

Nonlinear Functions

A linear function grows by the same amount every step. A nonlinear one doesn't – it curves, bends, or bounces, because its rate of change is always shifting. This section is about reading that curve, not just plotting points.

1 What the question is really asking

A **nonlinear function** is any function whose graph is not a straight line – its rate of change (slope) is not constant. Instead of $y = mx + c$, you'll see an exponent, a variable in denominator, or a variable under a root.

On the SAT, the three families that shows up most are **quadratic** (parabolas), **exponential** (growth/decay curves) and **radical or rational** functions. Each has its own signature shape and its own set of questions built around it.

2 The three families to know



Quadratic

$$y = ax^2 + bx + c$$

Graphs as a parabola. Has one vertex, opens up or down, and can cross the x - axis 0, 1, or 2 times.



Exponential

$$y = a \cdot b^n$$

Graphs as a curve that rises or falls faster and faster. Never touches the x - axis – it only approaches it.



Radical & Rational

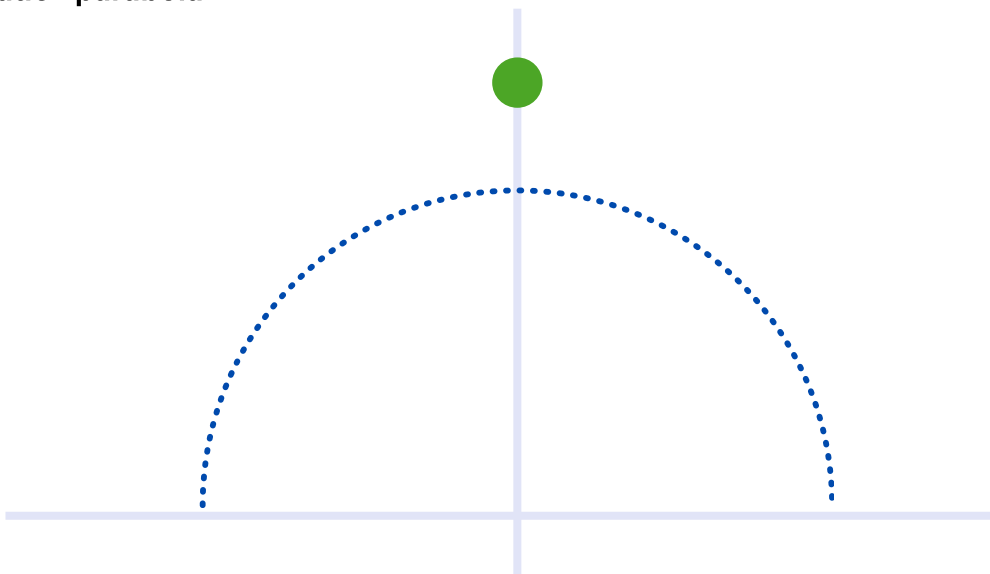
$$y = \sqrt{x} \text{ or } y = 1/x$$

Radical functions start at a point and sweep outward; rational function bend around lines they can never cross.

3

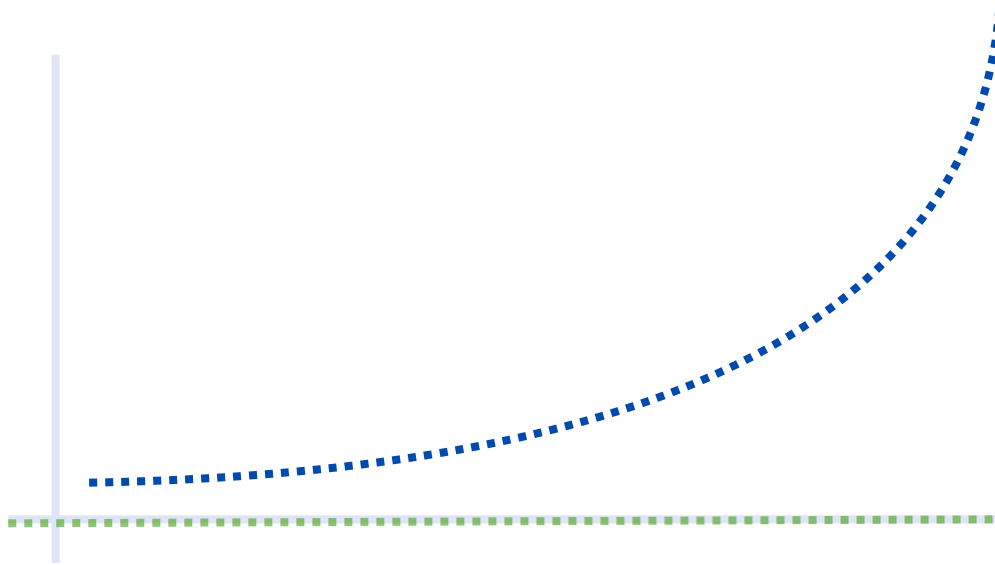
Reading the shapes

Quadratic - parabola



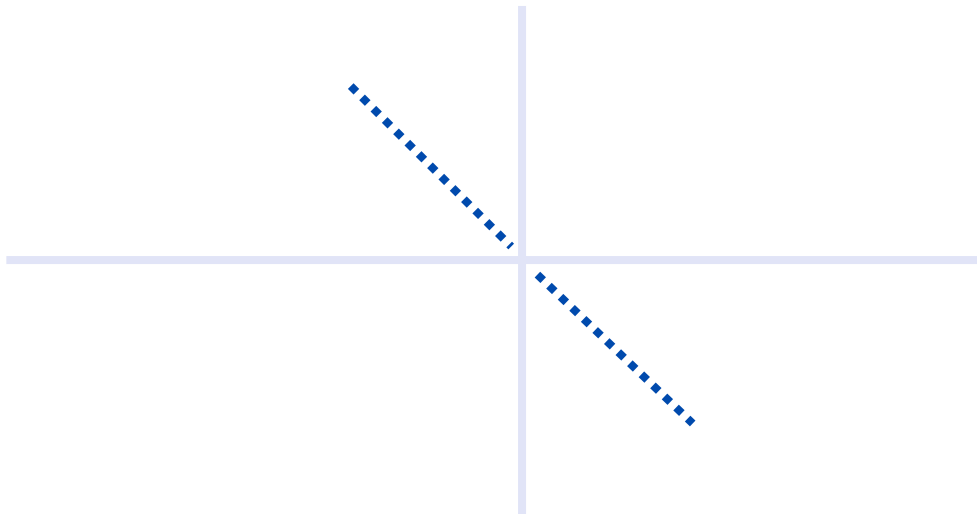
Vertex = maximum/ minimum point. Axis of symmetry runs through it.

Exponential — growth



Dashed line = horizontal asymptote. curve approaches it but never touches

Rational - $1/x$



Two different branches. Curve breaks at 0

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Reading the shapes

What you want	Use this form	Reads off directly
Roots / x-intercepts	$y = a(x - p)(x - q)$	Roots are $x = p$ and $x = q$
Vertex (max/min)	$y = a(x - h)^2 + k$	Vertex at (h, k)
y-intercept	$y = ax^2 + bx + c$	y-intercept is $(0, c)$
Axis of symmetry	$x = -b / (2a)$	Vertical line through the vertex
Number of real roots	$b^2 - 4ac$	Positive $\rightarrow$ 2 roots · Zero $\rightarrow$ 1 root · Negative $\rightarrow$ 0 real roots