

Learning on Steroids:

How to Remember Formulas



by Scott Young

How to Remember Formulas

A big question I'm often asked in this program is: how do you remember formulas in technical classes? Today I'm going to explore two methods—the first and most important is about understanding the formulas. The second, is about systematic methods to remember all the nitty gritty details of complex formulas without resorting to rote memorization.

The Quest for Deep Understanding

If I got you to memorize a string of letters and numbers, told you to use it for problems that had a certain “look” to them, and left it at that, I would have taught you nothing of value. Unfortunately, this is exactly how many students feel their professors are treating them in technical courses.

Learning on Steroids:

How to Remember Formulas

They are given complex formulas to remember, but they don't know why. Sure, they understand how the formula solves a problem—why $C_n = C_0(1+r)^n$ gives the future value of compound interest, but they don't know *why* it does.

If there is one lesson in my entire course, program and everything I've ever written on learning it is this: you cannot learn without deep understanding, you can only memorize.

So this means if you don't have some deep structure of connections, metaphors and understandings about *why* $C_n = C_0(1+r)^n$, then you're wasting your time with the formula. Sure, you might be able to pass some tests, but you'll never be able to do anything innovative with the problem. You're serving not as an intelligent person making unique contributions—but as a calculator.

The number one goal when tackling formulas is this: have a deep understanding of why they are the way they are.

Understanding One of the World's Most Confounding Mathematical Proofs

One of my favorite examples of this was done by Kalid Azad, one of the interviewees for [Learn More, Study Less](#). In this article, he explains, intuitively, [the reasoning behind Euler's formula](#), expressed as:

$$e^{i\pi} = -1$$

How to Remember Formulas

I won't rewrite his entire breakdown here, but it's clear Azad has developed a deep understanding of this formula at an intuitive level. It's this intuitive level that should always be your goal with understanding formulas.

Azad breaks it down by breaking down the problem into sub-components of understanding:

1. That e to the power of anything is similar to saying "continuously grow over X "
2. That the complex number i is like rotating normal numbers
3. That by putting e to the power of i , you are not growing continuously, but **rotating** continuously
4. That π , in radians, is the same as 180° of a circle.
5. That by continuously rotating the value of 1, by 180° , you will get exactly -1

Learning on Steroids:

How to Remember Formulas

My explanation lacks the sophistication and clarity of Azad's, as I'm trying to save space, so I suggest reading his breakdown for more.

My point is that Euler's formula is something that would baffle most people. But that's because most people see a formula on paper and their brain says "STOP". It's as if, to most people, a formula is a red-light where some other genius has already worked out the answer and us mere mortals can simply copy it.

Unfortunately, that red light in your brain that stops you from doing what Kalid has done, break down formulas to understandable components and then rebuilding them, is exactly why most people fail in formula-heavy classes. Because instead of understanding the formula intuitively, they just memorize it, so when the questions deviate from the norm, they are completely lost.

Why Reliance on Formulas is Your Enemy

How do you know if you've developed a deep understanding? Ask yourself if you could, by simple reasoning and not by premade formulas, answer all of the questions on an exam.

Could you reassemble all the formulas without being asked, because you understand **why** they must be as they are? If the answer is no, you don't have a deep understanding.

I'm setting the bar fairly high, and admittedly I don't always cross it myself. We all get pressed for time and aim to memorize a formula rather than really understand its basis.

How to Remember Formulas

However, even though formulas provide a workable shortcut, the answer of what to do when you're challenged in a technical class is simple: stop relying on formulas. Once you break down their essence, you'll have a much stronger web of ideas within that space.

Why I Can't Teach This Skill

Aside from metaphor, visceralization, the 5-year old method and a bunch of skills I've already shared with you, there is no simple trick to gaining a deep understanding of formulas in a technical subject. My suggestion is to read from people who do it well and study their approach. Kalid Azad is a good example.

The reason I've shared this in such detail is because the second method I'll discuss for formulas is a way to memorize

How to Remember Formulas

formulas. It will **not** give the deep understanding of formulas that a deep breakdown will, however it is a fast way to remember complex formulas.

This second method is best when combined with the first. Since, as formulas become more complex, it is harder and harder to remember every detail of their construction. Worse, if you tried to assemble them from scratch, you'd end up making mistakes and wasting a lot of time.

When combined with deep breakdown of formulas, this second method allows you to remember every detail fairly quickly. If I have to take a class which forces me to remember many formulas, I will use the breakdown method to get the gist of why they work, then I will use the formula pegging method to ensure I remember them accurately.

Formula Pegging

Formula pegging is a simple way to peg all the information in a formula so you won't forget the details. You can use this for simple formulas and complex ones. It can take up to several minutes to remember a formula permanently, but this can be sped up as you practice.

The advantage is that the stickiness of the formula in your mind greatly increases. And, if you use the formula in combination with your practice, the chance you'll make a mistake drops even more.

Note: reading the first guides on the chain method and then the peg method are a prerequisite to learning this one. If you haven't studied those guides, go back and read them, since I'll be diving right into the terminology.

How to Peg Formulas

Step One: Arrange all the formula components on a single line.

Formulas must be pegged linearly. Unfortunately, the graphical shorthand for formulas is two-dimensional, with elements being grouped above or below other elements. Pretend you were entering the formula into a calculator before you try to peg it—every element must follow in a straight line.

So a big formula like this one:

$$S = R \frac{(1 + i)^n - 1}{i}$$

How to Remember Formulas

We would need to write this as:

$$S = R((1 + i)^n - 1)/i$$

Step Two: Convert all the symbols into images

The next step is to convert every symbol into a reliable image you won't forget. Variables and letters are best converted into words that start with that letter, s becomes Snake, r becomes Rug. Numbers are converted by their peg values, so 1 becomes Tie, 3 becomes haM. Mathematical operators can be anything that will automatically be recognized as what they are:

Plus -> a cross (“+”)

Minus -> ice (as in below freezing, or -0 degrees Celsius)

Multiplication -> a star (“*”)

Division -> something on top of something else (“/”)

Learning on Steroids:

How to Remember Formulas

Squared -> A paper square

Cubed -> A paper cube

To the power of -> A carrot (“^”)

Square root -> A square plant root

Summation -> Sigmund Freud (Sigma)

Right bracket -> A frowning face

Left bracket -> A smiling face

I could go on and on, but what matters is that the symbols you use make sense to you, and that you use them consistently. If you sometimes use multiplication as a star and sometimes as a cross, you'll get it confused with addition. If you sometimes use minus as ice and other times as the color red, you may get it mixed up with a different variable.

Learning on Steroids:

How to Remember Formulas

For our previous formula, here's how it could be translated into images:

$$S = R((1 + i)^n - 1)/i$$

S -> snake

= -> a balancing scale

R -> rug

(-> frowning face

(-> frowning face

1 -> Tie

+ -> cross

i -> iPod

) -> smiling face

^ -> carrot

n -> kNot

- -> ice

1 -> Tie

) -> smiling face

/ -> on top of

i -> iPod

Learning on Steroids:

How to Remember Formulas

At first, this seems like waaay too much to remember. After all, the whole point of this exercise was to make it easier to remember formulas, but I've taken a rather simple one and turned it into sixteen different images.

Two things:

First, the tactic gets faster with training. If you use it often, you'll quickly turn mathematical operators and symbols into images. As a result, my detailed breakdown is only necessary when you're getting started.

Second, you can combine the images as long as it won't confuse the order. So in this one, I can reduce it to:

Learning on Steroids:

How to Remember Formulas

- S, =, R -> A snake on a balancing scale with a rug.
- (, (, 1 -> Two frowning faces, the last of which has a tie on
- +, i,) -> A smiling face holding out a cross and an iPod
- ^, n -> A carrot tied into a knot
- , 1,) -> A smiling guy sitting next to a tie encased in ice
- /, i -> All on top of a giant iPod

When combining, make sure that you won't violate BEDMAS rules by mixing up the symbols. If you combine an image that *must* be in a particular order, I suggest not combining them directly, as you may mix up the parts. Also, separate the images which don't go together. I separated the n from the -1 , because they are separate terms on the sheet, so it would be easier not to be mixed up.

Step Three: Generate a Mental Story, Following the Symbols

Use the rules of chaining to make each link in the story vivid and memorable. But imagine when walking through the formula that you're also moving corresponding with the formula on the paper. So as you move from the equal sign to the next elements, you should feel like you're going in a rightward direction.

So for this last formula, I could imagine the following story:

A huge **Snake** is curled around a **balancing scale** which is perfectly weighted to a gigantic **Rug**. As I pull on the thread of the rug, to the right I see that it is connected to a **two-headed frowning man** wearing an oversized **Tie**. Next to him is a **smiling man** holding towards him first a **cross** and then an **iPod**. He is leaning against a 12-foot tall **carrot** which has been tied into a

Learning on Steroids:

How to Remember Formulas

single **kNot**. Behind the carrot, I see a **smiling man** wearing a **tie** encased in **ice**. When I look down I realize that we were all sitting **on top of** an island shaped like an **iPod**.

Again, this seems like overkill for a single formula. However, if you master the peg method, all of these tricks should come naturally to you. My labored explanation can be repeated in just a minute or two of practice.

Step Four: Self-Test the Day After

Once you've pegged your formulas, you'll want to test the day after (and before any exams) to see that they still hold true. They won't last forever, but if you combine them with practice problems using the formulas, you'll be able to recall when you get stuck.

How to Remember Formulas

You can practice the problem by giving yourself the example problem where you need to solve for the first element of the equation (in our case, S), then just follow your story, writing down every element that translates to a particular symbol.

Conclusion

This is not an easy technique, and I don't expect most students to grasp it immediately. The tactic will work, but it first requires you to become very familiar with the rules of chaining and pegging. If any of those steps and skills seem foreign to you, the tactic will be slow and you'll make mistakes.

That said, it can be a great combination when used with deep understanding. Because a deep understanding won't produce the

Learning on Steroids:

How to Remember Formulas

same accuracy. You may accidentally use a plus sign instead of a minus sign. But such errors are difficult to make when pegging, since the symbols will be vastly different in your story (a cross versus a pile of ice).

Good luck with this tactic and I'll see you on the other side!