



The Mathematics and Physics Institute NEWSLETTER

Director: Jennifer Snyder

Associate Director: Richard Delaware

April 1, 2000

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OUR 16TH YEAR

Like most of the world, we survived Y2K with no problems. We also survived the introduction of a new Calculus text this year, with the usual rearranged topics. However, the most important event was the addition of the Blue Springs School District to the MPI program. Its two high schools are Blue Springs and Blue Springs South, and students at both schools have expressed interest in attending. So, we look forward to our 17th year with our first students from that district, as well, of course, as all the other students who join us for another intensive year of learning Calculus, Physics, and college-bound study habits. See you in August!

CALCULUS READINESS EXAMS

During the last week of April and the first week of May, the Associate Director will travel to most of the high schools participating in the MPI to administer the MAA Calculus Readiness Test, a 25 question diagnostic test designed to determine roughly how prepared a student is to take calculus. It covers analytic geometry, algebra and some trigonometry. A score of 12 or above is required to attend the MPI, although occasionally lower scores are accepted, provided a transcript and two recommendations are received, and a personal letter is written to the MPI Director, all by May 12th. this year. (All those details will be discussed with the Associate Director makes his visit.)

Of course, this little test is by no means definitive, and in fact, a student's commitment more often determines his or her success at the MPI than a score on one introductory test. However, this test has proved to be effective as long as it is complimented by CAREFUL SCREENING done at individual high schools by counselors and teachers who know the students in question. Let us be clear on this: Students who have all the prerequisite classes and score 12 or more on the test, but who possess no maturity or commitment to hard work will not succeed at the MPI.

TO ALL MPI ALUMNI:

HAVE YOU GRADUATED FROM COLLEGE?

IF SO:

PLEASE CONSIDER BEING AN
- ENRICHMENT SPEAKER -

CALL (816) 235-1272

or contact us at our NEW E-MAIL:

mpi@umkc.edu

MPI Alumni who have spoken:

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

ODDS AND ENDS

On February 8th, our Recruitment Day, we hosted 117 high school juniors, with about 6 other teachers and counselors, from 9 different schools: Blue Springs, Blue Springs South, Center Place Restoration, Ft. Osage, Northeast, Paseo, St. Mary's, Truman, and William Chrisman. We are particularly pleased to welcome the Blue Springs people for the first time.

On Sunday, April 9th, during the procession of flags at the closing service of the World Conference Jubilee for the Reorganized Church of Jesus Christ and Latter Day Saints, Megan MacDonald carried the flag of the United States. This event was televised internationally.

THE AUGUST 2000 ISSUE

The August 1 M π Newsletter will list the top ten MPI students for 99-00 and all those receiving awards at our May 11th Awards Presentation.

There will also be **IMPORTANT INFORMATION** and advice for the YEAR 17 class of 2000-2001. TAKE NOTE!

ENRICHMENTS

FOLLOW UP

On Friday, February 11th, Kathleen Kilway, an Organic Organometallic Chemist UMKC, spoke on **A TOUR IN PHYSICAL ORGANIC CHEMISTRY**.

Students responded:

■ Dr. Kilway began her talk by telling us about NMR (nuclear magnetic resonance) spectroscopy, which is about the same as an MRI in medicine. Basically, you use a magnetic field to orient the nuclei of atoms. After this, Dr. Kilway began to talk about C-60 and nanotubes. The rest of her talk had to do with hydrogen bonding. She really did a good job. It was very easy to understand what she was talking about.

■ Very well spoken. Kathleen Kilway kept my attention. Her subject was a little over my head, but she spoke to us on our level and she was very articulate.

■ It was an excellent presentation about physical organic chemistry. I gained a good amount of useful knowledge and understanding.

On Friday, February 25th, Richard Gentile, a Professor Emeritus of Geosciences at UMKC, spoke on **THE ANTARCTIC PENINSULA: VOLCANOES, PENGUINS AND ICE**.

Students responded:

■ Dr. Gentile shared many things with us about Antarctica. He went there with some other biologists. He had many great pictures of the peninsula, a volcano, and penguins. Dr. Gentile also shared with us how the continents were once hooked together and over time have drifted apart. He said that by looking at magnetite in the rocks, you can determine their location at a particular time in history. He said the ice is as much as 4 km. thick in places and an average of 2 km. thick everywhere.

■ The material he presented was very good and drew both our prior knowledge and his knowledge into one.

■ He seemed very intelligent and knowledgeable. Even though he talked about Antarctica, he reached out and gave us information that really wasn't useful for everyday life, but neat to know.

On Friday, March 10th, Chip Barger, a Special Agent for the Federal Bureau of Investigation, spoke on **AN APPLICATION OF SCIENCE & MATHEMATICS TO FEDERAL INVESTIGATION**.

Students responded:

■ Chip Barger has worked for the FBI for 15 years, in enforcement for 25 years. FBI agents come from a wide variety of backgrounds and these backgrounds are successfully used in the field, laboratory and other technical areas. Chip has a specialty in asset forfeiture. Its main goal is to take the profit out of crime which is the big motive for most crime in the U.S.

■ No changes – this was an excellent presentation. Now I want to become a Special Agent!

■ This was one of the best enrichments that we've had. He was much more interesting than some of the others.

■ Very interesting subject matter. Very good presentation all around, and Chip made the material very accessible and interesting.

■ I liked the simplicity of his demonstration and the unusual tie-in to MPI.

On Friday, March 24th, we made a field trip to the world-class Linda Hall Library of Science, Engineering & Technology located at the center of the UMKC campus (though independent of it), and to some UMKC Physics Department labs. At the Library we visited the Rare Book Room to view rare and historically significant mathematics books. At UMKC, in Physics we toured laboratories in Atomic Force Microscopy (Da Ming Zhu), Photoelectron Spectroscopy (David Wieliczka), Photo-Luminescence (Jerry Wrobel), and participated in a liquid nitrogen demonstration with Dr. Snyder. Finally, we ate lunch together. After the trip, students were required to complete a Calculus Writing Assignment, typing a paper about the mathematics books they personally examined.

Among the rare books (in English, Latin, and other languages) we viewed, were the following:

◆ The first calculus text, written in 1696 by L'Hopital

◆ Books by Newton (1728, 1729, 1736) and Leibniz (1684), the co-inventors of Calculus

◆ Several versions of Euclid's Elements, including the first printed edition of 1482, the first English translation in 1570, and a completely visual version in color created by Oliver Byrne in 1847.

◆ Descartes' book (1637) in which he invented Analytic Geometry.

◆ The 1670 edition of Diophantus in which Fermat's Last Theorem was first printed.

Students commented:

■ We went to the UMKC campus and visited some of the laboratories as well as the Linda Hall Library. After experimenting with liquid nitrogen in Dr. Snyder's lab, we toured a room with spectrometers and a lab with an atomic measuring device. We got to go into the Rare Book Room at the library and look through copies of books by famous mathematicians. Some were in Latin or French, and some had pop-up diagrams or fold-out charts. Then we ate a tasty lunch and went home.

■ The physics lab and going to see really old books was awesome.

■ I would suggest that we be given more time in the rare book room, both because it was very interesting, and because I didn't feel it was sufficient time to glean enough information for a 3-page report. I really appreciated that the librarians had also provided translations from their open stacks.

■ The whole thing was really cool. Especially the ice cream! The Polish professor reminded me of the Russian Cosmonaut in "Armageddon."

■ Give more time in the Linda Hall Library to study the books.

■ It was really great! The atom microscope was my favorite.

UPCOMING:

On April 14th, Lori Hill, an Electrical Engineer and General Manager for Flight Safety Systems, Business & General Aviation, at Honeywell, will speak on **GPS IN THE WORLD OF AVIATION**. Lori not only graduated from UMKC with her engineering

degree and later earned an MBA, but she was once an MPI tutor during the mid-1980's. We will be pleased to see her again.

We have not yet scheduled a speaker for April 28th.

Sunday, April 30th, will be our annual **WORLDS OF FUN PHYSICS DAY**.

Finally, we'll hold our annual **BREAKFAST** on Wednesday, May 10th, and our **AWARDS PRESENTATION** on Thursday, May 11th, the last day of MPI classes this year.

WE HEAR FROM PAST STUDENTS

Alex Maginness (93-94)
BS Mechanical/Aerospace Engineering
Chief Mechanic, Victoria Motorsports (Trans Am Series)

"After one year on the SCCA Trans Am Series Racing Circuit, the car I worked on placed second in the championship. In January I was told the team was being sold and I would be without a job. Fortunately, due to contacts gained last season, I found a job that was a promotion from my previous title and am not commuting across the country for races."

Josh Small (93-94)
BS Chemical Engineering
Production Supervisor, Cargill Incorporated

"The [MPI] program was very worthwhile for me. It helped prepare me for the rigorous courses that college had in store for me."

Heidi Miller (95-96)
Secondary Business Education Major
Northwest Missouri State University

"It has been so many years that I cannot quite remember MPI, but I do remember that the Calculus class thoroughly prepared me for college. My other high school classes were so easy and laid back for me that Calc was a struggle and so different. So, I would have to say the quality of MPI classes was very helpful. The Calculus class (Calc is the only one that I took) didn't affect my education much credit-wise, because I did not need Calc for my major. But, I think that the pressures and regime of the class helped prepare me for the whole college experience, as college classes are so much more demanding than high school!"

Thomas Gregory (96-97)
Pharmacy major
UMKC

“If any high school students want to be able to get through their freshman classes without C’s (with higher grades like B’s & A’s), then MPI would be a good choice.”

Erika VanTuyt (98-99)
Psychology and Business Administration major
Truman State University

“At MPI I learned that studying in groups helps. I learned that I wasn’t always going to get a perfect grade and how to deal with grades that I wished were higher. I loved being able to get all of those free college hours. They were a huge help.”

NEW MPI E-MAIL ADDRESS:

mpi@umkc.edu

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

**FINAL 1999-2000 STUDENT
IMPRESSIONS**

“MPI is an obstacle that you take one look at and never think you can overcome, but in the end it is great to know that you survived.”

Heather Biggs
William Chrisman High School
Independence School District

“MPI woke me up on the way to learning. Many students believe in slacking off their senior year. Getting up in the morning, however, is difficult because you are coming to college classes. I selected MPI in order for my knowledge to increase. I worked hard in MPI and have expanded my knowledge after seven months.”

Tri Do
Northeast School
Kansas City, Missouri School District

“This year has been both fun and educational. I met new friends from all over the area, and I learned how quickly I could make it across town at 7:00 in the morning. I had fun and would recommend MPI to any student looking to have fun and learn at the same time.”

Nathan Johnson
Truman High School
Independence School District

“MPI appeared to be nothing more than a math/science boot camp at the beginning of our 2nd semester adventure into the heart of Calculus and Physics. It’s taken me 6 months of 3 or more hours of homework a night, hundreds of pages of notebook paper and a lot of frustrations to fully understand all of the challenges presented by MPI. But now, I can fully comprehend everything from simple harmonic motion to integration. I have learned to apply mathematics to my everyday life, and I find myself wondering about the coefficient of friction between my tires and the road, the change in water height due to the rate at which the sink is draining, and about weight and tension distribution in construction cranes – That’s right...I am now a nerd. But I’m proud of my nerdhood and find myself better equipped for the problem solving and technical skills necessary for success in college, business, and life. Thanks MPI!”

Jeremy Knoll
Paseo Academy
Kansas City, Missouri School District

“Seven months ago we were hurled into a harsh realm where calculus and physics meet in the wee hours of dawn – a place called MPI. No amount of caffeine can ease the pain of learning how the universe works, but as final exams loom on the bleak horizon, a light shines from the end of the tunnel. Will we make it? Or will we be trapped in a world of integrals and coefficients for the rest of our mortal lives? Too late – have always have been, we just didn’t know it. The grim reality is only now beginning to sink in. Why, I can barely remember the days when...”

- ◆ The words “calculus” and “writing assignment” did not belong in the same phrase.
- ◆ Seventy percent was a bad grade.
- ◆ Nobody knew what all those buttons on the graphing calculators were for.
- ◆ Teachers made sure we learned the material.
- ◆ Antiderivatives sounded like something dark and sinister. Okay, maybe they still do.
- ◆ Stress ulcers were not a concern, and hair loss was for old people.

- ◆ Math and physics made sense, and school was enjoyable.

So much is different in MPI Land. But just kidding about the ulcers and hair loss...I think."

Matt Lane
Truman High School
Independence School District

"The one thing I can say for certain regarding MPI is, "man, this year has been weird." MPI has been one wild trip. Time distorts. We calculate everything from fuel economy to tips at Winsteads. I and my MPI buddies are certainly different people than we were before. We've discovered a better understanding of the universe, through math. Recently Sarah said, and we all agreed, that "This math is beautiful, just like art.""

Joe Moccia
Paseo Academy
Kansas City, Missouri School District

"MPI is just like any challenge; it's what you make of it. Every morning that you climb those 59 stairs you decide what you're going to put into it and what you're going to get out of it."

Sam Slee
Truman High School
Independence School District

A SOLUTION TO MATHEMATICS CHALLENGE #62

Recall the problem statement:

Suppose each point of the 2D plane is colored red or blue. Prove that some rectangle has its four vertices all the same color.

[From: Mathematical Morsels, by Ross Honsberger, 1978, Problem #8, p.15; Due to David Silverman, as Problem #138 in Vol. 3, 1959-64, p. 474, Pi Mu Epsilon Journal.]

SOLUTION:

Since each point of the plane is colored red or blue, any set of 7 points must contain at least 4 which are the same color. So, in particular we consider any 7 points which lie on the same line, then at least 4 of them, P_1, P_2, P_3, P_4 , are all the same color, say, red. If these 4 collinear points are projected onto two other lines parallel to the first line,

then two other quadruples are obtained, say, Q_1, Q_2, Q_3, Q_4 , and R_1, R_2, R_3, R_4 :

P_1	Q_1	R_1
P_2	Q_2	R_2
P_3	Q_3	R_3
P_4	Q_4	R_4

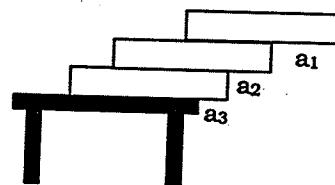
These last two sets of Q-points and R-points determine several rectangles with the P-points.

Now, if any two of the Q-points are red, say Q_i, Q_j , then the rectangle $P_i P_j Q_i Q_j$ is all red, and we have solved the problem. Likewise, if any two of the R-points are red, we are done. If neither of these cases holds, then some 3 or more Q-points must be blue, and some 3 or more R-points; must likewise be blue. But then, these trios of points cannot avoid being lined up so that a pair of each trio face each other to yield an all blue rectangle, which again solves the problem.

A SOLUTION TO PHYSICS CHALLENGE #53

Recall the problem statement:

Four identical uniform bricks, each of length L , are put on top of one another as in the figure in such a way that part of each extends beyond the one beneath. Find, in terms of L , the maximum values of a_1, a_2, a_3 such that the stack is in equilibrium.

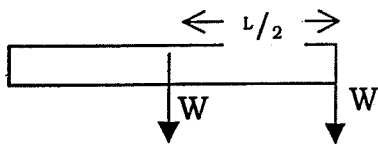


SOLUTION:

To get to the solution, you need to know that all things will balance if supported along their centers of mass. The trick is to find the centers of mass of the objects and then to put the support beneath that point. The question says that these are "uniform" bricks, which means that the mass is distributed uniformly throughout the blocks. Since the mass is distributed equally, the center of the mass of the first block will be at its center and therefore, the greatest that a_1 can be is $L/2$.

The second block itself has a center of mass at the center of the block, but the first block is sitting on top of it. So, we need to look at the center of mass for both blocks together. Consider the free body diagram drawn for the second block. The second block supports the weight of the first block at its edge. There is also the weight of the block itself, which is centered at $L/2$. Both of the weights are identical. The center of mass of this system will be the place

where the two torques from these forces are balanced. Using this as the pivot point, measuring from the edge of the block, and using the fact that the counter-clockwise and clockwise torques are equal about this point, we can find the answer as follows:

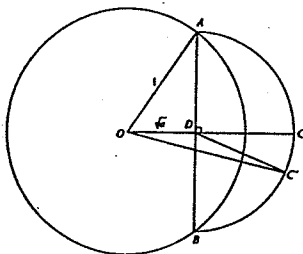


$$\begin{aligned} Wx &= W(L/2 - x) \\ x &= L/2 - x \\ 2x &= L/2 \\ x &= L/4. \end{aligned}$$

The greatest value for a_2 is then $L/4$. The solution for a_3 follows the same logic. Just following the pattern so far, you might guess that the answer is $L/8$, but if you set up the free body diagram and do the algebra, the answer will be $L/6$.

MATHEMATICS CHALLENGE #63

A semicircle is drawn outwardly on chord AB of the circle with center O and radius 1. The point C on this semicircle which "sticks out the farthest" from the given circle lies on the radius ODC which is perpendicular to AB, because for any other point on the semicircle, we have $OC' < OD + DC' = OD + DC = OC$. Of course, the exact size of OC depends on the choice of the chord AB.



FIND the length of chord AB, so that OC has maximum length.

[From: Mathematical Morsels, by Ross Honsberger, MAA, 1978, Problem #5, pp. 8-9; originally from PI MU Epsilon, Vol. 4, 1964, p. 355, Problem 187 by R. C. Gephardt.]

PHYSICS CHALLENGE #54

Suppose you have just made a hot cup of coffee, but you've still got 5 minutes until class. If you want to bring your coffee to class as hot as possible, should you put the cream (cold) in now or just before class? When should you add the sugar?

Do you have a physics problem that you'd like to challenge the MPI students and alumni with? Send your question (with solution!) to the MPI address or e-mail to: jdiscenna@umkc.edu.

Editor/Writer:

Richard Delaware

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