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Understanding how to relate different graphs through algebraic transformations is a fundamental skill in mathematics, especially in the study of functions. When given a graph of a function $f(x)$ in black and asked to find an equation that matches a second graph—in this case, a red graph—it's essential to analyze the transformations that map the black graph onto the red one. These transformations can include shifts (translations), stretches or compressions, reflections, and combinations of these. This article aims to guide you through the process of developing an equation in terms of $f(x)$ that corresponds to the red graph, starting from the black graph.

Understanding the Basics of Function Transformations

What Are Function Transformations?

Function transformations modify the graph of a base function $f(x)$ to produce a new graph. These modifications can be described algebraically and often involve:

- **Translations**: shifting the graph horizontally or vertically.
- **Stretches and compressions**: changing the size of the graph vertically or horizontally.
- **Reflections**: flipping the graph over an axis.

By understanding these transformations, you can express the new graph as a modified version of the original function $f(x)$.

Common Transformation Forms

Some standard forms of transformations include:

- Horizontal shift: $f(x - h)$ shifts the graph right by h units.

- Vertical shift: $f(x) + k$ shifts the graph up by k units.
- Vertical stretch/compression: $a \cdot f(x)$, where a changes the height, stretching if $|a|>1$ or compressing if $|a|<1$.
- Horizontal stretch/compression: $f(bx)$, where $b>1$ compresses horizontally, 0