Recall:

Divide 567 by 4 using long division

```
    141
4 ) 567
   -4
    16
   -16
     07
   -  4
      3R
```

$$\frac{567}{4} = 141\tfrac{3}{4}$$

```
567 | 4
4   |----
    | 1
```

```
567 : 4 = 1
4
----
14
```

3.3 Dividing a Polynomial By a Polynomial

Divide x + 4 into x² - 3x - 28

$$\begin{array}{r|l} & x - 7 \\ x+4 & x^2 - 3x - 28 \\ \ominus & x^2 + 4x \\ & -7x - 28 \\ \ominus & -7x - 28 \\ & 0 \text{ Remainder} \end{array}$$

Notes:

1. use the leading term in the divisor to find the multiplier
2. write the quotient terms above terms of the same degree
3. write the multiplied term below the dividend
4. ~~subtract by "changing" signs and adding down~~
5. bring down next term
6. keep going until remainder is found (remainder has to be a lower degree than divisor)

Write the answer in two ways:

Division Sentence

$$\frac{x^2-3x-28}{x+4} = (x-7)$$

Partial Factored Sentence

$$x^2-3x-28 = (x+4)(x-7) + 0$$

remainder

Don't forget restrictions!!

$x+4 \neq 0$

$\boxed{x \neq -4}$

notation: P(x) is the dividend polynomial

the thing we are dividing

D(x) is the divisor

what we divide by

Q(x) is the quotient function

R(x) is the remainder

division statement:

$$\frac{P(x)}{D(x)} = Q(x) + \frac{R(x)}{D(x)} \Rightarrow \frac{567}{4} = 141 + \frac{3}{4}$$

partial factored form:

$$P(x) = Q(x)D(x) + R(x) \Rightarrow 567 = (141)(4) + 3$$

Example 2: Divide $8x^2 + 14x + 15$ by $4x - 3$

$$
\begin{array}{r|l}
 & 2x + 5 \\
4x-3 & 8x^2 + 14x + 15 \\
\ominus & \underline{8x^2 - 6x \quad\downarrow} \\
 & \quad 20x + 15 \\
\ominus & \quad \underline{20x - 15} \\
 & \quad\quad 30
\end{array}
$$

Division Statement:

$$\frac{8x^2+14x+15}{4x-3} = (2x+5) + \frac{30}{4x-3}$$

but $4x - 3 \neq 0$

$\boxed{x \neq 3/4}$

Partial factored form:

$$8x^2+14x+15 = (2x+5)(4x-3) + 30$$

Example 3: Divide $(10 - 6x^3 + 4x^4 - 5x)$ by $(-1 + 2x)$

no x^2 term!!!

write in descending order!

$$
\begin{array}{r|l}
 & 2x^3 - 2x^2 - x - 3 \\
2x-1 & 4x^4 - 6x^3 + 0x^2 - 5x + 10 \\
\ominus & \underline{4x^4 - 2x^3} \\
 & \quad -4x^3 + 0x^2 \\
\ominus & \quad \underline{-4x^3 + 2x^2} \\
 & \quad\quad -2x^2 - 5x \\
\ominus & \quad\quad \underline{-2x^2 + x} \\
 & \quad\quad\quad -6x + 10 \\
\ominus & \quad\quad\quad \underline{-6x + 3} \\
 & \quad\quad\quad\quad 7
\end{array}
$$

remember

$2x - 1 \neq 0$

$x = 1/2$

$$\frac{4x^4 - 6x^3 - 5x + 10}{2x-1} = 2x^3 - 2x^2 - x - 3 + \frac{7}{2x-1}$$

We must use place holders for missing powers of x!

Synthetic Division (a short cut when dividing by (x - k))

Example: $\dfrac{3x^3 - 5x^2 - 7x - 1}{x - 3}$

remember place holders

$$\begin{array}{r|rrrr} 3 & 3 & -5 & -7 & -1 \\ & & 9 & 12 & 15 \\ \hline & 3 & 4 & 5 & 14 \end{array}$$

k $\times 3$ R

Quotient coefficients

Write out k-values and coefficients

$(x-3):\ \boxed{k=3}$

Drop down 1st coeff

now multiply by k-value and add down

final numbers are coefficients and remainder

write out answer properly

$$\frac{P(x)}{D(x)} = 3x^2 + 4x + 5 + \frac{14}{x-3}$$

Ex: $\dfrac{3x^5 - 2x^4 + 5x^3 + 0x^2 + 2x + 3}{x + 4} \Rightarrow \boxed{k=-4}$

$\boxed{x \neq -4}$

$$\begin{array}{r|rrrrrr} -4 & 3 & -2 & 5 & 0 & 2 & 3 \\ & & -12 & 56 & -244 & 976 & -3912 \\ \hline & 3 & -14 & 61 & -244 & 978 & -3909 \end{array} = R$$

$(\times -4)$

$$\frac{P(x)}{D(x)} = 3x^4 - 14x^3 + 61x^2 - 244x + 978 - \frac{3909}{x+4}$$

Homefun:

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Quiz Monday: Polynomial functions and their zeroes (not their heroes)