

Part of a workshop project

Supported by the

National Science Foundation

Joliet Junior College (IL)

Lee College (TX)

Editors Note: Most of this newsletter is focused on the IPC 3 conference that was held last summer. It features some of the sharing and the results of the group participant projects in waves.

Overview of the Third Introductory Physics Conference (IPC 3):

Waves — Sound, Light, and Matter

Introduction

The Third Introductory Physics Conference (IPC 3) was held June 16 - 20, 1998, at Joliet Junior College, Joliet, IL.

We looked at what we should be teaching about waves, some of the misconceptions, and how we can assess how well our students are doing in these areas. During the IPC 3, the participants heard about, worked on, and discussed the implications of current projects and developments in the topic area of waves in teaching introductory physics. Also during this conference, the participants participated in several “hands-on” mini-workshop sessions and developed materials for teaching waves.

Introductory Physics Conference 3

The 26 two-year college faculty members from 16 states who attended (see the list on page 8) had an opportunity to listen to, ask questions of, and work with some of the innovators in the teaching of waves. Although the five-day conference had a fairly full schedule, the participants seemed to enjoy the opportunity to focus on waves and interact with other TYC teachers. Prior to the conference, participants and leaders received a number of “pre-conference materials” (also listed on page 8). They were also asked to answer and bring with them a little “quiz” on waves (see page 9).

The conference began on Tuesday afternoon with a welcome by Tom and myself followed by a round of introductions of the participants. I started things off with a pres-

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Group Projects at the 3rd Introductory Physics Conference on Waves

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Most of the participants did not know each other at IPC3 since they included two-year college physics teachers from all over the country from California to New York. Throughout the conference, the participants were involved in a busy schedule of talks and workshops. However, working together in groups on projects promoted and enabled the development and building of friendships and partnerships.

On the first evening of the IPC3 (Tuesday), Dave Maloney from Indiana University-Purdue University at Fort Wayne assigned each participant to one of six groups of four or five members. Each group was to pick a specific concept, principle, or relationship where students have trouble with waves in introductory physics. Then they were to develop materials to aid student learning in that area and assessment tools to determine whether the new materials were effective. Each group had a total of about six hours between other sessions to develop their materi-

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entation and discussion on my Spring '98 class results on the pre-conference wave quiz.

Since our first scheduled speaker, Joe Redish, ended up in the hospital and was unable to attend, Michael Wittman (one of Joe's senior graduate students at that time) stepped in at the last minute and did a fine job of giving Joe's presentation on physics education research. Michael then followed with an outstanding presentation on mechanical waves based a great deal on his own research in this area.

After supper, groups were formed under the guidance of Dave Maloney. These groups then worked on the Tutorials in Introductory Physics (which included pretests) on mechanical waves developed at the University of Maryland.

The Wednesday morning session and part of the afternoon was spent on optics using Tutorials in Introductory Physics. This was presented by Lillian McDermott and Paula Heron of the University of Washington's Physics Education Group (PEG) who developed these materials and are further refining them.

Later on Wednesday afternoon, Alan Van Heuvelen led a session with the participants on waves using the *ActivPhysics ICD* and Experiment Problems.

In the late afternoon and evening, participants returned to the groups formed on Tuesday to begin developing various projects dealing with waves. These projects were to be a coherent package that employed various tools that were part of previous TYC workshops such as Ranking Tasks plus some of the new ideas that were presented at this conference.

The Thursday morning session was presented by Alex Dickison of Seminole Community College (FL). This session dealt with material from the new Introductory College Physics: Twenty-First Century (ICP/21) which is supported by the National Science Foundation's Advanced Technology Education program (see the separate article which describes more details on this session).

The Thursday afternoon workshop session was one in which the participants could try the *Interactive Journey Through Physics CD* and the *Virtual MBL* using a browser on a demo CD. There was a discussion on how these CDs could be used effectively in the classroom and/or distance learning environments.

Later on Thursday afternoon, the conference participants and leaders went to FermiLab in nearby Batavia, IL, for a tour which included a lecture on neutrino decay by one of the leading theoreticians in this field and a visit to the CDF (Collider Detector Facility). The CDF, responsible for finding the top quark, had been pulled out of the beam as it was undergoing a major upgrade. After supper, the participants returned back to campus to work together again on their projects.

On Friday morning and part of the afternoon, the participants experienced a presentation/workshop led by Dean Zollman who had just returned from Germany. The participants went through several modules from Visual Quantum Mechanics.

The rest of the afternoon was spent by the participants continuing their group projects working closely with David Maloney and the other workshop leaders. More group work was done after supper with many groups working very late trying to finish their presentations for the next day.

On Saturday morning, all of the groups made presentations on their projects to the other conference participants. They were outstanding and evoked much interest and discussion. Parts of these presentations are found elsewhere in this CaFD.

The conference finished with some discussions on where the community seems to be on the teaching of waves. In the afternoon, the participants who did not depart for home went to the Museum of Science and Technology in Chicago.

Summary

There were many aspects of IPC 3 that were enjoyable and beneficial to the attendees. First, they had time to meet with colleagues and discuss teaching techniques, strategies, class demonstrations, lab work, equipment, homework, exams, class policies, grading, implementation problems, and other TYC issues.

They also had the opportunity to meet some of the leaders and innovators in physics education research and discuss their recently developed curriculum materials.

In addition, the participants gained valuable working experience with a variety of tools available for teaching wave topics. Finally, they had a chance to work with peers to develop and present new materials and techniques that should enhance their teaching of waves.

als. Group projects were constantly evolving as groups tried to incorporate new ideas from the workshops and talks in the other sessions.

Each group presented its materials on the last morning of the conference (Saturday). The group presentations each lasted fifteen minutes. Following the conference, each participant received a complete set of all materials developed both on paper and on disk. These materials were essentially classroom ready (or close to it).

In this article I will present a brief (by necessity) overview of each of the six group projects in the same random order they presented their own work at the end of the conference. I think the group projects produced excellent materials and I hope that future newsletters will include a more complete description of each group's work written by the participants themselves.

Techniques For Tunes

Todd Leif, Cloud County Community College, Concordia, KS

Deb Lohr, Blackhawk Technical College, Janesville, WI

HC Snyder, St. Clair County Community College, Port Huron, MI

Laurie Thomas, Don Bosco Technical Institute, Rosemead, CA

This group's project is designed as an "enrichment" project to be used after students have finished covering waves and sound. The group has designed a three-part "tutorial" involving sound and music to give students a chance to see how the concepts they have learned tie together and can be put to use. Along with their tutorial, the group also provides a list of resources which might be of help to students including a segment from the film *Fantasia*, segments from the *ActivPhysics I* CD by Alan Van Heuvelen, and segments from the *Interactive Journey Through Physics* CD by Cindy Schwarz.

The first part of the group's tutorial guides students as they learned to produce different pitches on a string, then a slide whistle, and lastly a suspended solid rod. The group's tutorial is in a format requiring students to predict, observe, and then explain what they had observed. The second part of the group's tutorial has students finding combinations of two, then three, then four tuning forks that sound pleasant together. The students are instructed to look at the frequency ratios of the combinations which sound pleasant together.

The third part of the group's tutorial introduces students to music theory and the mathematics of the frequency ratios in-

volved in different musical scales. The students begin by finding a frequency between 264 Hz (Middle C) and 528 Hz (High C) such that the ratio $f/264$ is the same as the ratio $528/f$. The students then divide the octave into three steps instead of two and eventually work through the pentatonic scale, the major scale (do re mi...), and the equal-tempered chromatic scale. Along the way, students are introduced to the ideas of musical thirds, fourths, and fifths.

This group's assessment project requires students to build a simple instrument capable of matching three different pitches. The match would be judged based on whether beats could be heard. The student instruments would obviously need to be tunable.

Distinguishing Between Velocity of Propagation and Velocity of Particles of the Medium for Mechanical Waves

David Duluk, Henry Ford Community College, Dearborn, MI

David Kardelis, College of Eastern Utah, Price, UT

Umesh Pandey, Albuquerque Technical Vocational Institute, Albuquerque, NM
Herman Trivilino, College of the Mainland, Texas City, TX

This group's project is designed to help eliminate student confusion between the velocity at which a pulse moves through a medium and the velocity of a particle in the medium as the pulse passes by. This project includes a short, straight-forward test to be used as a pre-test and post-test of student understanding. This project's main component is a laboratory activity designed to help students understand which velocity depends on the nature of the medium and which velocity depends on the nature of the source of the pulse.

In the lab activity, students send a transverse pulse down a stretched spring along the floor. The propagation velocity is found from the distance traveled and time for it measured with a stopwatch. The speed of the particles in the medium is found by observing the hand creating the pulse with a motion detector and looking at the distance-time graph and velocity-time graph of the hand's motion. The procedure instructs students to move the hand at different speeds and use different springs in different trials.

The group originally intended to use the motion detector to measure the motion of an actual portion of the spring rather than the hand but they could not overcome technical difficulties. All of the group projects involving lab activities involved a great deal of time trying methods which didn't work

LEDs, Lasers, and Solid State Diodes

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This summer at Joliet Junior College during the TYC Introductory Physics Teaching conference the first draft of the “modern physics” module was introduced. It is part of the ten modules being developed by the Introductory College Physics: Twenty First Century (ICP/21) ATE, NSF project. ICP/21 is a new modular approach to the standard algebra/trigonometry based physics course. It is aimed at both the engineering and medical technical students.

The “modern” module written by Chuck Lang is divided into three sections. The first section develops the concepts of the photoelectric effect. Specifically, it builds the model needed to explain the photoelectric effect which develops the concept that light comes in “quanti-sized packages.”

ICP/21 incorporates a learning cycle. There are six stages:

Introduction,
Exploration,
Reflection,
Dialog,
Extension, and
Application.

The exploration stage of the first section has two activities. The first leads students through the observation of the heat, color, and spectrum of a long filament lamp using colored filters and diffraction gratings. The concept being developed is the relationship between the frequency and the energy of the light.

They then use an electroscope (we use the type developed for PSSC), charge it, and observe what happens when the top metal plate is exposed to various types of light. There are several variables to explore: the

The beauty of this activity is that students can view the same laboratory experiment again on the *Physics Cinema Classics* after doing their work.

sign of the charge on the electroscope; the type of light including UV; using a glass plate or not between the light and the metal plate (aluminum or zinc). Students are gently led to understand the photoelectric effect. They realize that the frequency of the light

and the type of metal used controls whether electrons are kicked out of the metal or not. The beauty of this activity is that students can view the same laboratory experiment again on the *Physics Cinema Classics* after doing their work. This reinforces what they have observed. In a class discussion the model for explaining this effect can be developed.

Next the students test their understanding of the concepts by doing a “reversed” photoelectric effect experiment using light emitting diodes (LEDs). Students determine the stopping energies corresponding to the various frequencies of the LEDs. When this is plotted on a graph, the slope is Planck’s Constant.

Finally, students are able to experiment with several applications including a feedback system and light transmission of sound. From our initial classroom trials, the students after completing this section understood the concepts of the photoelectric effect quite well.

The second section leads students to the understanding of the theory of how a laser works. To do this students need to understand about the idea of quantum “jumps” in the atom. Students start by observing an array of light sources using a hand held spectrometer. From this, the quantum model of the atom can be developed.

Students next develop a gravitational energy level diagram. They determine the potential energies of a person lying, sitting, and standing on three different levels of an outside amphitheater. Once this is completed, it is an easy transition to an atomic energy level diagram.

At this point, they are ready to understand the operation of a laser. The applications for this section include line-of-sight laser communications, simulated “retina,” and identifying life on other planets.

The third section explains the workings of a solid state diode. That story will be left for another time.

ICP/21 has plans to complete the modules and be ready for field-testing by January 2000. If you are interested in getting involved, please contact me.

Physics and the Atomic Structure of Matter

a review of Randall Knight's *Physics: A Contemporary Perspective*

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The purpose of this article is to share some of my experiences with the preliminary edition of Randall Knight's *Physics: A Contemporary Perspective* (hereafter referred to as PACP).

PACP is based extensively on the results of physics education research and follows the general guidelines of the Introductory University Physics Project. It is a two-volume, calculus-based textbook intended for a one-year introductory physics course. It is thematic rather than encyclopedic with its theme being the title of this review.

The textbook has a six-part structure. These parts are

Volume One

- Part I Single Particle Dynamics
- Part II Interacting Particles and Conservation Laws
- Part III Oscillations and Waves

Volume Two

- Part IV Thermal and Statistical Physics
- Part V Electric and Magnetic Fields
- Part VI Quantum Physics and the Structure of Atoms

In an effort to provide motivation for each new topic as it is introduced and to combat the fragmentation of physics as it is typically presented in textbooks, the book emphasizes the link between the microscopic properties of atoms and the macroscopic properties of bulk matter. He does so in a very conversational and personal way that has elicited favorable comments from my students on numerous occasions and that I find enjoyable and informative as well.

The *Workbook* which accompanies the text is intended to bridge the gap between the text and problem solving by providing students with the opportunity to develop skills, such as interpreting graphs, reasoning with ratios, drawing free-body diagrams, drawing electric field maps, and interpreting wave functions.

During the first two semesters of my course, I used the *Workbook* strictly as homework — a strategy that did not work well and that I have abandoned in favor of its use as Knight

intended; i.e., as a bridge between the content of each chapter and the exercises and problems at the end of the chapter. I also use the *Workbook* as a basis for in-class active learning activities. The end-of-chapter exercises and problems are very well thought out and original. My students and I have found them to be both challenging and instructive.

The *Instructor's Guidebook* includes learning objectives for each chapter, an overview of the chapter, a day-by-day strategy for completing each chapter, and specific suggestions for in-class activities that the author has found useful in promoting learning.

I've used essentially all of his suggested activities as "whiteboard problems" — a teaching strategy I picked up at the First IPC held at Joliet Junior College in the summer of 1996. I glued a 4' x 8' sheet of whiteboard material to a sheet of 3/8" plywood and cut this composite sheet into 6 smaller rectangular pieces with beveled edges. I put Knight's suggested activities on overhead projector transparencies and have my students work on these problems collaboratively while I wander about the room and make suggestions and ask questions. The whiteboards are easily held upright so that students can share their work and gain experience in explaining what they have done to their peers.

The *Instructor's Guidebook* also includes several suggested examination questions for each chapter. I stopped giving standard midterm examinations several years ago in favor of frequent quizzes, and so I've used these questions as 20-30 minute quizzes. The *Instructor's Guidebook* is the most useful guide that I have ever seen and urge potential adopters to seriously consider following its suggestions.

My experience with Knight's textbook is in a course in which I've obliterated the distinction between "lecture" and "laboratory". The class meets for three 2-hour blocks each week for three semesters in an MBL-equipped classroom. Thus I have been able to spend about 150% of the time he suggests on each chapter. I very seldom "lecture" having created an interactive-engagement

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learning environment. PACP lends itself well to this teaching strategy especially if one follows Knight's suggestions in his *Instructor's Guidebook*. We do very few traditional laboratory activities but use the MBL equipment whenever doing so serves an immediate purpose. I've also made extensive use of Ranking Tasks as an in-class learning activity.

I administered the Force Concept Inventory (FCI) as pre- and post-tests in the Fall of 1997 with a normalized gain, G , of 61% for the FCI and post-test average of 68% on the Mechanics Baseline Test (MBT). While the ultimate indicator of learning at the introductory level has to be the extent to which students find themselves prepared for the next level of study, such FCI and MBT results are encouraging and suggest that the use of PACP and interactive-engagement teaching strategies go very well together.

I plan to continue the use of this excellent book into the foreseeable future.

eMBL: Online Collaborative Science

Logal Software, Inc., is developing techniques to provide students a way to visualize through animation and analyze real experimental data over the Internet using a browser such as Netscape Navigator or Internet Explorer. The electronic Microcomputer Based Laboratory, or eMBL, allows people to use Logal's SimPlayer simulation tools (a free browser plug-in) to observe their own experimental data and those of others over the Internet.

Logal's SimPlayer technology is used to view the data—animation, graphs, and spreadsheets—and to analyze the data. Data that have been collected by sensors in a real laboratory can be uploaded and made available over the Internet at the Logal.net web site.

The current site features a physics lab on free-fall. It provides data and animation coupled to the data for a golf ball, a soccer ball, and a coffee filter in free fall.

One benefit of this system is that it will allow students to observe and analyze real experimental data from any place that has an internet connection without having the actual lab equipment before them. It also makes it possible to deal with experiments they might not usually do or be able to do. In addition, it can provide a supplement to hands-on experimentation, will allow students to "repeat" experiments, or can be used as pre-lab preparation.

Using Ranking Tasks for Assessment of Critical Thinking

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Introduction

In the Summer 1997 issue of the CaFD newsletter, Dwain Desbien discussed two uses of ranking tasks. As he mentioned, ranking tasks have many varied and interesting uses. This article will illustrate the use of ranking tasks combined with a technique known as Primary Trait Analysis. The combination of the two provides a powerful assessment tool to improve teaching and student learning.

I teach an algebra/trigonometry based College Physics sequence at Clermont College, a two-year branch campus of the University of Cincinnati. We are accredited by North Central Association of Colleges and Schools (NCA). As part of our accreditation, we must have an assessment plan to assess and document student academic achievement. The academic assessment plan is required to include assessment of general education. Critical thinking is included as a component of general education. The exact definition of critical thinking may vary from class to class or from school to school. At Clermont College, we have included interpreting, evaluating, problem solving, analysis, and inference in our definition of critical thinking.

Ranking Tasks

Ranking tasks are a great critical thinking exercise. A ranking task presents one physics concept and consists of a one-page exercise with as many as eight similar figures or examples that the students are asked to analyze and rank from greatest to least based on some physical quantity such as magnitude of force, velocity, acceleration, etc. Space is provided for the students to explain their reasoning and to rank, on a scale from one to ten, how sure they are of their answer.

For the most part, I use ranking tasks from the book *A Selection of Physics Ranking Tasks* but have created some of my own. I generally use ranking tasks as in-class assignments. The students first work individually and then in groups of three or four. Often, students will arrive at the correct ranking and understanding through peer discussion. This process of working through to a correct solution is in itself valuable practice in critical thinking. When students change their ranking as a result of group discussion, I ask them to write the new ranking above their

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 individual ranking because I am interested in the student's individual work. The groups' rankings are recorded on the board and discussed. I collect the ranking task assignment to evaluate the students' work, but have not used it as a graded assignment. I also have used ranking tasks as homework assignments.

Primary Trait Analysis

At about the same time I began using ranking tasks, I attended a workshop on using Primary Trait Analysis (PTA) for assessment. PTA is a method of evaluating student performance on a particular assignment. Specific criteria for evaluating the assignment are written, and a scale is created to score the student's performance. The scale typically consists of three to five levels with the top level being the most effective performance of the assignment and the lowest level being the least effective performance of the assignment. PTA can be used in any course and on any assignment. (A more detailed explanation of PTA can be found in *Effective Grading - A Tool for Learning and Assessment* by Barbara E. Walvoord and Virginia Johnson Anderson, Jossey-Bass Publishers, 1998.)

Using PTA as an assessment tool is beneficial for several reasons. It is faculty-driven, course based, time efficient, low cost, and is accepted as a form of assessment by NCA. It has helped me more clearly define my expectations for student performance and learning. When it comes to assessing the trait of critical thinking, using ranking tasks and PTA together is a natural fit.

Using ranking tasks as the critical thinking assignment, I began by creating a three level primary trait scale. Below is a description of each level and a table used for scoring the students, followed by an example.

Primary Trait Scale For Ranking Tasks College Physics (Critical Thinking)

- 3 The student's reasoning demonstrates an understanding of the basic concept presented, and the examples are correctly ranked.
- 2 The student correctly ranks the examples, but the student's reasoning is flawed. (The student is able to choose the right equation and plug numbers into it.)
 or
 The student's reasoning is correct, but the ranking is incorrect.
- 1 The student does not understand the concept and does not rank the examples correctly.

Scoring

Primary Trait Score	Number of Students Attaining Score
3	8
2	5
1	1

Example

The table above records the results from a ranking task that I have used in the past: "Springs & Masses - Period of Oscillating Mass" on page 60 of *A Selection of Physics Ranking Tasks*. It asks the students to rank the period of vibratory motion of a mass connected to a horizontal spring given the spring constant and the displacement. Over half of the class was able to rank the figures correctly and properly explain their reason for the order of their ranking. Five students had the general idea, but did not have a complete understanding. The one student at level one was not familiar with the material and guessed at the ranking. The information gained from this exercise allowed me to pinpoint the difficulties some students were having with this particular concept. After using the three-level scale for several quarters, I have considered using a four-point scale to more accurately evaluate the students.

A valuable part of the ranking task is the written explanation of the reasoning the student used to arrive at their conclusion. Most students are reluctant to ask questions or speak in class, and the written explanation allows the teacher to have some insight into the basic understanding that the student has of the topic and the thought processes they are using to arrive at their conclusions. In this way, modifications can be made in the way a particular topic is introduced and/or taught and misconceptions can be directly addressed.

Conclusion

In summary, using ranking tasks with the primary trait analysis provides a way to meet the requirements of NCA for assessment of critical thinking.

The ranking task provides a fine and very useful critical thinking exercise.

The PTA scale provides a method of data collection to document the student's academic achievement.

To complete the loop of a good assessment plan, the data can be analyzed and, if necessary, modifications can be made to improve teaching and learning.

IPC 3 Participants ('98)

Howard Balfour	Moraine Valley Community College	Palos Hills	IL
Emile Bernard	Piedmont Community College	Roxboro	NC
Nancy Bryant	Jamestown Community College	Olean	NY
Chad Davies	Cloud County Community College	Concordia	KS
Butch Diesslin	Vermilion Community College	Ely	MN
David Duluk	Henry Ford Community College	Dearborn	MI
Paul Haar	Southeast Community College	Lincoln	NE
Bill Hogan	Joliet Junior College	Joliet	IL
Bruce Kaasa	Iowa Central Community College	Fort Dodge	IA
Dave Kardelis	College of Eastern Utah	Price	UT
Joe Krivicich	Diablo Valley College	Pleasant Hill	CA
Todd Leif	Cloud County Community College	Concordia	KS
Deb Lohr	Blackhawk Technical College	Janesville	WI
Earl McMurry	Indian Hills Community College	Centerville	IA
David Mills	College of the Redwoods	Eureka	CA
Nick Nicholson	Central Alabama Community College	Alexander City	AL
Mickey Odom	Albuquerque Technical Vocational Institute	Albuquerque	NM
Umesh Pandey	Albuquerque Technical Vocational Institute	Albuquerque	NM
Marie Plumb	Jamestown Community College	Jamestown	NY
Sherry Savrda	Lake-Sumter Community College	Leesburg	FL
HC Snyder	St. Clair County Community College	Port Huron	MI
Bob Speers	Firelands College-Bowling Green St. Univ.	Huron	OH
Laurie Thomas	Don Bosco Technical Institute	Rosemead	CA
Herman Trivilino	College of the Mainland	Texas City	TX
Dennis Van Swol	Highland Community College	Highland	KS
Myra West	Kent State University	Kent	OH

IPC 3 Invited Presenters ('98)

Alex Dickison	Seminole Community College	Sanford	FL
Paula Heron	University of Washington	Seattle	WA
Curt Hieggelke	Joliet Junior College	Joliet	IL
Dave Maloney	Indiana - Purdue University at Fort Wayne	Fort Wayne	IN
Lillian McDermott	University of Washington	Seattle	WA
Tom O'Kuma	Lee College	Baytown	TX
Cindy Schwarz	Vassar College	Poughkeepsie	NY
Alan Van Heuvelen	The Ohio State University	Columbus	OH
Michael Wittman	University of Maryland	College Park	MD
Dean Zollman	Kansas State University	Manhattan	KS

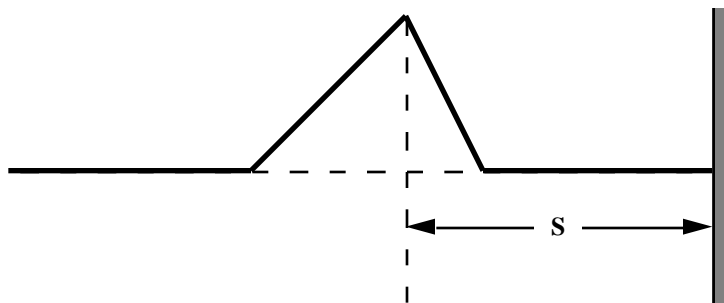
IPC 3 Pre-Conference Materials ('98)

1. "Student Difficulties in Understanding Image Formation by a Plane Mirror." Goldberg, F., & McDermott, L. (1986) *The Physics Teacher* 24 (8): 472-480.
2. "An Investigation of Student Understanding of the Real Image Formed by a Converging Lens or Concave Mirror." Goldberg, F. & McDermott, L. (1986) *American Journal of Physics* 55 (2) 108-119.
3. "Constructing New Ideas About Light and the Formation of Images." Dykstra, D., Boise State University (1995) Conference of the Association for Constructivist Teaching, San Francisco, CA.
4. "Student Difficulties in Understanding Mechanical Waves: An Overview of Research Results". (May 1996) Wittman, Michael. University of Maryland.
5. Pre-conference wave worksheet based on Jeff Saul's University of Maryland materials (page 9).

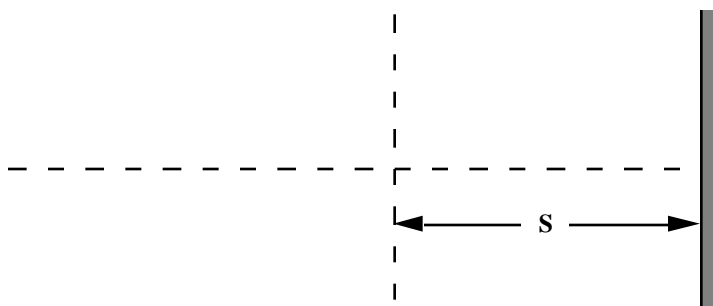
Pre-Conference Wave Worksheet*

A professor is demonstrating the motion of waves on a long, taut spring. She is holding the spring at one end and will move it so the spring will move back and forth on the floor. The spring is firmly connected to a metal rod at its other end. The spring is under a tension T and has a mass density m . She starts a triangular pulse moving towards the right as shown in the figure below. The pulse is triangular and is not symmetric. The figure below is shown at a time t_0 .

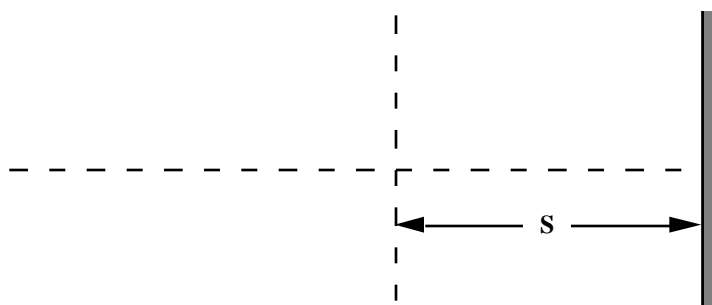
(a) Calculate the time it will take the peak of the pulse to reach the wall (to travel a distance S).



(b) What will the spring look like at time $t_0 + \Delta t$? Draw a carefully constructed and labeled diagram to show what it looks like and how you got your result.



(c) What will the spring look like at time $t_0 + 2\Delta t$? What is responsible for this result?



(d) The width of the pulse is 0.5 m. If the tension in the spring is 5 N and it has a mass density of 0.1 kg/m, how much time did the professor take to generate the pulse?

(e) What could the professor do to make a pulse that would reach the wall in less time?

'98 TYC Physics Workshop Participant Colleges

Central Alabama Community College	Alexander City	AL
Mississippi County Community College	Blytheville	AR
Chandler-Gilbert Community College	Chandler	AZ
Don Bosco Technical Institute	Rosemead	CA
Foothill College	Los Altos Hills	CA
Fullerton College	Fullerton	CA
Hartnell College	Salinas	CA
Coastal Georgia Community College	Burnswick	GA
Black Hawk College	Moline	IL
Joliet Junior College	Joliet	IL
Ivy Technical State College	Kokomo	IN
Barton County Community College	Great Bend	KS
Cloud County Community College	Concordia	KS
Highland Community College	Highland	KS
Independence Community College	Independence	KS
Johnson County Community College	Overland Park	KS
Prince George's Community College	Largo	MD
Glen Oaks Community College	Centreville	MI
Gogebic Community College	Ironwood	MI
Henry Ford Community College	Dearborn	MI
Southwestern Michigan College	Dowagiac	MI
Bethany Lutheran College	Mankato	MN
Minnesota West Community and Technical College	Worthington	MN
Vermilion Community College	Ely	MN
Cottey College	Nevada	MO
Jefferson College	Hilsboro	MO
Maple Woods Community College	Kansas City	MO
Ozarks Technical Community College	Springfield	MO
Penn Valley Community College	Kansas City	MO
St. Charles County Community College	St. Peters	MO
St. Louis Community College	St. Louis	MO
Forsyth Technical Community College	Winston-Salem	NC
Mitchell Community College	Statesville	NC
Piedmont Community College	Roxboro	NC
Surry Community College	Dobson	NC
Metropolitan Community College	Omaha	NE
Southeast Community College	Lincoln	NE
Clinton Community College	Plattsburgh	NY
Erie Community College/City	Buffalo	NY
Hudson Valley Community College	Troy	NY
Jamestown Community College	Olean	NY
Firelands College of Bowling Green State University	Huron	OH
Jefferson Community College	Steubenville	OH
Lorain County Community College	Elyria	OH
University of Cincinnati Clermont College	Batavia	OH
Penn Commercial Inc.	Washington	PA
Penn State DuBois	DuBois	PA
Chattanooga State Technical Community College	Chattanooga	TN
Nashville State Technical Institute	Nashville	TN
Volunteer State Community College	Gallatin	TN
Cisco Junior College	Cisco	TX
College of the Mainland	Texas City	TX
Del Mar College	Corpus Christi	TX
Lee College	Baytown	TX
North Harris College	Houston	TX
Wharton County Junior College	Wharton	TX
Wytheville Community College	Wytheville	VA
Big Bend Community College	Moses Lake	WA
Waukesha County Technical College	Pewaukee	WI
Casper College	Casper	WY

Integration of VQM into a Community College Physics Course: A Field Testers Perspective

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The Interactive Physics Conference III, held at Joliet Junior College was a conference that helped two year college physics teachers update themselves on the latest curriculum innovations and research being done on waves and quantum mechanics for undergraduate physics students. One of the presenters for the conference was Dean Zollman from Kansas State University. His research group's project, Visual Quantum Mechanics (VQM), is a project with which I am very familiar, because I have been a field tester for various modules of the VQM project while teaching in the physical science department at Cloud County Community College in Concordia, Kansas.

Taking part in the collaboration with a local university's curriculum and development project was a rather easy task for myself and my CCCC teaching colleague Chad Davies. Although I am a full time physical science faculty member at CCCC, I am also a physics education graduate student at Kansas State University. This connection between the two groups' science departments has afforded CCCC instructors the opportunity to field test numerous units in the Visual Quantum Mechanics curriculum produced by the Physics Education Research Group at KSU, as well as provide valuable feed back to KSU. Included in these testing opportunities were KSU provided equipment, and assistance in running the field test projects, evaluative testing and video taping of students.

The initial module tested, "Solids and Light" contains a set of units based on the fundamental properties of LED's and the spectrum of light they produce. Our integration of these units in algebra-based physics came after the study of simple electrical circuits and before a unit on general electromagnetic waves and spectrum. It was a nice transition into atomic theory and modern physics, and allowed for a review of the chemistry principles of gases and solids. The first group of physics students who used this material commented that the units within the modules "repeated" themselves too much during its questioning sections and it became monotonous. However, the material that they learned was interesting for the most part, and definitely applicable to the "Real World." Many of the students sugges-

tions were incorporated into the final "revised" edition which will be made available by a commercial vendor early in 1999.

The "Solids and Light" unit was tested in different semesters and in different courses including general chemistry and physical science for non-majors. It was also used in various instructional methods such as individual lab settings, group demonstrations and even as a take home project. A feature of the unit is the set of computer programs called "Spectroscopy Laboratory Suite", which has the ability to simulate the spectrum of gases, solids and other "special materials" which are discussed in a parallel unit called "Luminescence, its Cool Light". The suite of programs are currently available for downloading at the website. <http://www.phys.ksu.edu/perg/vqm>.

The units within each VQM module are based on a traditional Karplus learning cycle. Because of their flexible form and pedagogical style, they were easily adapted to each of my specific classroom settings for my particular instructional purpose. My physical science students found the first drafts use of "bread boarding" and circuits a little demanding. However, newer versions have added the options of the teacher producing a pre-built circuit and giving small student groups different colored LED's to report on. Thus, the total time using the circuit boards is minimized and they become hands-on tools for learning about LEDs. This method is especially effective when doing "Solids and Light" module Activity 9: "The Photoelectric Effect," a unit where students measured Planck's constant well within a ten percent error limit.

Our overall impression with the "Solids and Light" module was good. It was the most thoroughly developed and flexible of all the modules we eventually tested. The teachers guide was very helpful and the material could easily be incorporated across various science curriculums.

Our department also tested the "Luminescence, its Cool Light" unit during a different semester and, in a non-majors physical science class. This unit really did a nice job getting the students interested in a form of modern physics related to light formation

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by “special materials” known as luminescent materials. The unit could be placed literally anywhere in your curriculum because of the unique ideas and simple modeling approach taken during the formation of the basic physics ideas in luminosity. This unit could be used in an algebra-based course as an “extra” or a capstone type project with little direction provided by the instructor. Of all the materials produced by the VQM project, this unit seemed to be the most “user friendly” and provided the most fun and enjoyment during the student’s usage. Like the “Solids and Light” module, this one has a well developed instructors guide, making it simple to adapt and understand for even the most novice user of computers and poorly prepared “quantum” science instructors.

When Dean Zollman gave his presentation on “Wave and Wave Functions” at the IPC III meeting in Joliet, it was the only unit I hadn’t tested myself at CCCC. I saw how this would be a very useful unit at the two year college level, especially if you had a third semester to teach “Quantum Mechanics.” I was aware that another TYC Colleague Bob Hunt, who teaches at Johnson County Community College in Overland Park, Kansas, was teaching a Quantum Mechanics course and had been helping out with this units redesign. Through my discussions with Bob Hunt and the Zollman presentation at IPC III, I can only imagine the ease that quantum students might have if wave functions were taught by this active approach. Although I might have trouble teaching this to my Algebra-based students, I am sure that my teaching partner will give it a try in a Calculus-based Physics course next year.

Where will I go from here? This fall my Physical Science course will be a testing ground for the “Total Package.” Instead of integrating small pieces into an already overcrowded curriculum, I am going to try to make the VQM units my basic level course, while producing enhancement exercises as spin-offs from at least 3 or 4 of the modules. After being a part of the whole process I hope that this more radical approach to “immersion” rather than “integration” will provide a chance to make Physical Science a more “modern” oriented course. Will this method be effective? I guess that question may have an answer in the future.

For a more through description of the complete set of programs and the modules provided in the Visual Quantum Mechanics Project look at the KSU Physics Education Research Groups homepage at <http://www.phys.ksu.edu/perg>.

Vernier ULI USB Port Update

There are a number of questions about using the ULI and the USB ports found on the new iMac and new G3 computers. During a recent trip to Boston, I saw and tested briefly an iMac running a ULI both at Ron Thornton's Center for Math and Science Teaching at Tufts and at the booth of Vernier Software at the NSTA Convention. (I also saw and tested an iMac at the PASCO booth using a special SCSI adapter.)

Vernier Software has tested its new version of LoggerPro (1.1 available now on a CD) and the Keyspan USB Serial Adapter. This adapter is available from Mac catalogs such as MacWarehouse or directly (510) 222-0131, info@keyspan.com, or www.keyspan.com. This seems to be the best solution for interfacing Vernier equipment to a USB port.

They recommend using the ULI or Serial Box Interface with a Mac with a USB port: MacOS 8.5 or newer, LoggerPro version 1.1 or newer, KEYSpan USB SERIAL ADAPTER (requires driver 1.5.1 or newer, available at their web site).

They also mention that it is possible to use the PCI serial card from Keyspan (SX-2) for the new Mac G3 computers, but this is a more expensive solution.

For other Vernier products such as Mac Motion, Data Logger, or Graphical Analysis, it is also possible to use the Keyspan adapter. These programs work when the interface is attached to port 1 of the Keyspan adapter and Printer port was selected in the software. (Port 1 of the Keyspan adapter corresponds to the Printer port and Port 2 corresponds to the Modem port). Note that these programs will not work on Port 2 of the Keyspan adapter.

For more information visit Vernier’s web site at www.vernier.com or contact Vernier Software at (503) 297-5317 or email info@vernier.com.

1/99 Update from Todd Lief: Overall, I didn't get to the level that I wanted, or at least hoped for when I wrote that article, and I had to stick with the same thing that I was doing last semester. I did use the potential energy diagrams stuff during my energy unit, and I did do some of the luminescence stuff but didn't really get it incorporated as a full blown immersion.

well.

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When the activity was presented, the other participants and the group itself had many suggestions for extensions and enhancements. This group project included a ranking task designed to help students understand the difference between the two velocities.

Two-Slit and Multiple Slit Interference Patterns

Emile Bernard, Piedmont Community College, Roxboro, NC
Chad Davies, Cloud County Community College, Concordia, KS
Butch Diesslin, Vermilion Community College, Ely, MN
David Mills, College of the Redwoods, Eureka, CA

This group's project was inspired by the group members' interest in working with the tutorials presented by Paula Heron and Lillian McDermott from the University of Washington involving interference patterns. This group project includes several hands-on activities intended to be used in addition to the paper-and-pencil work of the tutorials. The group suggests using the pre-test and post-test from the tutorial to assess student learning.

This group project was designed as a set of activities to be used first for students to study two slits and then later these same activities are extended to more than two slits eventually building up to a diffraction grating.

The first activity students do with two slits (and later multiple slits) is to investigate the phenomena using a PASCO optics set including a bench, laser source, and easily changeable sets of two slits.

The second activity students do with two slits (and later multiple slits) is to simulate interference patterns using the *Interactive Journey Through Physics* CD by Cindy Schwarz.

The third activity students do with two slits (and later multiple slits) is to look at the patterns by mechanically constructing them with clear strips with sine waves printed on them which are tacked down at one end but free to rotate.

The last activity students do with two slits is to look at the patterns using a spreadsheet. I believe the spreadsheet was just finished as the deadline approached and no classroom materials or explanatory handouts were provided by the group.

Understanding the Doppler Effect

Paul Haar, Southeast Community College, Lincoln, NE
Bill Hogan, Joliet Junior College, Joliet, IL
Earl McMurry, Indian Hills Community College, Centerville, IA
Sherry Svarda, Lake Sumter Community College, Leesburg, FL
Dennis Van Swol, Highland Community College, Highland, KS

This group project was designed to help students understand the Doppler Effect with particular emphasis on student confusion between the frequency increasing or decreasing depending on the direction the source moves and the sound getting louder or softer depending on the direction the source moves.

This group project includes both a pre-test and a post-test to assess student understanding. This group project includes a set of materials which lead students step-by-step as they draw the locations of pulses emitted by a stationary source and then a moving source at different times.

This group project also includes a laboratory activity for students to measure the Doppler Effect. In the lab activity, students move a speaker emitting a constant frequency vertically up and down above a microphone connected to a computer which graphs the sound wave.

The students are led to determine the direction the source is moving during a time interval by looking at whether the amplitude of the wave is increasing or decreasing. The portion of the graph where the source is moving in each direction is expanded or blown up and the frequency is determined by counting peaks in a time interval.

Students are asked to calculate the speed of the source as it moves down and then as it moves up and to decide whether the speeds found are reasonable. In this experiment, the frequency shift is asymmetric because it is easier to move the source down quickly than up quickly. Students can verify this by moving the speaker vertically as they did before but this time over a motion detector.

This group initially intended to design an activity where students would measure the Doppler frequency shift and the speed of the source with the motion detector simultaneously but could not overcome the technical difficulties before the deadline.

Detecting Electromagnetic Waves

Howard Balfour, Moraine Valley Community College, Palos Hills, IL

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Joe Krivicich, Diablo Valley College,
Pleasant Hill, CA
Nick Nicholson, Central Alabama
Community College, Alexander City, AL
Marie Plumb, Jamestown Community
College, Jamestown, NY
Bob Speers, Firelands College, Bowling
Green State University, Huron, OH

This group project focused on polarization (despite the title). The group recommends that students work through the tutorial presented by Paula Heron and Lillian McDermott from the University of Washington about how to orient an antenna to detect radio waves before working on the activity the group has developed.

This group developed an interactive lecture demonstration (following the work of David Sokoloff and Ron Thornton) using a source of vertically polarized microwaves and an antenna used as a receiver. Students are asked to predict what will happen, observe what does happen, and then explain what did happen in different activities in the group's demonstration.

The first activity in the demonstration is to rotate the receiver and see how the intensity of the signal is affected. The second activity in the demonstration is to place a solid metal plate between the source and the receiver and observe the change in signal intensity. This activity also questions students about where the energy of the waves goes. Students may be surprised to see that the energy is mostly reflected and not absorbed.

In the last part of the demonstration, a metal plate with slits cut into it is placed between the source and the receiver at different orientations. Students probably will be surprised to see that the vertical grid blocks the vertically polarized waves but the horizontal grid allows the vertically polarized waves to pass. It is expected that this will occur since students will likely appeal to the example of transverse waves on a rope passing through a picket fence. The group project materials then lead students to make the jump from the microwaves and the grids to polarizers for visible light made from a long-chain of hydrocarbon molecules.

Fundamental Concepts of Standing Waves

Nancy Bryant, Jamestown Community
College, Jamestown, NY
Bruce Kaasa, Iowa Central Community
College, Fort Dodge, IA
Mickey Odom, Albuquerque Technical
Vocational Institute, Albuquerque, NM
Myra West, Kent State University, Kent, OH

This group produced a potpourri of materi-

als all related to standing waves. The first materials from this group have students observe that wave speed depends on tension and mass density and then use dimensional analysis to determine the relationship between v , T , and μ . This group's materials also include a handout leading students step-by-step from $v = \lambda / t$ to $v = f \lambda$.

Another set of materials from this group was inspired by the tutorials from the University of Maryland and leads students step-by-step in finding the shape of pulses reflected from a fixed end. The students draw the pulse at different places at different times and if part of the pulse has passed the boundary, the student uses a clear sheet of paper to trace the shape past the boundary and flip it over twice before superimposing the reflection on the incident pulse. A detailed test of student understanding about the shapes of reflections is included in these materials.

This group's materials include a lab activity where students whirl a corrugated plastic tube around and around and produce different frequencies measured by MBL and compare the calculated wavelengths with the length of the tube.

The materials also include two ranking tasks. The first ranking task asks students to rank wave speed based on tension and mass density. The second ranking task asks students to rank the maximum displacement to be produced by the superposition of a variety of pairs of oddly shaped pulses headed toward each other.

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be to have the students make one set of observations at the outset of the activity and then use the simulation from there on. This may go a long way to connecting the activity to the "real world." Additionally, a similar exercise can be developed using published data to determine the dependence of g on the mass of the central body. One could use the Earth/Sun system, the Earth/Moon system and a Jupiter/Galilean moon system to provide three data points for the graph. Additional planet/moon systems could also be added to increase the number of points, though they would cluster near the Jupiter mass value.

Students at Cloud have responded positively to this introduction to gravitation. By introducing the topic through the study of g , it is also easier to introduce the concept of a field and potential for use later in electrostatics.

Gravitation: A Conceptual Exercise

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I. Introduction

Teaching the subject of gravitation in an introductory physics class is usually lecture based/problem solving oriented in nature. This flies in the face of a growing body of physics research that shows that students learn most effectively when they construct their own models of the physical world. Hence, anecdotal evidence suggests that students learn gravitation as a set of equations to solve problems, not as a fundamental force of nature that is conceptually and historically rich. Additionally, it may even be more rare for the student to see gravitation as a force law entirely analogous to the electric force. What will be presented in this communication is a way to have students explore Newton's Universal Law of Gravitation by using a simulation of the Jovian system's large (Galilean) moons. In doing this, students will also get an opportunity to review topics in oscillatory behavior, circular motion and graphical analysis.

II. Physics at Cloud

Gravitation is studied at a somewhat later date at Cloud than in the normal introductory physics sequence. It is used to introduce the theme of the entire second semester course; forces as interactions. In this way, it prepares the student for the study of electrostatics by discussing topics that will be used in greater depth there such as force laws as causes of motion, interactions as consequences of the properties of matter (i.e. mass, charge) and potential theory. Therefore, the topic is covered following a broad introduction to Newton's Laws and oscillatory systems. The importance of this will become apparent shortly. Also, the calculus based physics course is taught in an integrated lab/lecture environment with a great deal of interactive, engaged learning and peer instruction. Thus, students are familiar with spreadsheet software and techniques, as well as modeling and simulations.

III. The Activity

The student begins the activity by investigating what has been assumed about the acceleration of gravity up to the present point of the course. The student is then prompted to explore what physical variables g might depend on if it were functionally dependent on anything. This allows the student to begin to search for ways to probe how one might test a prediction without being able to leave the Earth's surface or changes the Earth's mass.

From this point, the student is guided through a derivation that will allow the acceleration of gravity to be determined by measuring the period of an object undergoing circular motion. This is a nice place to introduce or continue a classroom discussion on indirect measurement versus direct measurement. Once the derivation has been completed and checked by the instructor, the student is directed to simulation software that will simulate the orbits of the Galilean moons of Jupiter. We use the "Revolution of the Moons of Jupiter" package available from Gettysburg College and the CLEA (Contemporary Laboratory Experiences in Astronomy) project (the program can be downloaded from the CLEA website at www.gettysburg.edu/project/physics/clea/CLEAhome.html). This package simulates looking at the Jovian system through a telescope in which the magnification can be varied. The user moves the mouse pointer to a moon of interest and clicks. The computer then reads out the name of the moon and the number of Jupiter radii the moon is away from the planet's center. It is possible for the instructor to disable the feature of the program that labels the moons. This gives a more realistic experience, but also makes the exercise more time consuming. The student is able to repeat the observations over several discrete time periods. In this way, a data set of each moon's position as a function of time is gathered. This time step may be varied by the user (the default value is 24 hours) which turns out to be useful for getting a more complete data set of Io's motions.

The student then graphs each moon's position as a function of time using Excel. This plot will produce a sine shaped curve from which the period can be measured for each moon. From this, the value of g for each moon can be calculated. By using the maximum of the sine curve, the student can also determine the radius of each moon's orbit. By plotting the value of g against the radius, the student can see then model the functional dependence of g on r . As a confirmation, the student is finally asked to fit the curve using Excel's fitting tools to verify the inverse square nature of the force.

IV. Some Final Notes

This process would be best done using real observations of Jupiter, but this is usually not a viable option. A nice alternative might

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PASCO's USB Port Update

PASCO is currently developing a revision to *ScienceWorkshop* 2.3 software that will allow ScienceWorkshop Interfaces to work with the new Apple computers through the Serial to USB adapters that have recently become available. The software revision will be finished this summer and available for free download from PASCO's web site. (A beta version is available now from their web site at www.pasco.com.)

They announced new software which will include the ability to communicate with the new Serial to USB adapters. *DataStudio* 1.0 will also be available this summer. I had a chance to play with it at the 1999 National NSTA Conference in Boston, MA. It was very nice. One really nice feature was the ability to change the graph displaying the data while it was being collected. However, it remains to be seen whether the new features it will have will be worth the cost of buying the new software. In other words, they do not consider it to be an upgrade to the *ScienceWorkshop* software but a new software program, but it looked like it to me. I hope someone who buys it or gets it will send CaFD a review of it to help us decide if it is worth the additional cost.

Adapters that work reliably on the Mac with the beta version of the ScienceWorkshop software are uConnect from Momentum, Inc., iDock from Compucable, Inc., and the iPort from Griffin Technology. However, the USB Serial Adapter from Keyspan (recommended for the Vernier ULI system) worked only intermittently with the beta version program according to PASCO.

On the Windows side, they have tested the USB Serial Adapter (Model F5U003) from Belkin Components (www.belkin.com) with a ScienceWorkshop 500 Interface under Windows 98.

CaFD is a component of the networking, follow-up, and dissemination process of a National Science Foundation supported Faculty Enhancement project (DUE 9554683). The opinions, statements, findings, recommendations, or conclusions expressed in this newsletter are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, Joliet Junior College or Lee College. Readers are encouraged to submit responses to articles. They should be sent to Curtis Hieggelke, Natural Science Department, 1215 Houbolt Road, Joliet Junior College, Joliet, IL 60431, or e-mailed to curth@jjc.cc.il.us

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