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| A picture of a winding road and trees  Millikan’s Oil Drop Experiment  EXPERIMENTAL REPORT | Abstract  ABSTRACT GOES HERE  Kyile Woods  With partners:  Michelle Riethmeuller  Tom Young  Pvb203 Experimental Physics |



Millikan’s Oil Drop Experiment

Experimental Report

Kyile Woods

With partners:

Michelle Riethmeuller

Tom Young

PVB203 Experimental Physics | 11/05/2019

# Abstract

A concise summary (100-150 words) of the major aspects of the entire report. It should include the aim, (very) brief method and outcome

# Introduction

Establishes the context of the work being reported, typically by providing an overview of the theory and background information. The introduction should also state the aim of the study in the form of a hypothesis. This should also include the main equations used for analysis.

# Materials and Methods

### Materials

This experiment included an apparatus designed for this experiment, called the *droplet viewing chamber*. This apparatus consists of a *spacer; A* round disc, approximately 50 mm thick, of transparent plastic with a hollow region in the middle (like a torus), to act as a viewing area. This plastic piece is designed to allow light to be shone through the side into the viewing area, as well as allow clear sight in through the side, into the viewing area. It also includes an adjoining region which has been cut out to allow a radioactive ionization source, in this case Thorium-232, which allows the viewing area to be either shielded or exposed to ionization, and also opens a small hole through which air can pass. This adjustment is made with a lever with ionization positions ‘on’, ‘off’, and also ‘spray droplet’ which opens the hole.

This plastic spacer has a capacitor plate above and below it, with connector pins. The top plate has a small hole in the center (approximately 1-2 mm radius). This hole has a cover, to stop air from flowing in. This assembly is house within a hollow cylindrical housing which acts a shield from ambient light, but also allows a light source to be shone into the plastic spacer to the viewing area. The housing also has a hole through which viewing scope can be placed. This assembly is called the *Droplet viewing chamber*.

In addition to that apparatus, the material required are

* Voltage supply
* Switch capable of reversing polarity, and disconnecting the voltage supply
* Multimeter
* Thermometer
* Barometer
* Graph for conversion between temperature and air viscosity
* Mass scale
* Focusing wire
* Oil
* Oil atomiser
* Viewing scope with reticle (engraved hairline displacement scale)

# Method

## Part 1

The chamber is wiped clean on the interior with a paper towel and the separation of the capacitor plates is measured and recorded by measuring the thickness of the spacer, on the surface which the capacitor plates will be resting (Careful not to measure any lips or grooves).

A focusing wire is inserted into the hole of the upper capacitor plate. The brightness of the light source is adjusted such that there is maximum contrast when viewed through the scope. The scope is adjusted such that the reticle and also the wire are both in focus. The droplet hole cover and lid are both replaced.

## Part 2

The DC power supply is attached to the capacitor plates and adjusted to supply about 500 Volts. A multimeter is connected across the plates, and the true voltage potential is recorded.

The barometric pressure is recorded. The ambient temperature is recorded, and used with the suitable graph to estimate air viscosity. The density of the oil is recorded, and loaded into the atomiser.

## Part 3

The capacitor plates are disconnected from the voltage source. A sheet of paper is held near the atomiser nozzle, which is pumped rapidly until oil is coming out properly (no air occlusion which cause inconsistent oil flow). The ionization source lever is moved to ‘spray droplet’ position, the atomiser is placed at the hole in the lid of the viewing chamber, and an observer views through the eyepiece. The atomiser is squeezed until a sufficient spray enters the viewing area, at which point the ionization source lever is turned to ‘off’.

From the eyepiece, a drop is chosen which is falling at 0.2-0.5 mm per second, and the capacitor plates are charged to whatever voltage causes droplet to begin rising. If the droplet does not respond to the charge, a new droplet should be selected.

The droplet should be allowed to rise through a pre-determined distance, and the time it takes to do so is recorded, with the distance and direction of travel (up/down). The capacitor polarization is toggled and the time taken for the droplet to travel the same distance is recorded, along with the distance and direction, again. This process should be repeated 10-20 times. If the droplet stops reacting to the voltage, a new droplet should be selected, and the chamber re-ionized, or the viewing chamber wiped clean.

Part 3 should be repeated entirely again, for as many droplets as is required.

# Results

## Group dataset results

The measurements obtained from part 1 of this experiment is presented below in Table 1

Table 1 Measurements of experimental conditions

|  |  |  |
| --- | --- | --- |
| **Measurement** | **Recording** | **Error** |
| Plate separation (metres) | 7.86 × 10-3 | 10-5 |
| Plate Voltage (Volts) | 502.9 | 0.005 |
| Temperature (Celsius) | 22 | 0.5 |
| Air Viscosity (Nsm-2) | 1.832 × 10-5 | 0.006 |
| Barometric Pressure (millibar) | 1008 | 0.5 |
| Oil Density |  |  |

The electric field strength between the two capacitive plates is given by with an error given by .

The value of electric field intensity, for all droplets of this experiment was E=64.0 × 103 ± 1.28 NC-1.

The data gathered for droplet #1 is presented in Table 2, as an example of the full dataset, which is available in full in Appendix 1 'Group dataset'

Table 2 Collected data for droplet 1

Travel Distance: 0.002 ± 0.000025 m

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Trial N | Time Fall (s) | Velocity (mm/sec) |  Velocity (mm/sec) | Time Rise (s) | Velocity (mm/sec) |  Velocity (mm/sec) |
| 1 | 3.570 | 0.056 | 0.008 | 1.410 | 0.142 | 0.050 |
| 2 | 5.490 | 0.036 | 0.003 | 1.260 | 0.159 | 0.063 |
| 3 | 5.990 | 0.033 | 0.003 | 1.020 | 0.196 | 0.096 |
| 4 | 6.920 | 0.029 | 0.002 | 0.920 | 0.217 | 0.118 |
| 5 | 5.140 | 0.039 | 0.004 | 1.320 | 0.152 | 0.057 |
| 6 | 4.180 | 0.048 | 0.006 | 0.920 | 0.217 | 0.118 |
| 7 | 4.420 | 0.045 | 0.005 | 0.790 | 0.253 | 0.160 |
| 8 | 6.400 | 0.031 | 0.002 | 0.790 | 0.253 | 0.160 |
| 9 | 3.690 | 0.054 | 0.007 | 0.900 | 0.222 | 0.123 |
| 10 | 4.000 | 0.050 | 0.006 | 0.790 | 0.253 | 0.160 |
| AVERAGE | 4.980 | 0.042 | 0.005 | 1.012 | 0.206 | 0.111 |

From the equations provided in the experimental instructions the charge on a drop of oil can be calculated by:

Equation 1 Equation to find charge, as a function of fall and rise times.

Where:

= charge carried by the droplet [C]

*d* = separation of the plates in the droplet viewing chamber [m]

= density of oil [kg/m3]

*g* = acceleration due to gravity [m/s2]

= viscosity of air [N.s/m2]

= constant -= 8.20 x 10-3 [Pa.m]

= barometric pressure [Pa}

= velocity of fall [m/s]

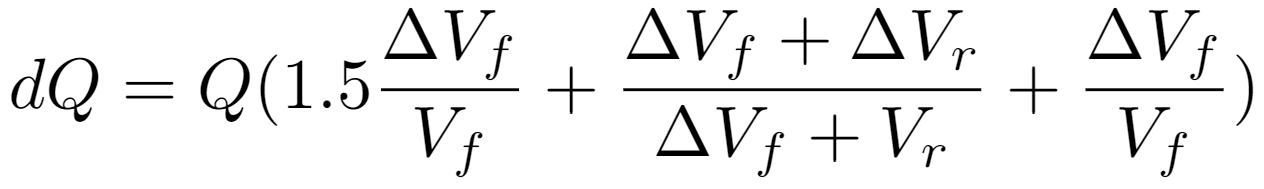
= velocity of rise [m/s]

*V* = potential difference across the plates [V]

Using the average values for fall velocity and rising velocity for this droplet (vf and vr) values presented in Table 2, this equation is now solvable for each droplet.

The error on q can be calculated by the equation in Equation 2, below.

Equation 2 Error calculation on charge, q.



For which the relative error is given by. This process was done for all droplets in the dataset. The data for droplet three shows a dramatic, change in behavior after its 12th change in direction. For reasons mentioned in the discussion of this report, that data is presented below as belonging to two different drops, number 3 and 4.

The results are presented below, in Table 3.

Table 3 Calculated charge on each droplet.

|  |  |  |  |
| --- | --- | --- | --- |
| Droplet Number (n) | Charge (Coulombs) | Absolute Error | Relative error |
| 1 | -1.103×10-18 | -8.198E-19 | 0.743 |
| 2 | -9.291×10-19 | -6.682E-19 | 0.719 |
| 3 | -8.501E-19 | -5.665E-19 | 0.666 |
| 4 | -5.277×10-19 | -5.563E-19 | 1.054 |
| 5 | -4.083×10-19 | -2.047E-19 | 0.501 |
| 6 | -2.468×10-19 | -9.973E-20 | 0.404 |

Droplet number 6, being the smallest, was then treated as being the fundamental charge which the others were multiples of. The charge on each droplet, and the error of charge on each droplet, was divided by the charge on droplet 6, to give the table below.

Table 4 Charge and error as a multiple of the lowest charge

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Droplet # | 1 | 2 | 3 | 4 | 5 | 6 |
| Multiple of charge | 4.46986 | 3.764392 | 3.444285 | 2.138017 | 1.654449 | 1 |
| error | 3.321552 | 2.707543 | 2.295096 | 2.254125 | 0.829439 | 0.404083 |

The table above was used to create Figure 1, below.

Figure 1 Charge as a multiple of the lowest charge

The same process was used as above, but comparing it to half of the lowest charge, to produce Table 5, below.

Table 5 Charge and error as a multiple of half the lowest charge

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Droplet # | 1 | 2 | 3 | 4 | 5 | 6 |
| Multiple of charge | 8.93972 | 7.528783 | 6.88857 | 4.276034 | 3.308897 | 1 |
| error | 6.643104 | 5.415085 | 4.590192 | 4.50825 | 1.658879 | 0.40408323 |

That data is presented in Figure 2 , presented below.

Figure 2 Charge as a multiple of the half of lowest charge

Figure 2 was further analysed by plotting how far from an integer multiple each droplet is. That data is presented below, in Figure 3

Figure 3 Each droplet’s distance to an integer multiple

## Class dataset results

The class dataset was not performed under the same environmental test conditions (barometric pressure, temperature, etc), nor was the same voltage recorded across the capacitor plates, despite having the same intended voltage. Therefore, no single table can be given to show these conditions, however, that information is available in the full dataset, in Appendix 1 'The full class dataset'.

A sub-sample of the first 5 entries of the class dataset (N=182) is shown below in Table 5.

Table 6 Sub-sample of the class dataset

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trial N** | **vf (mm/sec)** | **vf (mm/sec)** | **vr (mm/sec)** | **vr (mm/sec)** | **d**  **(mm)** | **T**  **(˚C)** | **p**  **[Pa]** | **V (Volt)** |
| 1 | 0.03863 | 0.01176 | 0.11325 | 0.03446 | 6.75 | 22.80 | 88900 | 500 |
| 2 | 0.07248 | 0.02206 | 0.27223 | 0.08284 | 6.75 | 22.80 | 88900 | 502 |
| 3 | 0.07174 | 0.02183 | 0.30102 | 0.09160 | 6.75 | 22.80 | 88900 | 499 |
| 4 | 0.03037 | 0.00924 | 0.81967 | 0.24943 | 6.75 | 22.80 | 88900 | 502 |
| 5 | 0.04864 | 0.01480 | 0.25907 | 0.07884 | 6.75 | 22.80 | 88900 | 502 |

The charge on the drops of oil was calculated from this data using Equation 1, and the error calculated using Equation 2, and a subset of the results are presented below in Table 6.

Table 7 Subset of the results of the class calculations of charge on each oil droplet

|  |  |  |
| --- | --- | --- |
| **Droplet number (n)** | **Charge, q (Coulombs)** | **Δq**  **(Coulombs)** |
| 1 | -2.84×10-19 | -3×10-19 |
| 2 | -1.09×10-18 | -1.2×10-18 |
| 3 | -1.25×10-18 | -1.3×10-18 |
| 4 | -2.6×10-18 | -2.8×10-18 |
| 5 | -9.13×10-19 | -9.7×10-19 |

The mean value of q was found to be with s standard deviation of .

The class dataset was adapted such that all values were all positive, for reasons discussed in the discussion section of this report, and then sorted in order of their charge. There was an apparent discontinuity in the seven lowest values, and so data which was not within five orders of magnitude of the average was removed. This resulting data is presented below, on a log-linear graph (Logarithmic10 Y-axis), in

Figure 4 Class data sorted in order of charge, with estimated charge plotted on a log10 scale

The class data was arranged in ascending order of charge strength, and the difference between each sequential charge was found (a “step-difference”). The data was re-arranged in ascending order of those differences. From Figure 4 a data point was chosen as a ’guess’ for the value of E, the fundamental charge. The point chosen was based on which one seemed to be part of the main sequence of data, but yet which was extremely small. This is because it could be assumed that a single-electron droplet may have been measured at least several time, and yet would be one of the smallest. The initial estimate was datapoint n=101, q=1.098×10-19.because of the position on the graph. For each data point, the estimate of charge was divided by this guess, and rounded down to a whole number. The associated step-difference, calculated earlier, was then divided by this integer. The average of that ratio was then found; this process yields a second ‘guess’, an estimated value for E. It was found to be equal to E= 6.015×10-21, with a standard deviation of 8.139×10-21.

A description of your observations without interpretation or speculation. Data can be presented objectively in both text and illustrative examples such as summary tables and graphs. Full tables of results should only be included as appendix. All data must be accompanied by the experimental error.

# Discussion

## Group dataset discussion

On the assumption that the charge on any given object is an integer multiple of some fundamental charge, and on the assumption that the amount of charge on the oil droplets is within a reasonable order of magnitude of that fundamental charge, the charge on each oil droplet was divided by the charge of the *least charged* oil droplet. The expectation is that the charges on the oil droplets would increase in steps of the size of some integer fraction of each other, or the least-charged droplet.

Figure 1 and Figure 2 show the results of this operation, and there is some apparent stratification involved, especially in Figure 2. This does not appear to hold up, as seen in Figure 3, where the data apparently has no tendency to be near an integer multiple, or any apparent trend as it approaches an integer multiple.

#### Group dataset error discussion

The group dataset consisted of 6 droplets, each with between 4 and 16 sets of measurements, wherein a ‘set’ is a rise time and a fall time.

Droplet Three showed an strong change in it’s rise and fall times which was strong and consistent, and so not suspected to be a random error. It was concluded that this droplet had in fact been struck by another droplet of unknown size or charge. In the sense of this experiment, the droplet had become a new droplet, and so that data is treated as such in this report. The new droplet was named ‘droplet 4’.

In Table 3 'Calculated charge on each droplet', the relative error on the calculation for q is quite significant, with error margins of between 40% and 110%, and these errors perpetuate and are revealed in Figure 1 'Charge as a multiple of the lowest charge', when it is seen that the error of margin for every droplet includes the error of margin for the least-charged droplet. The implication is that all of these droplets could in fact be equally charged, and there is no clear evidence that the rank order they are presented in is in fact the true order.

## Class dataset discussion

The class dataset was manipulated to have entirely positive values, because the experiment was performed in such a way as to disregard which sign (+/-) of charged plate the oil droplet was approaching in each measurement. This means that oil droplets of positive and negative charge are treated the same in the data, and there is in physics the general acceptance that an electron is equal and oppositely charged to a proton. Therefore, whether the ionization dislodged or added an electron is an immaterial difference, for this experiment.

The results of this experiment for the class dataset indicate an electron with a charge of E = 6.015×10-21.

### Class dataset error discussion

Provides a forum to interpret the experimental data in light of the pre-existing knowledge. This is where you should compare your experimental results to expected values. Experimental error: You should include a discussion about the sources of error in the experiment – and how they impacted your results. A full calculation of the error propagation is also required. The length of this section will depend on your results and the experiment. Other issues that may be covered in a discussion include questions raised by the study that require further analysis or inconsistencies between the current study and other relevant publications.

# Conclusions

A brief summary of your findings, with comments on the key points and suggestions on future work if required.

# References

Include appropriate references to the original papers or books reporting the theory and the results of similar experiments or findings. In physics journals, references are typically progressively numbered. For more info on how to number references see <http://www.citewrite.qut.edu.au/cite/qutcite.jsp#numbered-journal-print>

# Figures

Graphs needs to be clearly labelled, with axes and scales properly marked. Prefer the sans serif, more simple fonts (Arial, Calibri, Helvetica, etc) which are more clearly readable. Data points need to be clearly visible. Indicate the error with suitable error bars, and the fitting/theory with a continuous or dashed line. In the schematics of the apparatus the parts need to be clearly described by appropriate labels. Photos can be inserted, but only if they are important to the discussion. Every figure need to be accompanied by a figure caption, with progressive numbers.

# Appendix

Appendix 1 Group dataset

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Droplet 1 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | **Dvf (mm/sec)** | **Time Rise (s)** | **vr (mm/sec)** | **Dvr (mm/sec)** | **d(mm)** |
| 1 | 3.57 | 0.056022409 | 0.007846276 | 1.41 | 0.141843972 | 0.050299281 | 7.86 |
| 2 | 5.49 | 0.036429872 | 0.003317839 | 1.26 | 0.158730159 | 0.062988158 | 7.86 |
| 3 | 5.99 | 0.033388982 | 0.00278706 | 1.02 | 0.196078431 | 0.096116878 | 7.86 |
| 4 | 6.92 | 0.028901734 | 0.002088276 | 0.92 | 0.217391304 | 0.118147448 | 7.86 |
| 5 | 5.14 | 0.038910506 | 0.003785069 | 1.32 | 0.151515152 | 0.057392103 | 7.86 |
| 6 | 4.18 | 0.04784689 | 0.005723312 | 0.92 | 0.217391304 | 0.118147448 | 7.86 |
| 7 | 4.42 | 0.045248869 | 0.00511865 | 0.79 | 0.253164557 | 0.160230732 | 7.86 |
| 8 | 6.4 | 0.03125 | 0.002441406 | 0.79 | 0.253164557 | 0.160230732 | 7.86 |
| 9 | 3.69 | 0.054200542 | 0.007344247 | 0.9 | 0.222222222 | 0.12345679 | 7.86 |
| 10 | 4 | 0.05 | 0.00625 | 0.79 | 0.253164557 | 0.160230732 | 7.86 |
| AVERAGE | 4.98 | 0.04221998 | 0.004670213 | 1.012 | 0.206466622 | 0.11072403 | 7.86 |
| Droplet 2 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | **Dvf (mm/sec)** | **Time Rise (S)** | **vr (mm/sec)** | **Dvr (mm/sec)** | **d(mm)** |
| 1 | 2.83 | 0.070671378 | 0.012486109 | 2 | 0.1 | 0.025 | 7.86 |
| 2 | 3.14 | 0.063694268 | 0.010142399 | 1.88 | 0.106382979 | 0.028293345 | 7.86 |
| 3 | 3.05 | 0.06557377 | 0.010749798 | 1.17 | 0.170940171 | 0.073051355 | 7.86 |
| 4 | 2.39 | 0.083682008 | 0.017506696 | 2.38 | 0.084033613 | 0.01765412 | 7.86 |
| 5 | 3.31 | 0.060422961 | 0.009127335 | 1.36 | 0.147058824 | 0.054065744 | 7.86 |
| 6 | 3.15 | 0.063492063 | 0.010078105 | 1.71 | 0.116959064 | 0.034198557 | 7.86 |
| 7 | 3.62 | 0.055248619 | 0.007631025 | 1.5 | 0.133333333 | 0.044444444 | 7.86 |
| 8 | 3.54 | 0.056497175 | 0.007979827 | 1.71 | 0.116959064 | 0.034198557 | 7.86 |
| 9 | 3.02 | 0.066225166 | 0.010964431 | 2.18 | 0.091743119 | 0.021042 | 7.86 |
| 10 | 3.49 | 0.05730659 | 0.008210113 | 1.71 | 0.116959064 | 0.034198557 | 7.86 |
| 11 | 3.43 | 0.058309038 | 0.00849986 | 1.63 | 0.122699387 | 0.037637849 | 7.86 |
| 12 | 3.22 | 0.062111801 | 0.00964469 | 1.55 | 0.129032258 | 0.041623309 | 7.86 |
| 13 | 3.51 | 0.056980057 | 0.008116817 | 1.86 | 0.107526882 | 0.028905076 | 7.86 |
| 14 | 3.23 | 0.061919505 | 0.009585063 | 1.56 | 0.128205128 | 0.041091387 | 7.86 |
| 15 | 3.05 | 0.06557377 | 0.010749798 | 1.65 | 0.121212121 | 0.036730946 | 7.86 |
| 16 | 2.53 | 0.079051383 | 0.015622803 | 1.66 | 0.120481928 | 0.036289737 | 7.86 |
| AVERAGE | 3.156875 | 0.064172472 | 0.010443429 | 1.719375 | 0.119595433 | 0.036776561 | 7.86 |
| Droplet 3 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | vf (mm/sec) | **Time Rise (s)** | **vr (mm/sec)** | vr (mm/sec) | **d(mm)** |
| 1 | 5.18 | 0.039 | 0.004 | 1.010 | 0.198 | 0.098 | 7.86 |
| 2 | 5.37 | 0.037 | 0.003 | 1.210 | 0.165 | 0.068 | 7.86 |
| 3 | 5.09 | 0.039 | 0.004 | 0.620 | 0.323 | 0.260 | 7.86 |
| 4 | 4.86 | 0.041 | 0.004 | 0.970 | 0.206 | 0.106 | 7.86 |
| 5 | 6.45 | 0.031 | 0.002 | 0.990 | 0.202 | 0.102 | 7.86 |
| 6 | 4.78 | 0.042 | 0.004 | 0.920 | 0.217 | 0.118 | 7.86 |
| 7 | 6.13 | 0.033 | 0.003 | 1.100 | 0.182 | 0.083 | 7.86 |
| 8 | 6.48 | 0.031 | 0.002 | 0.990 | 0.202 | 0.102 | 7.86 |
| 9 | 5.93 | 0.034 | 0.003 | 1.150 | 0.174 | 0.076 | 7.86 |
| 10 | 4.76 | 0.042 | 0.004 | 0.970 | 0.206 | 0.106 | 7.86 |
| 11 | 4.20 | 0.048 | 0.006 | 0.830 | 0.241 | 0.145 | 7.86 |
| 12 | 5.94 | 0.034 | 0.003 | 0.910 | 0.220 | 0.121 | 7.86 |
| AVERAGE | 5.430833333 | 0.037472589 | 0.003572638 | 0.9725 | 0.211347321 | 0.11545197 | 7.86 |
| Droplet 4 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | vf (mm/sec) | **Time Rise (s)** | **vr (mm/sec)** | vr (mm/sec) | **d(mm)** |
| 13 | 4.00 | 0.050 | 0.006 | 1.620 | 0.123 | 0.038 | 7.86 |
| 14 | 5.00 | 0.040 | 0.004 | 1.780 | 0.112 | 0.032 | 7.86 |
| 15 | 4.03 | 0.050 | 0.006 | 2.460 | 0.081 | 0.017 | 7.86 |
| 16 | 4.60 | 0.043 | 0.005 | 2.770 | 0.072 | 0.013 | 7.86 |
| AVERAGE | 4.34 | 0.047 | 0.005 | 1.953 | 0.106 | 0.029 | 7.86 |
|  |  |  |  |  |  |  |  |
| Droplet 5 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | vf (mm/sec) | **Time Rise (s)** | **vr (mm/sec)** | vr (mm/sec) | **d(mm)** |
| 1 | 5.77 | 0.035 | 0.003 | 1.740 | 0.115 | 0.033 | 7.86 |
| 2 | 6.27 | 0.032 | 0.003 | 1.940 | 0.103 | 0.027 | 7.86 |
| 3 | 7.09 | 0.028 | 0.002 | 2.150 | 0.093 | 0.022 | 7.86 |
| 4 | 6.31 | 0.032 | 0.003 | 2.240 | 0.089 | 0.020 | 7.86 |
| 5 | 7.12 | 0.028 | 0.002 | 2.170 | 0.092 | 0.021 | 7.86 |
| 6 | 6.59 | 0.030 | 0.002 | 2.010 | 0.100 | 0.025 | 7.86 |
| 7 | 6.13 | 0.033 | 0.003 | 2.340 | 0.085 | 0.018 | 7.86 |
| 8 | 5.65 | 0.035 | 0.003 | 1.870 | 0.107 | 0.029 | 7.86 |
| 9 | 7.43 | 0.027 | 0.002 | 1.860 | 0.108 | 0.029 | 7.86 |
| 10 | 7.51 | 0.027 | 0.002 | 2.330 | 0.086 | 0.018 | 7.86 |
| 11 | 5.95 | 0.034 | 0.003 | 2.190 | 0.091 | 0.021 | 7.86 |
| 12 | 5.99 | 0.033 | 0.003 | 2.030 | 0.099 | 0.024 | 7.86 |
| 13 | 5.71 | 0.035 | 0.003 | 1.830 | 0.109 | 0.030 | 7.86 |
| 14 | 6.47 | 0.031 | 0.002 | 2.140 | 0.093 | 0.022 | 7.86 |
| 15 | 6.21 | 0.032 | 0.003 | 2.200 | 0.091 | 0.021 | 7.86 |
| 16 | 5.77 | 0.035 | 0.003 | 2.250 | 0.089 | 0.020 | 7.86 |
| 17 | 7.21 | 0.028 | 0.002 | 2.090 | 0.096 | 0.023 | 7.86 |
| AVG | 6.42 | 0.031 | 0.002 | 2.081 | 0.097 | 0.024 | 7.86 |
| Droplet 6 |  |  |  |  |  |  |  |
| **Trial N** | **Time Fall (s)** | **vf (mm/sec)** | vf (mm/sec) | **Time Rise (s)** | **vr (mm/sec)** | vr (mm/sec) | **d(mm)** |
| 1 | 15.90 | 0.013 | 0.000 | 1.400 | 0.143 | 0.051 | 7.86 |
| 2 | 14.68 | 0.014 | 0.000 | 0.840 | 0.238 | 0.142 | 7.86 |
| 3 | 10.03 | 0.020 | 0.001 | 0.770 | 0.260 | 0.169 | 7.86 |
| 4 | 13.74 | 0.015 | 0.001 | 0.510 | 0.392 | 0.384 | 7.86 |
| 5 | 11.19 | 0.018 | 0.001 | 0.570 | 0.351 | 0.308 | 7.86 |
| 6 | 15.79 | 0.013 | 0.000 | 0.860 | 0.233 | 0.135 | 7.86 |
| 7 | 11.35 | 0.018 | 0.001 | 0.800 | 0.250 | 0.156 | 7.86 |
| 8 | 13.94 | 0.014 | 0.001 | 0.800 | 0.250 | 0.156 | 7.86 |
| 9 | 18.42 | 0.011 | 0.000 | 0.700 | 0.286 | 0.204 | 7.86 |
| 10 | 13.71 | 0.015 | 0.001 | 0.460 | 0.435 | 0.473 | 7.86 |
| 11 | 2.00 | 0.100 | 0.025 | 0.520 | 0.385 | 0.370 | 7.86 |
| AVG | 12.80 | 0.023 | 0.003 | 0.748 | 0.293 | 0.232 | 7.86 |

Appendix 2 The full class dataset

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **DROPLET N** | **vf (mm/sec)** | vf (mm/sec) | **vr (mm/sec)** | vr (mm/sec) | **d(mm)** | **T (˚C)** | **p [Pa]** | **V (Volt)** |
| 1 | 0.03863 | 0.01176 | 0.11325 | 0.03446 | 6.75 | 22.80 | 88900 | 500 |
| 2 | 0.07248 | 0.02206 | 0.27223 | 0.08284 | 6.75 | 22.80 | 88900 | 502 |
| 3 | 0.07174 | 0.02183 | 0.30102 | 0.09160 | 6.75 | 22.80 | 88900 | 499 |
| 4 | 0.03037 | 0.00924 | 0.81967 | 0.24943 | 6.75 | 22.80 | 88900 | 502 |
| 5 | 0.04864 | 0.01480 | 0.25907 | 0.07884 | 6.75 | 22.80 | 88900 | 502 |
| 6 | 0.54120 | 0.87618 | 10.92001 | 2.72325 | 9.10 | 22.90 | 101000 | 500 |
| 7 | 1.21960 | 1.97447 | 20.34292 | 5.07316 | 9.10 | 22.90 | 101000 | 500 |
| 8 | 0.27544 | 0.44592 | 28.70264 | 7.15792 | 9.10 | 22.90 | 101000 | 500 |
| 9 | 3.73261 | 6.04292 | 2.30542 | 0.57493 | 9.10 | 22.90 | 101000 | 500 |
| 10 | 0.04127 | 0.01250 | 0.10305 | 0.01331 | 9.00 | 22.80 | 101100 | 500 |
| 11 | 0.06425 | 0.01365 | 0.24178 | 0.01104 | 9.00 | 22.80 | 101100 | 500 |
| 12 | 0.08228 | 0.01317 | 0.17947 | 0.01389 | 9.00 | 22.80 | 101100 | 500 |
| 13 | 0.18437 | 0.01629 | 0.15645 | 0.01236 | 9.00 | 22.80 | 101100 | 500 |
| 14 | 0.10500 | 0.01325 | 0.15281 | 0.01138 | 9.00 | 22.80 | 101100 | 500 |
| 15 | 0.11754 | 0.01357 | 0.12494 | 0.00991 | 9.00 | 22.80 | 101100 | 500 |
| 16 | 0.22104 | 0.01285 | 0.12189 | 0.01241 | 9.00 | 22.80 | 101100 | 500 |
| 17 | 0.11666 | 0.01051 | 0.14045 | 0.01186 | 9.00 | 22.80 | 101100 | 500 |
| 18 | 0.11671 | 0.01171 | 0.17253 | 0.01055 | 9.00 | 22.80 | 101100 | 500 |
| 19 | 0.12315 | 0.01019 | 0.16995 | 0.01086 | 9.00 | 22.80 | 101100 | 500 |
| 20 | 0.03700 | 0.16000 | 0.13200 | 0.13600 | 8.00 | 23.00 | 91900 | 495 |
| 21 | 0.04200 | 0.01900 | 0.24100 | 0.41600 | 8.00 | 23.00 | 91900 | 495 |
| 22 | 0.27675 | 0.05933 | 0.15773 | 0.04009 | 7.68 | 22.90 | 91000 | 500 |
| 23 | 0.14809 | 0.03184 | 0.14270 | 0.02992 | 7.68 | 22.90 | 91000 | 507 |
| 24 | 0.06900 | 0.01449 | 0.14346 | 0.03001 | 7.68 | 22.90 | 91000 | 487 |
| 26 | 11.41000 | 0.00022 | 1.92000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 27 | 11.18000 | 0.00039 | 2.59000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 28 | 4.42500 | 0.00305 | 3.89000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 29 | 4.59000 | 0.00305 | 2.14000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 30 | 7.77500 | 0.00305 | 1.91000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 31 | 7.98667 | 0.00305 | 1.24000 | 0.00022 | 8.00 | 22.50 | 100700 | 490 |
| 32 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 33 | 0.02000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 34 | 0.01000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 35 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 36 | 0.02000 | 0.01000 | 0.25000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 37 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 38 | 0.02000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 39 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 40 | 0.02000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 41 | 0.02000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 42 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 43 | 0.02000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 44 | 0.01000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 45 | 0.02000 | 0.01000 | 0.23000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 46 | 0.01000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 47 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 48 | 0.02000 | 0.01000 | 0.23000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 49 | 0.02000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 50 | 0.01000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 51 | 0.01000 | 0.01000 | 0.24000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 52 | 0.01000 | 0.01000 | 0.22000 | 0.01000 | 8.50 | 23.00 | 101000 | 498 |
| 53 | 0.07453 | 0.00252 | 0.19726 | 0.02211 | 7.74 | 23.00 | 100800 | 500 |
| 54 | 0.05325 | 0.00122 | 0.39906 | 0.01455 | 7.74 | 23.00 | 100800 | 500 |
| 55 | 0.09741 | 0.00100 | 0.12795 | 0.01604 | 7.74 | 23.00 | 100800 | 500 |
| 56 | 0.08578 | 0.00223 | 0.16364 | 0.00508 | 7.74 | 23.00 | 100800 | 500 |
| 57 | 0.00015 | 0.00003 | 0.00003 | 0.00001 | 7.54 | 21.00 | 1007 | 500 |
| 58 | 0.00012 | 0.00003 | 0.00002 | 0.00000 | 7.54 | 26.00 | 920 | 500 |
| 59 | 0.00033 | 0.00009 | 0.00001 | 0.00000 | 7.54 | 26.00 | 912 | 500 |
| 60 | 0.00060 | 0.00019 | 0.00001 | 0.00000 | 7.54 | 28.00 | 912 | 500 |
| 61 | 0.00101 | 0.00043 | 0.00001 | 0.00000 | 7.54 | 26.00 | 906 | 500 |
| 62 | 0.00010 | 0.00002 | 0.00021 | 0.00005 | 7.54 | 26.00 | 911 | 500 |
| 63 | 0.00013 | 0.00003 | 0.00004 | 0.00001 | 7.54 | 26.00 | 911 | 500 |
| 64 | 0.03863 | 0.01176 | 0.11325 | 0.03446 | 6.75 | 22.80 | 88900 | 500 |
| 65 | 0.07248 | 0.02206 | 0.27223 | 0.08284 | 6.75 | 22.80 | 88900 | 502 |
| 66 | 0.07174 | 0.02183 | 0.30102 | 0.09160 | 6.75 | 22.80 | 88900 | 499 |
| 67 | 0.03037 | 0.00924 | 0.81967 | 0.24943 | 6.75 | 22.80 | 88900 | 502 |
| 68 | 0.04864 | 0.01480 | 0.25907 | 0.07884 | 6.75 | 22.80 | 88900 | 502 |
| 69 | 0.01364 | 0.00684 | 0.11644 | 0.02356 | 7.95 | 23.50 | 91800 | 497 |
| 70 | 0.01401 | 0.00703 | 0.14313 | 0.02883 | 7.95 | 23.40 | 91600 | 497 |
| 71 | 0.01348 | 0.00676 | 0.19810 | 0.03989 | 7.95 | 23.30 | 91600 | 497 |
| 72 | 0.01788 | 0.00897 | 0.22124 | 0.04462 | 7.95 | 23.30 | 91600 | 497 |
| 73 | 0.01523 | 0.00764 | 0.32723 | 0.06594 | 7.95 | 23.20 | 91600 | 497 |
| 74 | 0.01257 | 0.00630 | 0.17253 | 0.03472 | 7.95 | 23.20 | 91600 | 497 |
| 75 | 0.02251 | 0.01131 | 0.36127 | 0.07307 | 7.95 | 23.20 | 91300 | 497 |
| 76 | 0.01315 | 0.00659 | 0.20408 | 0.04108 | 7.95 | 23.10 | 91300 | 497 |
| 77 | 0.01739 | 0.00872 | 0.19984 | 0.04032 | 7.95 | 23.10 | 91300 | 497 |
| 78 | 0.01489 | 0.00747 | 0.52854 | 0.10650 | 7.95 | 23.10 | 91300 | 497 |
| 79 | 0.05869 | 0.02969 | 0.36075 | 0.07427 | 7.95 | 23.10 | 91300 | 497 |
| 80 | 0.01225 | 0.00614 | 0.14384 | 0.02894 | 7.95 | 23.10 | 91200 | 497 |
| 81 | 0.01893 | 0.00950 | 0.39936 | 0.08063 | 7.95 | 23.00 | 91200 | 497 |
| 82 | 0.11400 |  | 0.75900 |  | 7.80 | 22.00 | 90600 | 500 |
| 83 | 1.56700 |  | 2.32400 |  | 7.80 | 23.00 | 90600 | 500 |
| 84 | 0.21600 |  | 0.78700 |  | 7.80 | 23.00 | 90600 | 500 |
| 85 | 0.20200 |  | 0.59300 |  | 7.80 | 23.00 | 90600 | 500 |
| 86 | 0.40500 |  | 1.96500 |  | 7.80 | 23.00 | 90600 | 500 |
| 87 | 0.66500 |  | 1.62800 |  | 7.80 | 23.00 | 90600 | 500 |
| 88 | 0.15700 |  | 0.49000 |  | 7.80 | 23.00 | 90600 | 500 |
| 89 | 0.45600 |  | 2.45600 |  | 7.80 | 23.00 | 90600 | 500 |
| 90 | 0.43000 |  | 1.78500 |  | 7.80 | 23.00 | 90600 | 500 |
| 91 | 0.59100 |  | 2.62900 |  | 7.80 | 23.00 | 90600 | 500 |
| 92 | 0.02621 | 0.00132 | 0.40078 | 0.08238 | 8.20 | 23.00 | 100000 | 505 |
| 93 | 0.03248 | 0.00184 | 0.20080 | 0.02502 | 8.20 | 22.70 | 100000 | 511 |
| 94 | 0.03128 | 0.00173 | 0.20441 | 0.02596 | 8.20 | 22.40 | 100000 | 511 |
| 95 | 0.04949 | 0.00365 | 0.39927 | 0.08864 | 8.20 | 22.50 | 100000 | 512 |
| 96 | 0.04005 | 0.00257 | 0.24690 | 0.03650 | 8.20 | 22.50 | 100000 | 512 |
| 97 | 0.04347 | 0.00294 | 0.16050 | 0.01680 | 8.20 | 22.60 | 100000 | 513 |
| 98 | 0.02345 | 0.00235 | 0.14011 | 0.01421 | 0.50 | 23.00 | 107000 | 499 |
| 99 | 0.03603 | 0.00362 | 0.14909 | 0.01533 | 0.50 | 23.10 | 107000 | 499 |
| 101 | 0.03365 | 0.00338 | 0.44301 | 0.04626 | 0.50 | 23.40 | 107000 | 500 |
| 102 | 0.02794 | 0.02794 | 0.04063 | 0.04063 | 0.50 | 23.30 | 107000 | 500 |
| 103 | 0.03365 | 0.02744 | 0.03987 | 0.03987 | 0.50 | 23.30 | 107000 | 500 |
| 104 | 0.01135 | 0.00227 | 0.11364 | 0.02299 | 7.76 | 23.00 | 101200 | 502 |
| 105 | 0.05139 | 0.01085 | 0.04669 | 0.01027 | 7.76 | 23.00 | 101200 | 502 |
| 106 | 0.02319 | 0.00561 | 0.06068 | 0.01451 | 7.76 | 23.00 | 101200 | 499 |
| 107 | 0.01737 | 0.00419 | 0.08532 | 0.01899 | 7.76 | 23.00 | 101200 | 500 |
| 108 | 0.01718 | 0.00477 | 0.37594 | 0.08616 | 7.76 | 23.00 | 101200 | 501 |
| 109 | 0.03237 | 0.23428 | 0.10883 | 0.48310 | 7.80 | 23.00 | 101000 | 503 |
| 110 | 0.02542 | 0.26945 | 0.10602 | 0.41908 | 7.80 | 23.00 | 101000 | 503 |
| 111 | 0.08319 | 0.22524 | 0.20377 | 0.31261 | 7.80 | 23.00 | 101000 | 503 |
| 112 | 0.02022 | 0.23050 | 0.14626 | 0.25290 | 7.80 | 23.00 | 101000 | 503 |
| 113 | 0.01258 | 0.00040 | 0.14286 | 0.05102 | 7.86 | 23.00 | 100700 | 504 |
| 114 | 0.01362 | 0.00046 | 0.23810 | 0.14172 | 7.86 | 23.00 | 100700 | 504 |
| 115 | 0.01994 | 0.00099 | 0.25974 | 0.16866 | 7.86 | 23.00 | 100700 | 504 |
| 116 | 0.01456 | 0.00053 | 0.39216 | 0.38447 | 7.86 | 23.00 | 100700 | 504 |
| 117 | 0.01787 | 0.00080 | 0.35088 | 0.30779 | 7.86 | 23.00 | 100700 | 504 |
| 118 | 0.01267 | 0.00040 | 0.23256 | 0.13521 | 7.86 | 23.00 | 100700 | 504 |
| 119 | 0.01762 | 0.00078 | 0.25000 | 0.15625 | 7.86 | 23.00 | 100700 | 504 |
| 120 | 0.01435 | 0.00051 | 0.25000 | 0.15625 | 7.86 | 23.00 | 100700 | 504 |
| 121 | 0.01086 | 0.00029 | 0.28571 | 0.20408 | 7.86 | 23.00 | 100700 | 504 |
| 122 | 0.01459 | 0.00053 | 0.43478 | 0.47259 | 7.86 | 23.00 | 100700 | 504 |
| 123 | 0.10000 | 0.02500 | 0.38462 | 0.36982 | 7.86 | 23.00 | 100700 | 504 |
| 124 | 0.01661 | 0.01291 | 0.21920 | 0.04908 | 7.54 | 23.00 | 101200 | 499 |
| 125 | 0.01705 | 0.00400 | 0.21587 | 0.10708 | 7.54 | 23.00 | 101200 | 499 |
| 126 | 0.01507 | 0.00392 | 0.22422 | 0.07556 | 7.54 | 23.00 | 101200 | 499 |
| 127 | 0.02461 | 0.00587 | 0.08728 | 0.03314 | 7.54 | 23.00 | 101200 | 499 |
| 128 | 0.01516 | 0.00403 | 0.10852 | 0.03146 | 7.54 | 23.00 | 101200 | 499 |
| 129 | 0.03998 | 0.00939 | 0.18823 | 0.04811 | 7.54 | 23.00 | 101200 | 499 |
| 130 | 0.01943 | 0.00489 | 0.07022 | 0.70885 | 7.54 | 23.00 | 101200 | 499 |
| 131 | 0.01787 | 0.00436 | 0.18570 | 0.09904 | 7.54 | 23.00 | 101200 | 499 |
| 132 | 0.01480 | 0.00764 | 0.20400 | 0.10531 | 7.54 | 23.00 | 101200 | 499 |
| 133 | 0.02882 | 0.01347 | 0.11761 | 0.05495 | 7.54 | 23.00 | 101200 | 502 |
| 134 | 0.01636 | 0.00083 | 0.09293 | 0.00508 | 7.76 | 23.20 | 100700 | 502 |
| 135 | 0.07733 | 0.00417 | 0.15821 | 0.00916 | 7.76 | 23.00 | 100700 | 503 |
| 136 | 0.03009 | 0.00155 | 0.11713 | 0.00654 | 7.76 | 23.00 | 100700 | 503 |
| 137 | 0.01750 | 0.00089 | 0.26184 | 0.01653 | 7.76 | 22.80 | 100700 | 503 |
| 138 | 0.00870 | 0.00088 | 0.23606 | 0.02930 | 7.76 | 22.70 | 100700 | 501 |
| 139 | 0.04494 | 0.00470 | 0.33857 | 0.04549 | 7.76 | 22.80 | 100700 | 503 |
| 140 | 0.02579 | 0.00265 | 0.17788 | 0.02096 | 7.76 | 22.80 | 100700 | 503 |
| 141 | 0.01830 | 0.00311 | 0.16595 | 0.03228 | 7.76 | 22.90 | 100700 | 503 |
| 142 | 0.05545 | 0.00585 | 0.34621 | 0.04703 | 7.76 | 23.00 | 100600 | 503 |
| 143 | 0.04866 | 0.00510 | 0.45930 | 0.06723 | 7.76 | 23.20 | 100600 | 503 |
| 144 | 0.00781 | 0.00100 | 0.16949 | 0.05998 | 7.70 | 22.00 | 101500 | 501 |
| 145 | 0.00910 | 0.00100 | 0.13824 | 0.05998 | 7.70 | 22.00 | 101500 | 501 |
| 146 | 0.00676 | 0.00100 | 0.41667 | 0.05998 | 7.70 | 22.00 | 101500 | 501 |
| 147 | 0.00893 | 0.00100 | 0.70423 | 0.05998 | 7.70 | 22.00 | 101500 | 501 |
| 148 | 0.06341 | 0.00740 | 0.17833 | 0.05998 | 7.70 | 22.00 | 101500 | 503 |
| 149 | 0.05387 | 0.00740 | 0.45002 | 0.05998 | 7.70 | 22.00 | 101500 | 503 |
| 150 | 0.03696 | 0.00740 | 0.28617 | 0.05998 | 7.70 | 22.00 | 101500 | 504 |
| 151 | 0.24000 | 0.00700 | 0.22000 | 0.00600 | 7.50 | 22.00 | 101400 | 490 |
| 152 | 0.14600 | 0.00700 | 0.11700 | 0.00500 | 7.50 | 20.00 | 101400 | 504 |
| 153 | 0.17700 | 0.00900 | 0.16500 | 0.00700 | 7.50 | 18.00 | 101500 | 509 |
| 154 | 0.18800 | 0.00900 | 0.17700 | 0.00700 | 7.50 | 18.00 | 101500 | 510 |
| 155 | 0.24700 | 0.00800 | 0.23300 | 0.01600 | 7.50 | 18.00 | 101500 | 510 |
| 156 | 3.09200 | 0.31920 | 5.51300 | 0.56130 | 7.00 | 23.00 | 101400 | 500 |
| 157 | 3.07300 | 0.23150 | 2.48400 | 0.25840 | 7.00 | 23.00 | 101400 | 500 |
| 158 | 3.00900 | 0.32570 | 2.73500 | 0.28350 | 7.00 | 23.00 | 101400 | 500 |
| 159 | 2.91600 | 0.17020 | 2.26000 | 0.23600 | 7.00 | 23.00 | 101400 | 500 |
| 160 | 2.83200 | 0.34210 | 3.75700 | 0.38570 | 7.00 | 23.00 | 101400 | 500 |
| 161 | 2.78200 | 0.33300 | 3.75400 | 0.38540 | 7.00 | 23.00 | 101400 | 500 |
| 162 | 2.64500 | 0.16980 | 1.85400 | 0.19540 | 7.00 | 23.00 | 101400 | 500 |
| 163 | 2.53800 | 0.14440 | 1.59200 | 0.16920 | 7.00 | 23.00 | 101400 | 500 |
| 164 | 2.40600 | 0.19860 | 2.15700 | 0.22570 | 7.00 | 23.00 | 101400 | 500 |
| 165 | 2.33100 | 0.14720 | 1.52000 | 0.16200 | 7.00 | 23.00 | 101400 | 500 |
| 166 | 2.21500 | 0.16910 | 1.75833 | 0.18583 | 7.00 | 23.00 | 101400 | 500 |
| 167 | 2.16100 | 0.16020 | 1.79100 | 0.18910 | 7.00 | 23.00 | 101400 | 500 |
| 168 | 2.12200 | 0.21590 | 2.30400 | 0.24040 | 7.00 | 23.00 | 101400 | 500 |
| 169 | 0.07439 | 0.01291 | 0.05398 | 0.00937 | 10.00 | 21.00 | 101500 | 500 |
| 170 | 0.03263 | 0.00339 | 0.21701 | 0.02253 | 10.00 | 21.00 | 101500 | 500 |
| 171 | 0.09918 | 0.01082 | 0.24656 | 0.02689 | 10.00 | 20.00 | 101500 | 504 |
| 172 | 0.05944 | 0.00621 | 0.74266 | 0.07762 | 10.00 | 20.00 | 101500 | 504 |
| 173 | 0.06476 | 0.00688 | 0.10611 | 0.01127 | 10.00 | 20.00 | 101500 | 502 |
| 174 | 0.07322 | 0.00760 | 0.58524 | 0.06076 | 10.00 | 20.00 | 101500 | 502 |
| 175 | 0.89000 | 0.50000 | 15.15000 | 0.50000 | 9.00 | 21.00 | 101960 | 507 |
| 176 | 1.96000 | 0.50000 | 6.45000 | 0.50000 | 9.00 | 21.00 | 101960 | 508 |
| 177 | 0.89000 | 0.50000 | 11.92000 | 0.50000 | 9.00 | 20.00 | 101960 | 509 |
| 178 | 2.66000 | 0.50000 | 8.72000 | 0.50000 | 9.00 | 22.00 | 101960 | 509 |
| 179 | 1.21000 | 0.50000 | 8.67000 | 0.50000 | 9.00 | 23.00 | 101960 | 509 |
| 180 | 1.41000 | 0.50000 | 11.06000 | 0.50000 | 9.00 | 22.00 | 101960 | 509 |
| 181 | 0.90000 | 0.50000 | 14.42000 | 0.50000 | 9.00 | 22.00 | 101960 | 509 |
| 182 | 1.09000 | 0.50000 | 19.87000 | 0.50000 | 9.00 | 22.00 | 101960 | 509 |
| 183 | 2.75000 | 0.50000 | 2.40000 | 0.50000 | 9.00 | 22.00 | 101960 | 503 |
| 184 | 1.48000 | 0.50000 | 8.34000 | 0.50000 | 9.00 | 22.00 | 101960 | 509 |