**Analysis of Circular Motion to Confirm the Relationship Between Centripetal Force and Period**

**Abstract:**

A fundamental formula of circular motion, $F_c = \frac{m4\pi^2 r}{T^2}$, is confirmed by examining the relationship between centripetal force ($F_c$) and the period of motion (T) represented as $\frac{1}{T^2}$ in the analysis. In this experiment $F_c$ was controlled by changing the mass of washers attached to a rope connected to a rubber stopper spinning at ($\frac{1}{T}$) rotations per second. Data analysis of this motion revealed a linear relationship between $F_c$ and $\frac{1}{T^2}$, with a constant value consistent with the predicted value, highlighting the inverse relationship between $F_c\ and\ T$. The main source of error in this experiment was the random error from mass of the rubber stopper, which was dealt with using weakest link rule in the calculation of the theoretical value. As the slope of measured values was consistent with the theoretical value after consideration of error and there was strong correlation in the observed data, the effect of unconsidered sources of error appears to be minimal and would not invalidate our conclusion.

**Purpose:**

In this experiment, we attempted to experimentally confirm the relationship between centripetal force and period of circular motion through graphical analyzation.

**Hypothesis:**

The relationship between centripetal force and $\frac{1}{T^2}$ is linear, with a slope value of $m4\pi^2 r$, indicating an inverse square relationship between $F_c$ and T, meaning that as the period of motion (T) increases, the centripetal force ($F_c$) decreases, and vice versa.

**Method:**

Initially with 2 washers, we spun the rubber stopper overhead while maintaining a constant radius, recording a new period for every 6 laps, for a total of 3 values recorded before adjusting the washer count. Afterwards, we used the recorded data to get average period and $F_c$ ($m_g$). Using the average period recorded and calculated washer gravitational force ( which was taken as the $F_c$ ), the data was analyzed using Logger Pro.

**Observations:**

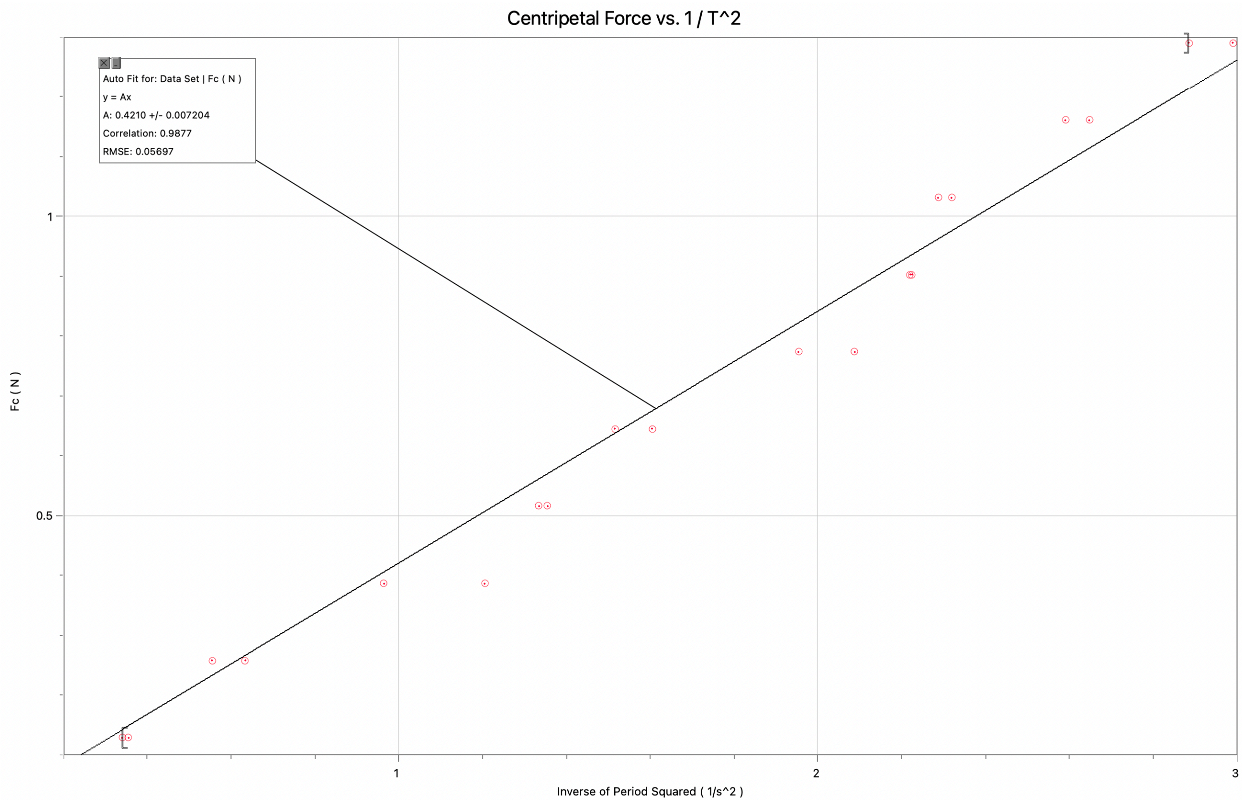


***Fig.1*** ( Relationship between measured centripetal force and the inverse of $T^2$ graphed in Logger Pro. A linear relationship between $F_c$ and $\frac{1}{T^2}$ is shown. radius = 0.8410m)

**Discussion:**

As depicted in *Fig.1*, the slope between Centripetal force and $\frac{1}{T^2}$ is (0.4210 ± 0.007204). Using the weakest link rule and using 'm' as the weakest link, we get a theoretical slope value of 0.3984 ±0.01660. Notably, the experimental slope value agrees with the theoretical slope value, as the difference between them fall within the estimated theoretical error range. This suggests that the relationship between centripetal force and $\frac{1}{T^2}$ is indeed linear with value of $m4\pi^2r$, as anticipated in the hypothesis. The linear nature of this relation confirms our expectation that when the period of motion (T) increases, the centripetal force ($F_c$) required decreases, and vice versa.

There are several sources of error that could have affected the measured data which include: random errors due to measurement and gravity, systematic errors from air resistance and the force of friction on the handle and system, and systematic errors from the assumption of constant mass on washers. Out of these errors the random error for m (mass in kg) was taken as weakest link, which provided us with our theoretical error range. In our analysis done by Logger Pro (refer to *Fig.1*), the correlation coefficient was 0.9877, approaching |1|, indicating that the line closely represents the observed data points. Due to the strong correlation to the line a slope that is within our theoretical error range, the impact of these errors is likely insignificant, and should not compromise the validity of our conclusion.

**Conclusion:**

The data collected from the experiment adhered to expectations, demonstrating a consistent linear relationship between centripetal force and $\frac{1}{T^2}$. In this experiment, strong correlation from recorded values to the regressed line supported the validity of the measured slope value, which fell into theoretical error ranges, strongly supporting our theoretical values and conclusions. Further experiments could explore the drooping angle due to gravity and its effect on the centripetal force or attempt to remove the effect of gravity on centripetal force through calculations.