

Math 495 - Fall 2015 - Course Page

<http://bit.ly/495-F15>

Class 9:00-11:30 am TR

Mackinac Hall A-2-155

Welcome to the course page! Agendas for class, homework, and important links will be posted here. Bookmark it now!

Preliminaries:

[Introductions](#)

[Syllabus](#) (this link used to go to a previous semester!)

[Facebook Group](#)

[Book Page](#)

[Preliminaries:](#)

[Day 1 How do you figure?](#)

[Day 2: It's all Greek](#)

[Day 3 Genius is...](#)

[Day 4 Who Dwells in the House of Wisdom?](#)

[Day 5 Tile laying](#)

[Day 6 Brahmagupta](#)

[Day 7 Nine Chapters on the Mathematical Arts](#)

[Day 8: math goes to Europe](#)

[Day 9: Spiraling Out of Control](#)

[Day 10: Ars not arse.](#)

[Day 11 But is it Science?](#)

[Day 12 Horse Before](#)

[Day 13 What are the Odds?](#)

[Day 14 Book Club](#)

[Day 15 Battle is ON!](#)

[Day 16 Euler I](#)

[Day 17 Euler II](#)

[Day 18 The Other The Man](#)

[Day 19 What about The Woman?](#)

[Day 20 How many?](#)

[Day 21 Group On](#)

[Day 22 Teacher and Student](#)

[Day 23 The Shape of Things](#)

[Day 24 Ramanujan](#)

[Day 25 The B stands for Benoit B Mandelbrot](#)

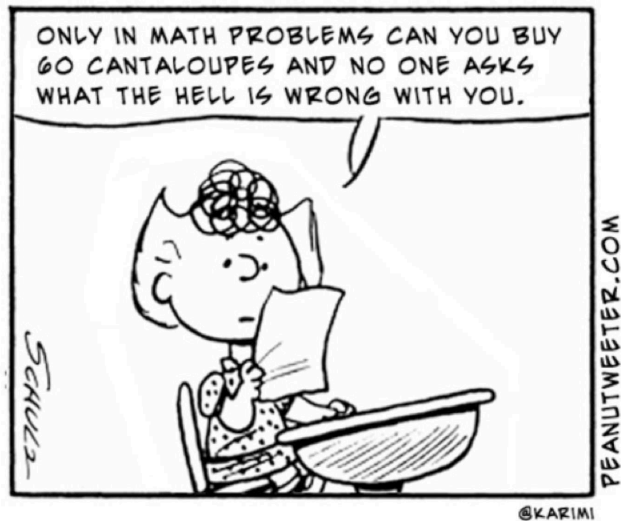
[Day 26 Which way? Conway!](#)

[Day 27 The Algebra Lesson](#)

[Day 28 Unfinished Business](#)



Last Day +1



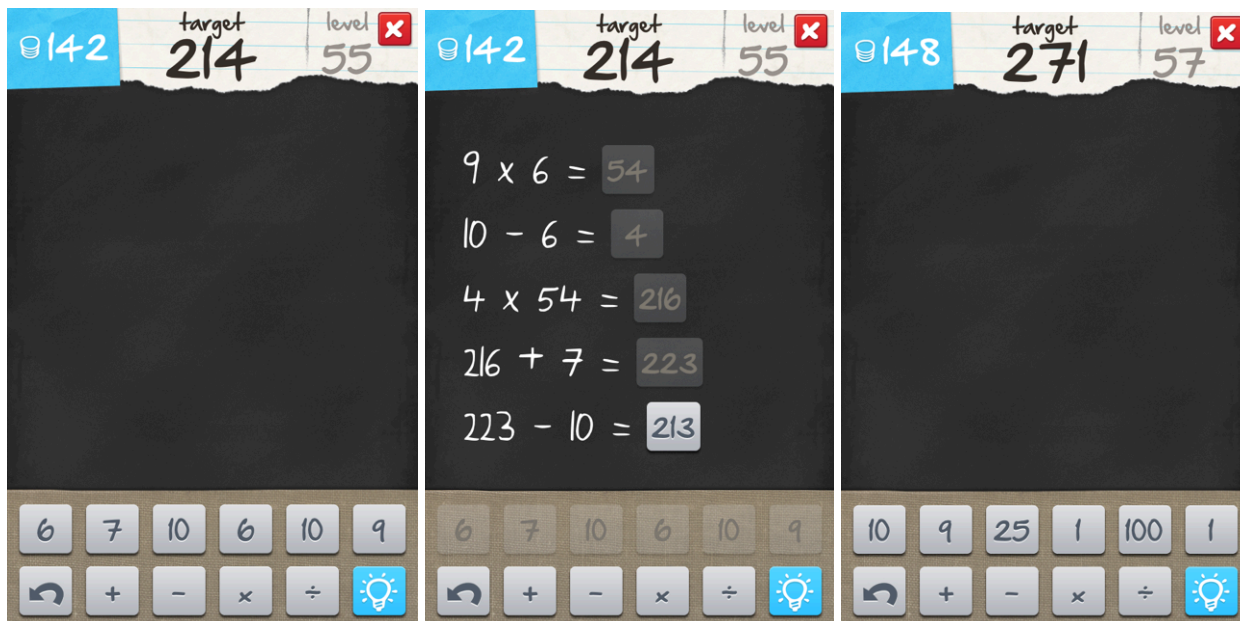
Day 1 How do you figure?

Objective: Once you've got numbers, what do you do with them?

- Sign in/Groups/Nameplates
- Last test you'll ever take? (Try solo; then discuss in group)
- Beast of Burden
- 6 numbers

Links

- The Man Who Counted [blogpost](#); link to [a pdf](#); [profile of Malba Tahan](#) by Alex Bellos
- James Tanton, [Line Multiplication](#) and [Liking My 3s](#); see also <http://www.jamestanton.com/>
- Math Pickle [\\$1,000,000 problems](#) (Grade 4 problem is a *classic*.)
- Sid Kolpas' [Finger Multiplying](#) (pdf)
- [6 numbers app](#) (iOS)



Threes: Is there a number N so that it and all its multiples $2N$, $3N$, $4N$, ... each contain the digit 3?

To Do: Usually this list will be more focused and shorter.

- Join [Facebook Group](#) if not already.
- Read [Syllabus](#), post questions to FB page.
- [Introductions](#) - add your entry
- Books - pick your book, record on the doc. [Book Page](#)
- Starting a blog?
 - <http://mathtwitterblogosphere.weebly.com/writing-a-blog.html>
 - MTBoS recommends WordPress because it has the best math typesetting. I'm on [blogspot.com](#) (Blogger) which has the advantage of being a Google product. [Tumblr.com](#) is the easiest but has the least structure and it's difficult to get comments. [Weebly.com](#) is a very flexible platform that allows a lot of different style pages.
 - why blog over Google docs? Main reason: it means you're writing for an audience instead of just your teacher. Looking forward, teachers use blogging for reflection and to connect. Math grad students have started blogging and the recent twin prime work has seen a breakthrough in mathematical blogging for research. And anytime you're looking for a job, having a public record of your smart writing is not a bad thing to put on a resume.

Blog 0:

- (One pageish) write up:
 - what is math? Biggest moments/discoveries in history of math. (Top 5 or milestones, etc.) Please don't research - just what you're bringing in to the course.
 - Post a link in the Facebook group to your What is Math? post before Day 2.

Time left? (Looking for 1.5 hours/class) Follow one of the links above. Or...

- Looking for mo' math? (Future daily or create)
 - write up some more not-quite-trick questions
 - read & solve Man Who Counted problems
 - investigate multiples of 3 times 37
 - try an arithmetic investigation from James Tanton or Math Pickle. (Links above)
 - [Die Hard 3 math](#) ([solution](#))

Bring computer on Wednesday

Day 2: It's all Greek

Sept. 2nd

Thales <http://www.geogebra.org/material/show/id/38870>

The Pythagoreans <http://www.geogebra.org/material/show/id/38900>

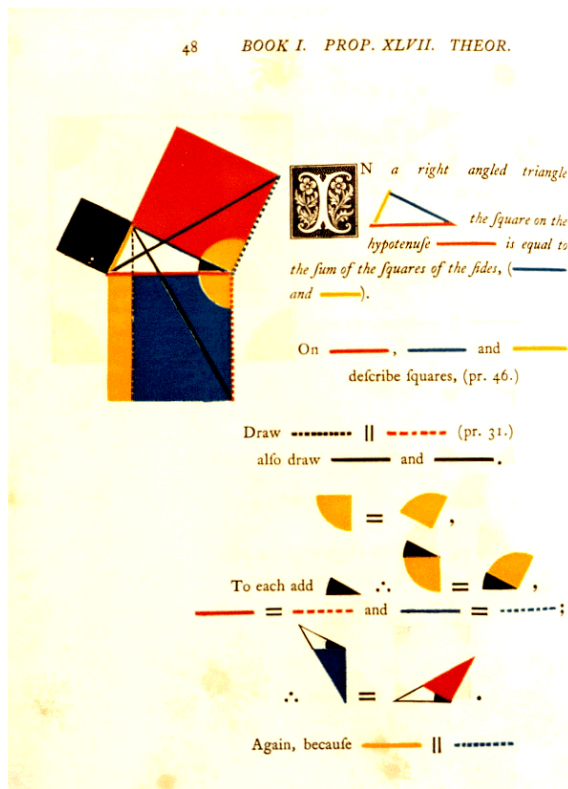
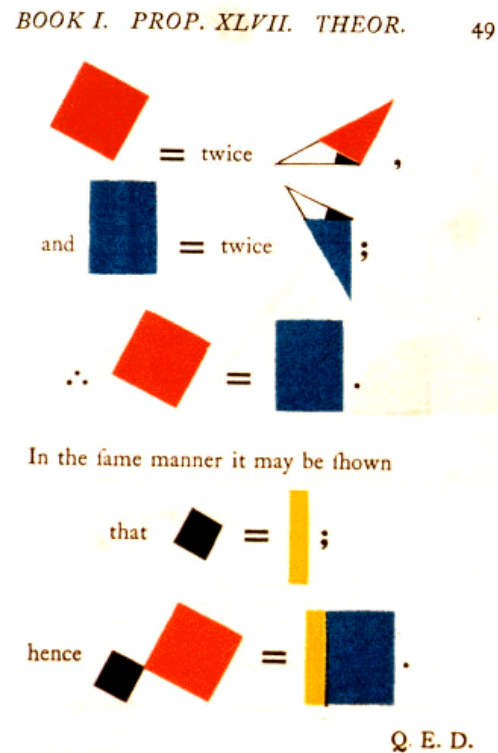
Euclid VII - translate to modern language, [record here](#)

- [David Joyce's dynamic version](#):



Links

- [Nicomachus' Introduction to Arithmetic](#) (translated;pdf) dense but interesting look into early Greek number theory
- David Joyce's beautiful dynamic illustration of Euclid's [The Elements](#)
- [Plain language Euclid](#) according to W14, or [Spring 14](#)
- Gorgeous [19th century edition of Euclid](#).
- <http://www.cut-the-knot.org/pythagoras/index.shtml> Proof Collection
- Get GeoGebra <http://www.geogebra.org/cms/en/download/>
- GeoGebra start up...<https://sites.google.com/site/ggbgvsu/intro>
- [Donald Duck in Mathmagicland](#)
- squares on triangles [Generalized Pythagorean Theorem](#)
- [Leonardo da Vinci's cool proof](#) of the Pythagorean Theorem



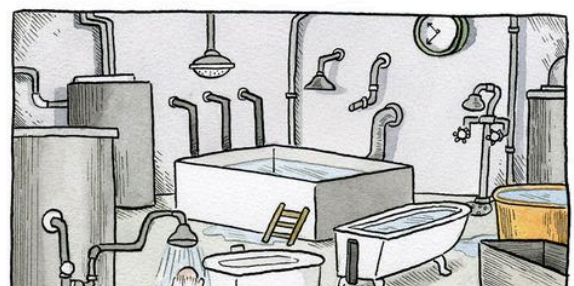
To Do:

Daily 2: Hour and a half selected from...

- Your own proof of the Pythagorean Theorem
- Implement one of Euclid's Propositions in GeoGebra. Please share this if you do it! (Link on the FB page.)
 - Check out Ryan Hirst's [GeoGebra of Euclid](#)
 - Matt's, a GVSU grad student/in-service teacher who [illustrated all of book 3!](#)
- Thale's theorem is connected to the problem of finding tangents to a circle from a point not on the circle. What is the connection?
- Play with the game of [Paper Pool](#). Some neat number patterns arise. (Applet is Java, but you can investigate on graph paper, too.)
- Playing with LCM and GCF. What do you notice?
- Writing up some of Euclid's number results in modern language. ([Add them here](#))
- Finding your own proof of a Euclidean proposition or other digging deeper into Bk 7.

Day 3 Genius is...

Wed, Sep 9



Class is a choose your own adventure NOT in the classroom. No meeting today! (Unless you want to meet and work together. I know an open room...)

Work your way through [this document](#).

It also has the homework for today.



Day 4 Who Dwells in the [House of Wisdom](#)?

Archimedes
Finding the Balance

Links:

- The Compendious Book, <http://www.wilbourhall.org/index.html#algebra> (website actually has an astounding amount of original texts in math and astronomy)
- Excellent blogger Mike Lawler [discusses the quadratic formula](#) and completing the square with his (astoundingly mathematically mature) kids.
- [Mathematical Treasures](#): images of original pages from great manuscripts [A page from the Compendious Book](#)

Daily 4: (90 min; choice)

- dig into the visual algebra of Khwarizmi.
- Try algebra tiles! http://media.mivu.org/mvu_pd/a4a/homework/applets_factoring.html
- Do the handout with other tidbits from the House of Wisdom.

Bonus!

Pat Bellew, retired teacher and great amateur math historian ([his blog](#) is a great resource for this course), saw [Dakota's post](#) on the stomachion, and shared his post on [the history of dissection puzzles](#).

Day 5 Tile laying

Wed., Sep 16

[Islamic Tessellations](#)

Graph paper:

- [isometric](#)
- [square](#)

Bonus:

- A [page of resources](#) for Escher's tessellations

Daily 5: 90 min

- make a tessellation, obviously! Post to FB or share your work in the document.
- if you just can't bring yourself to make the math art, investigate the [Wallpaper Groups](#). (A cool abstract algebra connection.)

Want something more analytical?

- Ibrahim ibn Sinan, grandson of Thabit ibn Qurra, wrote a treatise called "On Drawing the Three Conic Sections" - which I haven't been able to find. See what you can find out about it.
- Investigate the billiards problem known as Alhazen's Problem. Here's a [GeoGebra file](#) to get you started.

Also:

- read a couple of your classmates blogposts. Comment on at least one. (Try to find one without a comment yet.) What did you like and what's one way to make it better. Find from Facebook or this [list of links](#).

Day 6 Brahmagupta

Mon 9/21

Objective: our numbers ourselves.

Brahmagupta & Indian mathematics

- Brahmagupta found formulas for the sums: $1+2+3+\dots+n$, $1^2+2^2+3^2+\dots+n^2$, $1^3+2^3+3^3+\dots+n^3$.

- GeoGebra sketch of the [cyclic quadrilateral](#) results
- [GGB Brahmagupta's Theorem](#)
- [Brahmagupta's Formula](#)
- Brahmagupta's connection with [Pell's Equation](#)

Daily: 90 min

- Do the activity on Omar Khayyam. (Handed out in class.).
 - GeoGebra for cubic
- Extra time choices:
 - find another bit of interesting Khayyam mathematics. Post link to FB. (He was prolific.)
 - Is there a math-poetry connection? Poke around a bit at JoAnne Growney's collection. There's a lot... you might start with [this post](#) (with one of my favorite authors) and the anthology linked in the last paragraph.

Reading

- Keep notes on your reading in any form you like. There'll be a short review/essay about it due at the end of the book.

Bonus:

- Friendly Numbers [9437056](#) and [9363584](#)
- Overview of this period's [Islamic mathematics](#)
- Al Karaji's amazing [hydroengineering](#) and his inductive proof of [the sum of cubes](#). (GGB [visualization](#))
- [Correctly Established Doctrine of Brahma](#)
- [Cal State's Math Tourism Archive](#)
- [Heron's Formula](#)
- [Infinity commercial](#)
- Khayyam [biography](#) and [his great poem](#)
- [GeoGebra sketch](#) of a Khayyam solution, [another](#) via Holli, [another](#) via Sarah



Day 7 Nine Chapters on the Mathematical Arts

Wed, Sep 23.

Objective: application & decomposition

Nine Chapters on the Mathematical Arts

Cube decomposing

Links:

- Can you find a good online translation of Liu Hui's commentary or the Nine Chapters?
- [Jennifer's nets](#) for Chinese puzzle

To Do:

- reading: get book, read book, take notes. We hope to discuss around Class 13 in 3 weeks.
- daily 7: (90 min)
 - [EUGENIA CHENG!](#) Tea at 4, A-2-610, talk at 4:30 A-2-117.
 - Finish analysing Khayyam's cubic solution.
 - Other Chinese math (handout)
 - Find/explore the link between Horner's Method and synthetic division.
 - first check on dailies: class 9.
- blogpost 2: just ideas!
 - Doing math: solution of cubic, cyclic quadrilaterals, closed forms for sums of integers, squares or cubes. What about $1+2^4+3^4+\dots$? Or nets for geometric models.
 - Communicating math: amicable numbers
 - History of Math: Zero. Brahmagupta. Zero and Brahmagupta.
 - Nature of Mathematics: the role of our number system.

Comments on first posts should be done by Friday. (Sorry so tardy.) Generally:

- complete - shows about 2 hours work; has important aspects of topic addressed
- clear - understandable
- coherent - has a goal, moves towards it
- content - correctness, relevance of ideas
- consolidated - tied up, concluded, perceivable structure. One framework we use for this is what (summary), so what (importance) or now what (what's next). For short writing like these, you often don't need a summary.



Day 8: math goes to Europe

Roman Numerals

Leonardo of Pisa

- making sense
- puzzles
- The original puzzle



Project Brainstorming

To Do: 90 min

- *Daily:*
 - Finish working through the Fibonacci sheet.
 - explore one of the connections
 - How many ways to cover a $2 \times n$ grid with 1×2 dominoes?
 - There are an infinite number of Fibonacci numbers, and an infinite number of primes, but are there an infinite number of Fibonacci primes?
 - How does the Fibonacci sequence extend backwards?

- look into closed form generation of the numbers (Is there a function who's output for input n is the F_n , the n th Fibonacci number?)
 - make Fibonacci themed art ([Jennifer Silverman](#) or a [skyscape](#))
 - Prove a Fibonacci Proposition
 - Record a video pitch: why should you use these fancy new numbers rather than the old-fashioned roman numerals
- *Reading*: 3 weeks...
- *Commenting*: leave a comment for a colleague. Something you liked, something to improve. From FB or from [the Diigo list](#).
- Daily check: format of your choice, include a table of contents that has:
 - day ... couple words on what you did. Eg.
Day 8 - Fibonacci Proofs
Day 9 - built the sculpture

Extra:

- Google Books: [Liber Abaci](#) (modern translation)
- Brain Pickings: [A Man of Numbers](#), intro to Devlin's book on Filius Bonacci.
- [Devlin on Devlin's book](#) about Fibonacci
- All the math <https://oeis.org/A000045>

Day 9: Spiraling Out of Control

Objective: math mysticism... true dat or calling BS?

Homework share

Spirals & Golden Ratio? What is going on?

- make (cf. [spiral collection](#), lots of animation and GeoGebra)
 - types
- fit: find an equation that connects the points of the rectangular spiral (consider polar coordinates)
- [debunk](#) or [Devlin](#) or [GeoGebra](#)

Vi Hart awesomeness: [Part 1](#) of 3. WATCH at least part 1.

[Project brainstorm](#)

- From syllabus:
Expansion of one or more related pieces of work into a worthwhile project.

- developed mathematical writing on content of your own working
- historical profile of period in mathematics or of significant mathematician
- series of lessons that includes historical connection or context or connects significant math content to the Common Core.
- video or video series on any of the above
- mathematical art that explores any of the above

Past projects included Sabremetrics for GV baseball, analyzing some math in Magic: the Gathering, unit of lessons on polyhedra, a platonic solid art project, teaching a tech-infused HS geometry lesson... this is **very open**.

Expectation: project should show an investment of 16 or more hours. You might want to keep a log if the work is not self-evident.

KEY: Make it something on which *you* want to spend the time.

To do:

- post an idea or three to project ideas page
- explore golden ratio connections. Develop work in class, make art, curate the crazy, ...
 - weird current thing: loop de loops. Tangentially related... [Dan Meyer contest](#), [Anna Weltman questions](#). [GeoGebra support](#).

Extra:

- [Spreadsheet](#)
- History of the [equiangular/logarithmic spiral](#)
- [Crazy circle connection](#) (GGBT) and a [circle visualization](#) (GGBT)
- [Music & Fibonacci](#) lesson
- [Art & Fibonacci](#) lesson
- [GeoGebra](#) of Vi Hart's spirals
- [GeoGebra](#) for spirals in nature
- Dan Percy's [super sunflower simulation](#) (GGBT)
- My [spiral addiction](#)
- Euler spiral

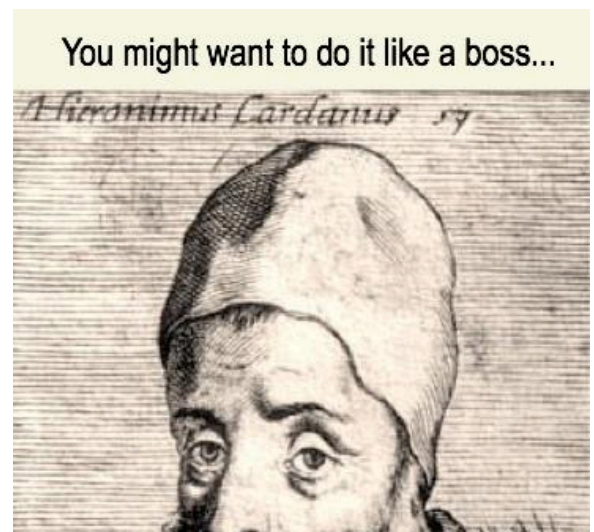
Next week: Return of the Cubic!

Day 10: Ars not arse.

Well, maybe.

Project discussion

The one, the only Gerrrrrrronimo!



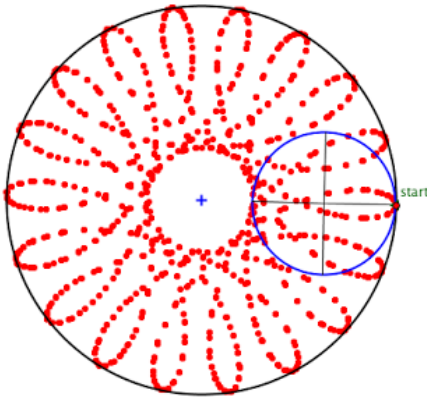
- [first cubic](#) solution
- [second cubic](#) solution

Cubic:

[GGB file](#) showing that shift to a depressed cubic

To do:

- Daily 8. Could finish the Cardano sheet (presuming we haven't)
 - Be good to spend some time with cubic functions/formulas.
 - solve specific cubics or make an interesting magic square.
 - revisit Khayyam's cubic solution
 - Cardano was also into hypocycloids (aka [Spirograph](#)) - I have a fun [GeoGebra sketch](#) for those. (Or a [more parametric approach](#).)
 - make a coherent explanation of the cubic formula derivation, or even explaining its use. Or... be like Tartaglia and write a solution in the form of a POEM.



Extra:

- Complex: [Rafael Bombelli](#)
- There's an artist whose work reminds me of the Cardan grill: [Austin Kleon](#). (His book *Steal Like an Artist*, is great, and good for any creative field.) Can you make a found poem out of a page from an old math text?
- [Tartaglia info](#)
- Cardano's Derivation of the Cubic Formula + [historical follow up](#) at MathWorld.
- [Clearest explanation](#) of Tartaglia's derivation that I know:
- [Nice derivation](#) of the cubic formula, plus several clearly worked out cubic formula examples.
- Open Resource Bank for Interactive Teaching ([ORBIT](#)) [Cubic activity](#). Great model of a content project for people choosing that option. And just cool mathematically.

Wondering: have any of you done Barbie Bungee in a class?

Day 11 But is it Science?

Galileo

- [Galileo experiments](#)



Bungee

- [video](#)
- Would you bungee jump?

To do:

- Reflection:
 - post to FB: is math a science?
- Daily 10:
 - experiment! Make a mathematical prediction, then see what really happens.
 - fine tune: what should the model be precisely for rubber band barbie bungee?
 - dig into Galileo's history. What is his role in mathematics?
 - Nice cubic problem: Consider the graph of $f(x) = x^3 + x + 2014$. A line that intersects f at three points, two of which have x -coordinates 20 and 14. Find the x -coordinate of the third intersection point. There's a brute way to do it, but Mike Lawler (from whom I got the problem) notes: "the time for that test is 20 questions in an hour. So, with 3 minutes for each question . . . good luck with factoring!"
- Blog 3
 - Possible topics: our number system, the cubic, math mysticism, is math a science, relationship between physics and math...
 - post to FB by replying to whomever posts first.
- Reading. Got your book? Read it! In class discussion: Day 14.

Extra:

- Galileo's [place in science](#)
- Galileo's [thought experiments](#)
- [Geometric Compass](#), one of Galileo's books
- Galileo and the [Math of Motion](#)

Missing one measuring tape!

Day 12 Horse Before

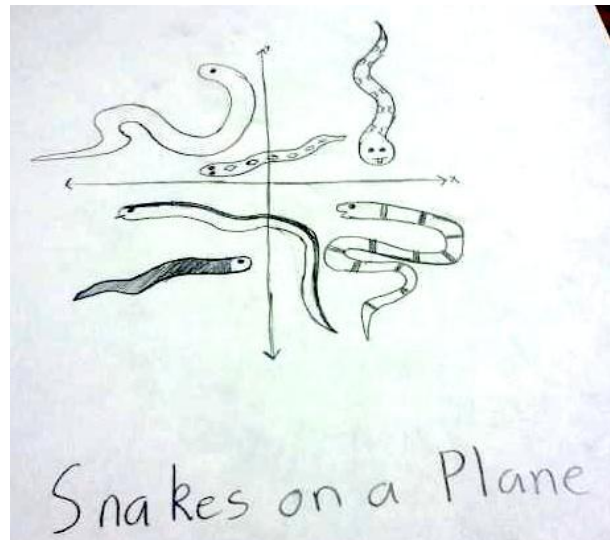
"Each problem that I solved became a rule which served afterwards to solve other problems." –

René Descartes

Qualitative Graphs

Descartes

- student.desmos.com, sign in to x78d
- desmos.com
- dailydesmos.com
- Desmos [activity builder](#) and [activity bank](#)



Daily 12:

- Read: Evelyn Lamb on [the Mystery Curve](#) - symmetry in equations and graphing. [GeoGebra for the MC](#) (of course I had to make it).
- Try a Daily Desmos or two.
- Create a Daily Desmos activity. (Send it to me, I'll post it and credit you.)
- Pick one of the extras to read and work on.



Extras

- Paper on the folium <http://vixra.org/pdf/1305.0008v1.pdf>
- I had some trouble getting the Folium graphed so @desmos gave me every variation! <https://www.desmos.com/calculator/zhebzm8981>
- <http://graphingstories.com/> - Make your own!
- See the other Desmos lessons: <http://teacher.desmos.com>

Next time: the most famous non-mathematician in math.

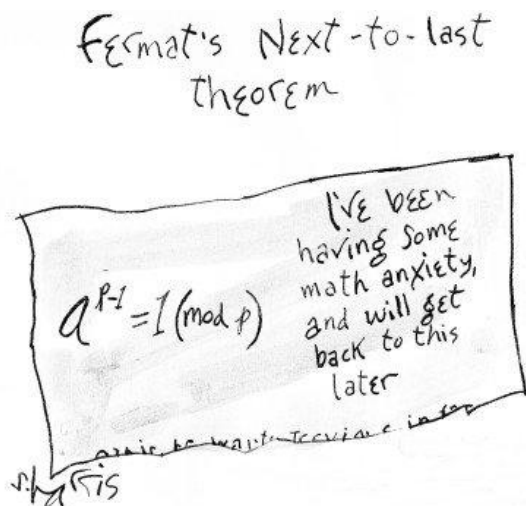
Day 13 What are the Odds?

Fermat and Pascal

- A game
- Number theory
- Le Triangle

To do:

- Daily
 - Pascal's triangles has untold riches. Dig in. The Fibonacci numbers are in there. Every degree polynomial. Fractals...
 - Fermat had amazing insight into numbers despite his distaste for proof. Watch the documentary on the Last Theorem, or research his connection to modern RSA cryptography. (Extra optional handout)
 - Analyze probability in a favorite game.
- Reading:
 - Book group Monday. Bring book, be ready to discuss.
 - somehow submit your reading notes. (Email, print, blog...)
 - On your blog write a roughly one page response to the book. Review, recommendation, critique, related thoughts...



- [Great documentary](#) on Fermat's Last Theorem (YT) (GREAT)
- [Fermat's Little Theorem](#)
- 2/3 of [the famous letters](#) between PdF and BP. (en anglais)
- Nice translation of & commentary on Pascal's [Treatise on the Arithmetical Triangle](#)
- 8th graders' [Rascal's Triangle](#)
- Enough about the triangle, what about [Pascal's Hexagon?](#)
- What's the connection between Pascal's Triangle and the [Sierpinski Triangle](#)?

Extra: very interesting [programming/proof problem](#) (Python, but can do w/o much experience) about Fibonacci's sequence from Robert Talbert

Day 14 Book Club

Objective: share the fruits of your reading and benefit from other's experience.



Group up with fellow readers

Whole class

Book swap

To do:

- Reading:
 - get John your reading notes, post a 1 page book response.
 - Get a 2nd book by swapping or borrowing from John. Don't have to (but may, of course) do a full read. Skim for a few weeks, then we'll have a briefer share in class.
- Daily:
 - catch up. Look over past dailies, blogposts and find anything you need to do to catch up.

Extra: Ed Frenkel
(author of Love and Math) had [two puzzles in the NYT](#) today. Also:

★ Edward Frenkel favored your Tweet
2h: Capstone stus discussing their self-chosen books by @stevenstrogatz @edfrenkel @DrEugeniaCheng @MarcusduSautoy & more. Energy level high x10



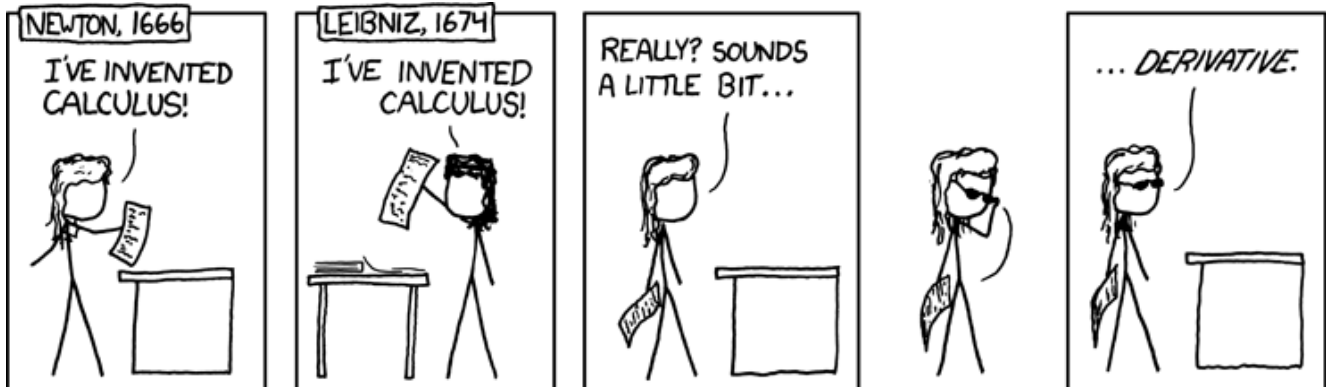
1h



Steven Strogatz @stevenstrogatz · Oct 19
Thanks, that is great to hear!

John Golden @mathhombre

Capstone stus discussing their self-chosen books by @stevenstrogatz
@edfrenkel @DrEugeniaCheng @MarcusduSautoy & more. Energy level high
x10



Day 15 Battle is ON!

[Back to the Future Day](#)

Book finish

- Euler: Master of us all
- The Math Book

Battle of Giants

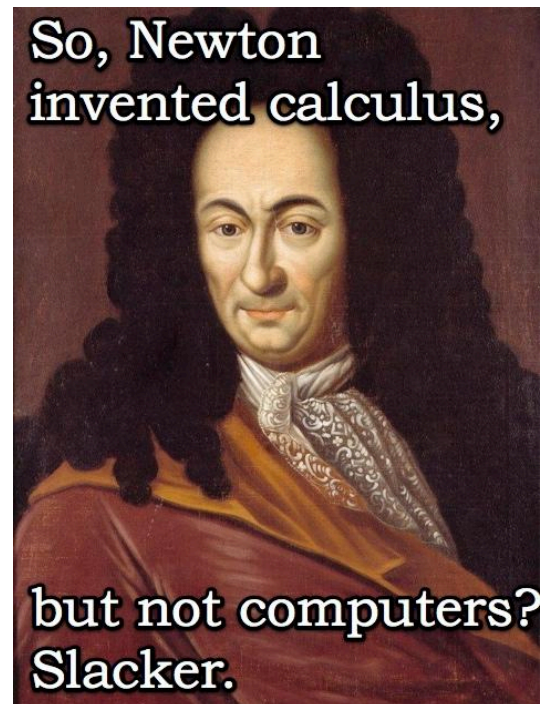
Book Bag

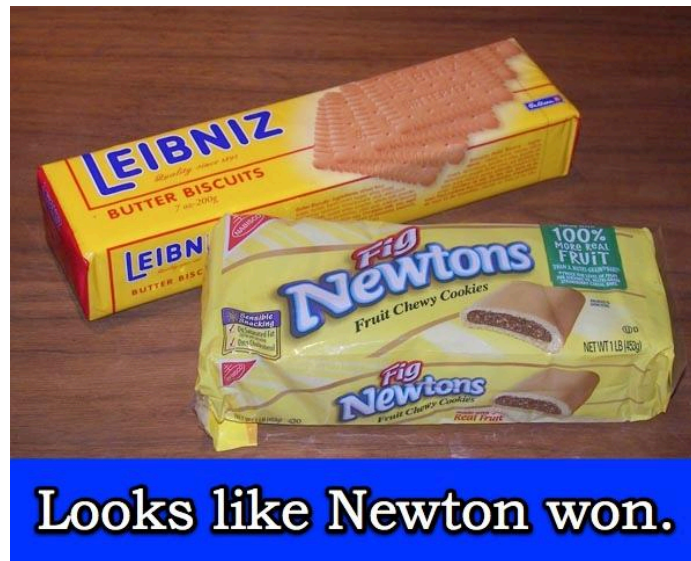
Daily:

- your daily work should involve the first or second Fundamental Theorem of Calculus for today. Be sure you understand it, can communicate it in plain language, and have an idea as to what makes it fundamental. How you do that is up to you, of course. (FTC [for dummies](#) ; [Proof Wiki](#))
- Student Colloquium. tea 4 pm, Anil Venkatesh, 4:30 A-2-117

Links:

- the [Controversy](#)
- the Epic Rap Battle: [good comic](#), (sorta) [lame video](#). Be good to have a real Rap Battle (*hint*)
- [Review of a Newton biography](#) that in itself is a good read. (By Marin Gardner.)
- Did Shourrya Ray [solve the Newton problems](#) or [not](#)?
- [Waker](#) - fun calculus based online puzzle/game
- Lack time to talk about them, but read up on [the Bernoullis](#), the closest we'll ever come to having a math family dynasty. One of the first brothers was Euler's teacher.





Extra:

- [Fibonacci, the Infomercial](#)
- [Is time travel possible?](#)
- [#ClickBaitLessons](#)

Day 16 Euler I

$$\int_{-\infty}^{\infty} \frac{\cos x}{(1 + x^2)^2} dx = \frac{\pi}{e}$$

Whaaat?

A Partitioning Problem:

Take a number and cut it into n pieces, then multiply the lengths of the pieces. For example:

24 → 2×12 → 12×12=144; 24 → 3×8 → 8×8×8=512. What is the biggest product you can make for 24? For 81? For 100?

e

the Master

Extra:

- [-1/12](#) and an [article about it](#)

- Of course XKCD did the identity. <http://xkcd.com/179/>
- The Man gets his own (well-deserved) digital archive: <http://www.eulerarchive.org/>
- GeoGebra: [Euler Line](#)
- GeoGebra: [Euler Circle](#) (Feurbach's Circle, Nine Point Circle)
- GeoGebra: a slick [formula from Euler](#) for arctan
- [Project Euler](#) is a self-teaching programming/number theory project. Great problems and really interesting discussion boards in any programming language you can think of after you solve each problem. [Sage](#) is probably the free platform a math major wants, which has powerful math commands and can run Python and other languages.
- Euler square. Arrange A, K, Q and J of all four suits in a square with no rank and no suit repeating in a row or column. (Diagonal or corners either, for bonus points.) What would this be like for 5?
- More on [partitions](#) by one of Akalu's advisors. Just read the first couple pages.

To do:

Blogging

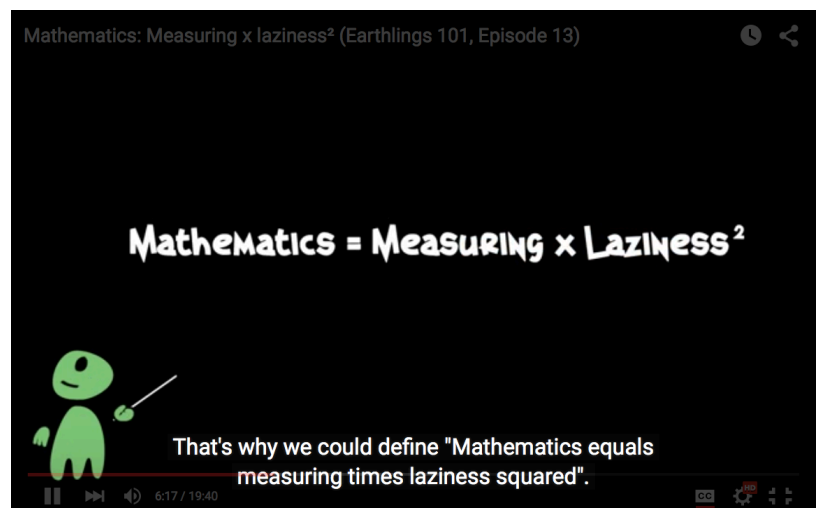
- Time for Blogpost 4. (Past actually; fall breather) Write me if you need ideas. Can you synthesize with your project?

Daily

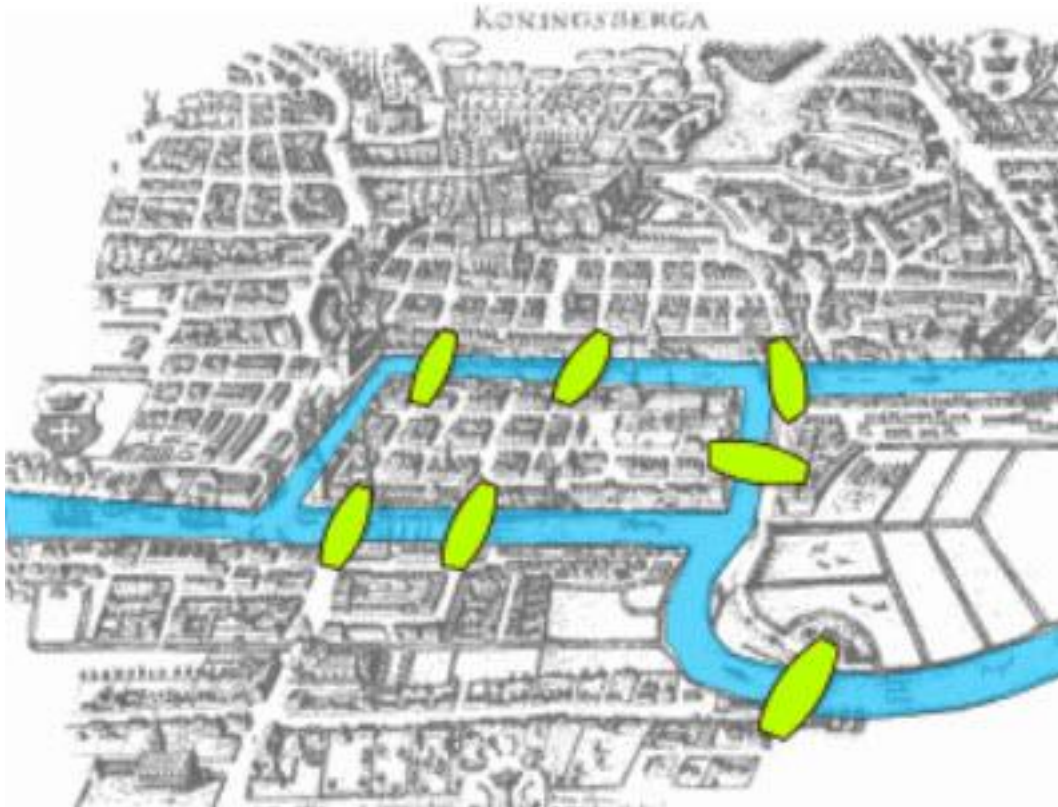
- make a flier or poster explaining or illustrating a math concept furthered or invented by Euler. Bring to class on Wednesday.

Throwback Extra:

- Mike Lawler delves (& 3-D prints) into [Archimedes' volume of a sphere](#) result.
- [ArtLab](#), St. Joseph
- [Alien view of earth mathematics](#) (YT), via Denise Gaskins.



Day 17 Euler II



two-dimensional finite [CW-complexes](#)

To do:

- catch up. (Feeling guilty for missing fall breather.)
- Daily check next Wednesday.
- Work ahead: comment on a blogpost 4 from a classmate.

Extra:

- [Euler factorization](#)
- [the Euler constant](#) γ - we don't know if it is rational or irrational!
- Euler made the first big advance in [perfect numbers](#) since Euclid. Maybe the most recent, also.
- 76 articles on [How Euler Did It](#). This one shows Euler [calculating probabilities for a card game](#), which - surprise! - winds up generating an infinite series and being connected to e . (Pretty followable, though.) Or Euler proving [a beautiful identity of Descartes](#) in geometry and trigonometry.
- Euler characteristic [one](#), [two](#) and [three](#).
- The [flaw in Euler's proof](#) of the characteristic!

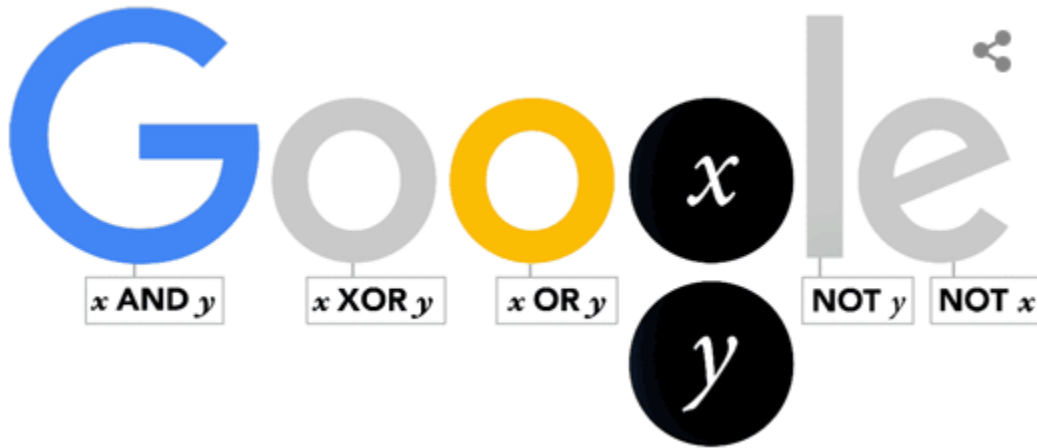
- Connecting Euler's elegant formula to [Gibb's elegant physics formula](#)
- A topologist [looks at a futbol](#).

Bonus:

- [amazing technique](#) for making paper polyhedra models. (I haven't tried it yet.)

[MathTeamMatics](#), Nov. 7

- [volunteering](#)



[George Boole](#)'s 200th Birthday

Day 18 The Other The Man

GAUSS

Modular Skirmish

Coprime if time

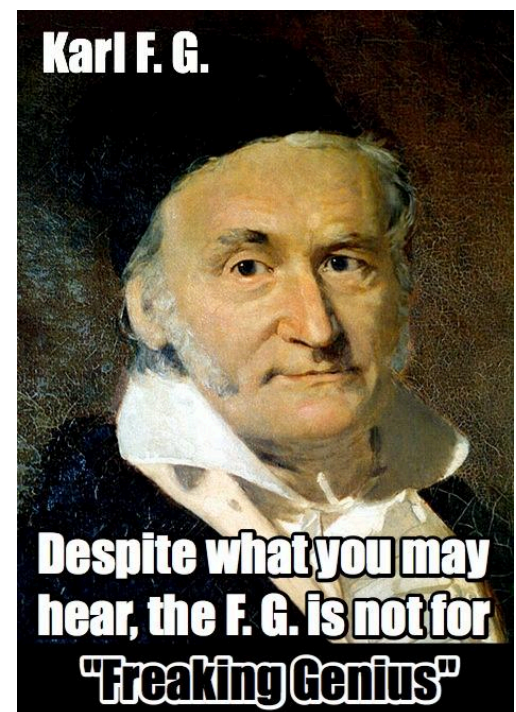
To do:

Project:

- Make progress, seek support.

Daily: lots to choose from, of course...

- Make sure you understand the Fundamental Theorem of Algebra. (Supporting [Numberphile video](#).)
- One neat result of Gauss was proving Fermat's conjecture that every counting number can be expressed as the sum of three triangular numbers. Good thing to play with, and fun that it connects to Gauss' 7 year old result.



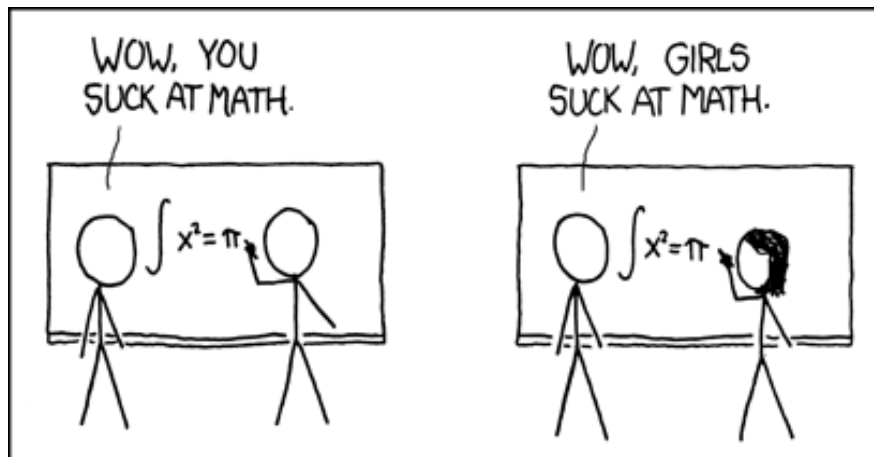
- work on a classic Gauss problem: how many ways are there to write a whole number as a sum of perfect squares? For example, 5 has 8 ways, not using zeroes but yes using negatives. So $(-1)^2 + 2^2 = 5$ is one way.
- Follow [Mike's process](#) through explaining that problem, Keep notes and make sense yourself of what he and his kids share.
- What Gauss couldn't prove: [his 163 conjecture](#).
- Play Modular Skirmish or Coprime

Extra:

- [Gauss Facts](#)
- James Grimes tells [The Story](#)
- The book. http://en.wikipedia.org/wiki/Disquisitiones_Arithmeticae
- [Gauss' proofs of the Fundamental Theorem](#) (pdf; tough read)
- Gauss was connected with the first great female mathematician of the modern era, [Sophie Germain](#), who had to overcome terrible sexism.
- Gauss was an advisor to [Bernhard Riemann](#), who made groundbreaking advances in geometry by describing geometric surfaces and more with complex-coefficient equations. Also responsible for the mysterious zeta function, and the as-yet-unsolved Riemann hypothesis.
- Jim Loy has a crazy collection of math resources, including a neat page on Gaussian primes (prime complex numbers): <http://www.jimloy.com/algebra/gprimes.htm> (dead link; here's [the archived page](#).)
- Why the bell curve is called a Gaussian distribution, and its odd connection with pi. <http://www.cut-the-knot.org/proofs/ClassicalIntegral.shtml>
- Gauss' modular arithmetic is the foundation of Public Key Cryptography. Here's [a clear exposition](#).
- A [pretty clear explanation](#) of the connection between AGM and ellipse perimeter.

Great quote via Pat Bellew: **"The shortest path between two truths in the real domain passes through the complex domain."** ~Jacques Salomon Hadamard

Day 19 What about The Woman?



Dailies Check

The Amazing Persistence of Sophie Germain

- [Sophie's Proof](#)

Part of the problem in a math history course is that there is a tendency to focus on European math of the last half-millennium, giving the impression that other cultural and ethnic groups are less capable as opposed to more repressed. And this applies how much more to women, who still today face obstacles in academia and in the sciences.

So for today's daily, research: (one of)

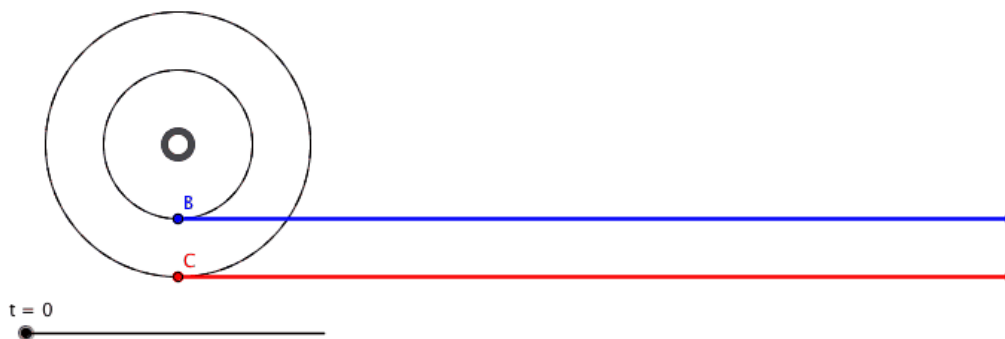
- understanding or applying a result from Sophie Germain
- historical women in mathematics (or focus on one); Hypatia, Agnesi, Noether and Kovalevsky are other mathematically famous historical figures. You might start at [MacTutor](#).
- current women in mathematics (or focus on one)
 - Interview one of the women of GVSU's math department
 - The [Noether Lecture](#) is a distinct honor and has had some of the greatest living women mathematicians as speakers. ([Booklet](#) profiling lecturers up to 2008.)
 - The first woman to win the Fields Medal: a Wired profile of [Maryam Mirzakhani](#)
- The mathbabe. Cathy O'Neil is a PhD mathematician, not an academic, a data scientist, blogger, [revolutionary](#), hip deep in [#Occupy](#), outrageous, writes a racy advice column... don't try to figure her out. Do read her:
 - I asked on twitter and she recommends this one on the [gender wage gap](#).

- [Gender and racial gaps in math](#)
 - [war on teachers](#)
 - [data science columns](#)
- societal bias against women in science
 - [gender bias in mathematics 101](#)
 - [NSF data](#)
 - [Virginia Valian](#) researches the cognitive causes of bias, focusing on bias against women. (Her book *Why So Slow?* is amazing to read.)

Extra:

- Nice PBS biography of [Madame Germain](#)
- On This Day in Math [April 1](#)
- Women in Science [Sophie](#)
- Mac Tutor [Sophie](#)
- Agnes Scott College: [Women Mathematicians](#)
- [Association of Women in Mathematics](#)
- [Fermat's Last Theorem](#) for amateurs (this includes your instructor)
- Stack Exchange: FLT for [Sophie Germain Primes](#)
- Top 20: [Sophie Germain Primes](#)
- The next great mathematician: [Lisa Sauerman](#)?

Extra extra: great [profile of George Boole](#) at Scientific American on his 200th anniversary.



Day 20 How many?

Infinity: "Use of it is never permitted in mathematics". - Karl Gauss

Sophie Recap: what did you do and find out?

Aristotle's Wheel

Infinity

- [Luceeee...](#)
- Infinite hotel

Cantor

To Do: *Daily*

- explore some aspect of what we did today.
History of infinity, nature of infinity, a paradox of infinity...

Project

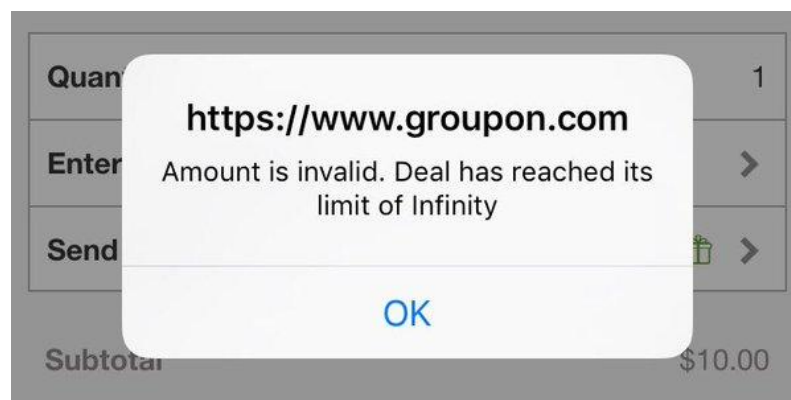
- make progress!

Extra

- Katrice [blogged about infinity](#).
- Good general audience [presentation on infinity](#)
- Some [infinity bijection animations](#).
- Hilbert's [Infinite Hotel](#)
- Read more about [infinity at Cut-the-Knot](#)
- Cantor's uncountability of the real numbers proofs at the [Proof Wiki](#)
- The algebraic numbers, however [are countable!](#)
- [It's not complicated](#)



A formative day for Georg Cantor.



Extra extra:

- content specific [I <3 math stickers](#)
- 3 million dollar [Breakthrough Prize](#) in math awarded. More on [Agol's work](#).

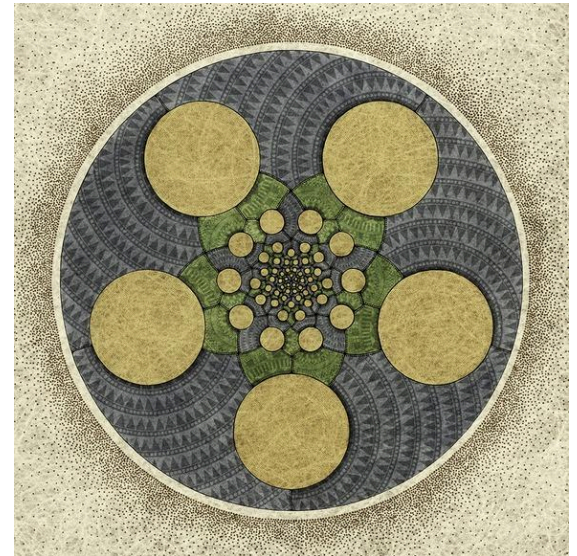


Day 21 Group On
Nov 11, Wed

Poor Galois
Group Game ([GGB](#))

To do:

- Learn more about Galois or groups, or how his work relates to the idea of a quintic formula. Here's an accessible explanation from [Mathematics Illuminated](#) or the links in the extras. (du Sautoy's talk is good.)
- Or think about [mathart inspired by symmetry groups](#). Here's another mathematical artist thinking about symmetry groups: [Conan Chadborne](#)



Extra

- Marcus du Sautoy [explains Galois](#) with several applications.
- Follow up TED ED on the [Rubik's Cube as a group](#) and piano music.
- Clearest, shortest explanation of Galois theory I know: <http://nrich.maths.org/1422>
- Malke Rosenfeld plays with [a physical version](#) of the activity we did in class today.
- [Group properties](#) wiki; [S^3 page](#)
- Terry Tao (candidate for greatest living mathematician) explains how Galois Theory proves the [impossibility of trisecting](#) the angle.
- Nice illustration of the [symmetries of a square](#)

Veteran's Day: From Fallujah to Pennsylvania, Chris Lusto's life as a Marine and a math teacher
<http://to.pbs.org/1SGW8Om>

Day 22 Teacher and Student

Riemann

- [Taxicab Geometry](#)



Hilbert

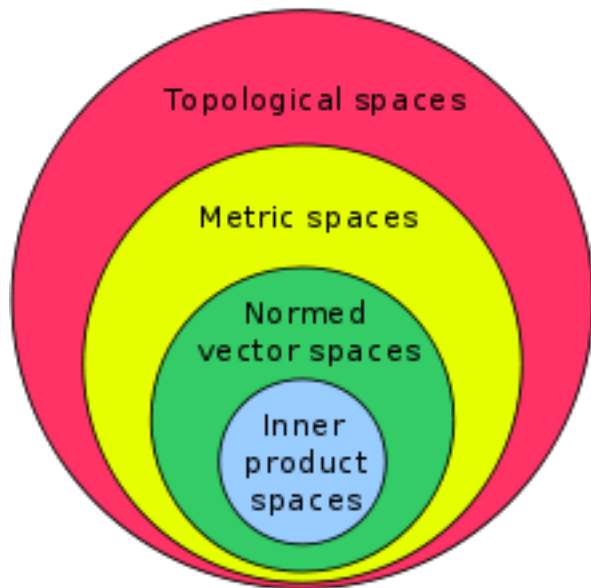
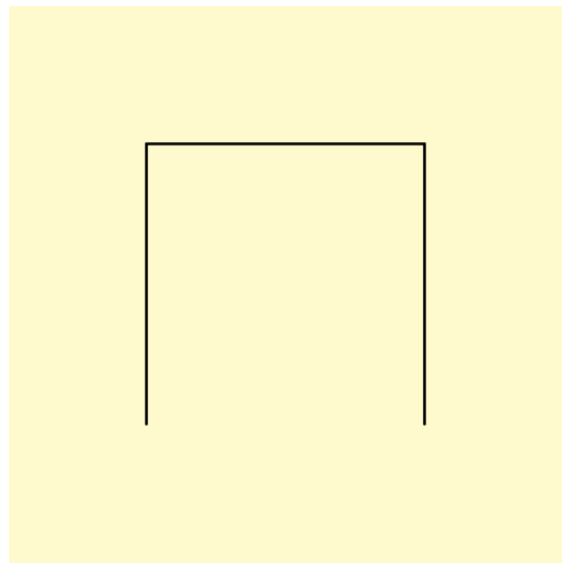
- [Vi squiggles](#)

To Do:

- First: read this. [Spaces in math](#), a key generalization. Post a couple sentence take away to FB
- Second: choice of...
 - explore an alternative geometry (Taxicab or [Spider](#))
 - doodle around with space filling curves.
 - Try this historical problem from Pat Bellew that combines geometry and number theory. [Heronian Triangles](#).

Extra:

- Riemann [biography](#)
- The four simplest [Riemannian manifolds](#).
- Mike Lawler connects the [Riemann sum idea to 3-D printing](#).
- Zeta function: [Wikipedia](#) and [Mathworld](#)
- Hilbert's [23 Problems](#)
- Past student project on Hilbert's 6th problem. [Solved or unsolved?](#)
- Pretty amazing story out on [the Riemann Hypothesis](#) this week. Was it solved?



Next up ... topology!

Day 23 The Shape of Things

Wed., Nov 18



A paper puzzle

Thurston

- [Representation](#)
- [Fashion](#) & [interview](#)

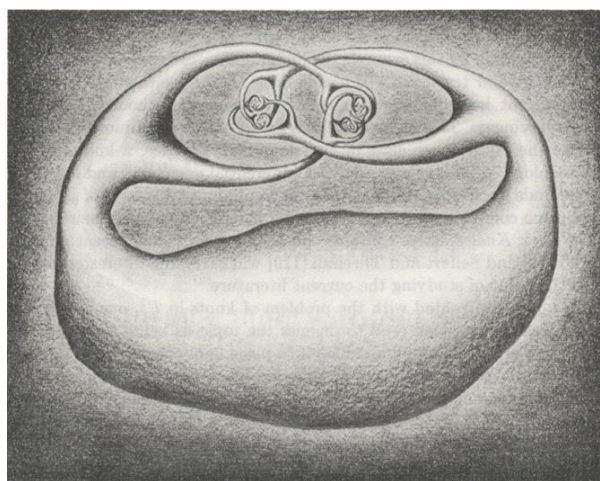
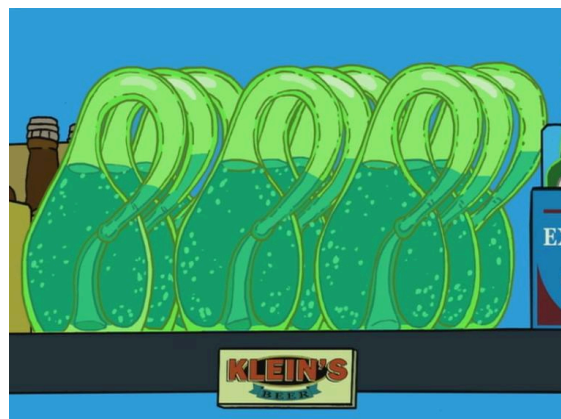
[Mr. Bean](#)

Möbius

To do: Follow links of interest from the extra and do some topology playing.

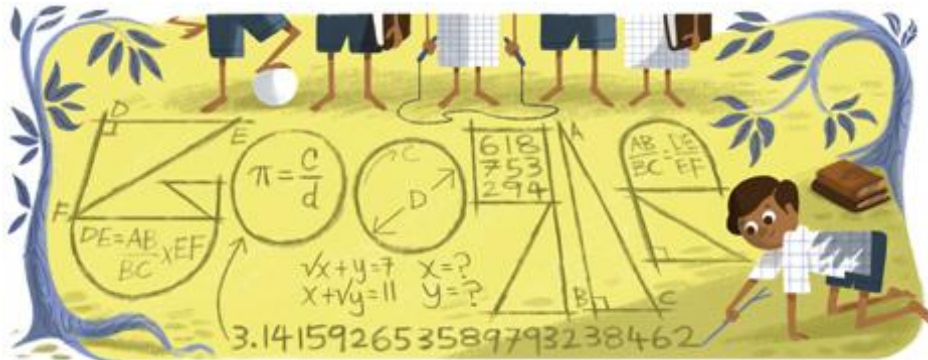
Extra:

- [Brouwer Fixed Point Theorem](#)
- [Hairy Ball Theorem](#)
- [Topological Puzzles](#) for K-12
- Ty Yann's [YouTube Math Puzzles](#)
- Dave Richeson's [topology playdough](#) - is this a legal move?
- A variation on the paper puzzle from class with [playing cards](#)
- Thurston's essay: [Why Do Mathematics?](#)
- Wikipedia page for the [Geometrization Conjecture](#)
- [Thurston explaining](#) his & Poincaré's conjectures (intense hour)
- Thurston [explains how Narnia might work](#) (only 10 min!)
- [Cornell memorial](#) page for Thurston
- [Klein bottle animation](#) from my mentor's [daughter](#)
- [Polyhedra in science](#)
- Numberphile does [a slick version](#) of our paper trick.



Day 24 Ramanujan

Ramanujan



- Magic Square [Google sheet](#); please make a copy before editing.
- The [jigsaw](#)

To do:

- Project: progress
- Community: comment on a blogpost without a non-Golden comment
- Daily:
 - If you didn't watch for Gauss, watch now! Numberphile: [163](#)
 - Read or play with one of the continued fractions resources below.
 - Extra time: make some Magic squares

9	10	19	64	102
63	20	13	6	102
12	7	62	21	102
18	65	8	11	102
102	102	102	102	102

My birthday is a row here.

Extra:

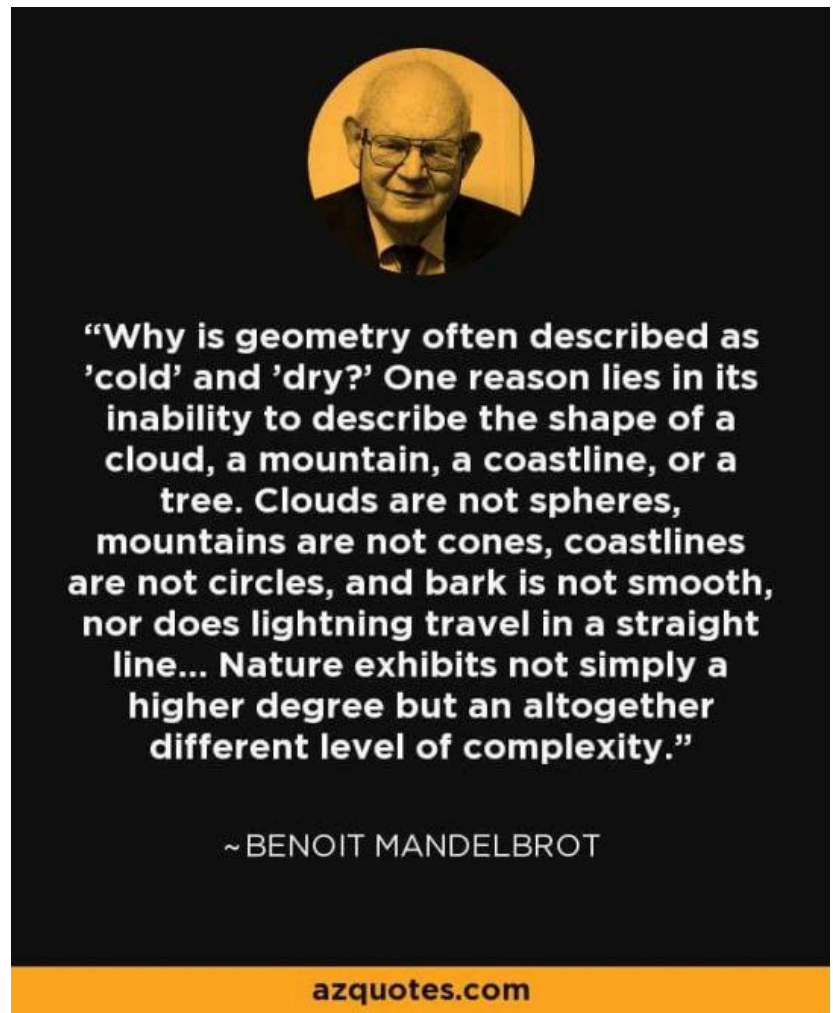
- One of Ramanujan's [particularly nice continued fractions](#).
- A collection of a [few accessible interesting Ramanujan results](#).
- Old fashioned website, but nice info [on Ramanujan](#). Also see the [St. Andrew's biography](#) or the [BBC documentary](#)
- A [continued fraction GeoGebra](#) sketch that I haven't had the chance to figure out yet.

- Online [continued fraction calculator](#)
- W|A [does continued fractions](#) (of course)
- 44 second [Ramanujan tribute video](#)
- Intergermania is a fun site where they encourage playing with number and calculation. They have a page dedicated to [1729 in honor of Ramanujan](#).
- [Ramanujan's magic square](#) video

Coming soon ... Fractals.

Extra extra:

- Scott Bladridge interviews [Clayton Shonkwiler](#), topologist and #mathart maven. Turns out random polygons have something to do with the chemistry of polymers, plus pretty pictures. [Clayton's blog](#).
- [Transformations game](#) adapted for grades 5-8.



Day 25 The B stands for Benoit B Mandelbrot

Sign in: it's time. Design your math tattoo.

- [Geometry Daily](#)
- [Naked Geometry](#) (SFW)
- [Made by Jones](#)
- [Dudeney's Dissection](#)

Fractals

- the rug
- Hausdorff dimension

- The Cantor set (a zero-dimensional topological space) is a union of two copies of itself, each copy shrunk by a factor $1/3$... its Hausdorff dimension is $\ln(2)/\ln(3) \approx 0.63$.
- The Sierpinski triangle is a union of three copies of itself, each copy shrunk by a factor of $1/2$; this yields a Hausdorff dimension of $\ln(3)/\ln(2) \approx 1.58$.

Mandelbrot

- [video](#)
- Complex Dynamics
- [visual](#)

Julia sets

- <http://julia-map.appspot.com> nice visualization tool (in HTML5, so tablet friendly)

Recursive Drawing

- [One](#)
- [Two](#)

Research

$$\text{dimension} = \log_2(\varphi) :$$

To do:

- free play. Fractals suggested. Or the wonderful [Cantor set](#). Or the Pascal's triangles variations; or really vary it [like this](#). Or the [Koch snowflake](#) that we didn't even talk about.
- Project.
- Reading: By next Monday, post to FB a response to your skim of the 2nd book. High point, low point (if any), recommend to whom?



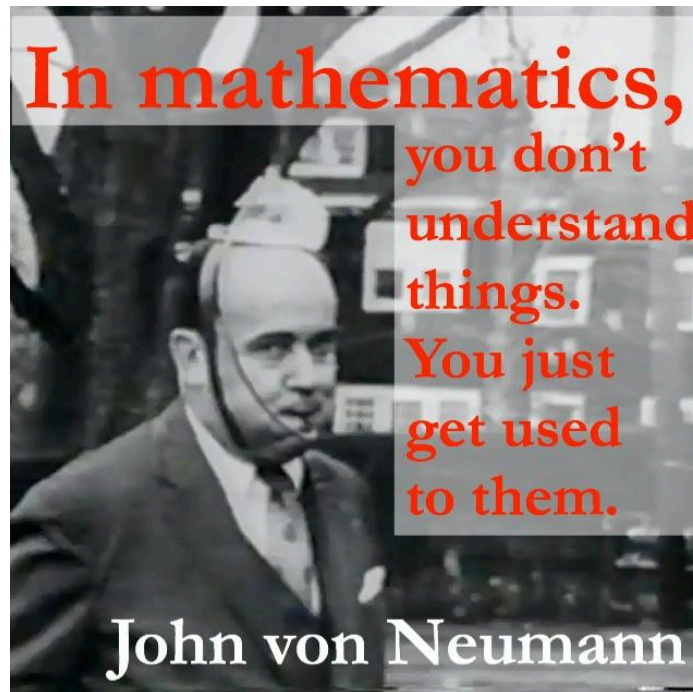
Extra:

- A few good [Benoit B. nuggets](#)
- One of BBM's last appearances, [a TED talk](#)
- Dan Anderson's [visualization](#) and [blogpost](#) about programming it.
- IBM tumblr's [fractal posts](#) (I know, IBM has a tumblr?)
- School lessons: [fractivities](#) & [fractal lesson plans](#) from Rice.
- [xFractal](#), good free fractal viewer for iOS. What's a good one for Android?
- Mozilla's [fractal explorer](#)
- Michael Ortiz does some [sweet fractal GeoGebra](#)
- Fractals [by dimension](#)
- My [simple fractal tree](#) or [Pythagorean spiral](#)
- <http://fractalmind.tumblr.com/>

- Kyle Zimmer's 495 project: the [MoKai Ninja Star](#)

Extra extra:

- [space filling curves and city simulations](#) - fascinating.



Day 26 Which way? Conway!

Sequence

John Conway

- Pinwheel Tiling [GeoGebra Sketch](#)
- Game of Life webpage <http://www.bitstorm.org/gameoflife/> (Java=not mobile)
- Game of Life webpage <http://www.quesucedede.com/public/gameoflife/game.html> (HTML5)
- iOS: favorite implementation - [Golly](#), Golly [on Android](#)
- Another iOS [Game of Life](#)

To do: try either

- Daily: try either
 - the game of life (experiment, keep notes on what you find) OR
 - the [game that explains surreal numbers](#). Are they numbers? In what sense? See also Mike Lawler's investigation with his kids on this, part [one](#) and [two](#)

- Project
- Reading: By next Monday, post to FB a response to your skim of the 2nd book. High point, low point (if any), recommend to whom?
- Last dailies check: Monday.

Extra

- Conway tangles [1](#), [2](#) and [3](#) from Nrich.
- Greatest living mathematicians
<http://divisbyzero.com/2013/04/12/greatest-living-mathematician-and-expositor/>
- Review of the [new Conway biography](#)
- A couple people have asked about Nature of Mathematics topics. Here's an unreasonable wikipedia page on [math and science](#) to make you go hmm.

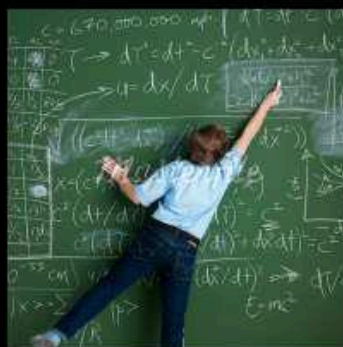
Mathematician



what my family thinks
I do



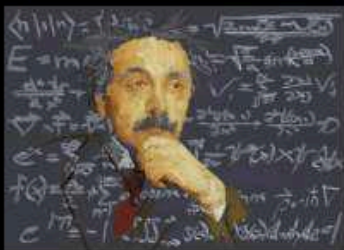
what college algebra
students think I do



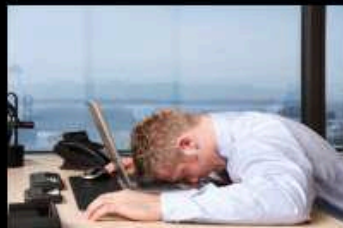
what my friends think
I do



what other math majors
think I do



what I think I do



what I really do

Day 27 The Algebra Lesson

God made the integers, all else is Man's work ~Leopold Kronecker

1823 Leopold Kronecker (7 Dec 1823; 29 Dec 1891) German mathematician who worked to unify arithmetic, algebra and analysis, with a particular interest in elliptic functions, algebraic equations, theory of numbers, theory of determinants and theory of simple and multiple integrals. However the topics he studied were restricted by the fact that he believed in the reduction of all mathematics to arguments involving only the integers and a finite number of steps. He believed that mathematics should deal only with finite numbers and with a finite number of operations. He was the first to doubt the significance of non-constructive existence proofs, and believed that transcendental numbers did not exist. The Kronecker delta function is named in his honour. (From [Pat Bellew](#))

[Jacob Lurie](#) ([bio](#); [Breakthrough Prize](#))

e is crazy! I mean, irrational.

- [GeoGebra](#)

Gödel

- [Wikipedia: CH](#)
- MacTutor [Gödel](#)

To do:

- [Last Daily](#)
- Last Blogpost. Optional: has your work this semester changed or refined your idea of what mathematics is and what mathematicians do?
- make up for an absence: chase down some current math, share results on FB. (60 min)
 - finish watching Lurie's talk, he gets into topology.
 - [Terry Tao](#) is a great current mathematician (another breakthrough prize winner), who is also a leader in trying to get mathematicians to use current communication methods. The recent Twin Prime work is a great example.
 - [Tim Gowers](#) is a Fields Medalist who blogs thoughts, teaching notes and serious mathematics on a no frills website.
 - [John Baez](#) is a mathematician involved in climate change who is also a good communicator.
 - [n-Category Cafe](#) is a group blog with grad students, mathematicians and more.



- [Ars Mathematica](#) is like a math news reporting blog with good linkage.
- [arXiv](#) is where many mathematicians post new results to establish authorship while sharing information prior to publication.
- Instead, look at a recent topic, the discovery of a [new class of polyhedra](#)!
- This [Wired article on the Kadison-Singer conjecture](#) is a topic from my old research area (I've met many of these guys - you're one removed!), connection with physics (quantum mechanics) and unintended connections and consequences.
- Project
- 2nd Book FB post if you haven't.

Extra:

- [Twitter conversation](#) that started this lesson (post by Mike Lawler)
- [Undergraduate expository mathematical writing](#) by Leo Goldmakher gives the base of the activity ([from here](#)).
- Fun site, new to me [Math Counterexamples](#). Via the [Aperiodical](#), which is doing a maths advent calendar. (They're English.)
- Deeper into Gödel's Incompleteness yet still an [Introduction](#). The best way to try and understand it is the book Gödel, Escher, Bach. ([Reddit thread](#) devoted to the book.)



If your last blog post is on a big question, cf.

- [Plato & vision](#), David Mumford & [the full paper](#).
- Kate's essay on [our number system](#)

Day 28 Unfinished Business

Gödel

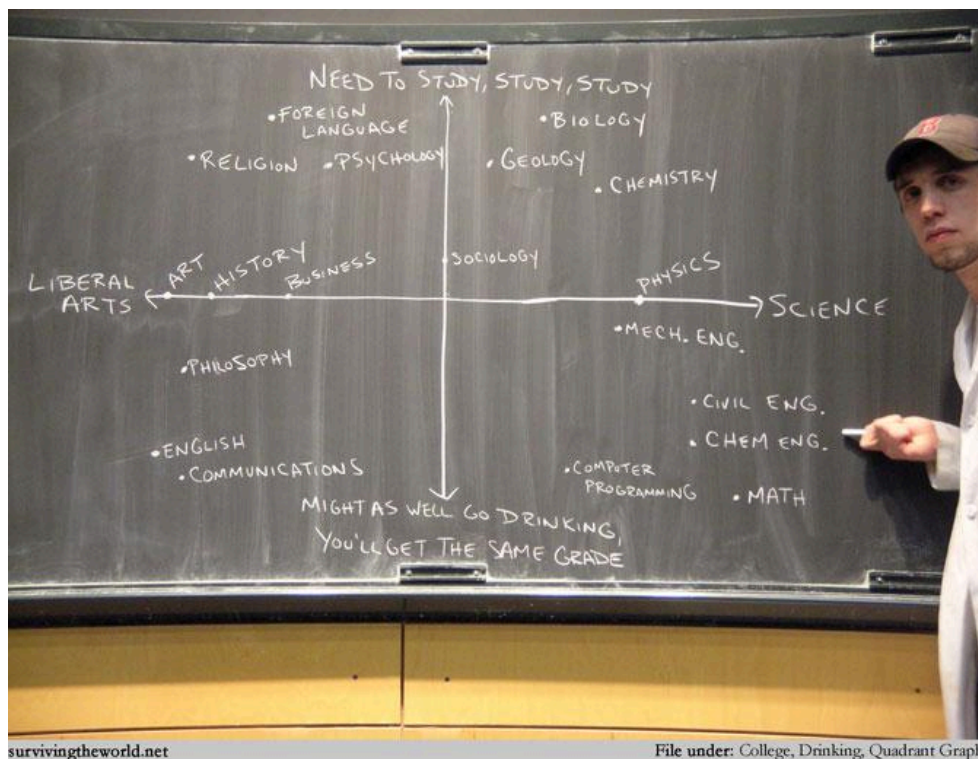
The last debates:

- Is math invented or discovered OR is math a science?
- Math Avengers or Math Rushmore

Presentations

Evaluations

Extra: [Kathy Reck's project](#) - a weebly of a lot of this course! Excellent resource.



To do: End of Semester:

Last Daily: give/send it to me, please.

Project: get me your project or a copy by next Monday. If not sharing today, be ready to share on Monday - what did you do? Mode of sharing is up to you; should vary by nature of the project.

Exemplars: from daily work, class work, or -usually - blogging, choose three items to best represent your work. Your exemplars should cover three of the four categories. Email me a link to the posts, turn them in in paper, deliver by kangaroo on cuneiform tablets... your choice. Evaluated by the 5C's. **For each exemplar** include two sentences: (1) which category and why; (2) what makes this your best work. Omitting this docks your consolidation.

- Doing Math - original mathematical work of your own that communicates your process and thinking. (As opposed to being answer focused.)
- Communicating Math - describing and explaining the mathematical work of others.
- History of Math - looking at the development of ideas or the contributions of mathematicians to the field.
- Nature of Mathematics - what is mathematics? What does it mean to do mathematics? Opinion supported by evidence or examples.

Last Day +1

Evaluations

Presentations!

- Josie's and Katie's [Slides](#)
- Dakota's [Playing Card Polyhedra](#)
- [Wallpaper Coloring Book](#) - Lauren, Natalie and Schmitty

