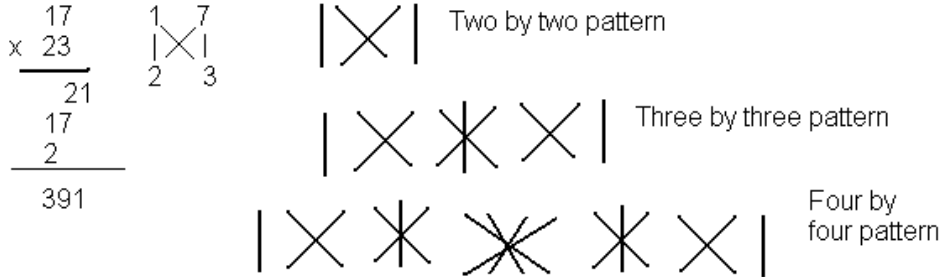
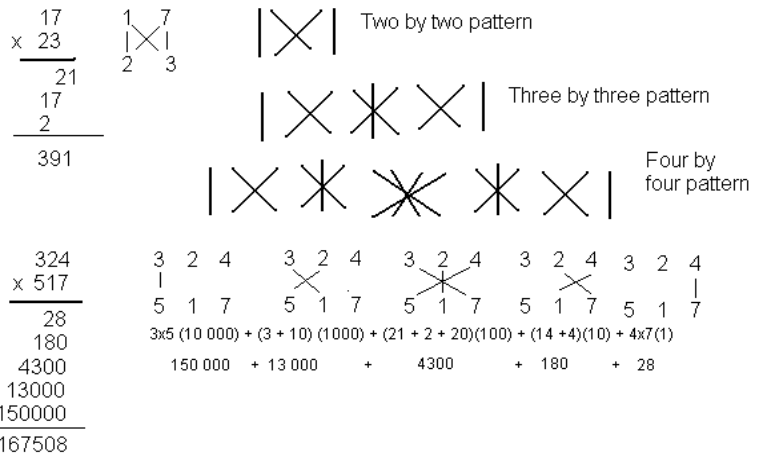


# Using Multiplying Polynomials to For Math Problems

Let's take multiplying a binomial times a binomial first.  $17 \times 23$  is  $(10 + 7)(20 + 3)$ . In her wonderful book on speed mathematics, Figuring-The Joy of Numbers, Shakuntala Devi shows a pattern for multiplying that is really neat. For the two numbers  $17 \times 23 = (10 + 7)(20 + 3) = 200 + 30 + 140 + 21$  or  $2 \times 100 + (3 + 14) \times 10 + 21$ . Now observe, 21 came from  $3 \times 7$ , they are directly above each other when written vertically, the 2 in 200 came from  $1 \times 2$  and they are directly above each other when written vertically. The 3 and the 14 came from cross multiplying  $1 \times 3$  and  $2 \times 7$ . In the following diagram, I have drawn that out on the left:



So, you can see how the two by two digit pattern works. Now, if you move to a three by three digit, there even is a pattern to the pattern. Start on the right with a one by one, bring in the cross of the two by two, bring in a new cross for a three by three, now go back to another two by two cross and finish off with a one by one line where you multiply the two hundreds digits. On the right, I have used the three by three pattern to do  $324 \times 517 = (300 + 20 + 4)(500 + 10 + 7)$ .



Once you see how the patterns are invented and applied, you can carry on. It is not necessary to write down any of the numbers between question and answer. You can just write the answer, I keep the number to carry on my left hand and write the answer on the whiteboard with the right hand. I have had students attack a 5 by 5 and a 6 by 6 digit question and just write down the answer, no intermediate work!

There are so many shortcuts that you can come up with, once students realize that 2 digit numbers can be written as  $10T + U$  and three digit numbers as  $100H + 10T + U$ , and so on.

Here are two other neat puzzles. On the right is little Johnny's simplifying of a fraction. Now, of course it doesn't always work, a counter example like 15 over 54 shows that. However, if you have two digits on top and two digits on the bottom and you cross-out the units and the tens digits like I have because they are the same, then what are the other 12 fractions that it does work with? Your numerator would be  $10T + U$  and your denominator would be  $10U + W$ , with the answer being  $T$  over  $W$ .

$$\frac{\cancel{1}6\cancel{4}}{\cancel{5}4\cancel{1}} = \frac{1}{4}$$

The second puzzle is this: Take any two digit number and reverse the digits to form a second number. Subtract highest take away lowest. Not only will the answer always be divisible by 9, but if the tens digit and the units digit are  $X$  apart ( $T - U = X$ ), the answer will be  $9X$ . Why?