

1. Find the derivatives of the following:

$$(a) f(x) = \sqrt{2x^5 + 1} \quad (b) g(x) = 100 + 25x - 16x^2 \quad (c) h(t) = \frac{1}{5t + 1}$$

2. Find the second derivatives of the following functions:

$$(a) f(x) = 15x^\pi - \sqrt{x} \quad (b) g(x) = 7\pi^3 - 7x^3 \quad (c) h(t) = \sqrt{5} + \frac{5}{t^6}$$

3. Find the rate of change of $R(x) = 100 + 27\sqrt{x}$ at $x = 9$

4. Let $P(x)$ be the profit in dollars of manufacturing origami speakers, where x is the quantity produced. Suppose $P(100) = 2000$ and $P'(100) = 30$. Estimate the profit at a production level of $x = 110$.

5. A ball is tossed upwards from an apartment balcony. Its height (in feet) t seconds later is given by $h(t) = -16t^2 + 32t + 48$. Show that its velocity when $t = 1$ is zero. Has the ball stopped moving at that time?

6. Find the derivatives of the following functions:

$$(a) y = \sqrt{x^2 + \pi^2} \quad (b) g(x) = 6x^{\frac{2}{3}} - 45\sqrt{7} \quad (c) h(x) = (x^3 + 5)^2$$

7. Find the equation of the line tangent to $y = 3x^2 - 9$ at $x = 2$. Sketch a graph showing the function and the tangent line.

8. For what values of x are the lines tangent to $f(x) = x^2 + 7x + \pi^3$ and tangent to $g(x) = \frac{5}{2}x^2 + x + \sqrt{2}$ parallel?

9. Find where the function $y = 12x^2 - 24x$ is increasing.

10. Find the equation of the line tangent to $f(x) = \sqrt{x}$ at $x = 9$

11. Find the derivatives of the following functions:

(a) $f(x) = (3x^2 + 1)^2$

(b) $g(x) = x^3(x^2 + 5)^2$

(c) $h(t) = \frac{3t^4 + 6}{7t + t^2}$

12. Use the second derivative test to find the min/max's of $y = x^3 - 6x^2 + 2011$

13. Suppose $f'(3) = 0$ and $f''(3) = -12$. What does that say about $f(x)$?

14. Sketch the graph of a function $y = f(x)$ where $f'(x)$ is positive for $-3 < x < 5$ and negative (or zero) otherwise.

15. Let $S(x)$ be the value in dollars of one share of stock in your OrigamiSound company where x is the number of days since your IPO. Suppose $S(120) = 40$ and $S'(120) = -0.3$. Estimate $S(130)$.

16. Sketch the graph of a function that is always increasing but whose derivative is always decreasing.

17. Sketch the graph of a function $y = f(x)$ where $f''(x)$ is positive for $0 < x < 2$ and negative (or zero) otherwise.

18. For what values of x is the line tangent to $f(x) = x^3 - 4x$ parallel to $5x - 2y = 7$?

19. Use the first derivative test to find the min/max's of $y = 2x^3 - 9x^2$

20. Sketch the graph of $y = f(x)$ where $f(2) = 6$, $f'(2) = -1$, $f(4) = -3$ and $f'(4) = 2$.

21. Suppose profit is $P(x) = 3x^2 + 2x + 100$. Find the marginal profit when $x = 2$
22. Find the equation of the line tangent to $f(x) = x^3 + 2x^2 - 7$ at $x = 1$
23. A ball is tossed upwards from an apartment balcony. Its height (in feet) t seconds later is given by $h(t) = -16t^2 + 44t + 100$. Find its velocity when $t = 2$. What does the negative sign mean ?
24. Find the equation of the line tangent to $y = \frac{1}{x^2 + 1}$ at $x = -1$
25. For what values of x is the function $f(x) = x^3 - 12x$ decreasing ?
26. Suppose cost is given by $C(x) = 1000 + 0.3x - 0.002x^2$. Find the marginal cost function.
27. Sketch the graph of a function $y = f(x)$ with $f(-2) = 3$, $f'(-2) = 1$, $f''(-2) < 0$ and $f(4) = 10$.
28. Find the equation of the tangent line to $y = \sqrt{x}$ at $x = 9$. Sketch a graph showing the function and the tangent line.
29. Find the inflection points of $f(x) = x^3 - 12x$
30. Find the equation of the tangent line to $y = x^2 + 1$ at $x = 1$. Sketch a graph showing the function and the tangent line.

31. Below are the graphs of a number of functions. Some of them pair up as a function and its derivative. Find as many pairs as you can.

