NEWSLETTER

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AAPT Winter Meeting Report

Reno, January 13 - 18, 1996

by Peter Scovil, Section Representative
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This year's winter meeting was held in very different surroundings—at a casino in Sparks, just outside Reno, Nevada. The weather was like early April in Ontario. The first two days were involved in workshops. I attended three on programmable calculators and calculator based labs. We worked with TI-82 calculators along with CBL units that Texas Instruments has designed for gathering data using various sensors available from them or a Vernier distributor. A new sensor is the accelerometer probe which is very interesting to use. I tried it out on an elevator ride. A roller coaster would be incredible. There is great potential in using this system because of its lower cost and much greater portability compared to a computer. They would be great for Science Day at Wonderland. Information can be transferred from calculator to calculator using a link cable so more students can share lab results and do their own individual spreadsheet and graphical analysis. Programming is more difficult, but a Graph Link can be purchased through a Vernier supplier allowing you to transfer data and programs between the calculator and a computer. A lot of programs are already available for almost every topic in the physics curriculum. I intend to give more details at the conference at York University in June.

Keith Jackson of Lawrence Berkeley Laboratory talked about microtechnology. Examples he gave included 19 x 19 μm horseshoe magnets for read/write heads, ($1.3 billion sales in '92), and 5.6 μm thick micromotors that can fit through the eye of a needle.

Several sessions related to the early history of X-rays, commemorating the centenary of their discovery. The first diagnostic X-ray took 20 minutes exposure time. Medical X-rays did not catch on for about 20 years because the early tubes depended on gas ions in the tube to hit the cathode and release electrons. This made them very tricky to use, and involved dangerous levels of excess exposure in checking their operation. The first *vacuum* X-ray tube was not developed until 1914. Now 120 million X-rays are taken per year, along with 9 million nuclear medicine scans and 7.7 million MRIs.

More Summer Reading

In the last newsletter Al Hirsch talked about Pierre Berton's book about Niagra, and his view on Nikola Tesla. Denis Brian's new biography of Einstein, Einstein: A Life (John Wiley & Sons, Inc., 1996), tells how Tesla rejected Einstein's view on gravity, called atomic power an illusion, and mocked the idea that energy could be obtained from matter according to the formula $E=mc^2$. Tesla's credibility was erroded, though, when word of some of his eccentricities leaked out (he was afraid of billiard balls and pearl necklaces, and was reluctant to shake hands for fear of catching a disease), and when he began working on devices such as a camera to photograph thoughts and a death ray. "But what finally brought his critical faculties into question was his confession to being romantically involved with a pigeon," (p. 104).

Brian's book is full of interesting asides about the people that touched on Einstein's ideas. It also contains many items (for example, that Einstein and his first wife Mileva had an illegitimate child) that have only been discovered since the release of controversial material withheld from researchers by Eintein's close friend and executor, Otto Nathan, and his long-time secretary, Helen Dukas.

I found this book to be a wonderful complement to other biographies, like that of Ronald Clark. It shows more of the human side of Einstein's life—his relationships with women for example—without undermining the greatness of what this one man accomplished.

Read any good physics books lately? Send us a review and let other teachers read about it.

OAPT Web Site

Guleph University is now the host of an OAPT web site. The URL is:

http://www.physics.uoguelph.ca/OAPT/index.html

Address Correction

Any correspondence for Bill Prior should be sent to:
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PHYSICS NEWS UPDATE

The American Institute of Physics Bulletin of Physics News
by Phillip F. Schewe and Ben Stein

INTERSTELLAR DUST PARTICLES ENTERING EARTH'S ATMOSPHERE have been detected by astronomers in New Zealand. Their radar scanner not only spots the tiny objects (tens of microns in size) but also determines the meteoroid velocities. Those with speeds of more than 100 km/sec (about 1% of the sample), well above the solar escape velocity of 73 km/sec, are believed to come from other planetary systems. The researchers, furthermore, use the annual variability in the flux of these fast meteoroids to identify several possible discrete extra-solar sources. (A.D. Taylor et al., Nature, 28 March 1996.)

THE FIRST X RAYS EVER SEEN COMING FROM A COMET have been observed by the orbiting Rosat x-ray telescope. Without really expecting to see much signal, the Rosat scientists monitored Comet Hyakutake, the brightest comet in more than 20 years, on its swing past Earth a few weeks ago. One provisional explanation for the phenomenon is that x rays from the sun were absorbed by and then reradiated by gas clouds at the comet. Another theory holds that the x rays result from solar wind particles striking the comet. (NASA press release, 27 March.)

TWO EFFORTS TO MEASURE THE HUBBLE CONSTANT are converging somewhat. Wendy Freedman of the Carnegie Institution reported at a NASA press conference today that she and her colleagues were finding that values for the Hubble constant (H), a measure of the expansion of the universe, hovered in the range 68 to 78 km/sec/Mpc. (In 1994, they reported a preliminary value of 80.) A separate group led by Allan Sandage, also of Carnegie, recently reported a Hubble constant of 57. Freedman's team is midway through a 3-year program of measuring the distance to 20 distant galaxies by observing Cepheid variable stars, whose intrinsic brightness is related to the rate at which their luminosity varies. These observations in turn can be used to calibrate other means for determining distances to objects at even larger scales where local gravitational interactions have a lesser impact on a calculation of H. The secondary yardstick methods include the determination of the peak brightness of type-Ia supernovas and the use of the Tully-Fisher relation, according to which a galaxy's luminosity is related to its rotation rate. The latest entry in Freedman's inventory is galaxy NGC1365 in the Fornax cluster, at a distance of 60 million light years. (NASA press release, 8 May 1996.)

THE OLDEST STARS IN THE MILKY WAY ARE 15 BILLION YEARS OLD. An important adjunct to the debate over the Hubble constant is the notion that the universe cannot be younger than its older stars, which appear to be those in globular clusters, spherical clumps of hundreds of thousands or millions of stars found near and around our galaxy. Don VandenBerg of the University of Victoria (davb@uvvm.uvic.ca, 614-721-7739) uses the Canada-France-Hawaii telescope to view the ancient, metal-poor stars (they largely lack the elements heavier than helium which many younger stars inherit from earlier supernova explosions) in globular clusters. By plotting the stars' luminosities versus their colors, and by employing the standard model for stellar evolution, the age of the stars can be calculated. VandenBerg, speaking at last week's meeting of the American Physical Society in Indianapolis, said the oldest reliably dated stars, in globular cluster M92, were most likely 15 billion years old. Uncertainties in the determination of the distances to the clusters (effecting calculations of the stars' luminosities) might permit an age of 13 or even 12 billion years. But VandenBerg asserted that the ages could not be much younger than that. New observations of his in globular cluster M13 did not alter this assessment.

It's not too late to register for this year's

OAPT Conference at York University

If you didn't receive a mailing with details of the conference,get in contact with us at one of the following numbers/addresses:

OAPT Newsletter, c/o Paul Laxon
201 Chestnut St., St. Thomas,
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Send to: Ernie McFarland, Department of Physics, University of Guelph, Guelph, Ontario N1G 2W1; Email: elm@physics.uoguelph.ca

"Demo Corner" (continued from page 4)

2. The direction of the wind impact force on the sail is not in the direction of the boat's motion, but is perpendicular to the surface of the sail. Generally speaking, when any fluid (liquid or gas) interacts with a smooth surface, the force of the interaction is perpendicular to the smooth surface.

The boat does not move in the same direction as the perpendicular force on the sail, but is constrained to move in a forward (or backward) direction by a deep, finlike keel beneath the water. In our demonstration, the four wheels determine this direction. The component of the force perpendicular to the keel is a useless force that tends to tip the boat over or move it sideways. Again, maximum speed of the boat can be no greater than the wind speed. However, because the acceleration is less, the time required to attain the maximum speed is greater.

Keeping the angle of the sail relative to the boat the same as in Fig. 3, suppose now you direct your boat so that it sails directly across the wind (Fig. 4), rather than directly with the wind. Will you sail faster or slower than before? The answer is faster.

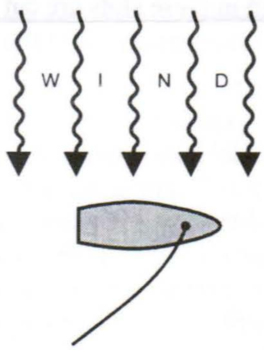

Figure 4

As before, the force vector perpendicular to the surface of the sail can be broken into components, one along the direction in which the boat can move, which drives the boat, and the other which is perpendicular to the boat's motion and is almost useless. (This transverse force is not entirely useless the generation of a small angle of "heel" increases the waterline length, and because of complex hydrodynamic effects, increases the boat speed somewhat.) Now, if the principal force vector in this case were not greater than before, the speed of the boat would be the same. But the force vector is greater. The reason is that the sail does not catch up with the wind speed so it will not eventually sag like before. Even when the boat is travelling as fast as the wind, there is an impact of wind against the sail. This drives the boat even faster, so it can sail faster than the wind in this position. It reaches its terminal speed when the 'relative wind' the resultant of the 'natural' wind and the 'artificial' wind due to the boat's motion blows along the sail without making impact (Fig. 5).

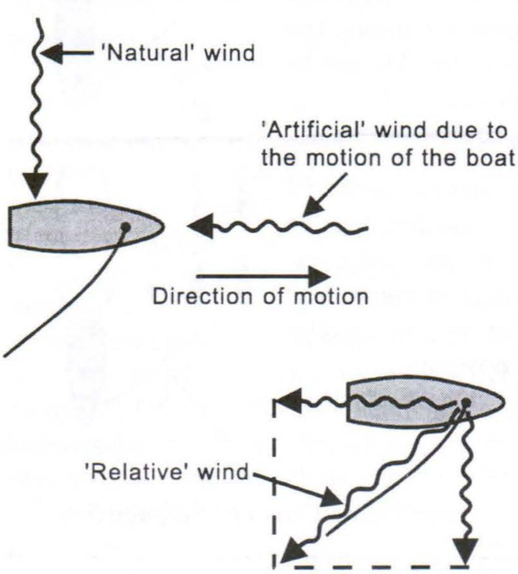

Figure 5: When the angle of the relative wind is the same as the sail angle, the wind impact is zero

It is very interesting to note that, if the wind speed is doubled, the impact against the sail is more than doubled. This is because in one second twice as much air strikes the sail and at twice the speed, so twice the mass moving twice as fast produces four times the force.

As strange as it may seem, maximum speed is attained by cutting into (against) the wind, that is, by angling the sailboat in a direction upwind. Although a sailboat cannot sail directly upwind, it can reach a destination upwind by angling back and forth in a zigzag fashion. This is called **tacking** (Fig. 6).

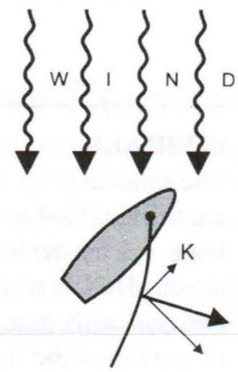

Figure 6

Component **K** will push the boat along in a forward direction, angling into the wind. In this situation, the boat can sail faster than the speed of the wind. This is because, as the boat travels faster, the impact of wind is increased. The boat reaches its terminal speed when opposing forces cancel the force of wind impact. The opposing forces consist mainly of water resistance against the hull of the boat. The hulls of racing boats are shaped to minimize this resistive force, which is the principal deterrent to high speeds.

Because of its minimal drag on the surface, an ice boat can go up to an estimated five times the speed of the wind. The official iceboat speed record, 230 km/h, was set by an old-fashioned stern-steerer in 1938, but the unofficial record is claimed by a giant yacht which covered 1.9 km in 25 seconds, reaching about 274 km/h.

The Sailboat Problem

by

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MATERIALS

1. The sailboat (Fig. 1): a block of wood 24 cm long, 7 cm wide, and 2 cm thick. Glued at the centre of this is another wooden block, 20 cm long, 4.5 cm wide, and 2.5 cm thick. Four roller-skate wheels are attached to this glued block. Slots of 1 cm depth and of width such that one can easily mount and remove the cardboard in these slots are cut on the top of the first block one parallel to the wheel axles but at the centre of the block, another perpendicular to the axles along the keel but at the centre of the block (call it the keel slot), a third at about a 20° angle to the keel slot but at the centre, and the fourth at about a 45° angle to the keel slot but again at the centre.
2. The sail: stiff cardboard of area 929 cm^2 (one square foot) to be placed in the slots, at various angular positions.
3. An electric fan.

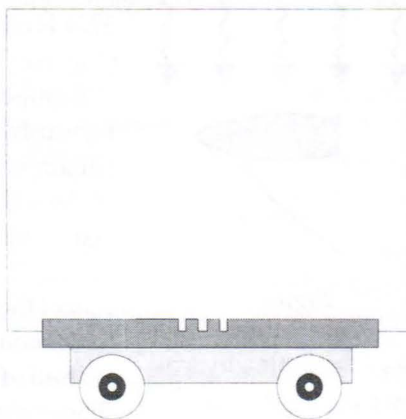


Figure 1

DISCUSSION AND DEMONSTRATIONS

The sailboat provides one of the most interesting illustrations of vector resolution. Some of the many questions raised are:

1. Suppose you are sailing directly downwind with your sails full, in a 30 km/hr wind. What maximum speed would you hope to attain?
2. You are sailing downwind and you pull your sail in so that it no longer makes a 90° angle with the keel of the boat. What will this tactic do to the speed of the boat?
3. Keeping the angle of the sail relative to the boat the same as in the previous question, suppose you now direct your boat so that it sails directly across the wind, rather than directly with the wind. Will you sail faster or slower than before?
4. Can a sailboat travel against the wind?

Consider first the case of a sailboat sailing downwind (Fig. 2). The force of the wind impact against the sail accelerates the boat. Even if the drag of water and all other resistance forces are negligible, the maximum speed of the boat is the wind speed. This is because the wind will not make an impact against the sail if the boat is moving as fast as the wind. The sail will simply sag. If there is no unbalanced force, then there is no acceleration. The force vector decreases as the boat travels faster. The force vector is minimum when the boat travels as fast as the wind. Hence the boat, when driven only by the wind, cannot exceed the wind speed.

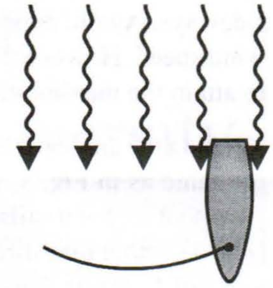
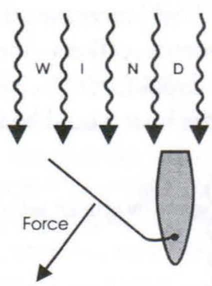
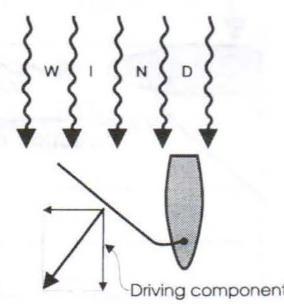


Figure 2: A sailboat sailing downwind

If the sail is oriented at an angle as shown in Fig. 3, the boat will move forward, but with less acceleration. The reason for this can be stated in two different, but equivalent, ways:



1. The force on the sail is less because the sail does not intercept as much wind as in this angular position.



See "Demo Corner" on page 3

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