YEAR 10

As we begin the last year of our first decade, we continue to update and improve the MPI program:

-- Since Calvin Nelson from Northeast High School, one of our prized physics teachers, retired at the end of Year 9, we have been searching for a replacement from the Kansas City, MO School District and should have one soon.

-- Over the summer of 1993 we have bought 5 new pieces of physics software, which will find their way into the physics course this year, and some new physics labs have been written.

-- In order to produce better computer demonstrations in both physics and calculus, we have bought an LCD projection panel, allowing us to project computer screens as well as full-motion video onto a large screen for easier viewing. We hope to make much use of this new tool.

-- All calculus computer labs have now been brought together and typed as MPI labs, so we won't be dependent on buying published manuals of labs, most of which we don't use.

-- Computers, loaded with all MPI software, printers, and carts identical to those used at the MPI will now be present at East, Northeast, and Van Horn high schools, to complement those already available last year at Fort Osage, Truman, and Wm. Chrisman high schools.

--We are also buying sets of graphics calculators for loan to all MPI students while they are enrolled. For the majority of time that they are away from the computers at the MPI and in their schools these calculators put graphical power into their hands, and we hope, will encourage them to think about mathematics and physics more often.

--Finally, although there will be some changes in the tenants of the UMKC Truman campus building where the MPI is located, such as the arrival of Metropolitan Community College classes this Fall, and the departure of the Engineering program in January, the MPI will remain unaffected.

MPI STUDENT ORIENTATION SEPT. 8 - 10, 1993

Each year the first three days at the MPI are spent in giving our students an overview of how we operate, a discussion of our policies on attendance, grading, etc., and two diagnostic tests. Time is then set aside for the instructors to informally 'get to know' their classes before we all become preoccupied with class work.

In particular, on the first day, Sept. 8, 1993, we'll provide each student with a packet of information and have each of them fill out a personal data form.

PLEASE BRING, ON SEPT. 8 TO THE 'LOFT' (Room 207)

● Social security number.

● Daily schedule of high school classes.

● Schedule of extracurricular activities.

● High school counselor's name.

● Car license number, make and model, for those ever planning to drive to the MPI.

● Ideas for Enrichment Speaker topics.

We look forward to seeing our 10th class on Wed. Sept. 8!

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│                                 │
│    MPI E-MAIL ADDRESS:          │
│                                 │
│    rdelaware@vax1.umkc.edu      │
│                                 │
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1993 MPI AWARDS PRESENTATION AND
TOP 10 MPI STUDENTS OF 1992-93

Our final awards presentation was held on May 20, 1993, during which we were pleased to present many of our 1992-93 students with the following variety of awards:

Certificates for Outstanding Achievement (college grade of A or B) in:

CALCULUS I

(Name)	(School)
Rachel Allen	Wm. Chrisman
James Coney	Truman
Todd Johann	Wm. Chrisman
Amanda Koster	Wm. Chrisman
Tab Lawson	Truman
Jessie Nolle	Truman
Andrea Slusser	Wm. Chrisman
Ric Stuck	Wm. Chrisman
Tim Thacker	Truman

CALCULUS I and II

Eric Swearingen	Truman
Brett Williams	Truman

PHYSICS

Mike Bush	Truman
James Coney	Truman
Richard Fulton	Wm. Chrisman
Todd Johann	Wm. Chrisman
Amanda Koster	Wm. Chrisman
Kyle Langlands	Ft. Osage
Tab Lawson	Truman
Jessie Nolle	Truman
Andrea Slusser	Wm. Chrisman
Ric Stuck	Wm. Chrisman
Tim Thacker	Truman
Thuy Tran	Northeast
Brett Williams	Truman

We also honored the TOP TEN students (ranked according to the mean of their full-year college calculus and physics grades) by giving them a one year subscription to Scientific American magazine, a copy of the May issue of Scientific American, and a copy of "What's Happening in the Mathematical Sciences":

TOP 10 MPI STUDENTS 1992-93

1) Todd Johann	Wm. Chrisman
2) Jessie Nolle	Truman
3) Brett Williams	Truman
4) Ric Stuck	Wm. Chrisman
5) Amanda Koster	Wm. Chrisman
6) Andrea Slusser	Wm. Chrisman
7) Kyle Langlands	Ft. Osage
8) Eric Swearingen	Truman
9) Tab Lawson	Truman
10) Thuy Tran	Northeast

Finally, we list those MPI students planning to attend UMKC who received various scholarships from UMKC; included here are those students to whom the MPI awarded Chancellor's Scholarships:

UMKC Chancellors Award Winners:

Shelley Carter	Northeast
Sayam Chaiyote	Northeast
Andrea Slusser	Wm. Chrisman
Deuandara Sysavath	Northeast
Tim Thacker	Truman
Thuy Tran	Northeast

UM Curators Award Winners:

Jessie Nolle	Truman
Andrea Slusser	Wm. Chrisman
Brett Williams	Truman

ADVICE TO STUDENTS OF YEAR 10 FROM THE STUDENTS OF YEAR 9

At the end of this last year, in May, we decided once again to have our students write however much they wanted in answer to the question:

"What ADVICE would you give to incoming students about study, attitude, or any other aspect of surviving the MPI in 1993-94?"

We were pleased at how seriously and with what maturity they wrote, and so each incoming student,

after a few weeks of class, will receive a complete set of these words of advice from 35 students of Year 9. Here are some excerpts from that document:

"Don't get discouraged by the first test grade, just study harder next time. The classes are tougher and require more study time. The teachers are a great resource, so don't hesitate to use them."

Kristi Bass
Truman High School

"Be sure that you're sure about wanting to come, and if you decide to come be sure to be prepared to do some serious studying and taking notes. If you don't want to do this then you shouldn't be here, because you will drown in all the work that comes charging toward you and you'll feel like somebody is holding your face in a swimming pool and won't let you come up for a breath of air.

Because you have to like doing math and science. Because if you don't it will seem like a never-ending duty of misery. My main advice to anyone who wants to come here is this, "Study, study and don't give up". Oh, yeah, be ready to get up early each and every morning."

Kristi Brown
Van Horn High School

"Don't poop out because you're doing lousy. I found that by going over old tests and reminding myself of what I already knew, my test scores leaped. By the way, if you try to do what I did by thinking you're superhuman (holding a job, 3 college courses, several extra-curricular activities, etc...), be careful--I almost burnt out. I had to quit calculus because of it. I'm not saying to drop the courses if life gets tough, but you're not going to do yourself any good by trying to run your motor 24 hours a day. If something must be sacrificed, you gotta do what you have to sometimes."

Carey Driscoll
Van Horn High School

"I know you think you can breeze through MPI like you did High

School. But you can't! And I know you probably won't believe all of us when we say you have to work at least an hour every night. I thought last year's students had just been trying to scare us too! But after my 1st tests, I was scared. I emphasize the need to study and stick to it. Through the year it's been rough w/absences, and those chapters you won't understand; and senioritis will come quickly. But if you start to give up, you'll have a hard time of getting back in the saddle again. Classes go so quickly you can't afford to get behind. You can't afford to get a negative attitude. This is your best year of high school. You'll meet new people, and experience a whole new "culture". Take advantage of this opportunity and have fun!"

Amy Fox
Ft. Osage High School

"Studying is not as important as understanding the material presented in lectures. You can study till the cows come home, but it will not do you any good unless you understand why things are the way they are. 15 minutes of study before problem solving is more beneficial than 3 hours the night before the test."

Ric Stuck
Wm. Chrisman High School

THE 1993-94 CLASS (TO DATE)

Section A

Caroline Chapman	Northeast
Kelly Cannavan	Wm. Chrisman
Matt Cianciolo	Truman
Jeffrey Flowers	Wm. Chrisman
Monique Green	Van Horn
Roger Hatridge	Ft. Osage
Karena Hess	Truman
Aaron Holland	Ft. Osage
Amy Hurd	Truman
Dung La	Northeast
Jodi McHenry	Wm. Chrisman
Curron Mitchell	Van Horn
Celeste Mosby	Ft. Osage
Jesse Skinner	Wm. Chrisman
Teresa Tran	Northeast
Trang Tran	Northeast
Joanna Tucker	Wm. Chrisman
Erik Warner	Ft. Osage
Mike White, Jr.	Ft. Osage

Section B

Patricia Butler	Northeast
Erick Chapman	Van Horn
Charity Coney	Truman
Derek Fisher	Truman
Mark Hamblin	Truman
Aubrey Hanks	Ft. Osage
Huy Mai	Northeast
Ginny McCarty	Wm. Chrisman
Aaron McLean	Ft. Osage
John Miller	Ft. Osage
James Moseley	Wm. Chrisman
Brad Owings	Ft. Osage
Michelle Peterson	Wm. Chrisman
Hanh Phan	Northeast
Daisie Riley	Van Horn
Jessica Schmitt	Ft. Osage
Jason Walker	Wm. Chrisman
Willy Wang	Wm. Chrisman
Dana Watson	Northeast
Hattie Williams	Van Horn

Section C

Josh Camden	Wm. Chrisman
Jill Dawson	Truman
Sam Dorton	Wm. Chrisman
Michael Freeman	Wm. Chrisman
Chris Goldsmith	Truman
Jenna Medina	Wm. Chrisman
James Wong	Truman
Jennifer Yutzy	Wm. Chrisman

Section D

Chris Allen	Ft. Osage
Matt Barrows	Truman
Kelly Beale	Wm. Chrisman
Mark Cleveland	Ft. Osage
Rachel Hayes	Ft. Osage
Jennifer Holland	Truman
Bobbi Hopkins	Wm. Chrisman
Alex Maginness	Truman
Michael Moore	Van Horn
Phong Nguyen	Northeast
Rea Rivera	Northeast
Christy Rogers	Wm. Chrisman
Joshua Small	Wm. Chrisman
Richard Smith	Van Horn
Kelli Stanley	Ft. Osage
Jessica Stobart	Ft. Osage
Martin Thibeaux	Northeast
Janice Wallace	Van Horn
Angie Zahner	Wm. Chrisman

These are the total of 66 students (as of this newsletter) who will be enrolled. As usual there will be additions and deletions through September.

THE 1993-94 STAFF

Our staff once again includes those high school teacher veterans of the past nine years:

In PHYSICS:

Larry Harding from Fort Osage,

and, in CALCULUS:

Sheri Adams from Truman,
Joe Kaifes from Van Horn, and
Al Morse from Wm. Chrisman.

We will also be welcoming a new physics instructor from a Kansas City, MO School District high school.

Our University staff is listed in the heading of this newsletter, and our half-time secretary and assistant is Doris Kirst.

PREVIOUS ENRICHMENTS

Student comments follow:

On March 26 we visited the **KANSAS CITY MUSEUM** and toured the NASA Space Station Freedom mock-up:

--This field trip was about a space station that will be built by year 2000. The space station has 3 different labs, for America, Japan and Europe. Bathroom and sleeping areas were funny. Also one of the nicest things was all the walls can be used as storage area.

--We toured through two tractor trailers made to resemble the space station Freedom. One trailer was the "habitation module" where astronauts who live there eat and sleep. The other was the "laboratory module" where all experimenting and data collecting is done. Nice to get out of the classroom.

On April 23 Brent Harding (MPI 84-85), now an aerospace engineer at McDonnell-Douglas spoke on **PUTTING THE GPS (Global Positioning System) INTO THE SPACE SHUTTLE:**

--From the "dark side of the moon" to the Vomit Comet, Brent was very good at getting his point across. And even more important keeping our attention. I think we related to Brent more because he was one of us!

Mathematics and Physics Institute

CALENDAR 1993 - 1994

MPI Begins	September 8, 1993
Mid-1st Quarter Progress Reports Sent	October 1, 1993
1st Quarter Grade Reports Sent	October 29, 1993
MPI OPEN HOUSE for Parents/Teachers/etc.	Sunday, November 7, 1993
Thanksgiving Holiday	November 25-26, 1993
Mid-2nd Quarter Progress Reports Sent	December 17, 1993
Christmas Holiday	December 20, 1993 - December 31, 1993
MPI Classes Resume	January 3, 1994
College Credit WD Deadline (Math C Only)	January 14, 1994
Martin Luther King Holiday	January 17, 1994
Final Exam - Calculus I - (Math C Only)	January 18, 1994
Deadline for Transfer from Math C to Math A, B, D	January 21, 1994
2nd Quarter/1st Semester Grade Reports Sent	January 21, 1994
Mid-3rd Quarter Progress Reports Sent	February 18, 1994
Presidents' Day Holiday	February 21, 1994
3rd Quarter Grade Reports Sent	March 25, 1994
MPI Spring Break	March 28 - April 1, 1994
MPI Classes Resume	April 4, 1994
Mid-4th Quarter Progress Reports Sent	April 22, 1994
Final Exams - Calculus I (A, B, D) and Calculus II (Math C Only)	May 16, 1994
Final Exam - Physics (A, B, C, D)	May 17, 1994
MPI Picnic Breakfast (McCoy Park)	May 18, 1994
MPI Awards Presentation/Last Day of Classes	May 19, 1994
4th Quarter/2nd Semester Grade Reports Sent	May 20, 1994

--He talked about how he got to where he is today. His schooling, how MPI helped him. Different projects he is working on. He also showed a video on the "vomit comet". Best one yet.

--He was really great! I had a lot of fun! The video was really cool, especially with the rabbit and bird. I hope he gets to become an astronaut, he'll be excellent!

--The general description of the Space Program was interesting. More interesting still was the explanation of the GPS. The global positioning system works much like spacial planes: first you locate one planar point, then another, then another and you have a single, unique point.

Finally, on May 7 Shelley Wolff, a civil engineer, discussed **HIGHWAY SLOPE DESIGN:**

--Most importantly she showed what it took to design a simple exit ramp to a complicated downtown loop. She had samples of drawings, like a thick, 300 page design booklet for just one three mile stretch. I definitely enjoyed her information and the way she presented it, but I wouldn't want to grow up to be one (a civil engineer).

--She talked about the kind of work she was involved in, like field work, highway slope design, and office work. I liked her better than most of the men we've had because she actually told us about her private life. She was interesting to listen to and I liked her presentation.

UPCOMING ENRICHMENTS

One of the special features of the MPI is its biweekly enrichment series, in which on alternate Fridays either professionals in the sciences, engineering, mathematics, etc., speak to our MPI students, or, we have a field trip to such places as the nuclear research reactor in Columbia, various science exhibits, or Worlds of Fun for some 'hands on' physics.

The October 1 newsletter will report on those speakers scheduled for October and beyond. But as part of our first three days of orientation, Jan Longhorn of UMKC, will speak on Friday, Sept. 10 about college admissions in general, and the importance of thinking about applications EARLY. (This is not intended to be a recruitment for UMKC, but a general discussion to help sensitize our students to the importance for colleges of deadlines.)

During the first two weeks of classes at the MPI we will also spend one day discussing three topics which we have come to believe are vital study and college survival skills that are too often not directly addressed. Specifically, these are: TEST-TAKING, READING A TEXTBOOK, and lastly, and perhaps most importantly, TIME MANAGEMENT. These sessions will be jointly presented by Augusta Nichols from UMKC's Academic Support Services, and the MPI mathematics coordinator on Fri. Sept. 17.

TO THE PARENTS OF THE 1993-94 CLASS AT THE MPI

[Modified from the August 1, 1987 newsletter.]

This newsletter is written for YOUR information, and there will be one sent to you every two months during this year while your son or daughter is at the MPI.

We firmly believe that without your support and concern at home students cannot succeed in such a rigorous program as the MPI. Our classes are NOT high schools classes, and require both study skills and a commitment that students still in high school, however talented, have not experienced before. In both of these areas YOU as parents can be of enormous help.

One of the first facts we have learned to face in the last nine years is that many bright students never learn to study efficiently; they have often gotten along very well with a 'wait and cram' attitude, giving textbooks only an occasional cursory look in time for testing, and relying on their innate ability to absorb information and skills in the classroom. However, in coming to the MPI these same students always find themselves at first, and suddenly, falling behind.

In general, in college classes MORE MATERIAL is covered, and MORE

SKILL with concepts is required, i.e., **THINKING** is expected regularly. This comes as a shock to many talented students. One of the MPI's goals is to expose students to this shock, and help them overcome it by learning effective study skills in actual practice. But YOU as parents can help this transition enormously, by suggesting that your children actually spend the minimum of one hour per subject, per night of study that we here at the MPI urge. They must come to realize that longer study times reflect the new rigor of the COURSES, not their lack of talent. This is a point of view that many students find hard to accept at first. Your encouragement can help them over this hump. Encourage them to seek the help of all the teachers involved in the program, and to put aside the false idea that only remedial students need to TALK about mathematics and physics. The fact is that true understanding comes only from learning to discuss and explain a subject, and this is ESPECIALLY SO in physics and mathematics.

Finally, we urge you to call us if you ever have a question, and we hope that you will find time to visit the MPI during our annual OPEN HOUSE on Sunday afternoon, November 7, 1993. (More about this in the October newsletter.)

PAST STUDENTS WRITE TO US

CINDY (KLEEMAN) ROSA (87-88)
(BS Political Science US AF Academy)
Meteorology Major

"I am currently enrolled at Texas A & M in order to get a BS in a year, so that I can be a weather officer. I can honestly say that basic calculus, physics and differential equations are extremely important because these are the tools that are used to solve all types of physical problems. I wish that I would have worked harder than I did at MPI, because the instructors there are very willing to explain and help you. I have learned since then that good and caring instructors are hard to come by. The students who plan on majoring in anything scientific or technical should take advantage of the MPI instruction and staff."

KIM (GALLAGHER) BROX (86-87)
(Mathematics & Physics Teacher)

"The first year of teaching has been an interesting experience to say the least. I've tried to model some aspects of my classroom on MPI, especially support for homework help. So many students refuse to give more than 30 min. to 1 hour to homework for an entire chapter. I'm told next year's seniors are really good students and hard workers.

Last week I gave a 2 hour physics test, made the problems hard and gave the kids all the time they needed. Then I curved the test. I had one student who got 95%, so that was the perfect example that the students can do it if they want to!

MPI is an ideal that can only work outside public high schools. Administrators and parents are concerned with extra curricular activities first and college prep. second. I'm grateful that I attended because students are likely to flunk if they don't get a reality check."

TIM PARKER (91-92)
(Engineering Major)

"While at MPI I matured mentally and intellectually, the way I was treated allowed me to get a better idea of college classes.

MPI set me ahead of other classmates. It will allow me to graduate earlier than anticipated.

I think that MPI could lobby for more programs like it so that students would have more opportunities for a more complete college atmosphere of classes."

KRISTI LYNN (91-92)
(Mechanical Engineering Major)

"I learned that thinking about how I got somewhere is sometimes just as important as the answer I got, whether or not its right or wrong!

There are many smart people and being at the top is hard but rewarding! I was excited because I made the dean's list! Thanks MPI!

I should have taken my B grade in calculus. Now I am behind and am going to have to go to school over

the summer. Other than that I'm glad that I attended the MPI. College is still a big adjustment. There are no time constraints and I find myself putting everything off! I'm getting better now though!"

MATT ROBERDS (90-91)
(Computer Science Major)

"I would say MPI classes are as good or better than the other math classes I took at UMR (Calc II & III). The MPI classes (esp. Calc I) hit the "basics" hard enough so one does not get lost in later courses.

The physics class, despite being "non-calculus based" was definitely _better_ than the UMR physics classes (Phys 23 & 24) I've had.

I was able to start the calc sequence (I→II→III) a semester ahead of other students. This was helpful in letting me get to my "core" major classes sooner, and avoiding the "weed-out" (No matter what anyone says, these are alive and well and living in Rolla.) Calc I class at UMR."

SHERI HARRISON-SMITH (90-91)

"I feel that my experience at MPI helped me be more prepared for college than a lot of the other freshman & even sophomores on campus.

My first semester I took a lot of more advanced courses than anyone my age, but I didn't feel dumb or out of place, even though I was the youngest in my classes.

MPI gave me a jump into college that I think everyone needs. It's hard enough being a freshman, but if you're in upper level classes, people tend to respect you more.

Keep on doing the good work you're doing! And if you're smart you'll hang on to Morse and Kaifes!"


RANA BARBER (89-90)
(Biology and Chemistry Major)

"MPI taught me a bit about college before I got there making the transition easier. I knew somewhat what to expect. I've since discovered that the problem solving

techniques taught by MPI are of good use whether I'm taking a Human Origins class or a Physics class. As a grader for one of my physics professors, I have first hand knowledge that many students at Baker couldn't do real problem solving if their lives depended on it even if Computer Science or Physics is purportedly their majors. Needless to say, I am grateful to everybody at MPI for their teaching."

A READER'S COMMENT ON MATHEMATICS CHALLENGE #27

A former MPI student, Phuc Do (MPI 85-86), now an electrical engineer, who reads this newsletter regularly, recently noticed that the pot in Mathematics Challenge #27 (as pictured)
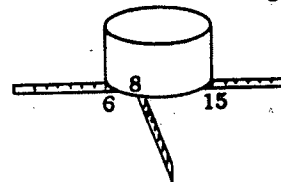
for which we found the diameter in the April issue, in fact has its center of gravity positioned so that were it placed (and drawn) as above, it would tip over backwards!
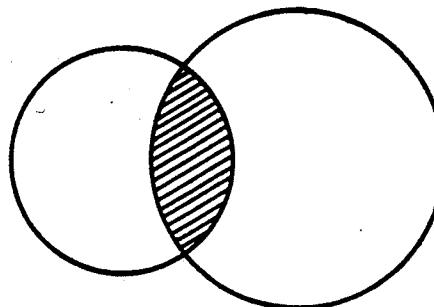
We encourage any of you who have comments about our Challenges to send them to the address found at the end of every newsletter.

A SOLUTION TO MATHEMATICS CHALLENGE #28

Recall the problem statement:

The following is culled from the book MRS. MINIVER:

"She saw every relationship as a pair of intersecting circles.

It would seem at first glance that the more they overlapped the better the relationship; but this is not so. Beyond a certain point, the law of diminishing returns sets in, and there are not enough private resources left on either side to enrich the life that is shared. Probably perfection is reached when the area of the two outer crescents, added together, is exactly equal to that of the leaf-shaped piece in the middle. On paper there must be some neat mathematical formula for arriving at this; in life, none."

Remembering that the two circles are rarely equal, what is the mathematical answer to Mrs. Miniver's enigma?

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

SOLUTION:

I

To set notation, suppose that the smaller circle has center α, radius a, and area: $A = \pi a^2$; the larger circle has center β, radius b, and area: $B = \pi b^2$, with $a \leq b$; the "leaf" has area L; the smaller circle's crescent has area: C_A; and the larger circle's crescent has area: C_B. Then from the picture above we see that:

(Smaller circle) $L + C_A = A$,
(Larger circle) $L + C_B = B$, and
adding: $2L + C_A + C_B = A + B$.

For the "perfection" Mrs. Miniver envisions, we require that

(Leaf) $L = C_A + C_B$.

Substituting above we have:

$$2L + L = A + B$$
$$3L = A + B$$
$$L = (A + B)/3. \quad (*)$$

Since the largest L can be is all of A (when the smaller circle is actually contained inside the larger), we must have:

$$L \leq A$$
$$(A + B)/3 \leq A$$
$$A + B \leq 3A$$
$$B \leq 2A.$$

[Note: If B = 2A, meaning L = A to begin with, then the less capable of

the two people is completely immersed in the other's life, and no private resources remain!]

Now, let r = b/a, the ratio of the larger radius to the smaller radius. Continuing from above we see that for "perfection":

$$B \leq 2A$$
$$\pi b^2 \leq 2\pi a^2$$
$$b^2/a^2 \leq 2$$
$$b/a \leq \sqrt{2}$$
$$r \leq \sqrt{2}$$

Since we assumed $a \leq b$, then $1 \leq b/a$, so we conclude: $1 \leq r \leq \sqrt{2}$.

II

Next, if one arc side of the "leaf" subtends an angle 2θ at the center β of the larger circle, and the other arc side of the "leaf" subtends an angle 2ϕ at the center α of the smaller circle, then we see from the picture below
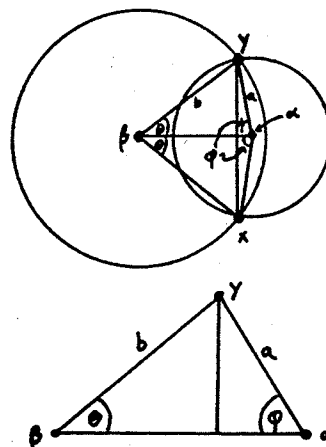
that

$$L = \text{Sector}(\beta xy) - \text{Triangle}(\beta xy)$$
$$+ \text{Sector}(\alpha xy) - \text{Triangle}(\alpha xy)$$

$$= (1/2)b^2(2\theta) - 2(1/2)a\sin(\phi)b\cos(\theta)$$
$$+ (1/2)a^2(2\phi) - 2(1/2)a\sin(\phi)a\cos(\phi)$$

$$= b^2\theta - a\sin(\phi)b\cos(\theta)$$
$$+ a^2\phi - a\sin(\phi)a\cos(\phi)$$

$$= b^2\theta + a^2\phi$$
$$- a\sin(\phi)[b\cos(\theta) + a\cos(\phi)].$$

Also from this picture we see that:
$a\sin(\phi) = b\sin(\theta)$, hence both

$\phi = \arcsin((b/a)\sin(\theta))$, and

$$a\cos(\phi) = +\sqrt{a^2 - (a\sin(\phi))^2}$$
$$= \sqrt{a^2 - (b\sin(\theta))^2}$$
$$= \sqrt{a^2 - b^2\sin^2(\theta)}.$$

Subsituting into L above yields:

$$L = b^2\theta + a^2 \arcsin((b/a)\ \sin(\theta))$$
$$-b\ \sin(\theta)\ [b\ \cos(\theta) +\sqrt{a^2-b^2\sin^2(\theta)}\,]$$

On the other hand, from (*) we have:

$$L = (A + B)/3$$
$$= (\pi a^2 + \pi b^2)/3$$
$$= (\pi/3)(a^2 + b^2).$$

Dividing these last two expressions for L by a^2, to put them in terms of the ratio r and variable θ, and then equating them gives the complicated equation:

$$r^2\theta + \arcsin(r\ \sin(\theta))$$
$$- \sin(\theta)\ [r^2\cos(\theta) + r\ \sqrt{1-r^2\ \sin^2(\theta)}\,]$$
$$= (\pi/3)(1 + r^2).$$

In a given situation, both a and b, hence r, are known, and we solve for θ to determine the "leaf". (Note that the mathematics remains as difficult as the social question!)

III

If the circles happen to be equal, then a=b, meaning b/a = r = 1, so the equation reduces to:

$$2\theta - 2\sin(\theta)\cos(\theta) = 2\pi/3$$
$$2\theta - \sin(2\theta) = 2\pi/3$$

Using DERIVE to solve for θ in this case, in order that $L = C_A + C_B$ as required, each arc side of the leaf must subtend the angle $2\theta = 2\phi \sim 2.6$ radians ~ 149.27 degrees.

A SOLUTION TO
PHYSICS CHALLENGE #19

Recall the problem statement:

WINGS ON RACING CARS

Racing cars have gone through a great many changes over the years, some obvious, some subtle. One of the best developments was the addition of a horizontal wing above the rear of the car. When a car with such a wing entered a curve, the driver would tilt the wing forward. Upon leaving the curve, the wing was leveled again. This wing and its adjustments proved very useful in keeping a car on the road in turns, hence allowing much higher speeds there. Were it not for the danger of broken wings resulting in uncontrollable cars on the tracks, these movable wings would still be in use. But safety forced the racers to fix their wings in place. In either case, movable or fixed wing, how would a wing help in keeping the car on the road?

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

SOLUTION:

The wing was tilted downward so that it forced the car downward and therefore increased the traction of the tires on the road. With greater traction, the car could take a turn faster. The aerodynamic force from the wing was just like on an airplane, but DOWNward instead of upward.

MATHEMATICS CHALLENGE #29

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.]

PHYSICS CHALLENGE #20

AN ATTRACTIVE DILEMMA

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]

MPI T-SHIRTS

Beginning in about October, we will once again be selling bright blue MPI T-shirts and sweatshirts to our students. These shirts have a classy 3D graph $(z = \cos x \cdot \sin y)$ on the back and our student-designed MPI logo on the left front.

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