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Notation and some math elsewhere in Europe

Some common algebraic symbols and when they were introduced:

+ for addition was first used by Nicole Oresme (1323-1382)
  - may have been a shorthand for the Latin word "et", meaning "and" (an older such shorthand is the ampersand "&")

− for subtraction was first used to indicate a deficit by Johannes Widmann (c. 1460-1500) in a book on arithmetic for merchants
(also use + to indicate a surplus)

$\sqrt{\ }$ first used by Christopher Rudolff (1499-1545) in a book on algebra
- resemble the "r" as in "radix" (Latin for "root")

= first used by Robert Recorde (c. 1510-1558) in a book on arithmetic and algebra (published in 1557).

× for multiplication first used by William Oughtred (1574-1660)
- also introduced the contractions sin and cos for certain trig functions
- invented an early slide rule

$\div$ ~~is~~ for division was first used by Johann Rahn c. 1659

· for multiplication was introduced by Leibniz, who also introduced the use of : to represent division or ratios.

/ Exercise: Who introduced the use of / for division? When?

Regiomontanus (1436-1476)

- a churchman, rose to be a cardinal
- originally from Germany, but travelled extensively for study and work in Europe

- very active scholar and translator
  - translated various classical works from Greek into Latin.
    - Ptolemy's Almagest - emphasized the mathematical portions

- wrote original works in mathematics

De triangulis omnimodis (1533) not published until

- trigonometry, including spherical trigonometry
- synthesized most of the existing knowledge about triangles & trigonometry [omitted the tangent function]

Tabulae directionum (published in 1490)

- a summary of trigonometry (including the tangent function)
- extensive trig tables

François Viète (1540-1603)

- lawyer by training, worked as a lawyer and a politician
- he broke codes for the French monarchy
  (he cracked the ciphers used by the Spanish)
- as a mathematician (on the side!)
  - he gave a fully modern (except for notation) solution to the cubic & quartic equations.
  - he worked on methods for computing approximate solutions to polynomial equations.
  - he devised better techniques for computing approximations to trig functions and had computed much trig tables than had existed before
    - he devised sum & difference formulas for trig functions
    - he also used trig functions & identities as tools for solving polynomial equations
- came up with "the first theoretically precise numerical expression for π"

$$\frac{2}{\pi} = \left(\sqrt{\tfrac{1}{2}}\right)\cdot\left(\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}\right)\cdot\left(\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}}\right)\cdot \cdots$$

- did a restoration/reconstruction of Apollonius' lost work Tangencies: Given 3 objects (each a point, a line, or a circle), find all the circles passing through the given point(s) and tangent to the given line(s) and/or circle(s).
  - Solved all the cases using only ruler & compass constructions in a book called Apollonius Gallus.

- he did the reverse of Omar Khayyam and used algebra to solve geometric problems

- algebraic notation: introduced the idea of systematically using letters to represent variables ($x, y, z, \ldots$) & constants ($a, b, c, \ldots$)