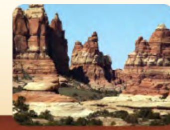
NUGGETS OF MATH APPLICATIONS

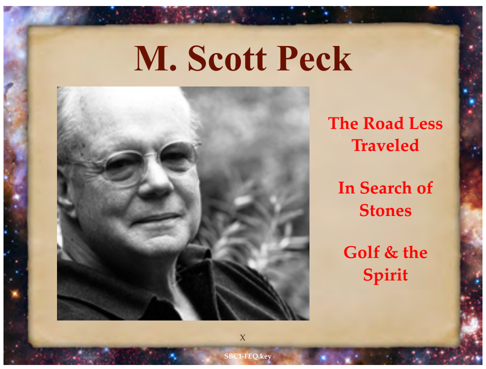
By Marvin L. Bittinger

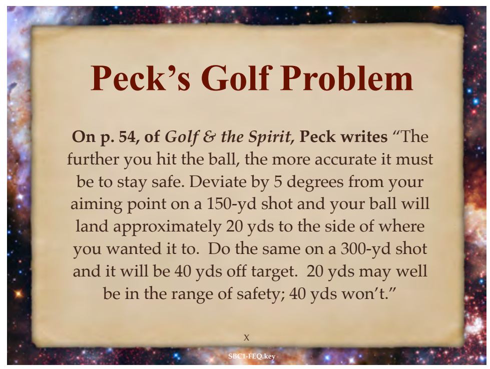




Nuggets of Math Applications:

As I wrote math textbooks for some 50+ years, I became "a cat on the prowl" for interesting, fascinating, engaging math applications. Some samples follow. Most of them are applied types of topics, but some are just enjoyable mathematics and follow the whims of my interest. Examples follow, not in any particular order. Many of them appear in my book, *One Man's Journey Through Mathematics.* Most of them are in our textbooks.

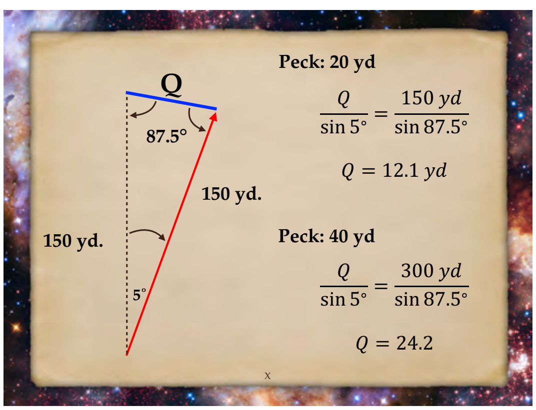
1. M. Scott Peck & His Golf Problem:





M. Scott Peck is one of my favorite authors. In my quest for math nuggets I was able to have some lengthy philosophical discussions with him. Peck is most famous for his *Road Less Traveled* books, but later wrote s book entitled *Golf and the Spirit*, in which he draws a parallel of golf to life: "Life is tough! Golf is tough!" Each hole represents a challenge much like each day of our lives.

See above the quote on p. 54 from his book. When I read this, I was delighted to find some reference to math in his book. I had the thought to verify the math. See the drawing as follows.



You hit a straight drive. It goes 150 yd. If you had deviated by an angle of 5°, an isosceles triangle is formed, the base of which is 12.1 yd, instead of Peck's listing of 20 yd. These computations use The Law of Sines. Similarly, if the shot was originally 300 yd, the deviation would be 24.2 yd instead of Peck's 50 yd.

I wrote Peck a glowing letter about his writing informing him of the correction. He graciously responded. What followed later was a two-hour phone call in which we discussed all kinds of philosophical topics like mystery, paradox, kenosis, and Christianity. I truly felt like I was sitting on a lap of wisdom. We discussed such topics as paradox, mystery, and kenosis. *Kenosis* is a psychological concept - the act of emptying oneself of self. I asked Peck because I so often wake up at 3:30 to go to the bathroom. My mind isn't clouded by other thoughts of the tasks of life. I so often have solutions to math problems or math writing come to me at that time.

The latter part of Peck's life was rapt in controversy, but for the time period shared with me, he was a truly fine human being and wise man. I will forever remember his kindness to me. And, what a terrific and engaging speaking voice he has! I urge my reader to make a point of enjoying his books.

Source: *Golf and the Spirit,* by M. Scott Peck, p. 54, Harmony Books, NY. Read especially, Ch 8, *Hole 8 Paradox*. BTW, my favorite number is 8. This is my favorite chapter.

2. Wind Chill Temperature (Temperature adjusted for Wind Speed):

My authoring mentor, Mervin L. Keedy, and I, worked on the following problem once while traveling to a conference.

Problem: Because wind speed enhances the loss of heat from the skin, we feel colder when there is wind than when there is not. The *Wind Chill Temperature* is what the temperature would have to be with no wind in order to give the same chilling effect. The wind chill temperature W is given by

$$W(v, T) = \frac{\left(10.45 + 6.68\sqrt{v} - 0.447v\right)(457 - 5T)}{110}$$

where T is the actual temperature as given by a thermometer, in degrees Fahrenheit, and v is the speed of the wind, in miles per hour. Find the wind chill temperature when T = 30°F, and v = 25 mph.

Source: *Calculus and Its Applications, Brief Version,* 12 ed, by Bittinger, Ellenbogen, and Surgent, 2020, Pearson Ed, 2020, p. 559.

3. Heat Index (Temperature adjusted for Humidity):

Related to the preceding problem is the adjustment made to actual temperature due to the effect of high humidity. One estimate of the *Temperature-Heat Index, Q*, is given by

$$Q(h, T) = 1.98T - 1.09(1 - h)(T - 58) - 56.9$$

where T is the actual air temperature, in degrees Fahrenheit, and h is the relative humidity, which is the ratio of the water vapor in the air to the maximum amount of water vapor possible at that temperature. *the humidity h is* usually expressed as a percentage (%). Find the temperature-humidity index when T =

90° and *h* = *100%*. I found this in a math journal, but have no recall of what it was – maybe an AMATYC publication?
Source: *Calculus and Its Applications, Brief Version,* 8th ed, by Marvin L. Bittinger, 2004, Pearson Ed, p. 509.

4. *n* Consecutive Composite Numbers of Which None are Prime:

Suppose we wanted to construct a string of n - 1 consecutive composite numbers of which none are prime. That string could be generated as follows:

$n! + 2,$	$n! + 3,$	$n! + 4,$	$n! + 5,$	… ,	$n! + n$
(1)	(2)	(3)	(4)		(n - 1)

Consider, $n! + 2$. The number 2 is a factor of both $n!$ and itself. So it is a factor of the sum $n! + 2,$ and therefore the sum is composite. By a similar argument, all the numbers in the sequence are composite. For example, 10! = 3,628,800, so the following is a string of 10 consecutive composite numbers
3,628,802; 3,628,803; 3,628,804; 3,628,805; 3,628,806; 3,628,807; 3,628,808; 3,628,809; 3,628,810; 3,628,811.

Similarly, let $m = 10^6 + 1 = 1{,}000{,}001$. Then the following is a string of m – 1, or 1,000,000 consecutive composite numbers:

$$m! + 2,\ m! + 3,\ m! + 4,\ \ . \ . \ . \ \ ,\ m! + m.$$

Pause and think about this. Here is a string of 1 million consecutive composite numbers, and none of them is **prime.**
Source: See Terence Tao's lectures on U-Tube on Random spacing of prime numbers.

5. Card Shuffling:

What is a perfect card shuffle? We answer that by referring the reader to YouTube where there are many videos which contain the answer. That begs the question, "How many perfect shuffles do you have to do to get the cards back to their original order?" The answer is 8 when the deck is 52 cards. For different size decks, the answer varies. *Warning:* Your patience may be tested trying to achieve just one perfect shuffle – it might take a very accomplished casino dealer to achieve 8 in a row. But it's fun to try.

Sources:
https://www.youtube.com/watch?v=OFjgPGPQoNA
Kevin Houston, How to Think Like a Mathematician.

https://www.youtube.com/watch?v=MtBzp_-hooQ
Tori Noquez

https://mathweb.ucsd.edu/~ronspubs/83_05_shuffles.pdf

or, simply plug "Perfect shuffle; images" into your Google Search browser.

See also pp. 271ff of Marcus Du Sautoy's book, *The Music of the Primes.*

6. Lightning Distance:

Ever see lightning and wonder how far away it might be? A simple formula for estimating is to count the number of seconds, *n,* after seeing the lightning until the thunder is heard. Then divide by 5. The result is the lightning distance *M,* in miles:

$$M = \frac{1}{5}n.$$

Source: *A Problem Solving Approach to Introductory Algebra, 2nd* ed, by Marvin L. Bittinger and Mervin L. Keedy, 1986, Addison-Wesley Pub Co. p. 309.

7. Baseball & Mathematics:

The following links provide lots of info on current trends in baseball in the use of analytics. The game is changing significantly because of these scientific/mathematical insights.

http://baseball.physics.illinois.edu/

https://iubaseball.shinyapps.io/IUGameTrackman/

See also the *Baseball and Mathematics* link on this website.

8. Economic impact of the NCAA Basketball Tourney:

The NCAA Basketball Finals have a tremendous economic impact on a city. Suppose 20,000 people visited a city and spent \$950 each while there. Then assume 80% of that money is spent again in the city, and then 80% of that is spent, and so on. What is the *economic -multiplier effect* on the city?

The "initial effect" is 20,000 x \$950, or \$19,000,000.

If 80% of that is spent again, and 80% of that is spent again, and so on, the economic-multiplier is the sum of an infinite geometric series:

$$\frac{\$19{,}000{,}000}{1-0.80} = \$95{,}000{,}000.$$

This is significant for the city!

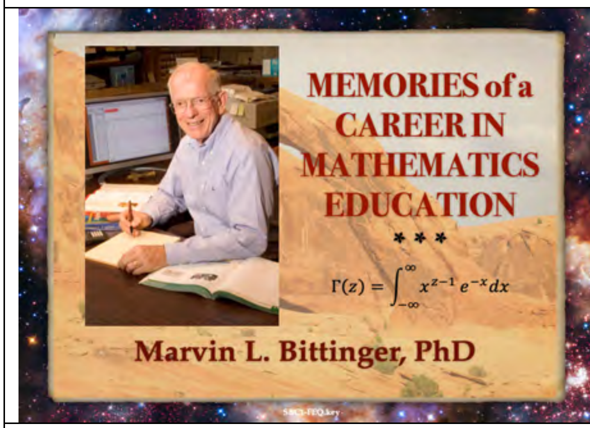
9. Internet Scam Using the Starbucks Cups:

The internet scam with the Starbucks Coffee cups. I'm not going to do this for you. Watch the movie, go to Starbucks obtain the cups. Then do the math and determine the scam. See how much mathematics you can find. Consider volumes or rings, cylinders, and disks.

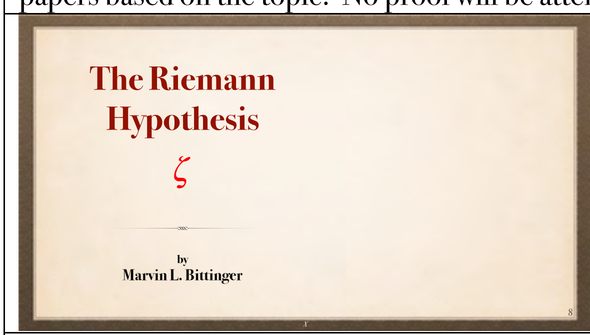
Talks on Math Applications:

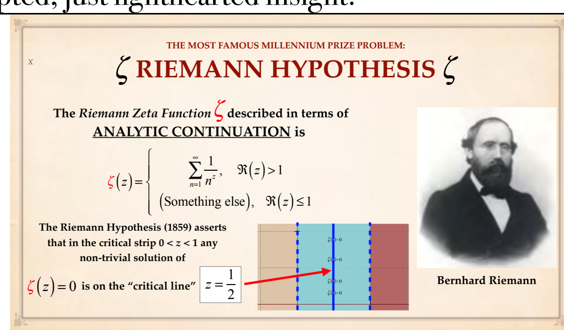
I often give talks on math college mathematics.   Some follow.

1. Memories of a Career in Math Education: This talk takes a path through my career considering the *lows* as well as the *highs*. From Manchester College, to Ohio State University, to Purdue University to a position as Prof of Math Ed at IUPUI. Along the way I was a Distinguished Visiting Professorship at The United States Air Force Academy and the author of numerous math textbooks for Pearson Education. The intent is to inspire people to overcome the bumps in life and pursue a career based on mathematics.

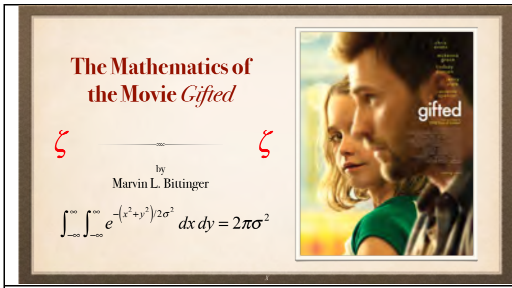


2. The Riemann Hypothesis: The Riemann Hypothesis is the most famous unproven statement in mathematics. Its valid proof earns $1 million. Yet, how many math students, professors, or teachers have even a hint of what it is and its power? Developed in 1859 by Bernhard Riemann, its proof may reveal the mysteries of the primes and enhance understanding of number theory, cryptography, quantum physics, and string theory as well as corroborating 500-1000 research papers based on the topic. No proof will be attempted, just lighthearted insight.



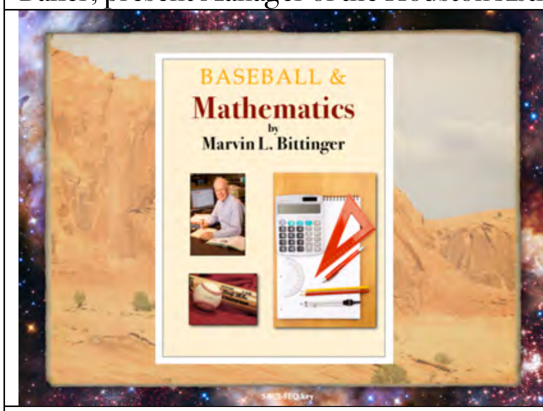


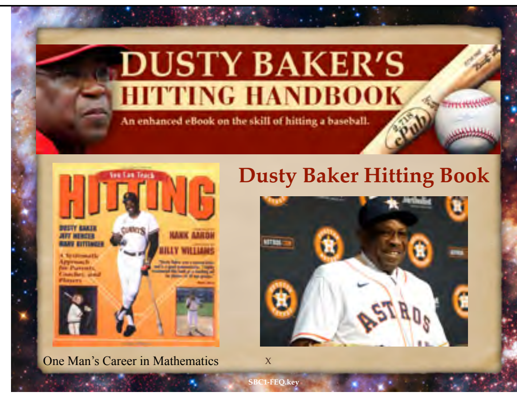
3. The Mathematics of the Movie Gifted: The movie *Gifted (2017)* tells the fictional the story of a 7-yr-old math prodigy caught in a custody battle between her uncle and her maternal grandmother. Held together succinctly with math topics ranging from the Trachtenberg Method to statistics to the Navier-Stokes Millennial Problem, the film is advised by four top research mathematicians. Clips will be shown with intermittent discussions of the math. The talk is about 50 mins, but at a couple of universities the movie was shown before the talk with a reception in between.



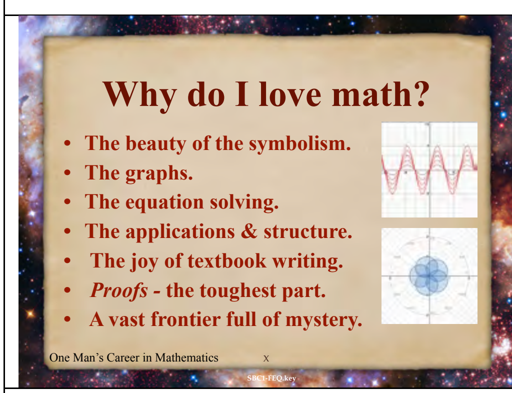
4. Baseball & Mathematics: Mathematics has many applications to baseball apart from statistical computations. We will examine how math applies to four-seam vs two-seam fastballs, the tale of the tape, the lost war years of Ted Williams, the physics of a baseball bat, the magic number, and the probabilities of outstanding players reaching extremely difficult records.

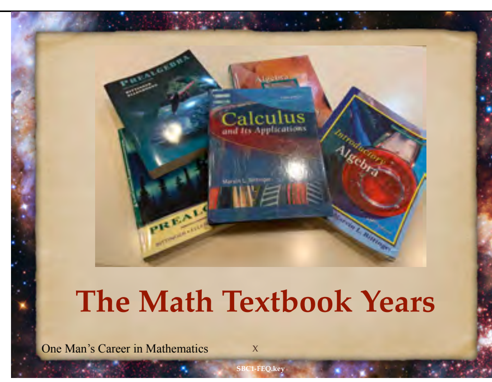
These applications were discovered by the author when he wrote a book on hitting with Dusty Baker, present Manager of the Houston Astros.



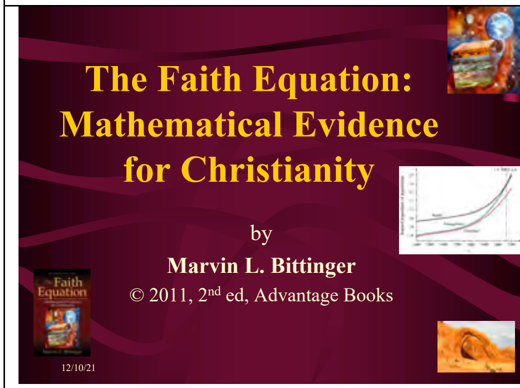


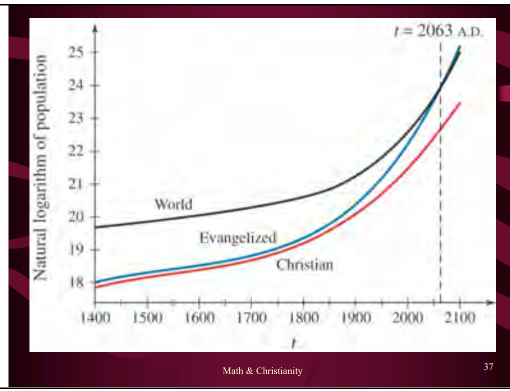
5. Why I Love Mathematics?: The author presents a multi-faceted answer to the question of why he loves mathematics. Ranging from the beauty of the symbolism & graphs, equation solving, proofs, to the use of imagination & creativity, the development of applications, and the writing of math textbooks, many brief examples of such topics will be considered.





6. Mathematical Evidence for Christianity: Best designed for presentation at a college or university with a Christian basis, this talk presents many kinds of evidence for the reliability of The Holy Bible and the Christian faith. Among topics considered are the probability of prophesy, statistical studies on the power of prayer, higher dimensions, and string theory. This talk has been presented at National Math meetings, college math clubs, groups such as Cru, and community rescue missions. It is based on the author's book *The Faith Equation: Mathematical Evidence for Christianity*.





Based on 50+ years of writing math textbooks for college students, Prof Bittinger provides ideas on such topics as (1) How he became such an author, (2) What goes into the process, (3) Finding and dealing with a publisher, (4) The revision process, (5) The bumps in the road, and (6) The joys of such a career.

Thank you for considering my ideas! BTW, I do not charge a fee for these talks.

Prof. Marvin "Marv" L. Bittinger, Prof. Emeritus of Math Ed, IUPUI.
You can reach me at exponent8@gmail.com.

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Math Study Tips:

Following are a few of my favorite Math Study Tips. They are gathered from years of teaching and writing mathematics.

1. Test Taking & "I Could do the Homework but Froze on the Test:

As a Professor, I have heard this storyline numerous times over the years. I'm going to give you my straight-from-the-heart explanation. In most cases students are doing a con job on themselves and trying to find a feeble excuse for lack of effort. They simply do not know the procedures and how to carry them out. When doing homework, they tackle an exercise with a token effort and jump to check the answer, if it is available, which it is in most of today's textbooks. The storyline is their scapegoat for lack of effort, and/or from the poor habit of rushing to the answers too quickly, or turning the test in too quickly without checking their work.

Have you ever thought of the difference in taking a test and doing homework exercises in a book? One of the differences may be that on most of the homework you have the answers, and you lean on them too much, and use them to talk yourself into believing you have acquired the task at hand. So, what is the tip? ***Do more exercises without answers!*** This way you practice the actual test taking skill that consists of doing problems without answers.

Think of a basketball game. What do the players do before the game? They shoot baskets and especially foul shots. They are practicing the skills needed in the game. When you do problems without answers you put yourself in the position of actually practicing what you perform on the test.

In connection with this act of doing exercises without answers, how can you do more to ensure you have the right answer? Suppose I were to offer you $10,000 for each correct answer. Then you might do the problem over again on a clean sheet of paper, working carefully and deliberately to get the correct answer. If you were solving an equation, you might check the answer by substituting into the equation. You might also use a simple calculator, or graphing calculator, or graphing software like *Desmos*, if allowed. All such tasks can be practiced on your homework as you do test problems. You then are practicing the tasks on a test beforehand, and the test is a more routine event. You have more carefully prepared yourself for the game of test taking.

2. Be the Last to Turn in Your Test:

There is a tip-within-the tip in the preceding paragraph. By performing the checking ideas, you will usually consume more of the allotted time for the test. I once received a D in Algebra II in High School. Now if you see my high school transcript, you won't find that grade as it was on a six-seek grading period and those grades were not included in transcripts. But, the memory of the event is well-imprinted on my mind.

When I went to the teacher she said, "Marvin, you are winning the race of turning the test in quickly, but you are losing the race of it being accurate." The message was clear: slow down and win the race of being accurate and getting a better grade.

3. Changing your Mindset with a Positive Attitude.

There have been books written about approaching a task with a positive attitude. You can ***choose*** to improve your attitude and raise the academic goals you have set for yourself. Projecting a positive attitude toward your study of mathematics and expecting a positive outcome can make it easier for you to learn and perform well in a math course.

Following are some positive choices you can make:

a) Choose to allocate the proper amount of time to learn.
b) Choose to place the primary responsibility for learning on yourself.
c) Choose to make a strong commitment to learning.

Well-known American psychologist William James once said "The one thing that will guarantee the successful conclusion of a doubtful undertaking is faith in the beginning that you can do it."

4. Anticipate Obtaining Mathematical Power:

I was blessed with several excellent math professors over the years. I tell people that may have been the reason I chose math education as a career. One prof, in particular, would finish developing a special skill or formula and then kind of step back and admire it saying, "Look at the powerful result we have acquired!" You can do this for yourself as you study. Look for the power you have obtained. Go into class thinking, "I wonder what kind of power we will achieve today? I can't wait!" Such thinking can go a long way to developing that positive attitude we discussed in Tip #3.

5. Studying or Previewing The Lesson Before Class – Minimizing Note Taking:

Though it takes double the normal prep time at the beginning, consider studying the lesson before going to class. Then when you go to class you have a mindset of what the prof is going to cover. Your book is actually a well-written set of notes. Consider not taking extensive notes, but listening to the professor as topics are presented, and honing in on what is covered. I know for myself, if I try to take extensive notes on a new topic, I inevitably miss explanations. In recent times such a method of studying is referred to as ***flipping the classroom***. It is worth a try.

6. Asking Questions:

Don't be afraid to ask questions either in class or by going to the professor's office hours. Most of them welcome this and encourage students to ask questions. There is often the possibility of your grade being on the borderline, and the prof has to decide which way to go. If you have been active in asking questions and the professor remembers you doing so, that could go a long way toward shifting the grade to a higher level.

7. You Tube Sources:

The advent of the internet has made available many kinds of math videos. Most of them are excellent. As you begin a class, go to You Tube and browse, searching for topics from the course you are studying. Make a list of the ones that appeal to you, and go back to them as you feel a need.

Below are a few that I really like:

3blue1brown, Grant Sanderson,
https://www.youtube.com/watch?v=s_L-fp8gDzY
Numberphile, Brady Haran
How To Use MyMathLab*x*
https://www.youtube.com/watch?v=sZU4ivx7VF8
Riemann Hypothesis, Katie Steckles, Matt Parker, Hannah Fry,
Khan Academy