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| **Title**  | Curve Sketching Stations |
| **Introduction**  | This lesson is designed to help students graph the derivative of a function precisely. This lesson builds on the motion sensor lesson from the previous day, in which students discovered the relationship between a function and its derivative through creating position vs. time and velocity vs. time graphs.  |
| **Curriculum Alignment**  | **These are the standards from the College Board AP Calculus AB Syllabus*** Understanding the relationship between the graphs of $f, f^{'}, f''$
* Finding critical points using *f’* and *f”*
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| **Materials Needed**  | * Calculators
* Grid Dry Erase Poster Boards or Grid Poster Board (this can be done with regular graph paper as well. The goal is to get students moving, while allowing time and space to think as a group)
* Meter stick or ruler (Any large straight edge will work)

**Technology Resources*** Graphing Calculators (helpful for students that are still struggling with graphing functions or have weaknesses in computation)
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| **Participant Prior Knowledge**  | Before beginning this lesson, students should have experience with finding limits and using the formal definition of a derivative. Students will have also experienced the relationship between the graph of a function and the graph of its derivative (this is part of the first lesson in the unit – “Using Motion Sensors to Explore Derivatives). In the lesson from the previous class, students developed an intuitive understanding of the concept of curve sketching through position and velocity. In this lesson, students will explore the relationship between the graph of the function and 1st and 2nd derivative values at critical points. |
| **Activities**  | **Warm-Up (5-10 minutes):** This is optional. My classes always begin with a short 5-10 minute warm-up that introduces the focus of the day’s lesson by reviewing previously learned material. In this warm-up, students will be asked to graph three functions and the derivatives (see attachment)**Activity:** This will be a station activity. Students will work through four 7 minute stations. Each station will target different objectives within curve sketching. 1. *Setting up the Classroom:* My class is 22 students and I want to keep the groups small. Therefore, there will be eight groups of two students and two groups of three students, allowing me to offer extra support for the two groups of three. There will need to be three sets of 4 station cycles to guarantee that every group has a station at all times. Each station should be color coded so that no group is repeating a station (for instance, four groups will complete the blue stations, three groups will complete the green stations, and three will complete the red stations). At each station, there will be three sets of grid poster board, grid dry erase board, or graph paper.

 1. *Stations Activity:* Students will be given 7 minutes to complete each station (see attached)
2. *Stations Activity Wrap-Up:* In the last 10-15 minutes of class, the teacher should ask students several discussion questions to help summarize the findings during the stations activity.
	1. Take two minutes to write down any relationships between the graphs of *f’ and f”* that you discovered at the different stations. After the two minutes, have students share their discoveries (all discoveries should be written on the board or overhead projector).
	2. Ideally, students will have discovered each of the following relationships:
		1. If *f’* > 0, then *f* is increasing. If *f’* < 0, then *f* is decreasing
		2. When *f’* = 0, *f* is at a maximum or minimum
		3. At a maximum, *f’* > 0 before the max and *f’ <* 0 after the max (the opposite for the minimum).
		4. When *f”* < 0, the graph of *f* is concave down (if they say opens down, that is fine, but guide their language to concavity)
		5. When *f”* >0, the graph of *f* is concave up
		6. When *f” =* 0, there is an inflection point (concavity switches)
	3. If students to not list these discoveries, questions should be asked to guide them to these realizations.
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| **Assessment**  | Every student will be given a colored note card with a different piece of information about the 1st or 2nd derivative of a function. Students will find the two other students that share their color note card (these should be different from the station groups). Using all the information from the note cards, students will draw an accurate graph of their function. Card 1 - *f’ =* 0 when *x* = 2 and when *x =* -3*f(2) = 5*For the interval (2, ∞), *f’ < 0*Card 2 - For the interval (-∞,-0.5), *f” > 0*For the interval (-0.5, ∞), *f” < 0*Card 3 - *f(-3) = -2*For the interval (-∞,-3), *f ‘ < 0*For the interval (-3, 2), *f’ > 0* |
| **Critical Vocabulary**  | * Position – the net distance traveled by an object
* Acceleration – the rate of change of an object’s velocity
* Velocity – the rate of change of an object’s position
* Speed – the absolute value of an object’s velocity
* Derivative – the slope of the line tangent to a curve at a given point
* Critical Points – points on a function including extrema, inflection points, and zeros
* Local Maximum/Minimum – the point on a function where the 1st derivative is 0 and the points surrounding that point are positive before the point and negative after or vice versa.
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| **Modifications**  | * Calculators to assist graphing functions and weakness in computation
* Group collaboration to assist struggling students
* Opportunities for one on one teaching during the stations – Advanced students can move independently, while extra assistance can be provided for those students that are having difficulty.
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| **Author Info**  | My name is Michael Belcher. I teach Algebra 1 and AP Calculus AB at Hillside New Tech High School in Durham, NC. We are a wall to wall project based learning school. Our goal is to foster academic success through real world applications of the Standard Course of Study. I am currently in my 3rd year of teaching at Hillside New Tech High School and my 6th year of teaching overall. I graduated with a B.A. in Mathematics and minors in Physics and Secondary Education from Wake Forest University in Winston-Salem, NC. I earned an M.A. from Teachers College Columbia University in New York, NY. |

