

Grade 11 Math: Functions & Applications: formula sheet

Quadratics, growth and decay, periodic motion, trigonometry and money · 43 formulas · metric edition 1

MODULE 1 · QUADRATIC FUNCTIONS

Math: Functions & Applications 11-1 Vertex x-Coordinate of a Parabola

$$h = -\frac{b}{2a}$$

The x-coordinate of a parabola's vertex, sitting midway between the two roots and marking the axis...

Math: Functions & Applications 11-5 Quadratic Formula (Positive Root)

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

The larger of the two solutions of $ax^2 + bx + c = 0$, taking the plus branch of the square root in...

Math: Functions & Applications 11-9 Displacement (Uniform Acceleration)

$$d = v_0t + \frac{1}{2}at^2$$

Distance travelled under constant acceleration, starting from an initial velocity, over a time t.

Math: Functions & Applications 11-2 Discriminant of a Quadratic

$$\Delta = b^2 - 4ac$$

The quantity $b^2 - 4ac$ under the square root, which reveals how many real roots a quadratic has...

Math: Functions & Applications 11-6 Quadratic Formula (Negative Root)

$$x = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

The smaller of the two solutions of $ax^2 + bx + c = 0$, taking the minus branch of the square root in...

Math: Functions & Applications 11-10 Projectile Maximum Height

$$H = \frac{v_0^2 \sin^2 \theta}{2g}$$

Peak height reached by a projectile launched at a given speed and angle above level ground,...

Math: Functions & Applications 11-3 Vertex y-Coordinate of a Parabola

$$k = c - \frac{b^2}{4a}$$

The y-coordinate of a parabola's vertex: its minimum value when a is positive, and its maximum when...

Math: Functions & Applications 11-7 Sum of the Roots of a Quadratic

$$S = -\frac{b}{a}$$

Vieta's relation giving the sum of a quadratic's two roots directly from its coefficients, without...

Math: Functions & Applications 11-11 Projectile Time of Flight

$$T = \frac{2v_0 \sin \theta}{g}$$

Total time a projectile stays airborne before returning to its launch height, set by launch speed...

Math: Functions & Applications 11-4 Completing the Square: the Constant Needed

$$k = \left(\frac{b}{2}\right)^2$$

The constant you add to $x^2 + bx$ to turn it into a perfect square trinomial, the pivotal step in...

Math: Functions & Applications 11-8 Product of the Roots of a Quadratic

$$P = \frac{c}{a}$$

Vieta's relation giving the product of a quadratic's two roots directly from its coefficients,...

MODULE 2 · EXPONENTIAL GROWTH & DECAY

Math: Functions & Applications 11-12 Exponential Growth

$$A = A_0(1 + r)^t$$

Amount after t periods of compound growth at rate r per period.

Math: Functions & Applications 11-13 Exponential Decay

$$A = A_0(1 - r)^t$$

Amount remaining after t periods of losing a fixed fraction r per period.

Math: Functions & Applications 11-14 Percent Change

$$c = \frac{x_{\text{new}} - x_{\text{old}}}{x_{\text{old}}}$$

Relative change from an old value to a new one, as a fraction of the old value.

Math: Functions & Applications 11-15 Declining-Balance Depreciation (Book Value)

$$B = C(1 - d)^k$$

Book value of an asset after k years when a fixed fraction d of the remaining value is written off...

Math: Functions & Applications 11-16 Half-Life Decay

$$N = N_0 \left(\frac{1}{2}\right)^{t/t_{1/2}}$$

Gives the quantity remaining after repeated halvings over an elapsed time measured in half-lives.

Math: Functions & Applications 11-17 Half-Life and Decay Constant

$$t_{1/2} = \frac{\ln 2}{\lambda}$$

Converts between a half-life and the exponential decay constant via the factor $\ln 2 = 0.6931471806$.

Math: Functions & Applications 11-18 Exponential Growth by Doubling Time

$$N = N_0 \cdot 2^{t/T}$$

Growth of a quantity that doubles every fixed interval T.

Math: Functions & Applications 11-19 Rule of 72 (Doubling Time)

$$n \approx \frac{0.72}{i}$$

Mental-arithmetic estimate of how many periods it takes money to double at rate i: with the rate...

Math: Functions & Applications 11-20 Solve an Exponential Equation for the Exponent

$$x = \frac{\ln(y/a)}{\ln b}$$

Solves $a \cdot b^x = y$ for the unknown exponent x using logarithms, the standard move behind every growth...

Math: Functions & Applications 11-21 Logarithm Change of Base

$$\log_b x = \frac{\ln x}{\ln b}$$

Value of a logarithm in any base, rewritten with natural logarithms so an ordinary calculator can...

MODULE 3 · PERIODIC FUNCTIONS

Math: Functions & Applications 11-22 Period-Frequency Relation

$$T = \frac{1}{f}$$

Period and frequency are reciprocals: seconds per cycle versus cycles per second.

Math: Functions & Applications 11-23 Wave Speed ($v = f\lambda$)

$$v = f\lambda$$

The universal wave equation: a wave's speed equals its frequency times its wavelength.

Math: Functions & Applications 11-24 Simple Pendulum Period

$$T = 2\pi \sqrt{\frac{L}{g}}$$

Period of a simple pendulum swinging through small angles, with $g = 9.80665 \text{ m/s}^2$ (standard gravity).

Math: Functions & Applications 11-25 Speed in Circular Motion ($v = 2\pi r/T$)

$$v = \frac{2\pi r}{T}$$

Speed of an object in uniform circular motion: one circumference ($2\pi r$, with $\pi \approx 3.14159265$) per...

Math: Functions & Applications 11-26 SHM Displacement at Time t

$$x = A \cos(\omega t)$$

Displacement of a simple harmonic oscillator at time t, a cosine of amplitude A and angular...

Math: Functions & Applications 11-27 Period of a Spring-Mass Oscillator

$$T = 2\pi \sqrt{\frac{m}{k}}$$

Period of a mass bouncing on a spring, set only by the mass and the spring stiffness.

MODULE 4 · TRIGONOMETRY APPLICATIONS

Math: Functions & Applications 11-28 Right-Triangle Sine Ratio (SOH)

$$\sin \theta = \frac{o}{h}$$

Relates an acute angle of a right triangle to its opposite side and the hypotenuse.

Math: Functions & Applications 11-29 Right-Triangle Cosine Ratio (CAH)

$$\cos \theta = \frac{a}{h}$$

Relates an acute angle of a right triangle to its adjacent side and the hypotenuse.

Math: Functions & Applications 11-30 Right-Triangle Tangent Ratio (TOA)

$$\tan \theta = \frac{o}{a}$$

Relates an acute angle of a right triangle to the ratio of its opposite and adjacent legs.

Math: Functions & Applications 11-31 Pythagorean Theorem

$$a^2 + b^2 = c^2$$

Relates the three sides of a right triangle.

Math: Functions & Applications 11-32 Law of Sines

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$

In any triangle, each side is proportional to the sine of its opposite angle.

Math: Functions & Applications 11-33 Law of Cosines

$$c^2 = a^2 + b^2 - 2ab \cos C$$

Finds the third side of any triangle from two sides and their included angle, or the angle from all...

Math: Functions & Applications 11-34 Triangle Area (Two Sides and Included Angle)

$$A = \frac{1}{2} ab \sin C$$

Computes a triangle's area from two sides and the angle between them, with no height needed.

MODULE 5 · SEQUENCES & FINANCIAL MATH

Math: Functions & Applications 11-35 Arithmetic Sequence nth Term

$$a_n = a_1 + (n - 1)d$$

The nth term of a sequence that steps by a fixed common difference.

Math: Functions & Applications 11-36 Geometric Sequence nth Term

$$a_n = a_1 r^{n-1}$$

The nth term of a sequence that multiplies by a fixed ratio each step.

Math: Functions & Applications 11-37 Arithmetic Series Sum

$$S_n = \frac{n}{2} (2a_1 + (n - 1)d)$$

Sum of the first n terms of an arithmetic sequence.

Math: Functions & Applications 11-38 Geometric Series Sum

$$S_n = \frac{a_1(1 - r^n)}{1 - r}$$

Sum of the first n terms of a geometric sequence.

Math: Functions & Applications 11-39 Simple Interest

$$I = Prt$$

Interest earned on a principal at a flat rate per period, without compounding.

Math: Functions & Applications 11-40 Compound Interest (Periodic)

$$A = P \left(1 + \frac{r}{n} \right)^{nt}$$

Amount after t periods when interest compounds n times per period at rate r.

Math: Functions & Applications 11-41 Present Value

$$PV = \frac{FV}{(1 + r)^t}$$

Today's value of a future amount, discounted at rate r per period.

Math: Functions & Applications 11-42 Future Value of an Annuity (Regular Deposits)

$$FV = D \frac{(1 + i)^n - 1}{i}$$

What an equal deposit made at the end of every period grows to after n periods at rate i: the...

Math: Functions & Applications 11-43 Loan Payment (Amortized Loan or Mortgage)

$$M = \frac{Pi}{1 - (1 + i)^{-n}}$$

Level payment that retires a loan of principal P in exactly n payments at periodic interest rate i:...