Lines: If \((x_1, y_1), (x_2, y_2)\) lie on a line \(L\), the slope of \(L\) is \(m = \frac{y_2 - y_1}{x_2 - x_1}\) and the equation is \(y - y_1 = m(x - x_1)\).

Distance: \((x_1, y_1)\) to \((x_2, y_2): \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}\). Circle, center \((a, b)\), rad. \(r: (x - a)^2 + (y - b)^2 = r^2\).

Trig: In a right triangle: \(\sin \theta = \frac{opp}{hyp}\), \(\cos \theta = \frac{adj}{hyp}\), \(\tan \theta = \frac{opp}{adj}\), \(\sec \theta = \frac{1}{\cos \theta}\), \(\csc \theta = \frac{1}{\sin \theta}\).

Identities: \(\sin^2 x + \cos^2 x = 1\), \(1 + \tan^2 x = \sec^2 x\), \(\sin(2x) = 2\sin x \cdot \cos x\), \(\cos(2x) = \cos^2 x - \sin^2 x\).

Exponentials and logarithms: \(a^x + a^{-y} = a^y\), \(\ln(a^x) = x \ln a\), \(e^x = y\) is equivalent to \(x = \ln y\), \(e^{\ln y} = y\).

Squeeze Theorem: If \(f(x) \leq g(x) \leq h(x)\) near \(x = a\) and \(\lim_{x \to a} f(x) = \lim_{x \to a} h(x) = L\), then \(\lim_{x \to a} g(x) = L\).

Intermediate Value Theorem: If \(f\) is continuous on \([a, b]\) and \(N\) is any number between \(f(a)\) and \(f(b)\), there is a number \(c\) in \([a, b]\), such that \(f(c) = N\).

Corollary: If \(f\) changes sign from \(a\) to \(b\), then \(f(c) = 0\) with \(c\) between \(a\) and \(b\).

Definition of the Derivative: \(f'(x) = \lim_{h \to 0} \frac{f(x + h) - f(x)}{h}\); \(f'(a) = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}\).

Rules of Differentiation: \(\frac{d}{dx}(cu) = c \frac{du}{dx}\), \(\frac{d}{dx}(u + v) = \frac{du}{dx} + \frac{dv}{dx}\), \(\frac{d}{dx}(u v) = u \frac{dv}{dx} + v \frac{du}{dx}\), \(\frac{d}{dx}(f(g(x))) = f'(g(x))g'(x)\).

Quotient Rule: \(\frac{d}{dx} \left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}\), \(\frac{d}{dx} \left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}\).

Chain Rule: If \(y = f(u)\) and \(u = g(x)\), then \(\frac{dy}{dx} = \frac{du}{dx} \frac{dy}{du}\), \(\frac{d}{dx} \left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}\), \(\frac{d}{dx} \left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}\).

Bodies in Free Fall. The distance above ground level of a body in free fall in the earth’s atmosphere is \(s(t) = s_0 + v_0 t - \frac{1}{2} g t^2\), where \(s_0\) is the position at time \(t = 0\), \(v_0\) is the velocity at time \(t = 0\), and \(g\) is the acceleration due to gravity with \(g = 32\text{ ft/s}^2\) or \(g = 9.8\text{ m/s}^2\).

Linear or Tangent Line Approximation (or Linearization) of \(f(x)\) at \(x = a\) is \(L(x) = f(a) + f'(a)(x - a)\).

Newton’s Method to approximate a solution \(r\) of \(f(x) = 0\). Choose a point \(x_0\) close to \(r\). Calculate the terms \(x_0, x_1, x_2, x_3, \ldots\) of the sequence defined recursively by \(x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}\).

Rolle’s Theorem: Suppose \(f\) is a function that is continuous on the closed interval \([a, b]\) and differentiable on the open interval \((a, b)\). If \(f(a) = f(b) = 0\), then \(f'(c) = 0\) for some \(c\) in \((a, b)\).

Mean Value Theorem: Suppose \(f\) is a function that is continuous on the closed interval \([a, b]\) and differentiable on the open interval \((a, b)\). Then there is a point \(c\) in \((a, b)\) such that \(f(b) - f(a) = f'(c)(b - a)\).

First Derivative Test: Suppose that \(f\) is a differentiable function and \(f(c) = 0\). (a) If \(f'\) changes sign from + to − at \(x = c\), a local maximum occurs at \(x = c\). (b) If \(f'\) changes sign from − to + at \(x = c\), a local minimum occurs. (c) If \(f'\) does not change sign at \(x = c\), neither a local maximum or minimum occurs at \(x = c\).

Second Derivative Test: Suppose that \(f\) is a twice differentiable function and \(f(c) = 0\). (a) If \(f''(c) > 0\), a local minimum occurs at \(x = c\). (b) If \(f''(c) < 0\), a local maximum occurs. (c) If \(f''(c) = 0\), the test fails.

L’Hôpital’s Rule: If \(\lim_{x \to a} \frac{f(x)}{g(x)} = 0\) or \(\pm \infty\), then \(\lim_{x \to a} \frac{f(x)}{g(x)} = \lim_{x \to a} \frac{f'(x)}{g'(x)}\). Here \(a\) may be a finite number or \(\pm \infty\).

Integration or anti-differentiation: \(\int f(x) \, dx = F(x) + C\) means that \(F'(x) = f(x)\). Formulas can be found by reversing the differentiation formulas: \(\int x^n \, dx = x^{n+1}/(n+1) + C\), if \(n \neq -1\) and \(\int x^{-1} \, dx = \ln |x| + C\).