# Algebra Formulas

## Factoring

$x^2 - y^2 = (x - y)(x + y)$

$x^3 + y^3 = (x + y)(x^2 - xy + y^2)$

$x^3 - y^3 = (x - y)(x^2 + xy + y^2)$

$(x + y)^2 = x^2 + 2xy + y^2$

$(x - y)^2 = x^2 - 2xy + y^2$

$(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3$

$(x - y)^3 = x^3 - 3x^2y + 3xy^2 - y^3$

## Exponents & Radicals

$a^0 = 1, a \neq 0$

$(a^m)^n = a^{mn}$

$a^m a^n = a^{m+n}$

$a^{\frac{m}{n}} = \sqrt[n]{a^m}$

$(ab)^m = a^m b^m$

$\sqrt[n]{ab} = \sqrt[n]{a}\sqrt[n]{b}$

$\frac{a^m}{a^n} = a^{m-n}$

$\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

$\sqrt{a} = a^{\frac{1}{2}}$

$a^{-m} = \frac{1}{a^m}$

$\sqrt[n]{a} = a^{\frac{1}{n}}$

$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$

## Important Formulas

Distance Formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Midpoint Formula: $(x_m, y_m) = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

Vertex form of Quadratic function: $y = a(x - h)^2 + k$

Parabola Axis of Symmetry: $x = \frac{-b}{2a}$

Center Radius Form: $(x - h)^2 + (y - k)^2 = r^2$

A circle with center ($h$,$k$) and radius $r$.

Quadratic Formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Difference Quotient: $m = \frac{f(x+h) - f(x)}{h}$

Law of Sines: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos C$

# Logarithm Rules

## Basic Rules

Change of Base: $\log_b M = \dfrac{\log M}{\log b}$

Domain of Logs: $\log x$ $where\ x > 0$

Log and ln Properties: $\log_b 1 = 0$ $\ln 1 = 0$ $\log_a a = 1$

Relationship Between Log and ln: $\log_e x = \ln x$

## Logarithm and Base 10

| | |
|---|---|
| $\log_b y = x$ then $y = b^x$ | Ex: $\log_3 x = 2 \rightarrow 3^2 = x$ |
| A log with no base has a base of 10 | Ex: $\log 100 = 2 \rightarrow \log_{10} 100 = 2 \rightarrow 100 = 10^2$ |
| $\log_a A^x = x$ | Ex: $\log_3 3^4 \rightarrow 4$ |
| $a^{\log_a X} = X$ | Ex: $5^{\log_5 9} = 9$ |
| $\log x + \log y = \log xy$ | Ex: $\log 3 + \log 5 = \log 15$ |
| $b \log x = \log x^b$ | Ex: $3 \log 2 \rightarrow \log 2^3 \rightarrow \log 8$ |
| $\log x - \log y = \log \dfrac{x}{y}$ | Ex: $\log_3 5 - \log_3 2 \rightarrow \log_3 \frac{5}{2}$ |
| $\log_3 x = \log_3 y$ $then\ x = y$ | Ex: $\log 4 = \log x + 1 \rightarrow 4 = x + 1 \rightarrow x = 3$ |

## Natural Log and e

*ln follows the same algebraic properties shown above

| | |
|---|---|
| $\ln e^m = m$ | Ex: $\ln e^4 \rightarrow 4$ |
| $e^{\ln m} = m$ | Ex: $e^{\ln 4} \rightarrow 4$ |
| $e^x = b$ then $\ln b = x$ | Ex: $e^{x+3} = 5 \rightarrow x + 3 = \ln 5 \rightarrow x = \ln 5 - 3$ |
| $a = \ln x$ then $e^a = x$ | Ex: $5 = \ln(x + 3) \rightarrow e^5 = x + 3 \rightarrow x = e^5 - 3$ |
| $\ln x = \ln y$ then $x = y$ | Ex: $\ln(x + 1) = \ln 5 \rightarrow x + 1 = 5 \rightarrow x = 4$ |
| $e^x = e^y$ then $x = y$ | Ex: $e^x = e^5 \rightarrow x = 5$ |