1. Function R is defined by $R(x) = \dfrac{2\,x^2 - 18}{(5\,x - 15)\cdot(2-x)}$.
   a) Explain why 3 is not in the domain of this function.
   b) Factor and simplify the expression for $R(x)$.
   c) Show work which computes $\lim_{x\to 3} R(x)$ or shows that limit does not exist.
   d) What do the results of parts (b) & (c) imply about the graph of $y = R(x)$ for x in $[2, 4]$?

2. Consider the following statement.

   $$\textit{If } \lim_{x\to 5} f(x) \textit{ exists and if } f(5) \neq 0, \textit{ then } \lim_{x\to 5} \frac{1}{f(x)} \textit{ exists.}$$

   Explain why that general statement is not correct. [Hint: ¿ Is there a function for which that statement is false?]

3. a) Explain why $\lim_{x\to\infty} \sin(x)$ does not exist.
   b) Show $\lim_{x\to\infty} \dfrac{\sin(x)}{x}$ does exist and compute its value.

4. $f(x) = \dfrac{x^2 + 2\,x - 3}{x^3 - 1}$ is not defined for $x = 1$. Is there a number c such that letting $f(1) = c$ would yield a revised function which would be continuous at $x = 1$? Explain your answer.

5. Find a value of parameter A for which the following function is continuous at 5. Explain why your choice of A "works".

   $$f(x) = \begin{cases} A + x & \text{if } x \leq 5 \\ A \cdot x & \text{if } x > 5 \end{cases}$$

6. a) Use a **limit** to define the derivative function of $f(x) = x^2 - 3$.
   b) Use the previous **limit** to verify that $f\,'(2) = 4$.

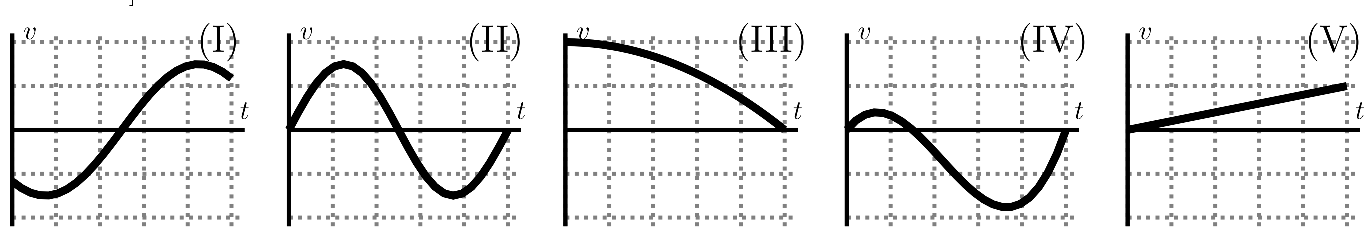
7. Let $g(x) = \sqrt{x+4}$. Use the limit definition of a derivative to verify that $g\,'(0) = \dfrac{1}{4}$.

8. The line with equation $3\,x - 4\,y = 7$ is tangent to the graph of $y = f(x)$ at the point with $x = -5$.
   a) $f(-5) =$
   b) $f\,'(-5) =$

9. Use an appropriate local linear approximation to estimate the value of $\sqrt[3]{7.98}$

10. An arrow is shot upwards. If the arrow hits the ground 20 seconds later, what was its initial velocity?

11. These graphs present velocity, $v(t)$, for several particles moving along the x-axis for times $0 \leq t \leq 5$. [All figures use the same scales.]



   For each of the following description of a motion, identify which graph(s) show that behavior.
   a) has a constant acceleration
   b) ends up farthest to the left of where it started
   c) ends up farthest to the right from its starting point
   d) experiences the greatest initial acceleration
   e) has the greatest average velocity
   f) has the greatest average acceleration

12. Suppose f and g are differentiable functions with values shown in these tables.

x	$f(x)$	$f'(x)$
2	3	5
4	-7	6

x	$g(x)$	$g'(x)$
2	4	-2
4	3	9

For each of the following parts, show how to use those table values to compute the specified derivative OR explain what extra information would be needed to finish that computation.

a) If $A(x) = f(x) - g(x)$, then $A'(4) =$

b) If $B(x) = f(x) \cdot g(x)$, then $B'(2) =$

c) If $C(x) = \dfrac{g(x)}{f(x)}$, then $C'(4) =$

d) If $D(x) = f\big(g(x)\big)$, then $D'(2) =$

13. Domain of function $f(x) = \ln\Big(\big|3\,x\big|\Big)$ includes all non-zero real numbers. Show work which finds an expression for $f\,'(x)$.

Hint: treat the case $x > 0$ first, then consider the case $x < 0$ separately. Simplify each result, then simplify further.

14. Differentiate some expressions involving Sine and Cosine several times.

a) Find the third derivative of $f(x) = \sin(7 + x)$.

b) Find the fifth derivative of $g(x) = \cos(2\,x)$.

c) Explain why repeatedly differentiating $\sin(x)$ will never produce $-2\,\cos(x)$.

15. Consider the equation $e^y - 2\,x^3\,y + 4 = 5\,x$.

a) Find an expression for $\dfrac{dy}{dx}$.

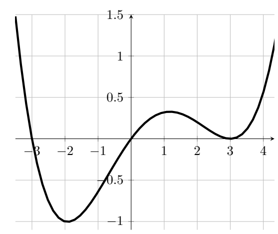
b) What condition must x and y satisfy so that the corresponding tangent line is horizontal?

c) What condition must x and y satisfy so that the corresponding tangent line is vertical?

16. Suppose g is a differentiable function such that $-1 \le g\,'(x) \le 3$ for all x in $[0, 12]$. Also suppose $g(2) = 5$.

a) What is the smallest possible value for $g(7)$? Explain your reasoning.

b) What is the largest possible value for $g(7)$? Explain your reasoning.



17. Examine this graph of the derivative of some function f.

a) Determine where f is decreasing.

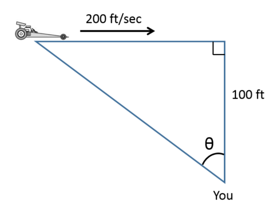
b) Locate the x values for the local extrema of f.

c) Determine where f is concave up.

d) Locate the x values for any inflection point of f.

18. Find the global extrema of the function $f(x) = 2\,x - e^x$ on the interval $[-1, 2]$

19. Examine this figure. You are taking a video of a racecar from a position that is 100 feet from the racetrack. The racecar is moving at constant rate of 200 feet-per-second. How fast is your viewing angle, θ in this figure, changing at the moment when the car is directly in front of you?



20. Starting at time $t = 0$ hours, water leaks out of a tank at rate $r(t)$, measured in gallons-per-hour. This table has some values for $r(t)$.

t [hr]	0.0	0.5	1.0	1.5	2.0	2.5	3.0
$r(t)$ [gal/hr]	0.0	6	11	15	18	20	21

a) What is the meaning of the quantity $\displaystyle\int_1^2 r(t)\,dt$? Write your answer in terms relevant to this situation AND make it understandable by someone who does not know any calculus; mention any units that are appropriate.

b) Write a three-term Riemann sum to estimate $\displaystyle\int_0^3 r(t)\,dt$ [this is not the definite integral given in part (a)]. Give your answer as an expression in terms of numbers, but you do not need to do the arithmetic.

21. Evaluate the following definite integrals and antiderivative.

A) $\displaystyle\int_{-1}^{3} (w+1)\cdot(w-1)\cdot(w-3)\,dw$

B) $\displaystyle\int_1^{e^3} \frac{5}{x} - 6x^2 + \sqrt{x}\,dx$

C) $\displaystyle\int 5\,e^t + \sin(t)\,dt$

22. Shade a region whose area is computed by $\displaystyle\int_{-5}^{5} \sqrt{25 - x^2}\,dx$; then use geometry to evaluate the definite integral.