Answer on Question #41145, Physics, Mechanics | Kinematics | Dynamics

A stones hangs from the free end of a sonometer wire whose vibrating length when tuned to a tunning fork is 40 cm. When the stone hangs wholly immersed in water, the resonant length is reduced to 30 cm. The relative density of the stone is

Solution:

The frequency of a string of length L, mass per unit length m and stretched with a tension T is given by

$$f = \frac{p}{2L}\sqrt{\frac{T}{m}}$$

where p is the number of segments in which the string is vibrating.

In the fundamental mode (the first harmonic), the string vibrates in one segment (p = 1).

Given:

$L_1 = 0.4$ m,

$L_2 = 0.3$ m,

$RD = ?$

In our case,

$$f = \frac{p}{2L_1}\sqrt{\frac{T_1}{m}} = \frac{p}{2L_2}\sqrt{\frac{T_2}{m}}$$

Thus,

$$\sqrt{\frac{T_1}{T_2}} = \frac{L_1}{L_2}$$

$$\frac{T_1}{T_2} = \left(\frac{L_1}{L_2}\right)^2 = \left(\frac{0.4}{0.3}\right)^2 = \frac{16}{9}$$

The tension is equal to weight

Relative density (with respect to water) can then be calculated using the following formula:

$$RD = \frac{W_{air}}{W_{air} - W_{water}}$$

where W_{air} is the weight of the sample in air (measured in newtons),

W_{water} is the weight of the sample in water (measured in the same units).

$$RD = \frac{W_1}{W_1 - W_2} = \frac{T_1}{T_1 - T_2}$$

$$RD = \frac{1}{1 - \frac{T_2}{T_1}} = \frac{1}{1 - \frac{9}{16}} = \frac{1}{\frac{7}{16}} = \frac{16}{7} = 2.29 = 2.3$$

Answer. $RD = \frac{16}{7} = 2.3.$