Mathematica knows how to solve some differential equations. The built-in function DSolve will solve equations symbolically. To solve the equation \( y' + \frac{2}{x} y = 2g \) (the equation for a chain piled up at the edge of a table sliding off the table under gravity), we proceed as follows:

\[
\text{In}[4]:= \text{DSolve}[y'[x] + \frac{2}{x} y[x] == 2g, y, x]
\]

\[
\text{Out}[4]= \left\{ \left\{ y \to \text{Function}\left[ \left( x, \frac{2g x}{3} + \frac{C[1]}{x^2} \right) \right] \right\} \right\}
\]

Note that \( y' \) is the first derivative of the function \( y[x] \) and an equation requires the double equals sign. DSolve needs three arguments, the equation, the dependent variable, and the independent variable. \( C[1] \) is the (single) arbitrary constant of integration.

To solve the equation \( y'' + 3 y' + 2 y = x \), we proceed as follows:

\[
\text{In}[5]:= \text{DSolve}[y''[x] + 3 y'[x] + 2 y[x] == x, y, x]
\]

\[
\text{Out}[5]= \left\{ \left\{ y \to \text{Function}\left[ \left( x, \frac{1}{4} \left( e^{-x} e^{2x} C[1] + \frac{-e^{-2x} C[2]}{e^x} - 3 + 2 x \right) \right) \right] \right\} \right\}
\]

This second-order differential equation has two arbitrary constants \( C[1] \) and \( C[2] \) and a particular solution \( \frac{1}{2} x - \frac{3}{4} \) which has no arbitrary constants.