

I hope you remember from last week, that whenever you multiply any digit times two, you'll either have a zero or a one in the tens column of the product.

In other words, when I multiply 0,1,2,3,4 by two, there's going to be nothing in the tens column of the answer.

But when I multiply 5 by two, I get 10, which leaves me with a 1 in the tens column, and if I multiply by 6,7,8, or 9 by two, I'll still have a one in the tens column. So that one is the only number I will ever possibly have to carry into the tens column, when I multiply by 2.

The other columns can only end in even numbers, and none of them can be higher than 8, because two times 0 is 0, times 1 is 2, times 2 is 4 times 3 is 6, times 4 is 8, times 5 goes back to 10, so there's a 1 in the tens column, but only a 0 in the units column. And times 6 has only a 2 in the units, times 7 is 4 in the units, times 8 has a 6 in the units column, and times 9 is as high as it can go, and there is only an 8 in the units column

So if I ever have to carry a 1 into the product of a 2, it will never make it go higher than nine, never make it go to twenty-something. The highest thing we can have is, let's say I'm doing 99 times 2, and I look at the last nine, and see, ok, that's going to be an 18, so I'm going to have to bump up the next column by 1, so when I look at the digit I am working on, I'll say, ok, *that's* going to be an 18, so I'll have to bump it up 1 it can only be 19, and never any larger.

I can never go higher than 19 when I'm multiplying a digit by two, so there's never any danger. All the columns are more-or-less safe. The most I can ever bump it up is the natural number of the tens column of the multiplication of the digit to the right of it.

This is really important for you to understand because it is the basis of multiplication of all one-digit numbers from left to right.

So let's start multiplication by three.

It turns out that when you multiply the numbers 7, 8, or 9 by 3, you get a 2 in the tens column of the product. And there are some numbers, which, when you add a 2 to them, they're going to bump up higher than they are already at.

First, I'd like to introduce you to my friend, Galileo. He's my big red golden retriever, who's sitting right next to me. As I scratch him, he likes to breathe into the microphone. Can you hear him? Oh, now he's stopped. Come on, Galileo, breathe for the nice people. Yeah, he's licking the microphone. So if you hear heavy breathing, it's not me, it's just my dog, Galileo. There he is.

OK, so let's multiply by three. When I multiply three, I get 0 times 3 is 0, 1 times 3 is 3, 2 times 3 is 6, 3 times 3 is 9. We could have a problem here, because we never had a 9 in the ones column of any multiple of 2 before. If I have to carry 1 to that 9, it's not only going to change that 9, but it's going to change the tens column by 1.

In other words, if I add 1 to a 9, I'm going to have a 10 in the column, instead of a 9. And I can't write "10" in a column. I have to carry that 1 in the tens column of that number, into the next highest column. In other words, I'll have to carry further, one column further to the left.

I may have to carry, not just to the number immediately to the left of it - I may have to carry it even higher up the chain.

For this lesson, we are going to make sure we're not going to multiply by any digits that will make us carry anything higher up the chain.

So we're going to start with what I call the safe digits for multiplication by three. Those digits are digits, that when you multiply them by three, end in a digit that is seven or less.

In other words, we are not going to use any multiples of three that will require us to go any higher up the change once we add a carry to them from behind.

I'll give you an example of safe digits. 2 is a safe digit. Let's take another one - 4 is a safe digit. 24 times 3. It's got a two and a four in it.

When I multiply that 2 times three, I look to the right, I see I'm going to multiply by 4 after that, which will make me carry. It will be 12, which will make me carry 1 up into the tens column. So when I multiply that 2 times 3, I get 6, with the carry is 7. That 7 is a one-digit number, so I don't have to carry anything further up into the hundreds column.

Had I multiplied, on the other hand, let's say 34 times 3 instead of 24 times 3; because 3 is not one of our safe numbers, this is going to happen:

you look at the 3 and say, "OK, when I multiply this by 3 I'm going to get 9. And when I look to the right I multiply that 4 times 3, and I'll get 12. I'll have to carry 1".

When you carry that 1 up into the tens column, all of a sudden you're dealing with another two-digit number. And you're going to have to carry one further, up into the hundreds column, because when you add that carry to the 9, you're going to get a 10. And that 1 in the tens column of the 10 will have to be carried higher into the hundreds column.

In other words, you're carrying further up the chain. But we won't be doing that in this lesson. We'll do that tomorrow. It's not very difficult, but let's first do multiplication of three by digits that I call the "safe digits."

And those safe digits are all the digits except for 3 and 6. Because when 3 or 6 are multiplied by three, they may be caused to carry one higher up the chain that we have been dealing with so far. So we are going to leave them out for now.

In other words, we are going multiply three times numbers, no matter how long, we can do hundred digits long now, as long as none of them are 3s or 6s they should be absolutely no problem for you.

So let's try one. Let's try 47 times 3. That's pretty simple to begin with.

OK, you look at that 4, and you look over to the right, and I see that you will see a 3 and you'll think, "That's 7 times 3. That's going to make me carry 2. That's different than the last time, but it's no big deal."

Then you'll think, "OK, when I multiply  $4 \times 3$  I'll get 12 and I'll carry a 2 to it. It becomes 14."

So I'm not going any higher that I would have. With 14, I haven't changed anything in the tens column, just in the ones column of this product. I changed the 2 to a 4, but the 1 remained the same. The 12 became 14. So I write 14, but say, "One hundred forty" to myself.

Now we're at the last digit, which is seven. 3 times 7 is 21. We already carried the 2, we just write the 1. So we can say, "One hundred forty-one." Forty-seven times 3 is One hundred forty-one.

Try that on your calculator and see if it works out. Get away from that calculator, I was just kidding!

What you can do, though, is get out your deck of cards out and take out the 3s and 6s, and then deal out a long number and multiply it by three.

I made some worksheets, with the answers. The questions are on the left side of the sheet, so you can fold the worksheets in half, with the right side in back, so you can't see the answers as you do the questions. They are simply multiplications by three, but they are very long numbers in the billions. They are only of the safe numbers. No threes or sixes will be in the multiplicand.

By the way, you should know that the *multiplicand* is the number that is *being* multiplied, and the *multiplier* is the number it is being multiplied *by*.

In other words, if I say "8 x 3," or "eight multiplied *by* three," then 8 is the multiplicand, and three is the multiplier.

In other words, the multiplier is the one doing the work.

Just like the plumber is the one doing the plumbing, and the doctor is the one doing the doctoring, and the soldier is the one doing the soldiering; the multiplier is the one doing the multiplying.

So you're being doctored *by* the doctor so-and-so, and the multiplicand is being multiplied *by* whatever digit is doing the multiplying.

I hope you get that. It's a silly analogy, but it works.

Now there are an awful lot of multiplications on that worksheet, but they are really very easy. They are all multiplications just by 3, with no major carrying. Only carrying a 1 or a 2 one up the chain.

It should only take you a few minutes to do the whole sheet. There are only about twenty examples, and each is about ten digits long. You shouldn't have any problem doing them, and you can check them against the answers on the other side after you do them.

If you get them wrong, If you go back to that same web-page, and click on it again, and it will give you a different set of numbers each time. So each time you go there, you get a different set of numbers with their answers every time.

It's not the same worksheet each time - it's an unlimited amount of worksheets. So you can do one every day, or you can do three or four sheets every day.

But I figure if you do one sheet a day of the stuff I give you from now on, you're going to be crankin' with this stuff in a very short time.

Okay, see you tomorrow.