

The AP Calculus Exam

Things to Know

The AP Calculus exam is the culmination of everything you have learned about mathematics in high school. This is the big game. The calculus we have studied in the last year completes our preparation.

Everything we have studied in calculus has been presented (as much as possible) verbally, numerically, analytically, and graphically. This is known as the Rule of Four. We have looked at the relationship among all four-how the same idea shows up in words, in equations, in numbers, and in graphs. The AP exam tests your understanding of all four.

For example: numerically a linear function is one which when written as a table of values, regular changes in the x-values produce regular changes in the y-values. Graphically a linear equation has a graph that is a straight line. Analytically it is one whose equation can be written as $y = mx + b$. The graph can be drawn using the number m by going up and over from one point to the next. The idea of slope as "rise over run" expresses this verbally. Everything in mathematics and especially in calculus works that way.

Learn the concepts - the exam emphasizes concepts.

Learn the procedures and the formulas - even though the concepts are more important than the computations you still have to do the computations. Like it or not, learn to do the algebra, the arithmetic and the graphs. It would be a real shame to miss points on the exam because of simple mathematics.

Learn to be methodical - work neatly and carefully all year. Learn and use the test taking strategy presented during the year. There are ways to maximize your total points on standardized tests taken under time constraints. Remember we are trying to fatten our "CATS" ratio (Correct Answer to Time Spent).

Think about what you are doing. Watch yourself work. It is natural to concentrate on the material you know you can do, but you need to concentrate on the things you do not (yet) know or are the weakest in. As we work on practice tests look at wrong answers as a signal that you need to learn more about the topic. Do not get discouraged. The point in practice tests is simply to point out our weaknesses so that we may concentrate on overcoming them. Practice tests are like pre-season scrimmages in sports; we really don't care about whether we

win or lose only about how we can make ourselves better.

Reviewing for the Exam

In the few weeks before the exam you will need to review what you have studied, firm up what you have learned, work on your areas of weakness (as identified by the practice test), and memorize some formulas. Knowing what kinds of questions will be asked (and the different ways they will be asked), and how best to answer them will be key. Specifically:

- Understand the format of the exams. Know how your knowledge will be tested. Part of any grade on an exam is not only knowing the material but knowing how to take the test.
- **STUDY WHAT YOU DO NOT KNOW!** That may seem obvious, but many students enjoy getting the right answers so much that they only review the stuff they know. The time to concentrate on what you know is when you are taking the test!
- Practice writing free-response answers. Look at the practice exams and learn what is expected and what is not needed.
- Plan your review carefully. Don't try to cram for the exam the weekend before the exam. Relax and get a good night's sleep. The test is grueling, even though you are up for it. You will spend a total of 3 hours and 15 minutes actually taking the test with short breaks between sessions.

The Format of the Exams

There are two parts to the AP Exams (each separated into two sessions); a multiple choice section and a free response section.

Both sections count equally towards your final grade. Both sections cover the full range of topics. It is natural to expect that different classes will cover some topics in greater detail than others; the exam will evaluate your knowledge of the calculus. It is not necessary to answer all the questions to get a good score. Expect not to be able to answer some of the questions, and don't worry about it. Use your time on the ones you can answer.

The Current AP Calculus Exam Format

Section I Part A (55 minutes) 28 multiple-choice questions for which you may not use a calculator.

Section I Part B (50 minutes) 17 multiple choice questions. You may use your calculator on this section. Remember, some of these questions require the use of a graphing calculator, others do not.

Section II Part A (45 minutes) Three free-response questions. You may use your calculator on this section. In this section you will find longer questions with several related parts. You are required to show your work in this section. You may continue work on this section without a calculator after you start part B. So make sure that you attempt as many questions that require a calculator during the first 45 minute session. Then if you have time to go back you will still be able to complete some of the problems.

Section II Part B (45 minutes) Three free-response questions. You may not use your calculator on this section. In this section you will find longer questions with several related parts. You are required to show your work on this section. You may use part of this time to work on Section II, Part A without a calculator.

Multiple Choice Questions

Read each question carefully and look at the answer choices. Do the ones you are sure of. Use the method we have learned about identifying those you can do easily with little time. Remember your time is limited and you do not need to answer all of the questions. There is a penalty for guessing, so don't guess blindly. We will work on multiple-choice test taking strategies that will help you narrow down the choices. You will receive one point for each correct answer. One-quarter point is deducted for each wrong answer (whether you guessed or not!) Nothing is deducted for a question that is left blank. Be sure to bubble in your answer in the correct space on the answer sheet.

Types of Multiple-choice Questions

■ One type of question may ask for a computation (a limit, a definite or indefinite integral) and give five possible answers. Be aware that answers which result from predictable mistakes are among the choices - work carefully, just because the answer is there doesn't mean it's correct.

- Another type may ask you only to set up a problem. Looking at the answer choices may keep you from doing too much work (and wasting valuable time).
- Some questions ask you to choose the one true or false statement from a list of five statements. Be sure you know if you are looking for a true or a false statement.
- Another type of question asks which of three statements is true (or false). The answer may be any one or some combination of the statements.
- Another type may ask you to choose the correct table or graph among five choices.

Free-response Questions

The general directions for Section II require you to show your work and indicate the methods you use to arrive at your answers. In addition, parts of questions may say, "Justify your answer" or "Show the analysis that leads to your conclusion." Your answers will be read by calculus teachers who will judge your work. It is important that you clearly show how you arrived at your answer. Unsupported answers lose points even if the final answer is correct. Remember, I am not grading the exam. I have learned to decipher some of your writing. The teachers grading the exam do not know you and have not had the practice that I have had. Write neatly and clearly. Make grading the exam easy for whomever grades it.

Some Things to Keep in Mind About Free-response Questions

- Don't write a long essay. It's not necessary. Do show the work that you do so that the reader will understand you. You may use common terms and names like "the First Derivative Test." You do not need to name the theorems you use. You may show a number line as your analysis of the sign of the derivative- be sure to label it appropriately, for example y' or y'' .
- The free-response section of the exam rarely requires long complicated computation. If you find yourself doing a long complicated computation, you've probably gone wrong somewhere and should start over.
- Expect to be able to explain or interpret something. Answer with one or two short sentences. It is one way you will be tested on the "verbal" part of the Rule of Four. Do not try to impress the reader with additional knowledge of the subject. If what you add is incorrect points will be deducted. Answer the specific question asked, then stop.

- Avoid simplifying numerical answers. Answers may be left unsimplified as fractions, radicals, powers of e , in terms of π , etc. Do not take a chance of pushing the wrong button once you have an acceptable answer. If you do arithmetic, it must be done correctly. Every year students find correct answers, change it to a decimal incorrectly, and lose a point. Decimal answers (for example a definite integral on your calculator) are acceptable even if an exact answer is possible.
- If you make a mistake, cross it out. This is faster than erasing. Crossed out work will not be read or graded. If you leave wrong work on your paper, not crossed out, it will be read and may affect your score.
- If you work the problem two different ways, choose the best one and put an X through the other. If both are left, they will both be scored and the scores will be averaged. This can lower your score even if one solution is perfect.
- Standard notation must be used. Don't use calculator notation. For example: $\text{fnInt}(x^2, x, 0, 2)$ is not acceptable, use the standard $\int_0^2 x^2 dx$.
- Answers without work do not receive full credit. Don't do work on a calculator without indicating what you are doing. For example, if you are evaluating a definite integral, write the integral on your paper and put the calculator answer next to it. You do not need to show the work in-between (the antiderivative).
- Don't put things where they are not needed. Work must be shown on the part of the answer booklet where it is used. For example, if you need a derivative in part (b) of a question and you have it in part (a), where it is not needed, you will not get credit for finding the derivative (in either part). Either copy it in part (b), or draw an arrow over to where you wrote it. You must show that you know where you need the derivative as well as your ability to find it.
- Finally, parts of the free-response question are related to each other. This can help you in two ways:
 - Sometimes each part may be answered without reference to the other parts. Read and try all of the parts. If you cannot answer part(a), maybe you can do part (b). Perhaps doing part (b) will give you a hint on how to do part (a).
 - Other times the one part will lead you to the next. This is done to help you find your way through the problem. Keep in mind that this may be the case, and work your way from

part (a), to part (b), to part (c), even if you're not sure where the problem is heading.

■ Try all of the free-response questions. They are written so that the first parts are easier in order to help you get started. Even if you don't do the entire problem, some points are better than no points.

Common Free-response Mistakes

- Algebra and arithmetic mistakes.
- Missing limits of integration (or the differential!).
- Not considering the endpoints of an interval (for example, when looking for the absolute (global) maximum value of a function).
- Giving answers from outside the given interval.
- Not giving coordinates of a point when required.
- Giving both coordinates when only one is asked for; remember, "value of a function" means the y-value.
- Having your calculator in degrees mode.
- Not answering the question that was asked even though all the work is correct. If it is a yes or no question, say "yes" or "no."
- Ignoring units of measure.
- Family of function problems: Questions that start with a phrase like, "This question deals with the functions defined by $f(x) = 1 + b\sin(x)$ where b is a positive constant..." are meant to be done in general, not for a specific value of b . Even if you get the correct answer using a specific value of b , you may lose points. The reason is that, because you used a particular value, you have no way to be sure that your answers are true for all values of b .
- Don't Curve Fit: Occasionally, a function is given as a graph or a table of values with no equation. You are being asked to demonstrate that you can work from the graphical or numerical data. The questions that follow can be answered without an equation. You may have

learned to approximate functions using regression analysis. This should be avoided. While this is a perfectly good approach in the real world, you may lose points because you are not working with the function you were given, (only an approximation of it), and curve fitting is not one of the four allowed calculator operations.

- Using a built-in calculator utility or a program without showing all the work and justification for what you are doing. You may do only the four things stated below.

Calculators

You may use your calculator any way you wish. There are four types of things you should definitely know how to do. They are:

- Plot the graph of a function within an arbitrary viewing window.
- Find the zeros of functions (solve equations numerically)
- Calculate the numerical value of a derivative at a point
- Calculate the numerical value of a definite integral