A2 Physics Coursework

Final experiment

Changes to be made to final experiment and reasons

- To improve reliability of my results I will perform 3 runs for each measurement rather than 1, this will allow me to average the 3 results for each measurement which will improve reliability of results, and if there is one of the 3 that does not fit it can be excluded and average the other 2. I will no longer need to do 5 oscillations and then divide by 5 as the accuracy of the readings by the light gate ensures that the experimental error will already be eliminated as human error and reaction time no longer applies.

- I will scale up parts of the experiment which produced larger than expected error. Therefore I will use a larger diameter of wire, which will therefore reduce the percentage error as the accuracy of the micrometer will still be the same.

- The time period was where the majority of the errors occurred in the preliminary. Therefore I am going to use a light gate to measure the time period, this will reduce error on the time period significantly. It will eliminate the human error as the error due human reaction time will no longer apply. There will only be a reading error now, which is far less significant than the experimental error.

- I will use a range of lengths from 100-500mm rather than 100-800mm, as when the length becomes very long the bar on the bar on the wire tends to wobble a lot more than when a shorter length is used. Therefore I am hoping this will further reduce the error in the time period. I will go up by 50mm each time so that I get a suitable number of results.

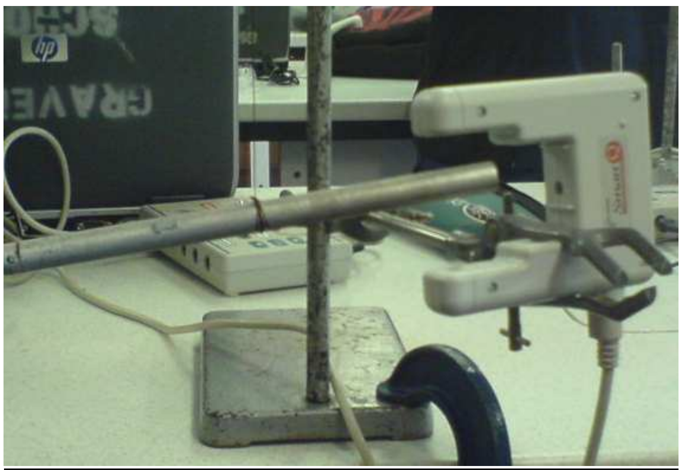
Aim: Investigate the effect of changing the length of wire on the time period for a Torsional pendulum.

Equipment:

- Retort Stand with clamp to hold the wire and bar when oscillating and to hold the motion sensor.
- Bung cut into two halves so I can change length of the wire easily and hold the wire tightly.
- Metal Bar which will move through the motion sensor to give time periods.

- Approximately 0.700,m long wire(extra 200mm to allow for tying wire and excess at top of clamp to easily be able to change length)
- Laptop with Sensing science (graph) software which logs the data in real time.
- Light gate including easy sensor and cables, this will measure the time period.
- Micrometer to measure diameter of the wire.
- Meter long ruler to measure out correct lengths of wire and measure length of the bar.

Diagram:



Fair test:

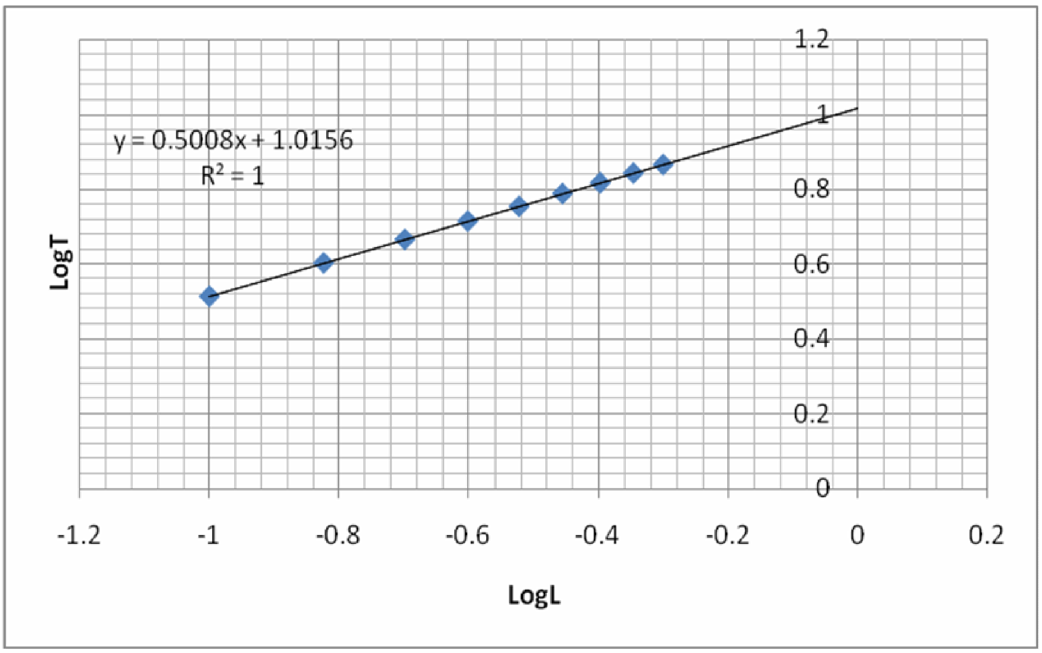
It is important to make the experiment fair to ensure reliability of results. The following must be considered when carrying out my experiment.

- Ensure the same bar is used for each run so that these constants (mass and length) don't change.
- Ensure the diameter of the wire is the same for the whole length, take readings at regular intervals on the wire to be sure.
- Turn 90 degrees anticlockwise for each time period measured, as the twist on the wire will be different otherwise. Also ensure that before turning 90 degrees that the wire and bar are in the equilibrium position, 0 angular displacement / no twist.

Theory:

As I predicted in the preliminary I expect the time period to increase as the length of wire increases, this is due to the equation derived in my research above. **T=2π** $\sqrt{\frac{I32L}{G\pi d^4}}$

Where theoretically the relationship between time period and length should be $T \propto L^{0.5}$. However, from the equation I can see that the diameter is to the power of 4, therefore even a very small change in diameter will cause a major difference in the time period, therefore using a greater diameter will cause the denominator to be much larger and so the overall time period will be significantly lower. For example I will expect the time period for 0.1m to be significantly less than 6.162s, which is obtained from the preliminary using a smaller diameter. Using the theory above I can make a predicted graph of what I am expecting from my log log graph, by simply putting the lengths into the formula, as I already have the measured diameter of wire, length and mass of bar. This is what I obtained.



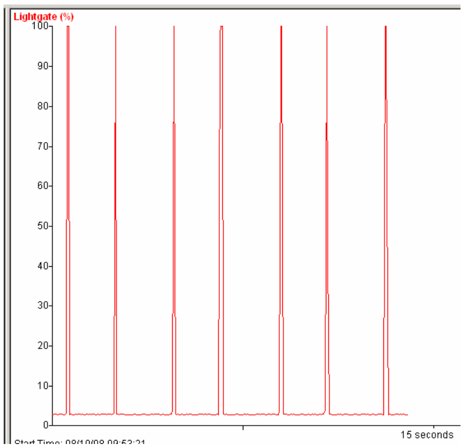
This shows that I should obtain exactly 0.5 as the gradient and the R squared correlation should be as close to 1 as possible to represent a strong correlation

Method:

- Set up the apparatus shown above, connect lead into laptop and open sensing science software, select com1. Set the time to 30 seconds and tick light gate sensor.
- Measure the length of the bar using a meter ruler and the mass using a scale.
- Get two 700mm copper wires and tie them together ensuring that the diameter is constant for the whole length. Then connect the wire to the metal bar, attach the

wire to the bung and tighten. Measure the diameter of the wire at a few intervals and ensure that it is the same, record this diameter.

- Rotate the bar 90 degrees anticlockwise and let go, and at the same time press on run on the laptop. Allow the bar to complete 3 oscillations; this would be 2 peaks, 3 times, as shown below.



- Once 3 oscillations are complete then click the stop button. Click on interval and hold and drag from one peak to 2 peaks later, this will give you the time period for one oscillation. Record this in a suitable format and do the same for the next 2 oscillations.

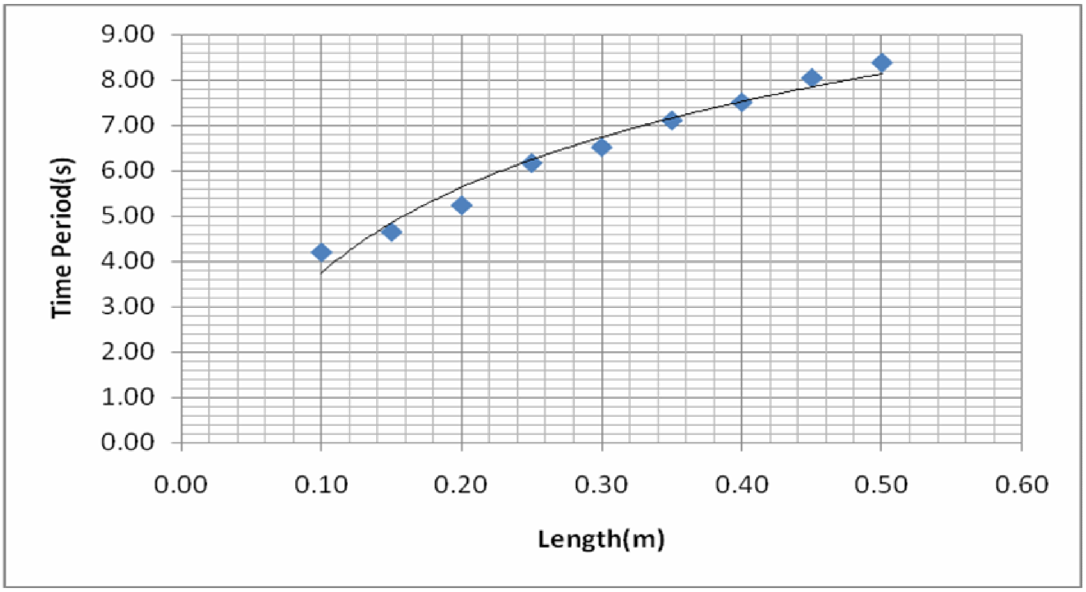
- Repeat this process for lengths 100-500mm going up by 50mm each time, this will ensure I have enough results to be able to have a good graph.

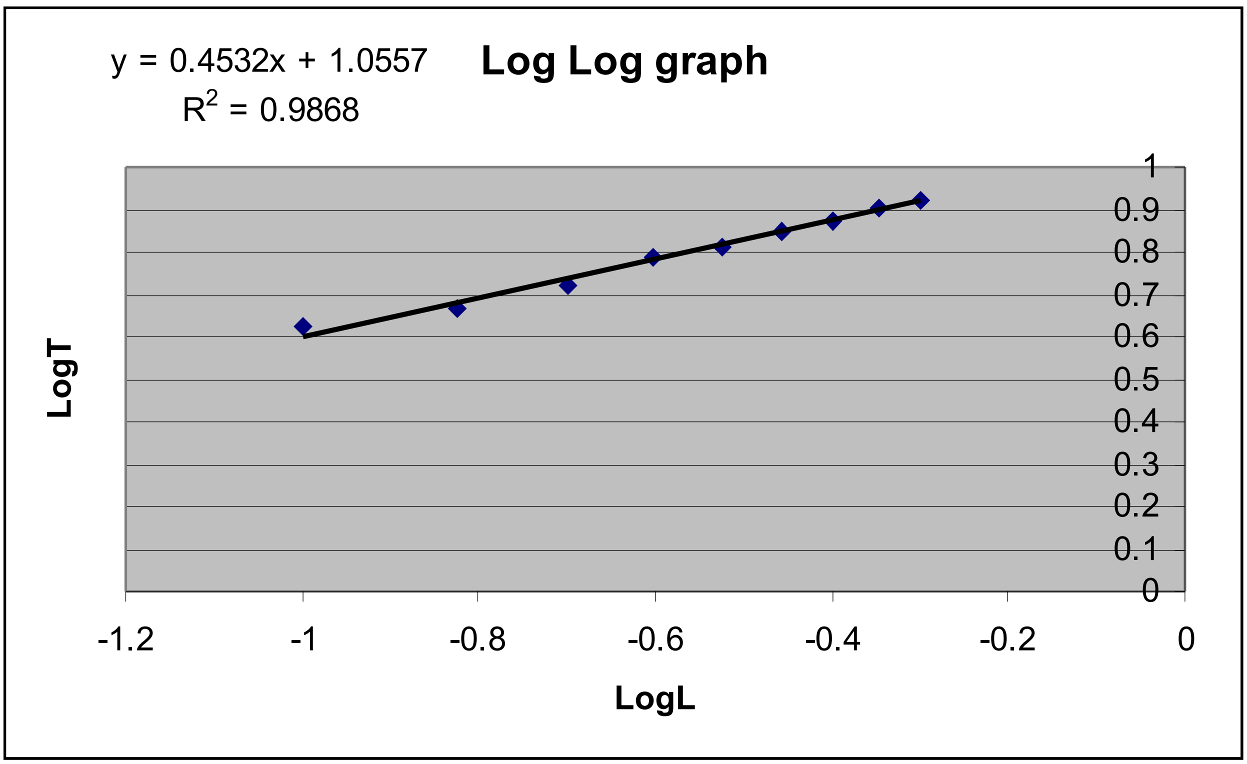
Results:

Diameter of wire	0.49mm
Length of bar	205mm
Mass of bar	196.3grams

length(mm)	Time Period (seconds)			
	Run 1	Run 2	Run 3	Average
100	4.23	4.21	4.15	4.20
150	4.62	4.67	4.65	4.65
200	5.25	5.25	5.20	5.23
250	6.13	6.21	6.15	6.16
300	6.49	6.55	6.50	6.51
350	7.22	7.08	7.01	7.10
400	7.48	7.53	7.50	7.50
450	8.05	8.00	8.07	8.04
500	8.35	8.40	8.38	8.38

logl	logt
-1.00	0.62
-0.82	0.67
-0.70	0.72
-0.60	0.79
-0.52	0.81
-0.46	0.85
-0.40	0.88
-0.35	0.91
-0.30	0.92





Conclusion:

From the graph you can see that the gradient which is b = 0.4532 And that log A=1.0557, therefore to get A I would unlog it, $10^{1.0557}$= 11.368 (3.d.p), So if A= 11.368 and b=0.4532 then the relationship becomes **$T=11.368 \times l^{0.4532}$**

As you can see from the first graph without the logs, the relationship is that an increase in length causes an increase in time period. This was the prediction I made and also that the time periods would be significantly less than the preliminary due to a greater diameter of wire.

I also added an R squared value to my log log graph; this gives me the strength of the correlation. With 1 being the highest, mine was 0.9868, which shows very strong correlation.