20CSE1030 Zubin Shah

Helmholtz Resonator

Aim: To verify the relation between the frequency (ν) and the resonating volume (V) and hence find the unknown frequency of the given tuning fork.

Operators: Resonator bottle, set of tunning forks, rubber pad, and measuring jar.

Introduction:

- Hermann von Helmholtz studied about frequency of the tuning fork and its relation with the volume. Now a days it plays a very important role in everyday life. A coke bottle makes unique sounds when air blown through it. The Helmholtz resonator is used in many sound deducting places. This is placed inside the musical instruments and used to decrease the sound.

- These are placed even inside the musical instruments like guitars in everyday life. In these resonators water is filled completely and some amount is released by loosing the cork. Then the water in the Helmholtz resonator Oscillators producing sound. If the frequency of the tuning fork matches the resonating column then a sound produced is high.

- It is also used as a sound absorber in noise reduction applications, air conditioning rooms, auto mobile engines.

Principle:-
Spring mass system is similar to the principle behind this expt. Air in the neck will act like piston alternatively compressing and rarefying the air contained in the resonator when tuning fork is sounded above the neck.

If 'n' is the frequency of tuning fork and V is resonating air column then for a particle resonator
$n^2 V$

$$n^2 V = \text{constant}$$

We need to plot the graph between V and $1/n^2$ should be straight line.

$$N^2 \times V = \text{const}$$

$$N_x = \sqrt{\frac{n^2 V\ (\text{mean})}{V_x}}$$

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Procedure:

1. The resonator is filled with water till its neck.
2. Then arrange the set up as shown in fig.
3. Keep the tuning fork in decreasing order of frequency.
4. Note that you are placing the tuning fork horizontally above the neck of the tuning fork.
5. Then keep the tuning fork on the neck by exciting with the rubber fork,
6. Note the values of the corresponding frequency and volume in the table.
7. Also plot the graph V v/s $1/n^2$ with the values obtained in the table.

Observations:

Sr. No	Frequency (n)	Volume(V) in ml	$\frac{1}{n^2}$	n^2V
1	512	90	3.81×10^{-6}	2.36×10^{7}
2	480	119	4.34×10^{-6}	2.74×10^{7}
3	426	137	5.51×10^{-6}	2.48×10^{7}
4	389	159	6.61×10^{-6}	2.40×10^{7}
5	341	193	8.60×10^{-6}	2.24×10^{7}
6	320	223	9.76×10^{-6}	2.28×10^{7}
7	288	264	12.06×10^{-6}	2.19×10^{7}
8	256	381	15.26×10^{-6}	2.50×10^{7}
9	n	268		

Mean $n^2V = 2.40 \times 10^{7}$

Calculations:

n^2V (mean) from the table $= 2.4 \times 10^{7}$ ml s^{-2}

n^2V from slope of graph $= 2.17 \times 10^{7}$ ml s^{2}

$$n^2V \text{ (mean)} = \left(\frac{2.17 + 2.40}{2}\right) \times 10^{7}$$

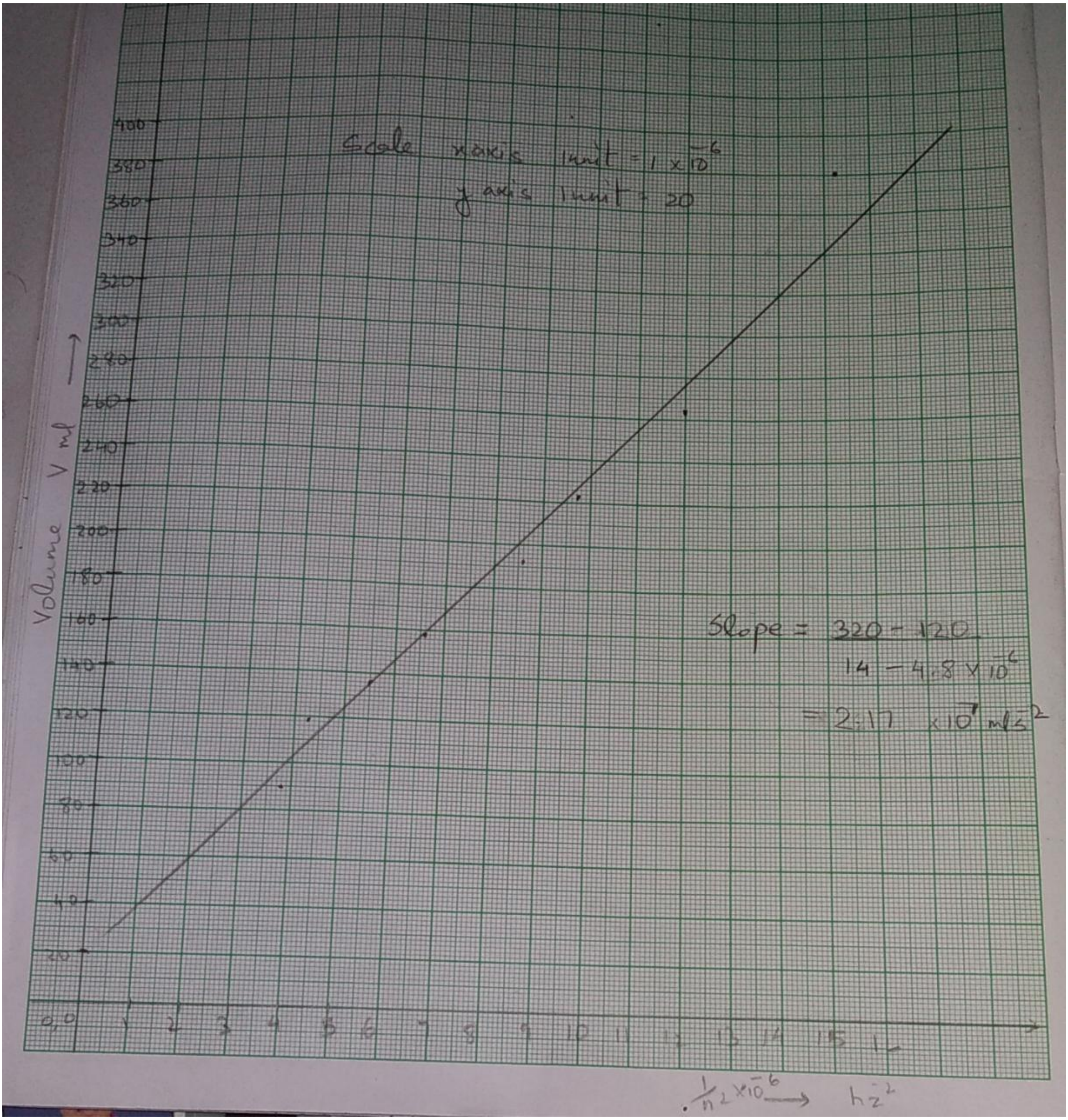
$$n^2V \text{ (mean)} = 2.28 \times 10^{7} \text{ ml } s^{-2}$$

$$n_x = \sqrt{\frac{n^2V\text{(mean)}}{V_n}}$$

$$= \sqrt{\frac{2.28 \times 10^{7}}{268}}$$

$$n_x = 291.67 \text{ Hz}$$

$$n_x = 292 \text{ Hz}$$



Scale x axis 1 unit = 1 x 10^-6
y axis 1 unit = 20
Slope = 320 - 120 / 14 - 4.8 x 10^-6
= 2.17 x 10^7 ml s^-2
Volume V ml
1/n^2 x 10^-6 hz^-2

Conclusion:

- Straight line curve in graph between V vs $1/n^2$ shows that $V \propto 1/n^2$, Vn^2 = constant.
  Thus exists a relation between frequency and resonating volume.
- The unknown frequency of the given tuning fork as determined through Helmholtz resonator experiment was found to be 292 hz.

Result:

- The unknown frequency of given tuning fork is 292hz.