**2.5 Polynomial Division and the Remainder Theorem**

**Polynomial Long Division** can be used to divide by linear and nonlinear polynomials. It is similar to long division with real numbers.

Examples:

1. Use polynomial long division to divide $\frac{2x^{2}-5x-12}{x-4}$
2. $\frac{3x^{3}+5x^{2}+8x+7}{3x+2}$
3. $(x^{2}-8x-16)÷(x+4)$

**Synthetic division** can be used to divide a polynomial by a linear polynomial

* To use synthetic division, the divisor must be of the form *(x-a)*, where *a* is a real number.
* Use the following steps to divide polynomials using synthetic division. An example has been provided for clarity.
* If the remainder is 0, then the divisor is a factor of the polynomial. This is called the remainder theorem



Examples:

1. Find the quotient of $(x^{2}-5x-20)÷(x-4)$ 2. Find the quotient of $(x^{3}-8x+6)÷(x+5)$
2. Is $\left(x+2\right)$ a factor of$ (x^{2}-10x+11)$? 4. Is $\left(x-6\right)$ a factor of$ (x^{2}-14x+48)$?

Synthetic division can also be used to find the value of a function. This is known as **synthetic substitution**.

* To evaluate a polynomial using synthetic substitution, follow the same process described for synthetic division. For example, given the function $3x^{2}-20x+12$, if you want to determine the value of the function at $x=3$, use 3 as the *a* value in the divisor of the synthetic division. The resulting remainder gives the value of the polynomial when evaluated at $x=3$.

Examples:

1. Evaluate $3x^{2}-20x+12$ at $x=3$. 2. Evaluate $x^{4}-x^{2}-32$ for $x=-7$.

1. The amount of a certain medication remaining in the bloodstream *t* hours after taking the medicine is modeled by the equation $M\left(t\right)=-x^{3}+5x^{2}+3x+18$. Package directions recommend taking a second dose 4-6 hours after the initial dose. Use synthetic substitution to show that these directions are accurate.