Answer on Question #60276-Physics-Other

An aluminium wire of linear density 0.026 gm/cm is joined to steel wire of linear mass density 0.078gm/cm. The compound wire is stretched by a load of 10 kg wt. and set into transverse vibrations. If the total vibrating length of the compound wire is fixed at its ends is 146.6cm find the lowest frequency of excitation for which a stationary wave is produced such that the joint in the wire is node. Also find the total number of loops formed. (Length of aluminium wire=86.6cm, length of steel wire =60cm)

Solution

Let $n_1 \; and \; n_2$ be the total number of loops in aluminium and steel wire respectively. The frequency n is given by

$$n = \frac{n_1}{2l_1}\sqrt{\frac{T}{m_1}} = \frac{n_2}{2l_2}\sqrt{\frac{T}{m_2}}$$

where $l_1 \; and \; l_2$ represents the lengths of the aluminium and steel wire respectively.

$$\frac{n_1}{2l_1}\sqrt{\frac{T}{Ad_1}} = \frac{n_2}{2l_2}\sqrt{\frac{T}{Ad_2}}$$

where $d_1 \; and \; d_2$ represents the densities of the aluminium and steel wire respectively.

$$\frac{n_1}{n_2} = \frac{l_1}{l_2}\sqrt{\frac{d_1}{d_2}}$$

We have

$$\frac{n_1}{n_2} = \frac{0.866}{0.6}\sqrt{\frac{0.026}{0.078}} = 0.8333 = \frac{5}{6}$$

The total number of the loops is

$$5 + 6 = 11.$$

$$n = \frac{n_1}{2l_1}\sqrt{\frac{T}{m_1}} = \frac{5}{2(0.866)}\sqrt{\frac{10(9.8)}{0.0026}} = 560 \; Hz.$$