Calculus Without Tears

Series Overview:

Volume 1 – Constant Velocity Motion
Volume 2 – Newton's Apple
Volume 3 – Nature's Favorite Functions

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Introduction:

These lessons are a revolutionary approach to learning calculus. There is no algebra, no trigonometry, and no geometry (beyond the formula for the area of a rectangle). Why? - because they are not needed. Calculus is the mathematics of change, and change is represented by functions. The basic operations in calculus are differentiating and integrating functions, and solving differential equations. If the functions and equations are easy, there is no need for any algebra or trigonometry at all. The approach in these lessons is to learn calculus using easy functions; once the fundamentals are understood using easy functions, only then are more complex functions studied.

Modern math and science started with a single differential equation. In the 17th century Isaac Newton discovered gravity, and wrote the differential equation (Force = Mass * Acceleration) that explained the motion of the moon and the planets. This equation launched the scientific and technological revolution that has transformed our world. It is the basis for physics, and is used every time motion is analyzed, from the calculation of the trajectory for the Apollo spacecraft, to the design of the rotor in your electric toothbrush.

The motivation for all mathematics beyond arithmetic is physics, and physics begins with differential equations (see previous paragraph). Yet in secondary school we are teaching complex algebra, geometry, and trigonometry before teaching the physics necessary to motivate their study. The current math curriculum is upside down. Teaching calculus early it will make it possible to study problems from physics and electronics (circuit analysis also starts with differential equations) that will motivate the entire math and science curriculum.

These lessons were written to teach calculus to a student in the 4th grade. The formal prerequisite is decimal arithmetic, that is, adding, subtracting, multiplying, and dividing easy decimal numbers. Some familiarity with rate problems is also desirable (e.g., if a car travels at 15 miles per hour, how long does it take the car to travel 45 miles?). Surprisingly, the fundamentals of calculus are easy and intuitive. Here is a shocker: differentiation is a generalization of the formula velocity = distance / time, and integration is a generalization of the formula distance = velocity * time! The presentation is rigorous in essence but not weighted down by technical details. The goal is for the student to understand calculus and differential equations the way someone who works with them every day understands them, with a good intuitive grasp of the fundamental concepts.

William Flannery
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