BEAM

Bridge to Enter Advanced Mathematics

BEAM Alumni Newsletter

March 2019

Math Mistakes in Movies and Television

We can learn a lot from movies and television! However, when it comes to the math, it is often worth taking a second look. After all, there are only three types of entertainment: Those that get the math right, and those that do not.

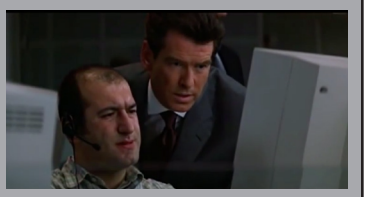
Star Trek "Court Martial" (1967)

THE TV SHOW SAYS: "Gentlemen, this computer has an auditory sensor. It can, in effect, hear sounds. By installing a booster, we can increase that capability on the order of one to the fourth power."

THE MATH SAYS: If you multiply an amount by a number greater than 1, then you increase it; if you multiply it by something between 0 and 1, you decrease it. By increasing the capability by 1 (by multiplying the current capability by 1), they have actually kept it exactly the same, which probably does not help much.

$$1^4 = 1 \times 1 \times 1 \times 1 = 1$$

The World is Not Enough (1999)

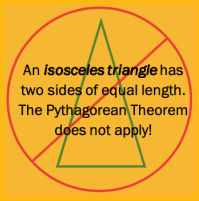


THE MOVIE SAYS: "How far is that rig from the terminal, and how fast is [the bomb] traveling?"
"It's 106 miles from the terminal, going 70 mph."
"We've got 78 minutes."

THE MATH SAYS: To determine how long it will take for the bomb to arrive, divide the distance by its speed:
106 miles / 70 miles per hour = 1.51 hours, about 90 minutes. Plenty of time to save the world!

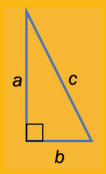
The Wizard of Oz (1939)

THE MOVIE SAYS: "The sum of the square roots of any two sides of an isosceles triangle is equal to the square root of the remaining side."



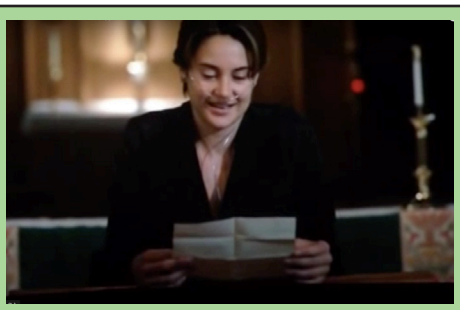
THE *Pythagorean Theorem* SAYS:

A triangle is a ***right triangle*** if and only if $a^2 + b^2 = c^2$, where a and b are the lengths of the *legs* (shorter sides) of the triangle, and c is the length of the *hypotenuse* (longest side) of the triangle.



Some right triangles are also isosceles, but not all!

The Fault in Our Stars (2014)



THE MOVIE SAYS: "I am not a mathematician, but I do know this: There are infinite numbers between 0 and 1. There's .1, and .12, and .112, and an infinite collection of others. Of course, there is a *bigger* infinite set of numbers between 0 and 2, or between 0 and a million. Some infinities are simply bigger than other infinities."

THE MATH SAYS: While it is true that some infinities are bigger than other infinities, there are actually just as many numbers between 0 and 2 as there are between 0 and 1. Why is this? Imagine that you and your friend each have a really big box with ping-pong balls in them, with a ball for each real number between 0 and 1. You take the balls in your box and, one at a time, erase the number on each ball and write two times that number on it. The quantity of balls you have doesn't change, because all you do is erase the numbers on them and write new numbers. But now you have a ball for every real number between 0 and 2. How do we know? Well, you know you have the ball for 1.5, because you used to have a ball for 0.75 and you erased it and wrote two times 0.75 (which is 1.5) on that ball. You know you have the ball for 0.3, because you used to have the ball for 0.15 and you erased it and wrote 0.3 on it. You have the a ball for every number between 0 and 2. And still you have the same quantity of balls as your friend, because all you did was write on the balls you already had.

How to submit your answer:
Email it to *info@beammath.org* or text a photo to (217) 649-1100.

Dan's Challenge Problems

Challenge Problem 1:

What is the least Integer that is divisible by all of 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10?

Hints for Challenge Problem 1, as well as the solution, can be found on page 4.

Challenge Problem 2:

A group of 10 friends were discussing a large positive integer.

"It can be divided by 1," said the first friend.

"It can be divided by 2," said the second friend.

"And by 3," said the third friend.

"And by 4," added the fourth friend.

This continued until everyone had made such a comment.

If exactly two friends were incorrect, and those two friends said consecutive numbers, what was the least possible integer they were discussing?

Send in the solution to this problem to win a free book!

The deadline for submissions is April 15, 2019.

Challenge Problem Solution for November 2018

Congratulations to Daniel Mintz and Alexis Menses, who solved the last problem:

Two trains move straight towards each other starting 1400 miles apart. Train A moves at 60 miles per hour, while train B moves at 40 miles per hour. A really fast mosquito, flying at 80 miles per hour, starts at the front of train A just as the trains start moving, and then flies to train B. When the mosquito hits the front of train B, it turns around, flying straight back to train A. When it hits the front of train A, it turns around again and flies straight towards train B. It continues like this, zigzagging between the two trains, until it is crushed as the two trains collide.

What was the total distance flown by the mosquito?

Solution:

If you try to do this by figuring out how far the mosquito flew until it got to train B, then how far until it got back to train A, and so forth, it will be very hard and take a long time. Instead, if you look at it from a different perspective, you can solve the problem quite quickly!

Each hour, the trains get 100 miles closer to each other (60 miles for train A, and 40 miles for train B). Because they start 1400 miles apart, they will collide after exactly 14 hours.

The mosquito flies the entire time at 80 miles per hour. Because it flies for 14 hours in total, the distance it travels is 14*80 = 1120 miles.

Why Sleep?

by Dara S. Manoach and Robert Stickgold

We human beings spend about a third of our lives sleeping. That means that if you live to 90, you'll sleep for about 30 years – probably more time than you'll spend doing anything else. Sleep is really important since we cannot live without it and spend so much time doing it. Yet unlike the other basic biological drives such as eating and reproducing, we still don't understand exactly why we need to sleep. It used to be thought that sleep was mainly to rest and restore the body and the mind, and to keep us safe from predators that hunted at night. But over the last 15 years, this view has radically changed. We now know that sleep plays an essential role in learning, memory and emotional well-being. In this review, we'll first discuss the structure of a good night's sleep, and then the role of sleep in learning and memory.

A GOOD NIGHT'S SLEEP

Just as a good meal is made up of different kinds of food, a good night requires different kinds of sleep. A night of sleep can be divided into rapid eye movement (REM) and non-REM sleep, and non-REM sleep can be further broken down into four different stages based on the type of activity in the brain (See Figure 1). This activity can be measured using a technique called electroencephalography (EEG), which involves placing sensors on the scalp that detect the brain's electrical activity. During the night, you pass through the different stages, from lighter to deeper sleep and back again over and over again, every 90 minutes.

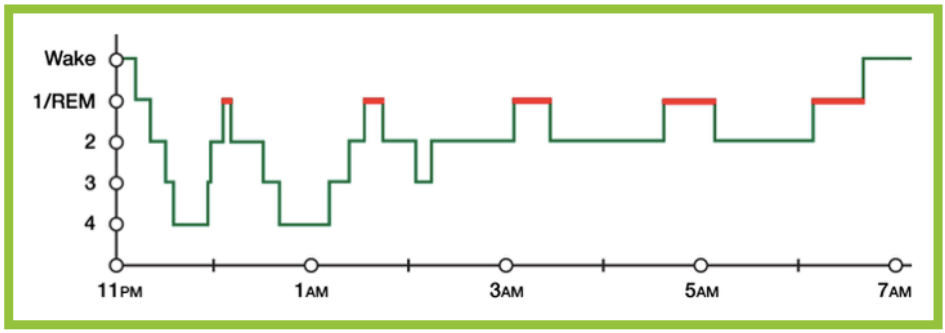


Figure 1 - A good night's sleep.
The normal progression of sleep stages across a night of uninterrupted sleep. REM sleep is highlighted in red. On the y-axis are wake, REM sleep, and the four sleep stages. On the x-axis is time. The green line shows how much time is spent in each sleep stage.

In the wee hours of the morning, sleep becomes lighter and you spend more time in REM sleep, which means more dreaming. In addition, the different patterns of brain activity seen in these sleep stages serve different functions, and as a result each stage helps with specific kinds of learning and memory.

SLEEP, LEARNING AND MEMORY

Scientists once thought that all of our learning occurred during the day, while we are awake. Now we know that the brain continues to work on new information for days and even years, and that much of this continued learning happens while we're asleep. Sleep is involved in strengthening new memories and fitting them in with what we already know, and changing and updating our older memories based on what we just learned. But we do not remember everything we learn during the day. Somehow, the sleeping brain knows what new information is important enough to keep and what can be allowed to fade away. Here are some examples of the many kinds of learning and memory that we need to sleep on.

PROCEDURAL LEARNING

Procedural learning means learning how to do something. When you're learning a new skill, like skiing or playing the piano, you may have the experience of reaching a point during practice where you just can't get any better. But when you try again the next day, right away your performance is much, much better. For most types of procedural learning, this improvement happens while you're asleep, and not just after some amount of time. For example, if you spend 10 minutes typing a sequence of keys on a computer keyboard over and over, as fast as you can, after the first 5 minutes you just don't get any faster. But the next morning you'll not only be faster, but you'll be typing more smoothly. On the other hand, if you train in the morning and test that evening with no sleep in between? Nada, zip, zero. You won't be any better. Interestingly, not all sleep helps. The overnight improvement is greater if you spend more time in Stage 2 sleep (See Figure 1) and have more sleep spindles, which are brief, powerful bursts of brain activity that occur during Stage 2 sleep.

INSIGHT

Most everyone has heard of "sleeping on a problem," but does it really work? A group of German researchers taught students how to do a special kind of mathematical problem. Unknown to the students, there was a much easier way to do it, but almost none of them figured it out. Twelve hours later, they were tested again. Some students were trained in the morning and tested 12 hours later (with no napping) that evening, but they weren't much better. Only about 22% figured out the shortcut. In contrast, when students were trained in the evening, and tested 12 hours later after a good night of sleep, 60% of them – two and a half times as many – discovered the shortcut. So sleep can lead to insights!

SOLVING MAZES DURING DREAMS

When students play an arcade style video game where they have to find their way through a complex maze, they can actually get better at it by simply taking a nap after practicing. Does dreaming have anything to do with this improvement in their memory of the layout of the maze? It's starting to look like the answer is, Yes. When researchers woke the students up during their naps and asked them what they had been dreaming about, it turned out that those who reported that they were dreaming about something related to the maze later showed ten times more improvement than those who didn't! (See Figure 2).

WHAT HAPPENS IF YOU DON'T SLEEP ENOUGH?

When you don't sleep enough, well, you become tired. And aside from the bad health effects of not enough sleep (people who don't sleep enough tend to eat more and unhealthier foods, gain weight, and get sick!), you also don't learn as well the next day and have trouble paying attention. Its almost as if your brain is too full to absorb any more information. For some information learned the day before, its like you've missed the opportunity to press the 'save' button – its gone forever. For other learning, you just don't show the normal sleep-dependent improvement (like for that piano piece you practiced). You are also more emotionally reactive to both pleasant and unpleasant events, which can lead you to feel stressed out, yell at friends and make bad decisions, based more on emotion than reason.

SO WHAT'S THE BOTTOM LINE?

Get enough sleep, and don't sleep with your cell phone by your side. Sleep is too important to miss. A good night's sleep is like a symphony of brain rhythms with each movement serving a different function. Cut it short, or let it be interrupted by a text or a tweet, and you may miss the chance to have a breakthrough on that thorny problem you were sleeping on, or to perfect that piano piece just in time for the recital. And its not like you can make up for it the next night – you'll probably have to start from scratch. Keep in mind that most teenagers need at least 9 hours of sleep per night! So here's wishing you many good nights of sleep and sweet dreams.

To read this article in its entirety, including information about how sleep can affect emotions, visit this link:
https://kids.frontiersin.org/article/10.3389/frym.2013.00003

Citation
Manoach D and Stickgold R (2013) Why Sleep?. Front. Young Minds. 1:3. doi: 10.3389/frym.2013.00003

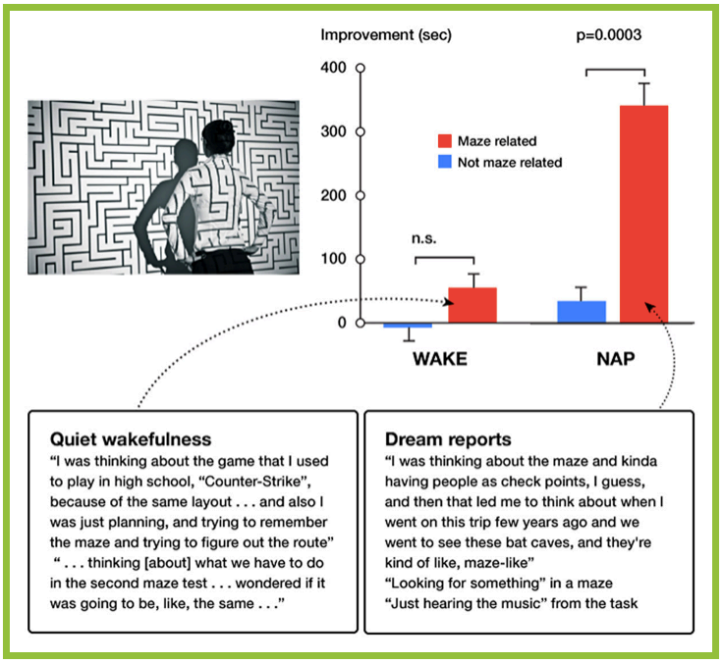


Figure 2 - Dreaming about the maze helps you get through it faster. Top left: A person looking at a maze. Top right: Improved speed for students who did not (WAKE) and did (NAP) take a nap between training and testing, and who did not (blue bars) or did (red bars) report thinking or dreaming about the maze. Only students who napped and reported dreaming about the maze got significantly better (n.s. means that the difference between the bars was not statistically significant). Bottom: Samples of reports given by students.

Program Name Changes

BEAM's programs have changed names!
The old and new names for each are:

BEAM 6	-->	BEAM Discovery
BEAM 7	-->	BEAM Summer Away
The years that follow BEAM Summer Away	-->	BEAM Pathway Program

Dan's Challenge Problem 1 Hints and Solution

(See page 2 for original problem.)

Hint 1: 1*2*3*...*10 = 3,628,800 works but it is way too big. The answer is less than 10,000.

Hint 2: Use prime factorization.

Hint 3: If a number is divisible by 9, then it is already divisible by 3. So you do not need to multiply in a 3. What else don't you need to multiply in?

Solution: 2520

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Attention BEAM 6 Alumni!

If you attended BEAM 6 2018 and are not attending BEAM Summer Away 2019 (formerly BEAM 7), please tell us if you would like to continue receiving the BEAM newsletter! You can confirm at this website:

www.beammath.org/alumni-newsletter-opt-in

You must confirm to continue receiving the newsletter next year.

Questions? Comments?

We want to hear from you! Is there something that excites you that you want to know more about? Have you had an experience that you think others could learn from? Tell us about it by sending an email to: newsletter@beammath.org. We might write about it!

Moving?

If your address has recently changed, or if you are planning to move soon, please let us know by sending an email to info@beammath.org. Thank you!

Written/Edited by Amanda Cooper