Mπ The Mathematics and Physics Institute NEWSLETTER

Director: Jennifer Discenna
Associate Director: Richard Delaware

December 1, 1998 Vol. 13, No. 3

OPEN HOUSE THANK YOU

We had an excellent turn-out for the MPI Open House this year. There were 95 people who attended the November 8th event. A total of 32 MPI students and 7 staff, greeted the 54 parents and family and 2 school administrators, and presented demonstrations and lab activities from both physics and mathematics. I want to thank everyone who attended for taking time out from your busy schedules to attend the Open House. I feel that the students did a fantastic job of displaying what they've learned so far at MPI.

Also, I would particularly like to thank the parents for attending. It was very encouraging to see such a high turnout. It indicates that you are involved in your son's or daughter's education which is essential for their success both here at MPI and in future years.

We realize that the demands and expectations at MPI may be a new experience for your son or daughter. Although we want everyone to have a solid foundation in physics and mathematics, the real goal of the MPI is to help the student develop good study habits, reasoning abilities, and problem solving skills, which are essential to continued success in mathematics and physics in the future.

If you have any questions about MPI or about your son or daughter, please feel free to call.

Jennifer Discenna
Director

TO ALL MPI ALUMNI:

HAVE YOU GRADUATED FROM COLLEGE?

IF SO:
PLEASE CONSIDER BEING AN
- ENRICHMENT SPEAKER -

CALL (816) 235-1272
or E-MAIL
rdelaware@cctr.umkc.edu

MPI Alumni who have spoken:

Brent Harding	(84-85)
Pam Deters/Stephen Koop	(84-85)
Seth McMenemy	(88-89)
Mitch Dobson	(89-90)
Rachel Allen	(92-93)

ODDS AND ENDS

On **Nov. 20**, the Associate Director and Sheri Adams visited the mathematics teachers and spoke with the principal at Blue Springs South High School, a visit organized by Tim Jones who also teaches mathematics there. We have yet to visit Blue Springs High School, or talk to the superintendent, but we hope this is the beginning of a process through which the Blue Springs School District will join the MPI for next year. In any case we will invite both schools to our MPI Recruitment Day in February 1999.

On **Nov. 23**, MPI students ordered nine MPI T-shirts and three MPI sweatshirts.

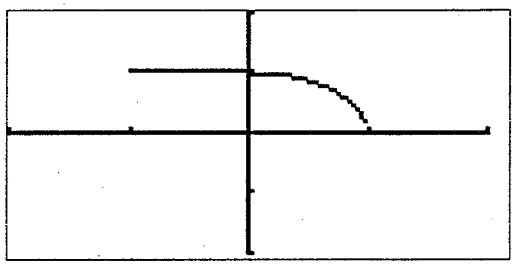
From **Jan. 9-14**, Larry Harding will attend the annual AAPT (American Association of Physics Teachers) conference in Anaheim, CA.

MATHEMATICS TECHNOLOGY REPORT

When one of our MPI students, Tennille Grant of Northeast High School, graphed the following piecewise-defined function on her SHARP calculator,

$$f(x)=\begin{cases}1 & when\ x<0\\ \sqrt{1-x^2} & when\ 0\le x\le 1\\ x-1 & when\ x>1\end{cases}$$

entering it (correctly) as $Y1=1(x<0)+\sqrt{1-x^2}(x\ge 0)(x\le 1)+(x-1)(x>1)$, and viewing it in the window $[-2,2]x[-2,2]$, she saw the following incorrect graph:



Here's a puzzle for you:

(i) Sketch the correct graph.

(ii) Why did the calculator produce this incorrect graph? (This actually turns out to be a function question!)

[The *answers* appear at the end of this issue of the Newsletter.]

ENRICHMENTS

FOLLOW UP

Friday **Oct. 9**, Steve Snyder, Director of Science for Kansas City's Science City, spoke on **THE PHYSICS OF TOYS.**

Students responded:

■ He talked to us about the use of physics in toys and optical illusions. He also told us about his experience with accelerators. We saw magnetic GAC, and optical illusions, and a cup that talked... will MPI take a field trip to the new Science Center? – a very good idea it sounds like!

■ He worked with the atom smasher which spins electrons around really fast and turns them into a beam which can be sent to an exact spot. This is now being used to treat cancers such as brain cancer.

■ Steve Snyder briefly described the physics of toys. He also told us about the Science City that will open in Nov. of next year. I also learned how a lava lamp waves. That's cool because I have a lava lamp of my own. Science City will definitely be a place to go and visit when it opens.

■ He talked about the power of magnetic fields, because he's worked with them. Also he talked about some toys that dealt with physics; gaks alive, the plastic talking strip, the lava lamp (not a toy), and showed us that neat optical illusion hand trick. He was good, he kept my attention throughout the presentation. It was weird, because I see him at my work all of the time doing his science experiments for children.

■ Steve Snyder talked to us about the physics of many common toys in today's society. He talked of how he enjoyed being able to look beyond the toy itself and see the science behind it. As a physicist, he gave us a whole new viewpoint on the avenues you can go with a physics degree. This helped me learn that there is a lot more to a degree than what appears on the surface, and to look more into this.

■ Science has many aspects and is involved in everything. The aspect that catches my attention was the way science is involved in the functions of toys. Physics plays a large role in how toys operate and where they originated from. He was very knowledgeable and humorous. He definitely kept my attention.

■ I really enjoyed listening to Steve and his outlook on physics. I believe that his whole goal as a physicist is to make it fun and more appealing to his younger pupils. One of the many ways he is doing this is by working with toys. Steve wants to take advantage of the intriguing ways

physics affects the human mind, and thus making it more enjoyable for anyone to study and work with the science of physics. I hope that one day I have as fun a job as Steve does.

■ The topic was interesting. I never realized there was so much science in my toys.

■ Mr. Snyder's main focus was that science is in everything that we use even if we don't realize that we are doing science. The surroundings that are around us will use science in one way or another. Also that science doesn't have to be boring, it can also be fun.

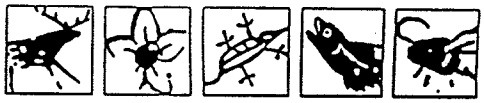
Paleontologist and dinosaur hunter Craig Sundell of KU spoke on **Oct. 23** about **THE REAL JURASSIC PARK: A WINDOW INTO PALEOECOLOGY.**

Some student comments:

■ Dinosaurs couldn't have evolved from birds, birds have digits 2, 3, and 4, while dinosaurs have digits 1, 2, and 3. They have changed history of a certain type of dinosaur by their findings in Wyoming. Found momma, daddy, and juvenile dino, they think may not have lived solitary lives, but lived in family groups.

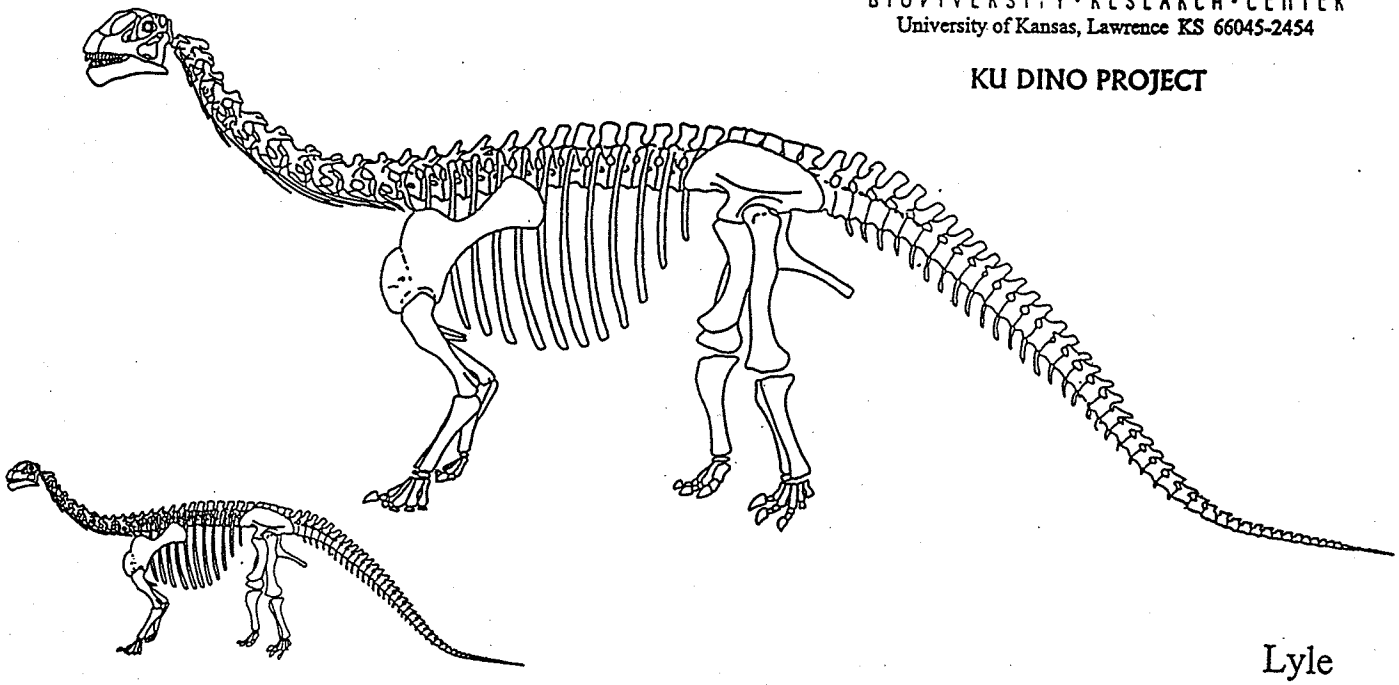
■ Passed around several dino teeth, bones, and one dino egg. He showed us the inside nail of a meat-eating dino. Made a good point about birds not being ancestors of dinos, the myth. To prove it, he explained that birds lose their thumb and pinky finger, but dinos lose pinky and ring finger. Also, all meat-eating dinos have serrations on their teeth in the Triassic and Jurassic Periods, but birds first started out with teeth without serrations. Told us not to misinterpret evidence or the data to be another thin, get valid evidence. Until this speaker, probably all I've ever known about dinos was in watching "Jurassic Park", he has opened my eyes to the REAL JURASSIC PARK.

■ Craig Sundell was a great speaker, he introduced some things about Paleontology to the group. First, he showed us a few items, they ranged from dinosaur bones and casts of bones, to prehistoric eggs. He showed us how people are discovering more and more about how birds are not really descendants of dinosaurs at



NATURAL HISTORY MUSEUM
BIODIVERSITY·RESEARCH·CENTER
University of Kansas, Lawrence KS 66045-2454

KU DINO PROJECT



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all. I thought he was excellent. Maybe he could have talked about other periods in the prehistoric era. I have always been interested in this subject. I am glad he came.

■ He began by laying to rest the idea that birds came from dinosaurs. He took us through the prehistoric time line, beginning 230 million years ago in the Paleozoic Era. There was a time between the Triassic and Jurassic periods when the equator went through Texas! During the Jurassic and Cretaceous periods the earth saw the warmest period in history. These eras are what Craig studies on a daily basis at KU. He recently uncovered an exciting site on a ridge south of the Black Hills. Here they found a wonderfully preserved camarasaurus "family" which they hope will continue to rewrite the books on paleontology. I thought it was very interesting. I wouldn't change it (but I love dinosaurs!).

■ He talked all about the different ancient time periods and dinosaurs while he was here. He showed us really cool fossils and dinosaur parts and passed them around. It was a great enrichment, non-stop information.

■ Always question science. Dinosaurs could regrow teeth. He talked a lot about where paleontology is going today. He showed us a lot of slides and interesting pictures from his expedition and we were able to finger actual dinosaur bones and casts of bones and teeth.

■ Craig Sundell got the opportunity to dig up old dinosaur bones in the summer of '93. He and other paleoecologists traveled to northeastern Wyoming to hopefully find a Morison Formation hot spot. The Morison Formation is a huge group of rocks that are known to have dinosaur fossils. Well, he hit the jackpot! This particular spot is one of the largest in the world now. During the age that dinosaurs ruled, much of the midwestern America was under water. That's why it's a rarity to find bones here. Even though dinosaurs were reptiles, (thus they were cold-blooded) they didn't have to worry about freezing to death because the temperature never was below 65° in their time on the earth. The handout is really cool!

■ I always have seen and heard about how big dinosaurs are, but... the finger of the dinosaur was 3 times bigger than my hand.

■ He obviously was very learned in this subject. It makes it much easier to follow someone who knows what they are talking about. I was glad that he brought lots of visual aids. For us that don't know much about dinosaurs, it makes descriptions and things easier. The slide show was helpful in understanding what paleontologists really do.

■ Mr. Sundell's talk was <u>wonderful</u>! I think I want to major in Paleontology or Anthropology so this topic was of particular interest to me. I thought his examples were very interesting and his offer of letting us help with assembling the skeletons is really exciting for me and I hope I get to do it. He was great! Craig Sundell was very good – I only wish we could have stayed longer to hear more!

■ The casts that Mr. Sundell brought were really interesting. It was obvious that Mr. Sundell was very well informed in this area, and shared many neat things. The ground penetrating radar that is being used for Mr. Sundell's project was designed in part by my dad – just thought I'd share!

■ Craig was a very energetic and exciting speaker. I like to listen to people who obviously love what they are doing so much.

■ Mr. Sundell talked about the findings his group made on a famous ridge in Wyoming. His group made some amazing discoveries that enlightened the world of Paleontology. He discovered articulated Camarasaurs which others had never done before. I thought overall it was a good presentation. Katie Allen's dad invented the ground penetrating radar. (She told me to put that in.)

On **Nov. 6**, Frank Booth, from the Kansas City Regional Crime Laboratories, returned with his very popular **SCIENCE IN THE CRIME LAB** talk.

The students responded:

■ We learned exactly how to commit a

crime. Example: wear leather gloves, and always strangle because blood is very messy and hard to clean up. Shave all of your bodily hair, and wear a rubber suit. Wear shoes with good tread, and burn them after you are done with the crime. Never kill a business partner and then leave town, (it's obvious). If you must use a gun, be sure to dispose of it properly, as any atom of it can be traced back to you. (I think you may have to melt it.) Never eat food and run at the crime scene, because it (the BLT) can also be traced back to you. There is more, but you get the idea.

■ Labs can tell what kind of guns are used, tell what was used for a break-in, pictures of crime scenes, arson, & DNA. They can tell how close a gun was shot by powder burns on clothes. Can tell what specific gun fired a bullet by the grooves caused by the rifling. They can tell how fast a car was going by looking at a ultraviolet picture of the speedometer, can also tell tire marks by grooves in tires. I think he was a really good speaker.

■ I want to be a criminal defense attorney, so this kind of gave me a little of the input I needed.

■ The guy talked about how they use modern day technology in the crime lab to solve crimes. He also showed how they have a special spray that turns blood glowing blue in a dark room. They also showed how they could find serial numbers on things where people have tried to file them down to tamper with the merchandise.

■ Mr. Booth made a cast of a hot dog half eaten, and they later identified the murderer because of this. I think this stuff was really interesting. I also thought it was funny how some criminals are caught and identified. Maybe we could go to a crime lab, that would be awesome.

■ Thanks to Frank Booth, the MPI student body is much better equipped to commit well-planned crimes. From his explanation on hair, we realize that a criminal should shave his entire body. He explanation on guns and bullets discourages the use of firearms. Thanks to luminal, a spray which causes blood to illuminate as a blue color, it is nearly impossible to hide blood one it has been spilled. Crime lab specialists also use special film, chemical stains, fluorescent lights, and other tactics to trace criminals. After learning about the science behind crimes, I feel much safer, even if it is sick.

■ Frank talked about how rifling in the barrel gives each bullet a match to the gun. When people steal things such as guns and all stamped serial numbers can be brought back through an acid process. Shoe prints can also be used to convict criminals. Small pieces of evidence such as a piece of leather from a shoe can be used. Hair samples are often used when found at the crime scene. The pattern of the blood can determine if the fight was self-defense, or if it had been a murder. He knows how to keep our attention, I never felt bored. He's probably the best speaker so far.

■ The speaker was great. He got my attention and kept it. He brought up simple mistakes that criminals make that allows them to be caught.

■ Mr. Booth came in to tell us about how scientific methods can help a detective solve a crime. First we saw how a bullet and cartridge can be identified to the gun. We also saw how using UV photography shoe prints and serial numbers can be enhanced. We also saw how a scientist can use hair to identify a suspect or victim. DNA ID's a person. Blood stains can tell what happened. We saw how Luminal works. Let's go to the crime lab!! That would be so cool. Also, let's go to the Medical Examiners office.

■ I think that it was neat to hear about all of the different things that are used for evidence. This isn't something that is talked about every day so it is very interesting. Not something that everyone hears about! I think he did a great job. The slides really helped. Interesting discussion!

■ I was amazed with some of the detail he has caught, and the chemicals they use to show blood at the labs.

■ Mr. Booth talked to us about how crime labs are used to convict criminals. He told us there are only about 250 labs in the United States. I think Mr. Booth was an excellent speaker with fascinating material. I wish he had a little more time.

■ There was not anything he could improve on. The presentation was great. Forensics has always interested me, and I really enjoyed this enrichment.

■ I thought Mr. Booth was excellent and he really discouraged me from killing someone.

Finally, on Friday, **Nov. 20**, we took our fifth annual trip to the **UMKC PHYSICS DEPARTMENT.** This year we toured laboratories in: **Atomic Force Microscopy** (Steve Harrington), **Scanning-Tunnelling Microscopy** (Fred Leibsle), **High Pressure Physics** (Michael Kruger), **Chaos /Non-linear Dynamics** (Dave Penwell), **Photoelectron Spectroscopy** (David Wieliczka), and **Photo-Luminescence** (Jerzy Wrobel).

Student comments:

■ We saw a microscope that you can see an atom with. Another guy had a vacuum that tested metals, not an actual cleaning vacuum! The third guy was fun. He showed us neat little toys that we could play with and fun things to do with magnets.

■ I saw how these men were really excited about what it is they are doing. It's not often you find people excited about their job and what it is they're doing.

■ Kruger had a great finale.

■ My favorite was being able to see the lasers after we smacked erasers together. Then we went to Jerzy Wrobel, he talked about photoluminescence. We saw how black lights worked, and how people have luminescence. Then went to David Wieliczka, talked about how he worked for the government trying to figure out how to prevent rust on aircraft. I had fun.

■ Our group went to the undergraduate optics lab, played with lasers. Then we went to the photoluminescence lab, that was cool, so was the French accent.

■ Michael Kruger talked to us about the importance of pressure in science. He showed us interesting toys dealing with magnetics. Steve showed us his equipment that measured the shape of things. He had computer images. David showed us the Physics II lab. It was neat because we got to play.

■ First we talked to David Wieliczka about Photoelectron Spectroscopy. He showed us his equipment and his computers, as well as some of his results. Next we talked to Fred Leibsle about Scanning Tunneling Microscopy. He showed us his microscope, and explained how it worked. Then he showed us some of his results, and how they take results as a reaction occurs in order to learn more about it. Next, we talked to Michael Kruger about High Pressure Physics. He showed us electromagnets, and liquid nitrogen (superconductivity). I enjoyed this trip, and I learned a lot about how physics is actually used.

■ New microscopes are being made which can be used to see atoms. The images show up on a computer screen, high pressure physics is utilized to find out more about different materials and how they can be used. A very important thing about this, I learned, is that P = F/A - pressure = force per unit area. materials are squeezed between 2 flat diamonds to see how they behave. The smaller the area, the higher the pressure is. To examine the molecular surface of an object, a very fine point on the very tiny cantilever is used. A computer is used to see this visually, and measurements are made in micrometers.

■ It was also interesting to see some of the strange applications of physics such as the "black goo". I thought the trip was pretty good, but the subject matter didn't strike me as that interesting. I thought the guy with the liquid N_2 was pretty interesting, however.

■ Excellent trip. Everything was interesting. The only improvement would be to spend longer; it seemed that all the professors had something more to say, but had to stop early.

UPCOMING

On **Dec. 4**, Doug Bullock (MPI 84-85) a mathematics professor at Boise St. University, will speak on **HOW CAN YOU DISTINGUISH KNOTS?**

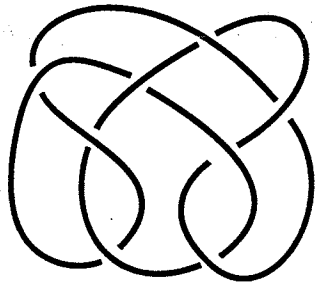
E-mail received 11-16-98 from Doug:

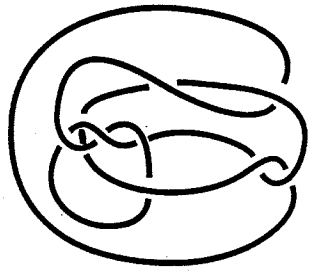
Abstract (for the talk):

While intuitively easy to grasp, and easy to physically model, knottedness as a mathematical phenomenon is often maddeningly elusive. No sooner is the question, "What is a knot?" posed than it becomes apparent that even recognizing a non-trivial knot may be difficult. More generally, given two knots, how can one tell if they are different? Mathematicians are fond of simply-phrased problems whose solutions resist not only time but ever increasing abstraction and invention. This, after all, is the engine that creates new mathematics, and the puzzle of knottedness has remained a rich source for more than a century.

We will look into the early combinatorial methods that developed around the problem of distinguishing knots, with the goal of proving that tricolored projections can at least verify the existence of non-trivial knots.

As promised, this alone is slippery enough to occupy most of the lecture. However, since the limitations of tricoloring can be seen even in the brief time we are allowed, we will also survey more modern devices. Those interested in a closer look at recent developments are encouraged to attend the follow-up lectures at **UMKC."**





Tuesday, **Jan. 5**, we'll hold our annual **PANEL DISCUSSION AND REUNION** with current and former MPI students.

Our **Jan. 29** speaker is Sam Gill who is an instructor at Johnson County Community College where he teaches Critical Thinking, and has written for The Skeptical Inquirer magazine. He will discuss **UNSOLVED MYSTERIES.**

MPI E-MAIL ADDRESS:

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A list of known MPI Alumni e-mail addresses is available on request.

1998-99 STUDENT FIRST IMPRESSIONS

"A sense of humor has been the characteristic I have had to use most for MPI. Calculus tests leave me no choice but to laugh. The happy nature of everyone in the program makes the early morning hard work bearable."

Laura Van Fleet
Ft. Osage High School
Ft. Osage School District

" 'The greatest labor-saving invention of today is tomorrow'. Vincent T. Fass

Who can **fcn** at 7:00 in the morning? We're the only people alive **wrt** the rest of the world! No one's mind is **SHARP** that early, yet Mπ does its best to stretch ours to the **lim.** Here's my Theorem: If Mπ gave us doughnuts every morning like they did at Recruitment Day, Then we'd all be more rational!"

[Editor's Note: The following mathematical abbreviations are used above: "**fcn**" = function, "**wrt**" = with respect to, "**SHARP**" refers to our MPI graphics calculator, "**lim**" = limit in the calculus sense.]

Jennifer Jecker
Center Place Restoration High School
[Independence School District]

"It has been a challenging year for me and I'm sure that it's the same to all of the MPI students. I never had any classes at school as tough as MPI. I think that MPI will well prepare me for higher education."

Phuong Le
Van Horn High School
Kansas City, MO School District

"My experience at MPI so far has been a good one. It is a lot harder than the high school classes that I was used to. The MPI has made me think about my work and study for the tests. The teachers say it gets easier with time. I hope they're right."

Jason Merling
Wm Chrisman High School
Independence School District

"I had thought that while attending MPI there would be no threat of writing assignments. This is an example of how wrong I can be sometimes. (You can leave off that little rant Mr. Delaware and begin with...) I don't know exactly what I want to do in the future, or how I'll use Calculus or Physics, but solving equations or describing motion is an exercise in complex thinking, and manipulating many parts of a problem to find a solution."

Mychel Varner
Truman High School
Independence School District

A SOLUTION TO MATHEMATICS CHALLENGE #55

Recall the problem statement:

Fifteen sheets of paper of various sizes and shapes lie on a desk top covering it completely. The sheets may overlap one another and may even hang over the edge of the desk top.

Prove that five of the sheets can be removed so that the remaining ten sheets cover at least two-thirds of the desk top.

[From: Which Way Did the Bicycle Go? and Other Intriguing Mathematical Mysteries, by Konhauser, Velleman, & Wagon, 1996, Problem #5, p. 54]

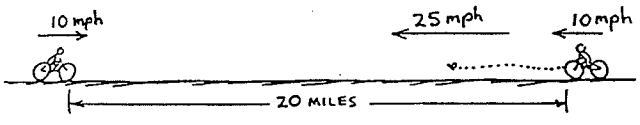
SOLUTION:

Imagine that the desk top was freshly painted just before the fifteen sheets of paper were placed on it. Then some of the sheets of paper will have picked up some paint when they were placed on the desk top. More precisely, each sheet of paper will have picked up paint on it from any part of the desk which it covers that is not covered by any sheet lower in the pile. Since the desk top is completely covered by the paper, the total area of paint on all fifteen sheets of paper together is exactly equal to the area of the desk top. If we remove the five sheets with the least paint on them, then we have removed less than or equal to one-third (5/15 = 1/3) of the total area of paint. So, clearly the total area of paint on the remaining ten sheets is at least two-thirds of the area of the desk top, and therefore at least two-thirds of the desk top is covered by these remaining ten sheets.

A SOLUTION TO PHYSICS CHALLENGE #46

Recall the problem statement:

Two bicyclists travel at a uniform speed of 10 mph toward each other. At the moment when they are 20 miles apart, a bumblebee flies from the front wheel of one of the bikes at a uniform speed of 25 mph directly to the wheel of the other bike. It touches it and turns around in a negligibly short time and returns at the same speed to the first bike, whereupon it touches the wheel and instantaneously turns around and repeats the back-and-forth trip over and over again – successive trips becoming shorter and shorter until the bikes collide and squash the unfortunate bee between the front wheels.



What was the total mileage of the bee in its many back-and-forth trips from the time the bikes were 20 miles apart until its hapless end?

(This can be very simple or very difficult, depending on your approach.)

a) 20 miles
b) 25 miles
c) 50 miles
d) More than 50 miles
e) This problem cannot be solved with the information given.

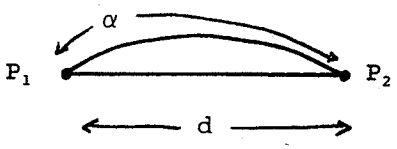
[From: Thinking Physics, Practical Lessons in Critical Thinking by Lewis Carroll Epstein, p. 10]

SOLUTION:

The answer is: b. The total mileage of the bee was 25 miles. The simplest approach to this solution is to consider the time involved. It will take the bicyclists an hour to meet, since each travels 10 miles at a speed of 10 mph - so the bee makes its many back-and-forth trips in an hour also. Since its speed is 25 mph, it travels a total distance of 25 miles. Again, time is an important consideration in velocity problems!

MATHEMATICS CHALLENGE #56

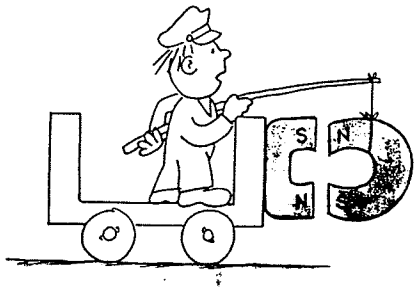
It is well-known that through any three points in Euclidean Geometry a unique circle can be drawn. But can the same be said if the information is given in another form? For instance, suppose below we know both the length α of the circular arc and the distance d between the points P_1 and P_2 as shown.



In terms of α and d, what is the radius r of the circle determined by these points, and is it unique, as we suspect?

PHYSICS CHALLENGE #47

Will hanging a magnet in front of an iron car, as shown, make the car go?

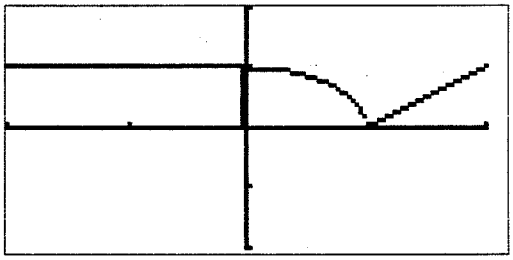


a) Yes, it will go
b) It will move if there is no friction
c) It will not go

[From: Thinking Physics, Practical Lessons in Critical Thinking by Lewis Carroll Epstein, p. 46]

ANSWERS TO MATHEMATICS TECHNOLOGY REPORT QUESTIONS

(i)



We found that to graph this correctly, we needed to enter <u>two</u> functions such as, for example:

$Y1=1(x<0)+(x-1)(x>1)$
$Y2=\sqrt{1-x^2}(x\geq 0)(x\leq 1)$.

(ii) Apparently the SHARP allowed the natural domain of $-1\leq x\leq 1$ for the center function $\sqrt{1-x^2}$ to limit how the other two function pieces graphed. So, outside the interval [-1,1], the first and last function pieces did not graph!

Editor/Writer: **Richard Delaware**

The Mπ Newsletter is typed in WordPerfect 5.1 with MoreFonts and published five times a year on the first of the month during the months of August, October, December, February, and April at the Mathematics and Physics Institute (MPI), 600 W. Mechanic, Room 224, Independence, MO 64050, phone (816) 235-1272, e-mail: rdelaware@cctr.umkc.edu. Please address all correspondence concerning this newsletter to 'Mπ Newsletter'.

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