Welcome to Honors AP Calculus AB at Morton High School!

Dear Students and Parents,

Mathematics is a discipline that constantly builds on previous knowledge. Students entering AP Calculus AB will be expected to recall and apply the material that they learned in previous courses. Calculus is the most challenging class offered by the Mathematics Department. It can also be the most rewarding. During this course you will be asked to look at functions in a whole new way. To help prepare you for the course ahead, this packet has been provided. Included in this packet you will find:

As an AP Calculus AB student, you have been given the privilege of being issued your textbook prior to the end of the school year to help you as you prepare for the year ahead. You are expected to take good care of this textbook. Any lost or damaged book will need to be replaced, at a cost of the book, which is currently $109.00.

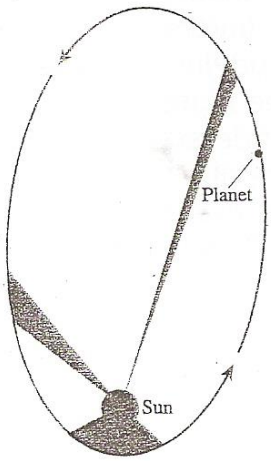
You can find the assignment posted on the Morton High School website at **http://mhs.morton709.org/my-class/math**. You will find a listing of all of our classes. Please select AP Calculus AB Honors Summer Review. This is an extremely long packet with solutions included. I do NOT recommend printing the entire packet!

Please spend some time looking over these materials before attending class on August 15th. After a few days of instruction, there will be a 45 point test over this included material on Monday, August 20th.

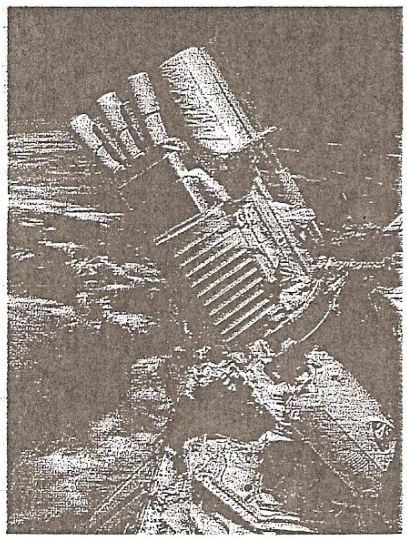
If you have any questions, contact Mrs. Durand at rosie.durand@mcusd709.org .

Have a wonderful summer!
The Mathematics Department

What Is Calculus?



P.1 A planet moving about its sun. The shaded regions have equal areas. According to Kepler's second law, the planet takes the same amount of time to traverse the curved outer boundary of each region. The planet therefore moves faster near the sun than it does farther away.



P.2 Calculus helped us predict that moons would travel in elliptical orbits about their planets; it also helped us to launch cameras and telescopes to observe the planets of our solar system. This photograph shows the Astro-1 group of telescopes on board the space shuttle *Columbia* in December 1990. One of the goals of this mission was to investigate the magnetic fields of Jupiter. We describe the effects of magnetic fields on moving electrical charges with calculus.

Calculus is the mathematics of motion and change. Where there is motion or growth, where variable forces are at work producing acceleration, calculus is the right mathematics to apply. This was true in the beginnings of the subject, and it is true today.

Calculus was first created to meet the mathematical needs of the scientists of the sixteenth and seventeenth centuries, which were mainly mechanical in nature. Differential calculus dealt with the problem of calculating rates of change. It enabled people to define slopes of curves, to calculate the velocities and accelerations of moving bodies, to find the firing angle that gave a cannon its greatest range, and to predict the times when planets would be closest together or farthest apart. Integral calculus dealt with the problem of determining a function from information about its rate of change. It enabled people to calculate the future location of a body from its present position and a knowledge of the forces acting on it, to find the areas of irregular regions in the plane, to measure the lengths of curves, and to locate the centers of mass of arbitrary solids.

Before the mathematical developments that culminated in the great unifying discoveries of Sir Isaac Newton (1642–1727) and Baron Gottfried Wilhelm Leibniz (1646–1716), it took the astronomer Johannes Kepler (1571–1630) twenty years of concentration, record-keeping, and arithmetic to discover the three laws of planetary motion that now bear his name:

1. Each planet travels in an ellipse that has one focus at the sun (Fig. P.1).
2. The radius vector from the sun to a planet sweeps out equal areas in equal intervals of time.
3. The squares of the periods of revolution of the planets about the sun are proportional to the cubes of their orbits' semimajor axes. If T is the length of a planet's year and a is the semimajor axis of its orbit, then the ratio T^2/a^3 has the same constant value for all planets in the solar system.

With calculus, deriving Kepler's laws from Newton's laws of motion is but an afternoon's work. Kepler described how the solar system worked — calculus and Newton's laws explained why it worked that way.

Today, calculus and its extensions in mathematical analysis are far reaching indeed, and the physicists, mathematicians, and astronomers who first invented the subject would surely be amazed and delighted, as we hope you will be, to see what a profusion of problems it solves and what a wide range of fields now use it in the mathematical models that bring understanding about the universe and the world around us.

Economists use calculus to forecast global trends. Oceanographers use calculus to formulate theories about ocean currents and meteorologists use it to describe the flow of air in the upper atmosphere. Biologists use calculus to forecast population size and to describe the way predators like foxes interact with their prey. Medical researchers use calculus to design ultrasound and x-ray equipment for scanning the internal organs of the body. Space scientists use calculus to design rockets and explore distant planets. Psychologists use calculus to understand optical illusions in visual perception. Physicists use calculus to design inertial navigation systems and to study the nature of time and the universe. Hydraulic engineers use calculus to find safe closure patterns for valves in pipelines. Electrical engineers use it to design stroboscopic flash equipment and to solve the differential equations that describe current flow in computers. Sports equipment manufacturers use calculus to design tennis rackets and baseball bats. Stock market analysts use calculus to predict prices and assess interest rate risk. Physiologists use calculus to describe electrical impulses in neurons in the human nervous system. Drug companies use calculus to determine profitable inventory levels and timber companies use it to decide the most profitable time to harvest trees. The list is practically endless, for almost every professional field today uses calculus in some way.

"The calculus was the first achievement of modern mathematics," wrote John von Neumann (1903–1957), one of the great mathematicians of the present century, "and it is difficult to overestimate its importance. I think it defines more unequivocally than anything else the inception of modern mathematics; and the system of mathematical analysis, which is its logical development, still constitutes the greatest technical advance in exact thinking."*

Prerequisites to AP Calculus AB (as indicated by College Board)
Before studying calculus, all students should complete four years of secondary mathematics designed for college-bound students: courses in which they study algebra, geometry, trigonometry, analytic geometry, and elementary functions. These functions include those that are linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piecewise defined. In particular, before studying calculus, students must be familiar with the properties of functions, the algebra of functions, and the graphs of functions. Students must also understand the language of functions (domain and range, odd and even, periodic, symmetry, zeros, intercepts, and so on) and know the values of the trigonometric functions of the numbers 0, pi/6, pi/4, pi/3, pi/2, and their multiples.

How to Learn Calculus

Learning calculus is not quite the same as learning arithmetic, algebra, and geometry. In those subjects, you learn primarily how to calculate with numbers, how to simplify algebraic expressions and calculate with variables, and how to reason about points, lines, and figures in the plane. Calculus involves those techniques and skills but develops others as well, with greater precision and at a deeper level. Calculus introduces so many new concepts and computational operations, in fact, that you will no longer be able to learn everything you need in class. You will have to learn a fair amount on your own. What should you do to learn?

1. Read the text carefully. You won't be able to learn all the meanings and connections you need just by attempting the exercises. You will need to read the relevant passages in the book and work through the examples step by step. Speed reading won't work here. You are reading and searching for detail in a step-by-step logical fashion. This kind of reading, required of any deep and technical content, takes attention, patience, and practice.
2. Complete the homework exercises, keeping the following principles in mind.
   a) Sketch a diagram whenever possible.
   b) Write your solution in a connected step-by-step logical fashion, as if you were explaining to someone else.
   c) Take a moment to think about why each exercise is there. Why was it assigned? How is it connected to the other assigned exercises?
3. Each time you complete a section of the text, try on your own to write short descriptions of the key points. If you succeed, you probably understand the material. If you do not, you will know where there is a gap in your understanding. There is a list of questions to guide your writing under the heading "Writing for Your own Knowledge" at the end of each section.

Learning calculus is a process — it doesn't come all at once. Be patient, persevere, ask questions, discuss ideas with classmates, and seek help when you need it, right away. The rewards of learning calculus will be very satisfying, both intellectually and professionally.

About AP

Are you ready for a unique learning experience that will help you succeed in college? Each year, students around the world who want to learn and achieve at the highest level become AP students. Through AP's college-level courses and exams, you can earn college credit and advanced placement, stand out in the admissions process, and learn from some of the most skilled, dedicated, and inspiring teachers in the world.

Why Participate?

With more than 30 courses and exams across multiple subject areas, AP offers something for everyone. Here are just a few reasons to sign up:

Earn College Credit and Advanced Placement

- Receive recognition from more than 3,600 colleges and universities that annually receive AP Exam scores. Over 90% of 4-year colleges in the U.S. provide credit and/or advanced placement for qualifying scores.
- Have time to move into upper-level courses in your field of interest, pursue a double major, or study abroad.
- Design a college experience that suits you and gives you the flexibility to get the most out of your college years.

Stand Out in the College Admissions Process

- Demonstrate your maturity and readiness for college.
- Show your willingness to take the most rigorous courses available to you.
- Emphasize your commitment to academic excellence.

Gain Skills that Will Help You Succeed in College

- Get a head start on college-level work.
- Improve your writing skills and sharpen your problem-solving techniques.
- Develop the study habits necessary for tackling rigorous course work.

Broaden Your Intellectual Horizons

- Be part of a community of students and educators who are passionate, curious, and committed to academic excellence
- Engage in intense discussions, solve problems collaboratively, and learn to write clearly and persuasively
- Take courses that are developed by leading professors to reflect the level of learning happening at colleges throughout the country

Calculator Policy

The use of a graphing calculator is considered an integral part of the AP Calculus course, and is required on parts of the AP Calculus Exams. Students should use technology on a regular basis so that they become adept at using their graphing calculators. Students should also have experience with the basic paper-and-pencil techniques of calculus and be able to apply them when technological tools are unavailable or inappropriate.

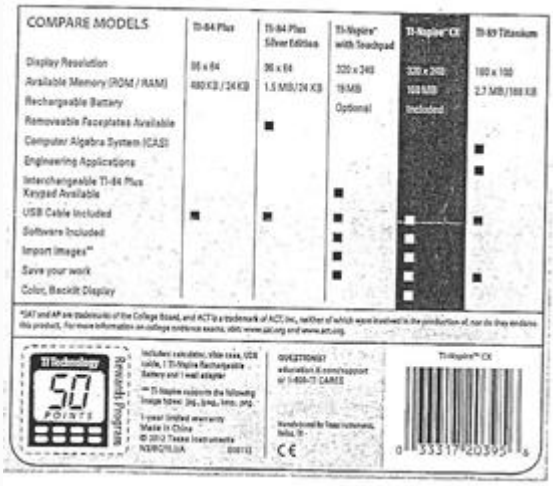
College Board Approved List of Graphing Calculators

Graphing calculators having the expected built-in capabilities are indicated with an asterisk (*). However, students may bring any calculator on the list to the exam. Nongraphing scientific calculators are not permitted. Morton High School recommendation are noted with a star . INSTRUCTION WILL BE PROVIDED FOR THE **TI-NSPIRE FAMILY OF CALCULATORS**.

Casio	**Hewlett-Packard**	**Texas Instruments**
FX-6000 series	HP-9G	TI-73
FX-6200 series	HP-28 series*	TI-80
FX-6300 series	HP-38G*	TI-81
FX-6500 series	HP-39 series*	TI-82*
FX-7000 series	HP-40 series*	TI-83/TI-83 Plus*
FX-7300 series	HP-48 series*	TI-83 Plus Silver*
FX-7400 series	HP-49 series*	TI-84 Plus*
FX-7500 series	HP-50 series*	TI-84 Plus Silver*
FX-7700 series	HP Prime*	TI-84 Plus C Silver*
FX-7800 series		TI-85*
FX-8000 series	**Radio Shack**	TI-86*
FX-8500 series	EC-4033	TI-89*
FX-8700 series	EC-4034	TI-89 Titanium*
FX-8800 series	EC-4037	TI-Nspire/TI-Nspire CX*
FX-9700 series*		TI-Nspire CAS/TI-Nspire CX
FX-9750 series*	**Sharp**	CAS*
FX-9860 series*	EL-5200	TI-Nspire CM-C*
CFX-9800 series*	EL-9200 series*	TI-Nspire CAS CX-C*
CFX-9850 series*	EL-9300 series*	
CFX-9950 series*	EL-9600	**Other**
CFX-9970 series*	series*†	Datexx DS-883
FX 1.0 series*	EL-9900 series*	Micronta
Algebra FX 2.0 series*		Smart[2]
FX-CG-10 (PRIZM)*		
FX-CG-20*		

Note: This list is current as of May 2018; other allowable machines will be added as necessary.

If you are buying a new calculator, please bring the <u>entire card</u> containing the TI Reward points to Mrs. Durand. If we collect enough, we will be able to get free products for instruction use.



Technology Restrictions on the Exams

You are not permitted to use these items on the AP Calculus Exams: nongraphing scientific calculators, portable and handheld computers, laptops, electronic writing pads, pocket organizers.

Additionally, you cannot use an graphing calculator models with these features or capabilities: QWERTY (typewriter-like) keypad as part of hardware or software (e.g., TI-92 Plus, Voyager 200); pen-input, stylus, or touch screen (e.g., PalmPilot, personal digital assistant, Casio ClassPad); wireless or Bluetooth capabilities; paper tapes; talk or make noise, require and electrical outlet; have a cell phone, audio, or video recording capacity; can access the Internet; or camera or scanning capability. Also, the use of hardware peripherals with an approved calculator is prohibited.

Proctors are required to check calculators before the exam. Therefore, it is important for each student to have an approved calculator. Students should be thoroughly familiar with the operation of the calculators they plan to use on the exam. Calculators may not be shared, and communication between calculators is prohibited during the exam. Students may bring to the exam one or two (but no more than two) graphing calculators from the current List of Graphing Calculators.

Calculator memories with not be cleared. Students are allowed to bring to the exam calculators containing whatever programs they want.

Students must not use calculator memories to take test materials out of the room. Student that attempt to remove test materials from the room by any method will have their exam grades invalidated.

Showing Work on the Free-Response Sections of the Exams

Students are expected to show enough work for Readers to follow their line of reasoning. To obtain full credit for the solution to a free-response problem, students must communicate their methods and conclusions clearly. Answers should show enough work so that the reasoning process can be followed throughout the solution. This is particularly important for assessing partial credit. Students may also be asked to use complete sentences to explain their methods or the reasonableness of their answers, or to interpret their results.

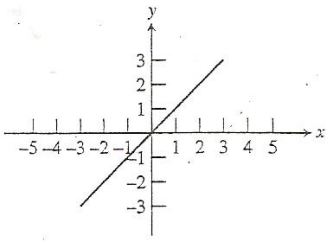
When a student is asked to justify an answer, the justification must include mathematical reasons, not merely calculator results. Functions, graphs, tables, or other objects that are used in justification should be clearly identified.

Note: As on previous AP Calculus Exams, a decimal answer must be correct to three decimal places unless otherwise indicated. Students should be cautioned against rounding values in intermediate steps before a final calculation is made. Students should also be aware that there are limitations inherent in graphing calculator technology; for example, answers obtained by tracing along a graph to find roots or points of intersection might not produce the required accuracy. Instead, use features in the calculations menu to find these values.

Graphs You Need To Know

Twelve Basic Functions

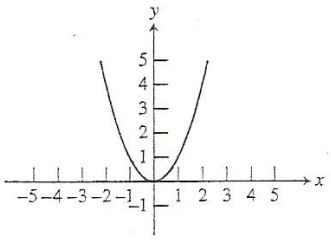
The Identity Function



$f(x) = x$

Interesting fact: This is the only function that acts on every real number by leaving it alone.

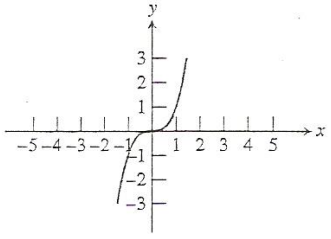
The Squaring Function



$f(x) = x^2$

Interesting fact: The graph of this function, called a parabola, has a reflection property that is useful in making flashlights and satellite dishes.

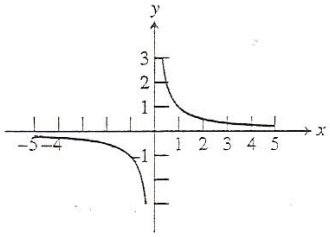
The Cubing Function



$f(x) = x^3$

Interesting fact: The origin is called a "point of inflection" for this curve because the graph changes curvature at that point.

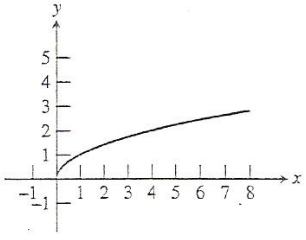
The Reciprocal Function



$f(x) = \frac{1}{x}$

Interesting fact: This curve, called a hyperbola, also has a reflection property that is useful in satellite dishes.

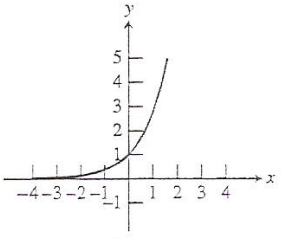
The Square Root Function



$f(x) = \sqrt{x}$

Interesting fact: Put any positive number into your calculator. Take the square root. Then take the square root again. Then take the square root again, and so on. Eventually you will always get 1.

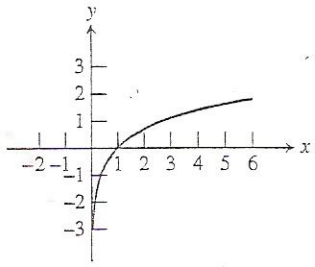
The Exponential Function



$f(x) = e^x$

Interesting fact: The number e is an irrational number (like π) that shows up in a variety of applications. The symbols e and π were both brought into popular use by the great Swiss mathematician Leonhard Euler (1707–1783).

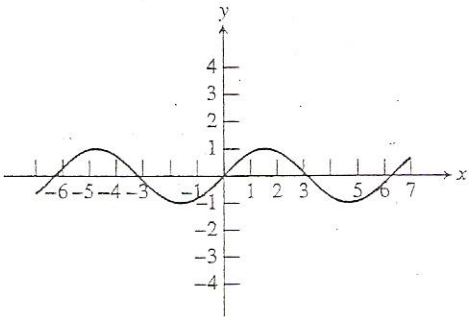
The Natural Logarithm Function



$f(x) = \ln x$

Interesting fact: This function increases very slowly. If the x-axis and y-axis were both scaled with unit lengths of one inch, you would have to travel more than two and a half miles along the curve just to get a foot above the x-axis.

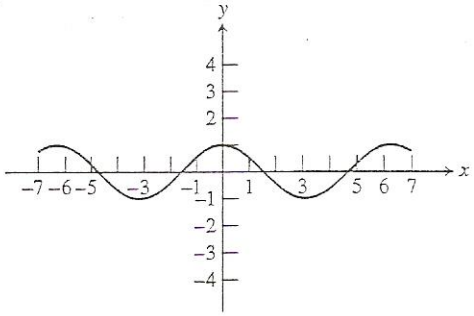
The Sine Function



$f(x) = \sin x$

Interesting fact: This function and the sinus cavities in your head derive their names from a common root: the Latin word for "bay." This is due to a 12th-century mistake made by Robert of Chester, who translated a word incorrectly from an Arabic manuscript.

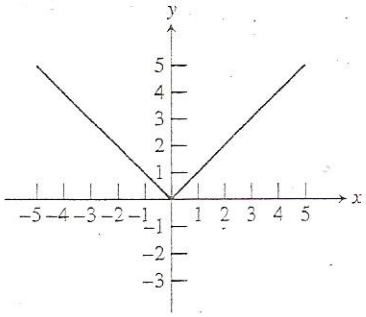
The Cosine Function



$f(x) = \cos x$

Interesting fact: The local extrema of the cosine function occur exactly at the zeros of the sine function, and vice versa.

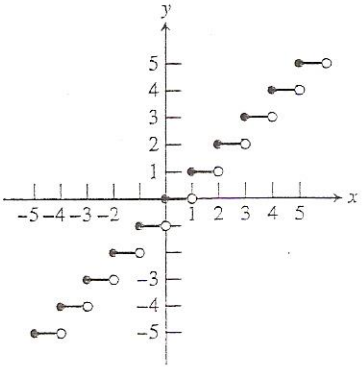
The Absolute Value Function



$f(x) = |x| = \text{abs}\, x$

Interesting fact: This function has an abrupt change of direction (a "corner") at the origin, while the other functions are all "smooth" on their domains.

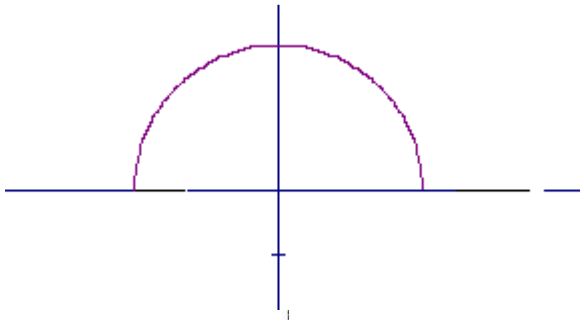
The Greatest Integer Function



$f(x) = \text{int}\, x$

Interesting fact: This function has a jump discontinuity at every integer value of x. Similar-looking functions are called *step functions*.

The Semicircle Function



$$f(x) = \sqrt{r^2 - x^2}$$

Chapter 1 Prerequisites for Calculus Assignments

Note: The problem set will indicate when not to use a graphing calculator. Please follow these instructions accordingly as quizzes and tests in Honors AP Calculus AB will have two parts: no calculator allowed and graphing calculator permitted.

AP Calculus with an approved Graphing Calculator Packet

Section 1.1 Lines
p.9 #3-36 by threes, 37, 41, 42, 49, 51, 54

Section 1.2 Functions and Graphs
p.19 #1, 3, 4, 6-33 by threes, 37, 39, 43, 48, 49, 51, 56, 57-61 odd

Section 1.3 Exponential Functions
p.26 #1-11 odd, 13-19 all, 21-31 odd, 38

AP Preparation: Sections 1.1-1.3
p.29 #4

Section 1.5 Functions and Logarithms
p.44 #9-24 by threes, 33, 34, 37-47 odd, 55, 57

Section 1.6 Trigonometric Functions
p.52 #10, 12, 17, 19, 21, 25, 27, 28, 31-41 odd, 52-55 all

AP Preparation: Sections 1.4-1.6
p.55 #4

Chapter 1 Review Exercises
p.56 #3-42 by threes, 55-65 odd

Chapter 1 Prerequisites for Calculus: Class Schedule

Note: These sections are an independent review (meaning your teacher will not be lecturing on any of these topics) of previously learned material. You are responsible for completing these problems either on your own or within a study group. Your teacher will provide time each class period for a question/answer session according to the schedule below. Please be prepared with questions each day. The Chapter 1 Test will be used to assess your readiness and placement in Honors AP Calculus AB.

Schedule for Honors Calculus Chapter 1 for 2018-19school year

Wednesday, August 15th – First Day of Attendance

Thursday, August 16th – Questions/Answers over Sections 1.1, 1.2 and 1.3

Friday, August 17th – Questions/Answers over Section 1.5, 1.6 and Chapter 1 Review Exercises

Monday, August 20th – Chapter 1 Test

AP Calculus with an approved Graphing Calculator

College Board allows a wide variety of graphing calculators for AP Calculus AB. Because of this, you must become familiar with the technological capabilities of the graphing calculator you choose to use for this course. This packet contains a set of problems for you to complete using your graphing calculator. The problems are a sample of the most basic graphing calculator skills necessary upon entry into AP Calculus AB. Please consult your user's manual or online resources such as:

http://education.ti.com/educationportal/sites/US/nonProductMulti/training_online_tutorials.html?bid=4
for graphing calculator instructions/tutorials.

1.1 Calculator Basics

In exercises 1-6, evaluate the given expressions.

1. $\sqrt{\sqrt{3.6}+4.2^2}$
2. $\dfrac{\frac{1}{3}-\frac{1}{2}}{\frac{1}{4}-\frac{1}{5}}$
3. $\sin\left(\dfrac{\pi}{6}\right)$
4. $\tan\left(\dfrac{7\pi}{6}\right)$
5. $\dfrac{12.34+\sqrt{12.34^2-4(3.65)(2.17)}}{2(3.65)}$
6. $\dfrac{\ln\left(3\frac{1}{7}\right)}{\log\left(3\frac{1}{7}\right)}$

1.3 Evaluating a Function

For exercises 1 and 2, evaluate the given functions by:

a) assigning values for x on the graph screen
b) using functional notation on the home screen
c) using the table screen

1. If $f(x)=\frac{1}{x}+\frac{3}{x+2}$, find: a) $f(1)$ b) $f(2)$ c) $f(-2)$
2. If $f(x)=x+.005x^{2.01}$, find: a) $f(.1)$ b) $f(10)$ c) $f(-1)$

1.4 Domain, Range, and Zeros

1. The following function does not appear on the screen when you use the Standard window settings. Determine a domain and range that show all features of the graph of:
   $f(x)=x^4+10x^2+12x+20$
2. The following function does not appear on the screen when you use the Standard window settings. Determine a domain and range that show all features of the graph of:
   $f(x)=\frac{-1}{x-100}$
3. Approximate all zeros of the function: $y=|x-1|-|2x+3|$
4. Approximate all zeros of the function: $y=\sqrt{x+1}+x-3$
5. Approximate all zeros of the function: $y=x^2-x-2x-1$
6. Approximate all solutions of the equation: $x^3-1=2x^2$
7. Approximate all solutions of the equation: $\frac{x}{x-1}=5-x$
8. Approximate all solutions of the equation: $\frac{x-3}{x+2}+\frac{5}{x-3}=\frac{3}{x+5}$

Chapter 1 Prerequisites for Calculus : Solutions

Below you will find the solutions for the Chapter 1 Prerequisites for Calculus assigned AP problems. Please use these to check your solutions to be prepared with questions.

AP Calculus with an approved Graphing Calculator Packet

1.1 1) 4.420 2) –3.333 3) 0.5 4) 0.577 5) 3.195 6) 2.303

1.3 1a) 2 1b) 1.25 1c) undefined
2a) 0.100 2b) 10.512 2c) imaginary

1.4 1) Domain: all reals Range: $y \geq 16.580$
2) Domain: $x \neq 100$ Range: $y \neq 0$

3) –4, –0.667 4) 1.438 5) –0.303, 3.303
6) 2.206 7) 3.618, 1.382 8) –3.947

AP Preparation: Sections 1.1-1.3

4a) $(-\infty, \infty)$ b) $(-2, \infty)$ c) –0.693

AP Preparation: Sections 1.4-1.6

4a) $g(x) = \frac{x+3}{5}$

4b) $f \circ g(x) = f\left(\frac{x+3}{5}\right) = 5\left(\frac{x+3}{5}\right) - 3 = x + 3 - 3 = x$

4c) $g \circ f(x) = g(5x-3) = \frac{(5x-3)+3}{5} = \frac{5x}{5} = x$