Because We Can

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Occasionally, no matter how amazingly prepared one might be for a particular class, some students will finish early and start fidgeting. In cases like this, it is always helpful to have an arsenal of miscellany to fight the fidgets and hopefully tweak their interest, at least long enough to occupy the balance of class.

In my Math 10 classes, one of the techniques I use is finding square roots without using a calculator. Back in the days before global warming when wooly mammoths roamed Alberta and I was in high school, one of my math instructors taught this to me and, in the great oral traditions of our society, I am passing this gem on to whoever stumbles across this article.

Often, when dealing with some obscure algebraic concept, my students will ask the perennial question "Why?" to which the obvious response is "Because we can." In an age when most electronic gadgets can spit out the square root of any number to ten decimal places instantly, the answer to the why question is more pointedly, "Because not many people can any more."

So without further justification, here is the technique. Don't ask a lot of silly questions. Just do it. (Nike, 1988)

Since the mechanics of using this method closely resemble a long division problem, in the interest of simplicity, I will refer to the parts of the problem using division terminology.

```
              Quotient___
Divisor      )Dividend

               Remainder
```

Suppose you are trying to calculate the square root of 2.

Step 1: Separate the number you are trying to find the square root for into couplets, from the decimal point left and from the decimal point right. This arrangement becomes the "dividend."

```
  ___________
 ) 2.00 00 00
```

Step 2: Start with the couplet furthest to the left. Find the number which, when squared, gives a value less than that couplet. Place this number above the corresponding couplet in the space for the "quotient."

```
        _1________
        ) 2.00 00 00
```

Step 3: Square the quotient number, place the answer below the corresponding couplet and subtract, just as in long division. Then bring down the next couplet.

```
        _1________
        ) 2.00 00 00
         -1
          1 00
```

Step 4: Double the quotient thus far and, leaving a space at the end, place the result as a new divisor in front of the remainder.

```
        _1. X______
        ) 2.00 00 00
         -1
    2X )  1 00
```

Step 5: Find a value for 'X' such that the product of 'X' and '2X' will be less than the new dividend. (e.g. 1 x 21, 2 x 22, 3 x 23, 4 x 24, 5 x 25, etc.)

In this case, 4 x 24 = 96, which is less than 100. Proceed similarly to Step 3.

```
         _1. 4______
        ) 2.00 00 00
         -1
    24 )  1 00
         -  96
             4
```

Step 6: Repeat Step 5 for as many decimal places as you would like.

```
A.      _1. 4_ X___
        ) 2.00 00 00
         -1
    24 )  1 00
         -  96
     28X  )  4 00
```

```
B.      _1. 4_ 1___
        ) 2.00 00 00
         -1
    24 )  1 00
         -  96
       281 )  4 00
```

```
          - 2 81
            1 19 00



C.      _1. 4_ 1_ X_
        ) 2.00 00 00
         -1
   24 )  1 00
        -   96
     281 )  4 00
           - 2 81
    282X ) 1 19 00

D.      _1. 4_ 1_ 4_
        ) 2.00 00 00
         -1
   24 )  1 00
        -   96
     281 )  4 00
           - 2 81
    2824  ) 1 19 00
            - 1 12 96
                 6 04
```

After this, one could add more zero couplets at the end to take the process out to as many decimal places as you have the stamina for.

Here's one more example, just to solidify things.

```
A.      _____________
        ) 3 81.20 00 00


B.      _1___________
        ) 3 81.20 00 00
        - 1
          2 81

C.      _1_X ._______
        ) 3 81.20 00 00
        - 1
   2X )  2 81
D.      _1_9 ._______
        ) 3 81.20 00 00
        - 1
```

29) 2 81
- 2 61
20 20

E. _1_9 . X______
) 3 81.20 00 00
- 1
29) 2 81
- 2 61
38X) 20 20

F. _1_9 . 5______
) 3 81.20 00 00
- 1
29) 2 81
- 2 61
385) 20 20
- 19 25
95 00

G. _1_9 . 5_ X___
) 3 81.20 00 00
- 1

29) 2 81
- 2 61
385) 20 20
- 19 25
390X) 95 00

H. _1_9 . 5_ 2___
) 3 81.20 00 00
- 1

29) 2 81
- 2 61
385) 20 20
- 19 25
3902) 95 00
- 78 04
16 96 00

I. _1_9 . 5_ 2_ X_
) 3 81.20 00 00

```
              - 1

        29  )  2 81
              - 2 61
         385 )  20 20
                - 19 25
         3902  )    95 00
                    - 78 04
         3904X )   16 96 00

    J.        _1_9 . 5_ 2_ 4_
              ) 3 81.20 00 00
              - 1

        29  )  2 81
              - 2 61
         385 )  20 20
                - 19 25
         3902  )    95 00
                    - 78 04
         39044 )   16 96 00
                    - 15 61 76
                        1 34 24
```

And so on …

For young Throckmorton, who will have mastered this in about two minutes, there's always synthetic division, or perhaps the rational roots test …