A TIME FOR PHYSICS FIRST

ACADEMY FOR TEACHERS - INQUIRY AND MODELING EXPERIENCES FOR PHYSICS FIRST

For 9th grade science teachers

NEWSLETTER: Vol 1, No. 3, December 2007

COMMUNICATION IS KEY

Andy and Barb Graf

St. Vincent High School, Perryville

Bread and butter, love and marriage, bacon and eggs, popcorn and soda, wind and rain. Some things just naturally go together, including math and science. But then, as physics teachers, you know that. So what are some ways we can collaborate between math and science departments to help students understand the relationship between the two subjects?

We have been trying to answer that question for the past two years. We both teach at St. Vincent High School in Perryville, Missouri. (Andy teaches physics and Barb teachers algebra). Our evenings are often spent in discussion about how each approaches a concept. When teaching uniform motion, physics teacher Andy would ask math teacher Barb why students were not familiar with the equation of a line. And Barb's response was usually that the math classes hadn't covered it yet. So what do you do? After teaching the Physics First program for one year, we have started to implement changes in both departments.

Barb attended a week of Physics First training this past summer to get first hand experience with the program. "This training has led me to make some changes in my teaching style. I now talk about vertical and horizontal axes when describing a graph, as well as the x- and y- axis. I also put greater emphasis on independent and dependent variables. I use physics equations in my example problems. I've even experimented with white boarding and group problem solving."

St. Vincent's purchased new Algebra I books this past summer, which should help address the timing of concepts. Now we will cover equations of lines during the early part of the year instead of waiting till the end of the year. This should coincide with the physics classes covering of uniform motion. When students see graphs and equations of lines in two classes instead of one, they assign more meaning to it. How many times do students say, "When will I ever use this?" Physics First experiences give them the answer to that question. The math curriculum is changing to match with Physics. And the Physics First program is flexible enough to cover electricity first to allow time for the math curriculum to lay some groundwork for equations.

Communication is the key. Both departments need to know what the other is doing so they can work together. It would be a good idea to hold a joint department meeting to discuss things. Ours are impromptu discussions since we are married. But with a little bit of planning, the Algebra teacher and Physics teacher can get together and talk. We all have e-mail. Send your colleague a comment or question about what you are covering in class each week.

With some cooperation, all students will know that math and science are as natural a combination as bread and butter!

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What It Takes to Implement Physics First

Charles Bock, Coach-Mentor

If physics and math form the foundation for the science education pyramid as proposed by Dr. Leon Lederman, with chemistry forming the next level followed by biology, physics must be learned and understood at the freshman level. The Physics First curriculum and methodology seems to be filling that criterion. For Physics First to be totally successful there are, in my opinion, three requirements that must be met. Teachers must have a clear understanding of the subject matter. The inquiry and modeling methods of teaching must be practiced for optimum student learning and Physics First teacher collaboration must be practiced.

Teachers need to be competent in the material and confident in their abilities to help their students learn physics by moving them from their experiences to an understanding of physics concepts. The summer academies are giving the teachers new to the teaching of physics a good foundation. I have seen a significant increase in the teachers' confidence as they develop a handle on physics content.

It has taken time and patience for the teachers to develop their skill in the use of inquiry and modeling in the classroom, but these methods provide a meaningful way for their students to learn physics. While observing one of my teachers, I was inadvertently treated to a stark contrast between the "traditional" approach to the teaching of physics and the Physics First approach using modeling and inquiry. During my classroom visit with a Physics First-trained teacher I was enjoying the conversations between him and his students as he listened to their white board presentations of responses to Unit II Framing Questions, made them defend their answers as he questioned them and encouraged other students to participate in the questioning and defense. The students were given hypothetical descriptions of objects experiencing uniform acceleration and then asked to draw motion diagrams, put the diagrams on their white board, and explain and defend them. I was thoroughly caught up in this back-and-forth interaction between teacher and students, and among students themselves, until my attention was diverted to the adjacent room.

There was another class of freshman physics being conducted in that room. Following the best tradition of the movie, "Ferris Bueller's Day Off" I was hearing, "Okay class, get out your textbooks. Read pages 17-19 and pages 30-33. You'll need to be quiet and carefully read the material, because you'll be taking a quiz after you're finished reading"; "The answers to the quiz items are ….." (No discussion of the items); "Now I want you to watch this video and pay attention to how speed is determined by dividing the change in position by the change in time." In that classroom, it appeared that physics was being "taught" to the freshmen by handing the information to them. This was in stark contrast to the classroom that I was observing in which physics was being shared, discussed, questioned and diagrammed.

In the classrooms that I observe, I see students learning how to learn as teachers model the behavior they want from their students by showing them how to observe, collect and organize information, look for patterns, represent those patterns graphically and mathematically, ask questions and form conclusions from facts. The best part is that in the Physics First classrooms the students are given opportunities to practice these behaviors, allowing them to get a more solid grasp of basic physics concepts.

Another critical factor in the success of the Physics First program is the team effort illustrated by teachers helping and collaborating with one another and being supported and encouraged by the administration on both the building and district levels. It is not a cliché that says, "A team is more than the sum of its parts." It is so much easier for the teachers and better for the students when there are several teachers in a building teaching physics to freshmen with all of them working from the same curriculum, using the same methods of instruction. Collaborating frequently, even informally, and helping one another makes each teacher more efficient. I mentor in a couple of schools where there is only one teacher out of several freshmen physics teachers trained in Physics First. That is not an optimum arrangement. These individual teachers do not have the benefit of having a team of like-minded teachers working together. I would like to see all the physics teachers in these schools encouraged by the department heads and building administration to observe their Physics First colleague and work together to implement the methodology along with the curriculum in all freshman physics classes in their school.

Meaningful administrative support for the teachers and the program is evident when the teachers are provided with sufficient equipment, their own classroom or classrooms dedicated to physics in which the equipment can be used more and moved less. Making a Physics First teacher share classrooms that are not dedicated to physics, necessitating the moving of lab equipment and classroom supplies, and setting up and taking down several times a day, is an inefficient use of teachers' time and discourages them from using hands-on activities. Providing a stable teaching environment is a very tangible way of encouraging the teachers to make maximum use of Physics First practices.

Implementing Physics First may seem to many teachers an almost overwhelming task at times and may not seem to be worth all the effort. Even though it may not be evident to the teacher on a daily basis, I can see the program coming together, providing a way for the students to build a solid understanding of physics.

Coach Mentors (l-r) Andrew West, Charlie Bock, Jim Sly and Linda Kralina

Update from DESE

Sara Torres, Columbia Public Schools

On October 31st, Michael Muenks, Coordinator from DESE, sent a memo to school administrators providing an update on work at DESE. The memo stated that the Missouri 2.0 grade-level and course-level expectations for each content area are posted on the DESE Web site for use by school districts.

Currently, the public postsecondary institutions are identifying "entry-level competencies" for each content area. Once that work is completed, DESE will eventually align the state assessments with those entry-level competencies. In addition, the Mathematics, Engineering, Technology and Science (METS) Coalition is working with DESE to identify K-12 learning goals in math and science.

Below is information regarding science state tests over the next three years:

2007-08: The MAP science exams will be given in grades 5, 8 and 11.

2008-09: Current MAP test in science will be given in grades 3-8. End-of-course tests in biology will be given in high school based on version 2.0 GLEs.

2009-10: Grade-level tests in grades 3-8 will be given in science based on version 2.0 GLEs. The second tier of end-of-course tests in biology will be based on the 2.0 GLEs.

If you have any questions regarding testing or GLEs/CLEs, please contact DESE.

District Administrators at the Physics First Summer Academy

Year Two: A Work in Progress

Amy Campbell, Hazelwood East High School, St. Louis

On any given day in this, my second year of teaching Physics First, there is a flurry of activity, interaction and an element of discovery. I attribute this lively atmosphere to the Physics First curriculum, which presents a variety of labs, assignments, independent readings and teaching tools. The curriculum is comprehensive, but I have also discovered that it is challenging and fun...for both the students and the teacher.

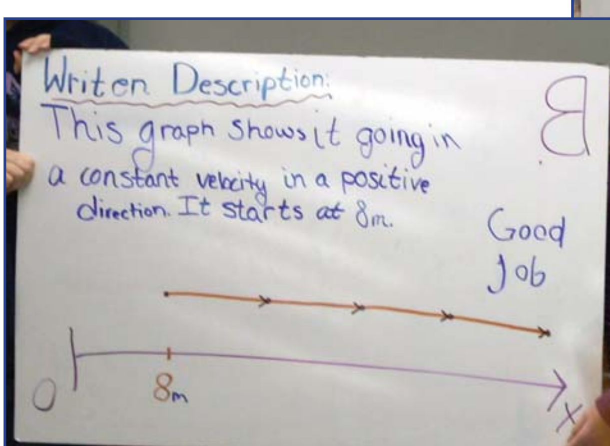
A total hands-on approach exists for the students, who are offered four different modes in which to learn a concept: verbal, graphical, pictorial and mathematical. This allows each student to see a single concept four different ways, thus providing for an in-depth experience. If a student does not understand one model, s/he is exposed to the same concept in a different learning style.

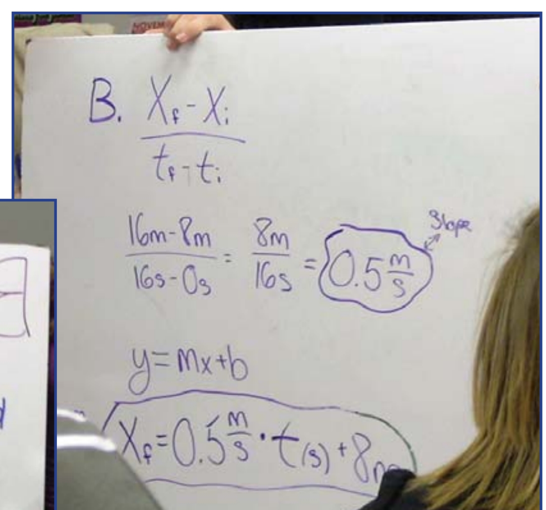
Another unique feature of the curriculum is that each new concept is introduced with a lab activity. Students assist in designing each lab and can select from a variety of options. Obviously, this is a 180 from yesteryear's lesson plans of teaching concept first, then conducting experiments, but I believe this gives students more interest in the labs.

Implementing such a curriculum has not been smooth sailing. Last year, I fumbled through the course. Adapting to a new class was compounded when I piloted the course in two of my classes, which were previously one-semester Physical Systems program. In Physics First, I initially tried to teach every activity and give every worksheet in Unit 1: Uniform Motion. I quickly realized this was neither necessary nor feasible, so I started picking assignments I felt my students could comprehend and would help them understand the concepts. By the time spring semester came around, I was more comfortable in identifying which assignments and activities helped my students.

For me, the second year of the curriculum has been just as challenging. I have frequent moments that transport me back to my rookie year in teaching, which consisted of 24/7 lesson preparation and evaluation. This curriculum, however, is flexible. Teachers can select and modify the material to better suit the needs of the students. This usually means additional prep time, and it does require extended effort to repeat labs, but I see that the students benefit.

Since I started teaching this class, I am more of a facilitator than a stand-behind-the-podium-listen-to-me-and-take-notes type of instructor. In fact, I have not lectured so far this semester. Instead, we have class discussions over labs and activities or we have white board discussions. My classes know that I will never just tell them the answer, and they respond to the challenge of working it out. Sometimes this process might take longer than I think it should, but in the end, the fun begins when the light bulbs go on, and ***they*** figure out the answer.





Above: Amy Campbell, Summer 2007
Center and right: Students whiteboards of written and mathematical descriptions of a problem on uniform motion (Elsberry)

My Perspective

Steve Wolf, Cole County R-1 Schools

As a charter member of the Curriculum Committee, I have been a part of the Physics First initiative since its early stages. As the principal at Perryville High School I strongly supported the components of Physics First and sent three teachers to the summer academy. We implemented criteria to determine which freshmen were placed in Physics First vs. a traditional physical science class. I also attended part of the academy in 2006 and was very impressed with the overall organization and topics covered. Implementation seemed to go fairly well at Perryville during year one.

During the summer I relocated to central Missouri and took the job as principal at Russellville High School. Russellville has one teacher in the Physics First Protégé program, and two science teachers on our faculty. We entered the Physics First program in spring 2007. I did not have the opportunity to implement the same criteria used for placing students that I used at Perryville. I wish criteria had been implemented.

It is difficult to compare implementation in these two unique districts. Perryville is in year two of the program and their teachers attended both summer academies. Russellville entered the program in 2007 and has a different perspective on the academy. One of the best aspects of the Perryville experience was the lesson study. Because their professional learning team (PLT) had three Perryville teachers and one teacher from the parochial school across town, feedback was immediate and the opportunity for collaboration was obvious. At Russellville, we only have one teacher so the communication level is different. Available funding for supplies is greater at Russellville and I have made a concerted effort to secure necessary supplies, having seen the success of the Perryville program.

I have viewed the Physics First initiative from the perspective of a curriculum committee member, as a principal with teachers in the program from its inception, and as a principal with a single teacher entering the program in the second year. There is no question the program is educationally sound. I think there is no question students completing the program will have long-term success. I think there is no question the amount and degree of professional development and networking available to teachers participating in the program is outstanding.

Who Changed my Tests - and Why?

Martha A. Henry, Evaluator

Many teachers have found that the units 1 and 2 Physics First tests have been changed from those that were administered last year. This wasn't done to introduce confusion into the already daunting testing process. The changes were made for several reasons including feedback from evaluators and teachers.

Teachers who gave the tests to their students last year reported that the test scoring was cumbersome and that scoring the units took an extreme amount of time. In addition, evaluators conducted reliability testing on the tests from the first two units during the 2006-07 school year.

Reliability testing is done on instruments in development to see if the test takers really understand what the question is asking and if they are answering it in the same way each time. A test/retest model was used to test for reliability of the first two units of the Physics First curriculum. The tests were given to 90+ students one week apart with no teaching of the concepts in between. Statistical analyses were applied that told us which questions were not producing the same answers – in other words, were not reliable. In addition, the teachers reported feedback from their students about the test items.

Evaluators reported these results to the project. Along with these data and the feedback from the Physics First teachers, the project refined the scoring rubric and reduced the number of redundant questions so that this year's administration and scoring should be much quicker and easier.

The revised version is now undergoing a second reliability testing so that the final product at the end of the program will be a set of tests that you can count on to measure what it is supposed to measure.

That's who changed your tests – and why! If you have questions about the reliability testing process, please contact us.

Physics First Follow-Up Meetings

Meera Chandrasekhar, University of Missouri

A TIME for Physics First is configured with four annual follow-up sessions. Two sessions are whole-group meetings, and the other two sessions are regional meetings connected by video link-up.

Why do we have follow-up sessions anyway? Extensive research on the efficacy of professional development has shown that teachers need excellent summer academies that integrate content and pedagogy *and* academic year follow-up to help a teacher implement new curriculum in the classroom. Teachers need coaches who visit the classroom, time to discuss ideas with small groups of colleagues on a frequent and regular basis, and time to meet with the large group and instructors during the school year. A TIME for Physics First is structured to provide all these forms of support during the academic year.

While our original plan for the follow-up sessions was broad, we have found that thematic sessions have worked well. Participants, coach-mentors and the leadership team provide feedback on participants' needs, and themes are crafted based on those needs. Furthermore, the grant was structured so as to give participants the opportunity to attend regional and national conferences, an opportunity that some of them may not have had otherwise. Therefore, follow-up sessions are held, preferably twice a year, at conference sites.

The first 2007-08 follow up session was held in conjunction with the Science Teachers of Missouri (STOM) meeting in Jefferson City, MO on Oct. 6, 2007. The theme for this meeting was GLE correlations. Participants have often wondered how GLE correlations published with our curriculum are made, and how one keeps student instruction in line with the GLEs. For the exercise at the October meeting, participants spent time in groups analyzing the GLEs and aligning them to selected activities in the different units. They then reported back their findings with the other groups, and discussed their findings. These report-backs yielded better understandings – for example, while a particular lab might primarily address a specific GLE, the depth of a questioning strategy used for a lab might allow the inclusion or exclusion of an additional GLE. We expect that this process will allow participants to better analyze their lesson plans in terms of the GLEs.

The second follow-up session was conducted on Dec 1, 2007 at four sites – Columbia, St. Louis, Kansas City and Springfield, with video link-up. Based on participant feedback from the October meeting, the agenda included opportunites for participants to understand the reliability issues in grading pre and post tests, examine student work, and review the rubric for Lesson Study. Teachers worked in groups grading a test and using a rubric. After the test was graded by three teachers, a discussion was held on the reliability of the grading. Ethics and the importance of a scoring rubric was discussed.

While working in a new team of three or four, teachers shared samples of student work. As the team observed the work they analyzed what the work told them about the student's learning:

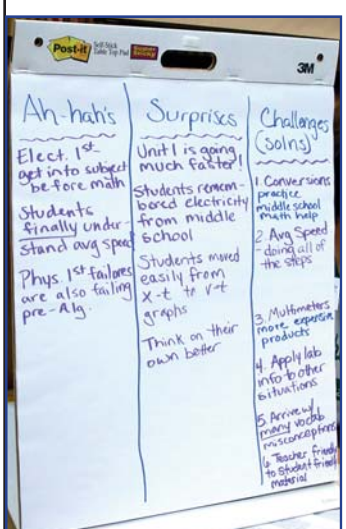
- What content does the student understand or can do?
- What is the student still struggling with (misconceptions, gaps in learning)?
- What does the work tell us about how the student learns?
- What does the work tell us about the success of the teaching strategies being used?

After analyzing the work, the teachers hypothesized what the teacher should do next to help this student be successful and/or what changes need to occur in the assignment.

Teachers continued to work collaboratively as they reviewed a sample lesson study report and rubric. As a team, the teachers scored the lesson study report and shared out their evaluation. This provided an opportunity for teachers to understand the expectation for them as they complete their Lesson Study.

Participants had varied responses to the day's activities. Frequent comments about the grading activity can be summed up by "Benefits = all graded the same; Challenges = rubric cannot address all possibilities." From examining student work participants found that "Students are more alike in their errors than different (same misconceptions)." Since the program is once more collecting teacher notes from several teachers, we hope that the next revision of the curriculum will be even more cognizant of student difficulties.

The academic year's third follow-up session will be held on February 23, 2008 in conjunction with the Interface conference. The fourth session will be a regional meeting on April 12. Keep the feedback coming as we craft themes for those meetings!



Changing the Culture of Teaching Through *Lesson Study*

Andrew West and Mark Volkmann, University of Missouri

As educators, we continually strive to improve our instructional practices so that we can engage our students more effectively in meaningful learning. Frequently, we work with our colleagues as we evaluate our practices, sharing insights, learning from each other's experiences, through discussion of our students' actions and behaviors. At times our conversations and interactions with our fellow teachers shift from the constructive and informative actions we can take as teachers to the discouraging and disappointing things that our students do. A professional development activity called Lesson Study helps to give focus and direction to the former.

Developed in Japan over the past 100 years, Lesson Study is the process of working as a team to plan and evaluate a lesson, looking for ways to improve instructional practices. A Lesson Study cycle consists of four main steps:

1. Setting goals and planning
2. Teaching the lesson
3. Discussing the Lesson
4. Consolidating the learning

Teachers begin by working together in a professional development team to set goals, select a lesson, and plan the lesson. In A TIME for Physics First, the purpose of the lesson is to focus attention on the teaching and learning of specific physics concepts. The next step is for one member of the team to teach a public lesson where the other members observe how the design of the lesson supports student learning. After the observation, the team meets to discuss the lesson and find ways to improve the quality of student learning. Based on the team's recommendation, a modified lesson is taught by another member of the team and the process of observation and analysis and is repeated.

Lesson Study is a simple idea, but it is a complex process. In addition to knowing the steps, participants build collegial relationships that support learning from one another, observational skills to learn from students, and awareness of content and pedagogy resources beyond those of the group. Knowing the process of performing a lesson study means doing these things in ways that build professional trust, observation skills, and knowledge of all participants, and doing it in such a way that everyone will want to continue to learn together from practice. This is a tall order. It involves a change in the professional culture of teaching.

Participants in A TIME for Physics First have completed one Lesson Study cycle and will complete two more cycles over the next two years. The fundamental hope of these Lesson Study experiences is to change the way we think about teaching. In the US, teachers strive to build expertise in solitude. Unfortunately, the expertise developed in private is seldom shared. The wisdom of practice, constructed through the hard work of each individual teacher, is lost at the point of retirement. Lesson Study seeks to move from privacy to collaboration, from solitude to community. We believe that Lesson Study offers an opportunity for teachers to open the doors to their classrooms and build teams that thoughtfully consider their own teaching practices in hopes of stimulating student interest, challenging student ideas, and engaging students in meaningful learning. We believe that each teacher brings expertise to the teaching endeavor, but in solitude the expertise meets a dead end. Lesson Study offers a pathway of professional development that builds, retains, and shares expertise as a network of knowledge that all teachers share.

St. Louis PLT meeting, Fall 2007

Physics First: My First Presentation:

Invitation, Application, Coordination, Anticipation, Presentation, Reflection

Sandy Letterman, Willow Springs High School

Many steps are involved in making a presentation. Each is full of the excitement of being a part of a presentation along with the stress of making sure it comes off just right.

The invitation to apply to present is exciting! The realization that I may actually have some knowledge or experience that is worthy of sharing with my peers is a great esteem booster (at least for someone who has never presented in front of her peers).

The application process is the easiest step - we all know how to fill out forms. Usually in the application, you must create the topic to be presented. Fortunately, our wonderful Physics First leaders had already come up with the topic and all that was required of me was to come up with a supporting lab. Easy enough: pick a lab from the Physics First curriculum that I had my students do in class. I chose to present the Bubble Lab as it is a good ice-breaker for freshman and it really gets them thinking about motion. Besides, the kids love it!

Coordinating the presentation was pretty much a breeze because Sara Torres already had it in her plans as to the order of the presentation. She let me know when I would present and approximately how much time I would have. Then I contacted Sarah Hill and told her what equipment would be needed for my lab and she got it all together for me. She then sent the equipment with Sara Torres to the conference. Now all I had to do was try to narrow down the Bubble Lab to twelve minutes.

The anticipation builds as each week passes, then each day and hour till it is Presentation Time! Did all the equipment make it? How many people will show up? What should I wear? And the most daunting question: can I really squeeze the important concepts of the Bubble Lab into twelve minutes??? What if Sara's portion runs over? What if that person that asks a hundred questions is present? What if.....?

Then it is show time! The equipment made it (thank-you, Sarah Hill!) The crowd is cooperating and interested! They are having fun with the bubble tubes. Time is running short. Time to revise and improvise. You wing it. And it is over.

Did they learn anything? Was this a good reflection of how the lab really should go? Did I leave anything out? Upon reflection, the presentation was like another day in the classroom!

Conference Presenters, Fall 2007

STOM, Jefferson City, October 6

Moving on to Physics First: Cathy Dweik, Sara Torres and Dorina Kosztin (Columbia Public Schools and MU)

Forces Point to Physics First: John Dedrick and Dorina Kosztin (North KC Schools and MU)

Lesson Study with Freshman Physics: Casey Zahner and Mark Volkmann (Poplar Bluff R-1 and MU)

NSTA – Detroit, October 18-20

Moving On to Physics First: Sara Torres and Jason Bradley (Columbia Public Schools and Aurora R-8)

NSTA – Denver, November 8-10

Forces Point to Physics First: John Dedrick and Dorina Kosztin (North KC Schools and MU)

Ninth Grade in the Physics First Curriculum: Introducing Forces: John Dedrick and Dorina Kosztin

NSTA – Birmingham, December 6-8

Moving On to Physics First: Andrew Graf and Gabriel de la Paz (Perry Co. 32 and Clayton)

Ninth-Grade in the Physics First Curriculum: Introducing Forces: Andrew Graf and Gabriel de la Paz

Brain Benders

Dorina Kosztin, University of Missouri

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?

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?

3. Milk in Your Coffee

Suppose you want to cool off your morning coffee within 5 minutes so you can drink it quickly. Should you pour in the milk first and wait 5 minutes, or should you wait 5 minutes and then pour in the milk? Or does it matter?

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.

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?

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 August 2007 Brain Benders

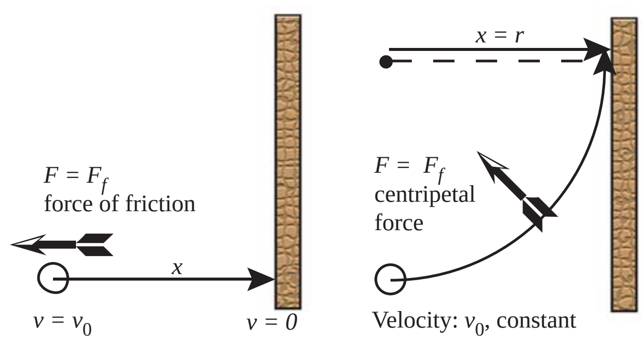
1. Astronaut Astrobatics

Can an astronaut who is motionless – that is, not rotating – reorient herself in any direction she wants?

Answer: yes, as long as there is some movement (not rotation though) the astronaut can initiate rotation around any axis. The astronaut can bring her hands in or out (like a spinning skater), tuck in or stretch out (like a falling cat) thus changing her moment of inertia. When the moment of inertia changes, the rotational speed of the astronaut also changes.

2. The Wall Ahead

You are driving too fast along a road that ends in a T-shaped intersection with a highway. There is a concrete wall directly ahead on the far side of the highway, and no car is visible in either direction. What should you do to avoid hitting the wall – steer straight at the wall and fully apply the brakes, or turn left into a circular arc as you enter the highway?



Answer: The figure above illustrates both situations. If you go straight, all the kinetic energy of the car must be transformed into work done by the force of friction, i.e.,

$$\frac{1}{2}mv_0^2 - 0 = Fx, \text{ therefore } x = \frac{mv_0^2}{2F}$$

Here x represents the stopping distance for a friction force F.

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If, instead, you turn left into a circular arc, the frictional force plays the role of centripetal force. The largest radius of arc in which you can travel and still keep from hitting the wall is when the distance between the car and the wall is equal to the radius of the curve (see figure). Assuming that your velocity v_0 remains a constant, the centripetal force will be

$$F = \frac{mv_0^2}{x}, \text{ therefore } x = \frac{mv_0^2}{F}$$

Here x represents the radius of curvature.

Comparing the two expressions above, one can see that the stopping distance when moving straight toward the wall is half the distance needed to turn left into a circular arc. Thus you have a better chance of stopping by driving straight and fully applying the brakes.

3. Race Driver

Professional race drivers increase their speed when going around a curve. Why?

Answer: if one accelerates when going around a curve, there is an extra force applied to the wheels. This extra force will have a component that pushes the car forward and one that pushes the car sideways. As long as the sideways component is smaller than the static friction, the driver will exit the turn with a higher speed than when entering it. This is an experiment that is NOT recommended for physics teachers except if they are also race drivers!

4. Spider Circuit

Classroom activity - answers will vary.

5. Turning the Corner

As an automobile turns the corner, the front wheels travel arcs of different radii, and so do the back wheels. Exactly how does the automobile accomplish this feat? Do any of the wheels slip?

Answer: when an automobile turns a corner, all the wheels slip a little. The outer wheels always travel a longer distance than the inner wheels. The front wheels though (and the back wheels for all wheel drive vehicles) are designed to minimize this slippage by allowing the two wheels to point in slightly different directions as well rotate at slightly different speeds.

For more info, see http://auto.howstuffworks.com/differential.htm

6. Seeing Around Corners?

Why can we hear but not see around a corner?

Answer: Both light and sound are waves and when encountering an opening they diffract as long as the opening has dimensions similar to the waves' wavelength. The wavelength for light is very small and thus it does not diffract when passing through a door, but the wavelength for sound is much longer, and diffraction occurs, therefore sound can be heard around corners.

7. Balloon in a Car

A child holds a helium filled balloon by a string inside a moving automobile. All the windows are closed. What will happen to the balloon as the car makes a right turn or stops suddenly? Which way will the balloon move?

Answer: when the car makes a right turn, the balloons will move toward the inside of the curve (left). The air inside the car will have the tendency to continue its forward motion when the car makes a turn, therefore, more air will be found on the right side of the car (air pressure increases on the right side). As a result, the balloons are pushed toward the inside of the curve.

Summer Academy 2007

The simplest description of how stretchy objects stretch is provided by Hooke's Law: the force necessary to either stretch or compress an elastic object is proportional to the amount it is stretched or compressed. Mathematically, $F=kx$.

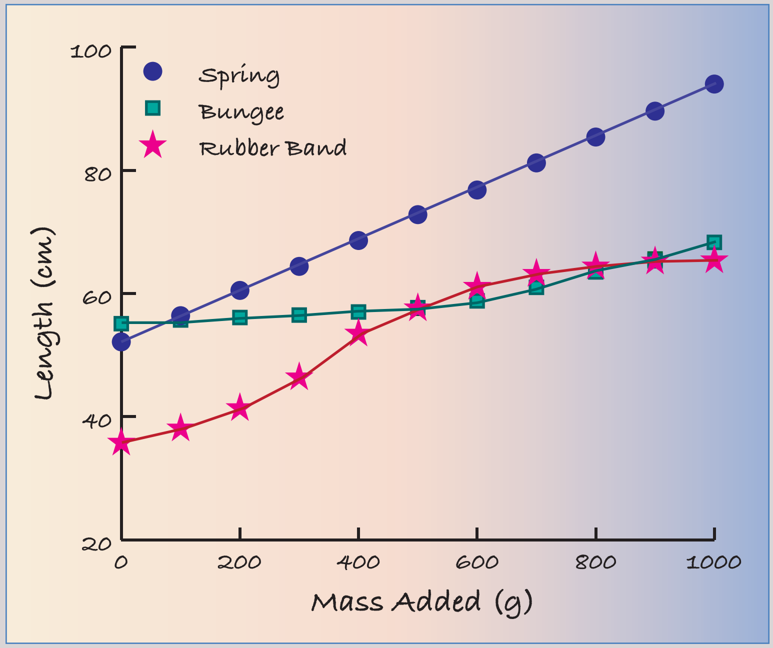
Where F=force, k=spring constant and x=length the spring is stretched (or compressed).

But not all stretchy things obey Hooke's Law regardless of the amount of force applied!

Springs have the most even (linear) stretch over a large range of applied force (or load). Rubber bands stretch evenly for low loads, but not as loads increase. Also - ever used a rubber band many times? Bungees also have a region where they stretch evenly, but they commonly exhibit more than one rate of stretch.

Any ideas on how metal wire and hair stretch? Yours to research why!!

How do Springs, Rubber Bands and Bungees Stretch?



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