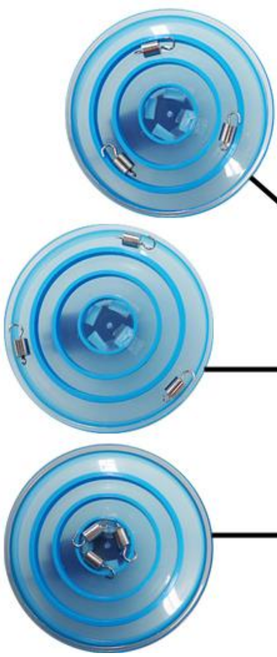
# Moment of Inertia for Point Masses

## Analysis

Three 30 gram masses were placed on the disc and a 30 g weight was allowed to fall. Angular velocity was plotted against time. Constant angular acceleration $\alpha$ was found in radians/s/s as the slope of the velocity-time graph.

Radii from the centre of rotation and angular accelerations have been entered in *Manual Columns* in Logger Pro.



| | Data Set | | | | | |
|---|---|---|---|---|---|---|
| | $R_1$ (cm) | $R_2$ (cm) | $R_3$ (cm) | $\alpha$ (rad/s/s) | $\Sigma mr^2$ (g cm²) | I (g cm²) |
| 1 | 2.0 | 4.8 | 7.3 | 3.38 | 2.4E+003 | 1.29E+004 |
| 2 | 4.8 | 4.8 | 4.8 | 3.51 | 2.1E+003 | 1.24E+004 |
| 3 | 7.3 | 7.3 | 7.3 | 2.81 | 4.8E+003 | 1.55E+004 |
| 4 | 10.1 | 10.1 | 10.1 | 2.15 | 9.2E+003 | 2.02E+004 |
| 5 | 2.0 | 4.8 | 4.8 | 3.58 | 1.5E+003 | 1.22E+004 |
| 6 | 2.0 | 7.3 | 7.3 | 3.08 | 3.3E+003 | 1.41E+004 |
| 7 | 4.8 | 7.3 | 10.1 | 2.73 | 5.4E+003 | 1.59E+004 |
| 8 | 7.3 | 7.3 | 10.1 | 2.54 | 6.3E+003 | 1.71E+004 |
| 9 | 2.0 | 2.0 | 2.0 | 4.07 | 3.6E+002 | 1.07E+004 |
| 10 | 0 | 0 | 0 | 4.23 | 0 | 1.03E+004 |

Values of $\Sigma mr^2$ have been listed in a *New Calculated Column* with the function …

30*("R$_1$"^2+"R$_2$"^2+"R$_3$"^2)

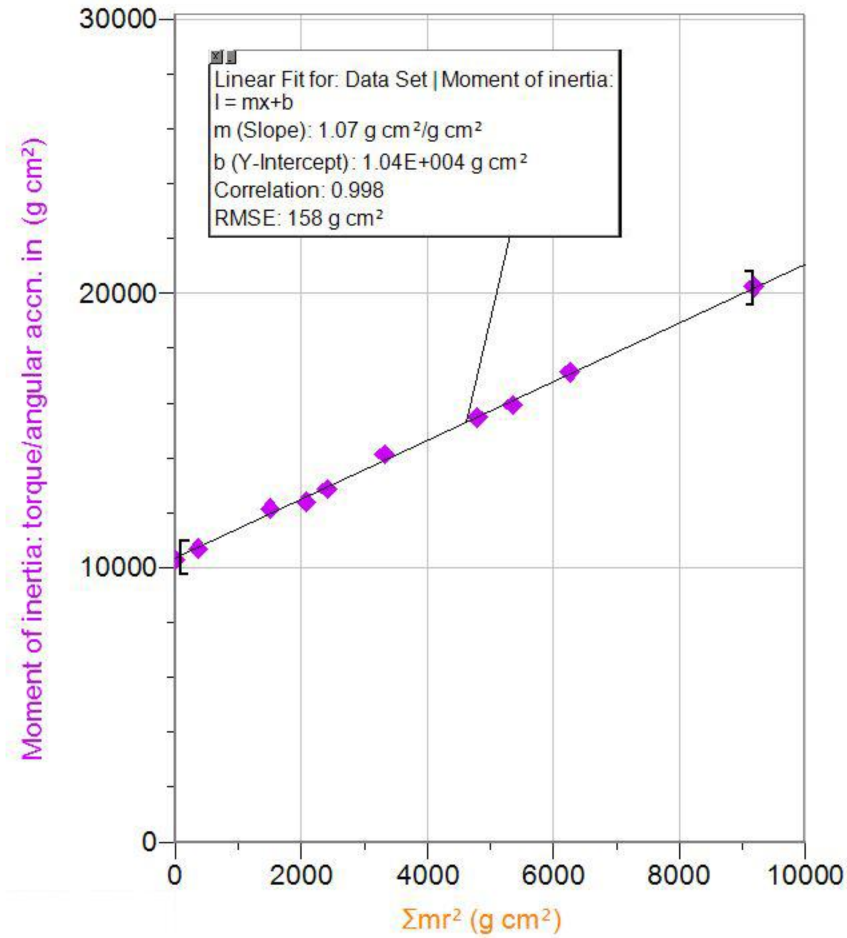
The moment of inertia was calculated with the function …

(0.30*10^5*1.45)/"Angular acceleration"

The calculations are in g cm$^2$. The applied force is expressed in **dynes** and the radius is 1.45 cm. One dyne (the cgs unit of force) is equal to $10^{-5}$ newtons.

Calculated values in columns 5 and 6 are reliable to two and three significant figures respectively. The displayed precision was set in these columns by opening the *Data* menu and selecting *Column Options*.

A plot of measured moment of inertia against $\Sigma mr^2$ is shown below.




A straight line has been fitted to the data points. The intercept on the vertical axis is the moment of inertia of the empty plate. The close linear fit with a slope close to one shows that the moment of inertia for the small 30 g masses is proportional to the radius squared as expected. *Why might the slope differ slightly from the expected value*?

## The value of $I_o$

The moment of inertia of a uniform disc about an axis through the centre of mass and perpendicular to the disc is found by integration to be ½ $mr^2$. The radius of the plate was 11.5 cm and the mass was 165 g.

$$\frac{1}{2} mr^2 = 10900 \text{ g cm}^2$$

The ringed plate is not strictly uniform but calculation shows that a good approximation is provided by the simple reationship.