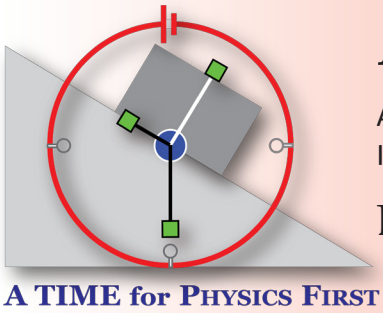
A TIME for Physics First

Academy for Teachers
Inquiry and Modeling Experiences for Physics First

Leadership in Freshman Physics, 2009-14

NEWSLETTER: Vol 4, No. 2, August 2010



STOM + Follow-Up = Fun

Sarah Hill, University of Missouri

The first Follow-Up meeting of the 2011-12 academic year took a lot of preparation to pull off, and overall I think it went pretty well.

The first step was deciding on dates for the meetings – for this first one, coordinating with the Science Teachers of Missouri (STOM) Fall conference was felt to be a convenient way to offer the opportunity to attend a statewide professional conference and bring all the PF Fellows back together to meet and discuss PF implementation.

So, on a hot day in July, I met with the STOM officers for a walk-through of the site in order to plan room assignments, discuss registration and collaborate on the schedules for presentations and our meetings.

The Management team met, decided on scheduling for each cohort, and we were off and rolling. I sent out announcements about registration for the conference, the deadlines (with lots of reminders) and information about stipends, mileage and overnight lodging to those who qualified. Debbie Hanuscin sent out requests for Share-A-Thon topics and plans started to fit together.

On the big day, each cohort met for a 90-minute span for their Share-A-Thon presentations, plus project information and housekeeping. Cohort 1 attended the STOM conference sessions of their choice during the morning and early afternoon then met in the Lange Library for the Follow-Up meeting. Cohort 2's schedule was the mirror image – their Follow-up meeting was the first session of the day, followed by their choice of STOM conference sessions for the remainder of the day.

The Share-A-Thon sessions covered a wide variety of both general and specific topics, all pertinent in PF classrooms. The rationale for Physics First, educating parents about PF, Inquiry, pacing, Socratic questioning, SMART boards, Google Apps, Special Ed accommodations, time management, formative assessment strategies, specific content related to electricity, energy and motion all came under scrutiny in discussions of 15-minute periods.

Many PF Fellows also developed conference presentations - kudos to John Clapp, John Dedrick, Cathy Dweik, Lisa Groteweil, Ann Neubauer, Joe Pistone, Katherine Schottmueller and Laura Zinszer. Several PF staff and faculty also presented, including Meera Chandrasekhar, Jaimie Foulk, Debi Hanuscin, Dorina Kosztin and Marsha Tyson.

We are very proud to mention that Dr. Debi Hanuscin was awarded the Missouri Science Educator Award for 2011 by STOM at the conference – more kudos to you, Debi!

The next Follow-Up meeting is scheduled for Saturday, February 18, 2012, and will be held in the MU Physics Building. In the case of inclement weather, we will meet the following Saturday, Feb. 25. The agenda will include a Share-A-Thon, so start thinking about your topic – sharing information that has helped in your classroom provides support to all Fellows and aids in PF success. If you have additional ideas for agenda items, please contact me at hillsar@missouri.edu to share your thoughts.

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Can We Do More Graphing in Electricity?

Matt Stacey, Jefferson City Public Schools

Graphing is a fundamental tool in physics. Qualitative graphs are essential visual representations displaying the dynamic relationships between variables. When one looks through the many fields of physics, they might notice that there is a lack of graphical analysis as well as graphical construction in the Physics First Electricity unit. We base much of our conceptual mastery in Physics First through qualitative graphs. With this in mind, I propose the question, how can we use more qualitative graphing in electricity?

When one looks at our curriculum, it's easy to see one of the intentions of the Electricity unit is to introduce the key concepts of Experimental Design and practice using the scientific method, but there are only a few graphs which are used…the relationship between voltage and current ultimately shows resistance, current/position graphs, and voltage/position graphs. This shouldn't be our only focus. As we progress deeper into series circuits, the students begin to see relationships between voltage and brightness, number of bulbs and brightness, resistance and brightness, number of bulbs and current, and resistance and current. Let's use these key relationships and graphically represent them!

Granted, if one is to do the math, they will notice that not all of these relationships are linear (which most students will assume they are), but the objective is to visually represent the main concepts to the students. Students need to understand that graphs are more than a bunch of lines drawn on a piece of grid paper. Students should be able to construct and interpret these valuable concepts that are a major focus in our Electricity unit. This helps lay down some groundwork for our future units where graphing is an essential skill as well as creating great discussions during whiteboarding. Try it!!!!

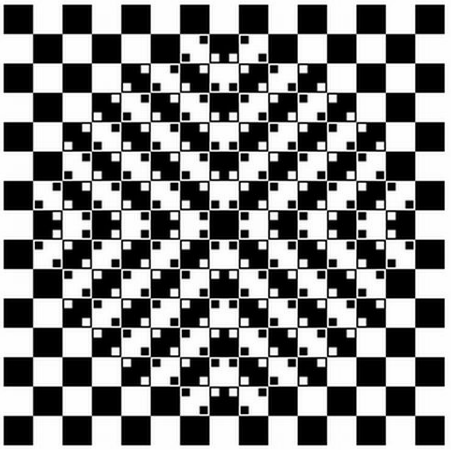
The UFO Ball

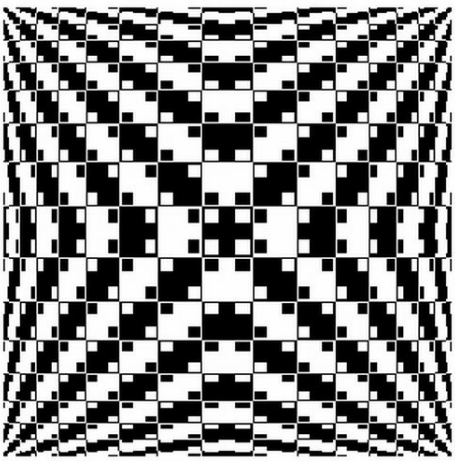
Lisa Grotewiel, Keytesville R-3

The "energy ball" or UFO ball is an effective demonstration to introduce the basic concept of an electrical circuit, and also as an application of conductors and insulators. If you haven't used the energy ball in the classroom, here are a couple of ways to try it out.

At the beginning of the electricity unit, give the energy ball to a group of 3-4 students, and ask them to find out what the ball can do. After one student gets the ball to light up by completing the circuit with 2 hands, challenge them to get it to work with 2 students, then 3 students, and so on. This works by building a "human circuit" where the students are holding hands in a circle (for 9th graders, I recommend just touching index fingers!). Eventually someone will ask, "Can we try it with the whole class?" I have seen it work with up to 15 students, and I've heard it will work for 30! This demonstration makes it incredibly easy for students to grasp the concept of completing the circuit.

Later in the unit at the conclusion of the lab for conductors and insulators, return to the energy ball circuit and insert a few of the conductors or insulators in between two students in the circuit. Conductors will allow the energy ball to light up; insulators will not allow it to light. This makes a good connection to an earlier activity, plus there's reinforcement from the lab as students have a lot of anticipation waiting to see if these results match their lab observations.





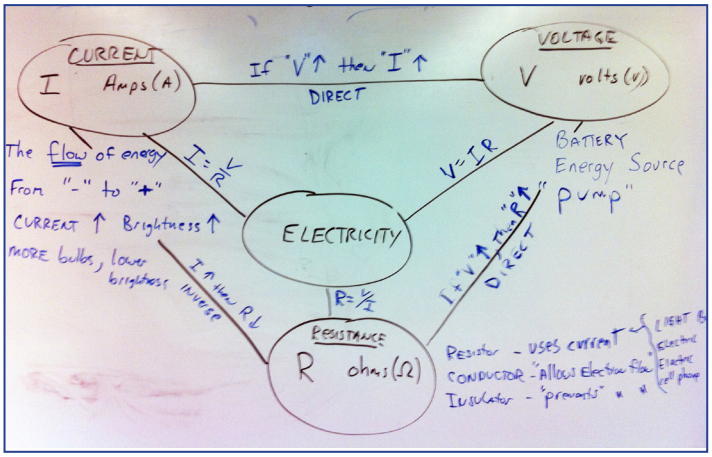
Electricity: What Worked

John Clapp, Hickman Mills C-1

The *Introducing Energy* lab provided an important segue to electricity since it is one of the forms of energy that we discuss. The energy lab will also provide links to future units of study as well.

One of the most important electricity labs at the beginning was the *Getting Charged* and the *John Travoltage* labs using computer simulations (PHET*). As we discussed the flow of charge from negative to positive, it was beneficial to refer back to the negative charges moving from the balloon to the sweater. It was also helpful to see the moving negative charges and seeing the positives remain relatively stationary.

The *Everyday Stuff Battery Lab* was fun and helped the students recognize electrodes and what they are made of, although it didn't explain how a battery works.



Multimeters were a big success. Students enjoyed learning how to use them with the various measurements. After using them to measure all three components of electricity, it was beneficial to move to the circuit building simulation on PHET. This saves time and helped supply more multimeters for use.

Finally, to help summarize the unit and prepare for the final test, a mind map was developed to help the students see the relationship between current, voltage and resistance (see photo).

* phet.colorado.edu

Differentiation

Marvin Allen, Lift for Life Academy

At the October 2011 Follow-Up session, Physics First Fellows participated in a Share-A-Thon. We discussed how best to reach the top and bottom 10% of students through differentiation. We talked about the difficulties of teaching in a smaller school where there are no honors or lower level classes and everyone is lumped together. At my school I have honors students and lower level students in the same classroom and I have found it difficult to reach both.

One of the methods I have tried is allowing students to choose some of the work that they do in class. Specifically, I use a rubric called Project Tic-Tac-Toe. It works by coming up with nine potential projects for the unit that we are working on and giving them to students in the form of a tic-tac-toe square. The students then draw a straight line connecting three projects. These are the projects that they must complete for the unit. If you set up the square with the easiest projects across the top, the moderately difficult projects in the middle, and the most difficult projects across the bottom, it allows the students to choose the projects that they are able to complete.

The lowest students (and the laziest) will draw a straight line across the top. Most students will draw a line down at a diagonal. Your top students will draw a line across the bottom. Most teachers, including myself at first, are reluctant to use this because they believe that all the students will choose the easiest projects. However, I have not found this to be the case. Most students pick the projects based on how interesting they are to them, and do not consider the difficulty of the task. The other teachers in the group generally liked this idea and discussed how we might use it in our classrooms.

I explained that in my classroom I give a lot of independent study to the higher-level students since they do not need the extra help. This allows me more time to work with lower level students one on one to make sure they get the material. I also allow some very advanced students to act as teaching assistants in the classroom.

Physics First Student-Parent Night

Melanie Utterback,
Community R-6

Within the Community R-6 school district, we changed from a freshmen physical science class to Physics First. After experiencing Socratic questioning in the summer academy, I felt it was important to invite parents in with their students to give them an idea about what was going to be expected in Physics First during the academic year.

I created a Physics First newsletter as an invitation and included some of Dorina's brain benders and mailed them the week prior to our Open House. I heard from or had in attendance 80% of the parents/students of my freshmen class. I do teach at a small school, so that was 15 of my 20 families. I was thrilled!

I shared with the parents the Socratic questioning method and explained that the students would not be given answers, but instead would be investigating their ideas. I explained whiteboarding and how we would be using this in class. I had the local Walgreen and Wal-Mart ads on the wall and showed parents where to find the cheapest supplies for my class.

Supplies required included: 1" binder, loose leaf paper and a calculator. I had two options they could buy depending upon what math classes they planned to take in the future: dry erase markers-optional, colored pencils/pens-optional, and pencils. I passed out student assents and parent consents and got most of them back that night. To further inform more people about our new program, I supplied Physics First information packets and copies of my newsletter for all board members and our superintendent at the August school board meeting. At the September board meeting, two of my freshmen demonstrated activities on the PHET* site for all in attendance to experience. The transition to Physics First has had a very warm reception!

* phet.colorado.edu

Data for an object traveling in the sky.

Time t, (minutes)	Position d, (miles)
0.1	4
0.2	7.1
0.3	9.7
0.4	10.5
0.5	13
0.6	16.8
0.7	18.6

Slopes Gone Wrong

Meera Chandrasekhar,
University of Missouri

It is the end of the semester, and for the nth time, we are graphing data and working on figuring out slopes. Really important stuff, especially being that scientific knowledge is frequently deduced from graphs, and "fits," as we geeks call it. Best-fit curves, as more reasonable people might call it.

In a lot of early experiments that students encounter, one fits linear- looking data to straight lines. Data is fit to the expression $y = mx + b$, and one obtains two parameters: the slope m and the intercept b. In the early stages of graphing and "fitting," one might only calculate the slope.

As the three of us teaching the class, Karen King, Shawn Hayden and I, riffle through the quizzes, we are struck by common errors made by students when they graph data and calculate slopes. The most common errors occur when students calculate slopes.

Example

Fig 1. shows how we expect slopes to be calculated. Data is organized in a table and plotted on a graph. A best-fit line is drawn through the data, and the slope is calculated from the best-fit line.

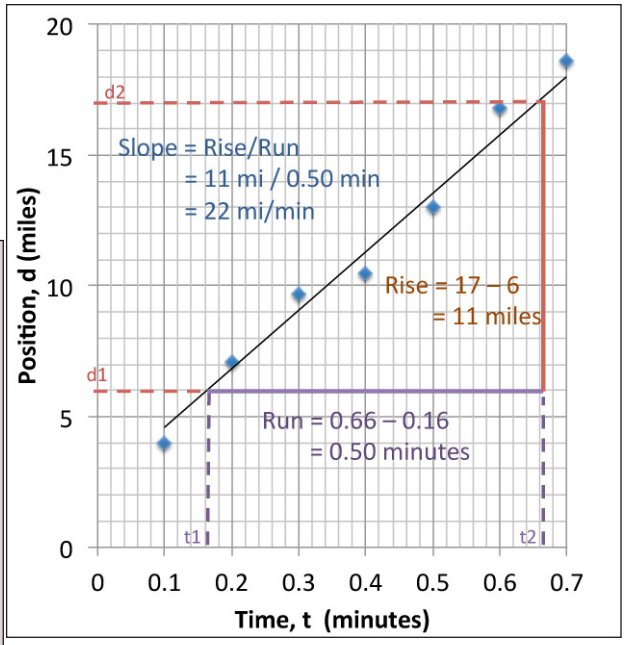


Fig. 1. Graph of data from table. The best-fit line is drawn, and the slope is calculated from the best-fit line.

Here are pointers on how to draw a best-fit line:

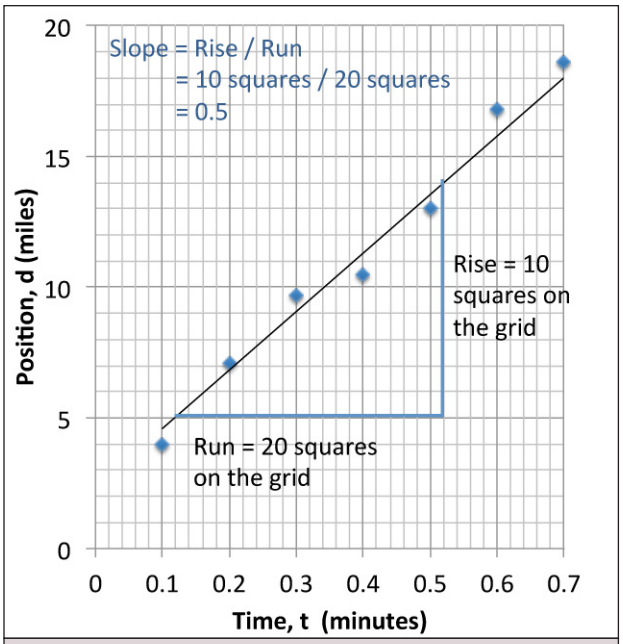
- When drawn manually, the best-fit line has about as many data points above it as below it. [The scatter above and below the line is similar].
- It may not go through (0,0)
- It may not go through all data points.
- If the points have a lot of scatter, it may not go through any data points!
- When drawn by a computer program, the best-fit line is calculated statistically.

Why draw a best-fit line?

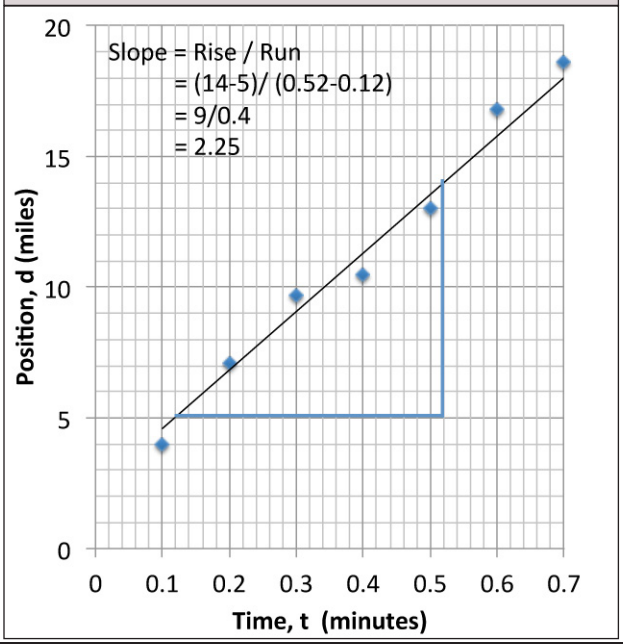
- A best-fit line is a way of "averaging" the data [Since data has been obtained for different values of the independent variable, it cannot be numerically averaged].
- Individual data points have errors due to the accuracy of tools used for measurement. The best-fit line is more accurate since it averages out those errors.
- Since the best-fit line is more accurate than the individual data points, we use this line to calculate slopes, rather than individual data points.

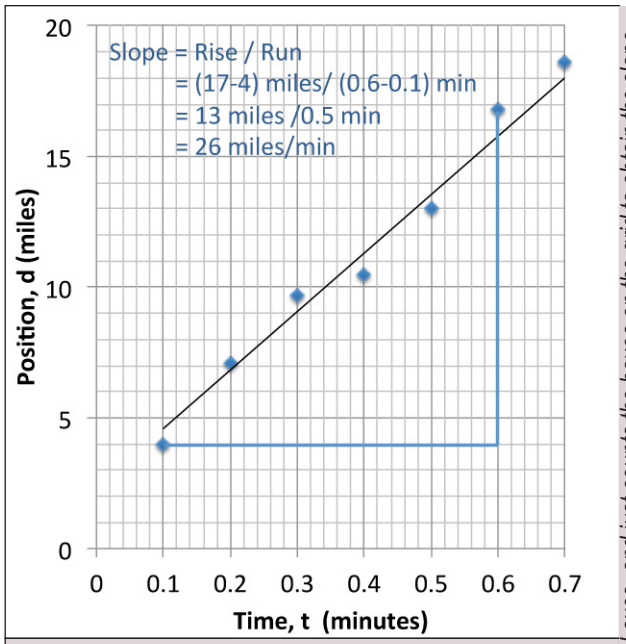
What are common mistakes made by students?

While students sometimes make mistakes on how they draw the best fit line (commonly connect first and last data points), the major errors appear to occur when they calculate slopes. See if you can figure out the errors in Figs 2-5.

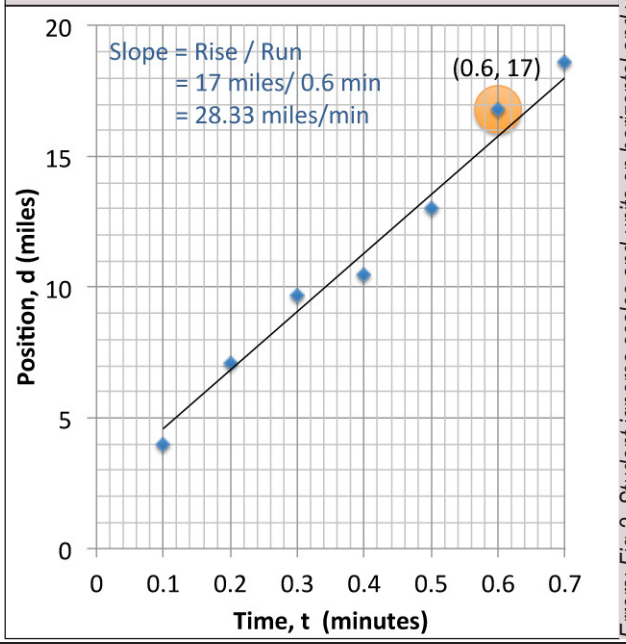


Find the errors in Fig 2 (above) and Fig 3 (below).





Find the errors in Fig 4 (above) and Fig 5 (below)



Errors: Fig 2. Student ignores scales and units on horizontal and vertical axes, and just counts the boxes on the grid to obtain the slope. This method gives the correct answer if the axes are scaled so that 1 unit = 1 grid box, and if there are no units, but is incorrect otherwise.
Fig 3. Student uses data values to calculate slopes, rather than the best-fit line.
Fig 4. Student uses best-fit line, but does not use units.
Fig 5. Student uses just one data point to calculate slopes. This method might give the correct result if the data point lies on the best-fit line, and if the line goes through the origin, but is incorrect otherwise.

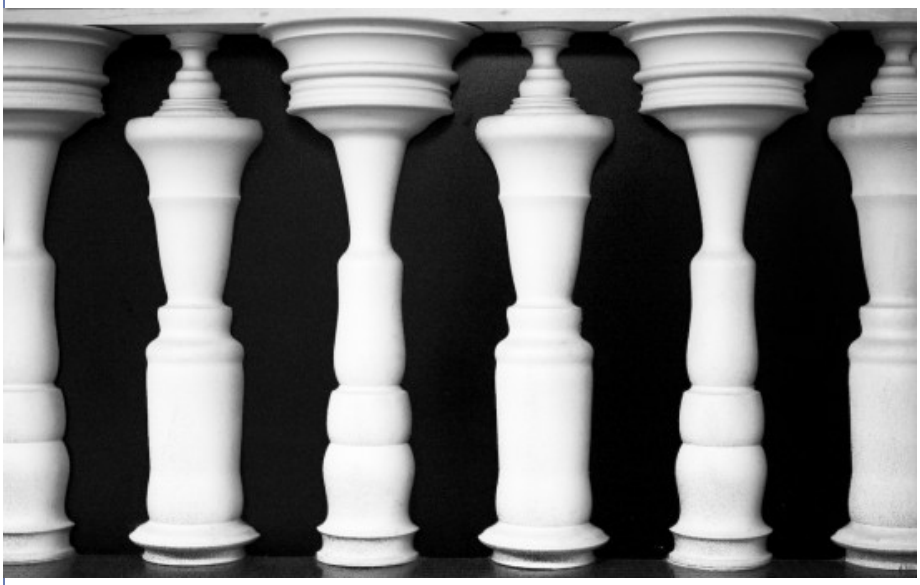
Solutions to August 2011 Brain Benders

The Turning Earth

You know that the Earth rotates around its axis, making a complete rotation in 24 hours. Why is it then that when you jump vertically upward, you land in your own footsteps rather than at a distance equal to the distance traveled by the Earth in the time it took you to jump?
Which physics law helps you explain this?

Answer:

You return to your footsteps because when you start jumping you are already in motion with the Earth, and you continue that motion according to Newton's first law.



Down...down...down...

A coin and a feather fall at the same rate (equal speeds at any given instant) in an evacuated tube. Would it be correct to say that in a vacuum equal forces of gravity act on both the coin and the feather?

Answer:

No, the forces of gravity acting on them are NOT equal. The two objects accelerate (or move at the same rate) because their ratio of their weight to masses are equal. Even though the two objects are in vacuum, gravity still acts on them.

Tug-the-Strongman

Strongman has his hands tied to ropes connected to two horses that are pulling in opposite directions. He can withstand the tension force exerted by the two horses. How would the tension force compare if only one horse pulled and the other rope was tied to a tree?

Answer:

The tension force would be the same when the tree takes place of the horse. The tree "pulls" on the rope the same way the horse would.

The Black Belt

When you deliver a karate chop to a stack of bricks, how will the impulse differ if your hand bounces back upon striking the bricks vs. if your hand remains in contact with the bricks? How does the force exerted on the bricks compare to the force exerted on your hand?

Answer:

The impulse is greater if your hand bounces back upon impact. If the time of contact is the same in both cases, a greater impulse means a bigger force. The force on the bricks equals the force on your hand according to Newton's third law.

Windmills

Rows of wind-powered generators are used in various windy locations to generate electric power. Does the power generated affect the speed of the wind? Would locations behind the "wind mills" be windier if they weren't there?

Answer:

Wind mills generate power by taking kinetic energy from the wind, so the wind is slowed by the interaction with the windmill blades. Yes, it would be windier behind the windmills if they weren't there.

Falling Freely

Pretend you are in an elevator at the top of a tall building. Mounted in the elevator is a video camera that takes pictures of you holding a ball in front of your face, then dropping the ball. If you drop the ball at the same time the elevator cable snaps, so the elevator falls freely, how will the video footage of you dropping the ball be similar to or different from footage of you dropping the same ball in the orbiting space shuttle?

Answer:

The footage would look the same: it will show the ball hovering in front of your face. So is it correct to say that there is no gravity in the outer space where the space shuttle orbits? No, it is not! The space shuttle is in continuous free fall toward the earth the same way the elevator was when the cable snapped.

BRAIN BENDERS

Dorina Kosztin and Dorina Mitrea, University of Missouri

Row, Row, Row...

During a girl scouts' training session, three fathers and their daughters are out in the forest. They must cross a river to get back to the camp. But there are two problems: the boat can carry only two people at a time and none of the girls want to remain on either side with a man who is not their father. All girls and their fathers can row the boat. How do they finally make it across the river?

The Biker

A cyclist has gone through 2/3 of his route when one of his tires gets punctured. He finishes his route walking, in twice the amount of time he spent cycling. How many times faster does he ride than walk?

Three Bulbs

A room has no windows and one door. Inside the room there is a lightbulb. Outside the room there are three switches. Only one of the switches turns on the light. You are allowed to open the door once, but you are not allowed to flip any switches while the door is open.

How do you find out which switch turns on which light?

...Pants on Fire

You are traveling on foot to city A. On your trip you arrive at a crosswalk guarded by two men. One of them always tells the truth and the other always lies. They each know which road leads to city A. You do not know which one tells the truth and which one lies. You are allowed to ask only one of them one question. What question do you ask to guarantee you will take the road to city A?

Sleeper

A passenger falls asleep on a train halfway to his destination. He sleeps until he had half as far left to travel as he traveled while asleep. For what fraction of the whole trip was he asleep?

Fast Facts:

Grant period: September 1, 2009 - August 31, 2014
Funding Agency: National Science Foundation
Target Participants: Ninth grade science teachers in Missouri school districts
Follow-up meetings: Oct 8, 2011, Feb 18, 2012 (snow date Feb 25) and April 21, 2012, all in Columbia
2012 Physics summer academies:
June 4-15 (Cohort 1); June 4-29 (Cohort 2)
2012 Math teacher academy: June 4-8
2012 Administrator academy: June 7-8
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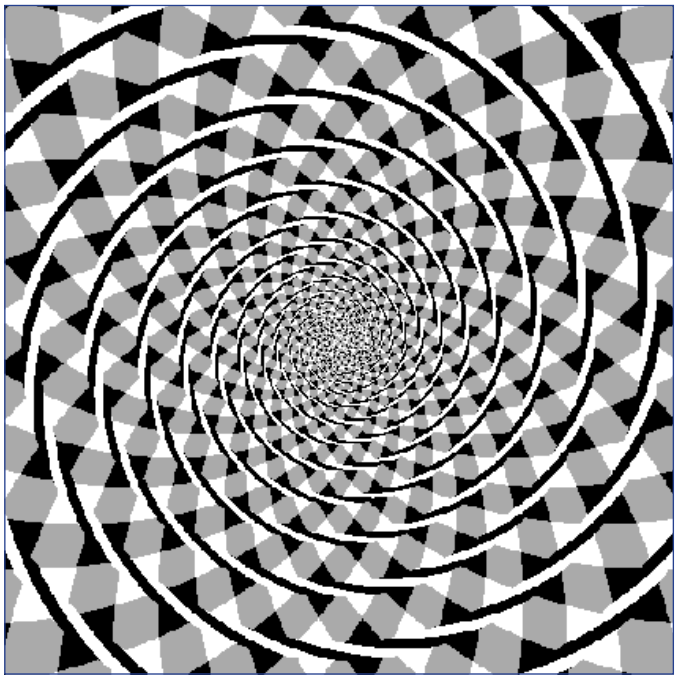
Triangles?



Spirals?

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