1. Compute $\frac{d}{dx}\left(\tan^{-1}(\ln(x+1)) + e^{\sin^2(x)}\right)\Big|_{x=0}$

2. Evaluate $\lim_{x\to 3} \frac{\sqrt{x+1}-2}{x^3-7x-6}$

3. Evaluate $\lim_{x\to 0} \frac{\cos(2x)-1}{\sin(5x)}$

4. Evaluate $\lim_{x\to\infty} \frac{\ln(x)}{\sqrt{x}}$

5. Evaluate $\lim_{x\to-\infty} \frac{7x^2+4x}{9-3x^2}$

6. Evaluate $\lim_{x\to 0} \frac{\sin(2x)}{\sin(7x)}$

7. Evaluate $\lim_{x\to\pi/2} \sec(x) - \tan(x)$

8. Evaluate $\lim_{x\to 0} \frac{e^{2x}-1-x}{x^2}$

9. Evaluate $\lim_{x\to 0} \frac{\arcsin(x)}{x}$

10. Evaluate $\lim_{x\to\infty} \left(1+\frac{1}{x}\right)^x$.

11. Sketch the graph of $y = x^3 - 3x + 5$ after making sign charts for the first two derivatives. Use a graphing tool such as Wolfram Alpha, a CAS, or a graphing calculator to check your answer.

12. Sketch the graph of the everywhere continuous function $f(x)$ for which $f'(x) < 0$ for $6 < x < 8$ and $x > 8$, $f'(8)$ does not exist, and $f'(x) > 0$ for $x < 6$; while $f''(x) > 0$ for $8 < x < 12$ and negative outside the interval $[8, 12]$.

13. Sketch the graph of the continuous even function $k(x)$ for which $\lim_{x\to\infty} k(x) = 0$; $k'(x) < 0$ for $x > 0$ and $k''(x) < 0$ for $0 < x < \frac{1}{\sqrt{3}}$, but $k''(x) > 0$ for $x > \frac{1}{\sqrt{3}}$.

14. Sketch the graph of the function $h(x)$ for which $\lim_{x\to 0^-} h(x) = -\infty$; $\lim_{x\to 0^+} h(x) = \infty$; $\lim_{x\to 1^-} h(x) = -\infty$; $\lim_{x\to 1^+} h(x) = \infty$; $\lim_{x\to-\infty} h(x) = 0$; $\lim_{x\to\infty} h(x) = 0$; $h'(x) < 0$ for all x; $h''(x) > 0$ for $0 < x < 0.5$ and $x > 1$ but negative otherwise.

15. Sketch the graph of the continuous function $g(x)$ with domain $x > 0$ for which $\lim_{x\to 0^+} g(x) = \infty$; $g'(x) < 0$ for $0 < x < 1$ and $g'(x) > 0$ for $x > 1$; while $g''(x) > 0$ for $x > 0$.

16. Sketch the graph of the continuous odd function $f(x)$ for which $f'(x) > 0$ for $0 < x < 1$ and $f'(x) < 0$ for $x > 1$; while $f''(x) < 0$ for $0 < x < \sqrt{3}$ and $f''(x) > 0$ for $x > \sqrt{3}$.

17. A cylindrical can with a bottom but not a top has volume equal to 8 m^3. What are the dimensions of the can that minimize surface area?

18. A poster of area 5000 cm^2 has blank margins of width 5 cm on the top and bottom and 2 cm on the sides. Find the dimensions of the poster that maximize the printed area.

19. Find the equation of the line through the point $(4, 12)$ so that the area of the triangle bounded by this line and the axes in the first quadrant has minimal area.

20. Let x and y be two positive numbers and k a constant so that $x + y = k > 0$ and suppose $n > 1$. Show that by setting $x = y$ that a) $x^n + y^n$ is minimized, and b) $x^n y^n$ is maximized.

21. All units in a 1000-unit apartment complex are occupied when the rent is \$1200 per month. The landlord knows from experience that a \$50 increase in rent per month will result in a lose of ten rented units. However, each occupied unit results in a \$200 maintanence charge for the landlord. What rent will maximize the landlord's profit? How many units will be rented at this price?

22. Approximate $\sqrt{11}$ to three decimal places using Newton's method and any calculating device. Hint: Estimate a zero for $f(x) = x^2 - 11$.

23. CAS problem (3 points): use a CAS device to solve the following problem. Submit a printed copy of the device's solution and your corresponding commands.

    Use Newton's method to estimate the solutions for $x^3 - 9x - 4 = 0$ using three different initial guesses: $g_0 = 1.5$, $g_0 = 1.73$, and $g_0 = 2$. Explain why the three estimates are different and decide if the estimates are close to a solution. Use a graph to help your explanation.

Brief answers

1. 1
2. 1/80
3. 0
4. 0
5. $-7/3$
6. 2/7
7. 0
8. DNE
9. 1
10. e
11. Hint: $y' < 0$ in $(-1, 1)$, $y'' > 0$ for $x > 0$.
12. Looks like $y = x\sqrt[3]{8 - x}$.
13. Looks like $y = \dfrac{1}{1 + x^2}$
14. Looks like $y = x^{-1} + (x - 1)^{-1}$
15. Looks like $y = x^2 - 2\ln(x)$.
16. Looks like $y = \dfrac{x}{\sqrt{2}e^{x^2/2}}$.
17. Radius $= \dfrac{2}{\sqrt[3]{\pi}}$; Height $= \dfrac{2}{\sqrt[3]{\pi}}$
18. $20\sqrt{5}$ by $50\sqrt{5}$
19. $y = -3x + 24$
20. Hint: a) use second derivative test;
    b) use the first derivative test.
21. \$3200 per month, 600 units
22. 3.317