Teacher's Signature: ______
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Section: E Batch: ______ Date: 07.03.2022

Experiment No. 04

Name of the Experiment: Determination of the frequency of a tuning fork by Melde's apparatus.

Theory:

When a tuning fork is excited and held near a stretched string, transverse vibrations are propagated along the string with a velocity,

$$v = \sqrt{\frac{T}{m}}$$

Where, T is the tension of the string and m is its mass per unit length. If the plane of vibration of the fork is perpendicular to the string, the frequency of vibration of the string is equal to that of the fork, while if they are parallel, the frequency is half that of the fork. The wavelength is therefore $\lambda = \frac{v}{f}$ for perpendicular vibrations and $\lambda = \frac{2v}{f}$ for parallel vibrations, where f represents the frequency of the fork.

For a given tension T, if the length of the string is properly adjusted so as to make its total length equal to an integral multiple of $\lambda/2$, then the stationary wave pattern will be formed. If l be the length of a single loop (distance between successive nodes), then when the fork vibrates perpendicular to the string, the value of l is given by the relation,

$$l = \frac{\lambda}{2} = \frac{v}{2f} = \frac{1}{2f}\sqrt{\frac{T}{m}}$$

$$\therefore f = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

When the fork vibrates parallel to the string, then

$$f = \frac{2}{2l}\sqrt{\frac{T}{m}} = \frac{1}{l}\sqrt{\frac{T}{m}}$$

If a load of W is applied to the string to keep it tight and M_p is the mass of the scale pan, then the total load applied is $M = W + M_p$ and the tension of the string is $T = Mg$ dynes.

Hence the 2 equations become,

$$f = \frac{1}{2l}\sqrt{\frac{Mg}{m}}, \text{ for perpendicular vibration}$$

$$f = \frac{1}{l}\sqrt{\frac{Mg}{m}}, \text{ for parallel vibration}$$

Apparatus:

- Melde's apparatus
- Thread
- Wooden clamps
- Meter scale
- Weight box and balance
- Rubber mallet etc.

Experimental Data:

(A) Mass of the scale pan, M_p = 31.20 gm

(B) Length of the sample thread, L = 195 cm

Mass of the sample thread, M = 0.62 gm

Thus, mass per unit length of the thread, $m = \frac{M}{L} = \frac{0.62}{195} = 0.00317$ gm/cm

(C) Longitudinal position

No. of obs.	Load on the scale pan, W (gm.)	Tension, $T = Mg = (W + M_p)g$ (dynes)	Distance between the pins, G (cm.)	No. of loops between the pins, N	Length of a segment, $l = G/N$ (cm.)	$f = \frac{1}{l}\sqrt{\frac{T}{m}}$ (Hz.)	Mean f (Hz.)
1	0	30576	156	2	78	39.816	
2	10	40376	86	1	86	41.49	40.77
3	20	50176	97	1	97	41.01	

7.3.2024

(D) Transverse position

No. of obs.	Load on the scale pan, W (gm.)	Tension, $T = Mg = (W + M_p)g$ (dynes)	Distance between the pins, G (cm.)	No. of loops between the pins, N	Length of a segment, $l = G/N$ (cm.)	$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$ (Hz.)	Mean f (Hz.)
1	0	30576	82	2	41	37.87	
2	10	40376	95	2	47.5	37.56	38.40
3	20	50176	100	2	50	39.78	

Calculation:

For Longitudinal position:

$$f = \frac{1}{l}\sqrt{\frac{T}{m}}$$

$$= \frac{1}{78}\sqrt{\frac{30576}{0.00317}}$$

$$= 39.81 \text{ (H.Z)}$$

For Transverse position:

$$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

$$= \frac{1}{2\times 41}\sqrt{\frac{30576}{0.00317}}$$

$$= 37.87 \text{ (H.Z)}$$

Result:

The frequency of the tuning fork is, $f = (40.77 + 38.40)/2$

$= 39.58$ (H.Z)

Physics Laboratory

Discussions:

Q: What is traveling wave and standing wave? How does standing wave differ from traveling waves?

Trcavelling waves transporct energy brom one arrea ob space to anotherc, whereas standing waves do not trans port energy.

Trcaveling waves

- The wave will more
- ~~Str~~ Trcansmits energy
- All parcticles are vibrating

Standing waves

- Wave will not move
- ~~Strong~~ Stores energy
- Consists ob nodes and antinodes.

Q: In this experiment why it is necessary to observe that resonance have occurred?

When the brequency ob a turing ~~b~~ fork because equal to the brequency ob the string then the resonance occurs, So we determine the brequency ob the turining bork by observing resonance between the turing bork and the string. That is why it is necessary to observe that resonance have occured.

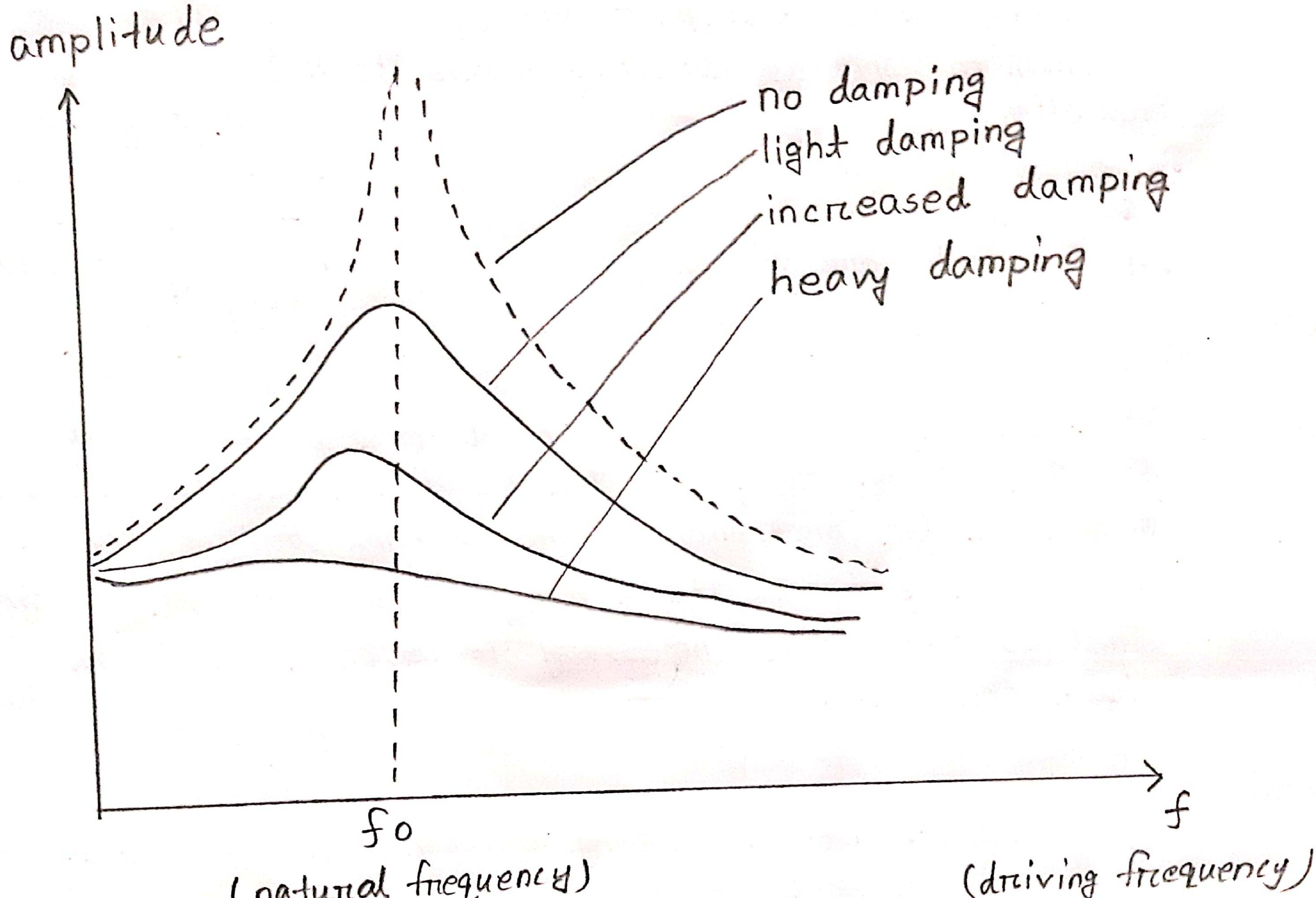
Q: Why the length of the string between the pulley and the scale pan should be kept short?

the length ob the string between the pulley and the scale pan should be kept short because if it is too long, the string will begin to sag downward due to its own weight. Thus, the system will have additional noise in it and the result will be erroneous.

Q: Why is it necessary to consider the mass of the scale pan?

It is necessary to considerc the mass ob the scale pan because even if it is a very light object, its weight contribudes to the tension ob the string.

Q: Draw the amplitude ~ frequency curve of a driven system in a low damping medium, in a high damping medium and in a medium where there is no damping?



Q: How do you know that a resonance has occurred between the fork and the string?

If resonance occurs between the fork and the string, not only will a standing wave form in the string but also, the vibration of the string will last for a long time. But if reasonance does not occur, a standing wave may appear to form momentarily but it will die down very quickly.