Directions:

- Do only the problems that you need to take and feel ready to take. If you have already earned Mastery on a Learning Target, do not attempt a problem for that Target! You can skip a Target if you need more time to practice with it, and take it on the next round.
- Each Learning Target problem is to be written up on a separate sheet, scanned to separate PDF files, and submitted to the appropriate Learning Target "assignment" on Blackboard. **Please do not submit more than one Learning Target in the same PDF, and make sure you are submitting it to the right Blackboard area.**
- If you are handwriting, submit your work by **scanning your work** using a scanning app or scanning device; **do not just take a picture** but scan your work to a clear, legible, black and white PDF file of size less than 100 MB. **Work submitted as an image file (JPG, PNG, etc.) will not be graded**.
- Please consult the grading criteria found in the Information on Learning Targets and Checkpoints document found in the *Learning Targets* area on Blackboard prior to submitting your work, to make sure your submission has met all the requirements.
- Please use the approved resources to double-check your work against errors prior to submitting your work.

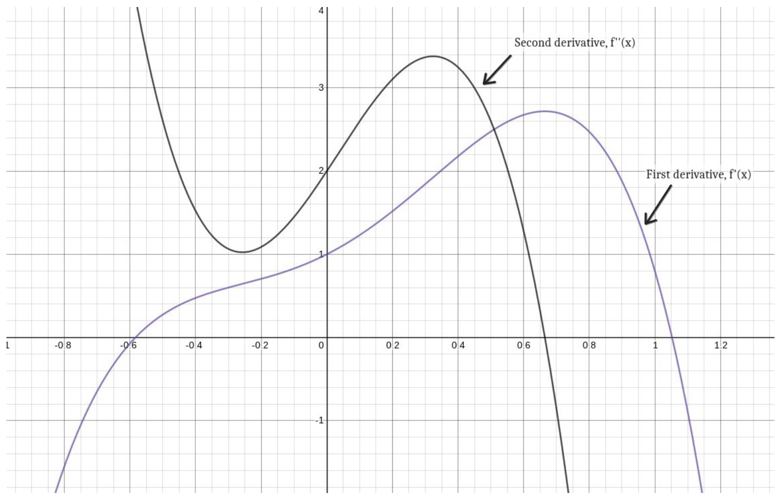
Learning Target 4 (Core): *I can use derivative notation correctly, state the units of a derivative, estimate the value of a derivative using difference quotients, and correctly interpret the meaning of a derivative in context.*

Fred drove from Lansing to Detroit. The function D gives the total distance that Fred has driven (in kilometers) t hours after he left.

1. Suppose $D'(5) = 100$. State the units of measurement for the numbers 5 and 100. (Clearly indicate which is which.)
2. Still assuming that $D'(5) = 100$. Explain the meaning of this statement in ordinary terms (that is, in terms of distance and time) and without using any technical jargon.
3. Suppose $D(3) = 80$, $D(4) = 65$, and $D(7) = 70$. Use forward, backward, and central differences to estimate $D'(4)$. Clearly indicate which estimate is which.

Learning Target 5: *Given information about f, f', or f'', I can correctly give information about f, f', or f'' and the increasing/decreasing behavior and concavity of f (and vice versa).*

Shown below are the graphs of the first and second derivatives of a function $f(x)$. The graph of f itself is not shown. You can assume that the behavior of the graphs shown at the edges of the window continues to the left and to the right.



1. On approximately what intervals is the original function f increasing? State your answer clearly and explain how you know.
2. On approximately what intervals is the original function f decreasing? State your answer clearly and explain how you know.
3. On approximately what intervals is the original function f concave up? State your answer clearly and explain how you know.
4. On approximately what intervals is the original function f concave down? State your answer clearly and explain how you know.

Important note: *Your explanations must refer to all functions explicitly by name.* Do not refer to "it", "the graph", "the function", "the line", etc. without also making it explicit which function you are referring to. Otherwise your work will not meet the grading standards since it won't be possible to tell which graph you are referring to.

Learning Target 6 (Core): *I can compute basic-level derivatives using algebraic shortcut methods and solve simple application problems. (Functions involved will include constant, power, polynomial, exponential, and sine/cosine functions; applications include rates of change and slopes/equations of tangent lines).*

In each of the items below, use only the derivative computation rules found in Sections 2.1 and 2.2 of the text. **Do not use the limit definition or any rules not found in Sections 2.1 and 2.2**. Use of these will result in the work being marked as not having met the grading standards. **If algebra is needed to simplify the function before taking its derivative, show all your algebra work.**

1. Compute the derivatives of the following functions.
   (a) $y = \pi + \pi x + \pi^x + x^\pi$
   (b) $g(x) = \cos(x) + 4\sin(x)$
   (c) $h(x) = \dfrac{5x^2+1}{x}$ (Remember, use only the rules from Sections 2.1 and 2.2. The Product, Quotient, and Chain Rules are off limits.)
2. Find an equation for the tangent line to the graph of $f(x) = 2x^3 - 10x^2 - 8x$ at $x = 0$.

Learning Target 7 (Core) : *I can compute derivatives involving the Product, Quotient, and Chain Rules.*

Find the derivatives of each of the following. **In each, state the rules you are using, in the correct order of use. You need only list when you use the Product, Quotient, or Chain Rules. In the case of the Chain Rule, clearly indicate the decomposition of the function by stating the "inner" and "outer" functions first. Correct answers given without this information will not meet the criteria for acceptability.** Show your work in a clear and logical order and circle/box off your answer. DO NOT simplify your answers.

1. $y = \sin(x)\cos(x)$
2. $y = \dfrac{x^2 + \cos(x)}{x^2}$
3. $y = e^{x^2+x+1}$

Learning Target 8: *I can compute advanced-level derivatives using algebraic shortcut methods.*

Find the derivatives of each of the following. **In each, state the rules you are using, in the correct order of use. You need only list when you use the Product, Quotient, or Chain Rules. In the case of the Chain Rule, clearly indicate the decomposition of the function by stating the "inner" and "outer" functions first. Correct answers given without this information will not meet the criteria for acceptability.** Show your work in a clear and logical order and circle/box off your answer. DO NOT simplify your answers.

1. $y = \tan(1 + x^2)$
2. $y = \sqrt{\ln(x) + x}$
3. $y = \arctan(x^3)$

Learning Target 9: *I can find the critical values of a function, determine where the function is increasing and decreasing, and apply the First and Second Derivative Tests to classify the critical points as local extrema.*

Consider the function $f(x) = 2x^3 - 10x^2 - 8x$.

1. Find all the critical values of the function. Make your reasoning clear by giving all calculus and algebra steps clearly and neatly.
2. Make a first derivative sign chart for the function and use it to determine the intervals on which the function is increasing and decreasing. Your sign chart must be legible and formatted using the rules we discussed in class, and you must state which points you are using as test points.
3. Using either the First or Second Derivative Test (your choice), classify each critical value as a local maximum, local minimum, or neither and explain your reasoning.

Acceptable work requires showing ALL Calculus steps used to arrive at your answer; however, you may use technology to perform any non-calculus task, like finding output values of functions, without showing the steps.

Learning Target 10: *I can determine the intervals of concavity of a function and find all of its points of inflection.*

Consider the function $f(x) = 2x^3 - 10x^2 - 8x$. Use calculus (not visual estimation from a graph) to find the intervals on which f is concave up and the intervals on which f is concave down, and state its inflection points.

If you construct a sign chart, make sure the chart has all the required properties that we have discussed. **Acceptable work requires showing ALL Calculus steps used** to arrive at your answer; however, you may use technology to perform any non-calculus task, like finding output values of functions, without showing the steps.

This is the same function used in Learning Target 9. If you attempted that problem and showed work there, you do not need to do that work again here.

Learning Target 11: *I can use the Extreme Value Theorem to find the absolute maximum and minimum values of a continuous function on a closed interval.*

For each of the following, use Calculus (not visual estimation from a graph) to determine the absolute extreme values of the given function on the specified interval. You may assume that each function is continuous on the interval. **Acceptable work requires showing ALL Calculus steps used** to arrive at your answer; however, you may use technology to perform any non-calculus task, like finding output values of functions, without showing the steps.

1. $f(x) = 2x^3 - 10x^2 - 8x$ on $[-1, 1]$
2. $g(x) = \dfrac{1}{1+x^2}$ on $[-2, 2]$

The first function above is the same function used in Learning Targets 9 and 10. If you attempted that problem and showed work there, you do not need to do that work again here.

Learning Target 12 (Core): *I can set up and use derivatives to solve applied optimization problems.*

Set up and solve the optimization problem found below the bullet list. **In order for your work to meet quality standards, it needs to contain ALL of the following. Check carefully before turning in your work to make sure you've included each one**. A lengthy solution is not necessary, but the written solution for Exercise 3 that was posted earlier would be a good guide for you.

- A clear indication of what each variable in the solution represents;
- A clear statement of what quantity you are optimizing;
- A formula for the quantity you are optimizing and a clear indication of how you obtained it;
- If you use a constraint in the problem, a clear statement of what that constraint is and how you used it;
- The use of a derivative to find the input that optimizes your quantity;
- Reasoning that explains why your solution is correct — *don't just find a value but explain how you know that value optimizes the target quantity.*

Problem for this Learning Target: Find the dimensions of the rectangle with area 361 square inches that has minimum perimeter, and then find the minimum perimeter. (Remember to give *both* answers and fully justify your reasoning.) **Use the list above as a checklist before you turn in your work**.

Learning Target 13: *I can calculate the area under a curve, net change, and displacement using geometric formulas and Riemann sums.*

Consider the function $f(x) = 2x^3 + x^2 - x + 1$. Estimate the area under the curve, above the x-axis, and between $x = 0$ and $x = 1$, using the following Riemann sums. **On each one**: Clearly state the value of Δx, clearly state which points you are using to construct the rectangles, and show the setup of your calculation. **Keep all approximations to four (4) decimal places**.

1. M_2
2. R_5