Answer on Question #42897 – Physics – Other

35. A 70 cm long sonometer wire is in unison with a tuning fork. If the length of the wire is decreased by 1.0 cm, it produces 4 beats per second with the same tuning fork. The frequency of the tuning fork is:

Solution.

The formula for the sonometer frequency is:

$$f = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$$

Where

L is the length, F is the applied force and μ is the mass per unit length.

Thus:

$$f_1 = \frac{1}{2L_1}\sqrt{\frac{F}{\mu}}$$

$$f_2 = \frac{1}{2L_2}\sqrt{\frac{F}{\mu}}$$

And

$$f_2 - f_1 = \Delta f$$

And f_1 is the frequency of the tuning fork. So:

$$f_2 = f_1\frac{L_1}{L_2}$$

And

$$f_1\frac{L_1}{L_2} - f_1 = \Delta f$$

Thus

$$f_1 = \frac{\Delta f}{\frac{L_1}{L_2} - 1}$$

Numerically:

$$f_1 = \frac{4}{\frac{70}{69} - 1}Hz = 4 * 69Hz = 276Hz$$

Answer: (c) 276 Hz

36. Two open organ pipes on sounding together produce 5 beats per second. If the length of a smaller pipe is 0.66 m the length of the larger pipe would be:

Solution.

Since a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe L is equal to λ/2, where λ is the wavelength.

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

$$\lambda = \frac{V}{f}$$

Where V is the speed of sound in warm air, let's consider it 340 m/s

$$f = \frac{2V}{L}$$

$$\Delta f = \frac{2V}{L_1} - \frac{2V}{L_2}$$

Therefore

$$L_2 = \frac{1}{\frac{1}{L_1} - \frac{\Delta f}{2V}}$$

Numerically

$$L_2 \approx 0.67m$$

Answer: (d) 0.67 m

37. An observer moves towards a stationary source of sound with a velocity one-fifth the velocity of sound. What is the percentage change in the apparent frequency?

Solution.

Due to Doppler effect:

$$f = f_0 \frac{V + V_r}{V + V_s}$$

Where V is the velocity of waves in the medium;

V_r - the velocity of the receiver relative to the medium; positive if the receiver is moving towards the source (and negative in the other direction);

V_s - the velocity of the source relative to the medium; positive if the source is moving away from the receiver (and negative in the other direction)

Therefore:

$$f = f_0 \frac{V + \frac{V}{5}}{V + 0} = f_0 * \frac{6}{5} = 1.2 f_0$$

Answer: (c) increase by 20%