# NEWSLETTER

**ONTARIO ASSOCIATION OF PHYSICS TEACHERS**
(an affiliate of the American Association of Physics Teachers)
Volume XVIII, Number 1 **Fall 1995**

## EDITORIAL:
# Practical Work
### Valuable Pedagogical Tool or Recipe for Mediocrity

Several years ago I heard Derek Hodson speak at a Science Teachers Association of Ontario (STAO) conference in Toronto. He questioned the usefulness of lab activities as practised by most science teachers, and made a plea for a more critical appraisal of practical work in the classroom.

With increasing class sizes, decreasing budgets and aging equipment, I think it is important to ascertain the pedagogical importance of using practical work in the science classroom. Practical work itself has been more broadly defined by Hodson (1993) and others to include any method that requires learners to be active, rather than passive, in accordance with the belief that students learn best by direct experience. Some alternatives to the lab bench activities that are the usual fare in science classes include interactive computer-based activities, case studies, interviewing, debating, writing, making models, posters and scrapbooks, library-based research, taking photographs and making videos.

Practical work is only one part of what should be an integrated and inter-related set that defines a science curriculum. Hodson (1993) proposes that science education has three major aspects: 1) learning science—acquiring and developing conceptual and theoretical knowledge; 2) learning about science—developing an understanding of the nature and methods of science, and an awareness of the complex interactions between science and society; 3) doing science—engaging in and developing expertise in scientific inquiry and problem-solving. But, "if education in science is about making sense of the physical world and understanding (and using) the conceptual and procedural knowledge that scientists have developed to assist them in that task, a first step in science education must be familiarization with that world," (p. 110). Here bench work is essential in order to build up a supply of personal experiences. Solomon (1988) states that "most practising science teachers...think that experiment has a key role to play in [teaching about scientific models] because it so clearly illustrates and brings to life the ideas that would otherwise be confined to words on paper," (p. 104). She also argues that experiment can be a powerful conceptual learning tool in science when it strives to connect 'word meaning' with 'practical perception'.

In general, the readings I have done affirm the use of practical work (and, as part of that, bench work) as a pedagogically sound method of teaching science. The contentious issue is not whether bench work should be used, it is the way in which it is currently being used in the science classroom. Hodson (1991) declares that "Laboratory work often provides little of real educational value," (p. 176). Sentiments similar to these are echoed by many researchers (for example: Hegarty-Hazel, 1990; Millar, 1987; Tobin, 1990). One of the main problems is that lab work is used unthinkingly by many teachers, without a specific purpose or goal which is explicitly formulated. Hodson (1993) lists five possible questions to ask when considering the necessity of practical work:

1. Does practical work motivate students? Are there alternatives or better ways of motivating them?
2. Do students acquire laboratory skills from school practical work? Is the acquisition of these skills educationally worthwhile?
3. Does practical work assist students to develop an understanding of scientific concepts? Are there better ways of assisting this development?
4. What view/image of science and scientific activity do students acquire from engaging in practical work? Is that image a faithful representation of actual scientific practice?
5. Are the so-called 'scientific attitudes', such as open-mindedness, objectivity and willingness to suspend judgement, likely to be fostered by the kinds of practical work students engage in? Are they necessary for the successful practice of science?

In considering laboratory activities as a pedagogical tool Tobin (1990) states:

> Theory and research suggest that meaningful learning is possible in laboratory activities if all students are provided with opportunities to manipulate equipment and materials while working cooperatively with peers in an environment in which they are free to pursue solutions to

see **Editorial** on page 2

Make plans to attend the

# 1996 OAPT Conference

# YORK UNIVERSITY

Thursday, June 20 to Friday, June 22, 1996

# Report on the OAPT Conference

University of Guelph
June 22-24, 1995

by Peter Scovil, Section Representative

This year, the physics department at the University of Guelph was celebrating 100 years of physics education, and the OAPT Conference was a fitting celebration of the event. We had a great turnout of about 100 members. In keeping with the theme, Malcolm Coutts, now retired and residing in Guelph, gave us a glimpse of physics teaching 100 years ago. At the banquet, Jim Hunt described changes in the teaching of physics in the old Ontario Agricultural College—not your typical physics program!

Teaching has changed in 100 years and does not only involve new material, but also new methods. Richard Jarrell (rjarrell@yoku.ca) at York described using multimedia presentations and group work instead of the traditional lecture. John Earnshaw at Trent uses a notebook computer and Lotus Freelance Graphics 2.0 for Windows to prepare lecture slides. Judy Evans, Bill Konrad, and Al Hirsch showed us various resources available on CD ROM. Jim Hunt of Guelph showed us the Guelph-Waterloo-McMaster Interactive Video-link for teaching small graduate classes from the three campuses together using a very user-friendly video linkage.

There were four excellent workshops on Thursday evening. Unfortunately, we could only choose one, so I hope they will be offered again in other years. I attended the one on making holograms by Dianne Ness (dianness@village.ca), and picked up some very useful ideas for doing this in my own school. Other workshops involved chaos & fractals (John Childs), internet tools and resources (Tom Craig and Susan Moziar), and electronics (John Wylie).

The weather played a significant role in this conference. Frank Theakston started off with a fascinating talk on his companies that are involved in simulation of wind and snow environmental problems by scale models. He has been involved in designing such things as barns for livestock, airports, city buildings, highway windbreaks. He showed slides of his work. Teachers not far from Guelph might be interested in taking tours of the facilities. Stuart Quick (U of T, Scarborough) outlined how he was able to obtain and use weather satellite data from the visible and infra red scanners. A receiver plus software is available for about $1000 US. Kent Moore (U of T) described the interactions of hot and cold air masses, and the effects of increasing fresh water in the oceans on our weather patterns.

SNO is not snow. It is the Sudbury Neutrino Observatory, and John Simpson (U of Guelph) updated us on the project and its purpose. Other astronomical topics included using the shareware program Skyglobe in teaching grade 10 astronomy (D. Ness) and Bode's Rule (Elio Covello). John Childs showed us a piece of apparatus that he built to work with a phonograph turntable to give a force-time graph of model rocket engines.

To shed more light on the conference, Peter Scovil (petescov@village.ca) showed demonstrations of using LEDs and lasers to transmit signals using relatively inexpensive materials. K. Dalnoki-Veress, J. Dutcher, and I MacKenzie (U of Guelph) described how to measure the speed of gamma photons. George Vanderkuur showed us aesthetically pleasing physics demonstrations which could add some real interest to a lesson. We had electrifying presentations of hot dogs and pickles—a great attention-getter—by Roland Meisel, magnetic monopoles (J. Wylie), and "alternate conceptions" in current electricity by Elgin Wolfe. Dianne Ness describe a set-up to measure acceleration of objects on inclined tracks, using two photogates. Al Hirsch brought us up to date on the Physics Day At Canada's Wonderland. This year a math component was added. About 10,000 students attended. New contests will be set up for next year's May outing.

The University of Guelph physics department did an excellent job in organizing the conference, getting excellent speakers, feeding us royally, and housing us. Thanks for a great time! Next year, the conference is to be held at York University. For information contact David Logan, 108 Stacie Blvd, York University, 4700 Keele St, Downsview, ON, M3J 1P3, phone: (416) 736-5051, fax: (416) 736-5950, e-mail: dave@unicaat.yorku.ca.

**...EDITORIAL** (from page 1)

> problems which interest them. A crucial ingredient for meaningful learning in laboratory activities is to provide for each student opportunities to reflect on findings, clarify understandings and misunderstandings with peers, and consult a range of resources which include other students, the teacher, and books and materials. (p. 414).

Practical work should not be just a cookbook recipe that students follow mindlessly before doing some number-crunching and then writing down some numbers that they don't really understand. There should be a clear purpose in mind, and this purpose should not be over-shadowed by problems in setting up equipment, or difficulties in obtaining accurate data, or anything else that is not explicitly part of the objective of the lab work.

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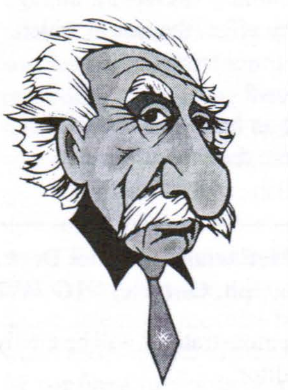
## THE PHYSICISTS' SOCIAL

One day, all of the world's famous physicists decided to get together for a tea luncheon. Fortunately, the doorman was a grad student, and able to observe some of the guests...

- Everyone gravitated toward Newton, but he just kept moving around at a constant velocity and showed no reaction.
- Einstein thought it was a relatively good time.
- Coulomb got a real charge out of the whole thing.
- Cavendish wasn't invited, but he had the balls to show up anyway.
- Cauchy, being the only mathematician there, still managed to integrate well with everyone.
- Thompson enjoyed the plum pudding.
- Pauli came late, but was mostly excluded from things, so he split.
- Pascal was under too much pressure to enjoy himself.
- Ohm spent most of the time resisting Ampere's opinions on current events.
- Hamilton went to each of the buffet tables exactly once.
- Volt thought the social had a lot of potential.
- Hilbert was pretty spaced out for most of it.
- Heisenberg may or may not have been there.
- The Curies were there and they just glowed the whole time.
- van der Waals forced himself to mingle.
- Wien radiated a colourful personality.
- Millikan dropped his Italian oil dressing.
- de Broglie mostly just stood in the corner and waved.
- Hollerith liked the hole idea.
- Stefan and Boltzman got into some hot debates.
- Everyone was attracted to Tesla's magnetic personality.
- Compton was a little scatter-brained at times.
- Bohr ate too much and got atomic ache.
- Watt turned out to be a powerful speaker.
- Hertz went back to the buffet several times a minute.
- Faraday had quite a capacity for food.
- Oppenheimer got bombed.



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## WHAT'S NEW

by Robert L. Park
THE AMERICAN PHYSICAL SOCIETY
(Note: Opinions are the author's and are not necessarily shared by the APS, but they should be.)

### Health and Cellular Phones

It all started, you will recall, when a grieving widower brought suit against cellular phone companies in 1993 after his wife died of brain cancer (WN 29 Jan 93). "She talked on the phone all the time and put it against her head," he mourned on Larry King Live. How much proof do you want? Well, if you're into statistics, a massive study is underway that will eventually include a million users. Preliminary results based on a cohort of 260,000 found no difference between cellular-phone users and a control group of mobile-phone users. Since the mobile-phone antenna is external, there is no brain exposure. But the most striking finding is that age-specific mortality of cellular-phone users is significantly below that of the overall U.S. population. So skip the broccoli, and spend a little extra time with your cellular phone.

### Nobel Laureate Dies

S. Chandrasekhar, who shared the 1983 Nobel Prize in Physics, died on Monday, August 21 at the age of 84. His work on collapsed stars led to the theory of "black holes." Subramanyan Chandrasekhar was on the University of Chicago faculty for nearly 60 years. A highly cultured man, he looked on physics as an aesthetic experience.

## Measuring the Height of a Roller Coaster

J.L. Hunt
Dept. of Physics,
University of Guelph
Guelph, ON
N1G 2W1

At the OAPT conference in Guelph in June/95 during a discussion following a presentation on "Science Day" at "Canada's Wonderland", it was mentioned that it was difficult to find the height of the various rides because it was difficult to measure angles with a precision of at least 1 degree.

A very ancient and simple device that does exactly this easily to a precision of 1/4 degree might be of interest to Ontario Physics teachers. The device is the "cross-staff" which has been used since ancient times for latitude determination and sun elevation. One form of the device is shown in the figure. This simple device can be easily made from smooth wood lath, screws and cardboard. Instructions for construction, assembly and use will be sent on request.

## WHY WAIT UNTIL IT'S TOO LATE?

The date on your address label is the expiry date for your membership. You may use the coupon below (or a facsimile) to renew it, or to indicate a change of address (or both) by checking the appropriate box. And, hey, what the heck, why not renew it for two (or more!) years; it will save you the hassle of renewing over and over again.

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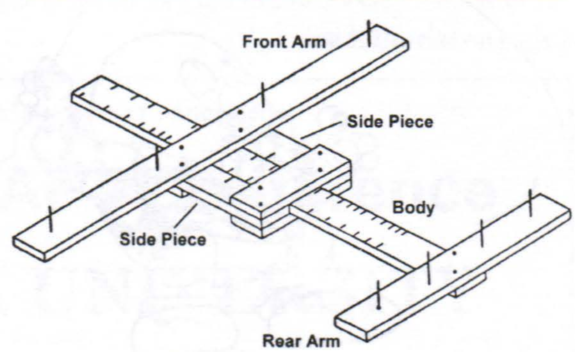



cross-staff

# Flying Time

by

**Dave Erb**

Red Lake District High School

Red Lake, Ontario P0V 2M0

This is a demonstration of centrifugal force.

## MATERIALS

- two 3-minute egg timers (the type with falling sand)
- string

## PROCEDURE

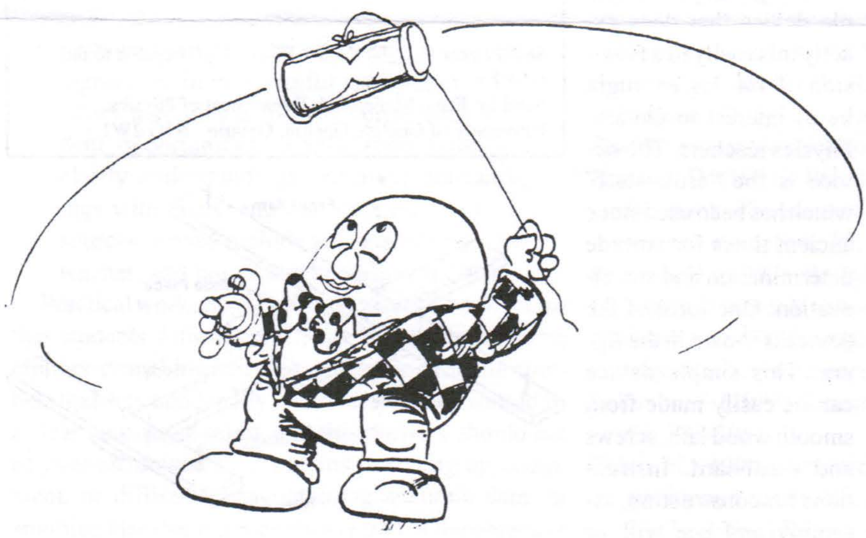
1. Ask the question "How can I get the sand to the other side of the egg timer faster?" This could be given as a challenge question to the students the night before.

2. Tie a string to one of the egg timers.

3. For comparison, turn over the timer without the string so that the sand begins to drain from one end to the other.

4. Ensure the sand of the other timer is near the string. Then swing the egg timer in a circle which is in a vertical plane pointing away from the students. A horizontal plane of swing is too dangerous because, if the timer should break, there is no way of predicting the direction the pieces will fly. You do not have to swing the timer very fast (2 to 3 Hz works well). Make sure you check the construction of the timer before you swing it. The timer may require additional glue to ensure it does not fly apart.

5. After less than one minute, you should be able to stop swinging the timer and the sand will be all in the other side. The sand in the other timer will still be falling and make a nice comparison.



Drawing by Patrick McWade

## DISCUSSION

In order to make the demonstration quantitative, we will assume that the rate at which the sand falls is proportional to the force acting on it. Therefore, the time (t) required for all the sand to fall is inversely proportional to the force (F).

Let:

$t_1$ = time required for sand to fall under gravity alone (3 minutes)

$F_1$ = force of gravity = mg

$t_2$ = time required for sand to fall under centrifugal force alone

$F_2$ = centrifugal force = $4m\pi^2 r/T^2$

where

m = sand's mass

r = radius of curvature

T = period of rotation

To compare the times, since $t \propto 1/F$

$$\frac{t_1}{t_2} = \frac{4m\pi^2 r / T^2}{mg} = \frac{4\pi^2 r}{gT^2}$$

therefore,

$$t_2 = \frac{gT^2 t_1}{4\pi^2 r}$$

Using a radius of curvature of 30 cm (r = 0.3 m) and swinging the timer around twice a second (T = 0.5 s) causes the 3-minute egg timer to drain in about 37 s, which agrees well with what is actually observed. (Therefore, our assumption that the rate of fall is proportional to the force must be pretty good.)

I have not included the effect of gravity on the vertical plane on swing because the effect of gravity at the top of the swing cancels the effect at the bottom.

## QUESTIONS

1. How long would it take an hour glass to drain if swung at 5 Hz using a string 40 cm long?
2. Does shaking an egg timer speed the rate at which the sand falls?
3. How could you stop an hour glass from draining?
4. Does the force of gravity affect the rate at which the sand falls when the timer is swung in a vertical plane? If so, how?
5. How long would it take an hour glass to drain if it was on the moon where the force of gravity is about 1/6 that of Earth's?

**Column Editor: Ernie McFarland, Physics Dept., University of Guelph, Guelph, Ontario, N1G 2W1**

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