Physics I

Rotational Kinematics

Equations for constant angular acceleration:

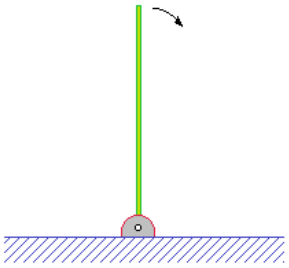
$\langle \omega \rangle = \frac{\theta}{t} = \frac{\omega_1 + \omega_2}{2}$ average angular velocity

$\omega_2 = \omega_1 + \alpha t$ $\theta = \omega_1 t + \frac{1}{2}\alpha t^2$ $\omega_2{}^2 = \omega_1{}^2 + 2\alpha\theta$

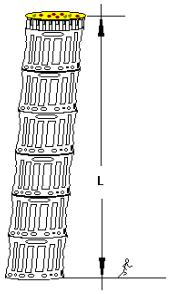
Rotational kinetic energy $KE_{rotational} = \frac{1}{2} I\omega^2$

Problem 1.- A thin uniform rod of mass M and length L is positioned vertically above a frictionless pivot point, as shown in the figure, and then allowed to fall to the ground. With what angular velocity (ω) does the rod strike the ground?
Suggestion: Use conservation of mechanical energy to solve this problem

Moment of inertia of a rod rotating about one end = $\frac{1}{3}ML^2$



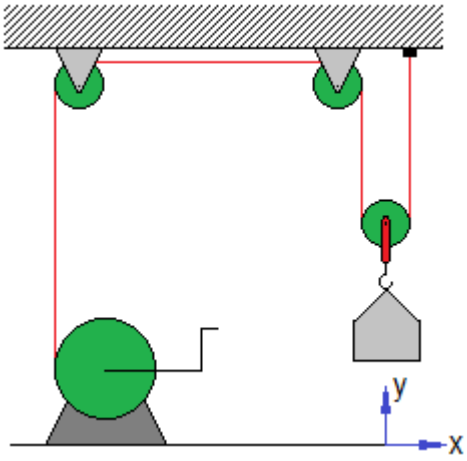
Problem 2.- The leaning tower of Pizza shown in the figure has a height of L=34 m and finally falls. Calculate the speed of the top of the tower when it hits the ground. To solve the problem consider the initial angle off the vertical to be negligible, assume that the mass of the tower is uniformly distributed, ignore any external torque and approximate the moment of inertia to the one of a rod rotated about one end $I = \frac{1}{3}ML^2$



Problem 3.- A clinical centrifuge accelerates uniformly from initial velocity zero to 3100 rpm in 6.0 seconds. Calculate the number of turns done by the rotor in that time.

Problem 4.- An engine accelerates uniformly from initial velocity 2000 rpm to 3200 rpm in 6.0 seconds. Calculate the number of turns done by the rotor in that time.

Problem 5.- A block is raised at a constant velocity of magnitude v. The three small pulleys have radius r and the large one R. The length of the handle is 2R. Take a coordinate system with x-axis to the right and y-axis upwards.



a) Determine the instantaneous position of the mass if at time t=0 its position was the origin of coordinates.

b) Determine the instantaneous angle of the large pulley.

c) How many turns do you need in the large pulley, so the mass reaches a height h?

Problem 6.- Why does the nitrogen molecule in the atmosphere has more heat capacity than argon atoms?

Problem 7.- You have two pulleys A and B with the same mass and with approximately cylindrical shapes. If the radius of pulley A is twice that of B, and both rotate at 360 rpm, what can we say about their rotational kinetic energies?

Problem 8.- A communications satellite rotates over its own axis at 10rpm to maintain a uniform temperature (while being heated by the sun). The satellite extends a retractable antenna, which increases its moment of inertia by 10%. What will happen to the rotational kinetic energy of the satellite?

Problem 9.- A clutch disk rotates freely at 300rpm when another identical disk, initially at rest joins it and end up rotating together at 150rpm. What can we say about the kinetic energy before and after?