<u>Directions to the teacher:</u>

I wrote this for my students to do as we revisit velocity, position and acceleration after doing extensive work with techniques of integration. I loosely follow the Finney, Demana, Waits, Kennedy text and this would go with section 8.1 "Net Change". It is around late February / early March when we would use this activity.

1. Copy page 2 on plain white paper for your students, enough for each student to have one. This will be their notes for the day, and a good reference guide for the future.

2. Copy page 3 onto brightly colored paper. Make enough "class sets" as you need. If your biggest class is 24, e.g., make 12 class sets. Cut up the cards and put all 18 cards in a zip-lock bag.

3. Now, you do the activity. Match the mathematical expression cards with the verbal descriptions. Record your results. Some of the boxes on page 2 will match with more than one card. No card will go in more than one box. Write one or both answers in. Make note of the left over card. Its units will be m/sec^3 (average jerk LOL.) Check your answers on page 4.

4. On the day you use this, give students 10-15 minutes in pairs to match the cards. Then, as a class, go over the results. This took us an additional 15 minutes. The notes are theirs to keep but they need to surrender their cards for the next class.

5. As an extension you might ask another way to write #5, e.g. The velocity at time d is $s'(d)$ but it is also $\lim_{h\to 0}\frac{s(d+h)-s(d)}{h}$.

If you have any comments or questions, please email me at virginia.cornelius@gocommodores.org.

AP Calculus **Motion Notes**

Let $s(t)$, $v(t)$ and $a(t)$ be the position, velocity and acceleration, respectively, of a toy car on a horizontal track where motion to the left is denoted by negative velocity. Time is in seconds and measurement is in meters. Give the units for position _________ , velocity _________ , and acceleration __________.
Use the cards provided to write the correct mathematical expression(s) for each phrase. Indicate units.

1. the change in position from time $t = c$ to $t = d$ A.K.A. the displacement from time $t = c$ to $t = d$	2. the total distance traveled from time $t = c$ to $t = d$
3. the position at time $t = d$	4. the average velocity from time $t = c$ to $t = d$
5. the velocity at time $t = d$	6. the average acceleration from time $t = c$ to $t = d$
7. the acceleration at time $t = d$	8. . the change in velocity from time $t = c$ to $t = d$
9. the speed is decreasing at time $t = d$	10. the speed is increasing at time $t = d$
11. the speed at time $t = d$	12. the left over card is

$v'(d)$	$v(d)$	$s'(d)$
$\|s'(d)\|$	$\frac{1}{d-c}\int_c^d a(t)dt$	$v(d) > 0, a(d) < 0$ -or- $v(d) < 0, a(d) > 0$
$v(c) + \int_c^d a(t)dt$	$\int_c^d a(t)dt$	$v(d) - v(c)$
$\int_c^d v(t)dt$	$v(d) < 0, a(d) < 0$ -or- $v(d) > 0, a(d) > 0$	$\frac{1}{d-c}\int_c^d v(t)dt$
$s(d) - s(c)$	$s(c) + \int_c^d v(t)dt$	$\int_c^d \|v(t)\|dt$
$\frac{v(d)-v(c)}{d-c}$	$\frac{s(d)-s(c)}{d-c}$	$\frac{a(d)-a(c)}{d-c}$

Answers:

1. the change in position from time $t = c$ to $t = d$ A.K.A. the displacement from time $t = c$ to $t = d$ $s(d) - s(c) = \int_c^d v(t)dt$ meters	2. the total distance traveled from time $t = c$ to $t = d$ $\int_c^d \lvert v(t)\rvert dt$ meters
3. the position at time $t = d$ $s(c) + \int_c^d v(t)dt$ meters	4. the average velocity from time $t = c$ to $t = d$ $\frac{s(d) - s(c)}{d - c} = \frac{1}{d - c}\int_c^d v(t)dt$ meters/sec
5. the velocity at time $t = d$ $s'(d) = v(c) + \int_c^d a(t)dt$ meters/sec	6. the average acceleration from time $t = c$ to $t = d$ $\frac{v(d) - v(c)}{d - c} = \frac{1}{d - c}\int_c^d a(t)dt$ m/sec^2
7. the acceleration at time $t = d$ $v'(d)$ m/sec^2	8. . the change in velocity from time $t = c$ to $t = d$ $v(d) - v(c) = \int_c^d a(t)dt$ meters/sec
9. the speed is decreasing at time $t = d$ $v(d) > 0, a(d) < 0$ -or- $v(d) < 0, a(d) > 0$ (no units)	10. the speed is increasing at time $t = d$ $v(d) < 0, a(d) < 0$ -or- $v(d) > 0, a(d) > 0$ (no units)
11. the speed at time $t = d$ $\lvert s'(d)\rvert$ meters/sec	12. the left over card is $\frac{a(d) - a(c)}{d - c}$ m/sec^3