A TIME for Physics First

Academy for Teachers - Inquiry and Modeling Experiences for Physics First

For 9th grade science teachers

NEWSLETTER: Vol 2, No. 1, April 2008

Summer Academy 2008

Meera Chandrasekhar, MU

Welcome back to what is turning into a habit – the Physics First summer academy! We have been working to provide a worthwhile and exciting experience, as always (don't smirk now).

Fifty Year 3 participants will face the challenge once again, and will absorb the content and pedagogy of the last three units of physics to bring back to their 9th grade classrooms for the 2008-09 academic year. Content in their classroom includes Electromagnetism, Waves, and Heat & Real-World Applications. Their academy is scheduled for June 9-27, 2008.

Twenty-two Year 2 protégés will be back for four weeks, June 2-27, 2008. Content in their classroom includes Energy, Momentum, Planetary Motion, Electromagnetism, Waves, and Heat & Real-World Applications.

Physics First faculty will consist once again of three teams: Dr. Meera Chandrasekhar (University of Missouri) with Dr. Dennis Nickelson (William Woods University), Dr. Dorina Kosztin, (University of Missouri) with Mr. Gabriel De La Paz (Clayton School District), and Dr. Mani Manivannan (Missouri State University) with Mr. James Roble (John Burroughs High School). The writing team has met monthly this academic year to develop the curriculum for the summer academy. As before, it will provide many rich learning opportunities for participants.

Sandy Scheble's class at Hazelwood East High School

As in 2006 and 2007, the PF program has invited math teachers to attend the first week of the regular academy. This year they will attend for three days, June 7 - 9, with their science teacher colleagues. District administrators are invited to attend the academy on June 16-17 to take part in classroom activities as well as meet with their colleagues from other participating districts. Applications for math teachers and administrators are available on the website.

And finally, a quick note about this issue of the newsletter. We are delighted to publish articles written by several of our participants. During the April 12 follow-up session participants discussed topical issues, and wrote short articles based on their discussions. The submissions are simply brilliant!

Contents

Technology in the Classroom

Jaimie Foulk, Camdenton High School
Kory Kaufman, Cathy Dweik, Eileen Westveer, Tara Frearson, Laura Zinszer and Mike Cranford, Columbia Public Schools

This group discussed the instructional method of using Vernier Force Probes to incorporate technology into the classroom. We used this technology during the Friction lab, the Strength of Weight lab, and other activities in the Force and Newton's Laws Units.

In the classroom it is important for students to understand principles behind technology. For this reason, we discussed the need to help students establish a basis of understanding of the concepts of weight and the relationship between force and mass. Prior to the introduction of technology it is important to make sure students have experiences with rudimentary data collection techniques, e.g. spring scales and triple beam balances, to ensure they are able to analyze data as related to the concept at hand. Spring scales could be used first, for example, so that when introduced to force probes the data collection becomes meaningful and accurate.

To guide students through Unit III, *Introduction to Forces*, we begin with an exploration activity using spring scales. The activity includes data collection and construction of a graph using pencil and paper. Later they make use of higher tech data probes to collect and analyze data. Students compare results of their "low-tech" first lab to the more advanced second lab, to see the connection between events and graphical representation of those events.

Our group identified several potential problems with using technology in the classroom. Some students' limited mathematical ability and skills make physics concepts difficult to understand. Technology can give both students and teachers a false perception of students' understanding, due to its ease of use and poses its own set of problems: lack of access, limited numbers of probes, and incompatibility with existing technology. Lab setup is time consuming and cumbersome when supplies must be stored or shared among faculty. Sometimes computers lock up or shut down, or probes do not work properly. Software has limitations, as well; for example, LoggerPro Lite, the software that comes free with Vernier probeware, will only open when a probe is attached; it is impossible to input data manually, so spring scale data cannot be compared to force probe data with this software.

Advantages of this method include comfort level of kids who are accustomed to using technology. It provides a means of addressing varied learning styles and serves as a motivator for students. Technology can also reduce human error and make data analysis quick and less tedious. Students can draw meaning from data quickly and easily, as long as they have fundamental understanding of concepts.

Technology can improve teaching by providing formative assessment. Teachers can circulate through the classroom and hear students' ideas throughout the lab activity. The technology also allows students to explore the same concept in varied circumstances, enabling them to build mental models of physics ideas.

Here's what some of the group members do in their classes:

- Cathy begins Unit 3: Introduction to Forces with spring scales. She checks one out to each student, requiring them to use it for all appropriate activities.
- Later in the Unit, Cathy switches to Vernier Force Probes; she formerly used spring scales to create the Fv vs. m graph, and result was fuzzy data; now data from force probes is so compelling that students come in before/after school to get better data.
- Mike uses force probes to do the "elevator" problem.
- Mike also plots F vs. t and pulls a different mass each time; students see the relationship between force and mass.
- Cathy uses the book *Inquiry Probes* from NSTA to help assess kids' understanding of concepts after using technology.

Class-Within-a-Class and Special Education as a Part of Physics First

Andrea Jones, Cole Co. High School; Rich Muschett, Versailles High School
Seth Willenberg and Nancy Shikles, Columbia Public Schools
Karen Griffon, Elsberry High School; Lisa Grotewiel, Keytesville High School

Our group looked at ideas that work from the CWC/SPED point of view. We chose this concept because most of us have IEP/SPED students in class (General Education or CWC) and use these approaches regularly. In the classroom we make sure the material is engaging with little or no down time, so kids stay focused the entire time. The use of hands-on activities or investigations greatly assists the tactile and visual learners in developing an understanding of the Physics First concepts.

The pace needs to be slower (depending on the number and level of students involved) with possibly some concepts/ideas skimmed over (concept less only, with no math) or skipped entirely if it does not affect the continuity of the unit.

The Student Reading Pages can be omitted if the concepts are discussed in class, or at least must be edited to a lower reading or understanding level, with examples and pictures, to help with fostering an understanding of the concepts.

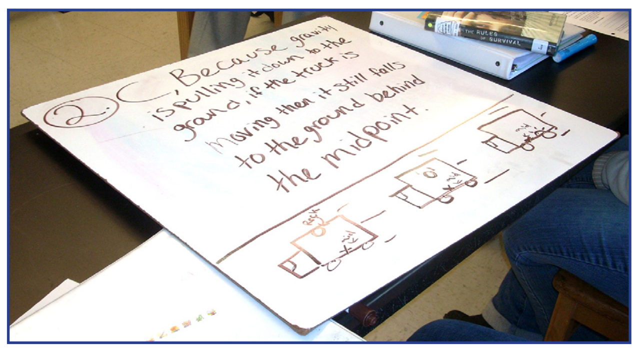
One member suggested pre-teaching the math skills that the students will be using in Physics First. Frequently students are lacking these skills in Algebra and Geometry, and the pre-teaching of the skills used will allow teachers to spend less time teaching these skills during the unit, which can detract from the concepts that we want them to learn, and give us more time to help the students develop a deeper understanding. Essential math skills are listed in "**Mathematics Underlying the *Physics First* Curriculum: Implications for 8th and 9th Grade Mathematics**" which can be found on the Physics First website, www.physicsfirstmo.org.

One problem encountered with hands-on activities is the additional burden on the teacher to set up and coordinate the activity and the possibility of destruction of equipment by the students. One way to ease this problem is to plan ahead and keep some equipment (if possible) set up all the time. From the student point of view, knowing the price of the equipment and the consequences of tearing it up are usually enough to keep them treating the equipment with respect.

The removal of behavioral issues, idle time and inattentiveness will help teachers in CWC, SPED or general education classes improve teaching in the classroom. While many of these techniques are used by learning specialists, all of these would benefit anyone who is teaching Physics First.

Acronyms used:

CWC: Class-Within-a-Class
SPED: Special Education
IEP: Individualized Education Program



Top: Student whiteboard from a 9th grade classroom in Mehlville Senior High School. Bottom: Jaimie Foulk, Andrea Jones and Richard Muschett at work during a follow-up meeting

White-Boarding - I

Casey Zahner, Poplar Bluff High School

Tom Struckmann and Amy Campbell, Hazelwood East High School

Christie Ortiz and Jackie Neeley, Oakville Senior High School

White-boarding has proven to be a very helpful tool. In our diverse school districts we find that we all use white-boarding. We use white-boarding to go over in-class worksheets, to answer homework questions and for qualitative graphs. By using white-boarding for a variety of lessons we are better able to check for student understanding and use it as a form of assessment.

When we begin a white-boarding session, students are grouped in pairs. We try to change partners each time so that students learn to collaborate with many peers. This also helps avoid student groups who are "chatty" or off-task. Once students are grouped they get their white boards, markers and erasers. After the student pairs are back in their seats the teachers gives them a question from a worksheet, lab, notes, etc.

At the beginning of the year, when white-boarding for the first time, we often encounter problems that must be addressed initially and repeated as the year progresses. Some of these problems include:

- partners do not equally share writing and talking duties
- the class is not a good audience; they may not listen, they may make derogatory or counterproductive comments while another group is presenting
- students in the audience may not follow along or make corrections to their work as needed
- some questions require more or less of a detailed answer; as a result, students who are finished early could cause discipline problems

After discussing the struggles encountered in our classrooms we strategized and came up with some solutions. We decided that we can avoid many problems simply by making a list of white-boarding rules available at the beginning of the school year and reminding students of proper etiquette prior to each white-boarding session. Some of our rules may include:

- Partners should take turns writing and presenting; if two questions are given, the duties of talking and answering the question should be divided equally.
- Students are expected to pay close attention to the presenters; you are advised to make positive reinforcement statements or you may correct any errors that you observe; counterproductive or derogatory comments will not be accepted.
- Students are responsible for all of the answers given but more importantly, are responsible for making changes to work if errors occur.
- Students may sometimes be given a question that requires a short answer; if a group finishes early think of questions to ask of your peers regarding other parts of the worksheet.

By presenting group white-boarding etiquette and modeling the proper white-boarding techniques at the beginning of the school year, students will become familiar with the technique and it will become a beneficial tool for self and group critique.

Although white-boarding can sometimes be time consuming, we find that if we use this method and if the negative aspects are addressed at the beginning of the school year and/or at the beginning of each class, the positive outcomes can be beneficial to all.

Dennis Nickelson's Whiteboarding Rules

1. You must make a commitment. This means that you must think about the question (problem, issue) and defend your thoughts. Be willing to state your understanding, point of view, belief.

2. You can change your mind at any time. If you hear a logical argument that changes your thinking or you make observations that changes your view, do so.

3. "The Thumper Rule". If you do not have anything nice to say, don't say anything at all. This comes from the movie Bambi, where the mother rabbit asks the baby rabbit (Thumper) what his father told him that morning. It is the teacher's job to create an environment that is safe for everyone to think and share their ideas.

White-Boarding - II

Melissa Reed, Webb City High School; Jeannie Horton, Dora High School
Todd Campbell and Jason Bradley, Aurora High School
Jaime Horton and Amy Scroggins Carthage Jr. High School
Trish Haltom, Ava High School; Sandy Letterman, Willow Springs High School

We all use white-boarding in our classrooms in a variety of ways and have had positive and negative experiences. White-boarding is used to check for comprehension, discuss concepts, and share ideas about the topic. Depending on the unit, it can be used as much as every day or as little as once every two weeks.

Some teachers have a white board for every four students, others have a board for every student. Some use cooperative groups to discuss and present concepts, others use it to check for individual understanding. The teacher may assign each group a different problem or concept, and have the student/group present what is written. When students make a mistake, the teacher can use it as a teaching moment.

The main difficulty in using whiteboarding is to keep the entire class focused and engaged, from the assignment of the problem to writing on the board, presentation and discussion. Another problem is that white boards and dry erase markers can be expensive.

A suggestion to help maintain the class' attention is to give a white-boarding participation grade. The teacher can give each student 4 out of 5 points for doing everything they are asked, staying on task etc. To earn the 5th point, they must ask a good question or explain beyond what is on the board. They can lose a point by being off task, talking or doodling. Another suggestion is to have a white board for every two students. A suggested solution to the marker problem is to have students earn community service points, homework passes, extra credit points, etc. for bringing equipment in. Also – having students bring supplies allows them to take ownership.

White-boarding allows students to have ownership of their learning and the learning process. It allows for more opportunities to utilize Socratic questioning. It provides a non-threatening way of checking for understanding and is a great formative assessment tool.

A Successful Start To a Physics Class

John Clapp, Hickman Mills High; Bruce Bradley, Ruskin Senior High School
Tonja Kearns, West Platte High School

A successful start to a class should ensure that students are engaged quickly and efficiently. Teachers suggested several methods:

- Use a Cryptogram that frames the current day's topic. A website to make Cryptograms is found at: discoverychannel.com – puzzlemaker.
- Review the agenda for the day: assignments and due dates can be written by the students in their planners.
- Start with a vocabulary exercise such as a Frayer Model that focuses on a current vocabulary term.
- Use practice exercises, for example from Pearson, to have students review current or past concepts.

Possible problems encountered include students choosing not to be engaged, coming in late or even just as the bell rings. Such students often become disruptive and hinder a good start. An incentive can help get students focus on the activity. To elicit accountability homework can be stamped during this time for completion credit. Other ideas included a bellwork grade for completing a certain percentage of the opening assignments on time, or to hand out the bellwork at the door to prevent distractions.

As a result of a successful start, students will be able to focus sooner and be in better shape to accomplish their daily tasks. As bellwork is incorporated into the day, the successful teacher will be able to use it to move right into the daily lesson or activity.

Framing Questions - To Use or Not to Use

Marsha Tyson, Oakland Junior High School

Before beginning a Physics First unit, teachers all have the same "drill." Give the pre-test then grade them, or often mine sit in a dusty corner until I have given the post-tests. The pre-tests are just papers to grade, and I don't have time to perform an item analysis on questions students don't have enough knowledge to answer. Then we get started on the unit's activities.

As a teacher, I have found an extremely helpful tool to assess student knowledge before beginning a unit, which involves no grading. The Framing Questions provided in the Physics First materials are a valuable resource for me to assess student preconceptions prior to learning content. Though PF has provided a framework, I have modified the questions to include a *Before Learning Content* section and an *After Learning Content* section. My classes fill out their responses at the beginning of the unit, and we whiteboard them. Then at the end, their homework is to revise their *Before* answers and use the newly learned "physics language," such as increasing velocity, constant acceleration, etc.

The Uniform Acceleration Framing Questions provide pictures of three different ramps, as a ball is rolling down it. There are two curved ramps and one constant slope incline. The constant slope incline provides the scenario in which students gather data for the Wheel Lab. Therefore, we whiteboarded only the flat ramp scenario after each student had written a response to the *Before Learning Content* section.

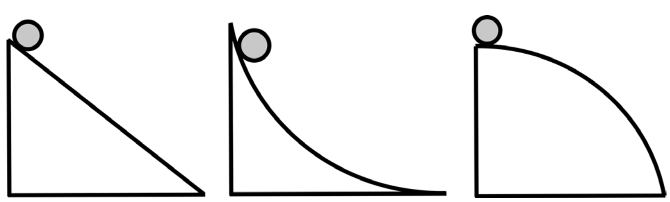
The answers I got in my honors classes surprised me! There were four distinctly different responses (page 7). I assumed my students understood that when an object goes downhill, it will go faster!

After whiteboarding the responses, there was a powerful discussion about each one. It was not my "job" to answer the question, but to set up the first learning opportunity—the Wheel Lab. The Framing Questions provided an opportunity for me to see what preconceptions they have upon entering a unit and allows the students to really talk about what they truly believe. After whiteboarding, many of the students said, "Wow, this is really harder than I thought. I didn't think there would be so many different possibilities."

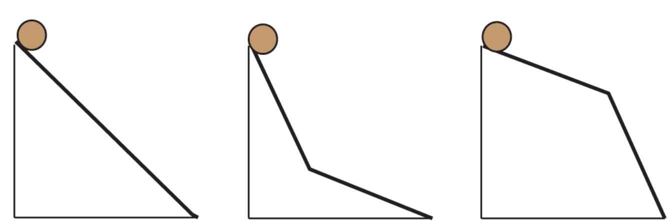
After students completed data and analysis of the Wheel Lab I showed them pictures of these early responses to the Framing Question. I asked again, which scenario is correct? Another rich discussion followed, and most students were on track with their answers. This is a perfect example of a student preconception "probe" being used not only as an assessment strategy, but as an instructional strategy as well.

At the end of the unit, I returned their original Framing Questions and asked them to modify their own answers and use "physics language" such as velocity and acceleration in their After Learning Content responses. I noticed right away they understood the constant slope ramp, but they had no real understanding of what was happening on a curved ramp. Many students said the ball would slow down on the second question! Wow, that would make a boring roller coaster ride!

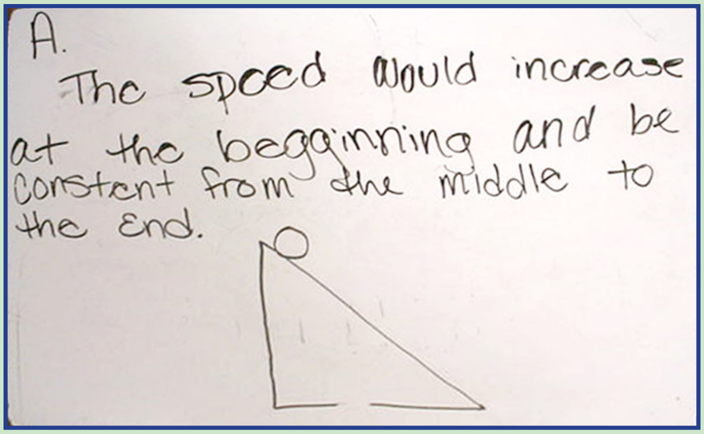
It was quite evident to me that I had missed the teaching mark. We had never discussed curved ramps. We had experimented with different **flat** inclines, but my students were not able to make the connection that a steeper incline would have a bigger acceleration and as it becomes less steep the acceleration would get less. This is clearly a higher-level jump my students were not making.



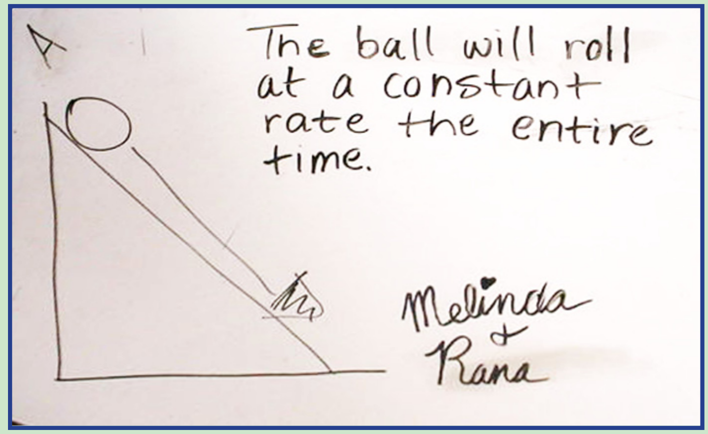
Uniform Acceleration Framing Question 1: Describe in words the motion of the ball along each of the ramps shown in the diagram above



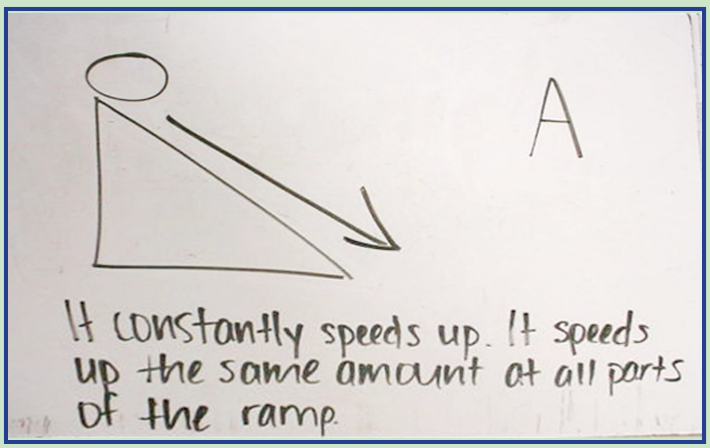
Ramps with two flat segments that simplify the curved ramps in the original version of Framing Question 1.



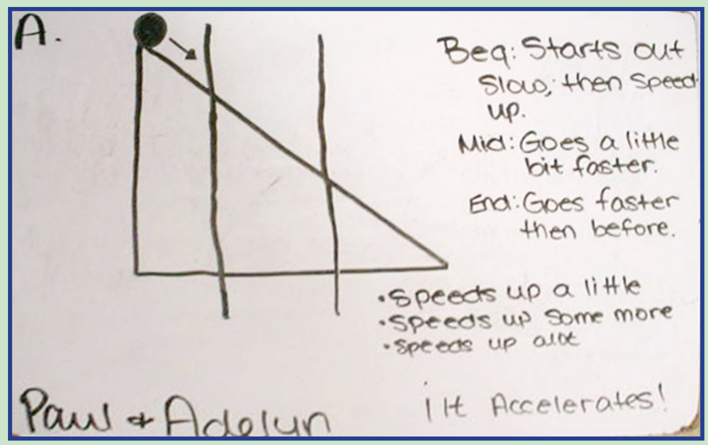
Response 1
This group understood there had to be some "speeding up" which had to occur in the beginning. But since we had just finished the unit on constant velocity, they thought it had to reach a constant rate at some point.



Response 2
This group clearly believes since we spent four weeks on constant velocity, every object moves with constant velocity. They may have been confusing a ramp with an x vs. t graph.



Response 3
This group understood there had to be some "speeding up" which had to occur throughout the entire ramp. They also say the amount it speeds up will be the same down the ramp. This group understands acceleration without using the word.



Response 4
This group understood that the ball will speed up the entire way down the ramp. However, upon further questioning, they thought the amount it speeds up would be less in the beginning and more in the end. Therefore, they believed the acceleration would be non-constant. They were confusing the velocity increasing with what happens to the acceleration.

Back to the drawing board for next year! However, one change I do plan on making to the Framing Questions is to eliminate the curved inclines and include one constant slope incline and two constant slope inclines pushed together. One example could be steep in the beginning and flatter in the end (see diagram). The other example could be flatter in the beginning and steeper in the end. These new ramps build upon concepts they have already learned.

Every great idea has its flaws! Each year, I adapt the PF materials to fit my own classes and teaching style. The Framing Questions for me have looked different both years. Sometimes I revise and rewrite a unit's questions. Sometimes I just pare them down to the absolute essential knowledge. One addition I plan to make next year is to require students to write a written description of why their *Before Learning Content* section is incorrect. Often explaining what is incorrect helps them make connections about what is correct. Framing Questions help **teachers** assess students' preconceptions before a unit, but also they allow **students** to participate in their own metacognition (thinking about their own thinking). Try it, if you haven't already!

What's the Big Idea?

Debra Johnson, Hickman Mills High School
James Allen and Walter Bowman, O'Hara High School
Tarigene Doile, Alan Parks, Carl Luecke, David Cornett and John Dedrick,
North Kansas City School District

The big idea in Unit 5 – *Free Fall and Two-Dimensional Motion* is that vertical and horizontal motion are independent.

Teaching Unit 5 includes much of the curriculum we have taught over the previous four units. It integrates ideas of uniform motion, accelerated motion, and force. We summarize below the primary activities and concepts illustrated in this unit.

First, we elicit prior knowledge by having students develop answers to the *Framing Questions* using Socratic questioning, white boarding or journaling. During this process, an important duty of the teacher is to allow students to feel safe and to encourage them to explore their initial ideas about 2-D motion.

Second, we focused on exploring the phenomenon of free fall and 2-D motion by doing some of the Physics First activities. We especially liked the dropping-the-balls activity that illustrated the idea that mass does not affect the fall rate.

Third, we decided to use the lab with a motion detector protected under a wire box and different sized balls. The motion detector quickly illustrates the motion of the ball. And with guidance from the instructor, the students will see that the acceleration is constant through the whole path, especially at the apex where the velocity equals zero. We agreed that this was a particularly difficult concept for students, and through this experimental experience they can be focused to learn the concept correctly.

Fourth, we planned to use the spark timer to directly gather data for a motion diagram in vertical direction and to show that the acceleration due to gravity is 9.8 m/s^2.

Fifth, using the "Ball shooting Apparatus" the students see a demonstration that the rate of fall is the same for both a vertically falling and a falling object with an initial horizontal velocity. The students had real observations that illustrated the concept, one that they really did not want to believe.

The use of physical activities and guided discussions is different from the traditional lecture procedure done in the past. One of the obstacles we face in our efforts to lead students to develop a deeper understanding on the concepts is that many of the students just want to know the correct answer for the test, they often don't want to really understand what is going on. The historically poorer students never did know the answers; so they are not frustrated by not being told the correct answers. What we face with them is the challenge of providing a safe and encouraging environment to explore and develop their ideas and understanding of concepts. The experience of doing the labs has helped make the data real and the principles more concrete because they draw conclusions based on their own observations.

North Kansas City High School and West Platte High School classrooms

Presenting at the Interface Conference

Kristen Wheatley, Mehlville Senior High School

As a member of the inaugural class *A TIME for Physics First*, it was expected that I present at a professional conference. I chose to present at the Interface conference in February with Associate Professor Dr. James Tarr, MU Department of Learning and Curriculum, for the session entitled "Working Together: Math and Physics." I enjoyed my first time presenter's experience. I have attended the Interface conference once before and gained a wealth of information and tips to use in my classroom. I was eager to return for both the information and the valuable conversations with other teachers in the state. I had never taken on the role of presenting at a formal conference, so I was a little apprehensive. My nerves were quickly settled as not only do I have a personal interest in the topic but Dr. Tarr is also a great partner.

It was helpful to communicate with Dr. Tarr throughout this process. Neither of us had experience in presenting at Interface and having a partner was a valuable resource to keep bouncing ideas back and forth off each other. Through our strengths and weaknesses, the presentation was really a breeze for us. As the conference approached, we corresponded through e-mails. As a professor of mathematics education, Dr. Tarr started by outlining the mathematics concepts needed to succeed in the PF curriculum units and developed the PowerPoint. I e-mailed him some of my concerns as a science teacher - the biggest difficulty that my colleagues and I are facing at Mehlville is students' lack of mathematical preparation. My main goal for the presentation was to explain to the audience that we were able to accomplish teaching physics concepts without watering them down due to the mathematics.

Dr. Tarr and I met for a short time immediately following our PF meeting at the conference. I reviewed what he had already put together in the PowerPoint and together we rearranged the sequence and how we would present certain aspects of the presentation. We wanted to address the issues surrounding the mathematics vs. science dilemma (the myth that students with only algebra skills could not be successful in a physics class) but consciously did not focus on "the blame game" of who is supposed to teach what. We decided to stick with what we knew; I handled the science portion of the presentation and Dr. Tarr handled the mathematics aspects. Our presentation was geared toward both mathematics and science teachers similar to us. I knew science teachers would be present, but the number of mathematics teachers who attended our session happily surprised me. Our presentation focused on how mathematics and science have different terminology for the same concepts and how mathematics and science teachers need to work together. Overall, our presentation was well received and we had great comments from the audience.

Conference Presenters, Spring 2008

Interface, Osage Beach, Feb 2008

Working Together-Mathematics and Physics First-James Tarr, MU, and Kristen Wheatley, Mehlville HS

Lesson Study through Physics First, Mark Volkmann, University of Missouri

Move on to Physics First, Sara Torres, Columbia Public Schools and Jamie Horton, Carthage Junior HS

Forces Point to Physics First, Jaime Horton and Amy Scroggins, Carthage Junior HS; Meera Chandrasekhar and Dorina Kosztin, MU

National NSTA, Boston, March 2008

Move On to Physics First, Linda M. Kralina, UMSL; Kristen Pierce, Oakville HS; Dorina Kosztin and Meera Chandrasekhar, MU; Gabriel de la Paz, Clayton HS

Forces Point to Physics First, Meera Chandrasekhar and Dorina Kosztin, MU; Dennis Nickelson, William Woods University; Jamie Foulk, Camdenton HS; Amy Campbell, Hazelwood East HS

Math-Science Partnership Conference, Chicago, March 2008

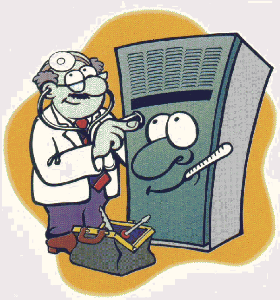
A TIME for Physics First, Sara Torres, Columbia Public Schools

National Council of Teachers of Mathematics Regional Conference, Kansas City, October, 2007

Physics First and its implications for teaching mathematics, James E. Tarr, MU

Brain Benders

Dorina Kosztin, University of Missouri



1. Cool and Not Humid?
Cooling the air in a room by air conditioning is accompanied by dehumidification. Why?

2. Shiny Metal Workers
Workers at open hearth furnaces often wear protective clothing coated on the outside with a thin metal layer. Since metals are excellent conductors of heat, wearing this clothing seems to make no sense. How does the metal clothing protect the workers from the heat?

3. Fireplace Logs
Does the amount of thermal energy radiating into a room from a fireplace depend upon how the burning logs are piled?

4. Not my Voice
When we hear our own recorded voices most of us will swear that this recorded voice sounds different from the voice we know. Are we victims of an illusion or is the difference real?

Answers will be published in the next newsletter. If you just can't wait until then, send your answers in to Sarah Hill (hillsar@missouri.edu), and we'll send you the key.

Answers to December 2007 Brain Benders

1. Cooking Hamburgers
"Hamburgers cook faster over a medium flame than over a high flame on a barbeque grill." Do you agree with this statement? Why or why not?

Answer: Hamburgers cook faster when cooked slowly! If the hamburgers are placed over high flame, the outside gets charred. This charred outside is a poor thermal conductor, so the inside meat will take longer to cook.

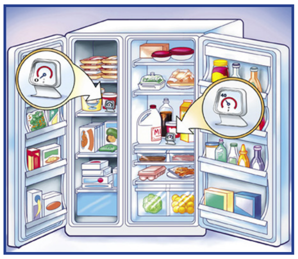
2. Identical Spheres are Heated
Two identical spheres receive equal amounts of thermal energy. The heat transfer occurs so quickly that none of the energy is lost to the surroundings. If the two spheres are initially at the same temperature, but one is on a table and the other is suspended by a string, will the spheres still have the same temperature immediately after the quick addition of thermal energy?

Answer: No. The suspended sphere will be warmer. The gravitational potential energy changes of the spheres will be different as they expand. Some of the thermal energy goes into raising the center of gravity of the sphere on the table, so its temperature rises less than expected. The expansion of the hanging sphere lowers its center of gravity so its temperature increases more.

3. Milk in Your Coffee
Suppose you want to cool off your morning coffee within five minutes so you can drink it quickly. Should you pour in the milk first and wait five minutes, or should you wait five minutes and then pour in the milk? Or does it matter?

Answer: Experimental results revealed that black coffee cools faster by about 20% than white coffee (under the same conditions). Newton's law of cooling also states that the cooling rate is proportional to the temperature difference between the outside surface of the coffee cup and the ambient air. But in real life, if the wait is less than about 10 minutes, go ahead and pour in the milk first.

4. A Refrigerator as an Air-Conditioner?



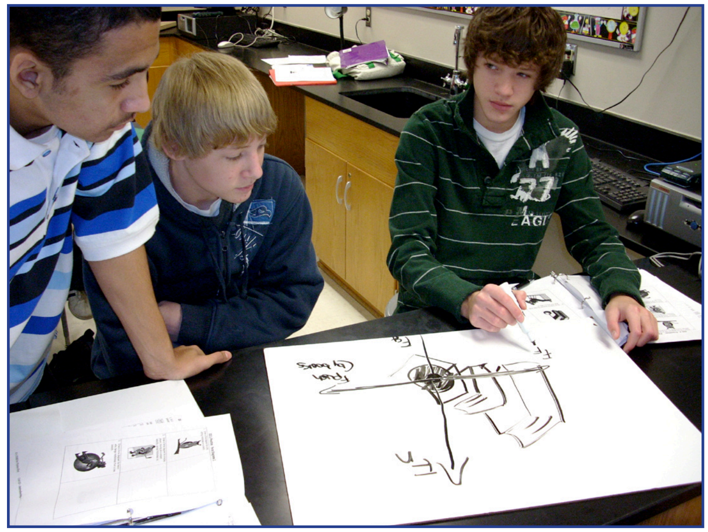
On a hot summer day you decide to help the air conditioner cool your room by opening the door to the refrigerator. Will this scheme work? Explain why or why not.

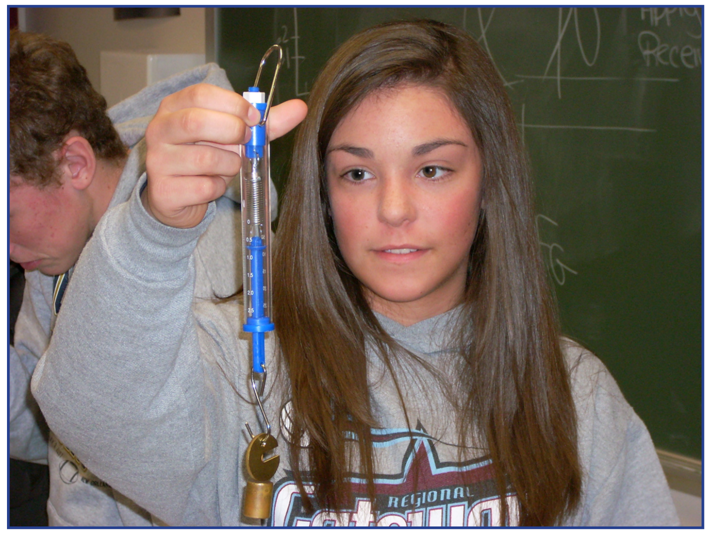
Answer: When opening the door of the refrigerator, the cool air inside the refrigerator will initially lower the temperature in the room. Once the refrigerator starts working again though, more thermal energy (from the coils behind the refrigerator) will be released into the room that it is absorbed by the cool air emanating from the refrigerator. Second law of thermodynamics tells us that the room will become warmer.

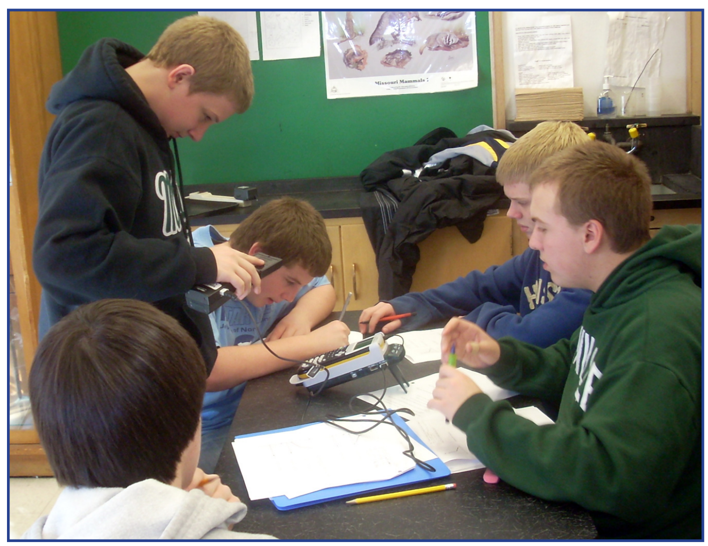
5. Singing Snow

When you walk on snow on a very cold day, you can hear your shoes squeaking. When the air temperature is barely above freezing there is usually no squeak. Why not?

Answer: At air temperatures of about 0°C, a very thin film of water on each ice crystal lubricates the rubbing between the shoe and snow. At much lower temperatures, there is no water film on the ice crystals so the friction between them in response to the shoe pressure produces an "oscillation" that sounds like a squeak.







Top to bottom: Students conduct experiments and discuss their results at North Kansas City School District, Oakville Senior High School, St. Louis and Mehlville Senior High School, St. Louis.

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Stephanie Allen and students in her class at Oakville Sr. High work on Unit 3: Introduction to Forces

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