Synthetic Division - an alternative short cut to long division

Steps:

1) Write the coefficients down in descending order. * 0 for missing terms
2) Write the constant of the divsor in the box. Set $x-r=0$.
3) Bring down the 1st coefficient
4) Multiply the 1st coefficient by r and write under 2nd coefficient
5) Add these together
6) Repeat #4 and #5 until you're done.
7) Write final poly. with 1 less degree

Remainder Theorem

When a polynomial $P(x)$ is divided by $(x-a)$, the remainder is $P(a)$.

Factor Theorem

For a polynomial $P(x)$, $(x-a)$ is a factor if and only if $P(a)=0$

Example 1. $(2x^3-13x^2+26x-24) \div (x-4)$

$$
\begin{array}{r|rrrr}
4 & 2 & -13 & 26 & -24 \\
 & \downarrow & 8 & -20 & 24 \\
\hline
 & 2 & -5 & 6 & 0
\end{array}
$$

← Remainder

Answer: $\boxed{2x^2-5x+6}$

Example 2. $\dfrac{x^4-10x^2-2x+4}{x+3}$

$$
\begin{array}{r|rrrrr}
-3 & 1 & 0 & -10 & -2 & 4 \\
 & \downarrow & -3 & 9 & 3 & -3 \\
\hline
 & 1 & -3 & -1 & 1 & 1
\end{array}
$$

← Remainder

Answer: $\boxed{x^3-3x^2-x+1+\frac{1}{x+3}}$

Example 3 Is $(x+3)$ a factor of $3x^2+7x-12$? No! It's $\neq 0$

$a=-3 \quad P(-3)=3(-3)^2+7(-3)-12$
$= -6$

Example 4 Find the remainder when $2x^4-15x^2-10x+5$ is divided by $x-3$.

$a=3 \quad P(3)=2(3)^4-15(3)^2-10(3)+5 = 2$

Synthetic Division