T.C.
GEBZE TECHNICAL UNIVERSITY
PHYSICS DEPARTMENT

PHYSICS LABORATORY I
EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Maxwell's Wheel

PREPARED BY

NAME AND SURNAME:

STUDENT NUMBER :

DEPARTMENT :

Signature:

Figure 5.2: Experimental setup: Maxwell's Wheel

1. Prepare the experimental setup as seen in figure. By using a spirit level, check/calibrate the disk's parallelism with the ground in fully extended position.

2. Measure the diameters of the disk (R) and the shaft (r) then calculate their radius.

$\boldsymbol{R}$ = ________ (   ) $\boldsymbol{r}$ = ________ (   )

3. Adjust the sensor to the possible highest position (h_x). Roll the disk until it touches to the upper edge of the frame and measure the difference in the height of the disk's center of mass and the sensor's middle point ($x = h - h_x$).

$\boldsymbol{h}$ = ________ (   )

4. Press "Start" button in the controller and start the experiment. Release the disk carefully to avoid initial speed, swing or tilt. Sensor reads the time between successive slits (ΔT). Repeat each measurement three times and take the average value of ΔT. There are 36 slits on disk, therefore multiply the calculated average ΔT values by 36 to obtain the period (T).

5. Adjust the sensor for four different heights h_x and repeat the measurements and calculations. Record the values to the table 5.1.

Table 5.1: The heights and periods of the disk.

$\boldsymbol{h_x}$ **(m)**	$\boldsymbol{x = h - h_x}$ **(m)**	$\boldsymbol{\Delta T_1}$ **(s)**	$\boldsymbol{\Delta T_2}$ **(s)**	$\boldsymbol{\Delta T_3}$ **(s)**	$\boldsymbol{\Delta T_{avg}}$ **(s)**	$\boldsymbol{T = \Delta T_{avg} \times 36}$ **(s)**

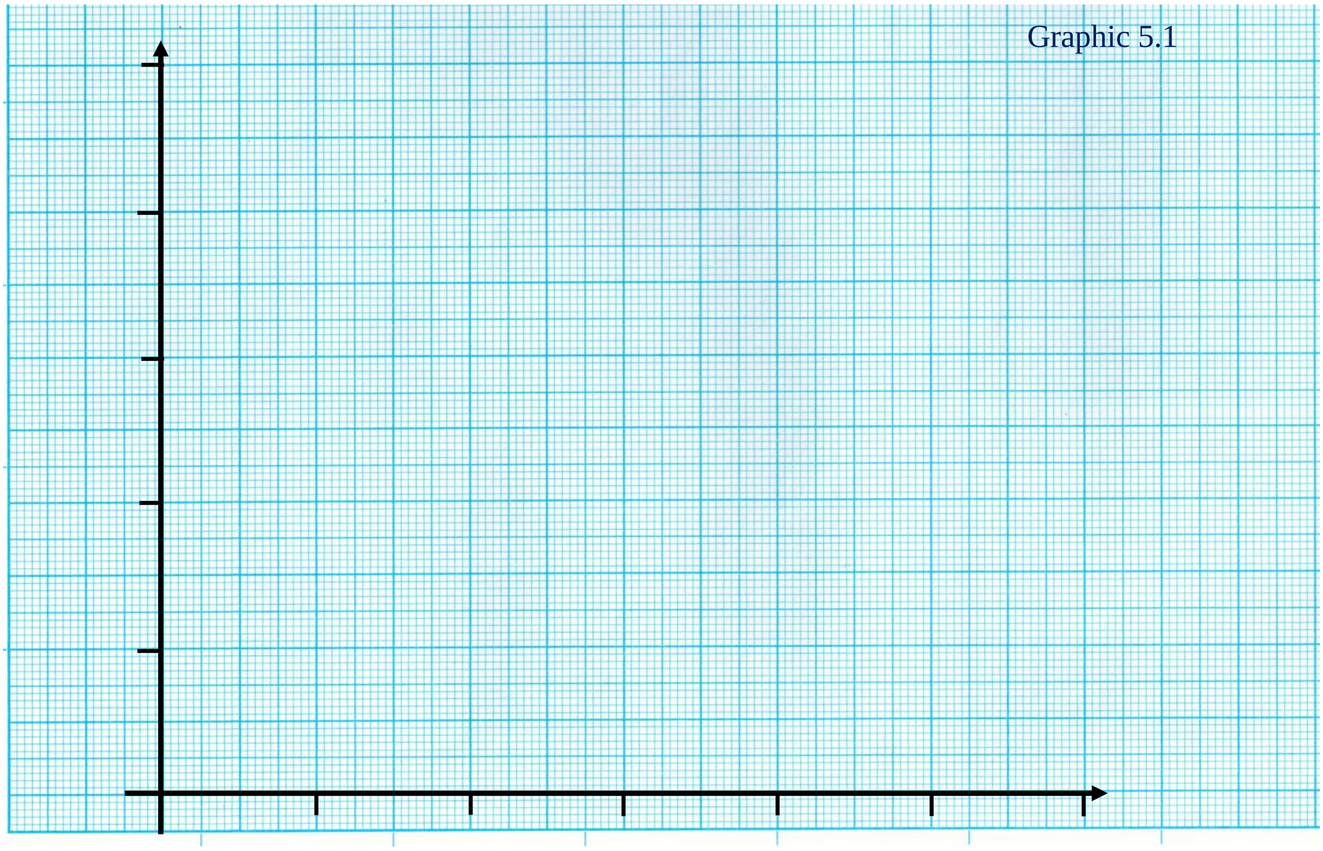
6. The period is the time for a complete rotation of the disk, and the angular value of a full turn is 2π, therefore, the angular velocity is given by $\omega = 2\pi/T$. The relation between the angular and linear velocities is given by $v = \omega r$. By using these two equations, one can calculate the linear velocity of the disk for each height. These calculated velocities are experimental values of ω and v_E. In theoretical part, we derived the Equation 5.16 for the velocity of such system for its measured radius and height. By using these measured values, calculate the experimental angular (ω) and linear velocities (v_E) for these four heights, and record your values to the Table 5.2.

Table 5.2: Angular (ω) and experimental (v_E) velocities.

x (m)	T (s)	$\omega = \frac{2\pi}{T}$ (rad/s)	$v_E = \omega R$ (m/s)	v_E^2 (m/s)^2

7. As we know from kinematics, velocity as a function of displacement *x* is given by the expression $v_f^2 = v_i^2 + 2a(x_f - x_i)$ for constant acceleration. If we assume the initial velocity $v_i = 0$, then the equation turns into $v^2 = 2ax$. The equation provides the final velocity in terms of the acceleration and the displacement of the particle.

Use the values in the Table 5.2 and plot v^2-x graph with x-axis the *height* (x) and y-axis is the *square of velocity* (v^2). Represent the values in the Table 5.2 as points on your graph. If one takes squares of both sides of the Eq. 5.16, one can get $v^2 = 2[\frac{g}{(1+\frac{R^2}{2r^2})}]x$ and the latter expression describes a linear (y=mx) relation between the square of the *velocity* (v^2) and the *height* (x), with the slope $m = 2[\frac{g}{(1+\frac{R^2}{2r^2})}]$. Use the slope m, which will be calculated in the following step; plot y=mx line on your graph. Observe the fitness of the line with your data points on the graph.



8. You are expected to calculate the slope $m = 2[\frac{g}{(1+\frac{R^2}{2r^2})}]$. The slope of the line could be calculated using the values in the Table 5.2 with the statistical fitting method called *"least squares method"*.

Calculate the two terms that will be used in the equations below.

$\sum_{n=1}^{4} x_n v_n^2 =$

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Substitute those values in equation below and calculate the slope *m*.

$m = \frac{\sum_{n=1}^{4} x_n v_n^2}{\sum_{n=1}^{4} x_n^2} =$

The acceleration *a* can be calculated from the slope *m* according to the equation

$y = mx \Rightarrow v^2 = 2ax$

$m = 2a \Rightarrow a = \frac{m}{2} =$ (______)

Conclusion, Comment and Discussion:

(Tips: Give detail explanation about what you've learned in the experiment and also explain the possible errors and their reasons.)

Questions:

1) There are an energy loss due to friction in this experiment. If we want to calculate the loss what changes should take place in the given energy formula (see also: theoretical background). Derive the new formula.

Signature: