**Cursory Data taken to determine the saturation point of the transmitter/receiver**

|  |  |
| --- | --- |
| Distance (m) | Pulse-Echo Timing(s) |
| 0.1 | 0.001659 |
| 0.15 | 0.001659 |
| 0.2 | 0.0016596 |
| 0.25 | 0.0016598 |
| 0.3 | 0.0016598 |
| 0.305 | 0.00166 |
| 0.31 | 0.0016647 |
| 0.32 | 0.0017217 |
| 0.33 | 0.0017811 |
| 0.34 | 0.0018462 |
| 0.35 | 0.0019064 |
| 0.4 | 0.0021948 |
| 0.45 | 0.0024842 |
| 0.5 | 0.0027735 |
| 0.55 | 0.0030632 |
| 0.6 | 0.0033533 |
| 0.65 | 0.0036423 |
| 0.7 | 0.0039326 |
| 0.75 | 0.0042217 |
| 0.8 | 0.0045016 |
| 0.85 | 0.0047998 |
| 0.9 | 0.0050883 |
| 0.95 | 0.005376 |
| 0.985 | 0.0055803 |

It can be seen from the data that the saturation point is located at 0.305m.

**Experimental Observations of the Pulse-Echo Timings**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distance (m) | Pulse-Echo Timing(s) | Timing Uncertainty(s) | Temperature(K) | Relative Humidity (%) |
| 0.31 | 0.00166266 | 4.70E-07 | 297.5 | 63.6 |
| 0.32 | 0.00171934 | 9.30E-07 | 297.6 | 64.5 |
| 0.33 | 0.00177876 | 4.30E-07 | 297.5 | 64.1 |
| 0.34 | 0.00183652 | 1.43E-06 | 297.5 | 64.2 |
| 0.35 | 0.00189456 | 5.00E-07 | 297.5 | 65 |
| 0.36 | 0.00195802 | 4.54E-07 | 297.5 | 63.7 |
| 0.37 | 0.00201976 | 4.30E-07 | 297.3 | 64.9 |
| 0.38 | 0.00207896 | 2.80E-07 | 297.3 | 64.4 |
| 0.39 | 0.00213524 | 5.10E-07 | 297.3 | 64.6 |
| 0.4 | 0.00219346 | 5.00E-07 | 297.3 | 64.6 |
| 0.41 | 0.00225136 | 4.80E-07 | 297.2 | 64.7 |
| 0.42 | 0.00230754 | 5.00E-07 | 297.2 | 66.4 |
| 0.43 | 0.00236627 | 4.40E-07 | 297.3 | 65 |
| 0.44 | 0.00242444 | 5.00E-07 | 297.3 | 64.2 |
| 0.45 | 0.00248156 | 5.00E-07 | 297.3 | 65.5 |
| 0.46 | 0.00253934 | 6.80E-07 | 297.3 | 64.9 |
| 0.47 | 0.00259656 | 9.00E-07 | 297.4 | 67.4 |
| 0.48 | 0.0026563 | 4.60E-07 | 297.6 | 66.6 |
| 0.49 | 0.00271286 | 6.90E-07 | 297.5 | 64.8 |
| 0.5 | 0.0027718 | 4.00E-07 | 297.5 | 64.3 |
| 0.51 | 0.00283106 | 6.50E-07 | 297.5 | 64.2 |
| 0.52 | 0.00288812 | 4.30E-07 | 297.5 | 65.1 |
| 0.53 | 0.00294494 | 8.10E-07 | 297.3 | 65.9 |
| 0.54 | 0.00300402 | 1.40E-07 | 297.4 | 64.9 |
| 0.55 | 0.00306012 | 6.80E-07 | 297.4 | 64.9 |
| 0.56 | 0.0031182 | 7.70E-07 | 297.5 | 65.1 |
| 0.57 | 0.00317592 | 6.60E-07 | 297.4 | 64.9 |
| 0.58 | 0.00323412 | 5.20E-07 | 297.5 | 64.6 |
| 0.59 | 0.00329268 | 5.80E-07 | 297.5 | 64.8 |
| 0.6 | 0.00334964 | 5.20E-07 | 297.5 | 64.3 |
| 0.61 | 0.0034072 | 4.50E-07 | 297.5 | 64 |
| 0.62 | 0.00346602 | 4.20E-07 | 297.5 | 64.5 |
| 0.63 | 0.00352434 | 4.70E-07 | 297.6 | 68.4 |
| 0.64 | 0.00358146 | 5.70E-07 | 297.6 | 67.4 |
| 0.65 | 0.00364012 | 6.50E-07 | 297.6 | 64.8 |
| 0.66 | 0.00369726 | 6.30E-07 | 297.6 | 64.9 |
| 0.67 | 0.00375598 | 4.20E-07 | 297.6 | 66.7 |
| 0.68 | 0.00381312 | 6.50E-07 | 297.6 | 64.9 |
| 0.69 | 0.00387084 | 5.80E-07 | 297.6 | 64.5 |
| 0.7 | 0.00392682 | 9.90E-07 | 297.5 | 64 |
| 0.71 | 0.00398688 | 5.90E-07 | 297.5 | 65.1 |
| 0.72 | 0.00404384 | 5.40E-07 | 297.5 | 64.1 |
| 0.73 | 0.0041028 | 6.00E-07 | 297.5 | 65.1 |
| 0.74 | 0.00416028 | 4.90E-07 | 297.5 | 64.4 |
| 0.75 | 0.0042186 | 4.90E-07 | 297.5 | 64.1 |
| 0.76 | 0.00427594 | 7.60E-07 | 297.6 | 68.6 |
| 0.77 | 0.00433372 | 5.70E-07 | 297.5 | 65.2 |
| 0.78 | 0.00439144 | 5.40E-07 | 297.5 | 64.5 |
| 0.79 | 0.00445074 | 5.90E-07 | 297.6 | 64.8 |
| 0.8 | 0.00450422 | 5.40E-07 | 297.6 | 64.2 |
| 0.81 | 0.00456352 | 5.00E-07 | 297.7 | 65.3 |
| 0.82 | 0.0046214 | 5.00E-07 | 297.7 | 65.5 |
| 0.83 | 0.00467916 | 5.00E-07 | 297.7 | 65.8 |
| 0.84 | 0.00473624 | 4.30E-07 | 297.7 | 65.8 |
| 0.85 | 0.00479434 | 5.90E-07 | 297.7 | 64.6 |
| 0.86 | 0.0048538 | 4.50E-07 | 297.7 | 65.4 |
| 0.87 | 0.00491168 | 4.70E-07 | 297.7 | 64.4 |
| 0.88 | 0.0049678 | 9.40E-07 | 297.7 | 65.3 |
| 0.89 | 0.00502796 | 4.50E-07 | 297.8 | 66.3 |
| 0.9 | 0.00508508 | 5.90E-07 | 297.8 | 64 |
| 0.91 | 0.005143 | 5.70E-07 | 297.8 | 63.9 |
| 0.92 | 0.00520128 | 7.20E-07 | 297.8 | 64.3 |
| 0.93 | 0.00525852 | 6.70E-07 | 297.8 | 64.9 |
| 0.94 | 0.00531678 | 5.80E-07 | 298 | 65.7 |
| 0.95 | 0.00537396 | 4.50E-07 | 298 | 64.3 |
| 0.96 | 0.00543248 | 6.70E-07 | 298 | 63.9 |
| 0.97 | 0.0054898 | 5.70E-07 | 298 | 63.9 |
| 0.98 | 0.0055468 | 5.70E-07 | 298 | 66.2 |

These results for the distance and time taken for the pulse to travel were then used in equation

To calculate the speed of sound in the direct method. This gave a value of 358.882ms-1.

As both the Temperature and Relative Humidity changes throughout the experiment the mean values of both should be taken.

|  |  |
| --- | --- |
| Mean Temperature (K) | 297.5588 |
| Mean Relative Humidity (%) | 64.9971 |

The percentage of water vapour in the air is calculated to be 1.96%

The table for the components of wet air with relative humidity 65% and temperature 297.56 K is now:

|  |  |  |  |
| --- | --- | --- | --- |
| Gas | ( % ) in wet air | molar mass (g) | γ (specific heat ratio) |
| Nitrogen | 76.55 | 28.013 | 1.404 |
| Oxygen | 20.54 | 32.000 | 1.401 |
| Argon | 0.91 | 39.948 | 1.668 |
| CO2 | 0.03 | 44.000 | 1.304 |
| H2O | 1.96 | 18.000 | 1.31 |

The specific heat ratio of wet air is then calculated by weighting the specific heat ratios of each component by their percentages in wet air. This is calculated to be 1.4038.

The molar mass of wet air is then calculated by weighting the molar mass of each component by their percentages in wet air. This is calculated to be 28.7467 g.

These values were then used in equation 4 to calculate the theoretical speed of sound as 347.6722ms-1.

