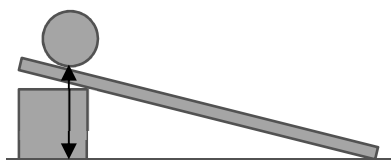# Experiments with the smartphone
speed measurement of a roll along an inclined plane with *Phyphox*

materials
1. smartphone with App *Phyphox* (Android, IOS)
2. chip can (Pringles) and scrap paper for padding
3. Inclined plane
4. scale, calipers

preparation
5. construction of the experimental arrangement corresponding to the left sketch.
6. Install *Phyphox* on your smartphone.
7. Start *Mechanics...Roll* and familiarize yourself with the functions.
8. Measure in advance the radius / diameter of the roll and the starting height as shown in the sketch.

video instructions https://youtu.be/gPq4Le9kXWE

Implementation

The "Phyphox" app is started and the radius of the roll is entered in the field provided. Then the smartphone with the filling material can be inserted into the box. The display should initially stick out a bit so that the program can be started using the play button at the top. Then, after activating the measurement, the smartphone is put in the tube and rolled down the ramp. The measurement is then ended and the experiment can be evaluated.

Note

Many smartphones have a 3-axis gyroscope with which the rotation of the smartphone can be measured. Together with the acceleration sensor, the software in the smartphone recognizes the change in motion and can react accordingly. This is sometimes used when navigating, aligning the display, or playing games. The sensor is able to measure and record the rotation around each of the three spatial axes x, y, and z. The sensor has a size of approx. Two by two millimeters and consists of an oscillating system, which is influenced by the Coriolis force when rotated. This is measured by means of capacitors and transferred to the angular velocity.

Questions and tasks

1. Explain how the program can determine the speed of the roll using the specified data and the measured angular velocity.
2. Transfer selected measurement pairs as precisely as possible into a $\square\ \square\square\ \square$ graph and determine the acceleration of the tube rolling along the plane.
   (You can access the measured values individually if you export them and display them in a corresponding program (Google Sheets, Excel, Word, ...).)
3. Enter the speed of the roll at the end of the inclined plane.
4. Determine the kinetic energy and the potential energy of the roll at the time of the start. Compare the values and evaluate the result.

   In addition to the translational kinetic energy ($E_T = \frac{1}{2} \cdot m \cdot v^2$), the cylinder also has rotational kinetic energy that can be calculated ($E_R = \frac{1}{2} \cdot I_Z \cdot \omega^2$ with $I_Z = \frac{1}{2} \cdot m \cdot r^2$). The kinetic energy of a rolling body can then be calculated using $E_K = E_T + E_R$.

5. Determine the rotational energy from your measured data and determine the actual kinetic energy. Compare your values again with the potential energy and evaluate the result.

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