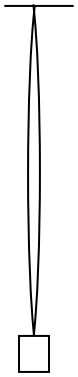
Q- A uniform string of linear density 10g/m is tied to the ceiling of an elevator. A 5kg mass is hung from the other end of the string at a point 1m from the ceiling. If the elevator accelerates upward at 0.10g what is the fundamental frequency of the string?



With the elevator the hanging mass is also accelerates and hence the tension F in the string is given by using Newton's second law of motion as

F – mg = ma

Or F = m(g + a) = m(g + 0.10g) = mg*1.10 = 5*9.8*1.10 = 53.9 N.

The velocity of the transverse waves in the string is given by

$$c = \sqrt{\frac{F}{\mu}}$$

Where F is the tension in the string and μ is the mass per unit length hence the wave velocity is

$$c = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{53.9}{10*10^{-3}}} = 73.42\ \text{m/s}$$

As the length of the string is 1 m and there are two nodes, one at each end of the string thus wavelength will be 2 m (distance between two consecutive nodes is $\lambda/2$) and hence the natural frequency of the string will be

n = c/ λ = c/2L = 73.42/2 = 36.71 Hz