



The Caliper is a publication for users of Vernier products

The Caliper

Volume 22 Number 1

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Collision Experiment with the New Vernier Dynamics System

Momentum conservation experiments in physics have a reputation for taking a lot of space to perform—more space than students typically have available. Did you know the new Vernier Motion Detector lets you easily perform a collision experiment with the Vernier Dynamics System track and a couple of Vernier carts?

Combining the 15 cm minimum distance of the new Motion Detector with the 1.2 m track makes for a nice, compact momentum-conservation activity.



We set up the track with a Motion Detector just a few centimeters from each end. In *Logger Pro*[®], the direction of one detector was reversed, and then both detectors were zeroed with the carts temporarily stuck together near the middle of the track. This places the origin of the common coordinate system near the middle, and the two readings will then be the same when the carts are in contact.

In order to create completely inelastic collisions, the Vernier carts include Velcro[®] end caps. After starting data collection, we waited a moment, and then rolled the carts toward one another, with one cart moving a bit faster than the other. On collision, the Velcro held the carts together as they rolled on.

Continued on page 2



Congratulations to 2005 Award Winners!

Thanks to all of you who applied for the Vernier Technology Award. This annual award rewards excellence in the teaching of science using data-collection technology. Your applications were reviewed by a committee appointed by NSTA, which selected the following winners.

Julia Green

Berry Elementary, Detroit, MI
"The Drinking Fountain Dilemma"

Diane Callahan

Fairfield Middle School, Fairfield, OH
"CSI: Creek Scene Investigation"

Robert Schlichting

Cleveland High School, Portland, OR
"Glacier Energy Balance"

Stan Wawrzyniak

Bow High School, Bow, NH
"ROVER: Remotely Operated Vehicle for Education and Research"

Gillian Winters

Sachem North High School, Lake Ronkonkoma, NY
"Planck's Constant"

James Vesenka

University of New England
 Department of Chemistry and Physics,
 Biddeford, ME
"Modeling The Bernoulli Principle with the Vernier Barometer"



Continued on page 2

IN THIS ISSUE

Physiology Sensors

Earth Day Event
 Baltimore, MD

New EasyData
 Application

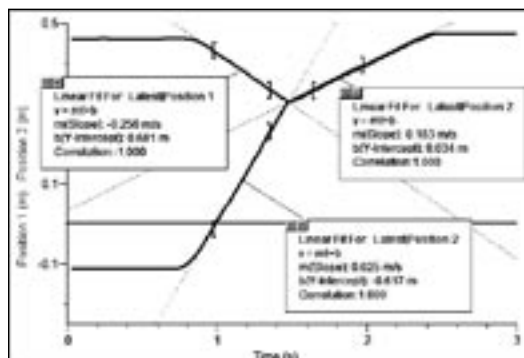
JASON Expedition

Collision—Continued from page 1

Note several features of the graph:

- Before the collision, the carts are moving with constant velocities of opposite sign, since they are moving toward one another.
- The carts move as a unit after the collision with a common, constant velocity.

Each cart is nearly 0.500 kg; the total momentum before the collision is then 0.184 kg m/s. Afterward, the momentum as 0.183 kg m/s.



Position vs. time for two carts

Winners—Continued from page 1

The winners were honored at a banquet at the NSTA Convention in Dallas, TX. Read more about the winning projects at www.vernier.com/grants/nstaawards.html.

Apply now for the 2006 award. The deadline for applications is October 15, 2005. Seven \$3,000 prizes are offered (\$1,000 towards travel to attend the NSTA Convention in Anaheim, CA where the awards will be presented, \$1,000 in cash, and \$1,000 in Vernier equipment). For information about applying for next year's award, visit www.vernier.com/grants/nsta.html.

20 Years Ago in *The Caliper*...

Our Spring 1985 issue of this newsletter offered tips on how to print graphs on "high resolution dot-matrix printers," a new technology that was starting to appear in classrooms. We also announced that our Graphical Analysis program (for Apple II) had won the first of many awards from *Classroom Computer Learning* magazine.

"Go Forth and Measure" at MIT

Dr. Barbara Hughey

One of the core courses in the Mechanical Engineering Department at MIT is the junior-level course, 2.671, Instrumentation and Measurement. This 50-year old course has been significantly redesigned in the last several years by Professor Ian W. Hunter, Director of the BioInstrumentation Laboratory at MIT. The underlying principle for the course redesign was that undergraduate education should be an interactive experience. The LabPro system and sensors from Vernier are perfectly suited for giving students the opportunity to make measurements, both during lecture and on their own.

At the first lecture each term, students are given an assignment called "Go Forth and Measure." Unlike the scripted experiments prepared for them in the laboratory component of 2.671, the measurements they make for this assignment are only limited by their imagination and the capabilities of the sensor or sensors. Each student in the class of about 50 is given a LabPro unit and one or more sensors.

The most popular sensor is the 3-Axis Accelerometer, which students have used to study hand motion while playing the piano, the motion of balls while juggling, the acceleration experienced by a gymnast, and a freestyle skier during flips and twists. One student used the Microphone to look for differences in the sound emitted by her cat in different moods!



Another topic that has inspired the students is the measurement of CO₂ concentration. A student who measured the difference in CO₂ levels for sleeping vs. awake mice commented that the most tedious part of the experiment was waiting for the mice to fall asleep. Another student's report titled, "When a Scientist Becomes the Cricket," described measurements of the CO₂ concentration in his poorly ventilated room during the night. Luckily for him, he terminated the experiment and opened his door before morning!

Finally, an enterprising student decided to examine her sleeping patterns during lectures (not 2.671 lectures, of course!) by measuring CO₂ levels at different locations in the lecture hall. She found that CO₂ levels were initially higher and increased more rapidly at the back of the large lecture hall, which could explain her tendency to fall asleep while sitting at the back. We are delighted to be able to provide the students with inexpensive, easy-to-use products that allow them to "Go Forth and Measure!"

New Motion Detector Design



We've redesigned our new Motion Detector! You will recognize the case, as it is the same shape as before, but we have made two very important changes.

First, the minimum working distance has been reduced to just 15 cm. That means you can move your experiments closer, wasting less lab space. The cone of sensitivity is narrower at shorter distances, so simply moving your target closer will often make the experiment setup easier and data better.

The other change is hidden beneath the pivoting sensor head. A switch allows you to tailor the sensitivity to your experiment. With most experiments, you will want the "Normal", or full sensitivity position. However, if you have

a very reflective target you can choose the "Track" mode, which reduces the sensitivity. In "Track" mode the Motion Detector is much less sensitive to stray objects in the room or on the desktop near your experiment. Again, setup is easier, so you can concentrate on the science or math!

New Vernier Support for palmOne™ Handhelds, Including Tungsten T5

We have good news for teachers who have had difficulty in the past finding compatible handhelds for data collection. First, palmOne has chosen a new standard connector for future models, called a multi-connector. We have developed a Palm-to-LabPro cable with a multi-connector. This means that we will be able to support most new palmOne models soon after they are released, with much less development time required.



Secondly, because palmOne's new Tungsten T5 uses the multi-connector, we will be able to support this model in May. This support will be in the form of a new Data Pro package:

Data Pro Multi-Connector Package..... Order Code DP-MP \$58

This package includes the Data Pro software, Palm-to-LabPro cable, and cradle.

If you noticed the announcement of Data Pro support for the Garmin iQue handhelds in the 2005 catalog, you may have wondered if Data Pro could collect GPS data along with sensor data. This will be possible with Data Pro version 1.6. The Data Pro 1.6 updater will be a free download from our web site for current users in April. Data Pro 1.6 will begin shipping with all Data Pro packages in May.

A Moving Glacial Study

Here's a story about a really cool—literally—use of Vernier equipment. Robert Schlichting of Cleveland HS in Portland, OR, has been taking some fascinating data on the process of *glacial ablation*; that is, how quickly the surface of a glacier recedes due to solar radiation.

As a part of a larger study on the energy budget of a rock debris-covered glacier, Schlichting wanted to measure the change in height of the top of the glacier as a function of time. A Motion Detector, usually used to follow the motion of a rapidly moving cart or ball, was used to measure the distance from a fixed point to the debris on the surface of the glacier. Of course, the surface of the glacier doesn't move very fast, and therein is the challenge for this data-collection effort.

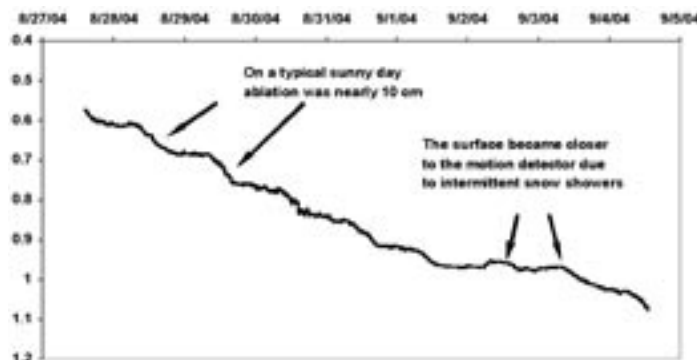


In order to collect data remotely for a long period of time (two weeks or more), Schlichting needed to provide for additional power to the Vernier LabPro. He built a solar charger for a 6 V gel cell battery system and used this to supply power to the LabPro.

The charger, LabPro, and Motion Detector were all mounted in a plastic bucket for protection from the elements. The downward facing bucket and detector were then mounted on a deeply set post. The location chosen was the Eliot Glacier on one of our local volcanoes, Mt. Hood.

The data-collection parameters were set to one point every 15 minutes, over a period of 14440 minutes (10 days!). Note several interesting things about the results shown below:

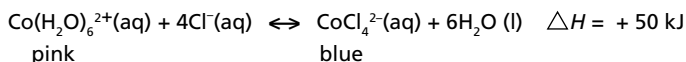
- 1) The glacier lost about 10 cm each sunny day.
- 2) In September, some early season snow added depth to the glacier.



Level of snow field as a function of time

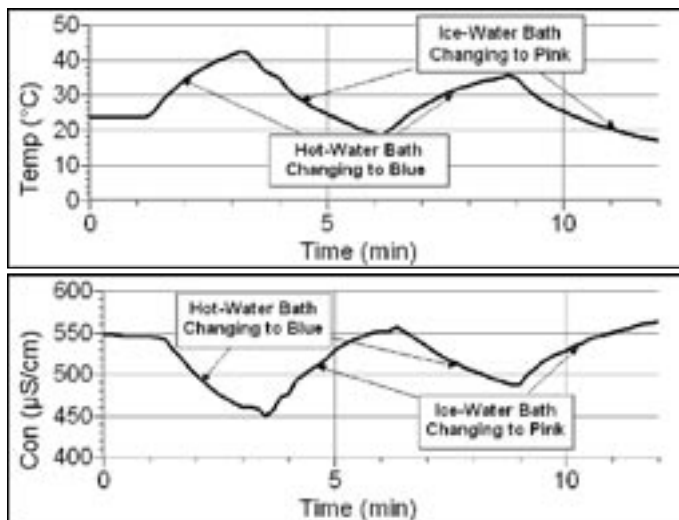
Blue and Pink: The Effect of Temperature on the Cobalt Chloride Equilibrium System

About once a month, we receive a good suggestion of a chemistry experiment from “retired” teacher, Walt Rohr (Easton, PA). Here is one of his ideas for using a Temperature Probe and Conductivity Probe to monitor a well-known equilibrium reaction:



This reaction makes a great demonstration during your equilibrium studies in the spring. Since it is endothermic in the forward direction, a temperature increase results in the formation of additional products and the appearance of blue color (due to the CoCl_4^{2-} ion). Of course, cooling off the reaction favors the reverse exothermic reaction, returning the color to pink (due to the $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ion). Walt noticed that there are unequal numbers of ions in the reactants and products of this reaction: 5 ions in the reactants, 1 ion in the products. As a result, he thought there might be a noticeable conductivity change as the reaction created more products or more reactants.

This equilibrium system is prepared by dissolving 1 g of solid $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ in 170 mL of denatured (95%) ethanol (in a 250 mL Erlenmeyer flask). The solution is initially blue. Slowly add distilled water to it until it just turns pink (indicative of $\text{Co}(\text{H}_2\text{O})_6^{2+}$). You will also need two 1 liter water baths, one with 500 mL of hot water at about 70°C, and the other with a mixture of crushed ice (or ice cubes) in 500 mL of water. The handles of the Conductivity Probe and Temperature Probe can be bound together with several wraps of a rubber band. The Conductivity Probe is set to the 0–2000 $\mu\text{S}/\text{cm}$ range setting. The probe combination can be placed into the Erlenmeyer flask and solution. Start up your data-collection program so the two probes auto-ID, and use a data-collection rate of 6 readings/minute for 10–15 minutes.



Temperature and conductivity changes in cobalt chloride reaction

Collect temperature and conductivity data for about 1 minute at room temperature and then place the flask and probes into the hot-water bath. Once in the bath, the contents can be swirled (or, for less disturbance, add a magnetic stirring bar to the flask, and place the flask and liter beaker on a magnetic stirring plate). After 3 minutes, the color will change from pink to the deep blue of CoCl_4^{2-} . Notice in the data shown here, as the temperature increased, the conductivity simultaneously decreased, due to fewer ions in the products.

Next, transfer the flask and probes to the ice-water bath, and see what happens to the equilibrium. As seen in our data, conductivity increases as the temperature drops, due to the formation of additional ions in the reactants (containing the predominantly pink $\text{Co}(\text{H}_2\text{O})_6^{2+}$).

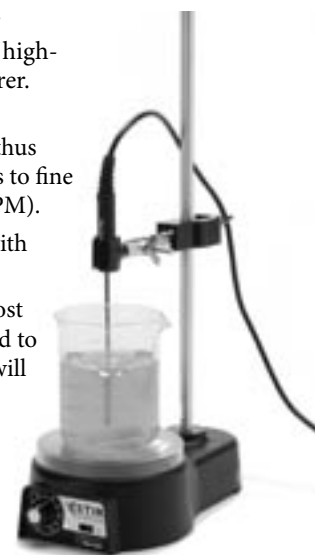
Your students may wonder if the temperature change alone could be the cause of the changes in conductivity. We were curious too (even though our Conductivity Probe has built-in temperature compensation). We performed a control run using sodium chloride solution in similar water baths and found only a small change in conductivity due to temperature.

Extension: You may want to try taking a digital movie of this demonstration, and use the video-synchronization feature of Logger Pro 3.3 to create an experiment file with the movie and data synchronized.

Vernier Stir Station

Chemistry teachers will like this new Vernier product. The Stir Station is a high-quality, multi-function magnetic stirrer. The Stir Station

- Uses a closed-loop speed control, thus making it easier than other models to fine tune its stirring speed (50-1250 RPM).
- Has a stirring platform that is lit with three white, cool LED bulbs.
- Includes a removable ring stand post conveniently positioned and affixed to the stirrer base, at a distance that will easily accommodate most buret or utility clamps.
- Runs on either AC power (adapter included) or four C batteries (not included).

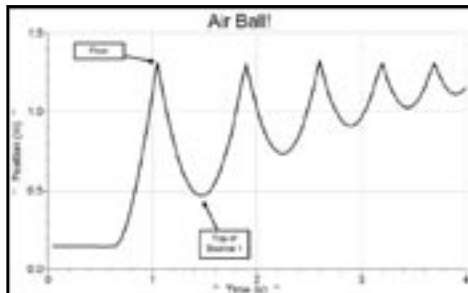


Vernier Stir Station Order Code STIR..... \$119

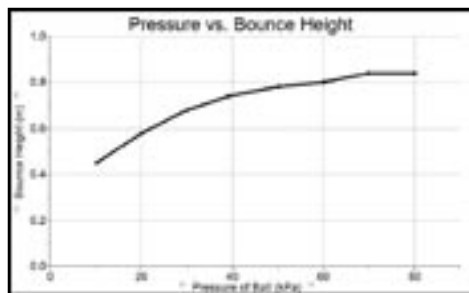
Elementary Science with Go!Motion

AIR BALL!

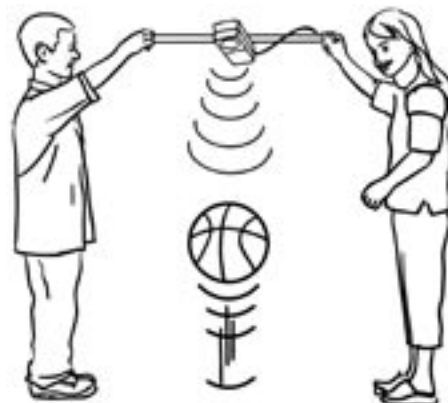
In this new activity from *Let's Go! Elementary Science*, students use our new Go!Motion to investigate how the pressure inside a basketball affects how high it bounces. The amount of air inside the ball is varied and its pressure is measured using a Gas Pressure Sensor. The bounce height is then measured with each variation using a Go!Motion. Your students will have a ball!



Graph of basketball bouncing



Pressure vs. bounce height



Our new *Let's Go! Elementary Science* lab book contains 34 fun and engaging activities investigating temperature, motion, force, magnetism, light, electricity, and pressure.

Order Code ELB-SCI \$30



Science Humor

A mathematician, a physicist, and an engineer were traveling through Scotland when they saw a black sheep through the window of the train.

"Aha," says the engineer. "I see that Scottish sheep are black."

"Hmm," says the physicist. "You mean that some Scottish sheep are black?"

"No," says the mathematician. "All we know is that there is at least one sheep in Scotland, and that at least one side of that one sheep is black!"

There are 10 kinds of people in this world: those who count in binary, and those who don't.

Prefixes:

- 16.5 feet in the Twilight Zone = 1 Rod Serling
- 1000 pains = 1 Megahurtz
- Basic unit of laryngitis = 1 hoarsepower
- 1 million-million microphones = 1 megaphone



Go!Motion

The new Go!Motion is our next-generation motion detector. It connects directly to a computer's USB port, eliminating the need for a data-collection interface. Go!Motion comes bundled with free Logger Lite™ software, which supports data collection on Macintosh or Windows computers. It is a great choice for all levels of science and math, and for anyone who wants to give computer data collection a try!

Go!Motion Order Code GO-MOT \$99

Go!Motion can also be used with LabPro, CBL 2, or TI graphing calculators. Visit our web site for more information at www.vernier.com/gomotion.

Physiology Sensors Make Their Debut



Our new physiology sensors are ideal for physiology investigations with your students. Our current selection of physiology sensors include the Blood Pressure Sensor, EKG Sensor, Hand Dynamometer, Hand-Grip Heart Rate Monitor, O₂ Gas Sensor, Spirometer, and Surface Temperature Sensor. This package of sensors greatly expands your capabilities to non-invasively study the dynamics of several systems of the human body. All of these sensors connect easily to the Go!Link, LabPro, and CBL 2. (Note that the Blood Pressure Sensor requires a computer.)

What Can You Do with Our Physiology Sensors?

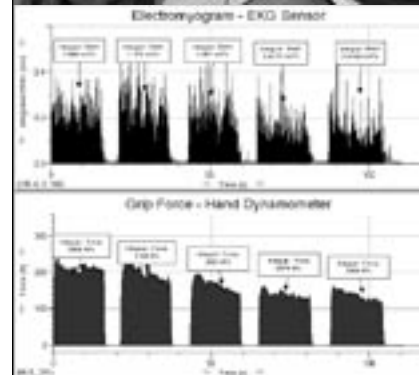
Listed below are several ways in which our expanded line of physiology sensors can be used in your classroom to study human physiology. Consider the possibilities!

- Investigate grip strength using the **Hand Dynamometer**. How do strength and endurance relate? Will squeezing a tennis ball as tightly as you can 50 times each evening for a month increase your strength, endurance, or both? At the beginning of the month, measure and record your basal grip strength and fatigue rate. At the end of the month, compare your readings with those taken earlier to see how the values compare.
- How much heat energy is released from the top of your head? Place the **Surface Temperature Sensor** at the site of your fonticulus anterior (your former soft spot), and measure your surface temperature. Compare this reading with others taken from the palm of your hand, the sole of your foot, the back of your neck, and the ambient air. Which site dissipates the most heat energy? What would account for this? As ambient temperature lowers, would the “hot spot” change?
- Does caffeine really affect one’s blood pressure? Enlist the **Blood Pressure Sensor** to allow your students to investigate this question.
- What is your tidal volume? How does your flow rate compare to other people your own age? Spirometry measures the volume of air inspired or expired as a function of time, and offers an index of one’s pulmonary health. The newly released **Spirometer** is the tool you need to evaluate lung function.
- Investigate EKG and/or EMG after mild exercise. Electrocardiograms and electromyograms are both possible when using the **EKG Sensor**. It offers fascinating insight into the working of electrical conduction in the heart or in specific muscular tracts. It allows students to move from mystery to functional understanding of an empirical phenomena we all share.
- Monitor the heart and how quickly a person’s heart rate returns to normal after exercise (recovery rate). This indicator of cardiac health is simple and accurate when monitored with the **Hand-Grip Heart Rate Monitor**.

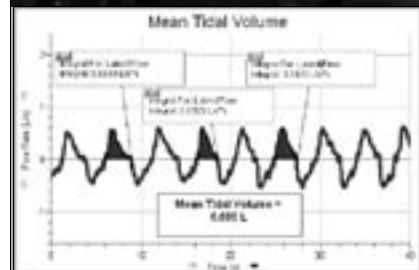
To complete our physiology product line, we are pleased to announce our new *Human Physiology with Vernier* lab book. The *Human Physiology with Vernier* lab book will be available just in time for the new school year (Fall, 2005).

Physiology Sensors

NEW! Blood Pressure Sensor	Order Code BPS-BTA	\$99
EKG Sensor	Order Code EKG-BTA	\$142
NEW! Hand Dynamometer.....	Order Code HD-BTA.....	\$94
NEW! Hand-Grip Heart Rate Monitor	Order Code HGH-BTA	\$114
O ₂ Gas Sensor	Order Code O2-BTA	\$186
NEW! Spirometer	Order Code SPR-BTA	\$199
Surface Temperature Sensor.....	Order Code STS-BTA	\$21



Measuring electrical activity of muscles with the EKG Sensor



Measuring lung capacity with the Spirometer



Innovative Uses

Make Physics Fun with Bridge-Building Contests

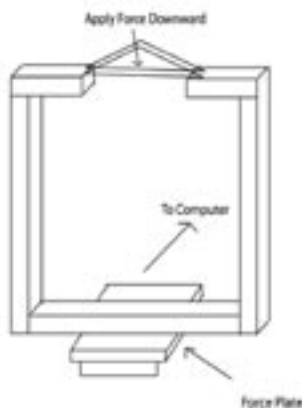
by Dave Vernier

When I taught high school physics, I had the students build model balsa-wood bridges. The goal was to make the strongest bridge spanning a specified distance with a certain mass limit (and some other restrictions). The contest was always a big hit with the kids, and it really helped bring attention to the physics program. The actual testing of the bridges was difficult, and it led me to do my first experimentation with force sensors, using strain gages. With the introduction of our Force Plate a few years ago, bridge-building contests became a lot easier.

Jeff Hellman, Elmira HS, Elmira, OR, recently had such a contest. He reported on it at the recent meeting of the Oregon section of AAPT. As the diagram below shows, Jeff made a U-shaped structure out of wood to support the bridge. This structure sits on the Force Plate. As force is applied to the bridge, the Force Plate records the force.

Jeff used a scissor jack to apply the force to the bridge, and he built a wooden outside frame to support the scissor jack. This is shown in the photo below. As force is applied to the bridge, the Force Plate records the force. Note that you can easily set up a column for “maximum force” in Logger Pro, so that even when the bridge breaks, the largest reading is noted. This makes for a great spectator sport. For more details about this contest, see Jeff’s web site at www.sciteacher.com/bridges.

One more personal note: the person who introduced me to the idea of bridge-building contests for physics classes (in 1975) was Jeff’s father, Walter Hellman (physics teacher at Hillsboro HS, Hillsboro, OR).



Physics students from Elmira HS show their creations

NASA Student Launch Initiative

The NASA-sponsored Student Launch Initiative (SLI) asks high school and college students to design, build, test, and ultimately launch reusable rockets carrying scientific payloads. At the high school level, several schools compete to construct a vehicle that is designed to reach an altitude of one mile above ground level. The Vernier LabPro and a variety of Vernier sensors are being employed by a few of this year’s participants. For more details check <http://education.msfc.nasa.gov/docs/127.htm>

LabPro as a Digital Multimeter

An article in the October 2004 issue of *The Physics Teacher* journal explains how to build an auto-ID resistance probe for use with LabPro. Robert C. Word and Erik Bodegom, from the Department of Physics at Portland State University, and Ian Honohan (Vernier Software & Technology) found that the home-made resistance probe can accurately measure electrical resistance in the range of 100 Ω to 1 M Ω . Along with Logger Pro software, a Voltage Probe, and Current Probe, the LabPro can perform the job of a digital multimeter.

The Physics Teacher journal often has many great ideas for teachers. Quite a few of them relate to using our products. Here are some recent examples:

“How About a Magnet and a Paper Clip?—Experiencing the Interaction Forces Kinesthetically” by Hans Pfister, Dickinson College, Carlisle, PA, in the February 2005 issue takes the Newton’s third law demonstration to a new level.

“Inductively Modeling Parallel, Normal, and Frictional Forces” by Edward P. Wyrembeck (a former Vernier Technology Award winner), Howards Grove HS, WI, in the February 2005 issue, has his students model forces on an inclined dynamics track.

“Deconstructing Black Box Aspects of a Computerized Physics Lab” by William P. O’Brien Jr., Southwestern University, Georgetown, TX, in the March 2005 issue, offers suggestions on how to introduce the use of computerized data-collection equipment in your classes.

“Fan Unit Physics” by Robert A. Morse, St. Albans School, Washington DC, in the March 2005 issue, explains how to do several good demonstrations or labs using dynamics carts with fans on them.

“The Effect Surface Temperature Has on Kinetic Friction” by Peter Kauffman and Mark Vondracek, Evanston Township HS, IL, in the March 2005 issue, does a unique study of friction on a heated griddle.

For more innovative uses, see
www.vernier.com/innovate

Baking Soda/Vinegar Reaction Revisited

The reaction between baking soda and vinegar can be followed in a number of ways: change in temperature, change in pH, or change in pressure (if you conduct the reaction in a sealed vessel). This activity describes a new method—using an Ohaus ScoutPro™ balance to measure the mass change as the reaction proceeds.

OBJECTIVES

The objective of this activity is to measure the temperature, pH, and mass change of the reaction between baking soda and vinegar.

MATERIALS

Vernier LabPro interface computer	baking soda
Vernier Temperature Probe	vinegar
Vernier pH Sensor	graduated cylinder
Ohaus Scout Pro balance	weigh boat or small cup
ring stand and two utility clamps	spoon
	large foam coffee cup

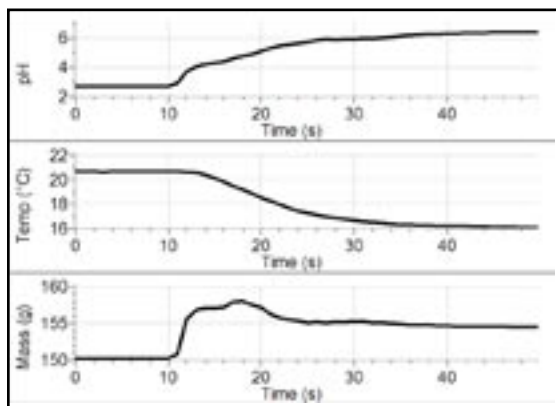
SUMMARY OF THE PROCEDURE

Measure out 50 mL of vinegar into a large foam cup. Connect a Temperature Probe and a pH Sensor to a LabPro and connect the LabPro to a computer. Connect an Ohaus Scout Pro balance to the computer. Place the foam cup of vinegar on the balance. Use a ring stand and utility clamps to position the probes in the foam cup of vinegar. Run *Logger Pro 3* and use the default settings. Measure out 3–4 g of baking soda. Start collecting data. Add the baking soda all at once to the cup of vinegar. Stop the data collection when the readings no longer change.

NOTE: It is very important to use a foam cup large enough to contain the reaction and not spill over onto the balance. Try it on the lab bench first!

DATA ANALYSIS

Because you have three sets of data for this reaction, your students will have many options for analysis. The novelty of this activity lies in the measurement of the mass change as the reaction proceeds. A variety of stoichiometric analyses can be conducted, or the students can compare the temperature-change data and pH-change data with the mass-change data to see which data set does the best job of precisely measuring the reaction.



Analysis of baking soda and vinegar reaction

ProScope Joins Vernier Menu



The adage “a picture is worth a thousand words” takes on new meaning with the addition of the ProScope to Vernier’s line of data-collection tools. This digital microscope connects directly to the USB port on your computer and makes it easy to magnify and examine objects on your Macintosh or PC computer screen. The built-in white LEDs light specimens, and the ProScope is

completely powered from the computer’s USB port. The included USB Shot software allows you to capture still images, time-lapse photography, or QuickTime™ movies.

The basic 50x lens is perfect for a wide variety of uses. Additional interchangeable lenses (sold separately) provide the ProScope with tremendous versatility. The C-mount adapter allows you to connect to traditional microscopes for even more magnification.

The best part about the ProScope is that *Logger Pro 3.4* (available in May) will allow you to capture time lapse images and sensor data simultaneously!

The ProScope can be used for many exciting lab activities:

- Reinforce the concept of friction. Examine the roughness of various surfaces and correlate to friction measurements.
- View the formation of gas bubbles during a reaction between hydrogen peroxide and potato catalase.
- Examine water samples for algae, animals, and other life during water quality studies.

The ProScope is available separately with an assortment of lenses or as part of the new Science CSI Kit. Activities for the ProScope can be downloaded for free from www.vernier.com/proscope.



ProScope image of soil taken with a 50x lens



Scoping out the anthers and stigma of a daffodil

Basic ProScope Kit (with 50x lens)	Order Code BD-PSB.....	\$219
Complete ProScope Kit	Order Code BD-PSC.....	\$750
Science CSI Kit	Order Code BD-CSI.....	\$999



Earth Day Event

On April 22nd, schools all over the U.S. will participate in Earth Day events aimed at increasing students' awareness of environmental issues. Several schools will be using Vernier products to collect data in their local communities. Here's what one school has planned.

Dundalk Middle School—Baltimore, MD

The city of Baltimore sits on the banks of Maryland's picturesque Chesapeake Bay. Surrounded on three sides by water, residents sometimes take the quality of that water for granted. But on Earth Day, Dundalk Middle School students will be carefully analyzing this precious resource, and reminding local residents that protecting the environment is a responsibility that should be shared by all.

The school's 200 eighth-graders are slated to visit Merritt Park, located on the Chesapeake Bay Watershed. There, they will visit a total of nine stations set up by their science teachers, and will perform a variety of experiments on water samples collected from the area. Using Vernier LabPros and CBL 2s, the students will test temperature, salinity, acidity, dissolved oxygen, turbidity, and more. Then, using Logger *Pro* software, laptop computers, and graphing calculators, students will be able to create colorful graphs and charts that will help them analyze the concentration levels of the various elements, and determine the overall quality of the water.

Science teacher Trish Knight envisions the activity as the kick-off for a series of similar events to be held in Baltimore monthly. "We don't plan to stop our water-quality monitoring after Earth Day is over," Knight explains. "We hope to have a group of kids who'll do more testing one weekend each month at different sites around the area, which will get the greater community involved. The students can continue collecting the data with the Vernier products. My hope is that parents, relatives, and friends will then venture over to see what we're doing with the technology."



Chesapeake Bay, MD

Knight says the Vernier instruments are ideal for today's visual learners. "The kids love these tools!" she says. "This generation of students is much more attuned to creating and using real-time data, instead of looking at some graph in a textbook. Being able to do the experiments from start to finish, and to see the results in real time, is so much more meaningful to them. And, the tools are so easy to use. Whenever the kids see the Vernier product box out on the table, they get very excited."

In a community in which many of the students' homes face the rivers and creeks of the Chesapeake Bay, there can be a tendency to forget the significance of that vast body of water. But Knight is confident that the Earth Day expedition will remind students and their families that treating the bay with respect today is the key to a clean, healthy future.

"Luckily, our principal, Tom Shouldice, was also a science teacher, and he's very involved in this initiative," says Knight. "And being a Title I school, we're extremely fortunate to have a full compliment of tools, including the Vernier sensors and software. We believe these types of activities—and the support we've received from Vernier—will help us maintain our focus on doing whatever we can to 'save the bay.'"

Reduce, Recycle... Reuse Your Probeware!

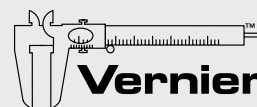
Teachers often ask us how to get free or reduced price hand-me-down equipment. This may sound a little wacky, but a lot of people are selling older Vernier equipment on eBay! We often get calls from people who have found older probeware at bargain prices online. The list changes often, but we did a quick search of eBay recently and found a few photogates, one CBL, and some motion detectors! If you would like to trade (instead of sell) older equipment, there is a new thread on our discussion board where several people have offered to donate their ULIs to other schools. Go to www.vernier.com/discussion/

Robotics & Control Kit

Our new Robotics & Control Kit is a great way to introduce your students to programming, electrical circuits, feedback and control, and other engineering concepts. The kit consists of an assortment of parts: DC motor, servo motor, stepper motor, buzzer, speaker, fan, LEDs, lamps, and a terminal strip. The booklet that comes with the kit explains 14 projects for students, some practical (alarm systems and greenhouse temperature control) and some whimsical (mousetraps and stepper motor tea makers). The projects can all be set up with no soldering, using common household and laboratory equipment. You can start experimenting with the projects with the programs we provide, but for best results, the student should get involved with a little programming—using a TI graphing calculator, LabVIEW on a computer (Macintosh, Windows, or Linux), or REALbasic on a Macintosh computer.

The Caliper is published semiannually by Vernier Software & Technology. It is distributed free of charge to Vernier customers.

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Vernier Helps Study Disappearing Wetlands

Each year, Dr. Robert Ballard leads a team of scientists and select students and teachers, *Argonauts*, on a week-long journey to explore research locations featured in the JASON curriculum. In addition, satellite and internet technologies create a telepresence that brings students and teachers in classrooms around the world into real-time contact with these scientists and researchers to model their work. This year's JASON Expedition traveled to Louisiana to study the wetlands. They worked with host researchers to better understand what wetlands are, why they are disappearing, and how to best manage these ecosystems in Louisiana, around the country, and around the world.

Vernier sensors were used with LabPros and TI graphing calculators to measure water quality parameters of salinity, pH, temperature, dissolved oxygen, and more. The ProScope digital USB microscope was also featured as a tool for studying oyster and fish anatomy.

Coming up next year—*JASON Expedition: Mysteries of Earth and Mars*. If you teach middle school or elementary, you should consider joining next year's expedition! Check it out at www.jason.org.



Photograph courtesy of Dan Splaine/JASON Foundation for Education

A nutria takes over data collection on a camera break.



Photograph courtesy of Dan Splaine/JASON Foundation for Education

Dr. Robert Ballard and Student Argonaut Charnele measure the pH and temperature of the water at Jean Lafitte National Historic Park and Preserve outside of New Orleans.



Dr. Earl Melancon (Nicholls State University), Teacher Argo Michael Godfrey, and Student Argonaut Colleen study oysters by measuring water quality in Cocodrie, LA.



Dr. Robert D. Ballard founded the JASON Foundation in 1989 after receiving thousands of letters

from school children wanting to know how he discovered the *RMS Titanic*. The JASON Foundation is a non-profit educational organization working in partnership with teachers, students, corporations, educational institutions and government to inspire in students a lifelong passion to pursue learning in science, math and technology through exploration and discovery.



Photograph courtesy of Dan Splaine/JASON Foundation for Education

Dr. Melancon and Student Argonaut Cathy use a ProScope to show the audience the anatomy of an oyster



Blue-Light Special on Older Motion Detectors

We recently redesigned our Motion Detector and made some enhancements that improve functionality, especially in physics applications (see page 1). In this process, we ended up with extras of the older model, and we are making them available at a great price. These are the models that we have been selling for many years. The only difference is that they do not come with a clamp, which is available separately. If you are looking for Motion Detectors at a great price, you might want to consider this option.

- Motion Detector (for LabPro and CBL 2) Order code MDO-BTD**\$45**
- Motion Detector (for ULI) Order code MDO-ULI.....**\$46**
- Motion Detector Clamp Order code MD-CLAMP.....**\$6**

If you wish to order online, go to www.vernier.com/overstock.

On the Halfpipe

The halfpipe used by skateboarders and BMX bike riders allows for some spectacular tricks. Given that the riders can rise nearly two meters above the top of the pipe, which is itself about three meters high, the forces and accelerations must be fairly large.



The Discovery Channel holds a competition for middle school students who won their regional science fairs. The students went through several challenges, among them the skateboard physics task. The question asked of the students was this: where, during the ride, is the halfpipe pushing on the rider the most, and where is the force the least?

To make these measurements, the riders carried a Vernier 3-Axis Accelerometer connected to a Vernier LabPro. A standard video camera with a video capture board provided images to synchronize with the acceleration data in *Logger Pro*.

We created a calculated column that is the square root of the sum of the squares of the individual acceleration values, yielding the net or scalar acceleration values. Scalar acceleration with an accelerometer corresponds to the perceived *g*-factor.

Because the accelerometer responds to both kinematic acceleration and the Earth's gravitational field, the scalar "acceleration" is 9.8 m/s^2 when the device is at rest. The measurement is really the Normal Force per Unit Mass, which we'll call the *g*-factor for short. Kinesthetically, the *g*-factor corresponds to the compression one feels in the legs during snowboarding. You feel a *g*-factor of 9.8 m/s^2 (or 1 *g*) when standing still.

This *g*-factor measurement is exactly what we needed to confirm the student predictions as to where in the halfpipe the forces were large, and where they were small. To make your own prediction, you'll need the skater talk: the halfpipe includes the *vert*, or vertical wall; the *coping*, or the railing at the top of the vert; the *transition*, which is the curved part of the pipe; and the *floor*, which is the flat part at the bottom. What is your prediction?



Go to www.vernier.com/innovate/innovativeuse33.html for a video of the *Logger Pro* screen, showing both the video of a BMX biker, and the synchronized accelerometer data. Was your prediction correct?

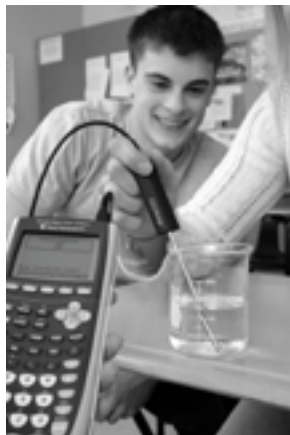
Our thanks to the Discovery Channel for inviting us on this data-collection expedition!

EasyTemp™ and EasyData

One of our newest products is the Vernier EasyTemp. EasyTemp is a rugged, general-purpose temperature sensor that you can plug directly to the USB port of a TI-84 Plus or TI-84 Plus Silver Edition calculator. You can then take temperature measurements directly with the calculator. Its durability and temperature range (-20°C to 110°C) make it perfect for a variety of activities in science and math. Typical uses include monitoring temperature in

- weather studies
- chemical reactions
- cooling curves
- insulation studies
- specific heat experiments
- heat of fusion experiments

EasyTemp has a mini-A USB connector that allows you to attach the temperature probe directly to the USB port of a TI-84 Plus or TI-84 Plus Silver Edition calculator. You can then take temperature measurements directly with the calculator. EasyTemp comes with two labs, but more free labs can be downloaded from our web site at www.vernier.com/easy/easytemp.html.

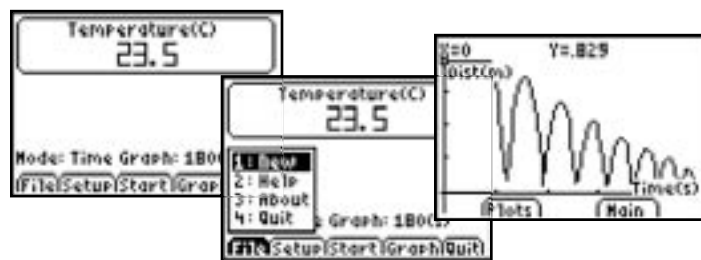


While we were designing EasyTemp, we developed a new data collection program called Vernier EasyData™, which is compatible with the TI-83 Plus and TI-84 Plus families of calculators. EasyData was primarily developed to support data collection with sensors that connect to the USB port of the TI-84 Plus and TI-84 Plus Silver Edition

calculators. Those sensors include EasyTemp and the CBR 2™, TI's calculator-based USB motion detector. The EasyData application can also be used with LabPro or CBL 2 and a wide range of sensors, e.g., pH, Oxygen Gas, Dual-Range Force, etc. EasyData brings a new level of simplicity to calculator-based data collection. Program navigation is performed using the five graph keys, located directly below the graph screen, making data collection simple and fast. Program options are displayed in pop-up dialog boxes or simple wizards. Below are sample screen shots from the program.

When you use EasyData with EasyTemp, data collection couldn't be easier. All you have to do is turn on the calculator, plug in the EasyTemp, and EasyData will automatically launch, preparing you to collect data. It's that easy!

EasyData comes preloaded on TI-84 Plus and TI-84 Plus Silver Edition calculators manufactured after January, 2005. If you have a TI-84 Plus manufactured before then or if you have a TI-83 Plus calculator, EasyData is a free download from our web site at www.vernier.com/easy. Give it a try!



EasyData screens on a TI-84 Plus

