



# N EWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS  
(An Affiliate of the American Association of Physics Teachers)  
Spring, 2003

## Pedagogically Useful Applets in Elementary Physics

By: J. L. Hunt

There are a lot of physics applets available today on the internet - so many that there are at least three large indices of them complete with search engines. The pedagogical value of these applets varies considerably from those that are just fun to serious lessons. Building applets into student's curricula can be a very useful addition to physics courses; indeed some are so good that they can be the central experience for the students around which the topic may be structured. There are a few caveats however:

1. Many applets on the internet are ephemeral -here today and gone tomorrow. My advice is to try to avoid such material; you may expend much effort constructing lessons around them only to have them disappear. Of course you can't avoid them completely but it is best to try to use ones from sites that look stable (e.g., a university teaching site as opposed to a private address on a public server, like Geocities).

2. Elaborate artwork and animation is not a guarantee of good pedagogy, although stodgy layouts are off-putting. Some of the best are simple single-concept lessons.

3. The best applets are those from large suites by single authors who have a coherent plan and style.

4. The very best are those from authors who permit you to download the applets and run them on your own machine or network.

I would like to offer some examples of the latter:

1. Walter Fendt of Germany has created a large number of applets in all areas of Physics and Astronomy at various levels. The artwork is excellent and the animations work well. Many can be used as animated problems or as a problem checker (rather than supply answers to assigned problems). These can be downloaded from

<http://www.walter-fendt.de/ph11e/>

2. Michael Fowler of the University of Virginia has also made his applets in Mechanics available at

[http://www.phys.virginia.edu/classes/109N/more\\_stuff/Applets/home.html](http://www.phys.virginia.edu/classes/109N/more_stuff/Applets/home.html)

3. Finally, what I think is the most interesting and generous effort is that of Ron Green collectively titled "Physics Illuminations". This is an on-going project (updated monthly) with dozens of simple tutorials in Kinematics, Dynamics and Vectors. They are all single-concept, simple and progressive. They include graphing exercises, calculations, concept understanding and tests. They can be downloaded from

<http://www.uno.edu/~rgreene/illum.html>

These are highly recommended and Ron is to be commended for his generosity in granting blanket rights to the Physics teaching community. They are highly recommended. (They run best on Explorer. Netscape cuts the activation buttons in half but they will still run.)



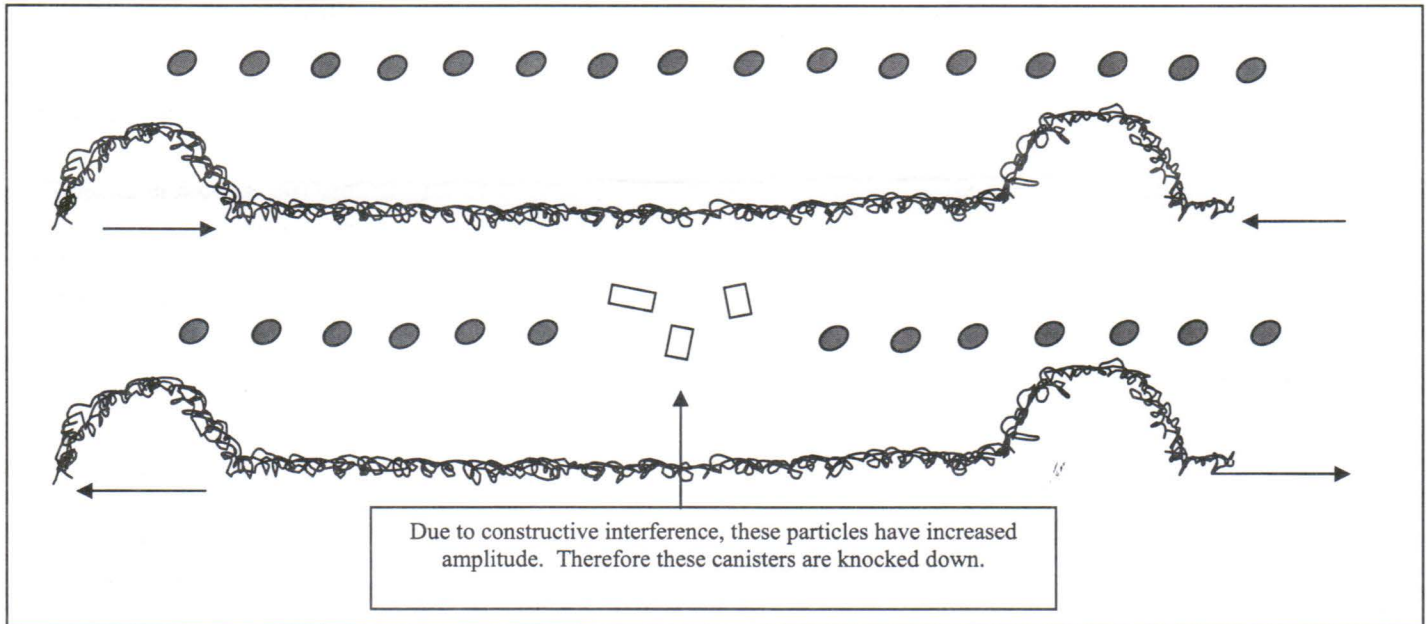
## The Demonstration Corner

### Superposition Principle – Kicking the Canister by Diana Hall, St. Charles North HS, Illinois

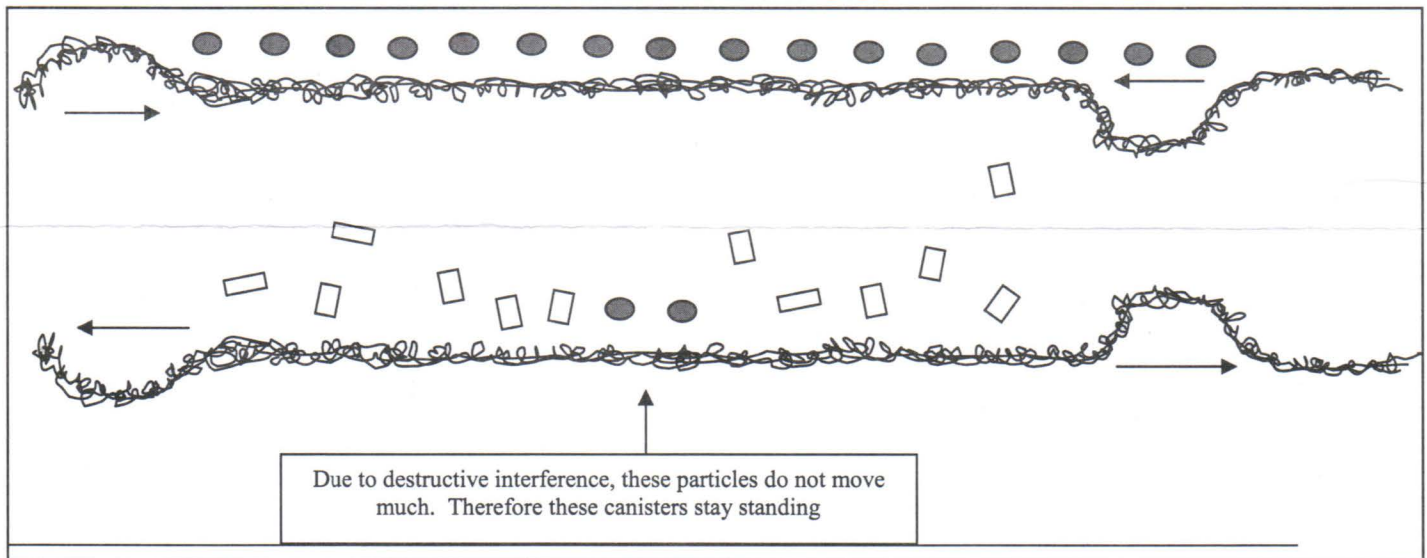


My students have fun predicting which canisters will get knocked down in an interference demonstration. We stretch out a long spring across the classroom floor. We then line up film canisters (or other substitutions) alongside the spring. Students predict which ones will get knocked over and which will be left standing. They must also say why.

#### Constructive Interference



#### Destructive Interference



Column Editor: Ernie McFarland, Physics Department, University of Guelph, Guelph, Ontario, N1G 2W1  
Email: [elm@physics.uoguelph.ca](mailto:elm@physics.uoguelph.ca)

Submissions describing demonstrations will be gladly received by the column editor.

# Extra Dimensions in String Theory

by Geoff Potvin, M.Sc., Ph.D. candidate

Every day we experience the passage of time and the extent of three dimensional space (usually only two!). When Newton formulated his laws of mechanics and gravity, he implicitly used this experience to assume a uniform, rectangular four-dimensional (three space, one time) grid upon which objects interact. In this way, space and time are absolute.

However, Einstein forced people to reconsider this notion. Trying to align Maxwell's theory of electromagnetism with the laws of mechanics led him to show that: a) the speed of light is constant, and b) different observers must observe space and time passing differently, depending on their relative velocity. This is the essence of special relativity. Generalizing this for all observers (moving with any velocity or acceleration) led to the conclusion that massive objects also distort space and time, like the bending of a large sheet when a heavy object is placed in the centre. Einstein named this theory general relativity, and it is known today as classical field theory. Classical field theory states that objects interact via fields, but the quantization (discreteness) of energy levels and fields is ignored.

Early attempts to unify General Relativity with the quantum theory of electromagnetism were ambitious, if somewhat premature. It was shown very early that if the Universe was five dimensional (4+1) then these two theories could be beautifully put together, except that there needed to be an extra dimension! The most logical thing to do is "roll" it up: compactify it so it does not extend like the other space-time dimensions. [Analogously, a two-dimensional plane can be compactified so it looks like a very long cylinder: far away, this looks like a one-dimensional line.] However, this will lead to a spectrum of particles with identical properties (charge, spin, etc) but with increasing masses, loosely called a "tower" of states. Since no tower of states is actually observed, this theory was discarded.

With the success of quantum field theory in the decades that followed (the efforts of which resulted in the Standard Model of Physics), theoretical physicists were led to the idea that all forces in nature will unify at a high energy scale. This includes gravity, which must have a quantum field theory description. The leading (and so far only) theory of unified physics and quantum gravity is string theory, which has remarkable features and beautiful mathematical structure. However, it has again forced theoretical physicists to reconsider our notions of space and time: string theory only lives consistently in TEN (9+1) dimensions! Researchers came back to the early work in general relativity to compactify the extra six dimensions. Again, this compactification leads to the possible existence of a spectrum of massive particles, none of which have been observed. However, the theory is

saved since even the lightest state in the tower will be too massive to see, if the dimensions are rolled up tight enough!

A great and useful discovery of the 1990's was that there are many other objects in string theory, which are like higher-dimensional membranes, called D-branes. In essence, the "particles" (read: strings) that correspond to our usual matter/fields such as electromagnetism are stuck on a D-brane, while gravity can interact in the full ten-dimensional bulk of string theory. One such possibility is that we live on a D3-brane (this has three space dimensions and propagates in time), which is embedded in some higher number of dimensions.

It is a fact that the behaviour of gravity at short distances is not well measured. It is possible that one or more of the extra dimensions of string theory is rather loosely rolled up, just beyond our current detection. Then precision experiments could detect small deviations at short distances from the Coulomb-type potential (force is inversely proportional to separation-squared) between two massive bodies. Our current limitations on this sort of scenario is that the compactified dimensions must be less than about 1/10 of a millimetre (large by the standards of particle physics in which protons and neutrons are about  $10^{-15}$  mm!)

This research has left unanswered the burning question, How many dimensions do we live in? Recent progress suggests that this question may not have a meaningful answer, from a technical point of view. While it is obvious that our low-energy, large distance Universe is four-dimensional, at least to a very good approximation, the complete field theory of physics may not be. A recent postulate, called the AdS/CFT correspondence throws our intuition of dimensions into doubt. This postulate states that a certain TEN-dimensional string theory construction (on an Anti-de Sitter background) is equivalent to a FOUR-dimensional quantum field theory (a Conformal Field Theory). "Equivalent" means that the physics described by these theories is the same, even if the description of any particular object/particle/string/state looks very different in each. From this we conclude that the number of dimensions of a theory may not be meaningful, rather it may be a theoretical tool like any other used to describe the objects and interactions of our Universe.

---

*Geoff Potvin is a Ph.D. Candidate in the Department of Physics at the University of Toronto. His research focuses on the resolution of space-time singularities in string theory.*

---



*The Ontario Association of Physics  
Teachers Presents:*

**The Twenty Fifth Annual Conference  
22-24 May 2003**

*Hosted by the University of Western Ontario*



**Program**

<b>Thursday Evening</b>	Renew friendships at the Barbecue Empower your teaching at one of the Workshops
<b>Friday</b>	Medical Physics - talks by internationally known London Scientists Afternoon Tours; the Banquet; Star Gaze at Cronyn Observatory
<b>Saturday</b>	Physics Education in Canada; Traffic Accident Analysis; Kinematic Illusions in Motion Pictures. Contributed papers by teachers.

"I have attended the conference 6 of the last 9 years and have always enjoyed it (despite the hassle of arranging coverage and scrounging for PD funds). I have made some lasting professional friendships and as a new teacher was very appreciative of the support offered by my Physics teacher colleagues keen to pass on their expertise" Kim Benke

We are looking forward to meeting you at this great conference. For full details and to register, visit this web site: [http://www.physics.uwo.ca/news/conferences/oapt\\_2003/](http://www.physics.uwo.ca/news/conferences/oapt_2003/). If you cannot access the web, contact: Professor Whippey, Department of Physics & Astronomy, UWO, London ON N6A 3K7.

For those of you who remember the classic "Powers of Ten" video, there is a reasonable facsimile on the web:

<http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/>

Thanks to Ernie McFarland for this submission. If you have a useful web site that you would like to share, please submit to the editor, Paul Passafiume ( [paulpassafiume@hotmail.com](mailto:paulpassafiume@hotmail.com) ), for inclusion in the next edition of the NewsLetter.

**Do you want to give back to your profession? Participate in the OAPT!**

This wonderful organization needs volunteer help in the following capacities:

- Guest presenters
- Conference organizers, and facilitators
- Members of the executive committee
- Article, and classroom idea contributors for the Newsletter



New articles, ideas, or other information items may be sent to Glen Wagner ([glenn.wagner@ugdsb.on.ca](mailto:glenn.wagner@ugdsb.on.ca)) or Paul Passafiume ([paulpassafiume@hotmail.com](mailto:paulpassafiume@hotmail.com)). Ideas for demos may be sent to Ernie McFarland ([elm@physics.uoguelph.ca](mailto:elm@physics.uoguelph.ca)).

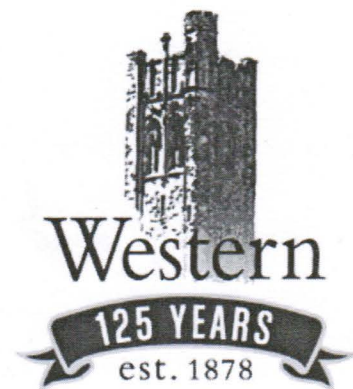
**Editorial Note**

Congratulations to all for yet another wonderful year as an educator, and proud member of the OAPT! Special thanks to those people who contributed papers, or ideas that have helped enrich all of our classrooms. Well done!



# Ontario Association of Physics Teachers

Twenty Fifth Annual Conference  
22-24 May 2003



## Highlights

- Thursday Evening** Renew friendships at the Barbecue  
Empower your teaching at one of the Workshops
- Friday** Medical Physics - talks by internationally known London Scientists  
Afternoon Tours; the Banquet; Star Gaze at Cronyn Observatory
- Saturday** Physics Education in Canada; Traffic Accident Analysis;  
Kinematic Illusions in Motion Pictures.  
Contributed papers by teachers.

“I have attended the conference 6 of the last 9 years and have always enjoyed it (despite the hassle of arranging coverage and scrounging for PD funds). I have made some lasting professional friendships and as a new teacher was very appreciative of the support offered by my Physics teacher colleagues keen to pass on their expertise” Kim Benke

## Contributed Papers

We need your contributions to make this a vibrant experience for all. Share your experiences in the classroom with others. We have room for more contributed papers. Contribute **on-line** using our website below.

## !!!Register On-Line!!!

Or use the enclosed Registration form. Either way, we are looking forward to meeting you at this great conference!

For full details and to register, visit this web site:

[http://www.physics.uwo.ca/news/conferences/oapt\\_2003/](http://www.physics.uwo.ca/news/conferences/oapt_2003/)

If you cannot access the web, contact:

Professor Whippey, Department of Physics & Astronomy, UWO, London ON N6A 3K7.

Voice (519)-661-2111 ext. 86431

Fax (519)-661-2033

[pwhippey@uwo.ca](mailto:pwhippey@uwo.ca)

# Ontario Association of Physics Teachers Annual Conference Registration Form 22-24 May 2003



Fill in this form and return it to:  
OAPT c/o P. W. Whippey  
Department of Physics and Astronomy  
The University of Western Ontario  
London ON N6A 3K7

Tel: (519)-661-2111 x 86431 Fax: (519) 661-2033 Email: [oapt@physics.uwo.ca](mailto:oapt@physics.uwo.ca)

<b>Last Name</b>		
<b>First Name</b>		
<b>Email Address</b>		
<b>Address Line 1</b>		
<b>Address Line 2</b>		
<b>City</b>		
<b>Province</b>		
<b>Postal Code</b>		
<b>Phone</b>		<b>Extension:</b>
<b>School</b>		
<b>Dietary restrictions</b>		
<b>Conference Fee</b>		\$95 Required; Student teachers \$45; Students \$20.
<b>Banquet Friday evening</b>		\$30 Optional.
<b>Lunch Saturday Elgin Hall</b>		\$12 Optional. Little food is available on campus on weekends.
<b>OAPT Dues</b>		\$ 8 Optional. Many people renew their annual dues here.
<b>Total Due</b>		Make cheque out to Ontario Association of Physics Teachers.
<b>Workshops</b>		You can attend one Workshop. Give your top 3 choices: 1 2 3
<b>A OPETA Optics</b>		
<b>B Dave Doucette HOTS</b>		
<b>C Bill Konrad Pasco</b>		
<b>D Rolly Meisel IP 2000</b>		
<b>E Jim Ross Box Diagram</b>		
<b>Tours</b>		You can attend one Tour Give your top 3 choices: 1 2 3
<b>F Diamond Aircraft et al.</b>		
<b>G Observatories</b>		
<b>H Robarts Research Inst.</b>		
<b>I Wind Tunnel &amp; Fowler K.</b>		
<b>J Integrated Manufacturing</b>		
<b>Notes</b>		

Registration for Residence Accommodation is done separately.  
Please visit the following web site: <http://www.uwo.ca/hfs/cs/oapt.htm>: