

Math 131 - Test 2

October 9, 2025

Name _____

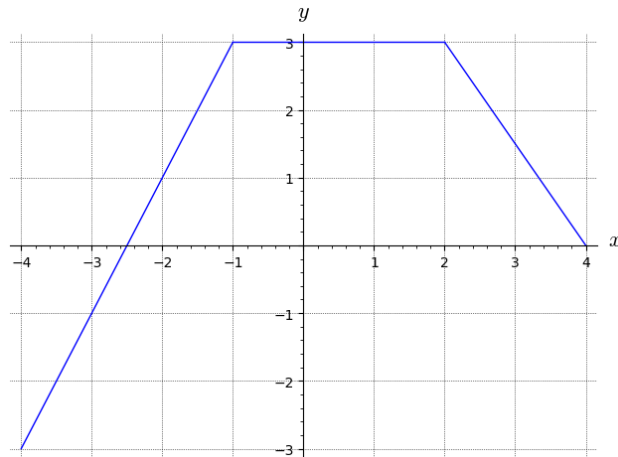
Score _____

Show all work to receive full credit. Supply explanations where necessary. Unless otherwise indicated, use differentiation rules for all derivatives and do not simplify.

1. (8 points) Let $f(x) = 4 - x + 2x^2$. Use the limit definition of derivative (not differentiation rules) to determine $f'(x)$.

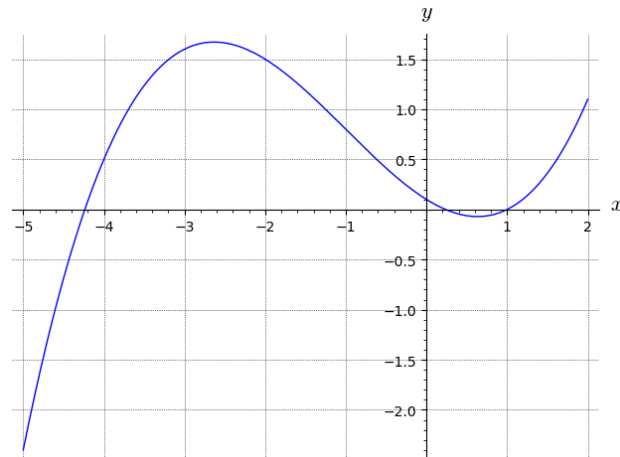
2. (6 points) Use differentiation rules to confirm your result above. Then find an equation of the line tangent to the graph of $f(x) = 4 - x + 2x^2$ at the point where $x = -1$. Write your final answer in slope-intercept form.

3. (6 points) The graph of the function f is shown below. Use the graph to determine each of the following. Show work or explain.



- (a) $f'(-2)$
- (b) $f'(3)$
- (c) $f'(1)$
- (d) $f'(2)$
4. (8 points) State two ways in which a function's derivative may fail to exist at a point where the function itself is defined. Then use a single graph to illustrate both ways. Label which is which.

5. (7 points) The graph of the function g is shown below. Use the graph to solve the following problems.



- (a) Sketch the tangent line at $x = -4$. Then use your tangent line to estimate $g'(-4)$.
- (b) Find approximate coordinates of a point on the graph at which $g'(x) = 0$. Explain how you know that $g'(x) = 0$ at your point.
- (c) Find approximate coordinates of a point on the graph at which $g'(x) < 0$. Explain how you know that $g'(x) < 0$ at your point.
6. (5 points) Use trig identities and the quotient rule to derive our formula for the derivative of $y = \tan x$ from the basic rules for the sine and cosine.

7. A rock is thrown vertically upward with a velocity of 48 ft/sec from over the edge of the top of a 160-ft building. Use the position function

$$s(t) = -16t^2 + v_0t + s_0,$$

where s represents height (in feet) at time t (in seconds), to solve the following problems.

- (a) (2 points) Write the function $s(t)$ that gives the rock's height at time t .
- (b) (2 points) Determine the average rate of change the rock's height over the interval from $t = 0$ to $t = 3$. (Include units with your answer.)
- (c) (2 points) Determine the function that gives the rock's velocity at time t .
- (d) (1 point) Determine the rock's velocity after 4 seconds. (Include units with your answer.)
- (e) (2 points) What is the acceleration of the rock at time t ? (Include units with your answer.)
- (f) (3 points) Determine the rock's maximum height. (Include units with your answer.)
- (g) (3 points) When does the rock hit the ground?
- (h) (2 points) What is the speed of the rock when it hits the ground? (Include units with your answer.)

8. (6 points) Determine the higher-order derivative: $\frac{d^3}{dx^3} (2x^6 - 5x^4 - 5 \sin x)$

9. (12 points) The table below gives the values of the functions f and g and their derivatives at selected values of x .

x	0	1	2
$f(x)$	3	-5	0
$f'(x)$	1	-1	-4
$g(x)$	-2	2	1
$g'(x)$	2	6	-7

(a) If $h(x) = 4f(x) - 2g(x)$, compute $h'(2)$.

(b) If $h(x) = \frac{g(x)}{x^2}$, compute $h'(1)$.

(c) If $h(x) = f(g(x))$, compute $h'(2)$.

10. (15 points) Differentiate. Do not simplify.

(a) $\frac{d}{dw} \left(\frac{1}{w^2} + w^\pi + \sqrt[5]{w} \right)$

(b) $\frac{d}{d\theta} (\theta^2 \csc \theta)$

(c) $\frac{d}{dx} (2 \cos^7 x)$

11. (10 points) The function below is discontinuous at two points. Find and classify the discontinuities. For full credit, your work must show how you are using limits and the definition of continuity.

$$f(x) = \begin{cases} \frac{x}{x-3}, & x < 3 \\ 3x + 5, & 3 \leq x < 6 \\ x^2 - x - 5, & x \geq 6 \end{cases}$$