Student ID: 20205237
Name: Hariharan, Tejas

H

Wave on a vertical string
A uniform rope of mass m and length ℓ hangs vertically from the ceiling.
a) Find the speed of a wave on the string as a function of x, the distance from the lower end of the string.

$V_{\mathrm{w}}(x) = \sqrt{\frac{T(x)}{\rho}}$
$T(x) \propto x$
$T(x) = kx$
$T(x) = \frac{mg}{l}x$
$V_{\mathrm{w}}(x) = \sqrt{gx}$

$v_{\mathrm{w}}(x) =$ _____

b) Find the time taken for a wave to travel from the bottom to the top of the string. (Hint: This will involve an integral.)

Find time it takes to travel a distance of l, at $v_{\mathrm{w}}(x) = \sqrt{gx}$
$V = \frac{dx}{dt}$
$dt = \frac{dx}{V}$
$\Rightarrow t = \int_0^{\mathrm{l}} \frac{1}{V} dx$

$\Rightarrow t = 2\sqrt{\frac{\ell}{g}}$

$t_{\ell,m} = 2\sqrt{\frac{\ell}{g}}$ _____

c) Find the time taken for a wave to travel from the bottom to the top of the string if the mass of the string is doubled.

t does not depend on mass.

$t_{\ell,2m} = 2\sqrt{\frac{\ell}{g}}$ _____

d) Find the time taken for a wave to travel from the bottom to the top of the string if the length of the string is doubled.

$t_{2\ell,m} = 2\sqrt{\frac{2\ell}{g}}$ _____