Calculating the viscosity of glycerol essay

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Viscosity is a measure of the resistance against the flow of a substance (fluid). The higher the viscosity of a fluid, the less easily it can flow. The viscosity of a fluid can be calculated by using Stroke’s Law, which relates the viscosity of a fluid to the viscous drag (opposing force) and velocity at which it is travelling.

One method of calculating the viscous drag (also the method I will be using) is by subtracting the upthrust exerted by the fluid on an object (ball) from the weight of the object as it is dropped through the fluid, assuming that the object has reached it’s terminal velocity and therefore has equal forces acting on it. Aim: To observe and record the terminal velocities of different sized balls falling through Glycerol, and hence calculate the viscosity of Glycerol. Variables: The only variables that will be changed for us to gain a range of results will be the size of the balls. All other variables including the densities of both the balls and fluids must remain the same.

Although temperature changes could cause expansions and contractions in the substances, it will not affect the results significantly as the changes will have an effect on both the fluid and ball, hence having no overall effect on the experiment. There may be other variables such as the gravitational force and density of Glycerol through the tube that we will assume to be constant, as any changes cannot significantly alter the final result. Range: To obtain the most accurate and reliable results we can get under the conditions given, I will be repeating the experiment with each size ball three times at least. To ensure that the maximum velocity has been reached by the falling balls (vital, as this is the only condition where the forces acting on it are equal),

we will record two time’s consecutively with equal distances, comparing the times to check that they are reliably close.

If this is not the case the terminal velocity may not have been reached, so the distance to the first mark may need to be increased, allowing more time for the forces to balance out. The only other measurements that should be repeated at least once to ensure there are no mistakes are the diameter’s of the balls (from different positions using a micrometer) and the masses of both the balls and glycerol (allowing us to calculate an accurate value for the densities). Apparatus:* Cylindrical tubing (blocked off at bottom)* Rubber bands/tape for marking start and stop distances* Metre ruler, stopwatches and micrometer* Glycerol and set of different sized balls (densities assumed to be the same and constant through the balls and fluid)* Measuring tube/flask and balance to obtain a volume and mass for the calculation of densities. Hypothesis: For this investigation, I am not expecting to obtain perfect results as there are a number of errors that are likely to occur due to the limitations of our apparatus and judgement.

For one, the times we obtain may not be absolutely correspond, as we our using our own eyesight and stopwatches to gain this measurement, and is therefore limited to the speed of our reaction. Also, it cannot be guaranteed that the balls we use have gained maximum velocity, although the results may show that there is very little variation in the times (especially with larger balls, as their mass and therefore weight will cause them to move faster). Method:* Set up apparatus as shown below.* Mark distances with a meter ruler.* Measure mass and diameter of each ball* Measure volume and

mass of a tube-full glycerol (after measuring the tube alone)* Drop the balls one at a time, repeating each size ball three times.

* Start and stop the stopwatches one after the other and record each pair of results.* Plot all values and data into a spreadsheet to calculate the densities, radius2, terminal velocities, and viscosities from each size ball using average results.* Plot points on a graph of radius2 (y-axis) against velocity (x-axis)Conclusion: The graph obtained was not quite as expected, and the points seemed to have an exponential relationship rather than linear. This suggests that there were either too few results or large errors in the measurements and recordings (more probably so in the times). The method that was used was as accurate as it could possibly be in a classroom, but the inconsistent pattern in our results suggests that maybe some of the less obvious variables may have had an effect on the experiment.

Factors such as the actual densities of each ball could be the reason why there was so much variance in the calculation of viscosity, although I believe it might have more to do with the inaccuracy of what we assumed was terminal velocity. As can be clearly seen, there was some differences in the times obtained, especially with the smaller sized balls. If none of the balls had reached their terminal velocity, it would have affected the smaller sized balls more significantly than the larger ones as they spent longer decelerating due to the resistive forces of the Glycerol. This is what our results showed, and I therefore believe it was this problem that caused uncertainty and inconsistent values for the viscosity. Evaluation: There are many improvements that can be made to give more accurate results for this experiment, although most of the changes that could be made do not include

much that is possible with the apparatus that was provided. However, if more accurate and precise apparatus were to be used to take measurements, it would not dramatically affect the results over the length of tubing that is suitable for the conditions we had to work under.

The main reason as I suggested before, for our inconsistent results was due to the balls not having reached their terminal velocity. The only method of allowing these balls to reach their terminal velocity would be to let them fall for a larger distance before recording the time’s. This is one improvement that could significantly better the experiment, any others being new methods of measuring the densities and velocities more accurately, maybe by using an electronic speedometer.