6/3/2023

Operations on Whole numbers:
Addition, subtraction, multiplication, division, exponents, roots
Order of operations

Addition algorithm for adding large whole numbers.

```
 11
496
+78
574
```

Start at the right and add the ones digits. Single digit values get written down and then move on to the next leftmost column. If you end up with a two-digit sum, put the ones digit under the ones digit column and then carry the tens digit to the next column. Then move on to the next column.

```
  1  1
406,173
+  4,381
 410,554
```

Subtraction
The subtraction algorithm, we also start at the rightmost column, and the two digits in the ones column can be subtracted normally, then we do that. If the top is smaller than the bottom however, then we borrow a tens from the next column to make a number like 2 into a 12, and we reduce the number we borrowed from by 1. Then continue until you run out of columns.

```
496
 -78
418
```

```
406,173
 -  4,381
401,792
```

```
3007
 -192
 2815
```

If you are trying to borrow from a 0, go over to the next non-zero column and borrow from there, and then borrow in succession until you get back to the column you need to compute.

Multiplication algorithm
Multiplication algorithm: start in the ones digit, and you multiply the two ones digits together, if the result is a single digit write down and move on the next column, if the result is a two-digit number, then write down the ones digit and carry the tens digit over to the next column. In the next column, multiply the two digits in the original number, then add the carryover from the previous column. Then write down the ones digit in the result, and carry over the tens digit to the next column.

Overall of this, each digit in the second number gets multiplied by everything in the top number before moving on to the tens digit in the second number. When you are multiplying the tens digit with the top number, you line up the ones digit result under the digit you started with.

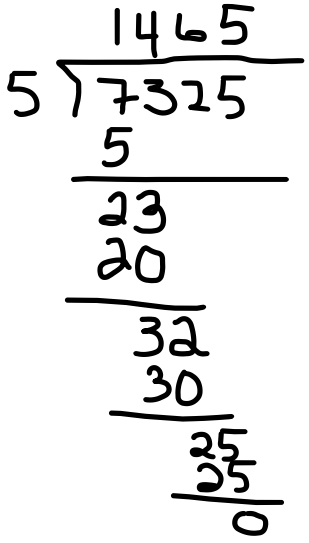
```
  25
X46
```

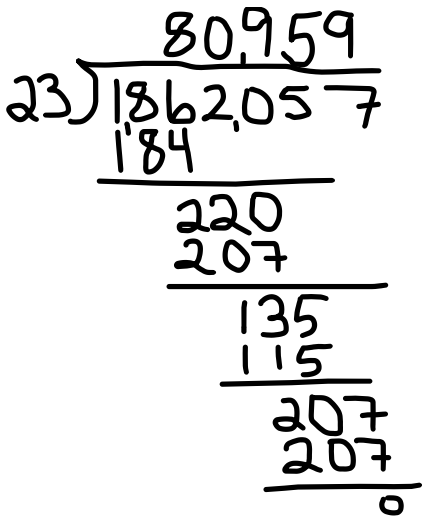
Essentially what the algorithm is doing is we are breaking up 46 into 40 and 6, and the first step is to multiply the top number (25) by 6 and get a result, and then in the second step, multiply the top number by 4(0).

```
   2
  25
X46
  150
100
1150
```

```
  11
  522
X638
 4176
 1566
3132
333,036
```

Long Division Algorithm:
Start with the number you are dividing into at it's left end (largest digit), and divide by the divisor (the number you are dividing by). If the number is smaller than the number you are dividing, add on a digit to the right until it's larger, then do the division. Write the whole number above the division bar, and subtract the product from the combination of digits, and then bring down another digit to divide.





If you get to the last digit of the division and there is a non-zero result of the last subtraction step leftover, write that next to your result as R#
If the last number was a 3, write R3 next to the answer, and this is read “remainder three”.

17/5 = 3 R 2 because 17 is 5*3 + 2

Exponents:

$$2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$$

Squares: $2^2 = 4, 3^2 = 9, 4^2 = 16, etc.$
Cubes: $2^3 = 8, 3^3 = 27, 4^3 = 64$, etc.
4th powers: $2^4 = 16, etc.$
5th powers: $2^5 = 32, etc.$
^ is the power key 2^4 to get 2^4, in some calculators the key that looks like x^y: type 2 x^y 4

Roots: square roots, but you can also have cube roots or fourth roots, etc.

$$\sqrt{64} = 8$$

Cube roots:

$$\sqrt[3]{8} = 2$$

Order of Operations

PEMDAS = Parentheses, Exponents (roots), MD (multiplication and division… left to right), AS (addition and subtraction… left to right)

(4+5)x6
4+5x6

In the first expression, we add 4+5 first because it's in parentheses … 9x6 = 54
In the second expression, we do multiplication first 5x6… 4+30=34

$$(9-4) \times 3 + 2^2 - 6$$

Parentheses:

$$5 \times 3 + 2^2 - 6$$

Exponents:

$$5 \times 3 + 4 - 6$$

Multiplication:

$$15 + 4 - 6$$

Addition (on left):

$$19 - 6$$

Subtraction (on the right):

$$13$$

Next time: integers