number of sheets of paper used in whole or in part by the contestants. The bridge that maximises this score wins. In the event of a tie, the bridge with the fewest staples will place highest.

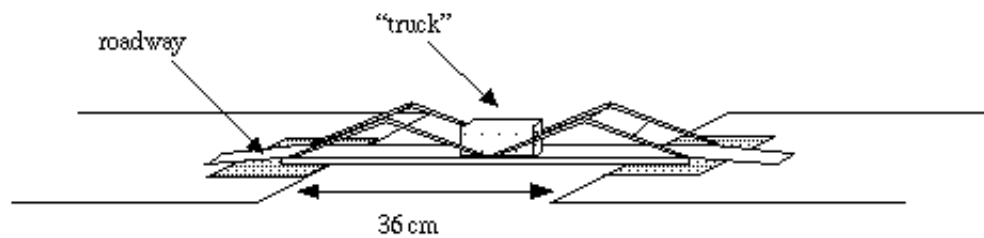


Figure 3: Example of a Bridge

Mystery Event

This event will involve solving a simple experimentally oriented problem or problems using logic and knowledge of basic principles of physics, especially Bernoulli's equation for fluid flow.

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 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.

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.

Optical Obstacle Course

The goal of this event is to direct a laser beam or beams through an optical obstacle course to a hit a target as accurately as possible. The optical obstacle course will contain optical objects such as prisms, plane mirrors and other transparent objects with specified indexes of refraction. 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) 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.
- 2) 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.
- 3) 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.

4) No trial runs are permitted. The laser will be turned on by one of the event coordinators after the students' set-up is complete. (Alternately, at the end of the allotted time if this comes before the contestants have fully completed their set-up). After the laser has been turned on by the coordinator, no course objects may be moved.

5) Score will be based on accuracy at hitting the target with severe penalties if beam path misses the required fixed course components. Time spent in solving the course will be used to resolve any ties with shorter time being better.

Intuitive Physics

Each team will be presented with three to four simple demonstrations or experiments based on basic principles of mechanics, electricity and magnetism. Teams will be required to provide answers to questions based on these demonstrations or experiments. 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.

An example of a simple demonstration is the following:

Teams are provided with plastic rods, one of which is suspended on a string, fur, silk and other items. Teams are invited to see what happens when the rods are rubbed with the various items and placed near each other. Teams are then asked which items have like charge and which have opposite charge when rubbed against plastic rods. Teams are also asked to explain how they arrived at their conclusions.

[Back to cover page](#)