Guide to Memorization in Calculus I
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Students often ask (usually just before a test), “What do I need to memorize?” The underlying assumption is that mathematics can be mastered, in large part, through memorization. You might assume that if you memorize all the formulas just before the test, you will be an A student. But success in mathematics requires a combination of knowing the facts/formulas AND being able to recognize key patterns and structures AND understanding/insight. If you eliminate any one of these, your results will be substantially diminished.

Solving problems in mathematics requires recognition of their structures and how various mathematical methods can be applied. Thus, developing the ability to recognize patterns and structures, is one of the most important skills in mathematics. Exposure to numerous problems and putting in many hours of practice is the key to building up both your ability to recognize these patterns/structures and building your understanding/insight. With these key elements in place, and having common formulas and identities (the required tools) both understood and memorized, ensures that you can solve problems quickly and confidently.

So should you memorize the items summarized on the back of this page? YES, YES, and YES! But do not expect your results to be satisfactory unless you also build up the ability to recognize the key elements and structures of the problems presented and you develop a meaningful understanding of the applicable mathematical principles.

Note that developing a solid understanding of key concepts can reduce (but not eliminate) the need for memorization. For example, should you memorize the value of \( \csc\left(\frac{5\pi}{3}\right) \) (I don’t) or should you become skilled at rapidly deriving the value (e.g., via a sketch of the unit circle)? It is your choice, but make sure you can come up with the value of any of the six trigonometric functions for any of the 16 standard angles. Similarly, should you memorize the formulas for \( \cos(2x) \) and \( \sin(2x) \), or do you just memorize the formulas for \( \cos(x \pm y) \) and \( \sin(x \pm y) \), and then set \( y = x \)? It is up to you. Do you memorize the identities involving \( \tan(x) \) and \( \sec(x) \) or \( \cot(x) \) and \( \csc(x) \), or do learn how to derive them from \( \sin^2(x) + \cos^2(x) = 1 \)? Again, it is up to you. Just make sure you can rapidly access the tools you need.

A list of items you should know (or be able to quickly derive) is presented on the next page, but this list takes many items for granted. For example, the multiplication tables are not listed nor are many basic facts of elementary geometry. The list is selective and is not exhaustive. It should be considered a good “basic tool kit” focused on the most useful items encountered in Calculus I (which become the basis for Calculus II) and nothing more. You should add to it as you practice solving problems.

So memorize these items (or learn how to quickly derive them) to make sure that you can access them quickly when needed, but also do as many problems as possible to build your ability to recognize the underlying patterns and structures of problems and to build your understanding/insight.

Your success depends on all three.
**BASIC FACTS, FORMULAS AND IDENTITIES YOU SHOULD HAVE AT YOUR FINGERTIPS**

Note: Many of these items precede Calculus I, 1A or 1B. Items related to inverse functions (e.g., logs and arctrig functions), Newton’s Method, L’Hôpital’s Rule, and anti-derivatives are developed in Calculus 1B. Once you complete Calculus I or 1B, all of these items should be at your fingertips.

- **Basic algebra**: See the “Basic Algebra Guide” available on the Calculus 1A and 1B web sites. Included in this guide are fundamental algebraic properties and laws of exponents/radicals.
- **Geometry formulas**: Pythagorean formula for right triangles. Area formulas for triangles, rectangles, trapezoids, and circles. Volume and surface area formulas for rectangular solids, cylinders, and spheres, and the volume formula for cones. Also know the ratio of the sides of 30-60-90 and 45-45-90 triangles.
- **Polynomials**: Properties of polynomials including their behavior at $\pm\infty$ and potential roots. For quadratic functions, $f(x) = ax^2 + bx + c$, know the quadratic formula and what it tells you about the location of the function’s vertex and the existence and location of roots. Of course you should know everything about linear functions (e.g., the standard forms, slope formulas, intercepts, etc.)
- **Logarithms**: Know the laws of logs including the change of base formula.
- **Algebraic identities**: Be able to factor quadratic expressions and $a^2 - b^2$ and $a^3 \pm b^3$.
- **Trigonometric facts/identities**: Definition of the radian measure of angles, arclength $s = r\theta$, the definition of the six trigonometric functions and how they relate to the coordinates of points on the unit circle, and that $\sin^2(\theta) + \cos^2(\theta) = 1$ and $\tan^2(\theta) + 1 = \sec^2(\theta)$.
- **Special formulas**: Newton’s Method and L’Hôpital’s Rule. Anti-derivatives of the derivatives listed above.