Girls' Angle Bulletin

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To Foster and Nurture Girls' Interest in Mathematics

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From the Director

Welcome to the first issue of the Girls' Angle Bulletin, the official magazine of Girls' Angle: A Math Club for Girls.

What began as a wispy dream…a vision of a program that empowers girls to go on and tackle any field, no matter the level of mathematical sophistication required and that surrounds girls with a community of supportive women professionals who use math in their work and that guides these girls to increased mathematical understanding through interaction with women who understand mathematics deeply and care very much about explaining it well…has made its first steps into the real world! Doing so requires a lot of help, and this first message is a message of thanks to all who have helped and continue to help Girls' Angle be a part of reality.

First of all, none of this would be possible without the encouragement, support, and advice of the Girls' Angle Board of Advisors. Each of them has made a positive mark on the program and Girls' Angle relies on them to find ways to give the girls the highest quality mathematics education possible. So thank you Lauren McGough, Yaim Cooper, Kathy Paur, Lauren Williams, Connie Chow and Beth O'Sullivan!

And, although he is not an official member of the Advisory Board, he has given me a lot of valuable advice. So a special thank you to my father, Warner Fan.

The character of Girls' Angle is largely shaped by its mentors, and we are off to a model start with Cammie Smith Barnes, Hana Kitasei, Lauren McGough, Alison Miller, Beth O'Sullivan, and Lauren Williams.

I also wish to extend a general thank you to all the women professionals who use mathematics in their work and have joined the Girls' Angle Support Network. In fact, the enthusiasm and encouragement that I get from these women gave me a lot of determination to see this project through. The Support Network of Girls' Angle is its fastest growing segment and there are too many women to name, although two who have already visited are Elissa Ozanne and Sarit Smolikov. You'll meet these women in time, either at the club or in the pages of this magazine.

Girls' Angle has received and is continuing to receive generous and superior legal support from the law firm of Choate, Hall & Stewart. I would like to thank lawyers Andrea L. C. Robidoux, Adrienne M. Penta, Michael J. Hickey, Jr., Anne Marie Towle, and Kathryn G. McArdle for their top quality professional services and counsel. I extend an extra special thank you to Andrea whose original concern for the welfare of Girls' Angle enabled Girls' Angle to acquire such incredible legal service in the first place! Thank you so much Andrea!

Special thanks to David Salomon who has given Girls' Angle a beautiful home near Central Square in Cambridge, the city that hosts two of the world's great mathematics departments. As you all know, Girls' Angle was forced to make a sudden location change days before its grand opening. Beth O'Sullivan contacted David and explained the situation and David welcomed us with open arms to Eitz Chayam.

Last but not least, none of this would be possible without the wonderful group of girls that are the first Girls' Angle members! All of the girls have a special twinkle in the eye that tells me that they all have splendid futures to look forward to.

I'll close this letter of thanks by addressing perhaps the most important question for the girls, which is, why study mathematics? There are so many good reasons to study mathematics. But during the formative years, perhaps the most important reason to study mathematics is that it is *the best way to learn how to think clearly and effectively*. No other subject forces one to examine and reexamine all the logical possibilities and no other subject so clearly separates correct arguments from the incorrect. Indeed, mathematics could be defined as the subject that covers anything that can be thought about clearly and precisely. So, if you want to improve the way you think, study mathematics!

I'll talk about the proper attitude to approach the study of mathematics another time. For now, let's do some math!

Ken Fan
Founder and Director

Girls' Angle Donors

Girls' Angle thanks the following for their generous contributions:

Mr. Charles Burlingham Jr
Anonymous

Girls' Angle Bulletin

The official magazine of
Girls' Angle: A Math Club for girls

girlsangle@gmail.com

This magazine is published about six times a year by Girls' Angle to communicate with its members and to share ideas and information about mathematics.

Girls' Angle welcomes submissions that pertain to mathematics. Subscriptions to the Girls' Angle Bulletin costs $20 per year and support club activities.

Editor: C. Kenneth Fan

Girls' Angle:
A Math Club for Girls

The mission of Girls' Angle is to foster and nurture girls' interest in mathematics and to empower girls to be able to go on and tackle any field no matter the level of mathematical sophistication required.

On the cover: **The Cat** constructed this table of numbers to tackle the Introduction Game.

The LCM and the GCF

Recently, two concepts have been lurking in the background of a lot of what we've talked about at the club. They are the **least common multiple** and the **greatest common factor**. Often, people use the acronyms LCM and GCF instead to save time when writing. Let's give these concepts a closer look now!

First, let's restrict ourselves to thinking just about the positive integers 1, 2, 3, 4, 5, etc. So when I say "number", I mean one of these positive integers.

Any pair of numbers has a least common multiple, and any pair of numbers has a greatest common factor.

Suppose you have two numbers.

Their least common multiple is *the smallest number which is a multiple of both numbers*.

Their greatest common factor is *the biggest number that divides evenly into both numbers.*

This table gives some examples.

Numbers		**LCM**	**GCF**
4	5	20	1
4	6	12	2
12	15	60	3
9	9	9	9
100	360	1800	20

If you want some practice figuring out least common multiples or greatest common factors, you can think of two numbers on your own and compute their LCM and GCF. Or, if you want to be systematic, fill in the tables on page 7. The advantage of being systematic is that patterns become easier to see. As you fill out such tables, you'll begin to notice patterns. Try it! Each time you notice a pattern, try to understand why that pattern exists.

Least common multiples and greatest common factors spring up in mathematics in so many places. At the club, Lauren Williams pointed out how, in the chocolate bar problem (see page 13), the number that ends up in the lower right chocolate square is the least common multiple of the dimensions. Do you believe her?

An application of the GCF

At the club, **August** gave a spot on definition of a rational number. She said that a rational number is a number of the form "p over q where q is not zero". Here, p and q are integers. In symbols, we can write:

A rational number is a number of the form $\frac{p}{q}$ where p and q are integers with $q \neq 0$.

This is absolutely true. If you look at every number of that form, you will get exactly the set of all rational numbers.

But here's a natural question to ask whenever you have such a representation: Do you get each rational number exactly once? In other words, can two ratios of that form stand for the same number? Think about that for a moment.

> While you're thinking, here's a logical interlude. We can shorten the definition of a rational number if we remember that division by zero is undefined:
>
> A **rational number** is a number that can be expressed as a ratio of two integers.
>
> We don't have to worry about whether the denominator is zero because no number can be expressed as a ratio with a denominator of zero!

OK, did you think about fractions that are not simplified?

$$\frac{1}{2} = \frac{2}{4}$$

If you have a fraction, you can get an equivalent fraction by multiplying the numerator and denominator by the same amount. To simplify a fraction, you divide the numerator and denominator by any common factors.

In fact, to reduce a fraction to its lowest terms, *you divide the numerator and denominator by their **greatest common factor!***

An application of the LCM

In music, the performer is sometimes called upon to beat out two different rhythms at the same time. One hand might be striking a drum two times every second and the other hand might be striking another drum three times every second. It can be hard to learn how to do that because it is hard to simultaneously count "one-two-one-two" and "one-two-three-one-two-three"!

But, by using the least common multiple, such cross rhythms can be turned into a single rhythmic pattern.

The LCM of 2 and 3 is 6. Because 6 is a multiple of both 2 and 3, both the one-two count and the one-two-three count can be simulated by beating the drum at precise moments of a six-count.

Six Count	1	2	3	4	5	6
Two Count	strike			strike		
Three Count	strike		strike		strike	

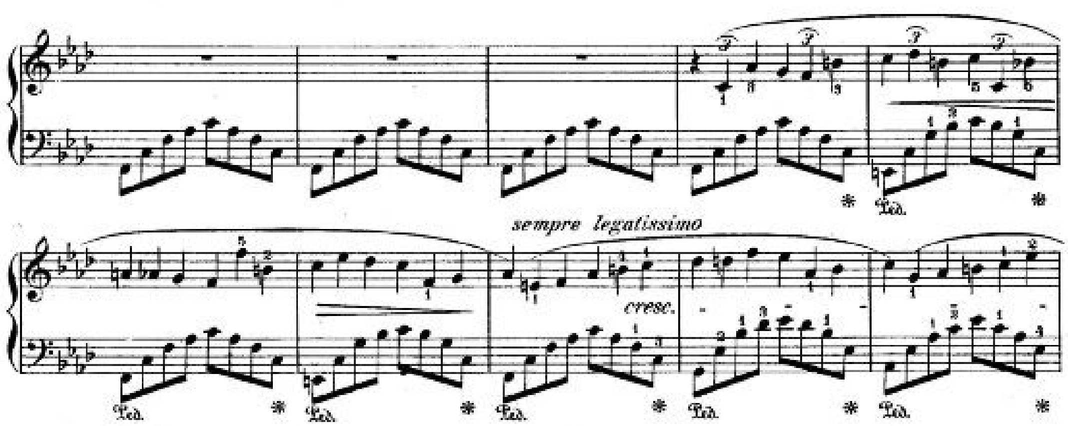
Instead of trying to count "one-two-one-two" and "one-two-three-one-two-three" simultaneously, count "one-two-three-four-five-six", and strike the drums according to the table. Start slowly and soon, you'll have the pattern of strikes down. Gradually speed it up, and before you know it, you'll be beating out the cross rhythm like a pro!

In Chopin's first etude in f minor from *Trois Nouvelles Études*, the pianist must play a "four on three" rhythm for nearly the entire piece. Again, rather than trying to count to four and to three simultaneously, you can use the LCM of 3 and 4, which is 12.

Twelve Count	1	2	3	4	5	6	7	8	9	10	11	12
Three Count	*				*				*			
Four Count	*			*			*			*		

Now, you just have to worry about counting to twelve over and over, and learn the pattern of striking as shown by the asterisks in the table.

Think about why this works. What could you do to learn how to play a "four on seven" rhythm? How about a "four on six" rhythm?



This is an excerpt from Chopin's f minor Etude from *Trois Nouvelles Études*. Chopin had a penchant for cross rhythms.

Things to think about

1. Can you generalize the notions of LCM and GCF to more than two numbers? What do you think the LCM and GCF of a set of numbers should be?

2. How many different ways can you think of to compute the LCM and GCF?

3. Can you show that the LCM of a and b is always less than or equal to their product ab? When is the LCM equal to ab?

4. What does it mean if the GCF of a and b is a?

5. Let n and m be two numbers. Let L be their LCM and let G be their GCF. Can you show that $nm = LG$?

Tables of LCMs and GCFs

Table of Least Common Multiples

n \ m	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	2	2	6	4	10	6	14	8	18	10	22	12	26	14	30
3															
4															
5															
6															
7															
8															
9															
10															

Table of Greatest Common Factors

n \ m	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
3															
4															
5															
6															
7															
8															
9															
10															

What patterns can you unearth?

Attacking the Introduction Game

To investigate the Introduction Game (see page 13), **The Cat** made a table (see cover).

Here is her table, partially completed.

Introduction Game Table
The number of people named in a circle of *N* people with skipping number *x*.

N \ x	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
3	3	3	1	3	3	1	3	3	1	3	3	1	3	3	1
4	4	2	4	1	4	2	4	1	4	2	4	1	4	2	4
5	5	5	5	5	1	5	5	5	5	1	5	5	5	5	1
6	6	3	2	3	6	1	6	3	2						
7															
8															
9															
10															
11															

When investigating a math problem, making tables like this is a great idea. To make it, you have to be very systematic and careful. Because the table itself presents the data in a systematic way, it becomes easier to find patterns.

Can you complete the table? Do you notice any patterns?

Our original question was for what skipping numbers will all the people get to introduce themselves? But notice that **The Cat**'s table includes further information: it specifies exactly how many people will get to introduce themselves. It would be wonderful if you could unravel the mystery behind this magical table of numbers!

The interview conducted for this issue of the Girls' Angle Bulletin is available by special request and only in printed form.

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Proof…by Contradiction!

At the second meeting, Ken showed how to solve the polygon problem from the first meeting using results that girls noticed for the Introduction Game. I think this proof is worth studying carefully, so I'm presenting it again here in the Bulletin.

It is a classic example of a *proof by contradiction*. A contradiction happens when two statements are mutually impossible. For example, the statements $a = b$ and $a \neq b$ cannot both be true, so one statement contradicts the other.

The general strategy of a proof by contradiction goes like this:

1. **Assume that the opposite of what you're trying to prove is true.**

2. **Deduce a contradiction.**

3. **Conclude that what you originally assumed cannot therefore be true. Since what was originally assumed was the opposite of what you were trying to prove, what you were trying to prove must be true instead!**

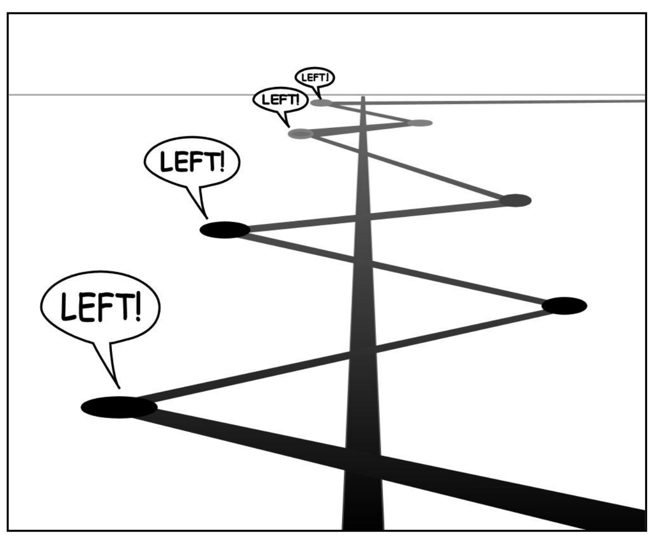
This type of proof, which appears all the time in mathematics, is also known as "reduction to absurdity", or, in Latin, *reductio ad absurdum*.

So, the question is, does there exist a 2007-sided polygon with the property that a single line passes through all of its sides? I claim that such a polygon does *not* exist and will prove this using a proof by contradiction.

1. **Assume that the opposite of what you're trying to prove is true.**

In this case, we want to prove that a 2007-sided polygon with the line property does *not* exist. So assume that there *is* a 2007-sided polygon and a line that passes through all of its sides.

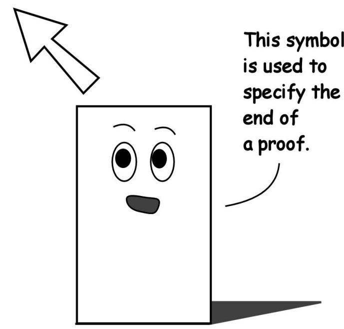
2. **Deduce a contradiction.**



Notice that the line divides the plane into two halves, which I'll call the left half and the right half. Pick a vertex of the polygon. We're going to go around the polygon passing through its vertices, just like we went around the circle of people in the Introduction game. Notice that each time you go from one vertex to the next, you pass across the line and switch from the left half to the right half, or the right half to the left half of the plane. So each time you skip over two vertices, you come back to the same half that you started in. So we can go around the vertices of the polygon skipping by two, and all of these vertices must be in the same half of the plane. But, from the Introduction game, we know that if you skip by 2 and there are an *odd* number of people, everybody will get a chance to speak. Because a 2007-sided polygon has 2007 vertices, skipping by 2 around the vertices will eventually hit *all* of the vertices. (2007 is an odd number.) But that means that *all* of the vertices are in the same half plane. In other words, *all* of the vertices are on one side of the line. *But that's a contradiction!* They cannot all be on the same side of the line if the line passes through the sides.

3. **Conclude that what you originally assumed cannot therefore be true. Since what was originally assumed was the opposite of what you were trying to prove, what you were trying to prove must be true instead!**

Therefore, our assumption that there is such a polygon *must be wrong*. There is no 2007-sided polygon with the property that a line passes through all of its sides. □



Whenever you prove something, it is often a good idea to try to generalize what you've proven. For example, in the above proof, it wasn't important that the polygon had precisely 2007 sides. What was really important was that the number of sides was *odd*. If you go through the argument, you will see that the same proof would work if you replace 2007 by any odd number.

So in fact, there is no polygon with an odd number of sides with the property that a line passes through all of its edges.

What about polygons with an even number of sides?

Trisscar showed a construction that demonstrates that polygons with 4N sides can have the property that a line passes through all of its edges. (See page 14.) This almost handles all the remaining cases. Missing are polygons with 6, 10, 14, 18, 22, etc. sides. That is polygons with 4N + 2 sides, where N is a positive integer. Can you figure out how to get all the cases?

By the way, the above proof is not the only one! Can you think of your own proof?

If you want more practice with proofs by contradiction, try to prove these statements by creating a proof by contradiction:

1. The greatest common factor of two consecutive integers is 1.

2. The positive square root of 2 is not a rational number.

3. Here are two facts: there are over 3,000,000 people living in the Greater Boston Area and nobody has more than 250,000 hairs on their head. Prove that there are at least 12 people in the Greater Boston Area who all have exactly the same numbers of hairs on their heads.

Notes from the Club

These notes cover some of what happened at Girls' Angle meets. They are not meant to be complete.

First Meeting - September 20, 2007

Mentors: Alison Miller, Beth O'Sullivan, Hana Kitasei, Ken Fan, Lauren McGough

We began with the introduction game, which leads to this question. If *N* people arrange themselves into a circle, and a beanbag is passed around in such a way that each person with the beanbag passes it to the person *x* persons over, counting clockwise, how many people will end up touching the beanbag? (This *x* is what we've been calling the "skipping number". A skipping number of 1 means passing the bean back to the person next to you.)

The second half was spent writing algorithms for how to eat a banana, and then executing those algorithms. Although some mentors had to eat some banana skin, not to worry, the bananas were organic and thoroughly washed!

The Cat evidently decided that describing how to peel a banana would be too difficult so her solution was to drop the banana on the floor and stomp on it repeatedly until the flesh oozed out. It was a surprisingly effective method!

Sylvia wondered aloud something very important: What does the banana algorithm have to do with math? At Girls' Angle, we enthusiastically encourage questions like this! If you are ever wondering *why* we are doing something, please don't be shy! Ask!

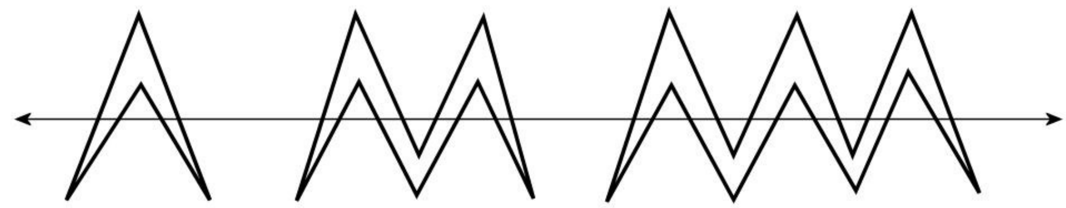
As for the banana algorithm, mathematics is written in a very precise language. It is important to try to speak and write as clearly and precisely as possible. Writing an algorithm for eating a banana gives practice in this regard without having to worry about learning something new, because everybody knows how to eat a banana! Also, doing this exercise showed how we often make unspoken assumptions. That's also something we should try to avoid in mathematics because it helps to ensure that everybody is talking about the same thing.

More Things to Ponder

1. Can a 2007-sided polygon be made so that a line passes through all of its edges?

2. In an N by M chocolate bar, if pieces are selected diagonally with wrap-around, for what N and M will the entire bar be selected?

Trisscar asked an important question concerning problem 1, which was "How do you define line?" This question inspired the "Define This Game" game that we played in the second meeting. Also, she developed a method to construct a polygon with 4N sides, for any positive integer N which has the property that there is a line which passes through all the sides.



Trisscar's construction

Second Meeting – September 27, 2007

Mentors: Alison Miller, Beth O'Sullivan, Hana Kitasei, Ken Fan, Lauren McGough, Lauren Williams

Special Guest: Elissa Ozanne, Harvard Medical School faculty

Girls' Angle welcomed two new members: **Tree** and **Cat**.

Trisscar's questions about how to define a line inspired a game about definitions. Lauren M. hosted the game and two teams were formed: "I don't know" versus "Math".

On team "I don't know" were **Resday**, **Cat**, **The Cat**, **Sylvia**, and Alison.
On team "Math" were **Tree**, Hana, **Trisscar**, **August**, and Lauren W.

The game revolves around making good definitions for mathematical terms, such as "even number", "line", and "equation". Many excellent discussions ensued. I'll mention just two.

Sylvia had to define the word "cube". She thought a moment and came up with "3-D quadrilateral"…a very creative definition! The mentors generally agreed, however, that this would not be suitable as a definition for cube because a close inspection of the word "quadrilateral" suggests a geometric object with four sides, so a three dimensional quadrilateral would, perhaps be something like what you would get if you looked at the edges of a rectangle that has been folded along a diagonal. But **Sylvia** was thinking along the following lines: If one takes a square and thickens it, it becomes a tile, and if we keep thickening, it'll become a cube! This is a very nice idea, and we plan to explore this idea further during Imagination Time.

Trisscar had to define the word "line" (of course!). She came up with "infinitely thin, goes on forever, and is straight". Her teammate **August** felt that she was defining a line. But, on the opposing team, **The Cat** asserted that a plane would fully satisfy the same definition, and she'd be quite right! The girls were then asked whether "space" also satisfies that definition. What does it mean to say that "space" is straight? We'll explore these ideas in the future as well!

During the last half hour, the mentors discussed some new problems and some old problems. Hana introduced Euler's Königsberg bridge problem. Ken addressed the polygon problem (see Proof by Contradiction on page 11). Lauren W. discussed the chocolate bar problem.

Third Meeting – October 4, 2007

Mentors: Beth O'Sullivan, Cammie Smith Barnes, Hana Kitasei, Ken Fan, Lauren McGough

Special Visitor: Sarit Smolikov, Harvard Medical School

While waiting for all the girls to show up, **The Cat** continued her investigation of the Introduction Game and **August** brought in a math problem from school which she and **Resday** worked on.

The problem **August** brought in went like this: A magician asks a person to think of a number. Then the magician has that person go through a series of mathematical operations. First, add 15, then multiply by 3, then subtract 9, then divide by 3, then subtract 8…at which point the magician asks for the result. Without skipping a beat, the magician tells the person what the original number was. **Resday**, based on two worked examples, concluded that all the magician had to do was subtract four to get the original number. She then redid her calculations using a variable instead of a specific number. In so doing, she could see that her conclusion was true in general.

This problem involves two important concepts in mathematics. One is **simplification** and the other is the concept of an **invertible operation**.

Simplification results when you say the same thing only in a simpler way. You can probably imagine the advantage of simplifying! In this problem, all the operations that the magician called for can be simplified by simply saying "add four". In other words, if you take a number and then "add 15, then multiply by 3, then subtract 9, then divide by 3, then subtract 8", it has the same result as just saying "add 4"!

An **invertible operation** is an operation that can be undone. Each of the operations that the magician called for can be undone. That's how it is possible to recover the original number. If the magician, at some point, used an operation that could not be undone, then the magician wouldn't be able to do the trick. For example, if the magician said, "think of a number. Now, square it. What is the result?" The magician would not be able to figure out the original number because squaring a number cannot be undone. If the result of squaring is 9, the magician wouldn't be able to decide if the original number were 3 or -3 because both 3^2 and $(-3)^2$ are equal to 9.

The Cat tackled the Introduction Game by making a table of data. See page 8.

After everyone arrived, Ken talked about addition, multiplication, and exponentiation. **The Cat** wondered if there were further operations that generalized the idea of multiplication being repeated addition and exponentiation being repeated multiplication. She described what she meant with an example: two to the two to the two to the two, etc. We'll return to these ideas later.

Sarit Smolikov, the first woman from the Girls' Angle Support Network to work with the girls, came to explain how she uses math to study worms. She talked about chromosomes and the process of forming germ cells. She used a game involving a red and blue colored five-pointed star, both dissected into the same three basic shapes to show that the process for creating germ cells in nature cannot be a random process like flipping coins. She also brought in Petri dishes with thousands of worms! Amazingly, these worms, *C. elegans*, have a very specific number of cells in their bodies. All adult *C. elegans* hermaphrodites have 956 cells.

Special Announcements

Sarit Smolikov invites Girls' Angle members to visit her laboratory. If you are interested, let us know and we will put you in touch with Sarit so you can arrange a visit.

Calendar

Session I:

September	20	Grand opening!
	27	Special Guest: Elissa Ozanne
October	4	Visitor: Sarit Smolikov, Harvard Medical School
	11	
	18	Visitor: Kimberly Pearson, Harvard Medical School
	25	Visitor: Tamara Awerbuch, Harvard School of Public Health
November	1	
	8	
	15	
	22	No meet – Thanksgiving.
	29	

Session II:

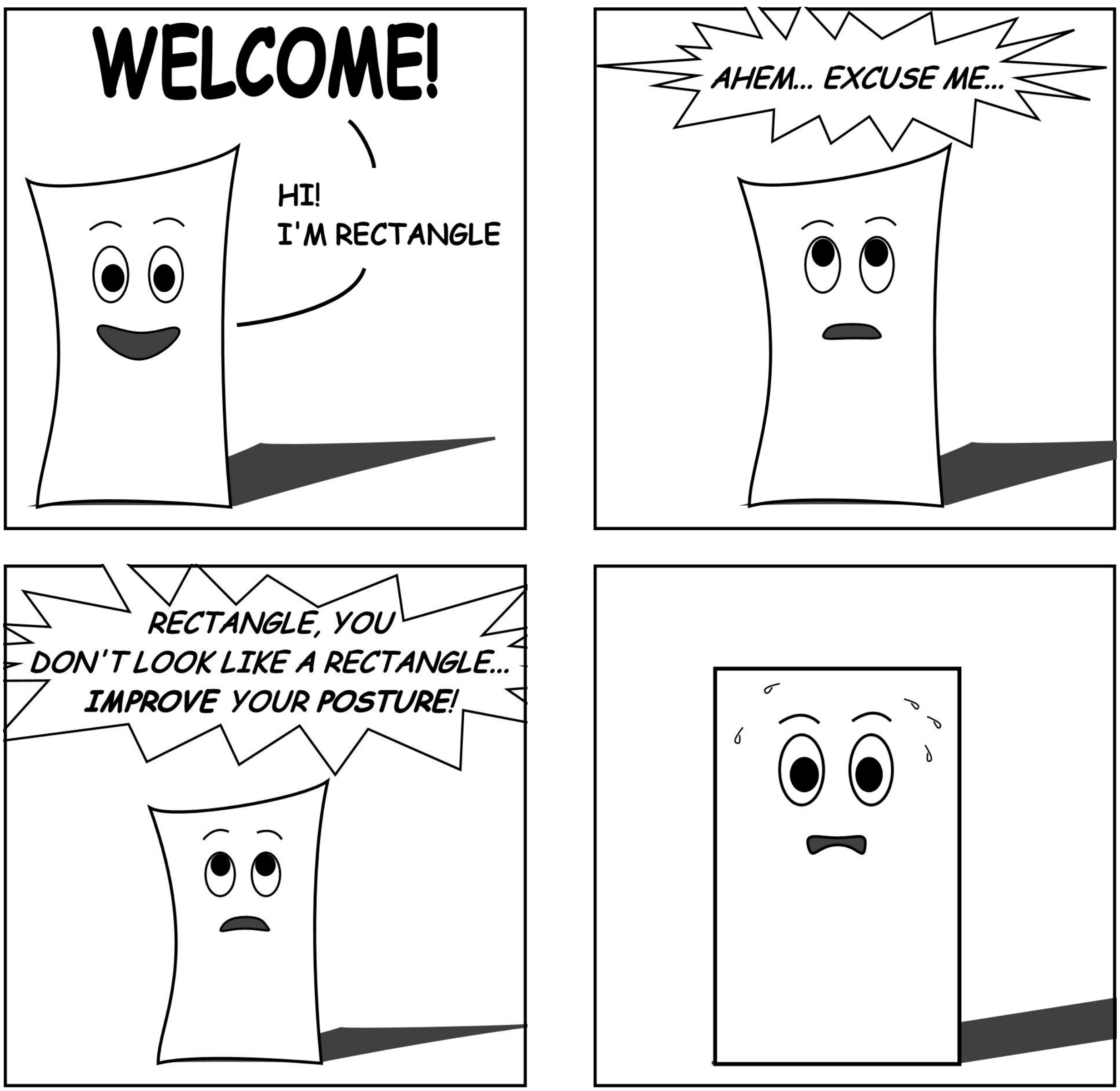
To be announced…

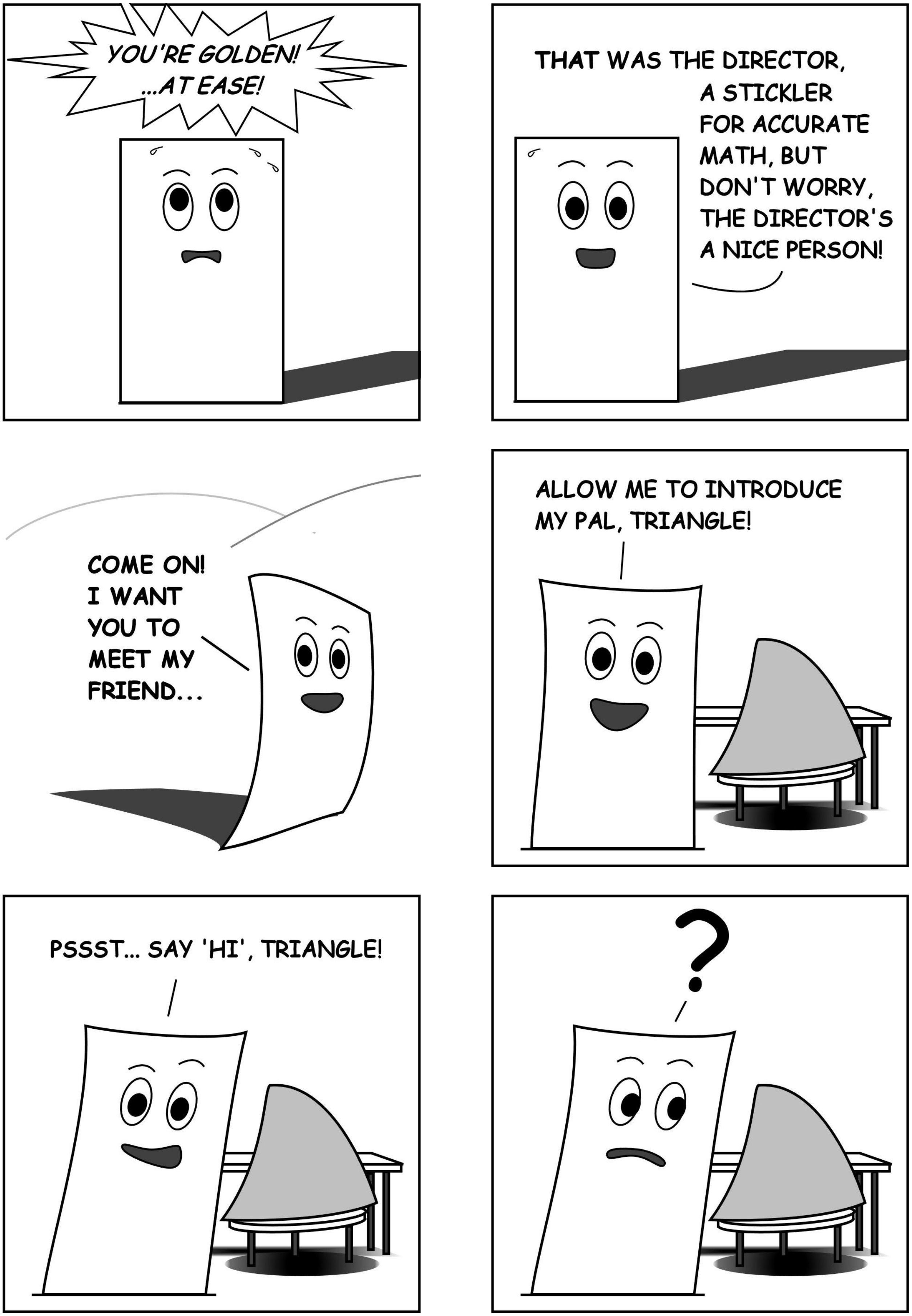
Feedback

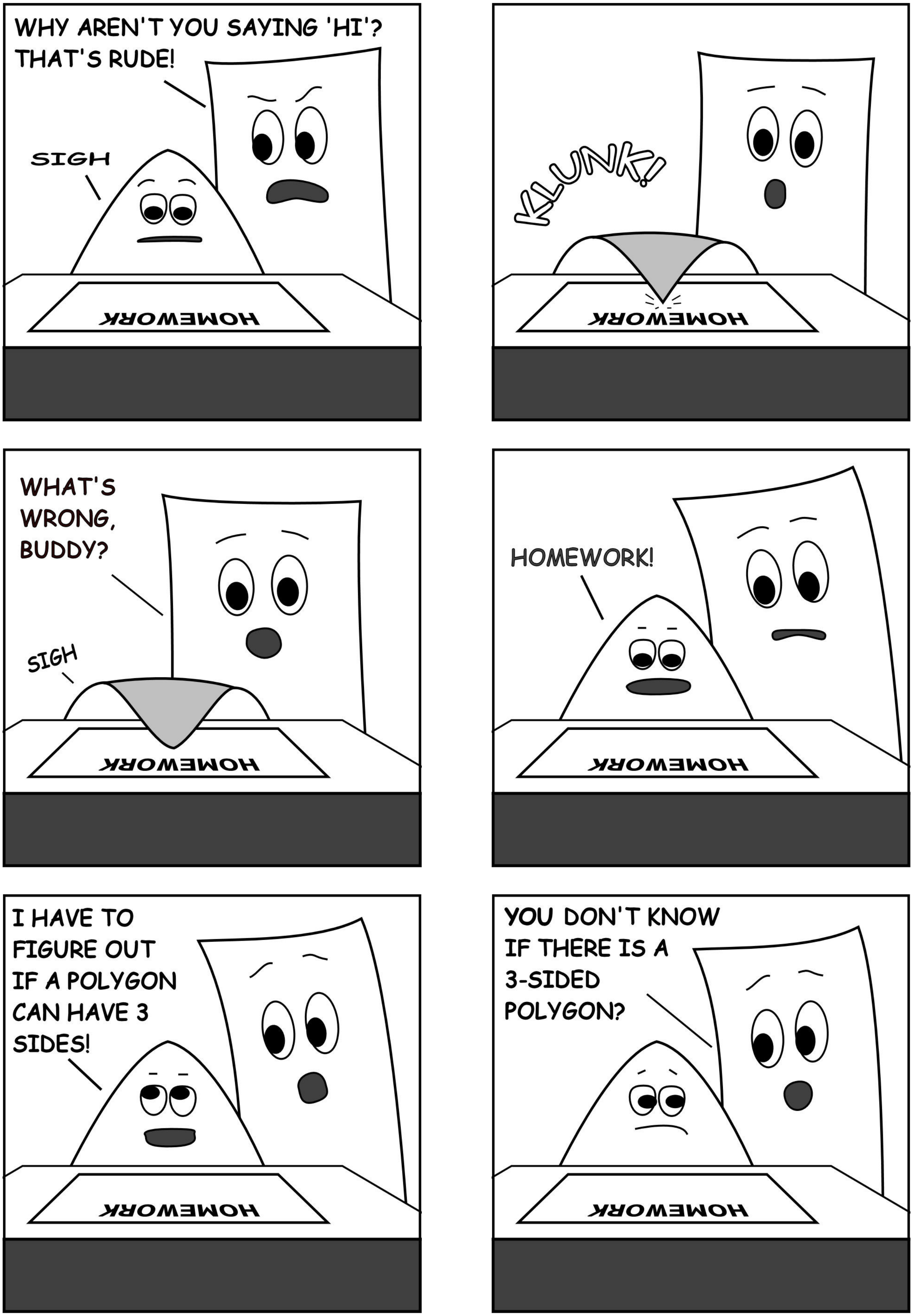
Please send feedback to girlsangle@gmail.com. We'd love to hear from you!

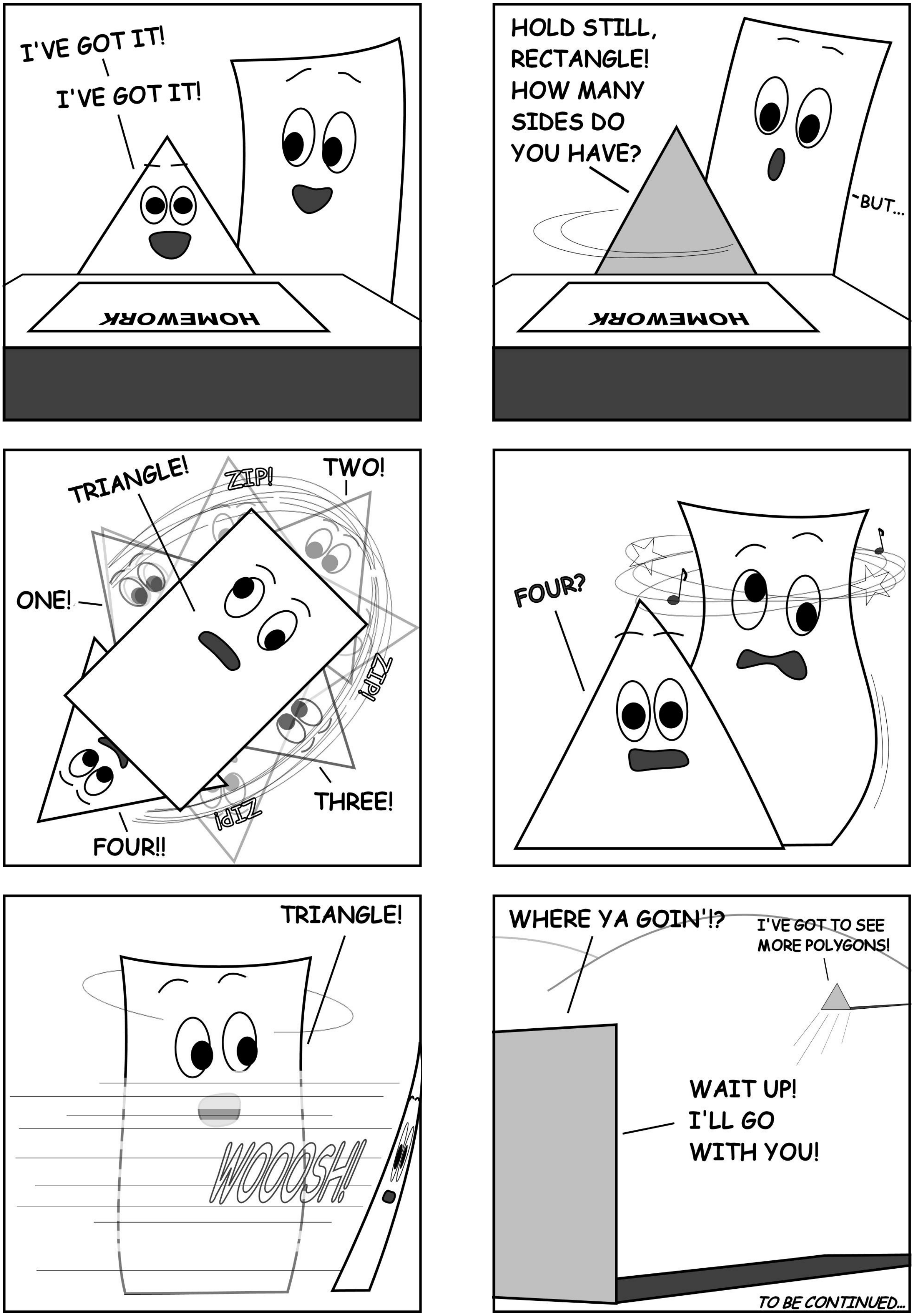
It Figures!

by CKFan




YOU'RE GOLDEN!
...AT EASE!
THAT WAS THE DIRECTOR, A STICKLER FOR ACCURATE MATH, BUT DON'T WORRY, THE DIRECTOR'S A NICE PERSON!
COME ON! I WANT YOU TO MEET MY FRIEND...
ALLOW ME TO INTRODUCE MY PAL, TRIANGLE!
PSSST... SAY 'HI', TRIANGLE!
?


WHY AREN'T YOU SAYING 'HI'? THAT'S RUDE!
SIGH
HOMEWORK
KLUNK!
HOMEWORK
WHAT'S WRONG, BUDDY?
SIGH
HOMEWORK
HOMEWORK!
HOMEWORK
I HAVE TO FIGURE OUT IF A POLYGON CAN HAVE 3 SIDES!
HOMEWORK
YOU DON'T KNOW IF THERE IS A 3-SIDED POLYGON?
HOMEWORK


I'VE GOT IT!
I'VE GOT IT!
HOMEWORK
HOLD STILL, RECTANGLE! HOW MANY SIDES DO YOU HAVE?
BUT...
HOMEWORK
TRIANGLE!
ZIP!
TWO!
ONE!
ZIP!
THREE!
ZIP!
FOUR!!
FOUR?
TRIANGLE!
WOOOSH!
WHERE YA GOIN'!?
I'VE GOT TO SEE MORE POLYGONS!
WAIT UP! I'LL GO WITH YOU!
TO BE CONTINUED...

Girls’ Angle: A Math Club for Girls

Gain confidence in math! Discover how interesting and exciting math can be! Make new friends!

What is Girls’ Angle? Girls’ Angle is a math club for girls that aims to foster and nurture girls’ interest and ability in mathematics. Instead of modeling after the traditional classroom experience, Girls’ Angle is inspired by the lively activity in math department common rooms. Our philosophy is that mathematical ability is best developed through interaction with people who have both a deep understanding of mathematics and a genuine interest in helping others learn. Rather than 'teach math' at the club, we'll have helpers who work on motivation, motivation, motivation! The helpers, who will mostly be women, will introduce the girls to all kinds of activities, objects, and ideas that are math related trying to hook their interest. Once hooked, we will encourage them to explore, to think, and to ask and seek the answers to questions. We will show them all kinds of techniques that help one find answers, and we will show them how to craft questions that promote progress. The goal is to empower girls to be able to tackle any level of mathematics in the future so that no field, no matter how technical, will be off limits. We aim to overcome math anxiety and build solid foundations, so we will be welcoming all girls, not just those deemed gifted in mathematics.

Who can join? Ultimately, we hope to open membership to all women. Initially, we will be opening the doors primarily to girls in grades 5-8. We welcome *all girls* regardless of perceived mathematical ability.

In what ways can a girl participate? There are 3 ways: **membership**, **premium subscriber**, and **basic subscriber.** **Membership** ($180 or $20 per session) is granted for 10 weeks and includes access to the club, the math question email service, and a subscription to the Girls’ Angle Bulletin. **Premium subscriptions** ($100) also last 10 weeks and include the math question email service and subscription to the Girls’ Angle Bulletin. **Basic subscriptions** ($20) are one-year subscriptions to the Girls’ Angle Bulletin. We operate in 10-week blocks, but girls are welcome to join at any time. The program is individually focused so the concept of “catching up with the group” doesn’t apply.

What is the Girls’ Angle Bulletin? The Girls’ Angle Bulletin will be a bimonthly (6 issues per year) electronic publication that will feature articles and information of mathematical interest as well as a comic strip that teaches mathematics.

What is the math question email service? The math question email service allows a subscriber to email math questions that will be answered by staff or addressed during club meetings. Please note that we will not do math problems that *appear to us* to be for homework.

What do members get? Members get a one-year subscription to the Bulletin and 10 weeks of access to the club and the math question email service. The club will be a friendly place staffed mainly by women who have been selected for their deep understanding of mathematics and their desire to truly help others learn math. Helpers will take a personal interest in each member, assessing her mathematical abilities and working with her to motivate an interest in mathematics and mathematical topics by encouraging questions and explaining strategies and techniques for finding answers. Helpers will also organize fun activities that serve to introduce, explain, and clarify mathematical topics.

Where is Girls’ Angle located? Girls’ Angle is located about 10 minutes walk from Central Square on Magazine Street in Cambridge. For security reasons, only members and their parents/guardian will be given the exact location of the club and its phone number.

When are the club hours? Girls’ Angle meets Thursdays from 3:30 to 5:30. Please inquire about the calendar. It is very important that you pick up your child promptly at 5:30.

Can you describe what the activities at the club will be like? Girls' Angle activities will be tailored to each girl's specific needs. We will assess where each girl is mathematically and then design and fashion strategies that will help her develop her mathematical abilities. Everybody learns math differently and what works best for one individual may not work for another. At Girls' Angle, we are very sensitive to individual differences. If you would like to understand this process in more detail, please email us!

Are donations to Girls' Angle tax deductible? Yes. If you believe in our approach and goals and want to help support us, we appreciate any contribution you can make. Currently, Science Club for Girls, a 501(c)3 corporation, is holding our treasury. Please make donations out to **Girls' Angle c/o Science Club for Girls** and send checks to Ken Fan, 27 Jefferson St., Cambridge, MA 02141.

Who is the Girls' Angle director? Ken Fan is the director and founder of Girls' Angle. He has a Ph.D. in mathematics from MIT and was an assistant professor of mathematics at Harvard, a member at the Institute for Advanced Study, and a National Science Foundation postdoctoral fellow. In addition, he has designed and taught math enrichment classes at Boston's Museum of Science and worked in the mathematics educational publishing industry. Ken believes that mathematics education in this country can be improved significantly. Also, through the years, he has witnessed instances of gender bias in mathematics and in math education. The last two summers Ken volunteered for Science Club for Girls and worked with girls to build large modular origami projects that were hung at Boston Children's Museum. The girls of Science Club for Girls showed a lot of creativity and ingenuity and were able to realize their ideas in the final project, something that may not have happened in a co-ed environment. These experiences have motivated him to create Girls' Angle.

Who advises the director to ensure that Girls' Angle realizes its goal of helping girls develop their mathematical interests and abilities? Girls' Angle has a stellar Board of Advisors. They are:

Lauren Williams, assistant professor of mathematics, Harvard
Kathy Paur, graduate student in mathematics, Harvard
Yaim Cooper, undergraduate math major, Massachusetts Institute of Technology
Lauren McGough, advanced high school student who founded her school's math club
Connie Chow, executive director of Science Club for Girls
Beth O'Sullivan, co-founder of Science Club for Girls.

At Girls' Angle, mentors will be selected for their depth of understanding of mathematics as well as their desire to help others learn math. But does it really matter that girls be instructed by people with such a high level understanding of mathematics? We believe YES, absolutely! One goal of Girls' Angle is to empower girls to be able to go on and tackle *any* field regardless of the level of mathematical competence required, including fields that involve original research. Over the centuries, the mathematical universe has grown enormously. Without guidance from people who understand a lot of math, the risk is that a student will acquire a very shallow and limited view of mathematics and the importance of various topics will be improperly appreciated. Also, people who have proven original theorems understand what it is like to work on questions for which there is no known answer and for which there might not even be an answer. Much of school mathematics (all the way through college) revolves around math questions with known answers, and most teachers have structured their teaching, whether consciously or not, with the knowledge of the answer in mind. At Girls' Angle, girls will learn strategies and techniques that apply even when no answer is known.

Also, math should not be perceived as the stuff that is done in math class. Instead, math lives and thrives today and can be found all around us. Girls' Angle helpers can show girls how math is relevant to their daily lives and how this math can lead to abstract structures of enormous interest and beauty.

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Membership Application

Applicant's Name: (last) ______________________________ (first) ______________________________

Applying For:
- ☐ Member (Access to club, Math question email service, Receive Bulletin)
- ☐ Premium Subscriber (Math question email service, Receive Bulletin)
- ☐ Basic Subscriber (Receive Bulletin)

Parents/Guardians: ____

Address: ____ Zip Code: __________

Home Phone: ________________ Cell Phone: ________________ Email: ______________________

Emergency contact name and number: ____

Pick Up Info: For safety reasons, only the following people will be allowed to pick up your daughter. They will have to sign her out. Names: ____

Medical Information: Are there any medical issues or conditions, such as allergies, that you'd like us to know about? ____

Photography Release: Occasionally, photos and videos are taken to document and publicize our program in all media forms. We will not print or use your daughter's name in any way. Do we have permission to use your daughter's image for these purposes? **Yes** **No**

Eligibility: For now, girls who are roughly in the grade 5-8 range are welcome. Although we will work hard to include every girl no matter her needs and to communicate with you any issues that may arise, Girls' Angle has the discretion to dismiss any girl whose actions are disruptive to club activities.

Permission: I give my daughter permission to participate in Girls' Angle. I have read and understand everything on this registration form and the attached information sheets.

____ Date: ________________________
(Parent/Guardian Signature)

Membership-Applicant Signature: ____

- ☐ Enclosed is a check for (indicate one) (prorate as necessary)
  - ☐ $180 for a 10 session membership
  - ☐ $100 for a 10 week premium subscription
  - ☐ $20 for a one year basic subscription
  - ☐ I am making a tax free charitable donation.

- ☐ I will pay on a per session basis at $20/session. (Note: You still must return this form.)

Please make check payable to: **Girls' Angle c/o Science Club for Girls**. Mail to: Ken Fan, 27 Jefferson St., Cambridge, MA 02141. Paying on a per session basis comes with a one year subscription to the Bulletin, but not the math question email service. Also, please sign and return the Liability Waiver.

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Liability Waiver

I, the undersigned parent or guardian of the following minor(s)

____,

do hereby consent to my child(ren)'s participation in Girls' Angle and do forever and irrevocably release Girls' Angle and its directors, officers, employees, agents, and volunteers (collectively the "Releasees") from any and all liability, and waive any and all claims, for injury, loss or damage, including attorney's fees, in any way connected with or arising out of my child(ren)'s participation in Girls' Angle, whether or not caused by my child(ren)'s negligence or by any act or omission of Girls' Angle or any of the Releasees. I forever release, acquit, discharge and covenant to hold harmless the Releasees from any and all causes of action and claims on account of, or in any way growing out of, directly or indirectly, my minor child(ren)'s participation in Girls' Angle, including all foreseeable and unforeseeable personal injuries or property damage, further including all claims or rights of action for damages which my minor child(ren) may acquire, either before or after he or she has reached his or her majority, resulting from or connected with his or her participation in Girls' Angle. I agree to indemnify and to hold harmless the Releasees from all claims (in other words, to reimburse the Releasees and to be responsible) for liability, injury, loss, damage or expense, including attorneys' fees (including the cost of defending any claim my child might make, or that might be made on my child(ren)'s behalf, that is released or waived by this paragraph), in any way connected with or arising out of my child(ren)'s participation in the Program.

Signature of applicant/parent: ____Date: ________________

Print name of applicant/parent: ____

Print name(s) of child(ren) in program: _____________________________________

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