THE TWENTY FIRST

UBC PHYSICS OLYMPICS

RULE BOOK

March 7, 1998

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 olympics@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 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:

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Allison Teasdale Doug Thiessen Jenny Riecken Bethany Jackson Elizabeth Nethery Lilian Fan Adrien Desjardins Don Witt

and to

Dr. Tom Tiedje, Head UBC Department of Physics and Astronomy

and all students of the Physics and Physics Engineering program who assist in the organization and running of this Physics Olympics.

The High Jump

This event will involve the construction of a simple mechanism that will jump, fling or otherwise transport itself over a wall.

Materials:

The jumper can be made **only** of the following materials:

pieces of wood, for example popsicle sticks
string

rubber bands (of any type)
lead fishing weights, washers or laboratory weights
glue

Rules for Construction of the Jumper:

1. The jumper must be pre-built and checked in upon registration.

2. The jumper must carry out its jump using only the potential energy stored in it, either in the elastic potential energy of the rubber bands or in the mechanical potential energy of its initial configuration.

3. The jumper must fit in a box that is 20x20x20 cm immediately before release and immediately upon landing.

The event designers will provide two high jumps. One consists of a 1 meter by 1.5 meter launch area of hard linoleum floor, a 1 meter high wall and a 1.5 meter by 1.5 meter landing area covered in 1 inch polystyrene foam. The other consists of a 1 meter by 1.5 meter launch area of hard linoleum floor, a 2 meter high wall and a 1.5 meter by 1.5 meter landing area covered in 1 inch polystyrene foam.

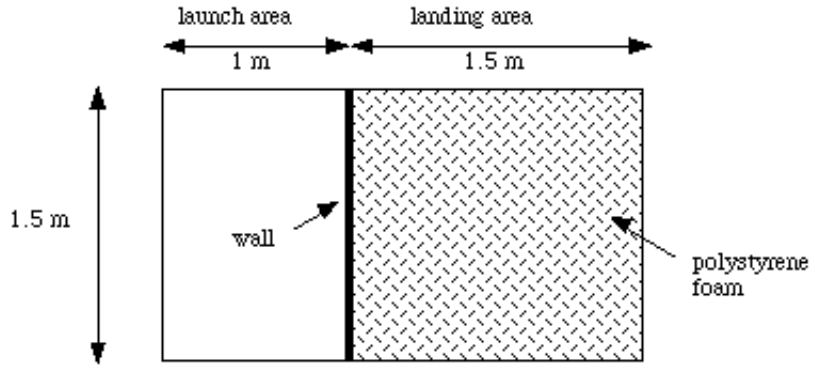

Figure 1. Diagram of a high jump.

Rules:

4. Teams will have a maximum of 8 minutes to set up their jumper and complete three trial jumps. Adjustments can be made on the jumper between trial jumps. These adjustments can include changing the weight of the jumper. A different height wall can be attempted with each jump.

5. Teams must notify the judges in advance of each jump which wall they will attempt to clear and wait for the judges indication to proceed.

6. The jumper must be in contact with the floor and entirely in the launch area at time of launch. The entire jumper must transport itself over the wall; no part of the device must be left on the original side of the wall. It must remain in one piece at all times, including at landing.

7. The jumper must not touch the wall at any point including the top at any time during its jump. The jumper must also remain in or above the chosen high jump set-up at all times for a trial jump to be successful.

8. Only one contestant is allowed to aim and release the jumper. However, this human intervention cannot supply external energy to the jumper during launch. For example, the contestant cannot throw the jumper over the wall.

9. The ceiling of the event area is at a height of approximately 4.2 meters from the floor. Jumpers that hit the ceiling at any point during their jump or damage the hard linoleum floor will be disqualified.

10. If desired, teams may bring materials to cover part or all of the landing area to assist in stopping their jumper. These materials must be no more than 5 cm thick, must be easily removable and must remain entirely in the 1.5 meter by 1.5 meter landing area.

11. The score for a successful jump will be given by wh^2 where h is the height of the wall and w the weight of the jumper at the time of the successful jump.

12. The best jump out of the three trial jumps will be the final score for this event. The highest score will win. Ties, if any will be broken by considering the scores of the other two trial jumps.

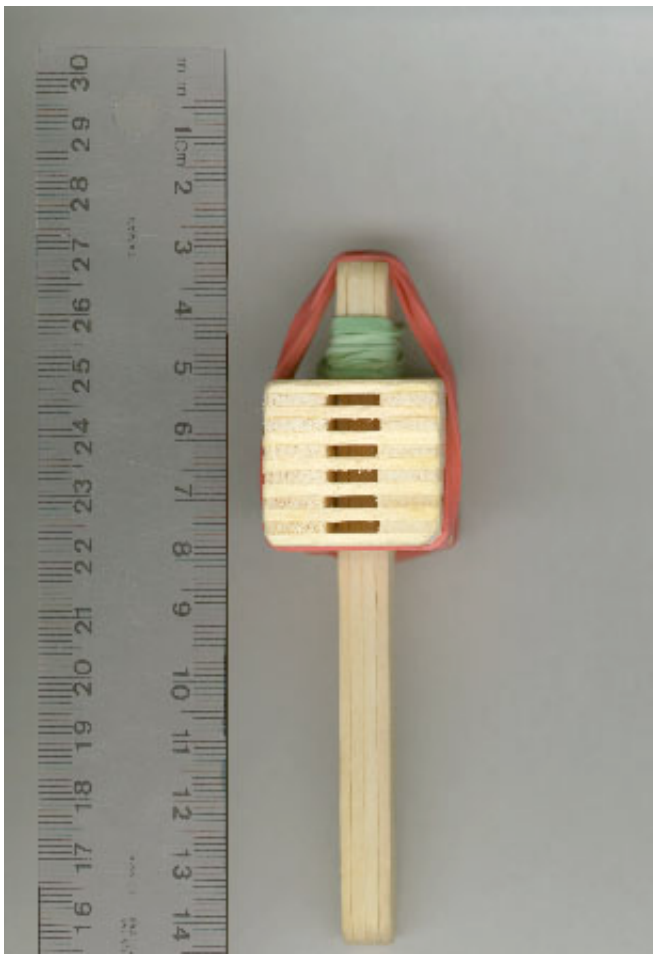

Figure 2. Picture of a jumper made of popsicle sticks and rubber bands.

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

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

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 Amazing Capacitor

Capacitors are electrical devices that can be used to store charge. This event will explore properties of simple capacitors such as a parallel plate capacitor.

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 such as aluminum foil, paper and plastic will be provided for constructing simple capacitors. You will also be given a simple circuit that will allow them to easily measure the capacitance of the capacitors they construct.

3. You will be expected to do an experiment to determine a property or properties of the capacitors you build. 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 using the circuit.

To prepare for this event, you should familiarize themselves with the basic physics of capacitors.
If you want to practice further, you can build a simple parallel plate capacitor in the following way. Take two 8 by 10 inch sheets of aluminum foil. Carefully sandwich a piece of 8 1/2 by 11 inch paper between these two sheets, making sure that the aluminum foil sheets do not touch each other. Attach a wire to each of the two aluminum sheets using alligator clips. Presto, you now have a simple parallel plate capacitor with a capacitance of a few nanofarads.

The Stationary Derrick

Contestants will build a derrick that will support a stationary load as far from the edge of a table as possible.

Apparatus:

Definition of terms used in rules:

Table --A flat stable surface for the support of the derrick.
Derrick -- A structure that both rests on a table and extends beyond its edge hold the load.
Load-- A detachable mass that is supported by the derrick some distance from the table.
Base -- portion of the derrick in contact with the table's surface.

Note that event designers reserve the right to use an object such as a lab bench as the table.

1. The derrick and load must be pre-built and checked in upon registration.

2. The derrick must be constructed by the contestants themselves and should not consist mainly or exclusively of any sort of pre-purchased model kit or device. No construction kits (e.g. Meccano, Constructs, Kinex, etc) may be used.

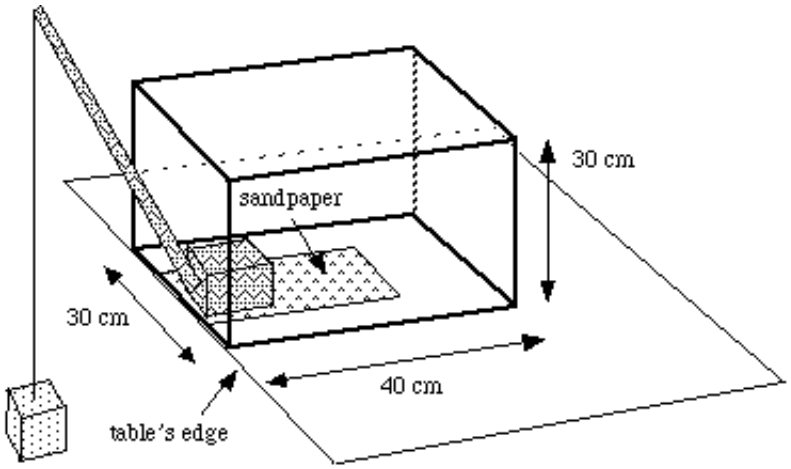

Figure 3. Diagram of the table illustrating the bounding box and a simple derrick.

3. Each team must supply their own load. It may consist of standard laboratory weights and may be of any shape, dimension or material so long as it complies with all other rules. The load must be readily detachable from the derrick for the purpose of scoring.

4. Both the derrick and the load must have a weight related to their mass by the usual formula,

$$W = mg$$

where W is their weight, m is their mass and g is the gravitational acceleration.This relation must hold at all times during the event. In addition, the weight cannot change during the event. Note that this rule restricts the composition and design of the derrick and load. For example, it rules out use of buoyant materials such as helium filled balloons.

5. The part of the derrick located directly above the table must be able to fit within a box positioned as in figure 3. This box extends 30 cm above the table's horizontal surface and 40 cm back from the table's edge. It is 30 cm wide. The part of the derrick extending beyond the table's edge can be any height and width.

6. No part of the derrick may extend below the plane defined by the table's horizontal surface. Note that this rule applies not only to the part of the derrick above the table but also to the part extending beyond the table's edge.

7. The base of the derrick may not have dimensions larger than 10cm x 10cm square.

8. The load must be supported by a single strand of string,wire or fishing line connected to the derrick at a single point. The uppermost point of the load must be at least 10 cm below the plane defined by the table's horizontal surface. The lowermost point of the load should be no more than 50 cm below this plane to ensure that it does not touch the floor. Its width must be such that it does not extend under the edge of the table.

Rules:

9. The contestants will be provided with a table for the trial. Its 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 table.

10. No part of the derrick may be attached either temporarily or permanently to the table. Moreover, the table's horizontal surface must provide the sole source of support for the derrick; for example, the it cannot be supported by the floor, ceiling or vertical edges of the table's top.

11. Only one trial will be permitted. Four minutes will be designated for the setup of the derrick. At the expiration of the four minutes or at the completion of the derrick's preparation, contestants will notify the judges they are ready to begin.

12. The trial period will begin when the judges indicate that they are ready and the contestants have released both the derrick and the load. The derrick must remain stationary, within the bounds described in rule 5, without collapsing, for the trial period of one minute. During the period no external intervention is allowed to adjust, steady, or support the derrick. A collapse of the derrick or intervention before the trial period has elapsed will result in a disqualification.

Scoring:

13. The score will be given by the formula

$$\frac{Fd}{m}$$

where F is the weight of the load, d is the horizontal distance from the table edge to the thin medium attaching the load to the derrick in and m is the mass of the derrick.

The Third Annual Physics Olympics Open Event

This year, we are again pleased to announce a completely optional event designed for the participation of those people who accompany the official teams to the Physics Olympics. This event **is not** an official Physics Olympics event and is intended for teacher teams, informal B teams (those not participating in the regular Physics Olympics events) and any other informal teams who wish to try it. No trophies will be awarded in this event, but the names of the top finishers will be announced at the awards ceremony. This event will be run at announced periods all day; anyone who wishes to participate can do so by showing up at one of these times. This year, we will revisit the 1994 event,

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 requested to bring

A pair of scissors.
A stapler with staples.

Manual cutting tools appropriate for work on polystyrene such as knives and files
One 8.5" by 11" piece of paper for notes/blueprints.

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

One 4" by 8" sheets of 1" thick Polystyrene.
One standard wooden pencil with 1.5" by 1.5" flag attached.
Four 3.5" by 2.5" pieces of rigid cardboard each consisting of 2 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 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 center 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:

4. The boat will be released 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 person launching it. The person launching it must release the boat without providing it any force.

5. The timer will start when the flag crosses the starting line and ends when the flag crosses the finish line.

6. The boat may hit the sides of the trough or take on water without disqualification, but all parts of the boat must finish together.

7. The boat must remain in contact with the water at all times.

8. The winning boat will be the one that finishes the course in the shortest time.

Note: If you want to practice, 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.