Q- The G string on an instrument is 49 cm long. When played without fingering, it vibrates at a frequency of 196 Hz. The next higher notes on the C-major scale are A (220 Hz), B (247 Hz), C (262 Hz), and D (294 Hz). What distance *x* from the end of the string must a finger be placed to play each of these notes?

The frequency of the stretched string is given by

$$n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

Here L is the vibrating length of the string, T the tension in the string and μ is its mass per unit length.

For the whole length

$$196 = \frac{1}{2*0.49}\sqrt{\frac{T}{\mu}}$$

Gives $\sqrt{\frac{T}{\mu}} = 196*2*0.49 = 192.08 m/s$

Let the distance vibrating length be x then

A. $220 = \frac{1}{2x_A} * 192.08$

Gives $x_A = \frac{192.08}{220*2} = 0.4365m$ = 43.65 cm

x_A = 43.65 cm

B. $247 = \frac{1}{2x_B} * 192.08$

Gives $x_B = \frac{192.08}{247*2} = 0.3888m$ = 38.88 cm

x_B = 38.88 cm

C. $262 = \frac{1}{2x_C} * 192.08$

Gives $x_C = \frac{192.08}{262*2} = 0.3665m$ = 36.65 cm

x_C = 36.65 cm

D. $294 = \frac{1}{2x_D} * 192.08$

Gives $x_D = \frac{192.08}{294*2} = 0.3267$ = 32.67 cm

x_D = 32.67 cm