Calculus and Vectors for AP Physics C

Calculus

In the late 17th century, Sir Isaac Newton developed a model of Nature that accurately described nearly all the physical phenomena that Renaissance-era natural philosophers and scientists had been exploring since Copernicus first placed the Sun at the center of the Universe. In order to clearly develop his ideas, Newton relied on the tried and true mathematics of Arabia and Greece, i.e. Algebra and Geometry. However, these powerful tools proved to be cumbersome and insufficiently elegant for Newton's new proposed interaction, a.k.a. force. Being the clever Brit that he was, Newton promptly invented a new mathematics. Yes, he invented Calculus – Yay!

We found an AP Physics teacher's YouTube channel. His name is Doc Schuster and he does a pretty good job of explaining the basics.

There are a total of 6 video and the first 4 are almost 30 minutes each. So feel free to break this up over a few days.

Here are the details:

- The link: https://www.youtube.com/DocSchusterCalculusLessons
- In case that doesn't work: YouTube Channel: Doc Schuster
    - o Titles of Videos: AP Physics Calculus Lessons
    - o 6 videos total
        - ♣ Intro To Derivatives
        - ♣ Why Derivatives are Awesome
        - ♣ Intro to Integrals
        - ♣ Applications to Physics
        - ♣ Definite Integrals
        - ♣ Averages and Other Nice Things
- Be ready to take notes. Pretend you are attending a lecture.
- Pause and back it up when necessary. Take your time.

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At the end of it, you should

- Understand what a derivative is and what an integral is.
- Take the derivative of a function, including sine, cosine, and e^x
  - Basic rule for a function $y(x) = ax^n$
    - $\frac{d(y)}{dx} = na\,x^{n-1}$
  - $\frac{d(\cos x)}{dx} = -\sin x$
  - $\frac{d(\sin x)}{dx} = \cos x$
  - $\frac{d(e^x)}{dx} = e^x$
- Take the integral of a function, both indefinite and definite integrals
  - $\int x^n\,dx = \frac{1}{n+1}x^{n+1} + C$
  - $\int_a^b x^n dx = \frac{b^{n+1}}{n+1} - \frac{a^{n+1}}{n+1}$
  - $\int \cos x\,dx = \sin x + C$
  - $\int \sin x\,dx = -\cos x + C$
  - $\int e^x\,dx = e^x + C$

The following is a link to an overview of **vectors**. These are in google slides and are representative of what is in your textbook. Reading through these carefully, answering questions and working through example problems will help you to better understand vectors when you get to class.

A note on example problems:

Example problems can be an incredible learning tool. First work through these problems using the solutions and reasoning given - like training wheels on a bike. Then work it again and only use the solutions when you get stuck. Finally, work the entire problem on your own. By using this system you will gain more in depth understanding and be more confident when approaching other problems from the same skill set. I typically will have you do example problems from the text to show me that you have read the material, and these are the instructions that I expect you to follow when I do. There are a few example problems in this set of slides - give it a try!

Vectors AP C

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Feel free to contact me over the summer with any questions or concerns regarding the AP Physics C-mechanics class.

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Finally, make sure you know the metric system. Standard International units are based on the metric system. One assignment on converting english units vs converting metric units will make it obvious why.

We will not use English units for any hands-on activities (labs).

Understand rates. Displacement/time, velocity / time, and acceleration over time are the basic rates of change you will work with the most.

Displacement / time gives velocity. Both displacement and velocity are vectors, and velocity is the derivative of displacement. Displacement is the integral of velocity.

Velocity / time gives acceleration. Both quantities are vectors, and acceleration is the derivative of velocity. Velocity is the integral of acceleration.

Acceleration is the hardest rate for students to grasp. Acceleration is the rate of change of an object's speed or direction.

An acceleration is a change in velocity. Since velocity is a vector, this change can be in speed or direction, or both. An object in circular motion that is moving at a constant speed still has an acceleration, since it is constantly changing direction. Also, we do not call slowing down a deceleration. We call it an acceleration (change in velocity).

Physical meaning:
Imagine you drop an object off of a cliff. The instant you drop it, it has a vertical velocity of 0 m/s. It then accelerates at a rate that is due to the force of gravity: 10 m/s/s or 10 m/s^2. I like the first term better, because it describes what is actually happening:

The object is speeding up by 10 m/s every second until the instant before it hits the ground. So think to yourself, what is the object's speed after 2 seconds? After 5 seconds? No calculations needed, it's easy to do in your head. This scenario can really help to grasp the concept of acceleration.

I look forward to seeing you when school starts. Don't hesitate to email me with any questions or concerns.