THE TWENTY EIGHTH

UBC PHYSICS OLYMPICS

RULE BOOK

March 4, 2006

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 preferably via email to schleich@noether.physics.ubc.ca or by phone to (604) 822-6286. This rule book and any clarifications 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 10 members, of which a maximum of 5 participate in each event. 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.

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

Don Witt	Darren Peets	Will Chao	Ana Pop. Jr.
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Johathan Fraser	Carole Yuen		

and to

Dr.Jeff Young Head, UBC Department of Physics and Astronomy

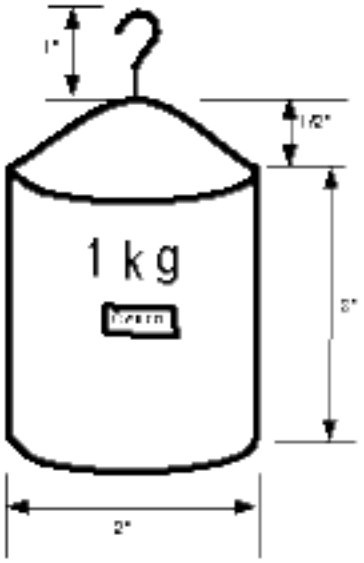
and all students of the Physics and Physics Engineering program who assist in the design organization and running of this Physics Olympics.

Do…You…Want…To…Play…A…Game?

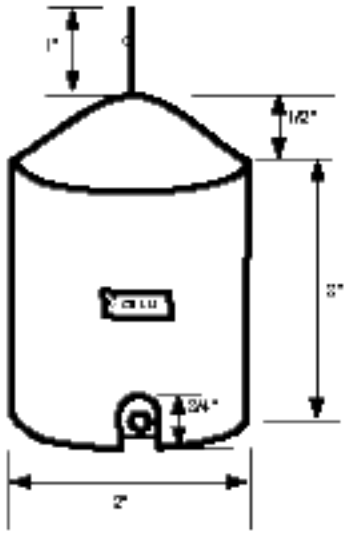
This is a pre-built event that involves the design of a cart that utilizes the energy produced by a falling 1 kilogram mass to cover a 3 meter track as quickly as possible while accurately launching a projectile using the energy stored in two rubber bands onto a target 1.25 meters to one side along the way**.**

Apparatus: The apparatus consists of three parts: the cart, the launcher and the projectile. The part of the apparatus that will be measured for time is called the cart. The part of the apparatus that will be launched and measured for accuracy is called the projectile. The launcher is the part of the apparatus that launches the projectile. The launcher must be permanently attached to the cart. The three parts must be designated by the contestants before the beginning of the trial runs.

1. The total energy for moving the cart can **only** come from the energy produced by one 1 kilogram mass falling a maximum vertical distance of 50cm. The mass must be released from rest. The 1 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 to event organizers at the end of the event. Note that if the mass is to be attached to the cart, **it must be attached by string or fishing line** in order to satisfy the requirements of this rule.



Front View of 1 Kilogram Mass



Side View of 1 Kilogram Mass

2. The total energy for moving the projectile can **only** come from two Dixon Star #32 rubber bands 3" x 1/8" (76 mm x 3.2 mm x .8 mm). The two rubber bands will be supplied by the event organizers. They can be utilized in any way and do not have to remain in original condition. They do not need to be returned to event organizers.

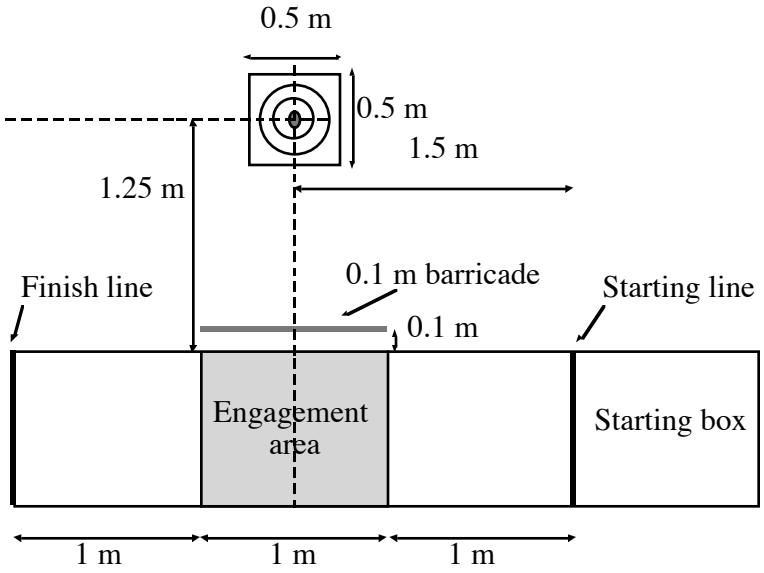
3. Observe that rules 1 and 2 do not preclude contestants from using small amounts of stored energy to trigger the launch of the projectile.

4. The cart and launcher together must have a maximum length, width and height of no more than 65 cm at all times.

5. The projectile must be a single black colored object with a maximum length, width and height of no more than 5 cm at all times. It must be completely disconnected from the cart and launcher after launch.

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.

7. 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 15 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 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.



Overhead view of the Theatre

The Theatre:

8. The theatre is illustrated above. The track is on a hard linoleum floor and is 3 meters long by .75 meters. The center of the target is 1.25 meters from the edge of the track and 1.5 meters from the starting line. Behind the starting line is a .75 meter by 1 meter starting box for set-up of the apparatus. The engagement area is the section of the track starting 1 meter after the starting line and ending 1 meter before the finish line and is delineated by black electrical tape. A 0.1 meter high barricade 1 meter in length is present parallel to engagement area 0.1 meter from the edge.

9. The circular target has an overall diameter of 1/2 meter. It is made of construction paper and is secured to the floor by tape. Its top is marked with a set of concentric circles of diameter 5, 10, 15, 20, 25, 30, 35, 40, and 50 cm. Scoring will be based on which of the concentric circles the projectile lies entirely within after it comes to rest.

Rules:

10. Contestants will be allowed a total of 5 minutes to set up their apparatus and complete two trial runs. Each trial run must be completed in 30 seconds. Contestants will tell the judges when they are ready to begin each trial. When indicated by the judges, contestants will begin the trial run by releasing the mass.

11. No part of the apparatus can be in front of the starting line before the mass is dropped. No external intervention is allowed after the release of the mass. **Specifically, no external**

intervention is allowed to guide the cart or trigger the launching mechanism.

12. The projectile must be launched from the cart onto the target while inside the engagement area and must pass over the barricade on its flight to the target. The cart must remain on contact with the ground at all times during the trial. The cart and launcher must travel entirely within the bounds of the track and not make contact with objects outside the track. All parts of the cart and launcher must cross the finish line together.

13. The score will be given by the score = T A/ M. T is the time for the cart to traverse the course. M is equal to 1 if the mass of the projectile is less than 35 g, 2 if the mass of the projectile is between 35g and 70 g and 3 if the mass is greater than 70 g. A is the diameter of the concentric circle on the target that the projectile lies entirely within when it comes to rest. Note that the smallest attainable value of A is 5. The lowest score attained in the two trial runs will be used as the team score. In the event of a tie, both scores will be used to resolve the tie.

14. The timer will start when the flag on the cart crosses the starting line and will stop when the flag crosses the finish line 3.0 m away. If the cart does not cross the finish line in 30 seconds, the run will be declared over. External intervention is permitted to stop the cart after it completely crosses the finish line to prevent undue damage. Carts that travel less than 3 meters in 30 seconds will be assessed an additional time penalty proportional to 3 meters minus the distance they attain.

15. Projectiles that break into pieces will be given an accuracy A based on the distance of the furthest piece from the centre of the target. Projectiles making contact with objects outside the track with the sole exception of the target will be assessed a penalty on their accuracy A.

16. Of course using your own W.O.P.R* to compute the necessary trajectories couldn't hurt.

*"WarGames" 1983 John Badham, director, Matthew Broderick and Alley Sheedy,

Conserve Your Energy (And Angular Momentum)

The event consists of constructing a device using given parts that will do its best to conserve potential energy and/or angular momentum.

Rules:

1. Teams are not allowed to bring or use any materials or equipment in the device to be constructed in this event other than those provided.

2. At the beginning of the event, each team will receive a set of various parts. All sets are alike. The device teams build must be made entirely from parts available. **Not all parts must be used.**

3. Teams will have 20 minutes to construct the device. After the 20 minute period, each team present their device to the judges for testing.

4. The device constructed will have to carry out a prescribed cycle or cycles of motion. The exact specification of this will be given to the teams only at the time of the event.

5. The team whose device best carries out the prescribed task will be the winner.

To prepare for this event, teams should review conservation of energy and angular momentum, especially as it applies to systems that both translate and rotate.

The Electrical Maze

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

Materials: The following equipment will be provided:

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 calculators and pens or pencils for writing.

2. Teams will be given a DC power supply and a small subcircuit containing one or more light emitting diodes and a circuit with 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. A capacitor is a charge storage device with the property that it does not allow the passage of DC current. A switch is a device that allows current to pass in both directions when closed, and does not allow current to pass when open. A resistor changes the voltage across itself according to Ohm's law.

3. Each team will be expected to find a path through the circuit that will provide a specified voltage and current to the small subcircuit. Successful completion of this task will cause the light emitting diode or diodes to perform in some specified manner. 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.

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.

Iron Chef: The Musical

In this pre-built event, contestants apply their knowledge of food and physics to the construction of a completely edible musical instrument capable of playing "Twinkle, Twinkle Little Star" in the key of G.

If memory serves us right, Canada is famous for its culinary, musical and physics talent. Thus today, March 4, we hold a novel competition in which the theme ingredients of this event are food, physics, and music. Not only must put your their culinary skills to the ultimate test like Iron Chef Rob Feenie, you must also give a winning musical performance like INXS lead singer J.D. Fortune that relies on your complete mastery of the physics of music.

Apparatus. The entire apparatus will be called the instrument.

1. Contestants must bring all materials needed for their instrument.

2. Teams can bring a tuning device to tune their instrument. However, contestants will **not** be allowed use any tuning meter or any other device to measure or adjust musical properties during the performance. **Teams found to be using such a device during the performance will be disqualified.**

3. The instrument must be constructed entirely by the contestants themselves and should not consist mainly or exclusively of any sort of pre-purchased device.

4. All materials in the instrument must be edible. In addition, the whole instrument must be edible immediately after the performance with no additional preparation. All adhesives used must be also be standard edible materials such as flour and water. Anything that must be boiled extensively before consumption or lacks nutritional or caloric value should not be a part of your instrument. In terms of materials, the best way to think of this criteria is: if you would be surprised to see it on your dinner plate, it shouldn't be a part or your instrument. Examples of **edible** materials are fruits, vegetables, candy, pasta, and cookies. Examples of **inedible** materials are sawdust, reeds, bark, and aluminum foil. Note that although these materials are nontoxic and are thus safe to be swallowed, they are not edible. Therefore they are examples of types of material that cannot be used.

5. Chairman Kaga will defer from consuming your instrument at this competition. Instead your team may be given the honor of eating your own creation. Teams should be prepared to demonstrate the nature of their materials by consuming samples of them in the presence of the judge.

6. The team must send a digital picture of their instrument and a recipe for it, both clearly labeled with the school name, before the start of the event on March 4, 2006. E-mail them to

ironchef@noether.physics.ubc.ca

7. The instrument is allowed to be of any type such as a string or wind instrument. However, the instrument must be the source of the sound production: teams cannot whistle or hum notes into the instrument. For example, an instrument such as a kazoo would violate this rule.

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Rules:

8. The team must have at most two members called musicians: one is the note player and the other is the song player. One person can do both duties. Teams must designate these two members to the

judges at the beginning of the performance.

9. All teams and spectators must be quiet during all performances. Any team making noise during any performance will be disqualified.

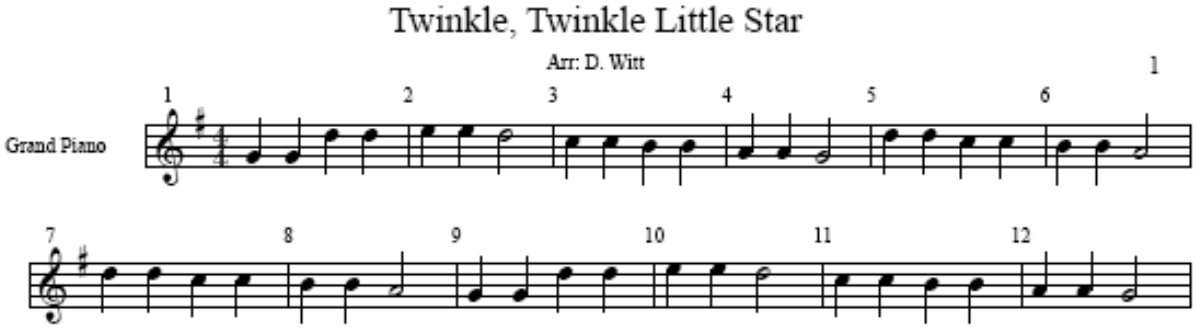
10. Before the start of the performance, the team will be called and given 2.5 minute to prepare and tune their instrument for playing. This is called the tuning period. At this point a team may use a tuning meter, or other tuning device they have brought to assist them.

11. After tuning the instrument, the performance will begin. The team note player will be asked to play and hold several notes from the song "Twinkle, Twinkle Little Star" on the instrument in the key of G. Teams may choose any octave they wish. Each note should be sustained for 2 sec. The judge will measure the accuracy of the pitch of the notes being played using sound analysis equipment. This equipment will be adjusted such that C is 256 Hz.

12. Next, with no further adjustments, the song player will perform the song, in key of G in the same octave chosen in rule 11. The tempo of the song should be such that the entire song is completed in a time between 20 and 30 seconds. Each performance will be recorded for the judge's use during the analysis. The judge will give a score based on the musical performance of the song. Again, this part of the score is determined by sound analysis equipment rating factors including but not limited to the accuracy of the pitch, the sustained nature of the notes and volume.

13. After the performance, the judge may ask your team to eat any portion of instrument.

14. The overall score is based on the score for accuracy of pitch (Rule 12) and the score from the musical performance (Rule 13). All teams will receive a score unless they are disqualified. Ties will be broken by best range and taste of the instrument.



Example: The following is a simple example of a crude instrument. This example is a wind instrument, however, your construction is not restricted to winds. Take a large carrot, 2 cm radius, and core it by using a large drill bit turned by hand. For safety, don't use an electric drill! Once the carrot is cored, one can make an open pipe or half open pipe. One can blow across the top of the carrot like a bottle to generate notes. Using multiple carrots of different lengths, a pan flute can be constructed. Finger holes can be added to improve the carrot instrument.

Two simple ways to do a rough test of the sound quality of your instrument are the following:

1. One can check it with a tuning meter. If one does not have access to a tuning meter, there are freeware and shareware tuning meter programs which can be downloaded and used on your computer to test your instrument; see our web page for details.

2. A very simple alternate to a tuning meter is to compare your instrument's notes to a ordinary instrument such as a piano or a tuning fork using beats.

Finally, teams can bring their own ice chest (cooler) to keep their instrument fresh