THE TWENTY FOURTH

UBC PHYSICS OLYMPICS

RULE BOOK

March 10, 2001

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 schleich@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.

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Update

Please note the correction to number of team members allowed: in particular, larger teams are welcomed, but only five or fewer members will participate in a given event. The following statement under General Rules has been added in the 2001 rule book.

A team will generally consist of five members. Smaller and larger teams are welcome, but only FIVE (or fewer) members of a team will participate in a given event, each wearing the team name tag. 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.

Back

The Loonie Car Event

This is a pre-built event which involves the design of a car that utilises the energy stored in two rubber bands to cover a 5.0 m course as quickly as possible while delivering a loonie to a target located 3.0 m from the starting line along the way.

Apparatus:

1. The total energy for moving the car can **only** come from the elastic potential energy stored in at most two size #32 rubber bands 3" x 1/8" (76 mm x 3.2 mm x 1.1mm). The two rubber bands will be supplied by the event organisers. They can be utilised in any way and do not have to remain in original condition. They do not need to be returned to event organisers.

2. The car must be constructed by the contestants themselves and should not consist mainly or exclusively of any sort of pre-purchased model kit or device. The car's mass must be less than or equal to 2 kg and its length in any direction must be no more than 0.50 m at all times.

3. The car must be designed to carry a loonie which it should try to drop at the appropriate time so as to land on a target marked on the floor. The loonie will be provided by event organizers and must be returned at the end of the event. The loonie cannot be modified in any way, for example by attaching other materials to it. The mechanism that controls the point at which the loonie is dropped must be self-contained within the car and must operate without any external intervention.

4. The car 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 and whose front edge is even with the foremost part of the car. This flag must be directly attached to a rigid vertical flagpole or other rigid vertical piece of the car. This flag must remain attached in this manner at all times. Note that flag placement is important as it is used to time the car.

Rules: The rules for the event are as follows:

1. The car will have to move on a linoleum floor drag strip approximately 1 meter wide and 5 meters long. Cars exiting this drag strip through the sides will be receive a score based on distance traveled within the drag strip (see rule 6). The starting line will be at one end of the drag strip and the target will be centred in the drag strip at the 3.0 m mark. There will be an approximately 1 meter square area behind the starting line for set-up of the car, and there will be space behind the finish line in which contestants can stop the car.

2. To begin a run, the car must be placed at the starting line with no part extending beyond this line. When the event organizers indicate to do so, a team member releases the car. No external intervention is allowed after the release of the car.

3. The car must remain in contact with the ground at all times. All parts of the car except the loonie must cross the finish line 5.0 m distant from the starting line. In particular, note that no material or substance except the loonie can be left behind the car at any point during the run.

4. The timer will start when the flag on the car crosses the starting line and will stop when the flag crosses the finish line 5.0 m away. If the car does not cross the finish line in 30 seconds, the run will be declared over (See rule 6). External intervention is permitted to stop the car after it completely exits the drag strip to prevent undue damage. For example, a person can catch the car after it completely exits; positioning must be well clear of the finish line and is left to the discretion of the judges.

5. The score for a trial run is given by the formula Score = T x d where T is the time taken for your car to traverse the 5.0 m distance from the starting line to the finish line and d is the distance from the centre of the target to the centre of the final resting place of the loonie. The winning car will be the car with the lowest score.

6. If the car does not cross the finish line in 30 seconds, a **time** T = 10 + 150 / x (x is the distance in meters traveled by the car) will be used in calculating the score. The score calculated in this manner will be higher than that of any finishing car; that is, all cars that cross the finish line will place above a car that does not. The distance x will be the shortest distance from the front edge of the flag to the starting line. If the car does not drop the loonie, or drops the loonie outside the drag strip area, a **distance** d= 400 cm will be used in the score calculation.

7. 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, the second score will be used to resolve the tie.

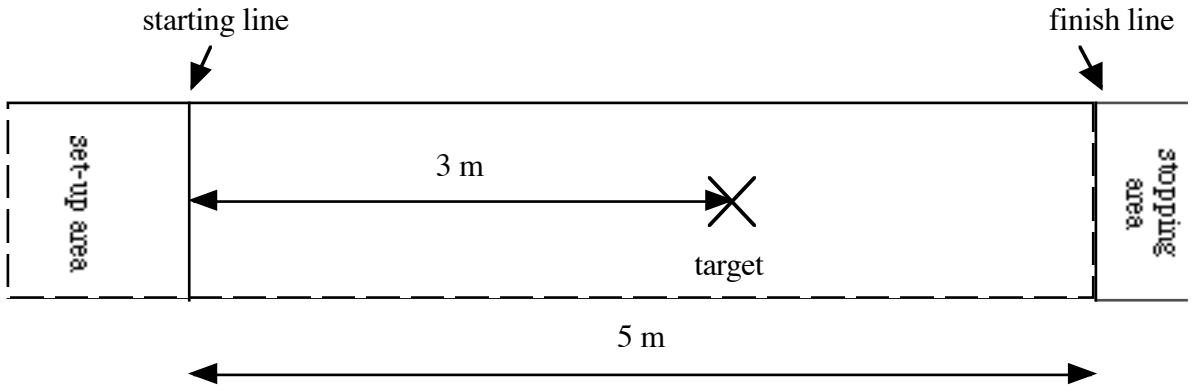


Figure 1: Top View of Drag Strip for Loonie Car Event

Intuitive Physics

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

Mystery Event

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

Micro Waves

This event involves an experiment that studies the basic properties of microwaves.

Rules:

1. Teams should bring a non-programmable calculator, pencil or pen, protractor, and a ruler. Teams are not allowed to bring or use any materials or equipment other than the above with the exception of the apparatus for the event.

2. The apparatus will consist of one or more sources that generate microwaves of constant frequency and one or more elements that will cause reflection, refraction, diffraction and or interference of these waves such as reflective surfaces and gratings. Students will also be provided detection equipment that will enable them to measure various properties of the waves.

3. Teams will be asked to measure properties of this system by devising an experiment that will do so using the given apparatus. Such an experiment may consist of a series of repositionings of the movable elements in the apparatus.

4. Teams will be judged on the accuracy of the value of their measurements. Ties will be resolved by answers to a set of of bonus questions.

The Black Monolith

This event involves teams to race to determine the circuit in the monolith. A simple example circuit for this event will be available at the Physics Olympics website, http://noether.physics.ubc.ca, in early March.

Materials: Multimeter
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 and a beta format videotape of 2001: A Space Odyssey as a lucky talisman.

2. Teams will be given a black box with several ports containing a fixed circuit consisting of some of the following components: a DC power supply, resistors, diodes, and switches. There will be no more than one component between any 2 ports.

3.The teams are expected to determine the circuit inside the black box and then draw it in a circuit diagram. There will be a sheet provided to the teams at the time of the event to outline some specific details of the circuit which will be essential to solving the problem. In addition teams may be asked to answer questions related to the circuit.

4. The winning team will be the team correctly answering all the questions and drawing the correct circuit. Part marks will be awarded to teams with partially correct answers. If two or more teams

receive the same score, the time they took to determine the correct solution will be used to break this tie.

Water Carrier

This is a pre-built event in which teams construct a rubber band powered crane which will lift and then lower a plastic Dixie cup filled with water. The crane that lifts and lowers the most water using the fewest number of rubber bands wins.

Apparatus:

1. The crane must be designed to lift, then lower, a plastic cup (Dixie 200 ml flexible party cup, 45 mm diameter base, 75 mm outer diameter top, 88 mm high) filled with water without spilling the water. The plastic cup and water will be provided by the event organizers.

2. The crane must utilize **only** the elastic potential energy stored in no more than 8 size #32 rubber bands (76 mm x 3.2 mm x 1.1mm) to accomplish its task. The rubber bands will be supplied by the event organisers. They can be utilised in any way and do not have to remain in original condition.

3. The crane consists of two parts: the body and the holder. The holder is the part that touches the cup. The body is the part that sits on the table (See figure 2). These two parts must be attached to each other only by string, fishing line or other thin flexible material.

4. The body of the crane must fit in a box of dimension 50cm high x 50cm wide x 50cm deep at all times. It must be designed so that it remains above the level of the table's top surface at all times during the event.

5. The holder must be designed so that the bottom of the cup is below all parts of the holder at all times during the event. The method of holding the cup must not alter it in any way; in particular any material used to secure the cup to the holder must be completely removable. The holder must never touch the ground during the event. The holder must allow the cup to be quickly freed for weighing after each trial.

6. The holder must not block water from flowing over the rim of the cup on any side at any time during the event. A simple test to see if the holder satisfies this requirement is that when a cup full of water is placed in the holder and the assembly is tilted in any direction, the water must freely spill out of the cup.

Rules:

1. The set-up for the event is illustrated in figure 2.

2. Each team will be allowed two trials. A successful trial consists of lifting and then lowering the cup. Each trial can take no longer than 1 minute.

3. Teams will be given a total time of 10 minutes to set up and run the two trials. Teams will be provided the plastic Dixie cup at the beginning of the 10 minute period.

4. When the team indicates that they are ready, an event organizer will provide them with water to fill the cup to the desired level. This level is chosen by the team. Note that nothing can be added to the cup except the provided water. Also the water itself must remain as provided.

5.The trial must start with the cup's bottom resting on the floor. The crane must lift the cup a minimum of 30cm as measured from the bottom of the cup to the floor than lower it back down to the floor. The trial must end with the cup at rest on the floor. No external intervention is allowed to control the crane nor is anyone allowed to touch the crane once a trial starts.

6. After the trial has ended, teams must remove the cup from the holder and give it to the event organizer. Any water on the outside of the cup must be dried off (with a paper towel) by a team member or members. The mass of the cup and water it contains as provided to the event organizer will be that used in the scoring. Observe that this means that spills of water during a successful trial or during removal of the cup by the team will lower the score for the trial.

7. The score for a successful trial will be given by the formula Score = M / N . M is the mass of both the cup and the water it contains. N is the number of rubber bands used in the crane. The best score of the two trials will be the final score. Ties will be broken using the second score and, if necessary, by the time that the cup remains above 30cm.

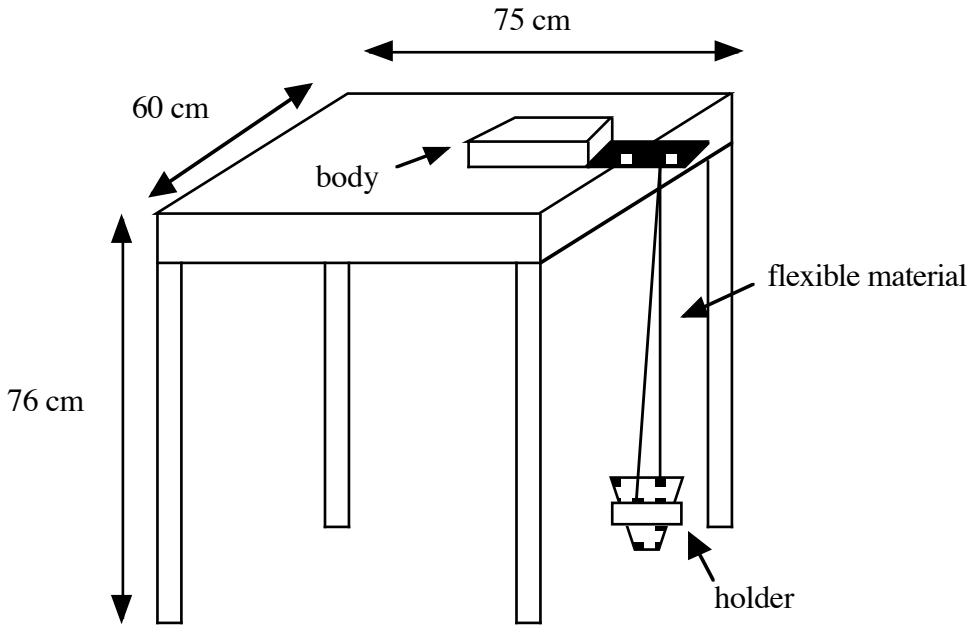
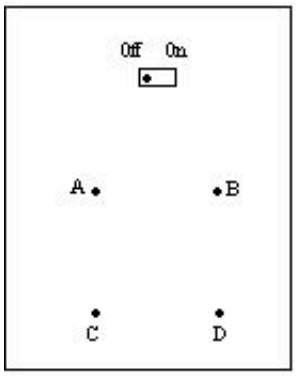


Figure 2: View of Set-up for the Water Carrier

Hint

Physics Olympics Black Monolith Problem

Black Monolith



There are five resistors in the monolith. Their resistances are 1000 Ω, 2200 Ω, and 470 Ω. Measurements between the terminal posts A, B, C, and D give the following results:

Switch off:	Switch on:
A-B = 1444 Ω	A-B = 859 Ω
A-C = 844 Ω	A-C = 723 Ω
A-D = 1375 Ω	A-D = 1375 Ω
B-C = 1600 Ω	B-C = 363 Ω
B-D = 1444 Ω	B-D = 345 Ω
C-D = 844 Ω	C-D = 723 Ω

See if you can determine the circuit inside the box based on this information. The actual circuit is shown below.