

2.2 Synthetic Division Lesson

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In this section you will learn how to use synthetic division as an alternate method to dividing a polynomial by a binomial. Synthetic division is an efficient way to divide a polynomial by a binomial of the form $x - b$.

IMPORTANT: When using Polynomial OR Synthetic division...

- Terms must be arranged in descending order of degree, in both the divisor and the dividend.
- Zero must be used as the coefficient of any missing powers of the variable in both the divisor and the dividend.

Part 1: Synthetic Division When the Binomial Is of the Form $x - b$

Divide $3x^3 - 5x^2 - 7x - 1$ by $x - 3$. In this question, $b = 3$.

- List the coefficients of the dividend in the first row. To the left, write the b value (the zero of the divisor).
- Bring the first term down – this is the coefficient of the first term of the quotient. Multiply it by the b value and write this product below the second term of the dividend.
- Now add the terms together.
- Multiply this sum by the b value and write the product below the third term of the dividend. Repeat this process until the chart is complete.
- The last number below the chart is the remainder. The numbers before it are the coefficients of the quotient, starting with the degree that is one less than the dividend.

$$(3x^3 - 5x^2 - 7x - 1) \div (x - 3)$$

3	3	-5	-7	-1
		9	12	15
		3	4	5
		14		
		x^2	x	# R

Don't forget that the answer can be written in two ways...

$$\frac{3x^3 - 5x^2 - 7x - 1}{x - 3} =$$

OR

$$3x^3 - 5x^2 - 7x - 1 =$$

Example 1: Use synthetic division to divide. Then write the multiplication statement that could be used to check the division.

a) $(x^4 - 2x^3 + 13x - 6) \div (x + 2)$

Rewrite the dividend with the missing power: = _____

Note: since the remainder is zero, both the quotient and divisor are _____ of the dividend.

b) $(2x^3 - 5x^2 + 8x + 4) \div (x - 3)$

Part 2: Synthetic Division When the Binomial Is of the Form $ax - b$

Divide $6x^3 + 5x^2 - 16x - 15$ by $2x + 3$

$$2x + 3 = 2\left(x + \frac{3}{2}\right) \rightarrow b = -\frac{3}{2}$$

- To use synthetic division, the divisor must be in the form $x - b$. Re-write the divisor by factoring out the coefficient of the x .
- We can now divide $6x^3 + 5x^2 - 16x - 15$ by $\left(x + \frac{3}{2}\right)$ using synthetic division as long as you remember to divide the quotient by 2 after.

$$(6x^3 + 5x^2 - 16x - 15) \div \left(x + \frac{3}{2}\right)$$

$$\begin{array}{r|rrrr} -\frac{3}{2} & 6 & 5 & -16 & -15 \\ & & -9 & 6 & 15 \\ \hline & 6 & -4 & -10 & 0 \\ & x^2 & x & \# & R \end{array}$$

Check answer using long division

Note: Synthetic division can only be used with a linear divisor. It is most useful with a divisor of the form $x - b$. If the divisor is $ax - b$, it can be used but long division may be easier.

Example 2: Find each quotient by choosing an appropriate strategy.

a) Divide $x^3 - 4x^2 + 2x + 3$ by $x - 3$

b) Divide $12x^4 - 56x^3 + 59x^2 + 9x - 18$ by $2x + 1$

c) Divide $x^4 - 2x^3 + 5x + 3$ by $x^2 + 2x + 1$

d) Divide $x^4 - x^3 - x^2 + 2x + 1$ by $x^2 + 2$