2015 F=ma Exam: Problem 24

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Recall the wavelength of the fundamental mode is given by $\lambda = 2L$. The fundamental frequency f is then

$$f = \frac{v}{\lambda} = \frac{v}{2L}$$

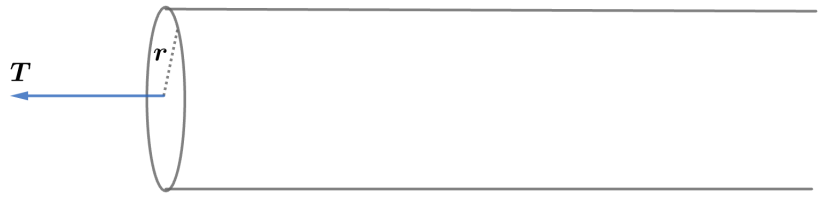
Since the speed of a wave in a string is given by

$$v = \sqrt{\frac{T}{M/L}}$$

we have

$$f = \frac{1}{2L}\sqrt{\frac{T}{M/L}} \propto T^{1/2}M^{-1/2}$$

since we are considering strings of the same length.



In terms of the radius r, the maximum possible tension $T \propto r^2$ since it is determined by the tensile strength (force per area) of the material. The mass $M \propto r^2$ since the volume of the string is proportional to its area. Then

$$f \propto (r^2)^{1/2}(r^2)^{-1/2} = 1$$

so the frequency is independent of radius. Thus, the answer is $\boxed{\text{A}}$.