Q- One of the 63.5 cm long strings of an ordinary guitar is tuned to produce the not B (frequency 245 Hz) when vibrating in its fundamental mode.

(a) find the speed of the transverse wave on this string.
(b) If the tension in the string is doubled, what will be the new fundamental frequency of the string?
(c) If, instead, the string had been pressed against a fret to reduce its effective length by half. What would the new fundamental frequency have been?

(a)

The speed of the transverse wave on a stretched wave is given by

$C = n*\lambda$

Where n is the frequency and λ is the wavelength

As the nodes are formed at two ends of the string and the distance between two consecutive nodes is half of the wavelength

$\lambda/2 = 63.5 \text{ cm} = 0.635 \text{ m}$

And $\lambda = 0.635*2 = 1.27 \text{ m}$

Hence the speed is given by

$C = n\,\lambda = 245*1.27 = 311.15 \text{ m/s}$

(b)

The fundamental frequency of the string is given by

$$n = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \qquad \text{---------------} (1)$$

Where *l* is the length of the string, T is the tension in the string and m is the mass per unit length of the string. If the length and the mass per unit length of the two strings will be the same, from above equation we get

$$\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}$$

Hence if the tension is doubled the new frequency is given by

$$n_2 = n_1\sqrt{\frac{T_2}{T_1}} = 245\sqrt{\frac{2T_1}{T_1}} = 245 * \sqrt{2} = 346.48\ Hz$$

(c)

Using the same equation (1) if the tension of the string remains the same but the length *l* is reduced to *l*/2 the new frequency n_2 is given by

$$\frac{n_1}{n_2} = \frac{l_2}{l_1}$$

Hence

$$n_2 = n_1\frac{l_1}{l_2} = 245 * \frac{l}{l/2} = 245 * 2 = 490\ Hz$$