1. $f'(x) = -\csc x \cot x \cos(\csc x)$

2. $g'(r) = 3r^2 \tan(3r^6 - 9r + 2) + r^3(18r^5 - 9)\sec^2(3r^6 - 9r + 2)$

3. $y'(x) = -35x^6 \csc^2(1 + 5x^7)$

4. $\dfrac{dh}{dp} = \dfrac{\frac{(4p^3+2)\sin 6p}{2\sqrt{p^4+2p-7}} - 6\cos 6p\sqrt{p^4 + 2p - 7}}{\sin^2 6p}$

5. $\dfrac{dh}{d\theta} = \dfrac{6(7 - \cos 2\theta)\sec^2 6\theta - 2(\sin 2\theta)(\tan 6\theta)}{(7 - \cos 2\theta)^2}$

6. $h'(z) = \dfrac{1}{5}\left(\dfrac{z^2 + \cos z}{-2z + \tan z}\right)^{-\frac{4}{5}} \dfrac{(2z - \sin z)(-2z + \tan z) - (z^2 + \cos z)(-2 + \sec^2 z)}{(-2z + \tan z)^2}$

7. $y'(x) = -\sin x \cos(\cos x)\cos(\sin(\cos x))$

8. $g'(y) = 6y^5 \cos(4y - \sin y) - y^6(4 - \cos y)\sin(4y - \sin y)$

9. $f^{(35)}(0) = f'''(0) = -1$

10. $f^{(150)}(x) = f''(x) = -\cos x$

11. $\dfrac{dy}{dx} = \dfrac{3x^2 \cot y}{x^3 \csc^2 y + 2y\sec^2(y^2)}$

12. $\dfrac{dz}{dt} = \dfrac{\cos(t + z) - \cos t \sin z}{\sin t \cos z - \cos(t + z)}$

13. $\dfrac{dr}{dy} = \dfrac{2 - 3r^7}{2r + 21yr^6 - \cos r}$

14. $\dfrac{dy}{dr} = \dfrac{2r + 21yr^6 - \cos r}{2 - 3r^7}$

15. $y = \dfrac{1 + \sqrt{3}}{2}x + \dfrac{3 + 6\sqrt{3} - 4\pi}{12}$

16. $y = \sin(1)$

17. 3

18. $-\dfrac{3}{5}$

19. $-\infty$

20. $\frac{5}{3}$

21. ∞, don't worry about this one, though doing a change of variable of $x = 1/t$ and then $x \to \infty$ means $t \to 0^+$ and then this is a limit we are familiar with.

22. $\frac{1}{8\pi}\ cm/s$

23. $\frac{19}{\sqrt{10}}\ cm/s$

24. $\frac{7}{15}\ ft/min$

25. $\frac{300+96\sqrt{2}}{225-\sqrt{2}}\ mi/h$

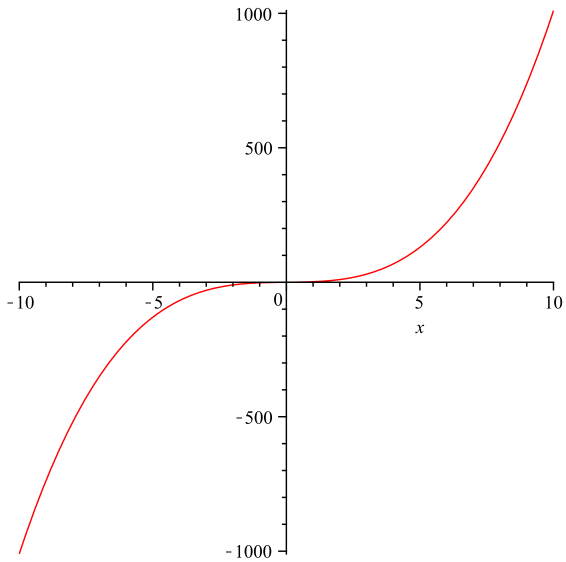
26. $\sqrt{9.001} \approx \frac{18001}{6000}$

27. $\sin\left(\frac{\pi}{100000}\right) \approx \frac{\pi}{100000}$

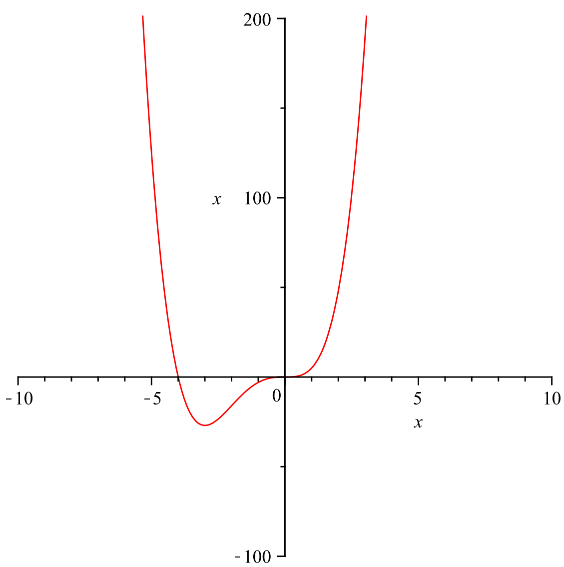
28. $\frac{1}{250}$

29. $-\frac{9}{200}$

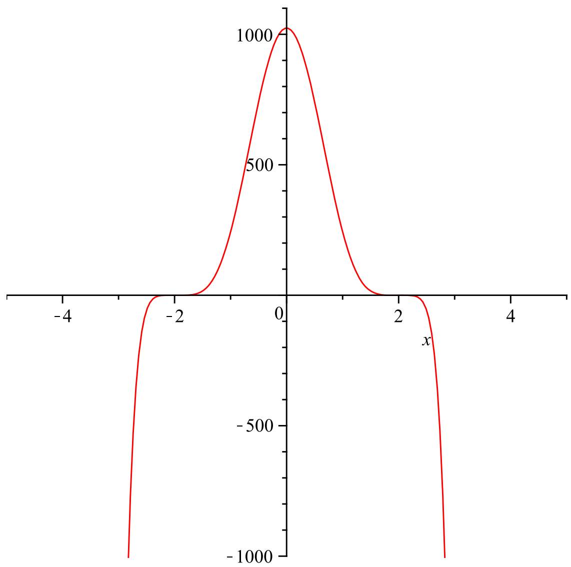
30. The function has no critical points, and hence no extrema. It has an inflection point at $(0, 0)$. It is increasing on $(-\infty, \infty)$, concave down on $(-\infty, 0)$ and concave up on $(0, \infty)$. It has no asymptotes.



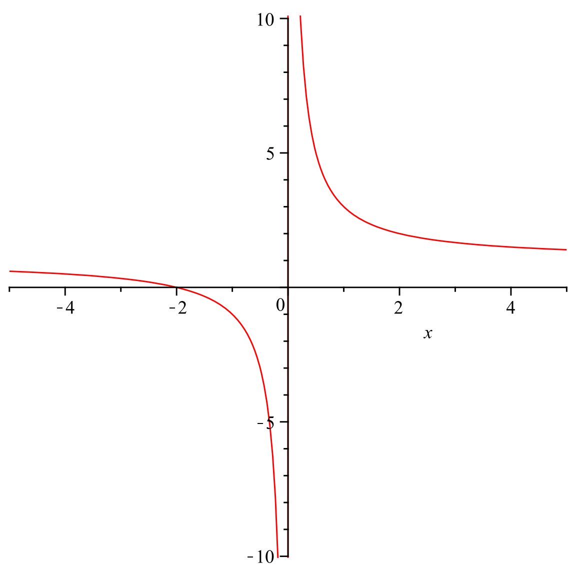
31. The function has critical points at $(0,0)$ and $(-3,-27)$. It has a local minimum at $(-3,-27)$. It has inflection points at $(0,0)$ and $(-2,-16)$. It is increasing on $(-3,\infty)$ and decreasing on $(-\infty,-3)$. It is concave up on $(-\infty,-2)\cup(0,\infty)$ and concave down on $(-2,0)$. It has no asymptotes.



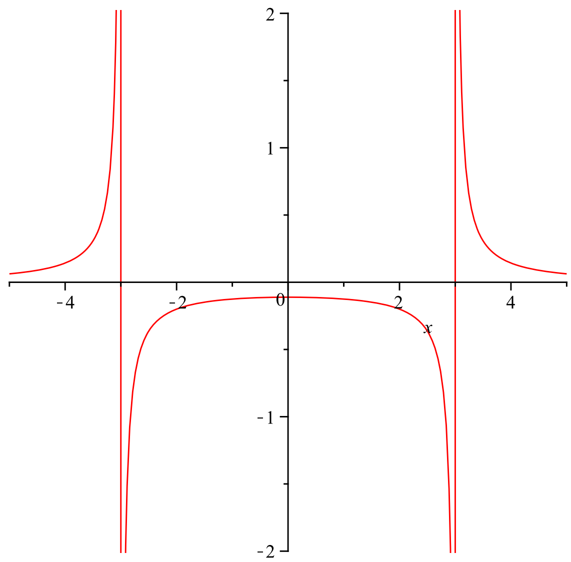
32. The function has critical points at $(0,1024)$, $(2,0)$, and $(-2,0)$. It has a local maximum at $(0,1024)$. It has inflection points at $(-2,0)$, $(-\frac{2}{3},\frac{33554432}{59049})$, $(-\frac{2}{3},\frac{33554432}{59049})$, and $(2,0)$. It is increasing on $(-\infty,0)$ and decreasing on $(0,\infty)$. It is concave down on $(-\infty,-2)\cup(-\frac{2}{3},\frac{2}{3})\cup(2,\infty)$ and concave up on $(-2,-\frac{2}{3})\cup(\frac{2}{3},2)$. It has no asymptotes.



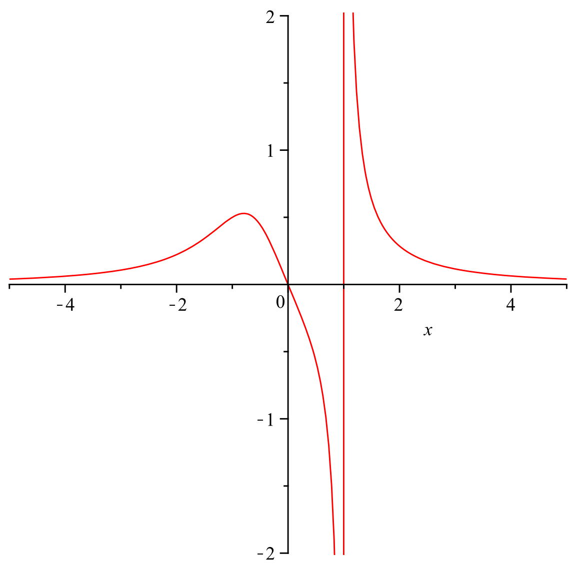
33. The function has vertical aysmptotes at $x = 0$ and $x = 2$. It has a horizontal asymptote at $y = 1$. It has critical points at $x = 0$ and $x = 2$. It has no extrema. It is decreasing on $(-\infty, 0) \cup (0, 2) \cup (2, \infty)$ and it's increasing nowhere. It is concave up on $(0, 2) \cup (2, \infty)$ and concave down on $(-\infty, 0)$.



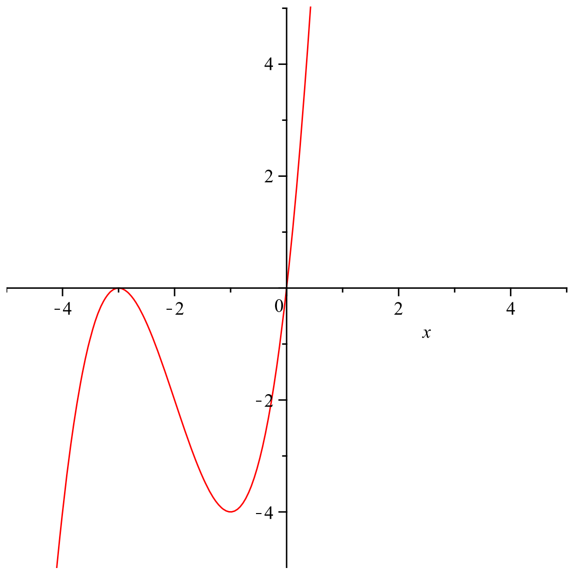
34. The function has vertical aysmptotes at $x = -3$ and $x = 3$. It has a horizontal asymptote at $y = 0$. It has critical points at $x = -3$ and $x = 3$ and $(0, -\frac{1}{9})$. It has relative maximum at $(0, -\frac{1}{9})$. It has no inflection points. It is decreasing on $(0, 3) \cup (3, \infty)$ and it's increasing $(-\infty, -3) \cup (-3, 0)$. It is concave down on $(-3, 3)$ and concave up on $(-\infty, -3) \cup (3, \infty)$.



35. The function has a vertical aysmptote at $x = 1$. It has a horizontal asymptote at $y = 0$. It has critical points at $(-\sqrt[3]{\frac{1}{2}}, \frac{3}{2}\sqrt[3]{\frac{1}{2}})$ and $x = 1$. It has a local maximum at $(-\sqrt[3]{\frac{1}{2}}, \frac{3}{2}\sqrt[3]{\frac{1}{2}})$. It has an inflection point at $(-\sqrt[3]{2}, \frac{\sqrt[3]{2}}{3}$. It is increasing on $(-\infty, -\sqrt[3]{\frac{1}{2}})$ and decreasing on $(-\sqrt[3]{\frac{1}{2}}, 1) \cup (1, \infty)$. It is concave up on $(-\infty, -\sqrt[3]{2}) \cup (1, \infty)$ and concave down on $(-\sqrt[3]{2}, 0) \cup (0, 1)$.



36. The function has no aysmptotes. It has critical points at $(-1, -4)$ and $(-3, 0)$. It has relative maximum at $(-3, 0)$ and a relative minimum at $(-1, -4)$. It has an inflection point at $(-2, -2)$. It is increasing on $(-\infty, -3) \cup (-1, \infty)$ and it is decreasing $(-3, -1)$. It is concave down on $(-\infty, -2)$ and concave up on $(-2, \infty)$.



37. 41

38. Use the intermediate value theorem to show that the function $f(x) = x^3 - 15x + 9$ has roots in $[-2, 2]$ by showing $f(-2) > 0$ and $f(2) < 0$. Then suppose that $a, b \in (-2, 2)$ are the roots, i.e. $f(a) = f(b)$. Then by Rolles' Theorem there must be a $c \in (a, b)$ such that $f'(c) = 0$. Then calculate $f'(x)$ and show that the solutions to $f'(x) = 0$ are outside of $[-2, 2]$.

39. No such function exists.

40. Pick any $x_1, x_2 \in (a, b)$, then by the mean value theorem one has $f(x_1) - f(x_2) = f'(c)(x_1 - x_2)$. Since $f'(x) = 0$ for all $x \in (a, b)$, this means that $f(x_1) - f(x_2) = f'(c)(x_1 - x_2) = 0$ and thus $f(x_1) - f(x_2) = 0$ and hence $f(x_1) = f(x_2)$ for all $x_1, x_2 \in (a, b)$. Therefore f is constant on (a, b).