

How to Succeed in Beginning Calculus

The following comments are based on over twenty years of watching students succeed and fail in calculus courses at universities, colleges and community colleges and of listening to their comments as they went through their study of calculus. This is the best advice we can give to help you succeed.

Calculus takes time. Almost no one fails calculus because they lack sufficient "mental horsepower". Most people who do not succeed are unwilling (or unable) to devote the necessary time to the course. The "necessary time" depends on how smart you are, what grade you want to earn and on how competitive the calculus course is. Most calculus teachers and successful calculus students agree that 2 (or 3) hours every weeknight and 6 or 7 hours each weekend is a good way to begin if you seriously expect to earn an A or B grade. If you are only willing to devote 5 or 10 hours a week to calculus outside of class, you should consider postponing your study of calculus.

Do NOT get behind. The brisk pace of the calculus course is based on the idea that "if you are in calculus, then you are relatively smart, you have succeeded in previous mathematics courses, and you are willing to work hard to do well." It is terribly hard to **catch up** and **keep up** at the same time. A much safer approach is to work very hard for the first month and then evaluate your situation. If you do get behind, spend a part of your study time catching up, but spend most of it trying to follow and understand what is going on in class.

Go to class, every single class. We hope your calculus teacher makes every idea crystal clear, makes every technique obvious and easy, is enthusiastic about calculus, cares about you as a person, and even makes you laugh sometimes. If not, you still need to attend class. You need to hear the vocabulary of calculus spoken and to see how mathematical ideas are strung together to reach conclusions. You need to see how an expert problem solver approaches problems. You need to hear the announcements about homework and tests. And you need to get to know some of the other students in the class. Unfortunately, when students get a bit behind or confused, they are most likely to miss a class or two (or five). That is absolutely the worst time to miss classes. Come to class anyway. Ask where you can get some outside tutoring or counseling. Ask a classmate to help you for an hour after class. If you must miss a class, ask a classmate what material was covered and skim those sections before the next class. Even if you did not read the material, come back to class as soon as possible.

Work together. Study with a friend. Work in small groups. It is much more fun and is very effective for doing well in calculus. Recent studies, and our personal observations, show that students who **regularly** work together in small groups are less likely to drop the course and are more likely to get A's or B's. You need lots of time to work on the material alone, but study groups of 3–5 students, working together 2 or 3 times a week for a couple hours, seem to help everyone in the group. Study groups offer you a way to get and give help on the material and they can provide

an occasional psychological boost ("misery loves company?"). They are a place to use the mathematical language of the course, to trade mathematical tips, and to "cram" for the next day's test. Students in study groups are less likely to miss important points in the course, and they get to know some very nice people, their classmates.

Use the textbook effectively. There are a number of ways of using a mathematics textbook:

- i. to gain an overview of the concepts and techniques,
- ii. to gain an understanding of the material,
- iii. to master the techniques, and
- iv. to review the material and see how it connects with the rest of the course.

The first time you read a section, just try to see what problems are being discussed. Skip around, look at the pictures, and read some of the problems and the definitions. If something looks complicated, skip it. If an example looks interesting, read it and try to follow the explanation. This is an exploratory phase. Don't highlight or underline at this stage — you don't know what is important yet and what is just a minor detail.

The next time through the section, proceed in a more organized fashion, reading each introduction, example, explanation, theorem and proof. This is the beginning of the "mastery" stage. If you don't understand the explanation of an example, put a question mark (in pencil) in the margin and go on. Read and try to understand each step in the proofs and ask yourself why that step is valid. If you don't see what justified moving from one step to another in the proof, pencil in question marks in the margin. This second phase will go more slowly than the first, but if you don't understand some details just keep going. Don't get bogged down yet.

Finally, worry about the details. Go quickly over the parts you already understand, but slow down and try to figure out the parts marked with question marks. Try to solve the example problems before you refer to the explanations. If you now understand parts that were giving you trouble, cross out the question marks. If you still don't understand something, put in another question mark and **write down** your question to ask your teacher, tutor, or classmate.

Finally it is time to try the problems at the end of the section. Many of them are similar to examples in the section, but now you need to solve them. Some of the problems are more complicated than the examples, but they still require the same basic techniques. Some of the problems will require that you use concepts and facts from earlier in the course, a combination of old and new concepts and techniques. Working lots of problems is the "secret" of success in calculus.

Working the Problems: Many students read a problem, work it out and check the answer in the back of the book. If their answer is correct, they go on to the next problem. If their answer is

wrong, they manipulate (finagle, fudge, massage) their work until their new answer is correct, and then they go on to the next problem. **Do not try the next problem yet!** Before going on, spend a short time, just half a minute, thinking about what you have just done in solving the problem. Ask yourself, "What was the point of this problem?" , "What big steps did I have to take to solve this problem?" , "What was the **process**?" Do not simply review every single step of the solution process. Instead, look at the outline of the solution, the **process**. If your first answer was wrong, ask yourself, "What about this problem should have suggested the right process the first time?" As much learning and retention can take place in the 30 seconds you spend reviewing the **process** as took place in the 10 minutes you took to solve the problem. A correct answer is important, but a **correct process, carefully used, will get you many correct answers.**

There is one more step which too many students omit. **Go back and quickly look over the section one more time.** Don't worry about the details, just try to understand the overall logic and layout of the section. Ask yourself, "What was I expected to learn in this section?" Typically this last step, a review and overview, goes quickly, but it is very valuable. It can help you see and retain the important ideas and connections.