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## The scenario

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| **Subject** | **Mechanics - Moment of Inertia** |
| **Length** | 1:39 |
| **Main objectives** | Determine the angular acceleration and moment of inertia of the wheel . |
| **Detailed objectives** | Rotational motion, Moment of inertia, angular velocity and acceleration |
| **Structure and description of experiments:** | |
| **1. Introduction** | Description: When the weight falls, it is a uniformly accelerated motion and the wheel rotates with a uniformly accelerated motion. |
| **2. Main subject** | Description: Defining moment of force and moment of inertia. |
| **Part 1** | **Turning the wheel using a constant force** |
| **(0:40)**<br><br><br>**(0:49)**<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>**(1:25)** | **Tools:** wheel, stand, meter, weights, scales, string<br><br>**Description:**<br>We fix the wheel on the stand so that it can rotate freely. We measure the diameter of the wheel (2*$R$ = 0,65 m), the weight of the weight ($m_z$ = 55 g) and wheel ($m_k$ = 1,65 kg ). We place the weight on the string and fasten it to the wheel so that it can fall freely on the mat. We set the weight so that it is at a height $h$ above the mat. After the wheel is released, the weight starts to fall down with acceleration $a$ and at the same time spins the wheel with angular acceleration $\varepsilon$. The weight takes time to fall $t$ and from the traveled path $\boldsymbol{h = ½\, a\, t^2}$ we can determine the acceleration $a$.<br>When the weight hit the pad, the wheel turned by an angle $\boldsymbol{\alpha = ½\, \varepsilon\, t^2}$ **,** from which we can determine the angular acceleration.<br>By comparing the results, we can confirm the relationships:<br>$\boldsymbol{h = \alpha R}$ - the length of the circular section after turning is equal to the length of the path of fall<br>$\boldsymbol{a = \varepsilon R}$. - the angular acceleration is proportional to the tangential acceleration times the radius<br>When the weight falls, an equal the torque acts on the wheel<br>$\boldsymbol{M = R \,.\, G = R \,.\, (m\, g)}$.<br>The relation also applies to the torque $\boldsymbol{M = I\, \varepsilon}$, where $I$ is the moment of inertia of the wheel.<br>By comparing the moments and the known angular velocity, we can determine the moment of inertia of the wheel.<br><br>t = 1.56 s, h = 0.71 m, $\alpha$ = 126°, a = 0.587 m/s$^2$,<br>$\varepsilon$ = 1.81 rad/s$^2$, I = 0,097 kg.m$^2$<br>$a = g \,.\, 2 \,.\, m_z / ( m^*_k + 2 \,.\, m_z)$<br><br>In the second attempt, we use a weight with twice the weight ($m_z$ = 110 g), while the other conditions of the experiment do not change. Since the weight is twice as heavy, the moment of force should be |

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| | twice as much and the acceleration with angular acceleration should be increase by approximately by two times. What will be the fall time?<br><br>**Questions:**<br>What is the relationship between **h** and $\alpha$?<br>After the impact of the weight, will the rotational movement be uniform or accelerated?<br>Where should a weight of twice the mass be placed so that the wheel rotates at the same angular speed?<br><br>**Conclusions:** The fall of the weight causes a constant force and the torque that turns the wheel. |
| **3. Summary, evaluation and notes** | Comparison of rotational and accelerated motion.<br>It is also possible to determine the moment of inertia based on a theoretical relationship.<br><br>**Level:** gymnasiums, secondary vocational schools (1st Year, ISCED 3 |

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