THE FIFTEENTH

UBC PHYSICS OLYMPICS

RULE BOOK

MARCH 28, 1992

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

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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.

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:
Brian Dudra, Thang Lieu , Hugh Thompson, Fayaz Khaki, Pong Ling Hiew, Isaac Leung, Cyndy Araujo, Don Witt, Gary Lim, Rob McDuff,
and to

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

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The Mass Powered Grand Prix

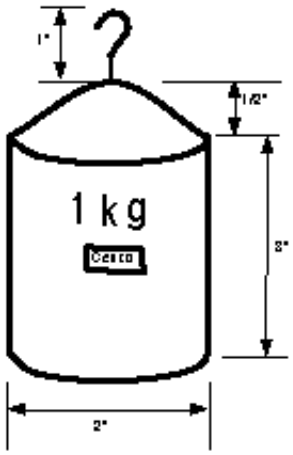
This event will be held in the Scarfe lobby. This event involves the design of an apparatus that utilizes the energy produced by two 1 kilogram masses falling a maximum vertical distance of one meter to move an object a distance of **precisely 10 meters.**

Apparatus: The part of the apparatus that will be measured for distance is called the object. The entire apparatus can be the object itself. The object must be designated by the contestants before the beginning of the race.

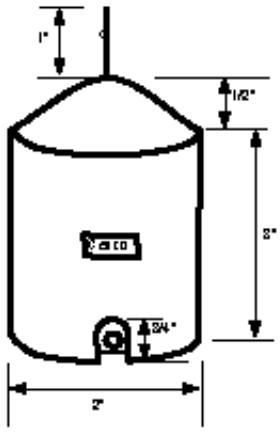
1. The total energy for moving the object can **only** come from the energy produced by the two 1 kilogram masses falling a maximum vertical distance of one meter. The masses must be released from rest. The energy produced by the falling masses can be stored or converted into other forms by the apparatus for use in moving the object.

2. The two 1 kilogram masses will be supplied by the event organizers. They must be mounted on or utilized by the apparatus without altering them in any way and returned undamaged at the end of the event. Note that if the masses are to be attached to the apparatus, **they must be attached by string or fishing line** in order to satisfy the requirements of rule 1.

3. 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.



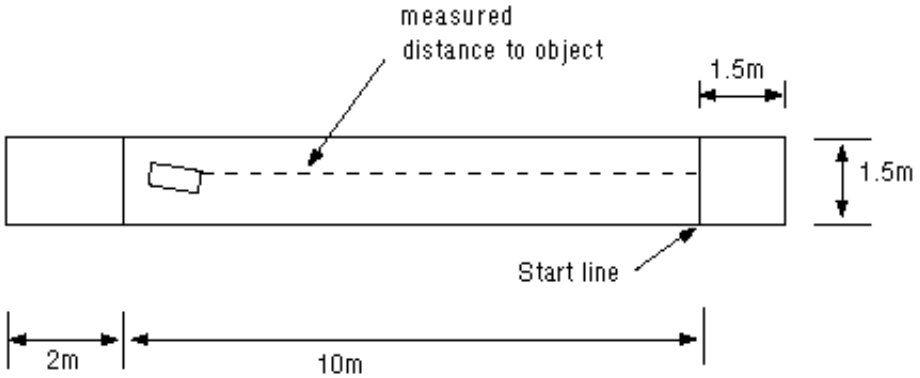
Front View of 1 Kilogram Mass



Side View of 1 Kilogram Mass

Rules: The rules for the event are as follows:

4.The object will have to move on a hard linoleum floor and will be required to complete their travel within an area approximately 12.0 meters long and 1.5 meters wide. Objects exiting this area will be disqualified. The object must remain in contact with the ground at all times. The starting line will be at one end of this rectangle and will be approximately 1.5 meters wide. There will be an approximately 1.5 meter square area behind the starting line for set-up of the apparatus.



Schematic of Track

5. No part of either the apparatus or the object can be in front of the starting line before the masses are dropped. No external intervention is allowed after the release of the masses. **Specifically, no external intervention is allowed to stop the object.**

6. The maximum score will be attained by an object that travels a distance of precisely 10 meters. **The distance will be the shortest distance from the rearmost point of the object to the starting line.** Objects that travel either further or less than 10 meters will be assessed a penalty proportional to the absolute value of their distance minus 10 meters, i.e. |d-10|. The distance that the object travels will be measured after the object comes to a complete stop. Anything attached to the object is considered to be part of the object as well in the measurement of distance. A maximum time of 5 minutes is allowed for the object to travel.

7. Contestants will be allowed two tries. The best score attained in the two tries will be used as the team score. In the event of a tie, both scores will be used to resolve the tie. A final tie breaker will be the creativity of the apparatus design as judged by the event organizers.

The Egg-Shot

This event involves the construction of a craft capable of sustained flight which safely conveys and lands an egg. The craft is to be constructed at the time of the event from the materials supplied by the event organizers. The craft will be tested by a vertical launch from a launcher supplied by the organizers.

Materials: The craft 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

Launcher: The launcher will be provided. It will consist of a horizontal platform on which the craft and any supplements must be placed. All parts must fit within a 0.6 meter diameter circle on the launch surface. The launcher will impart an average force of approximately 13 Newtons to the craft over approximately 0.4 meters of vertical travel. (For the purposes of prototyping a craft, this is roughly equivalent to an underhand toss.) Any supplemental materials such as dental floss and craft supports may be attached with duct tape within the 0.6 meter diameter circle on the launcher.

Landing: If weather conditions permit, the event will be conducted outdoors. If necessary, the event will be carried out on the stage of Scarfe 100 and the launcher will be placed against the back wall of the stage in a central location. The ceiling height of this room is sufficient to ensure that craft will not hit the ceiling. Measures will be taken to ensure fairness in the event of obstacles being hit; however craft striking fixed immovable objects such as walls will not be given an additional launch attempt.

Rules: The rules for the competition and scoring are as follows:

1. Contestants will have 12 minutes from the beginning of the event period to assemble the craft from the materials provided. 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 craft; 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. The material may also be used to make supplements to the launch pad such as supports for the craft. Sketches or blueprints of any size may be brought to the event but neither they nor any other material except those specified above may be used for any part of the team's entry. Wire cutters and scissors will be provided.

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 rebuild or modify their craft 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 craft 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. The actual launch of the craft will be conducted by an event organizer.

5. No form of external power or assistance of any kind may be given to the craft other than that provided by the launcher.

6. 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. Howev-er, hitting walls or other fixed obstructions will not be grounds for a re-launch.

7. If the egg is cracked or broken upon landing, the attempt is considered as failed and a score of 0 is awarded. 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 determination.

8. If the egg is unbroken upon landing, the score will be directly proportional to the time of flight. The time of flight will be measured from the time that the launcher begins its motion to the time that the craft first touches the ground. For scoring purposes, the launcher itself is defined to be part of the ground.

9. Ties will be resolved by the distance that the egg travels from the launcher. The furthest distance will win. The distance will be measured as the radial distance from the launcher to the point of first touchdown of the egg.

Hints: This event gives the best results to a true team effort; namely by having one person build an egg carrier, another cutting dental floss, a third cutting up the garbage bag, etc. If you wish to pre-test your ideas, it is suggested that you first try them using some non-breakable object the same mass as the egg.

Electrical Circuits

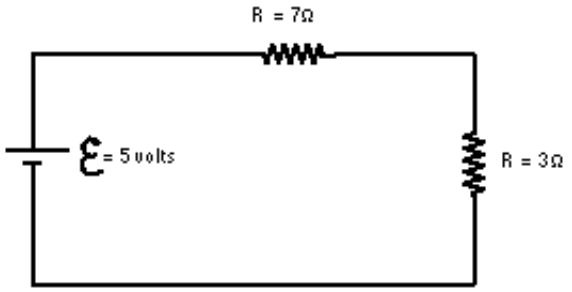
This event will require teams to solve a small number of circuit problems involving components such as resistors, capacitors, light bulbs, switches and diodes.

Materials: The following equipment will be provided: digital multimeters sufficient components to assemble all circuit problems a non-programmable calculator

Rules:

1. Contestants are not allowed to bring or use any other materials or equipment than those provided with the exception of pens or pencils for writing.

2. Teams will be provided with a sheet containing circuit problems at the beginning of the event. The teams are responsible for correctly assembling the corresponding circuits from these diagrams and the equipment provided. The teams must then add or modify a component in the circuit that will change its behavior in the required fashion. A simple example is provided the diagram below; given this circuit, find the size of the resistor that when added in series makes the



Simple Example of Circuit Diagram

current in the circuit become .25 A. Contestants should expect that the circuit problems at the event will typically be more difficult than this example.

3. Teams must draw in the component in the correct place on their circuit problem sheet and clearly label its value on the sheet. Teams must turn in their circuit problem sheets when they have completed the event or at the end of 30 minutes. No more than 30 minutes will be allowed for the completion of this event.

4. Teams are encouraged to test whether or not their solution is correct by "purchasing" the necessary size component from the event organizers. The event organizer will dispense the requested amount of resistance, capacitance, etc. upon written request of the team.

5. The score will be based on the number of correct answers less a factor based on the number of "purchases". For example, a team may receive a score of 5 for a correct solution to a circuit obtained with either 0 or 1 "purchase", a score of 4 for a correct solution obtained with 2 "purchases", a score of 3 for a correct answer obtained with 3 "purchases" and so on. An incorrect answer will receive a score of 0. Therefore, it is to a team's benefit to check their solutions!

6. Ties will be resolved by time; the team that obtains the maximum score in the fastest time will win.

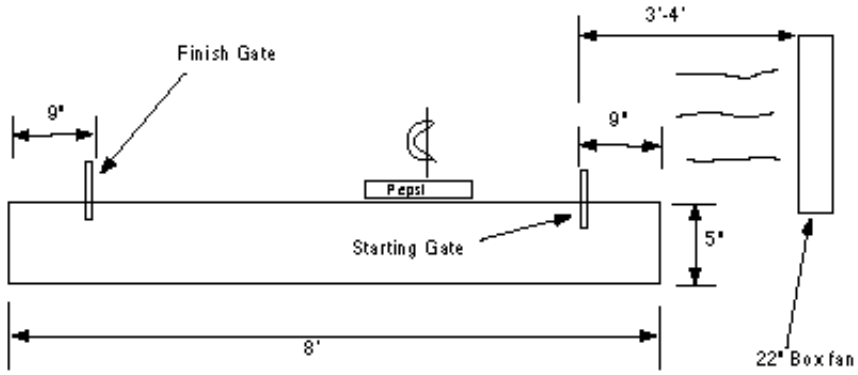
Pepsi Can Boat Race

The object of this event is to build a sailboat out of no more than 3 standard Canadian Pepsi cans that will sail the racecourse described below in the fastest possible time.

Materials: Rules for construction of boat:

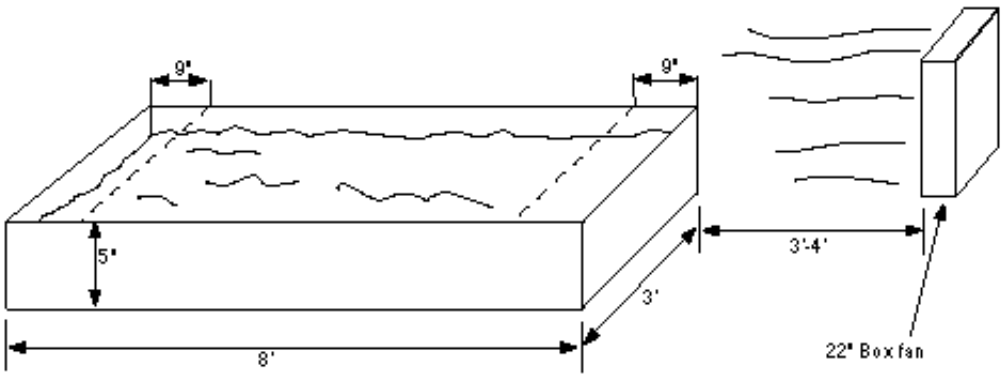
1. The boat must be constructed only from the pieces of no more than 3 standard 375 ml **aluminum** Canadian-made Pepsi cans. You may cut, bend, crimp, puncture, etc. the three cans, but **may not use any other material what-so-ever in the construction of the boat**.

2. The boat must not be longer than 9 inches and must have a minimum height of 4 inches above the water line.



Side 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 starting 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. There will be a source of wind power provided; it will be produced by a standard 22 inch by 22 inch box fan on low setting. The fan will be placed 3 to 4 feet away from the starting end of the trough.



Perspective View of Trough

Rules: For racing and scoring:

3. 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.

4. The timer will start when the sail crosses the starting gate and stop when the sail crosses the finish gate. The

score will be proportional to this time.

5. 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.

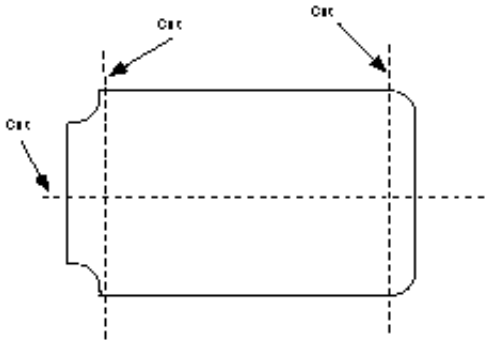
6. Should there be a tie for the best time, another set of time trials will be run to break the tie. The judge's decisions will be final.

Additional Information:

7. Each boat will be weighed upon arrival to ensure that it is not made of more than the allotted 3 Pepsi cans.

8. Judges reserve the right to disassemble any boat to check its composition after the time trials are completed. If materials other than those from Pepsi cans are used, the boat will be disqualified.

9. Contestants should take care when building their boats. Pepsi cans are fun to work with but watch out for sharp edges! Hint: One can obtain a flat piece of aluminum by making the indicated cuts on a Pepsi can.



Archimedes Principle

Teams will be required to determine the densities of various unknown fluids using Archimedes principle. There may be one or more immiscible fluids in any given container.

Equipment: Teams will be provided with: A scale (for weighing) A ruler A non-programmable calculator Water Objects of various known densities Containers filled with various unknown fluids

Rules:

1. Contestants will be allowed to bring **only** writing utensils (for the **sole** purpose of making legible marks on paper) and their own brains.

2. Teams will not be permitted to use their own calculators; the event organizers will provide a non-programmable calculator for use during this event.

3. The team's score will be based on the accuracy of the densities determined for the various unknown fluids. At the time of the event there will be a short bonus question that will be used to resolve ties.

4. Teams are allowed a total time of 30 minutes to complete this event.

5. Teams are allowed to bring and use the following lucky charms:

- 1 left foot Women's Air Nike shoe, size 7 1/2, any color
- 1 Cherry Flavored Gummi Bear

Mystery Event

Can you be cool under pressure? This event will involve the ideal gas law (Boyle's law). Also, know how to calculate volumes, surface areas, and circumferences of simple 3-D geometries (i.e. cubes, spheres, pyramids, etc). Bring a non-programmable calculator; note that this property will be verified by the event organizers.

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