ARANMORE CATHOLIC COLLEGE

YEAR 12 PHYSICS 3A3B – 2010

PRACTICAL TEST - SPEED OF SOUND IN AIR

NAME: SOLUTIONS.

MARK: /25

Aim: To determine the speed of sound in air.

Theory:

Longitudinal sound waves propagated through a tube open at both ends are reflected at the open ends and a standing wave is produced by the interference of the incident and reflected waves. The pressure remains at normal atmospheric pressure at the open ends, which are therefore pressure nodes. Antinodes will occur at various positions throughout the pipe. The speed of sound in the laboratory (v) is given by:

$v = 331 + 0.6\,T$ (where v is the speed of sound and T is the temperature in ^{o}C)

In an experiment to determine the speed of sound, a student uses a tube in which the length of the air column can be adjusted by varying the length of the tube. A small loudspeaker (which is connected to an audio frequency generator) is set up near one end of the tube. The audio frequency generator is set to 300 Hz and the tube is adjusted until the first resonance point is heard. This occurs at 55.0 cm. This procedure is repeated for settings of 500 Hz, 700 Hz, 900 Hz, and 1100 Hz. The results are shown below.

OPEN TUBE $\therefore \lambda_1 = 2L$

RESULTS: (2) (2)

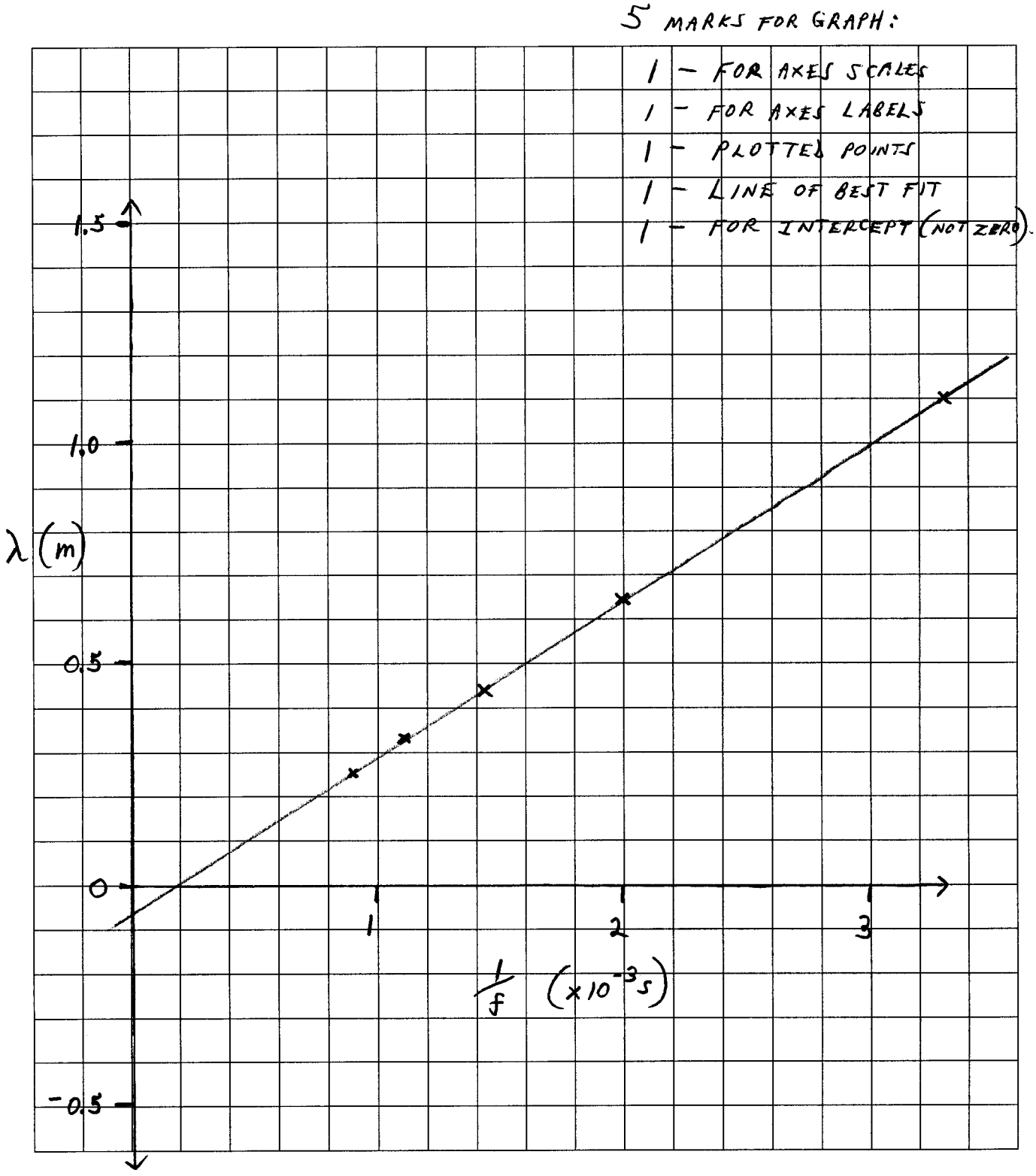
FREQUENCY (Hz)	$\frac{1}{f}$ $(\times 10^{-3}\,s)$	*TUBE LENGTH (cm)*	*WAVELENGTH/m*
300	3.33	55.0	1.10
500	2.00	32.1	0.642
700	1.43	22.2	0.444
900	1.11	16.8	0.336
1100	0.91	13.3	0.266

Temperature of the air in the laboratory = 21 ^{o}C

NOTE: The data will need manipulating before you can start to graph it. This is a graphing exercise and it is not sufficient to solve the problem by any other means.

TASKS:

1. After you have manipulated the above data, draw a graph using the appropriate data to produce a straight line whose slope can be used to find the speed of sound in air. (Use grid below.)
[9 marks]



2. What is the speed of sound in air according to this experiment? (Show all calculations from the data of your graph.) [4 marks]

3. Using the temperature recorded and the given formula, calculate the theoretical speed of sound in the laboratory. (Show working.) [2 marks]

4. Compare the value calculated in task (3) with the experimental value you obtained from the graph and calculate the percentage error in the experimental result. [2 marks]

5. Give one main reason for the difference between your experimental result and the theoretical result. [2 marks]

6. Estimate the internal diameter of the tube. (where $\lambda = 2L + 0.58D$) [3 marks]

Discussion:

Write a brief discussion and conclusion for your experiment. [3 marks]

(2) SLOPE OF GRAPH:

$$m = \frac{1.00-0.30}{(3.0-1.0)\times10^{-3}} = \frac{0.70\ m}{2.00\times10^{-3}\ s} \quad (2)$$

$$m = 350\ ms^{-1}. \quad (1)$$

$V = m = 350\ ms^{-1}$. (EXPERIMENTALLY, V_E) (1)

(3.) $V = 331 + 0.6(21)$

$= 343.6\ ms^{-1}$. (THEORETICALLY, V_T) (2)

(4.) $\%\ DIFF. = \frac{|V_T - V_E|}{V_T} \times 100\% = 0.0186 \times 100\%$ (2)

$\approx 2\%$ DIFFERENCE.

VALUES ARE COMPARABLE.

(5.) UNCERTAINTIES IN MEASUREMENTS:

e.g. ALLOWING $\pm\frac{1}{10}$ DIVISION WOULD GIVE: $m = \frac{0.69}{2.02\times10^{-3}} = 341.6\ ms^{-1}$ (2)

HENCE $V_E = 350 \pm 8\ ms^{-1}$ OR $\pm 3\%$

WHICH INCLUDES THEORETICAL VALUE.

(6.) $\lambda = 2L + 0.58D$

OR $2L = \left(\frac{V}{f}\right) - 0.58D$, MEANS SLOPE IS STILL V, BUT INTERCEPT (1)

IS $-0.58D$. $D \approx 10\ cm$. (1)

(1)