

# The Relationship between Musical Scale, Cello String Length, and Math

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## *Abstract*

I play the cello, but my intonation is not good because I do not always remember where to place my fingers on the strings. Usually I use a tuner to help me find the right spots, and then I put stickers to mark the locations. However, I always ask myself: What makes these locations the right spots for the right pitches? Can I prove it mathematically? In this project, I want to know the sticker locations using math only, without a tuner. First, I used my tuner to determine where to press the string for C, C#, D, D#, E, F, F#, G, G#, A, A#, B, and C. Next, I measured the pressed string length with a tape ruler. Then I calculated the pressed string length ratio to the whole string. For math, I knew there are 12 half-notes within an octave and the length is halved (50%) for each octave. I just needed to find a multiplier that divides the length between 100% and 50% equally. In other words, I needed to find a number  $M$  such that  $M^{12} = 0.5$ . By using a scientific calculator, I found the magic number,  $M$ , to be 0.944! This means that for each half-note, the string needs to be reduced to 94.4%, and for each whole-note, the string needs to be reduced to 89.1%.