Precalculus
Polynomial division and factorization of cubics with rational root

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Outline

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Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

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$$x - 1 \quad \overline{\left| x^3 + 2x^2 \qquad + 1 \right.}$$

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

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Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$\begin{array}{r} \color{red}{?} \\ x-1 \quad \overline{\left| \begin{array}{l} x^3+2x^2 \qquad +1 \end{array} \right.} \end{array}$$

Divide x^3 by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$\begin{array}{r} x^2 \\ x-1 \quad \overline{\left| x^3+2x^2 \quad +1 \right.} \end{array}$$

Divide x^3 by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$\begin{array}{rl} & x^2 \\ x-1 & \overline{\left| x^3+2x^2 \quad +1 \right.} \\ & ? \quad ? \\ & \hline \end{array}$$

Multiply x^2 by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$\begin{array}{rl} & x^2 \\ x-1 \quad \big) & x^3+2x^2 \quad\quad +1 \\ & \underline{x^3- x^2} \\ & \end{array}$$

Multiply x^2 by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl}
 & x^2 \\
x - 1 & \overline{\left| \begin{array}{ll} x^3 + 2x^2 & +1 \\ x^3 - x^2 & \\ \hline ? & ? \end{array} \right.}
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl}
 & x^2 \\
x - 1 & \overline{\left| \begin{array}{ll} x^3 + 2x^2 & +1 \\ x^3 - x^2 & \\ \hline 3x^2 & +1 \end{array} \right.} \\
- &
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 \quad ? \\
\cline{3-3}
x - 1 & & x^3 + 2x^2 \qquad +1 \\
- & & x^3 - x^2 \\
\cline{3-3}
 & & \qquad 3x^2 \qquad +1
\end{array}
$$

Divide $3x^2$ by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$\begin{array}{rl|l} & & x^2 + 3x \\ \hline x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\ & - & x^3 - x^2 \\ \hline & & 3x^2 \quad\quad + 1 \end{array}$$

Divide $3x^2$ by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl}
 & x^2 + 3x \\
x - 1 \quad \big) & \overline{x^3 + 2x^2 \qquad + 1} \\
- & x^3 - x^2 \\
\hline
 & \qquad 3x^2 \qquad + 1 \\
 & \quad ? \quad\ ? \\
\hline
\end{array}
$$

Multiply $3x$ by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x \\
\hline
x - 1 & & x^3 + 2x^2 \qquad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \qquad\quad + 1 \\
 & & 3x^2 - 3x \\
\hline
\end{array}
$$

Multiply $3x$ by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & ? \quad\quad ?
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x \quad ? \\
\hline
x - 1 & & x^3 + 2x^2 \qquad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \qquad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1
\end{array}
$$

Divide $3x$ by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x + 3 \\
\cline{3-3}
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\cline{3-3}
 & & \quad 3x^2 \quad\quad + 1 \\
- & & \quad 3x^2 - 3x \\
\cline{3-3}
 & & \quad\quad\quad 3x + 1
\end{array}
$$

Divide $3x$ by x.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x + 3 \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1 \\
 & & ? \quad ? \\
\hline
\end{array}
$$

Multiply 3 by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x + 3 \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1 \\
 & & 3x - 3 \\
\hline
\end{array}
$$

Multiply 3 by divisor.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rr|l}
 & & x^2 + 3x + 3 \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1 \\
- & & 3x - 3 \\
\hline
 & & \mathbf{?}
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
 & & x^2 + 3x + 3 \\
\hline
x - 1 & & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1 \\
- & & 3x - 3 \\
\hline
 & & 4
\end{array}
$$

Subtract last two polynomials.

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rrl}
 & & x^2 + 3x + 3 \\
x - 1 & \big| & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & 3x^2 \quad\quad + 1 \\
- & & 3x^2 - 3x \\
\hline
 & & 3x + 1 \\
- & & 3x - 3 \\
\hline
 & & 4
\end{array}
$$

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rl|l}
\textbf{Quotient:} & & x^2 + 3x + 3 \\
\cline{3-3}
x - 1 & x^3 + 2x^2 \quad\quad + 1 & \\
- & x^3 - x^2 & \\
\cline{2-2}
 & \quad 3x^2 \quad\quad + 1 & \\
- & \quad 3x^2 - 3x & \\
\cline{2-2}
 & \quad\quad\quad 3x + 1 & \\
- & \quad\quad\quad 3x - 3 & \\
\cline{2-2}
 & \quad\quad\quad\quad 4 &
\end{array}
$$

$$
\begin{aligned}
\textbf{(Dividend)} &= \textbf{(Quotient)} \cdot \textbf{(Divisor)} + \textbf{(Remainder)} \\
(x^3 + 2x^2 + 1) &= (x^2 + 3x + 3) \cdot (x - 1) + 4
\end{aligned}
$$

Example (Polynomial long division)

Divide with quotient and remainder $x^3 + 2x^2 + 1$ by $x - 1$.

$$
\begin{array}{rrl}
\textbf{Quotient:} & & x^2 + 3x + 3 \\
x - 1 & \big| & x^3 + 2x^2 \quad\quad + 1 \\
- & & x^3 - x^2 \\
\hline
 & & \quad 3x^2 \quad\quad + 1 \\
- & & \quad 3x^2 - 3x \\
\hline
 & & \quad\quad\quad 3x + 1 \\
- & & \quad\quad\quad 3x - 3 \\
\hline
\textbf{Remainder:} & & \quad\quad\quad\quad\quad 4
\end{array}
$$

$$
\begin{aligned}
\textbf{(Dividend)} &= \textbf{(Quotient)} \cdot \textbf{(Divisor)} + \textbf{(Remainder)} \\
(x^3 + 2x^2 + 1) &= (x^2 + 3x + 3) \cdot (x - 1) + 4
\end{aligned}
$$

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$2x - 3 \quad \overline{)\,6x^3 - 19x^2 + 17x - 3}$$

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$$2x - 3 \quad \overline{)\,6x^3 - 19x^2 + 17x - 3}$$

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$$\begin{array}{r} \color{red}{?} \\ \color{red}{2x} - 3 \quad \overline{\left| \color{red}{6x^3} - 19x^2 + 17x - 3 \right.} \end{array}$$

Divide $\color{red}{6x^3}$ by $\color{red}{2x}$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$\begin{array}{r} 3x^2 \\ 2x - 3 \;\overline{)\; 6x^3 - 19x^2 + 17x - 3} \end{array}$$

Divide $6x^3$ by $2x$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$\begin{array}{r} \quad 3x^2 \\ 2x-3 \;\overline{)\; 6x^3-19x^2+17x-3} \\ \quad ? \quad\; ? \\ \hline \end{array}$$

Multiply $3x^2$ by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$\begin{array}{rr|l} & & 3x^2 \\ \hline 2x-3 & & 6x^3-19x^2+17x-3 \\ & & 6x^3-\ 9x^2 \\ \hline \end{array}$$

Multiply $3x^2$ by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{r|l}
 & 3x^2 \\
\hline
2x - 3 & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & ? \quad ? \quad ?
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{r|l}
2x - 3 & 3x^2 \\
\hline
- & 6x^3 - 19x^2 + 17x - 3 \\
 & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$\begin{array}{r|l} & 3x^2 \quad ? \\ \hline 2x - 3 & 6x^3 - 19x^2 + 17x - 3 \\ - & 6x^3 - 9x^2 \\ \hline & -10x^2 + 17x - 3 \end{array}$$

Divide $-10x^2$ by $2x$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$\begin{array}{r} 3x^2 - 5x \\ \hline 2x - 3 \;\big|\; 6x^3 - 19x^2 + 17x - 3 \\ \underline{-} \\ 6x^3 - 9x^2 \\ \hline -10x^2 + 17x - 3 \end{array}$$

Divide $-10x^2$ by $2x$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{r|l}
 & 3x^2 - 5x \\
\hline
2x - 3 & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
 & ? \quad ? \\
\hline
\end{array}
$$

Multiply $-5x$ by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{r|l}
 & 3x^2 - 5x \\
\hline
2x - 3 & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
 & -10x^2 + 15x \\
\hline
\end{array}
$$

Multiply $-5x$ by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & ? \quad ?
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x \quad ? \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3
\end{array}
$$

Divide $2x$ by $2x$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x + 1 \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3
\end{array}
$$

Divide $2x$ by $2x$.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr}
 & 3x^2 - 5x + 1 \\
\hline
2x - 3 & \big| \; 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
- & -10x^2 + 15x \\
\hline
 & 2x - 3 \\
 & ? \quad ? \\
\hline
\end{array}
$$

Multiply 1 by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x + 1 \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3 \\
 & & 2x - 3 \\
\hline
\end{array}
$$

Multiply 1 by divisor.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x + 1 \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3 \\
- & & 2x - 3 \\
\hline
 & & ?
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x + 1 \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3 \\
- & & 2x - 3 \\
\hline
 & & 0
\end{array}
$$

Subtract last two polynomials.

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rr|l}
 & & 3x^2 - 5x + 1 \\
\hline
2x - 3 & & 6x^3 - 19x^2 + 17x - 3 \\
- & & 6x^3 - 9x^2 \\
\hline
 & & -10x^2 + 17x - 3 \\
- & & -10x^2 + 15x \\
\hline
 & & 2x - 3 \\
- & & 2x - 3 \\
\hline
 & & 0
\end{array}
$$

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rl}
\textbf{Quotient:} & 3x^2 - 5x + 1 \\
2x - 3 \;\big| & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
- & -10x^2 + 15x \\
\hline
 & 2x - 3 \\
- & 2x - 3 \\
\hline
 & 0
\end{array}
$$

$$\textbf{(Dividend)} = \textbf{(Quotient)} \cdot \textbf{(Divisor)} + \textbf{(Remainder)}$$

$$(6x^3 - 19x^2 + 17x - 3) = (3x^2 - 5x + 1) \cdot (2x - 3)$$

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rl}
\textbf{Quotient:} & 3x^2 - 5x + 1 \\
2x - 3 \;\big| & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
- & -10x^2 + 15x \\
\hline
 & 2x - 3 \\
- & 2x - 3 \\
\hline
\textbf{Remainder:} & 0
\end{array}
$$

$$\textbf{(Dividend)} = \textbf{(Quotient)} \cdot \textbf{(Divisor)} + \textbf{(Remainder)}$$

$$(6x^3 - 19x^2 + 17x - 3) = (3x^2 - 5x + 1) \cdot (2x - 3)$$

Example

Demonstrate that $6x^3 - 19x^2 + 17x - 3$ is divisible by $2x - 3$ using polynomial long division. Use your work to factor the cubic. Solve the equation $6x^3 - 19x^2 + 17x - 3 = 0$.

$$
\begin{array}{rl}
\textbf{Quotient:} & 3x^2 - 5x + 1 \\
2x - 3 \;\big| & 6x^3 - 19x^2 + 17x - 3 \\
- & 6x^3 - 9x^2 \\
\hline
 & -10x^2 + 17x - 3 \\
- & -10x^2 + 15x \\
\hline
 & 2x - 3 \\
- & 2x - 3 \\
\hline
\textbf{Remainder:} & 0
\end{array}
$$

(Dividend)=(Quotient) · (Divisor) + (Remainder)

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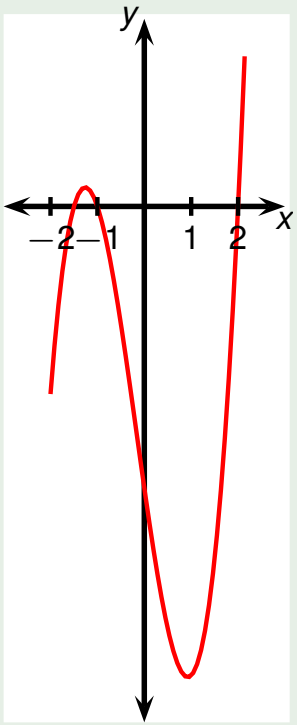

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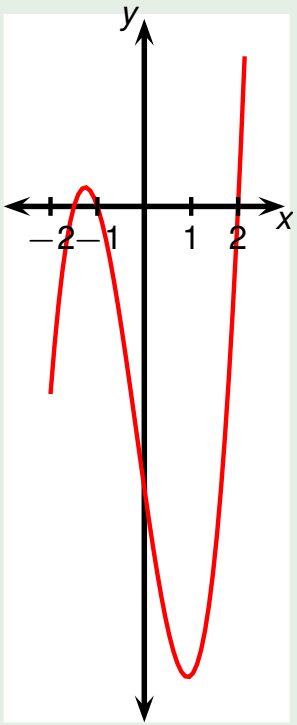

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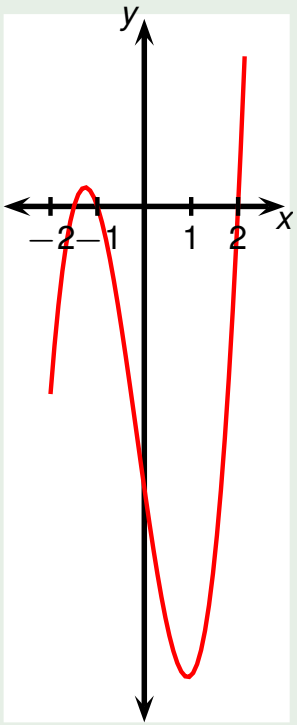

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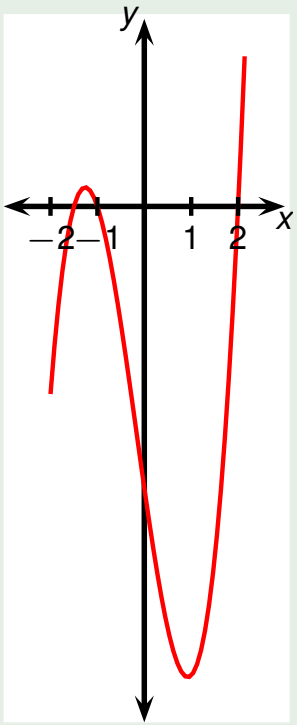

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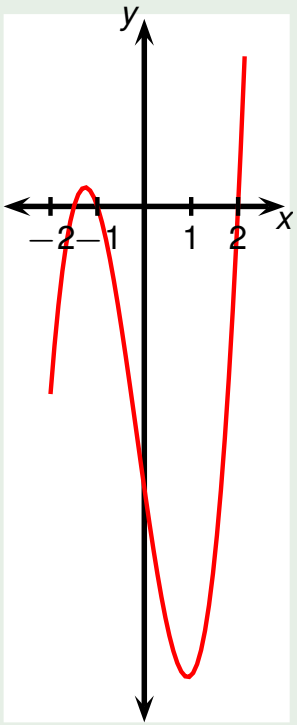

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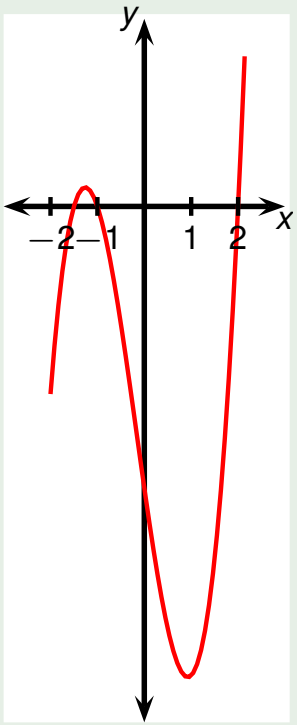

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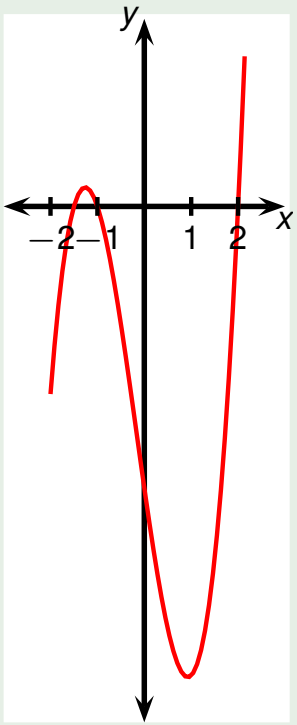

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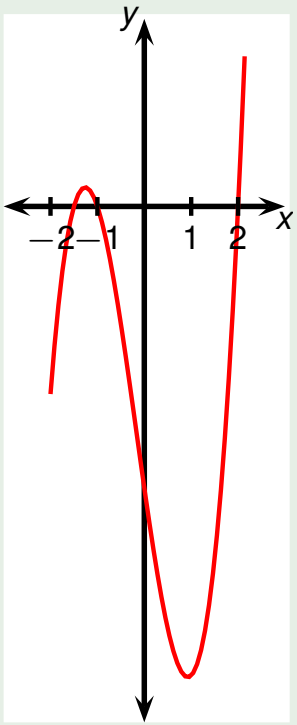

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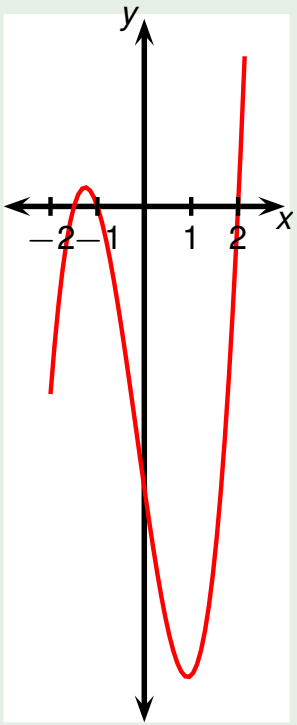

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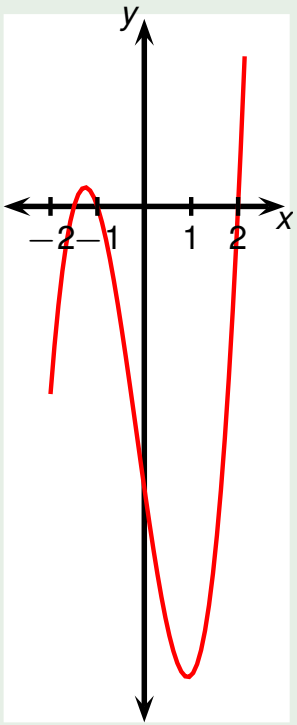

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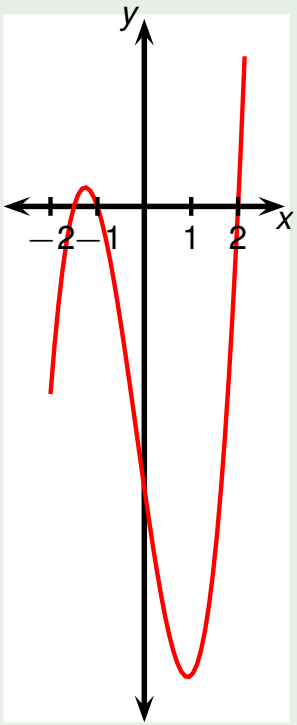

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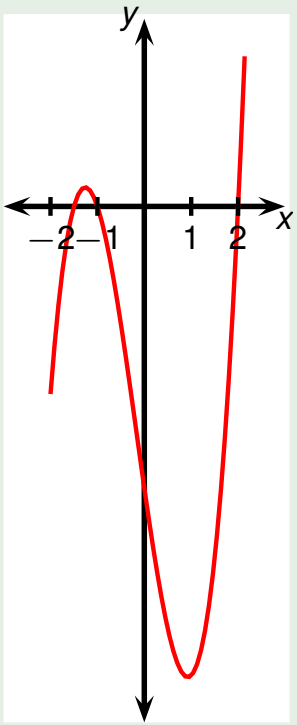

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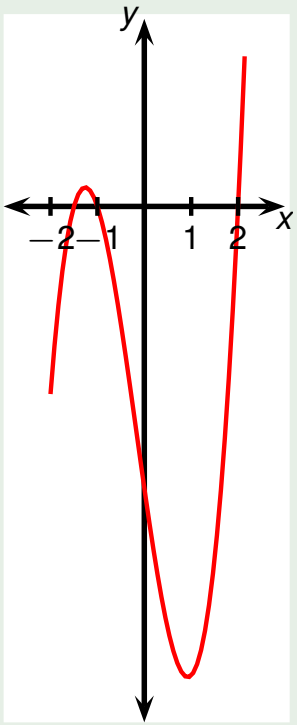

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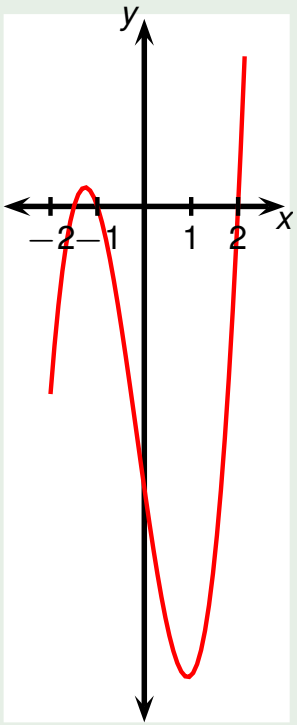

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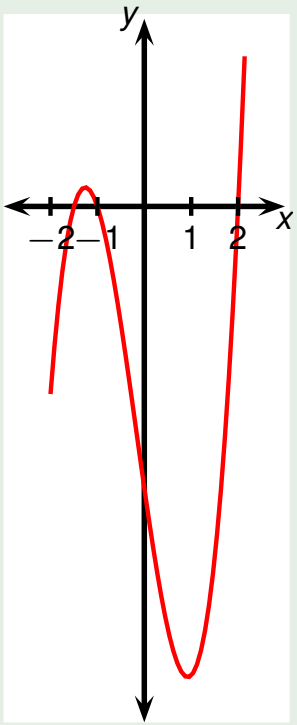
$$2(x - (-1.5))(x - (-1))(x - 2) = (2x + 3)(x + 1)(x - 2)$$

$$= (2x^2 + 5x + 3)(x - 2) = (2x^3 + 5x^2 + 3x) - (4x^2 + 10x + 6)$$

Check work to make sure we guessed the roots correctly.

Example



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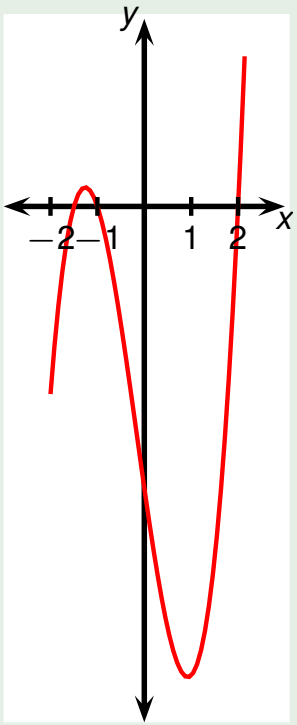

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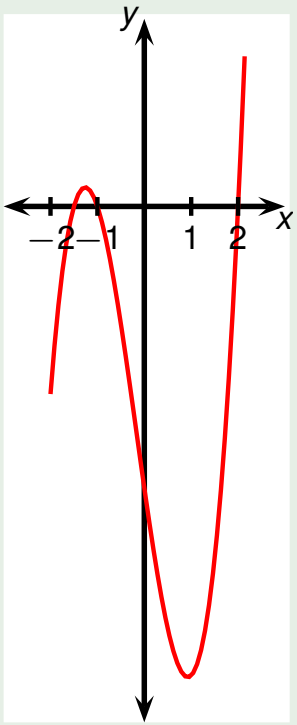

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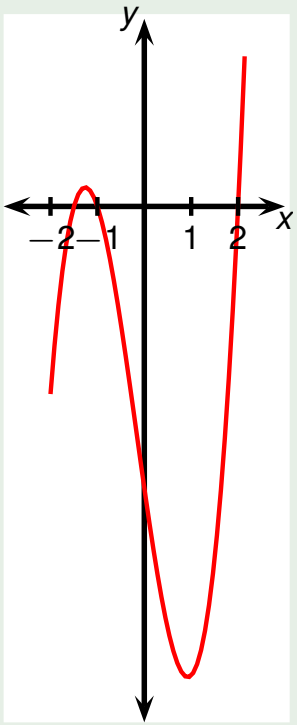

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$x = -\frac{3}{2}$ **or** $x = -1$ **or** $x = 2$

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Example

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$$x^3 - x^2 - 8x + 6 = 0$$

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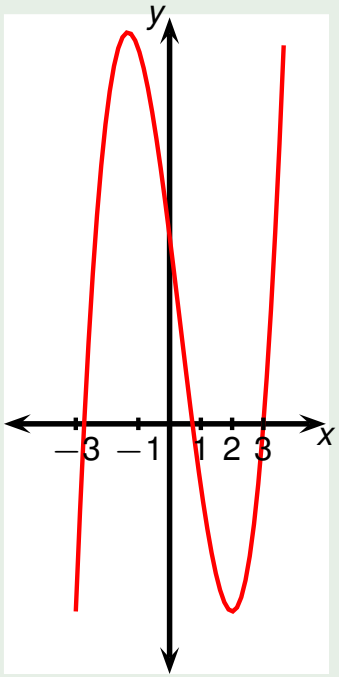

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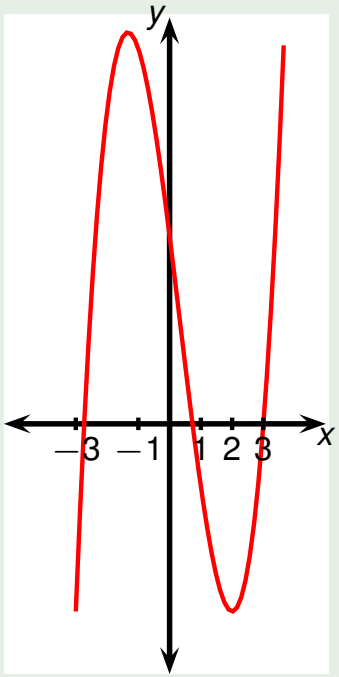

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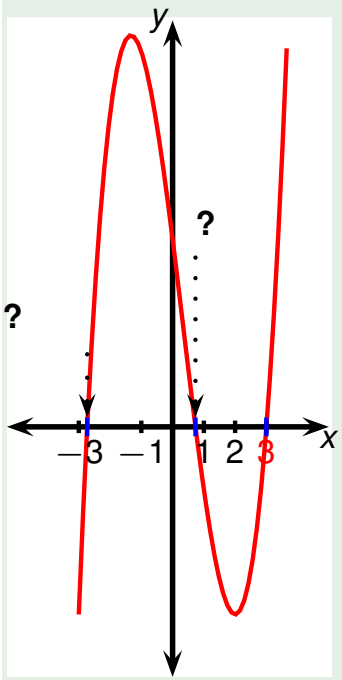
?

Example



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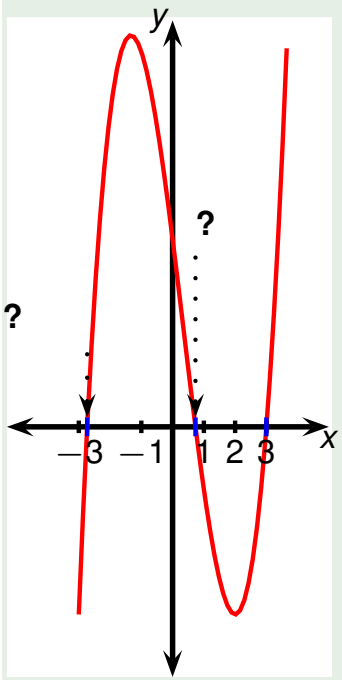

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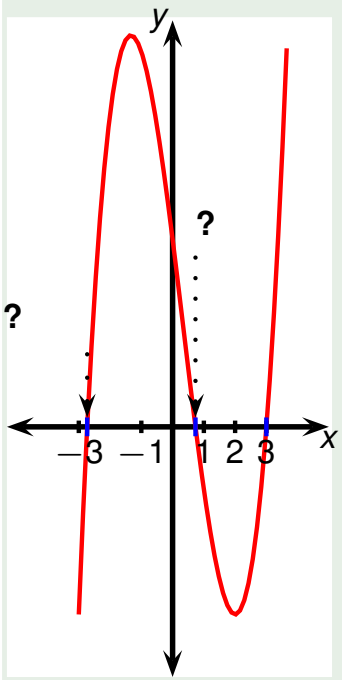

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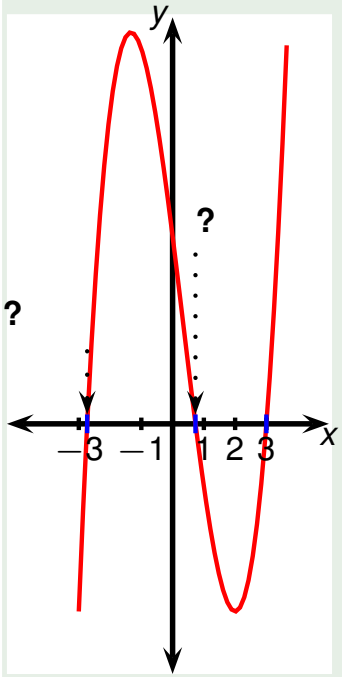

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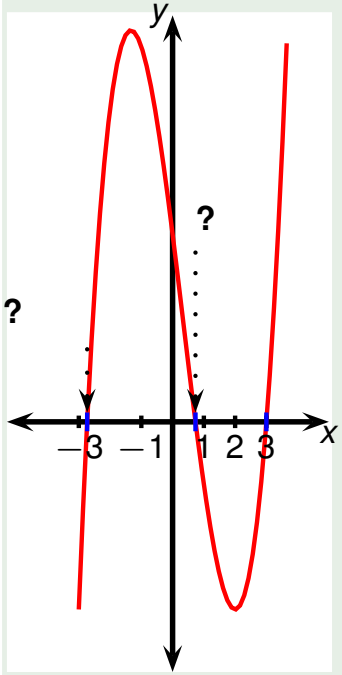

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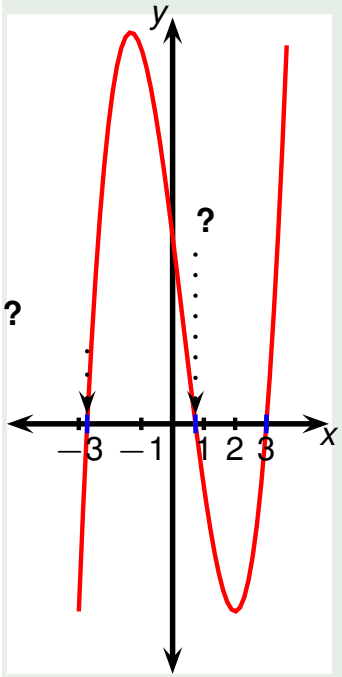
$$\qquad\quad ?$$

Divide x^3 by x.

Example



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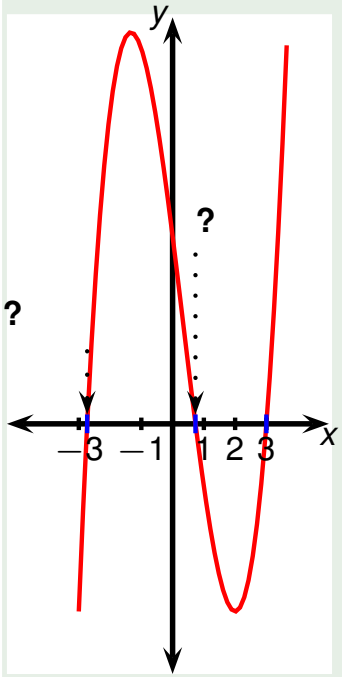

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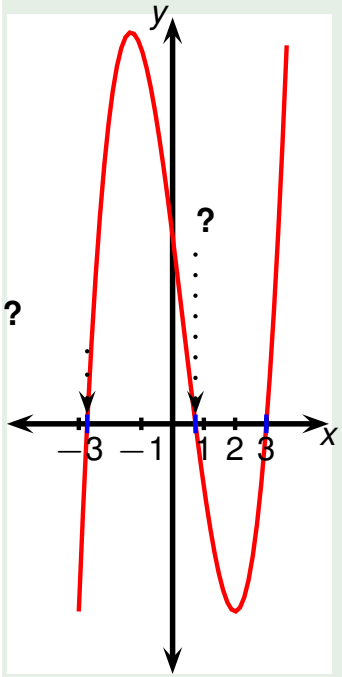
Multiply x^2 by divisor.

Example



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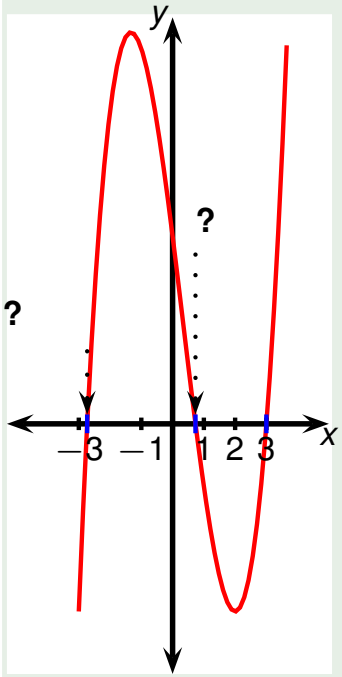

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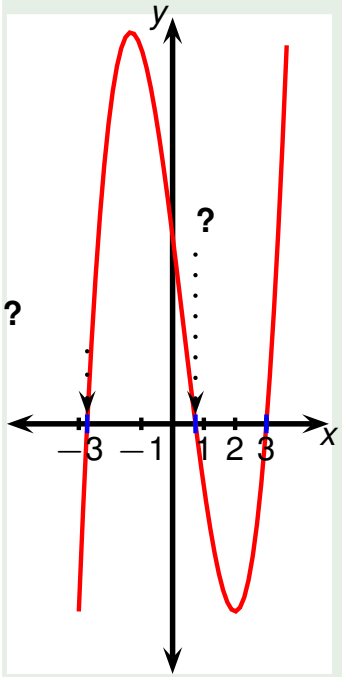
Subtract last two polynomials.

Example



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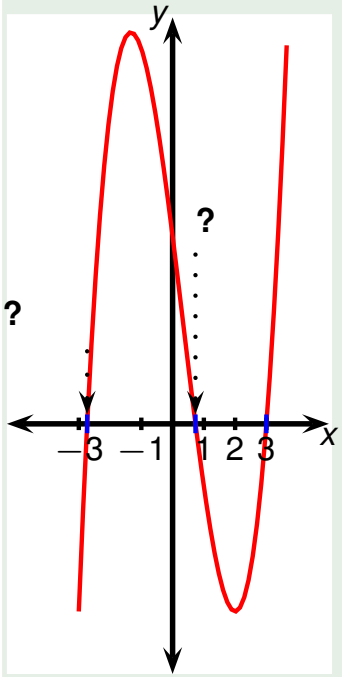

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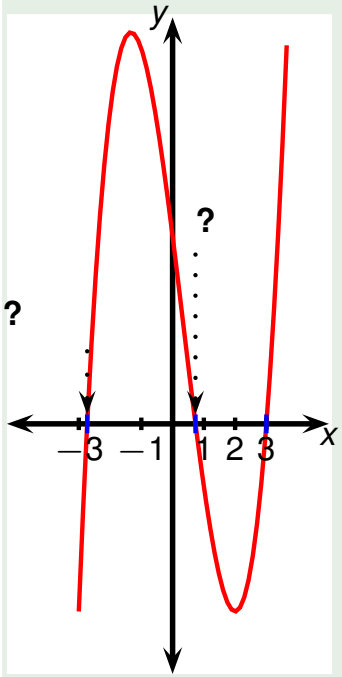
Divide $2x^2$ by x.

Example



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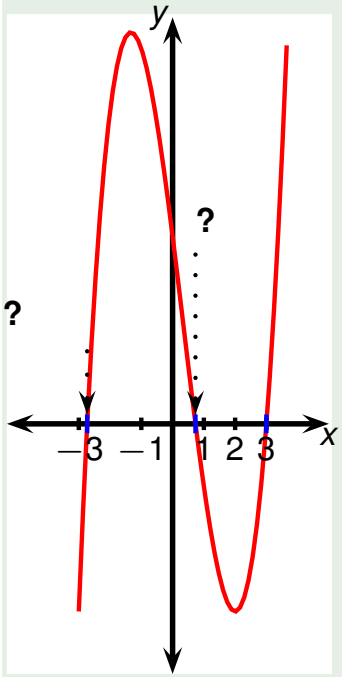

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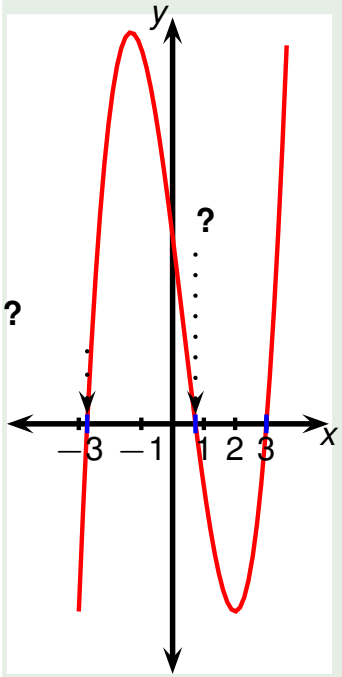

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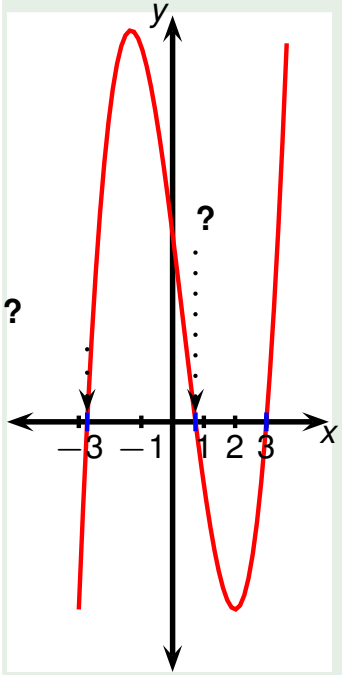

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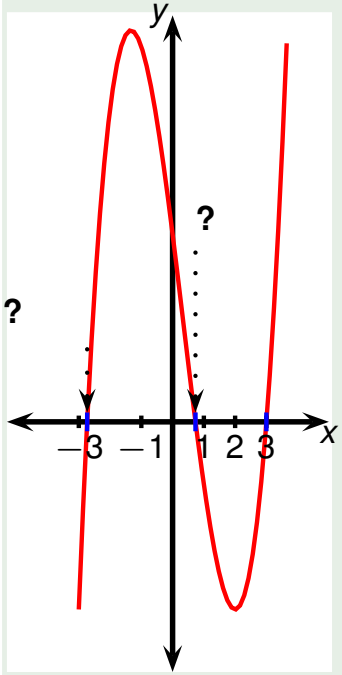

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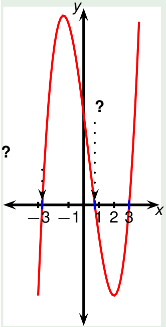

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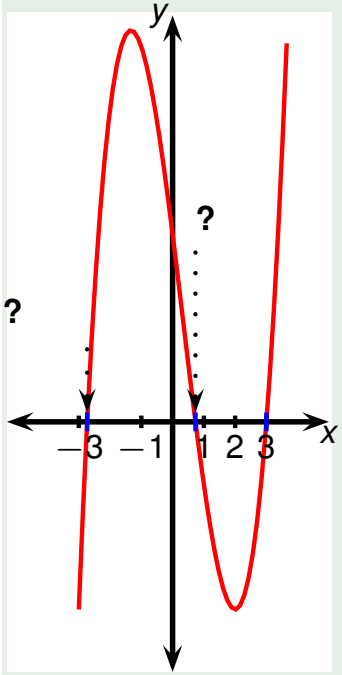

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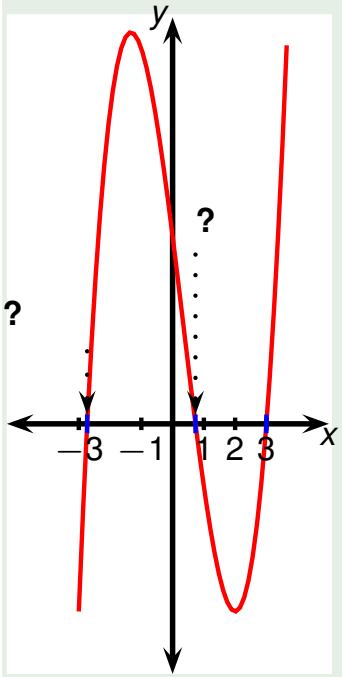

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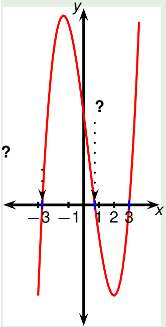
Multiply -2 by divisor.

Example



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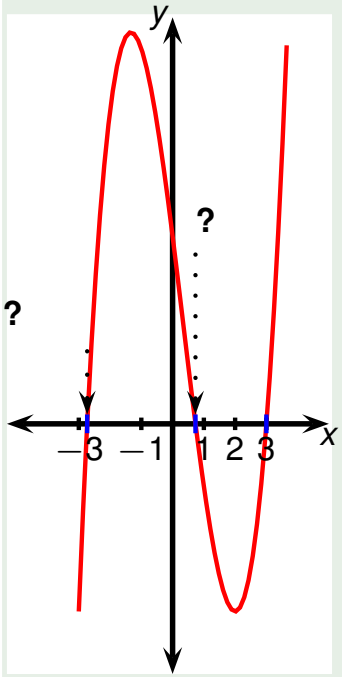

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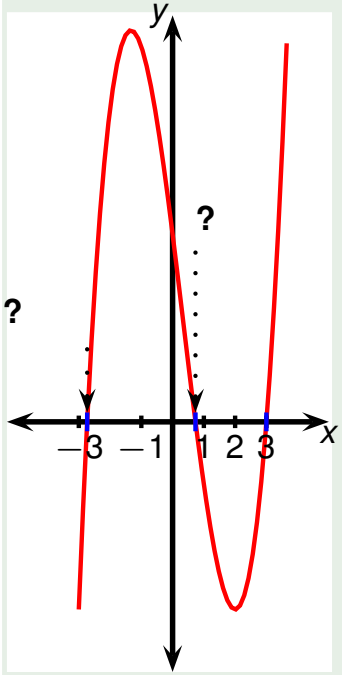
Subtract last two polynomials.

Example



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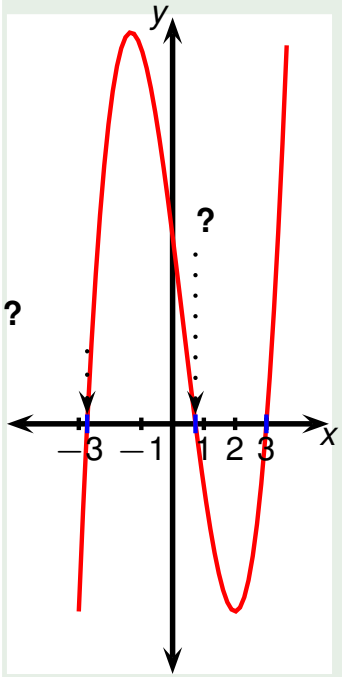

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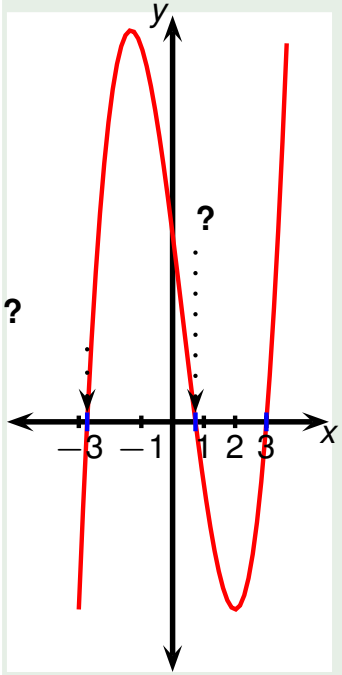
Example



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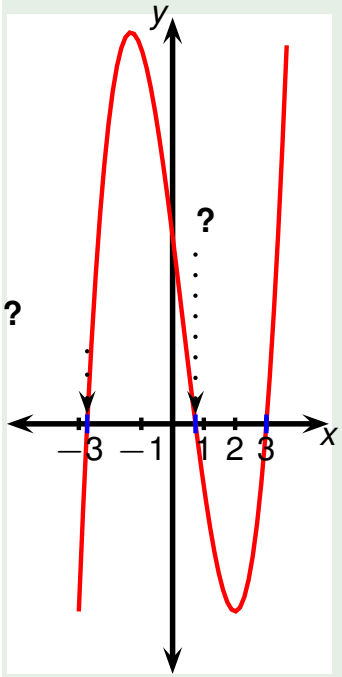

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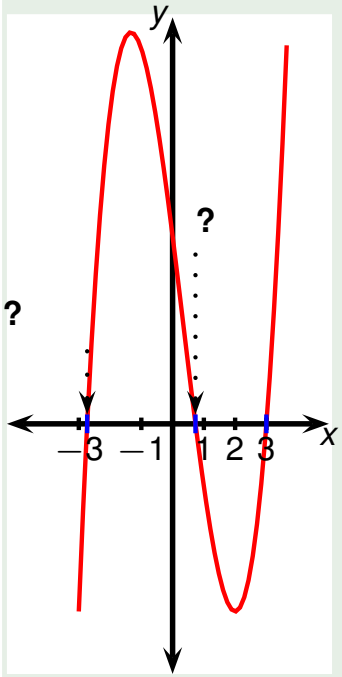

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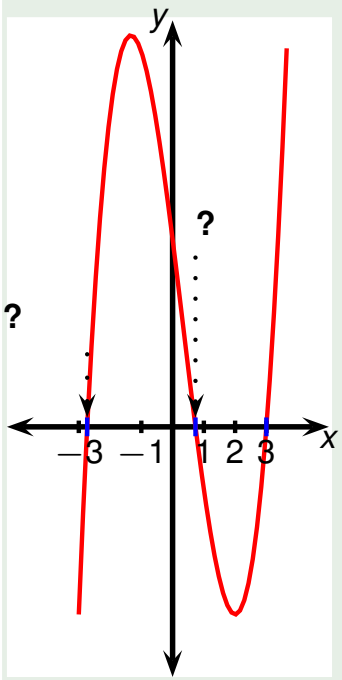

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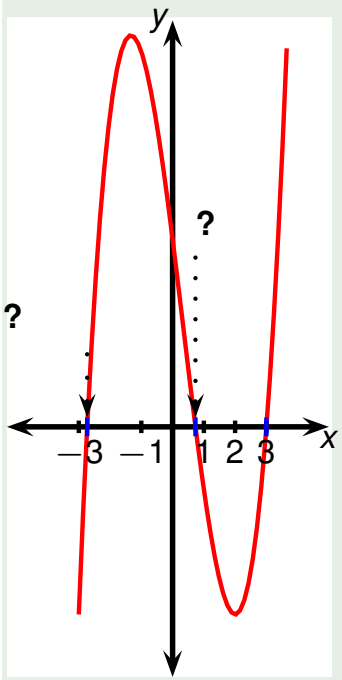

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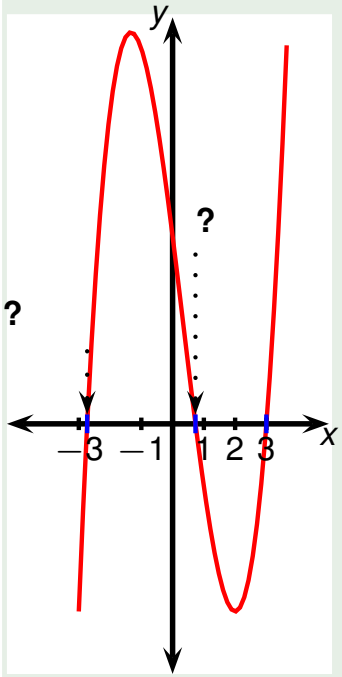

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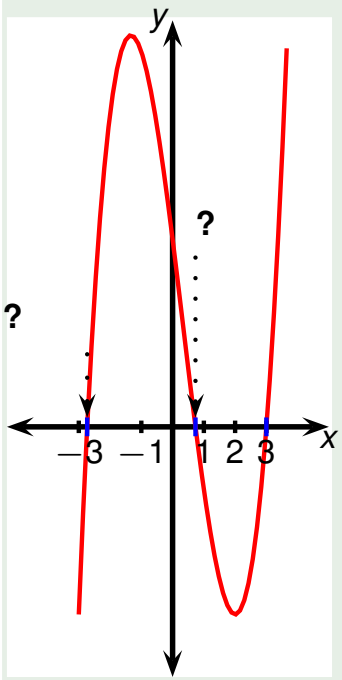

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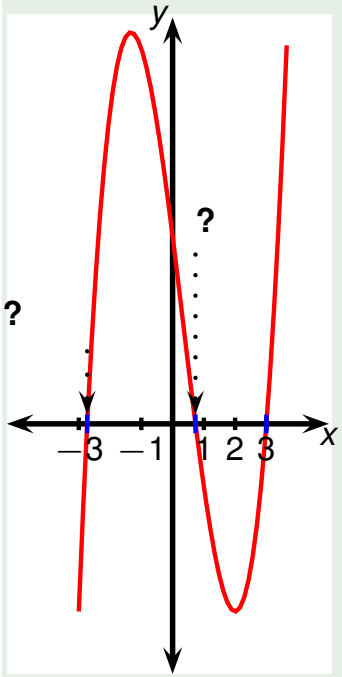

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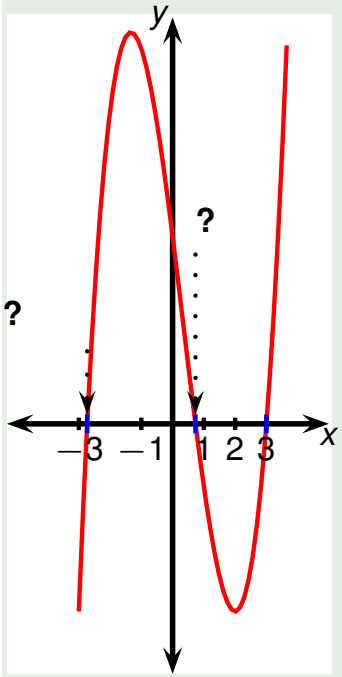

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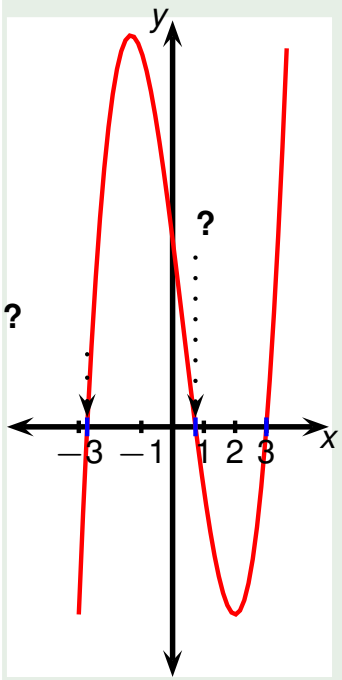

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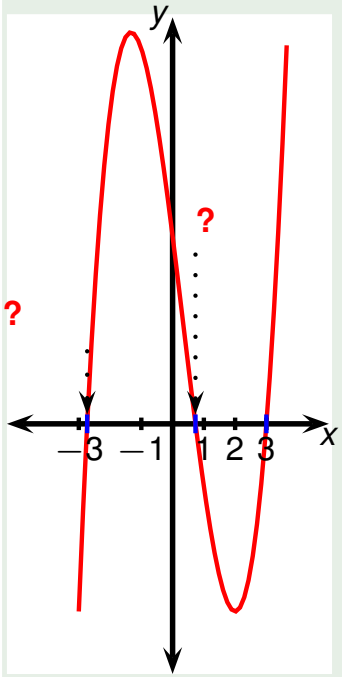

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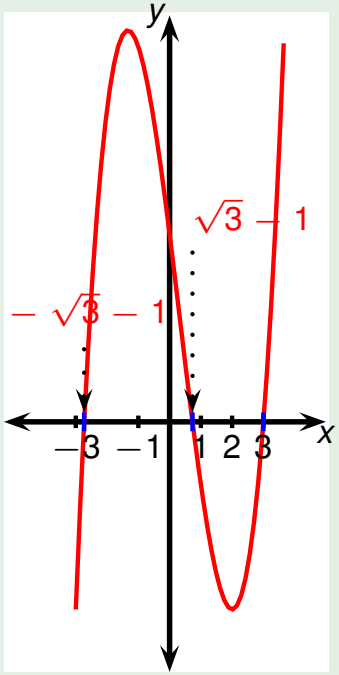

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The graph appears to intersect the x axis at: $-\sqrt{3}-1, \sqrt{3}-1, 3$. What are the two roots besides 3?

Final answer:

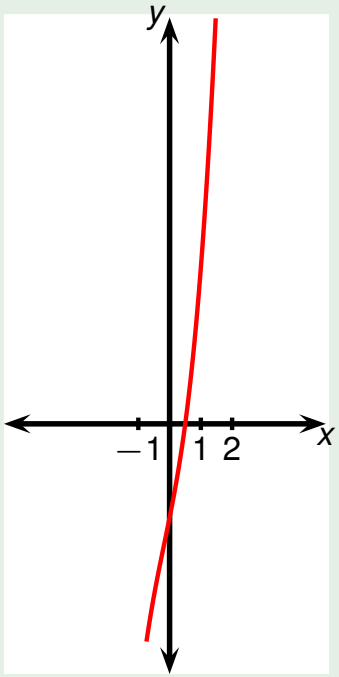
$x = 3$ **or** $x = -1 - \sqrt{3}$ **or** $x = -1 + \sqrt{3}$.

Example

Plot the left hand side of the equation with a graphing calculator. Find all real solutions of the equation.

$$2x^3 + x^2 + 5x - 3 = 0$$

Example



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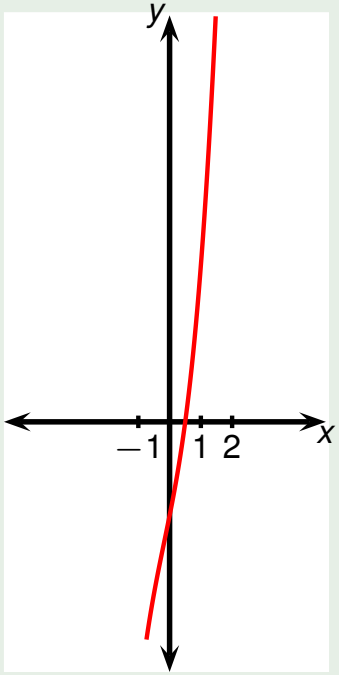

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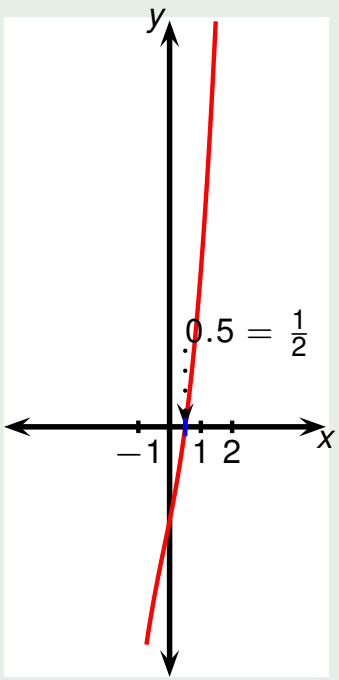

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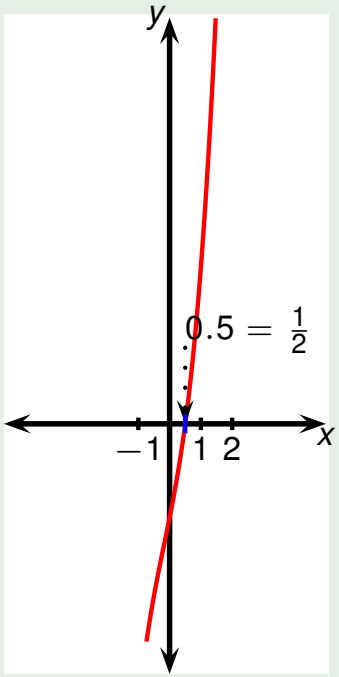
Example



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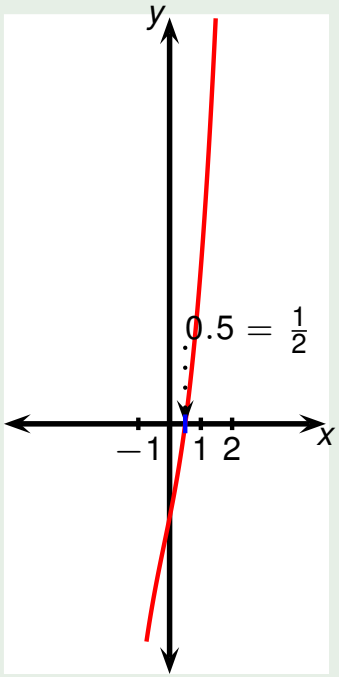

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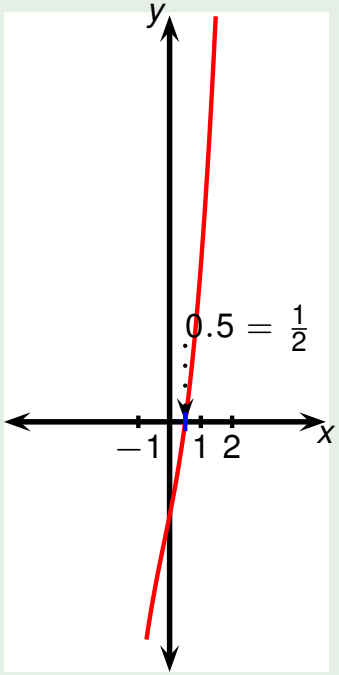

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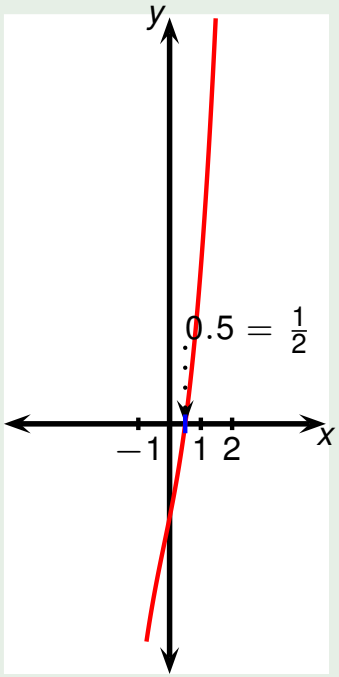

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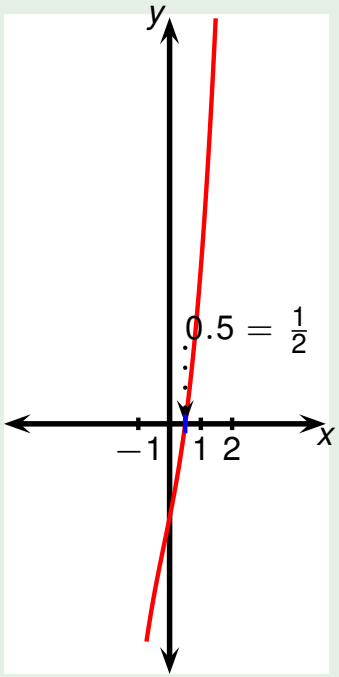

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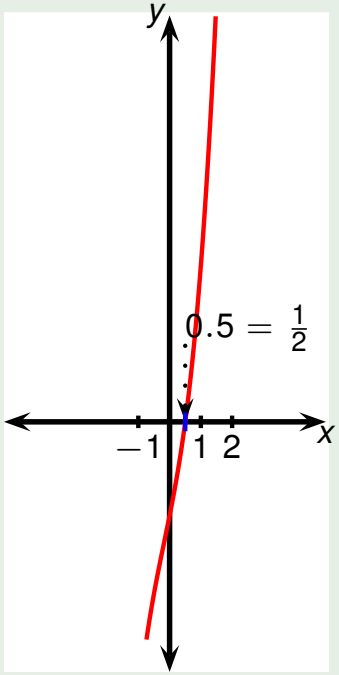

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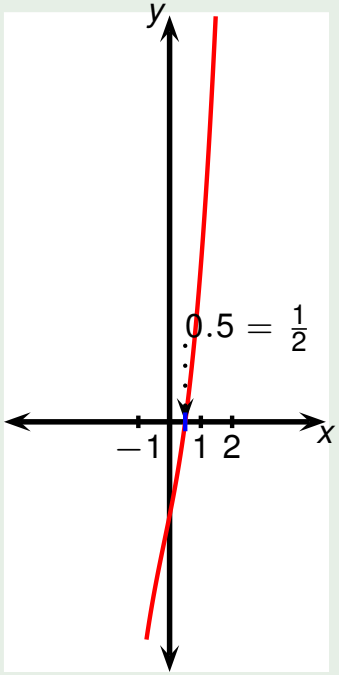

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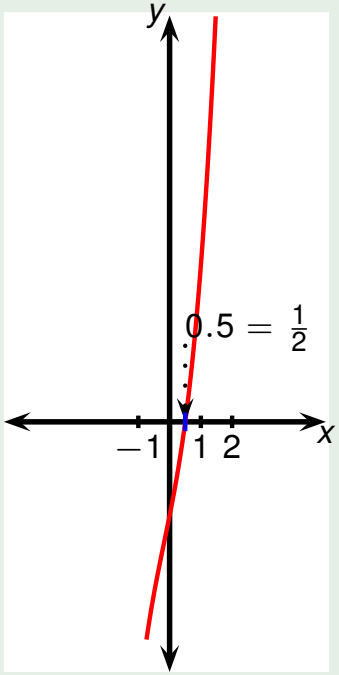

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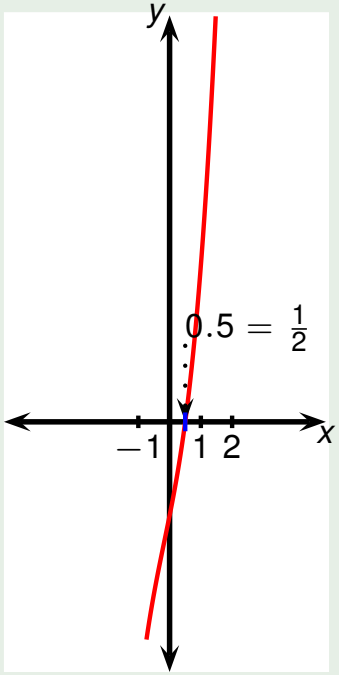
Multiply $2x^2$ by divisor.

Example



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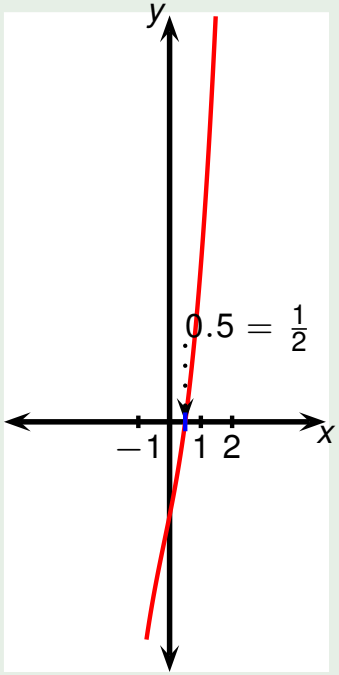

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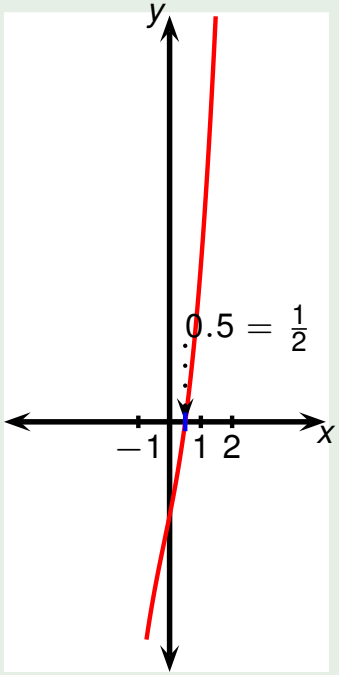
Subtract last two polynomials.

Example



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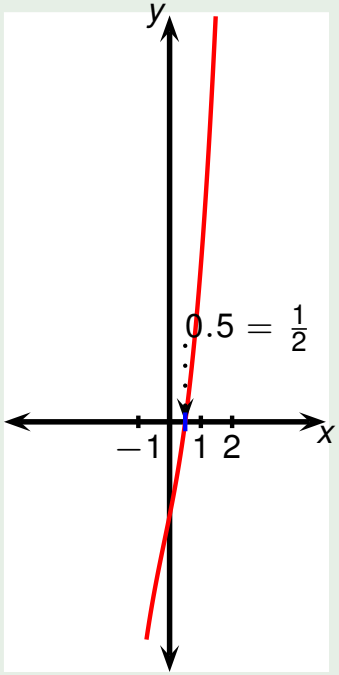

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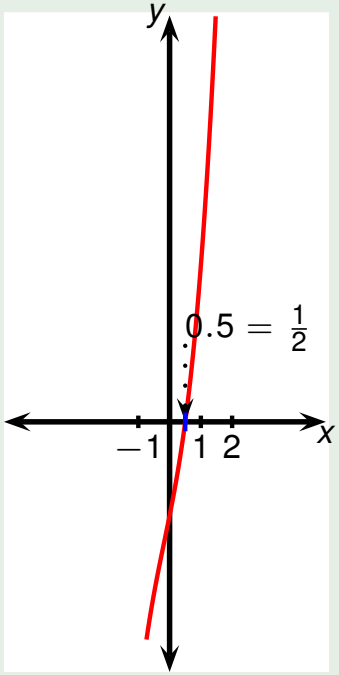
Divide $2x^2$ by x.

Example



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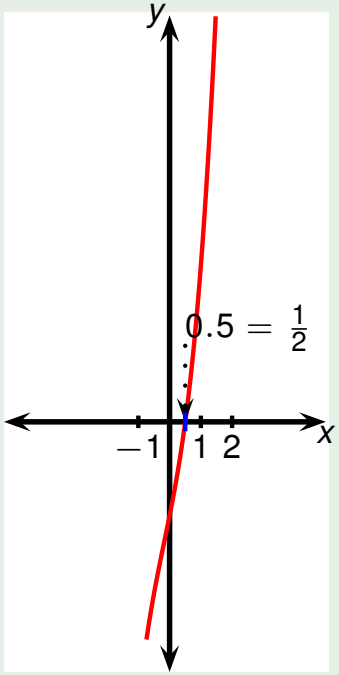

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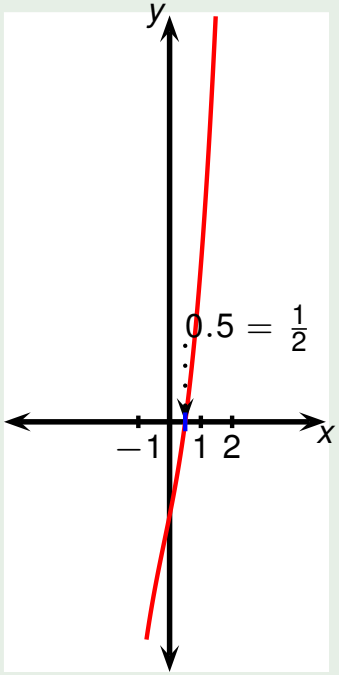
Multiply $2x$ by divisor.

Example



Plot the left hand side of the equation with a graphing calculator. Find all real solutions of the equation.

$$2x^3 + x^2 + 5x - 3 = 0$$

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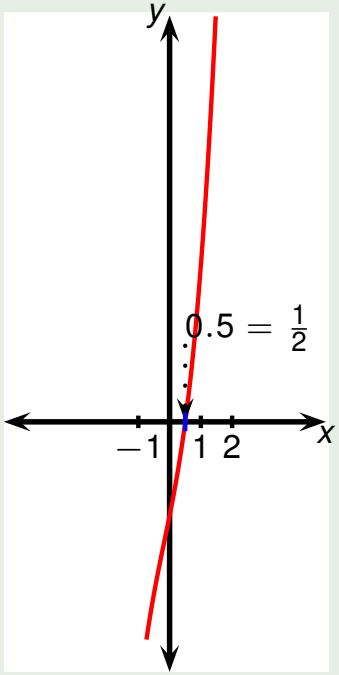

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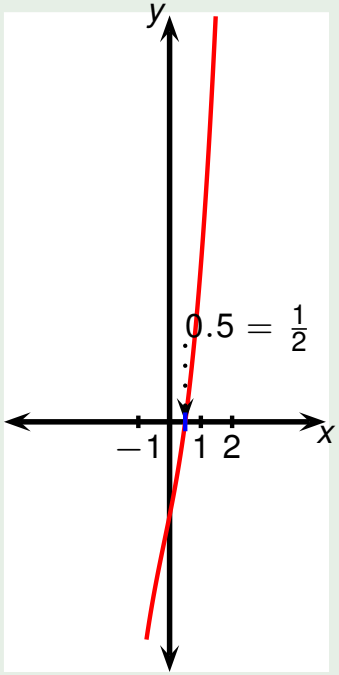
Subtract last two polynomials.

Example



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Subtract last two polynomials.

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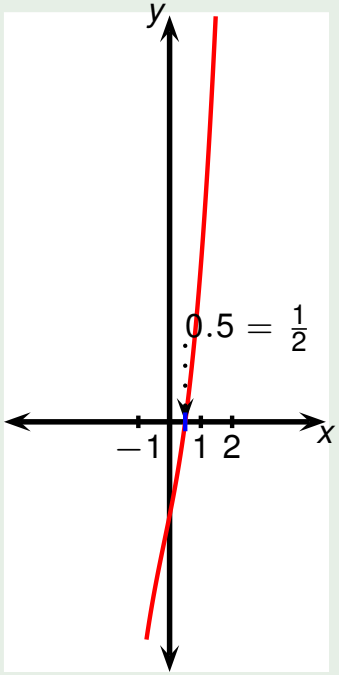

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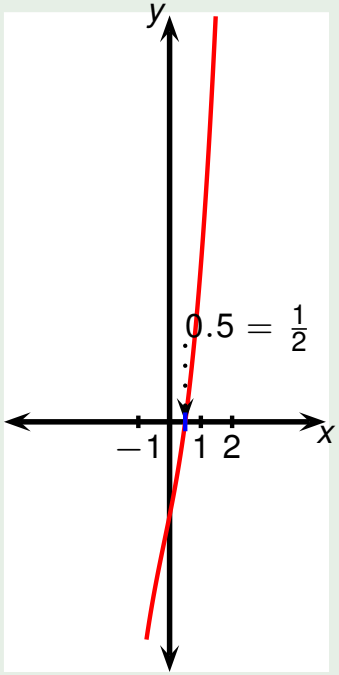
Divide $6x$ by x.

Example



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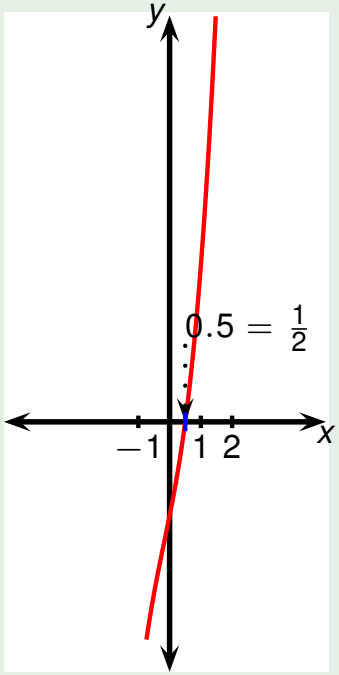

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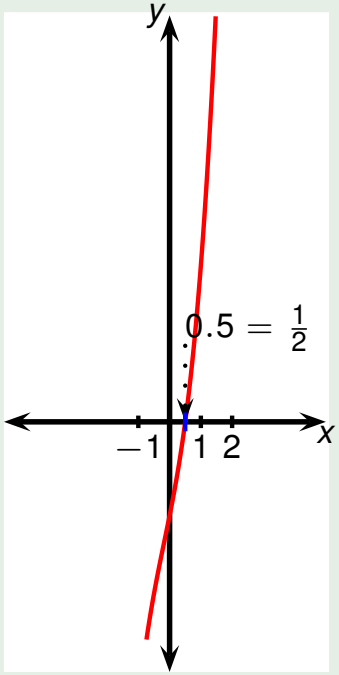
Multiply 6 by divisor.

Example



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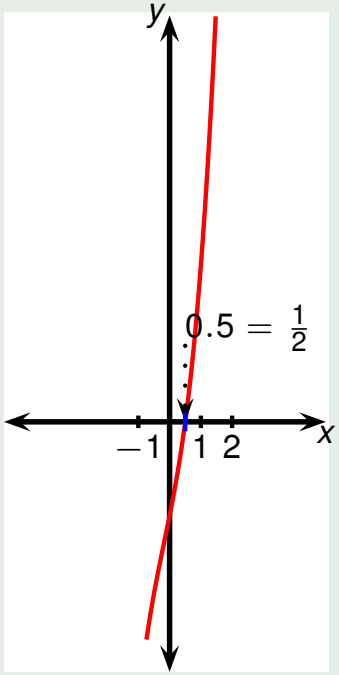

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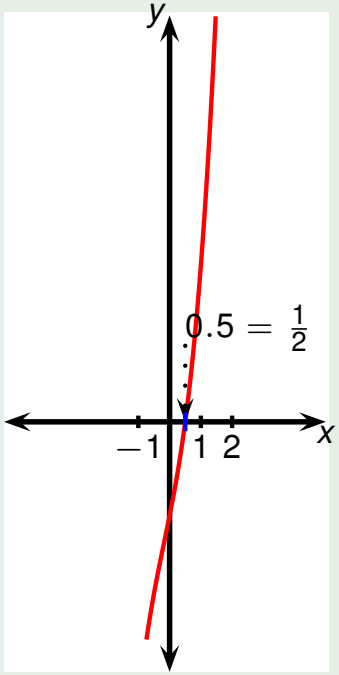
Subtract last two polynomials.

Example



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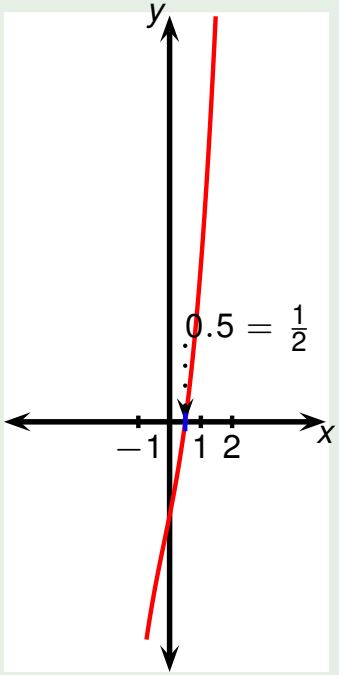

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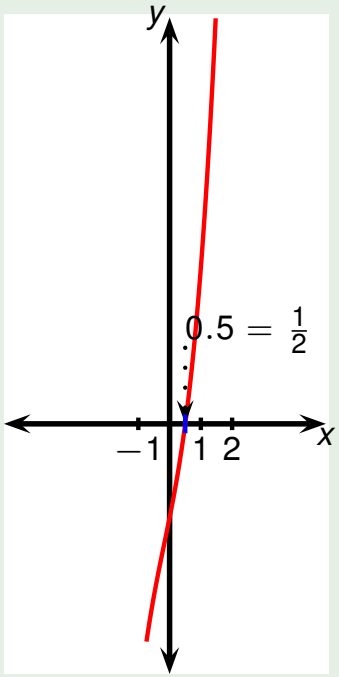

Plot the left hand side of the equation with a graphing calculator. Find all real solutions of the equation.

$$\begin{aligned} 2x^3 + x^2 + 5x - 3 &= 0 \\ \left(x - \tfrac{1}{2}\right)\left(2x^2 + 2x + 6\right) + 0 &= 0 \end{aligned}$$

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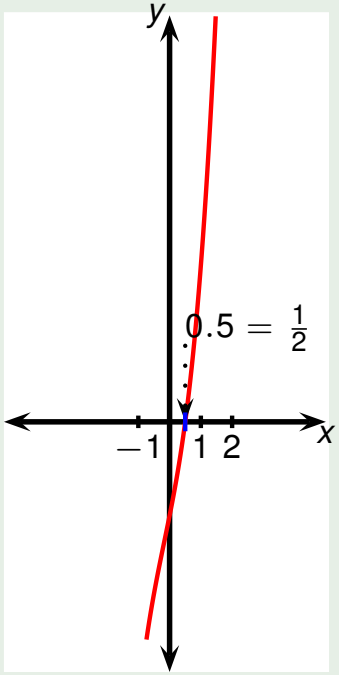

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Remainder: 0

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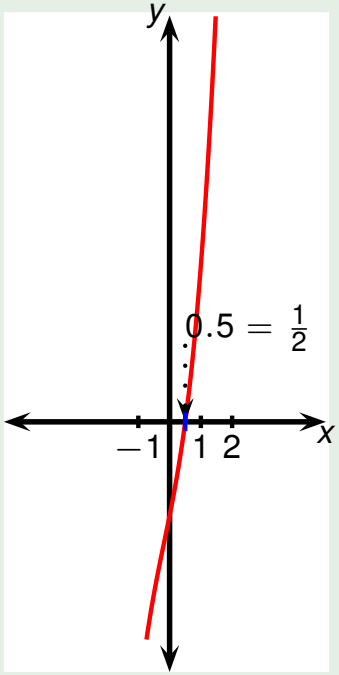

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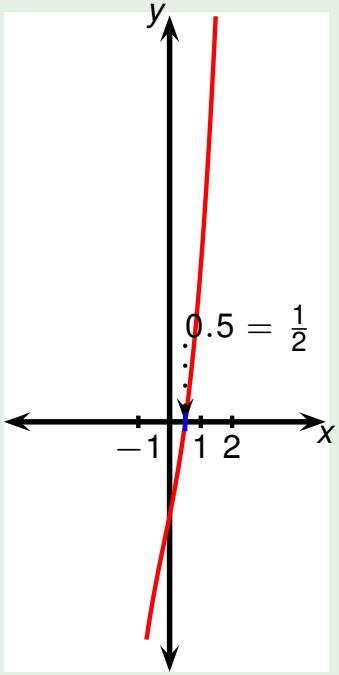

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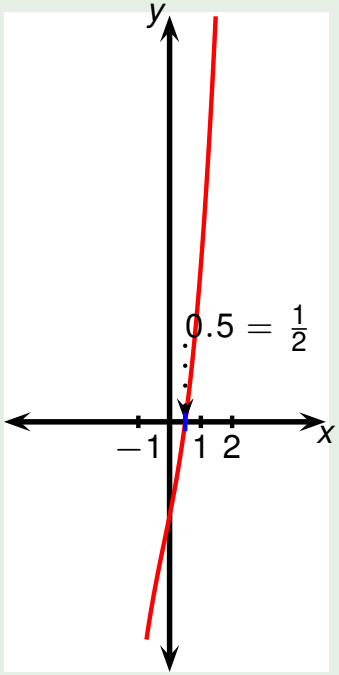

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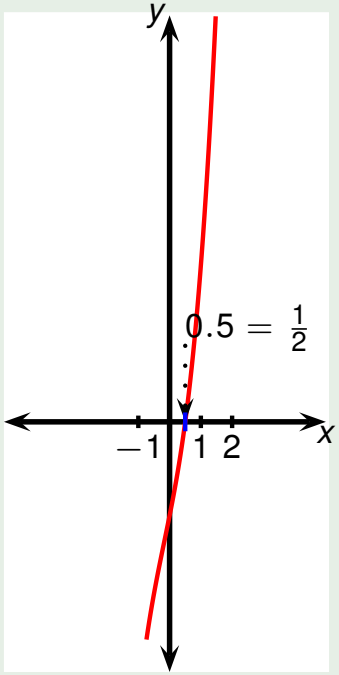

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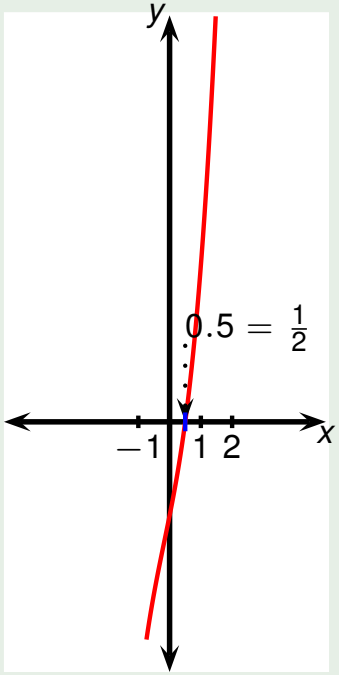

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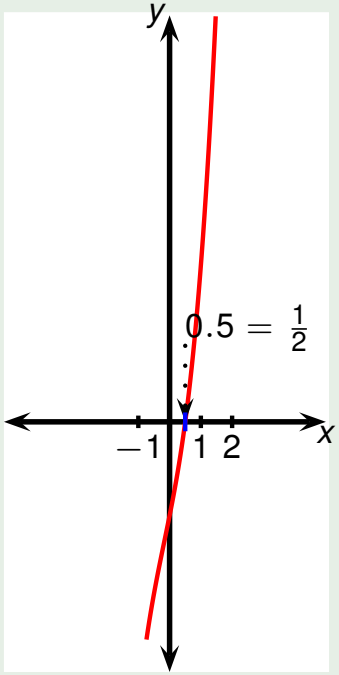

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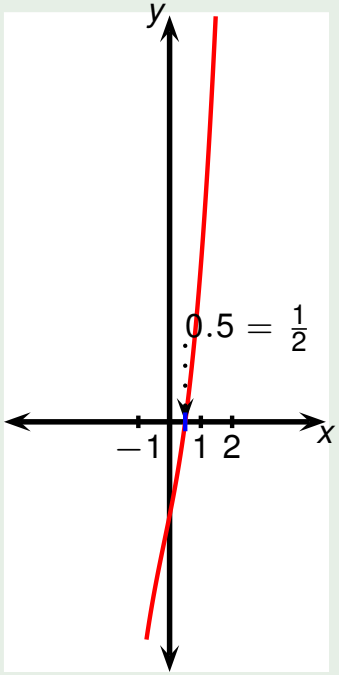

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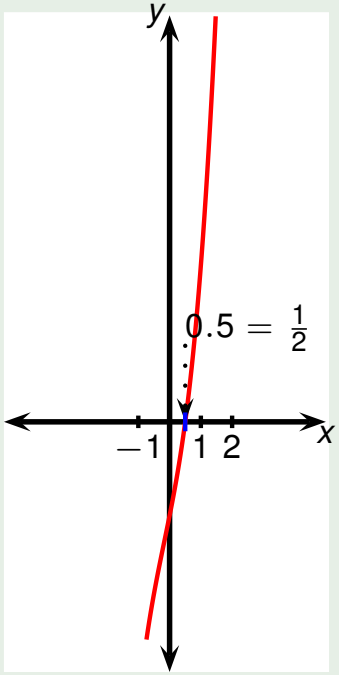

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no real solution

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