Mπ The Mathematics and Physics Institute NEWSLETTER

Director: Richard Waring
Mathematics Coordinator: Richard Delaware

October 1, 1993 **Vol. 8, No. 2**

YEAR 10 - IN BRIEF

Currently enrolled in the MPI are 62 students, 61 in Calculus and 60 in Physics; from East (2), Fort Osage (13), Northeast (12), Truman (10), Van Horn (8), and Wm. Chrisman (17) high schools. Of these, 30 (48%) are women, and 21 (34%) are minorities.

! MPI OPEN HOUSE !

Sunday Nov. 7, from 2-4 pm, the MPI will hold its annual OPEN HOUSE for parents, teachers, counselors, administrators, and anyone else interested in talking to the faculty, staff or students of the MPI.

We'll be in the Truman Campus Building of UMKC behind the Truman Library just north off Hwy 24 in Independence. There will be 1) physics demonstrations and laboratory set-ups, 2) mathematics demonstration problems on chalkboards with videotapes of recent problem-solving sessions, and 3) the MPI Calculus Lab in Room 223 will be open with MPI student assistants ready to demonstrate mathematics software to our visitors. In Room 207 at 2:30 pm, the MPI director will make some brief remarks and introduce the MPI teachers, and a 10-minute slide presentation will follow. And of course, there will be refreshments. If you have any questions, please call 235-1272. You're invited!

! MPI OPEN HOUSE !
SUNDAY NOV. 7, 1993, 2-4 PM

TO ALL MPI ALUMNI:

HAVE YOU GRADUATED FROM COLLEGE?

IF SO:
PLEASE CONSIDER JOINING OUR PANEL DISCUSSION THIS YEAR!
(Wed. Jan. 5, 1994)

ALSO, PLEASE CONSIDER BEING AN ENRICHMENT SPEAKER!

CALL (816) 235-1272

OUR NEWEST HIGH SCHOOL TEACHER

Following the retirement of Calvin Nelson, one of our original and much appreciated physics teachers from Northeast High School, we have hired a new physics instructor. JIM GRACZYK joins the MPI from Van Horn High School, where he currently teaches Principles of Technology (the first such course in the Kansas City, MO District), Introduction to Chemical and Ceramic Engineering (a discovery and exploration class), and lastly Engineering Special Projects, from which a team of Van Horn students has won the Missouri State Competition of the US Academic Decathlon, and competed in the National Competition.

Jim began his career, however, not as a teacher, but as an engineer. After receiving a BS in Chemical Engineering and another BS in Industrial Chemistry, he worked as a Chemical Engineer for 12 years, owned his own engineering consulting firm, XYZ Oil Co., for 5 years, and finally retired for 6 years. Then, as he tells the story, it was his

daughter's 7th grade mathematics homework that sparked the idea of his turning to teaching. Now, in his second career, he is certified to teach high school Chemistry, Physics, and Mathematics, and we are very pleased to have his "real world" outlook and experience here at the MPI.

SOME STATISTICS FROM OUR 92-93 ANNUAL REPORT

432 students have completed the MPI program (Years 1-9, Sept. 1984 - May 1993).

64% of MPI alumni who enrolled in college received a scholarship to the school of their choice.

Of the cumulative college GPAs reported in Dec. 1992 by 34% of MPI alumni (on a scale where A = 4.0), the Mean was 3.30 and the Median 3.40.

120 college degrees, 81 in Science, Mathematics, or Engineering, to the best of our current knowledge, have been received by MPI alumni from Years 1-4 (1984-88).

MPI E-MAIL ADDRESS:

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ENRICHMENTS

FOLLOW UP

On Oct. 1, Ed Kiker, a Harvard Graduate who majored in Lunar Geology, a member of the National Space Society, the Planetary Society, the Space Studies Institute, and a Management Analyst for the US Army at Fort Leavenworth, KS spoke on **LUNAR MINING AND SPACE TRANSPORTATION.**

The following description of his talk was written by MPI student Matt Cianciolo:

"Ed Kiker, member of the National Space Society, visited the MPI on Friday, October 1. He explained the program he is involved in-the study of the DC-X Delta Clipper. He also added his insights on a different power source called Deuterium/Helium III.

"The DC-X is the first spaceship to hover above the ground," Kiker said, "and still be able to land." He recently returned from White Sands, New Mexico where the DC-X was tested several times.

"The DC-X will rise to an altitude of 300 feet, hover for about three seconds, and then set down on landing feet, all in about 1½ minutes," Kiker said.

Kiker showed a videotape of the DC-X, which was built in only 18 months, being tested in White Sands on September 11. He said that eventually it will be able to rise up to 50,000 feet and still land safely.

Kiker also gave information on Deuterium/Helium III-a different source of energy that resides on the moon. This fuel will produce fusion energy without giving off wastes like other products such as the burning of coal.

If the Helium III can be transported to earth and sent through a tokamak machine which will heat the particles up slightly to produce fusion, this product will power the earth for many years with little radiation given off.

"The Helium III, which is in abundance on the moon, would be able to power the earth for 40,000 years," Kiker said."

UPCOMING

On Oct. 15 we hope to have a former MPI student, now out of college and working, as our speaker.

On Oct. 29, Larry Deaton, former Assistant Superintendent for Secondary Education in the Fort Osage School District will speak on **BIRTH ORDER** and its effect on personality and behavior.

Finally, on Nov. 12, we'll make our annual all-day field trip to the **NUCLEAR RESEARCH REACTOR** at the University of Missouri-Columbia campus.

WE HEAR FROM PAST STUDENTS

HANG DU (88-89)
(Elementary Education Major)

"MPI helped me take college more seriously. When I was at the MPI I played around a great deal because I didn't want to work very hard. The MPI has taught me that I need to work hard and not just give up. Thanks!"

SCOTT HUMMEL (91-92)
(Biology/Pre-Medicine Major)

"I learned I had to sit down and work on the problems in order to understand the concept.

It was a great experience meeting and working w/people from different schools & backgrounds.

In general, MPI is a great place."

CHHENG MENG (91-92)
(Nursing Major)

"I learned to spend my time wisely for studying because of my busy schedule. I want to thank MPI for the enrichments on "time management".

I learned to think logically. I didn't give up easily when I couldn't solve the problem.

I hope MPI will still exist in the future. The reason is that it helps high school students to prepare for college by taking these challenging courses. It also helps to improve the students thinking and study skills. Overall, MPI is very useful and it give students a head start.

I want to say "hello" to all of the instructors and those who have given me this knowledge."

FIRST IMPRESSIONS FROM THE STUDENTS OF YEAR 10

"MPI is neat so far. I'm waiting for it to become tougher. I like the problems we work on because I like to feel challenged. I'm glad we're only here for two hours because just when I'm ready for a break I have a ten minute drive to school to relax in."

Charity Coney
Truman High School
Independence School District

"So far MPI is pretty easy. But I know that eventually I'm going to have to start studying. That's a real tough reality check."

Jason Walker
Wm. Chrisman High School
Independence School District

"MPI started off as a means to meet new people and to learn physics and calculus. In addition I have befriended new people and am starting to develop study skills necessary for college."

Roger Hatridge
Ft. Osage High School
Ft. Osage School District

"When I first came to MPI I was scared because I didn't think I would survive out here, but after three weeks, I see that isn't as hard as I thought it would be."

Martin Thibeaux
Northeast High School
Kansas City School District

A SOLUTION TO MATHEMATICS CHALLENGE #29

Recall the problem statement:

An engineer whose daughter was to have a garden wedding the next day decided at the last minute that it would be nice to have an archway under which the bridal procession could file before the knot was tied. The opening had to be 7 feet high and at least 34 inches wide at the bottom. There was a conveniently level concrete walkway of adequate width on which to build the arch but unfortunately he found that he had just 86 bricks on hand and no mortar. The bricks, however, were in perfect condition, being very smooth and

having sharp corners. Moreover, their dimensions were quite uniform, 2 x 4 x 8 inches. These favorable conditions made him decide to attempt the arch, but it seemed that no matter how he tried to arrange the bricks, they would topple off one another before the arch reached the required dimensions. Finally, his young son Euclid, who had been looking on amusedly, stepped up and told his Dad how to do the job. How?

[From: Ingenious Mathematical Problems and Methods by L.A. Graham.]

SOLUTION:

We argue for the simplest solution. Since the arch ought to be symmetrical, each half (side) should be made up of $(1/2)\cdot 86 = 43$ bricks. Clearly the bricks, for stability, should be laid on their 4 x 8 inch faces, so each is then 2 inches high, and the total height of the bricks is $2\cdot 43 = 86$ inches. If we make the roof of the arch a single 2 inch high brick, then the height of the arch is exactly the required minimum of 84 inches = 7 feet.

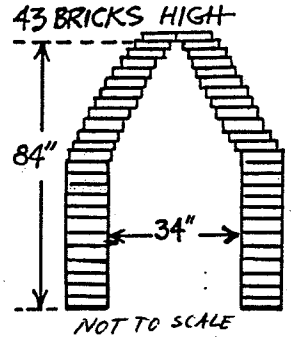
Now consider one side of the arch, and reason downward from the top. Clearly, the top brick could overhang the second brick by as much as 1/2 of its length without toppling. By finding the center of gravity of the top and second bricks together, we see that they could together overhang the third brick by 1/4 of its length. Likewise the top, second, and third bricks together could overhang the fourth by 1/6 of its length, etc., until finally the top 42 bricks together could overhang the 43rd by 1/84 of its length. To get the maximum width, we lay the bricks with their 8 inch length parallel to the plane of the arch. Along with the other side of the arch, this leaves at the bottom of the arch a total width in inches of:

$$2\cdot 8\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{6}+\cdots+\frac{1}{84}\right)\approx 34.6139,$$

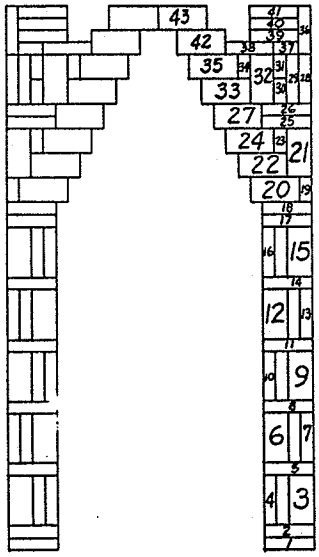
which is greater than our required minimum of 34 inches. In fact, we can do better. The shorter sum

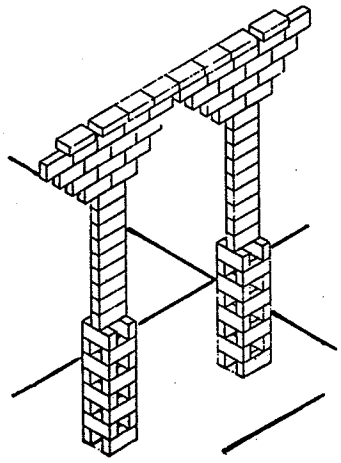
$$2\cdot 8\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{6}+\cdots+\frac{1}{78}\right)\approx 34.0283$$

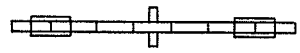
is the smallest such sum that exceeds 34 inches, so we could actually build the arch by just laying the lowest 4 bricks on either side vertically above one another, and 34 inches apart, then overhang the fifth lowest brick on each side (which is the 39th brick from the top) by $(1/76)\cdot 8$ inches, then, continuing upward, the next by $(1/74)\cdot 8$ inches, and so on, until the top bricks from the two sides meet, leaving a slight margin ($\sim$.6139 inches) of safety to spare. This solution is roughly sketched below:

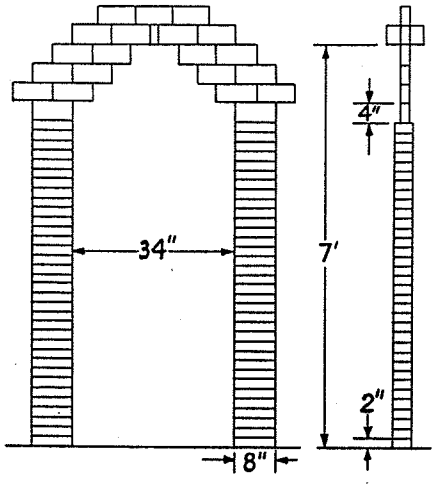


Here are 3 other less simple but nonetheless interesting solution sketches:









A SOLUTION TO PHYSICS CHALLENGE #20

Recall the problem statement:

On a table are two bars of iron identical in every respect, except that one has been magnetized. Determine which is magnetized. (You may move them but you may not lift them from the table. No other objects may be used.)

[From: PASCO Scientific Lab Notes]

SOLUTION:

Form a T with the two bars. If the bars are attracted together, the magnetized bar is the bottom of the T. If there is no attraction, the magnetized bar is the top of the T.

MATHEMATICS CHALLENGE #30

If you toss darts at a target and each dart can only yield either 4 points or 9 points, what is the largest score that you canNOT ever make? (Be sure to justify your answer.)

[From: Vena Long]

PHYSICS CHALLENGE #21

RUNNING A YELLOW LIGHT

Every driver will occasionally have to make a quick decision whether or not to stop at a yellow light. His intuition about this has been built up by many tests and some mistakes, but a calculation might reveal some situations where intuition will not help.

For some given light duration and intersection size, what combinations of initial speed and distance require you to stop (or run a red light)? What range of speed and distance would allow you to make it through in time? Notice that for a certain range of these parameters you can choose either to stop or not. But there is also a range in which you can do neither in time, in which case you may be in a lot of trouble.

[From: The Flying Circus of Physics by Jearl Walker]

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