

Mu Alpha Theta Newsletter

Fall 2006

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NEWS FROM THE PRESIDENT

Greetings from Mary Emma Bunch

Excitement is in the air. **Mu Alpha Theta will be 50 years old in the spring of 2007!** There will be a special celebration at the National Convention in Tampa this July. However, I think it would be great if each of our 1550+ chapters had a Mu Alpha Theta birthday party at one of their meetings in the spring. Start planning for your chapter's party now. After the party send a picture and an article about it to Kay Weiss, Executive Director of Mu Alpha Theta at matheta@ou.edu. It would be fun to include some examples of the celebrations in the Spring Newsletter.

Seniors! There are several new scholarships which will be available through Mu Alpha Theta this year. The Mary Rhein Memorial Scholarship for \$5000 and up to five other scholarships for \$4000 each. The amount of money for the Kalin and Andre Awards has been raised to \$2500 each. Check on the Mu Alpha Theta website to download the applications for these scholarships and awards.

The Mu Alpha Theta National Convention is an excellent opportunity for your members to interact with students from other states and countries. Why not plan to attend the 2007 Convention in Tampa, Florida? If your chapter has never attended a convention or has not been in three years, apply for a Convention Grant to help finance the trip. Look at www.mualphatheta.org under **National Convention** for more information on the grants.

Has your chapter participated in the **Rocket City Math League** and/or the **Log 1 Contest**? If not, these **free** math competitions are a perfect way for your students to have a chance to compete with other Mu Alpha Theta members while not leaving their own school. The Log 1 Contest is being revised and will be paper/pencil again, rather than on the computer. The information about these contests is available at www.mualphatheta.org > **Contests**, with links from the home page.

The Mu Alpha Theta web site has information on all aspects of Mu Alpha Theta as well as links to other important sites. As a sponsor or member, you should try to visit it often.

If you have any questions, or suggestions about ways the National Mu Alpha Theta Organization can assist you with your chapter, please feel free to contact me at bunchmao@gmail.com. I would be delighted to hear from you.

WELCOME TO OUR NEW GOVERNING COUNCIL MEMBERS

We would like to extend a welcome to all new members of our National Governing Council. Newly elected members of the Council took office in July at the close of the National Convention in Colorado.

President-Elect is Grace Mutz. Grace was a Mu Alpha Theta sponsor for twenty three years while teaching at Farragut High School in Knoxville, TN. She is a former host for two national conventions and will serve as Test Coordinator for the 2009 National Convention. Grace has previously served as the Governor of Region IV.

The Governor of Region III is Todd Taylor. Todd is presently a sponsor at Vestavia High School in Birmingham, AL and is the former sponsor of Auburn High School, also in AL. Todd has also worked on local, state, and national math tournaments over the years.

Dr. Mary Ann Gavioli joins us as the new Governor of Region IV. She is Department Chair and a teacher at Clarkstown High School South, West Nyack, NY. She has served as the Mu Alpha Theta sponsor of her school for over twenty-two years. She has presented at two NCTM Conferences and worked on both state and national mathematics competitions.

Carol Botzner joins us as our NCTM Representative this coming year. She formerly served on the Governing Council for a year as the Governor of Region IV. She has been involved with her Mu Alpha Theta chapter at Lakota West High School since 1997. She helped host the Regional for Region IV in 2005 and has been involved with state and national competitions, as well.

Pete Wildman joined us in Colorado as AMATYC Representative. We look forward to having Pete with us as AMATYC Representative in the future, as well. Pete teaches at Casper College in Casper, WY and is Central Vice President on the AMATYC Executive Board.

We thank these dedicated individuals for their commitment to steering Mu Alpha Theta for the next four years.

National Office Update

The National Office is open Monday through Friday from 9:30 am – 6:00 pm CST. The office closes for winter break from Dec.26, 2006 – Jan. 2, 2007 and is typically closed during the National Convention, July 16 – 21, 2007. Remember our busiest months are October, April and May. If you can send orders in during other months, we can usually have them out the same day as they arrive. While we try to accomplish this during our busy months, there could be delays depending on the volume of orders. Please remember the Online System is the fastest way to get your order to you.

Orders under 13 oz are sent first class mail, while orders over this weight go out by Priority Mail to arrive in two to three days. You now have the option of requesting two-day, overnight, or next morning overnight with Fed Ex for an additional amount. If you are “snail” mailing in an order with a check, please remember that it can take as much as a week for postal mail to arrive from the time you “drop it in the box.” Please take this into account. You can, however, enter the names online using the check number as your Purchase Order number and we will send them out right away and just wait for the check to arrive. When it does, we will send you a receipt.

The names of your new members must be submitted to the National Office within one month of your initiation ceremony. Remember that students cannot put Mu Alpha Theta membership on their college resume until their names are in our database and they are counting on you to submit names in a timely fashion.

The only price rise that we can foresee this year is for our banner, which will go from \$12 to \$15 on the first of January, 2007.

During the 2005-2006 school year, the Mu Alpha Theta Educational Foundation provided about \$15,000 worth of Grants, Prizes, Scholarships, and Awards to deserving Mu Alpha Theta students and teachers, as well as a \$20,000 donation to support the Mu Alpha Theta National Convention. Mu Alpha Theta provided about \$20,500 to support National mathematics competitions, about \$21,000 in money and prizes for Awards and Grants to outstanding mathematics students and contest winners, and about \$19,000 in support of our National Convention.

National Officers:

President:	Mary Emma Bunch 713 Hardwicke Drive Knoxville, TN 37923 mmbear@comcast.net
President Elect:	Grace Mutz 121 St. Andrews Dr. Knoxville, TN 37934 maokid1@msn.com
Secretary-Treasurer:	Paul Goodey University of Oklahoma Norman, OK 73019 pgodey@math.ou.edu
Governor Region I:	Tom Tosch Mount Rainier H.S. Des Moines, WA 98198 tomtosch@wamath.net
Governor Region II:	Mattie White 3700 Orleans Ave.# 5542 New Orleans, LA 70119 white_math@bellsouth.net
Governor Region III:	Todd Taylor Vestavia High School Vestavia Hills, AL 35216 taylorqt@vestavia.k12.al.us
Governor Region: IV:	Mary Ann Gavioli Clarkstown South H.S. West Nyack, NY 10994 mgavioli@ccsd.edu
NCTM Representative:	Carol Botzner Lakota West High School West Chester, OH 45069 elizabeth.botzner@lakotaonline.com
SIAM Representative:	Terry Herdman Virginia Tech Blacksburg, VA 24061 Terry.Herdman@vt.edu
AMATYC Representative:	Pete Wildman Casper College Casper, WY 82601 pwildman@caspercollege.edu
MAA Representative:	Steve Dunbar University of Nebraska Lincoln, NE 68588 sdunbar1@unl.edu
Executive Director:	Kay Weiss University of Oklahoma Norman, OK 73019 matheta@ou.edu

National Student Officers:

President:	Shivali Sarawgi Lakota West High School West Chester, OH JaneAusten4989@aol.com
Vice-President:	Sam Sargent Deerfield Beach High School Deerfield Beach, FL 4sarges@bellsouth.net
Secretary/Treasurer:	Anna Cunningham Mount Rainier High School Des Moines, WA anna.cunningham@hotmail.com
Parliamentarian:	Sheila de Guzman Baton Rouge Magnet High School Baton Rouge, LA thesheilerdee@gmail.com



The 2006 Fort Collins National Convention

By Anna Cunningham

The 2006 Mu Alpha Theta National Convention took place in Fort Collins, Colorado. The convention began on July 16th with a Mixer. Students worked together with their teammates by participating in a friendly competition between schools. The contest included solving math problems, word and crossword puzzles, as well as building with Legos. The activity promoted teamwork among schools, but lacked the opportunity for students to meet new people from other schools.

The convention this year was different from previous conventions because there was a theme: Leonardo Da Vinci. The theme affected many of the convention's events, both in and out of the testing rooms. Many scrapbooks flaunted Da Vinci-style decorations, and several posters incorporated Da Vinci's famous Vitruvian Man. The competition also featured a brand new topic test, "What Would Da Vinci Do?" in which there were questions about the famous mathematician's life and works. Yet another new test this year was the "Mystery Test". This exam truly was a mystery, with questions requiring knowledge about codes, history and complicated math.

On the fourth day of the convention, everyone went on an excursion to Estes Park, a small tourist town surrounded by mountain trails and other attractions, located at an elevation of over 7,500 feet. Many students explored the many souvenir stores and candy shops in the town, while others hiked on the trails in the area. There were also opportunities for horseback riding and touring the hotel in which Stephen King's *The Shining* was filmed.

Another addition to the convention this year was the Da Vinci Award. Each contestant was required to participate in chalk talk, take certain topic tests and complete a creative project of their choice. This award went to Natalie Gruenke of Lakota West High School, who wrote an outstanding essay. She also received \$2,500 toward her college tuition. Even students who did not win awards enjoyed spending the week with their math colleagues at this well-organized event.



SPONSORS



Get The Word Out!

Does your state organization have lots of great events planned for this year? Have you set up an awesome MAΘ website that you want us to check out? We want to know about it! Any interesting activities that other chapters might enjoy hearing about? Send us some info and a schedule of your events, so we can post it on our website and keep everyone informed.

Sponsor Awards for 2006

The Huneke Distinguished Sponsor Award was presented to **Dr. Thom Morris** of Berkeley Preparatory School in Tampa, FL. Dr. Morris was nominated by his students for his work with them as a math teacher and as the sponsor of their Mu Alpha Theta Club. Dr. Morris has also serviced both the Florida State Mu Alpha Theta Organization and the National Mu Alpha Theta, planning five National Conventions, including the Fort Collins, CO convention this past summer. Dr. Morris also won this award in 1996.

The Sister Scolastica Most Committed Sponsor Award was presented to **Mattie White**, retired sponsor of Benjamin Franklin High School in New Orleans, LA. Mattie taught at the high school for 34 years, sponsoring the Mu Alpha Theta club for 30 of those years. In addition to her dedication to her students, Mattie was active in the Louisiana State Mu Alpha Theta and is currently serving a second term as the Governor of Region II for the National Mu Alpha Theta.

We congratulate these two special teachers for all they have done for their students and for Mu Alpha Theta over the years.

Mu Alpha Theta will host a Booth at AMATYC and NCTM Conventions.

Kay Weiss will be manning a booth at both mathematical Conventions this year. If you will be attending either the AMATYC Convention in November or the NCTM Convention in March this year, stop by the booth for a free sponsor gift! It is always nice to meet sponsors face to face.

MAΘ National Convention 2007 in Tampa, FL

The 37th Mu Alpha Theta National Convention in Tampa will be hosted by Christine Brzycki and Dave Macfarlane from Palm Harbor University High School in Palm Harbor, FL. The convention will take place July 16-21, at the Grand Hyatt hotel overlooking Tampa Bay. It will include math competitions, contests, school and state bowls, social events and a trip to Busch Gardens Tampa Bay.

The registration fee will be approximately \$600 per person for those that register before April 1, 2007 with a \$50 non-refundable deposit. Registrations submitted after April 1 will be approximately \$50 more. All registrations and payment in full must be postmarked no later than May 15, 2007.

For more information, visit our website at www.mualphatheta.org > National Convention.

CONVENTION GRANT RECIPIENTS

The Mu Alpha Theta Educational Foundation awarded four Convention Grants to the 2006 Colorado Convention. Grants went to **Alfred M. Barbe High School** from Lake Charles, LA, **Richton High School** from Richton, MS, **Heidelberg High School** from Heidelberg, MS and the **International Christian School of Seoul**, from Seoul, South Korea.

Each Grant provided two registrations and up to \$250 in reimbursed travel expenses each for a sponsor and a non-senior student to attend the National Convention. To be eligible for a Grant, a Mu Alpha Theta chapter cannot have attended a National Convention for the three prior years. No chapter that has previously been awarded a Grant may apply.

Mu Alpha Theta will again offer these grants for the Tampa Convention in July, 2007. The Application is available online under National Convention > Convention Grants.

Region IV Regional Competition

Beavercreek High School in Beavercreek, OH will be hosting the Region IV Mu Alpha Theta Competition this December 9th. The competition will include Theta and Alpha individual tests, an Interschool Test, an Alpha-Theta three person team Sprint, an Ohio Bowl and a Gemini Test. Events run from 8:00 am - 4:30 pm. Registration fee is \$35 per student and covers breakfast, lunch, all tests, trophies and a t-shirt. The top Alpha and Theta winners are eligible for a free registration at the National Tampa Convention in July, 2007. For further information contact Dolores Williams at dolores.williams@beavercreek.k12.oh.us

Free Texas Instrument Calculators

Mu Alpha Theta has again purchased a limited number of TI 84 Plus Silver and TI 89 Titanium calculators to give away! We will provide up to six calculators to a school to give away as prizes at competitions you are running.

This year, for the first time, we will also offer a limited number of these calculators for sponsors to give as prizes to their own outstanding students as a reward or to auction off to raise money for your club. Preference will be given to schools that have not received free calculators in the past.

Email Kay Weiss to request your calculators today at matheta@ou.edu!

The Diane Rubin Award is

presented to the Mu Alpha Theta chapter which demonstrates a history of exceptional mathematics service to its community for at least two years. This service must promote interest in mathematics and benefit people other than students in its own chapter.

The winning chapter will receive a prize of \$500, a distinguished plaque to be presented at the National Convention, and. A Convention Grant for two free registrations and \$500 in reimbursed travel expenses. Applications forms can be downloaded from our website at www.mualphatheta.org > Awards > Rubin. Applications must be submitted to the National Office postmarked no later than **February 1, 2007**.

A NEW PARTNERSHIP WITH THE MATH FORUM @ DREXEL

The Math Forum @ Drexel (www.mathforum.org), one of the leading centers for mathematics and mathematics education on the Internet since 1993, is pleased to announce a special offer to all Mu Alpha Theta chapters. The Math Forum is an online community of students, educators, researchers, and others, representing a wide variety of perspectives. An educational enterprise of the Drexel University School of Education in Philadelphia, the Math Forum offers over one million pages of math content, including state-of-the-art resources, materials, activities, discussions, and educational products, including "Ask Dr. Math". Its Problem of the Week program supports students and teachers in 1) reasoning and thinking through solutions to challenging problems that represent new or non-routine situations and 2) explaining their approach to problem-solving in writing.

For the 2006-07 school year, the Math Forum is offering subscriptions to its High School Level Problem of the Week Library to all Mu Alpha Theta chapters for the discounted introductory annual rate of \$50. An online subscription entitles **all members of a chapter** to receive the Current Problems of the Week—four new problems issued every two weeks during the school year—and to access the High School archives of the Library, which contain problems at different levels of difficulty in Algebra through Calculus. Each sponsor may decide how to work with student members: online mentoring by the Math Forum's staff is offered for an additional fee or the sponsor may use a scoring rubric developed by the Math Forum to respond to and work with chapter members. The subscription may be used to give chapter members new and challenging problems to work on their own or as part of organized chapter activities. Also, for an additional fee, the Math Forum will train Mu Alpha Theta members to become mentors for other students in their chapter or to even to serve as online mentors for students in other schools.

Sponsor's can access a trial account for 21 days, in order to sample the Problem of the Week Library. To obtain this account, go to <http://mathforum.org/products>, when your individual name is requested, add (MAT) after it. In order to purchase a membership or for more information, call 800-756-7823, option 1. To receive this discounted introductory annual rate, you must either be a chapter sponsor or indicate that you have been authorized by your chapter sponsor to make the purchase.

The Math Forum is looking at other ways to work with Mu Alpha Theta and would be interested in hearing from chapter sponsors about the kinds of services that would be most valuable. Don't hesitate to contact them at <http://mathforum.org/cgi-bin/mailto.pl?key=66>

Thank You to Retiring Sponsors

The following teachers have retired as Mu Alpha Theta Sponsors during the past school year. Our thanks to these dedicated teachers:

- South Panola High School, Batesville, MS: Sue Phelps
- Bayou Academy, Cleveland, MS: Kay Daugherty
- Thurgood Marshall, Missouri City, TX: Alicia Russo Hayes (5 years)
- Frankfort High School, Ridgeley, WV: Patricia Martin (20 years)
- Destrehan High School, Destrehan, LA: Sam Buhler (6 years)
- Cocoa High School, Cocoa, FL: Pam Brockmeyer
- Lafayette High School, Williamsburg, VA: Patricia Travis (10 years)

NEWS FROM THE GOVERNING COUNCIL

The Governing Council of Mu Alpha Theta is the organization's board of directors. The GC meets twice a year. At the summer meeting, just prior to the Colorado Convention in Fort Collins, the following issues were discussed:

- Convention Grants for the 2007 Tampa Convention were included in next year's budget and would be made available to chapters that had not attended a convention in at least three years. Applications are due by March 30 and forms can be found online. The grants pay for two registrations and up to \$500 in transportation costs.
- Mu Alpha Theta will continue to purchase and give away 150 TI graphing calculators each year, if money is available for the purchase.
- Mu Alpha Theta awarded two \$1000 prizes to outstanding projects at the International Science Fair in May. Dr. Terry Herdman, our SIAM Representative, headed our team of judges.
- The Mount Ranier High School Math Club was selected to run the Log 1 Contest for Mu Alpha Theta during the 2006-2007 school year.
- Grissom High School will again receive financing to offer the Rocket City Math League free of charge. Over 4000 students participated in the contest this past year. Awards will be presented to Two-Year College students for the first time to encourage their participation.
- Changes will be made to the Kalin Award and the Andree Award. The winner of both will now receive \$2500.
- The Math and Music Monograph will be reprinted and sold for \$6 a book.
- Partnership discussions continue with the Math Forum at Drexel University and the Actuarial Foundation.
- Mu Alpha Theta will offer up to five \$4000 Scholarships to outstanding members of Mu Alpha Theta chapters during the 2006- 2007 school year. Applications are due by March 15, 2007. Forms will be posted online.
- The Foundation will award a \$5000 Mary Rhein Memorial Scholarship to honor a graduating senior. Applications to be due February 1, 2007.
- Mu Alpha Theta will have a 50th Anniversary celebration during the Tampa Convention.

Anyone having an issue to be brought up before the Governing Council should email or send it to the National Office before the February meeting. Recommendations and suggestions are always welcome and encouraged.

STUDENTS

From the National Student Delegate President:

Dear Mu Alpha Theta Sponsors and Members,

I would like to take the opportunity to introduce you to the new Student Delegate officers as well as to some of our new ideas for the upcoming year. I am Shivali Sarawgi, the current president of the student delegation and the Region IV officer. The vice president Sam Sargent hails from Florida, one of our largest delegations and is now the Region III delegate. Our secretary/treasurer is Anna Cunningham from Washington in Region I and our parliamentarian Sheila de Guzman is from Louisiana, Region II.

Three of our principal goals this year are to acquire new schools for our organization, increase the level of communication within existing schools, and to seek new sponsorship. To do this we are once again forming national committees that are headed by and run by fellow Mu students. Therefore, we are currently seeking dedicated members that would like to hold a national position and aid in the growth of Mu Alpha Theta as a whole. We have recently updated the student delegate web page and, although parts of it are still under construction, we encourage you to visit the site for updates and to join the forum to share ideas and thoughts across the nation and the world.

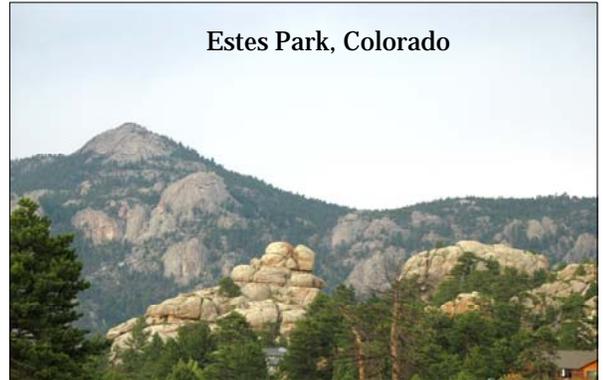
As regional officers we are all looking forward to competitions that will be held throughout the school year. Most of all however, we are excited about the 2007 Mu Alpha Theta National convention in Tampa, Florida and hope to improve upon the nationals experience by giving student input to the convention chairs. I encourage you to contact me and any of my fellow officers if you are interested in increasing your Mu participation or want more information. Please email me at JaneAusten4989@aol.com or visit the web site, mualphatheta.owns.it. I hope you enjoy this year in Mu Alpha Theta.

Shivali Sarawqi

Nominate your Outstanding Sponsor for the Huneke Distinguished Sponsor Award and/or the Sister Scholastica Most Committed Sponsor Award!

Each year Mu Alpha theta presents the above awards to teachers serving their school chapter of Mu Alpha Theta. Each award presents the teacher with a \$500 prize and a distinguished plaque. The teacher should be present at the National Convention to accept their award. Nomination forms are available online at www.mualphatheta.org > Awards and are due to the National Office by June 15 each year.

Estes Park, Colorado



Benjamin Cunningham of Rickards High School

Winner of the 2006 Kalin Award

Benjamin Cunningham from Tallahassee, FL was chosen the 2006 Kalin Award winner at the Colorado Summer Convention of Mu Alpha Theta. Benjamin won the \$1500 prize and a plaque. The Kalin award was established in 1981 by a grant from Dr. Robert Kalin of Florida State University and a former president of Mu Alpha Theta. The award is presented to a graduating senior who has superior mathematical ability and shown outstanding service to a Mu Alpha Theta chapter.

\$25,000 in New Merit Scholarship Money Available this Year!

See our website for details: www.mualphatheta.org > Scholarships. Applications will be posted online soon. The Mary Rhein Memorial Scholarship application is due February 1 and the Mu Alpha Theta scholarships will be due March 15, 2007.

FREE MATH COMPETITIONS!

The 2006-2007 Mu Alpha Theta LOG I CONTEST returns to a regular pen and paper format this year. **Mount Rainier High School Math Team (MRHS)** in Des Moines, WA will be running the contest.

The contest will consist of three rounds. On the first round students will select one of three Topic Tests to take. Choices are "Equations and Inequalities", "Sequences and Series" or "Number Theory". Round 2 will be a Ciphering Test including ten one problem rounds. Round 3 will be an individual test of general mathematics knowledge.

Contest materials will be sent to participants only by electronic mail (PDF formatted) and must then be photocopied for distribution. Round 1 materials will be emailed by December 1, 2006 and should be administered between Wednesday, December 6 and Tuesday, December 12, 2006. Round 2 materials will be emailed by January 5, 2007 and should be administered between Wednesday, January 10 and Tuesday, January 16, 2007. Round 3 materials will be emailed by February 2, 2007 to be administered between Wednesday, February 7 and Tuesday, February 13, 2007. Schools unable to participate on an official test date may make arrangements with MRHS to test on an alternate date. Teacher will post scores online and round results will be immediately available.

Prizes will include plaques and certificates for winners and Mu Alpha Theta will be awarding ten TI 89 Titanium Calculators and ten MA Θ Tote Bags to twenty randomly selected participating schools.

Participation in the contest is restricted to schools with active Mu Alpha Theta chapters. All students at the school may participate, but only Full or Associate members of Mu Alpha Theta are eligible for prizes. Registration will be completed online. The URL will be posted in early October. See www.mualphatheta.org > Contests > Log 1 Contest for further information.

The Rocket City Math League is a free international math contest open to all middle, high school, and two-year college students enrolled in Pre-Algebra through Calculus and above math courses. It is administered by the students at **Grissom High School** in Huntsville, AL. Participants are placed into one of four categories based on the level of math courses they are enrolled in. Each division will be given three 12 question tests lasting 45 minutes.

Tests are administered during any one day within the testing period, as determined by the each sponsor. Contest materials will be mailed to each school and the team sponsor will make copies and administer the tests during the designated time periods. Testing dates for the 2006-2007 competition are Round One: November 27 - December 1, 2006, Round Two: January 22-26, 2007, and Round Three: April 2-6, 2007. Winning teams and individuals will receive trophies and plaques.

All participants in the Rocket City Math League will require a sponsor who will register for the contest, proctor the tests, and input the scores online. Registration for the Rocket City Math League can be done at www.rocketcitymath.org.

We've Redesigned Our Website!

Go to
www.mualphatheta.org
and check out what
we've done.
Feel free to contact us
and let us know what
you think!

Andree and Kalin Awards Increase!

The Mu Alpha Theta Governing Council has voted to increase the award amounts for the Andree Award and the Kalin award to **\$2500** each. The Andree Award is presented to a student interested in pursuing a career as a mathematics teacher. Applications are due by **Feb. 1, 2007**.

The Kalin Award recognizes graduating seniors attending the National MA Θ Convention who have excelled in mathematics and performed notable service to MA Θ communities. Application is due **June 15, 2007**.

For information on how to apply for these great awards, visit our website at www.mualphatheta.org > Awards.

Summer Grants Impact Student Learning

In 2006, Mu Alpha Theta presented seven outstanding members with Summer Grants. These grants offer up to \$2000 per student to attend a summer math program or to conduct research in mathematics or applied mathematics.

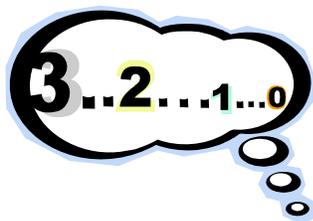
This year's recipients and the programs they attended are: **Gregory Burnham** and **Yuri Lin** - Canada/USA MathCamp 2006 in Tacoma, WA; **Timothy Harper** - Program in Mathematics for Young Scientists in Boston; **Johnny Hu** - Boston University Summer Research Internship Program in Boston; **Joseph Lemberg** - Oakland University Summer Math Institute in Rochester, MI; **Tianlun Chen** and **Andrew Wang** - AwesomeMath Summer Program in Dallas, TX.

Two of our students submitted reports on their summer work. Johnny Hu researched the influence of oxygen vacancies on the properties of indium oxide thin films at the MIT Francis Bitter Magnet Laboratory. He had this to say about his experience, "The emphasis of the program... was always for us to do as much independent thinking and research as possible, and we were even given the opportunity to choose our research topic after a week dedicated to learning about the basic principles behind the many available choices. Even though the work was very intense and I felt a little overwhelmed on some days, at the end of the program, I was very pleased because I had learned and done more in six weeks than I usually do in an entire summer."

Tianlun Chen shared this with us about the AwesomeMath Summer Program, "Everyday there are three lectures covering topics such as Inequality, Number Theory, Combinatorics, Geometry, and Games, etc. and one problem session during which students can expand their view in Olympiad math and experience problem solving. From Cauchy-Schwartz to Chinese Remainder Theorem, students not only learn, but also think and digest."

If you are interested in attending a Summer Math Program or working with a mentor on some form of mathematical research project, see the application online at www.mualphatheta.org > Summer Grants. Johnny and Tianlun's complete essays are posted there.

Congratulations to the recipients for all their hard work!



Interesting Mathematical Problems to Ponder

Our Mathematical offering in this Newsletter is presented by Dr. Titu Andreescu, a professor at the University of Texas at Dallas. Dr. Andreescu has been involved in mathematics education for twenty-six years. He holds doctorate and undergraduate degrees from the University of West Timisoara, Romania. Dr. Andreescu has coached the USA Mathematical Olympiad Team for thirteen years. Prior to assuming his post in Texas, he was the Director of the American Mathematics Competitions, a program that serves more than 600,000 students a year.

In Dallas, he directs the AwesomeMath programs, which include a summer camp for students training to succeed at the Olympiad level and a correspondence-based lecture series for these students' continuing education. In addition, Dr. Andreescu is the editor of *Mathematical Reflections*, a free online journal focused primarily on mathematical problem solving. He is the sponsor of the university's Math Club and coach of its W. L. Putnam Mathematics Competition team.

Interesting Mathematical Problems to Ponder

Dr. Titu Andreescu
University of Texas at Dallas

Exercise 1. Factor

$$a^3 + b^3 + c^3 - 3abc.$$

Solution: Consider the monic third degree polynomial whose zeros are a, b, c :

$$x^3 - (a + b + c)x^2 + (ab + bc + ca)x - abc.$$

Then

$$\begin{aligned}a^3 - (a + b + c)a^2 + (ab + bc + ca)a - abc &= 0 \\b^3 - (a + b + c)b^2 + (ab + bc + ca)b - abc &= 0 \\c^3 - (a + b + c)c^2 + (ab + bc + ca)c - abc &= 0.\end{aligned}$$

Adding up these three equalities yields

$$\begin{aligned}a^3 + b^3 + c^3 - (a + b + c)(a^2 + b^2 + c^2) + (ab + bc + ca)(a + b + c) \\- 3abc = 0.\end{aligned}$$

Hence

$$a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca). \quad (1)$$

Another way to obtain the identity (1) is to consider the determinant

$$D = \begin{vmatrix} a & b & c \\ c & a & b \\ b & c & a \end{vmatrix}$$

Expanding D we have

$$D = a^3 + b^3 + c^3 - 3abc.$$

On the other hand, adding up all columns yields

$$\begin{aligned}D &= \begin{vmatrix} a + b + c & b & c \\ a + b + c & a & b \\ a + b + c & c & a \end{vmatrix} = (a + b + c) \begin{vmatrix} 1 & b & c \\ 1 & a & b \\ 1 & c & a \end{vmatrix} \\ &= (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca).\end{aligned}$$

Note that the expression

$$a^2 + b^2 + c^2 - ab - bc - ca$$

can be also written as

$$\frac{1}{2} [(a - b)^2 + (b - c)^2 + (c - a)^2].$$

We obtain another version of the identity (1):

$$a^3 + b^3 + c^3 - 3abc = \frac{1}{2}(a + b + c) [(a - b)^2 + (b - c)^2 + (c - a)^2]. \quad (2)$$

This form leads to a short proof of the AM-GM inequality for three variables. Indeed, from (2) it is clear that if a, b, c are nonnegative, then $a^3 + b^3 + c^3 \geq 3abc$. Now, if x, y, z are positive numbers, taking $a = \sqrt[3]{x}$, $b = \sqrt[3]{y}$, $c = \sqrt[3]{z}$ yields

$$\frac{x + y + z}{3} \geq \sqrt[3]{xyz},$$

with equality if and only if $x = y = z$.

Exercise 2. Find the minimum of $3^{x+y}(3^{x-1} + 3^{y-1} - 1)$ over all pairs (x, y) of real numbers.

Solution: Let $f(x, y) = 3^{x+y}(3^{x-1} + 3^{y-1} - 1)$. We have

$$3f(x, y) + 1 = 3^{2x+y} + 3^{x+2y} + 1 - 3 \cdot 3^{x+y},$$

which is of the form $a^3 + b^3 + c^3 - 3abc$, where $a = \sqrt[3]{3^{2x+y}}$, $b = \sqrt[3]{3^{x+2y}}$, and $c = 1$ are all positive real numbers. From (2) it follows that $3f(x, y) + 1 \geq 0$ for all $x, y \in \mathbb{R}$, with equality if and only if $x = y = 0$. Hence the minimum of $f(x, y)$ is $-\frac{1}{3}$.

The same conclusion follows directly from the AM-GM inequality, because

$$3^{2x+y-1} + 3^{x+2y-1} + 3^{-1} \geq 3\sqrt[3]{3^{2x+y-1+x+2y-1-1}} = 3^{x+y},$$

implying

$$3^{2x+y-1} + 3^{x+2y-1} - 3^{x+y} \geq -\frac{1}{3}.$$

Hence

$$3^{x+y}(3^{x-1} + 3^{y-1} - 1) \geq -\frac{1}{3},$$

for all real numbers x, y , with equality if and only if $2x + y - 1 = x + 2y - 1 = -1$, i.e. $x = y = 0$.

Exercise 3. If $a + b + c = 0$, then $a^3 + b^3 + c^3 = 3abc$.

Solution: Follows immediately from (2).

Problem 1. Simplify

$$(x + 2y - 3z)^3 + (y + 2z - 3x)^3 + (z + 2x - 3y)^3.$$

Solution: Setting $x + 2y - 3z = a$, $y + 2z - 3x = b$, $z + 2x - 3y = c$, we have $a + b + c = 0$, and from Exercise 2 it follows that $a^3 + b^3 + c^3 = 3abc$. Hence the given expression is equal to

$$3(x + 2y - 3z)(y + 2z - 3x)(z + 2x - 3y).$$

Problem 2. Let a, b, c be complex numbers. Prove that $a^2b + b^2c + c^2a = ab^2 + bc^2 + ca^2$ if and only if $a = b$, or $b = c$, or $c = a$.

Solution: Because $(a - b) + (b - c) + (c - a) = 0$,

$$(a - b)^3 + (b - c)^3 + (c - a)^3 = 3(a - b)(b - c)(c - a),$$

so assuming $a^2b + b^2c + c^2a = ab^2 + bc^2 + ca^2$ yields

$$3(a - b)(b - c)(c - a) = a^3 - b^3 + b^3 - c^3 + c^3 - a^3 - 3[(a^2b + b^2c + c^2a) - (ab^2 + bc^2 + ca^2)] = 0.$$

Then $a = b$, or $b = c$, or $c = a$. The converse follows immediately.

The conclusion of the problem follows directly from

$$(a - b)(b - c)(c - a) = abc - (a^2b + b^2c + c^2a) + (ab^2 + bc^2 + ca^2) - abc = (ab^2 + bc^2 + ca^2) - (a^2b + b^2c + c^2a).$$

Problem 3. Let x, y, z be distinct real numbers. Prove that

$$\sqrt[3]{x - y} + \sqrt[3]{y - z} + \sqrt[3]{z - x} \neq 0.$$

Solution: Assume the contrary, and let $\sqrt[3]{x - y} = a$, $\sqrt[3]{y - z} = b$, $\sqrt[3]{z - x} = c$. Then $a + b + c = 0$, and, from Exercise 2, $a^3 + b^3 + c^3 = 3abc$. This yields

$$0 = (x - y) + (y - z) + (z - x) = 3\sqrt[3]{x - y}\sqrt[3]{y - z}\sqrt[3]{z - x} \neq 0,$$

a contradiction. The problem is solved.

Problem 4. Let r be a real number such that $\sqrt[3]{r} - \frac{1}{\sqrt[3]{r}} = 2$. Find $r^3 - \frac{1}{r^3}$. (UWW Mathmeet, 2003)

Solution: With $a = \sqrt[3]{r}$, $b = -\frac{1}{\sqrt[3]{r}}$, $c = -2$, we have again $a + b + c = 0$, hence $a^3 + b^3 + c^3 = 3abc$. This yields

$$r - \frac{1}{r} - 8 = 3\sqrt[3]{r} \left(-\frac{1}{\sqrt[3]{r}} \right) (-2),$$

or, equivalently,

$$r - \frac{1}{r} - 14 = 0.$$

By applying the result in Exercise 2 again, we get

$$r^3 - \frac{1}{r^3} - 2744 = 3r \left(-\frac{1}{r} \right) (-14),$$

or

$$r^3 - \frac{1}{r^3} = 2744 + 42 = 2786.$$

Problem 5. Show that if the numbers \overline{abc} , \overline{bca} , \overline{cab} are divisible by n , then so is $a^3 + b^3 + c^3 - 3abc$.

Solution: We have seen that

$$\begin{aligned} a^3 + b^3 + c^3 - 3abc &= \begin{vmatrix} a & b & c \\ c & a & b \\ b & c & a \end{vmatrix} = \begin{vmatrix} 100b + 10c + a & b & c \\ 100a + 10b + c & a & b \\ 100c + 10a + b & c & a \end{vmatrix} \\ &= \begin{vmatrix} \overline{bca} & b & c \\ \overline{abc} & a & b \\ \overline{cab} & c & a \end{vmatrix}, \end{aligned}$$

and the conclusion follows.

Problem 6. The number of ordered pairs of integers (m, n) such that $mn \geq 0$ and $m^3 + 99mn + n^3 = 33^3$ is

a) 2 b) 3 c) 33 d) 35 e) 99.

(AHSME 1999)

Solution: Write the given relation as

$$m^3 + n^3 + (-33)^3 - 3mn(-33) = 0.$$

From the identity (2) it follows that

$$(m + n - 33) [(m - n)^2 + (m + 33)^2 + (n + 33)^2] = 0.$$

The equation $m + n = 33$, along with the condition $mn \geq 0$, yields 34 solutions: $(k, 33 - k)$, $k = 0, 1, \dots, 33$. The second factor is equal to zero only when $m = n = -33$, giving the 35th solution.