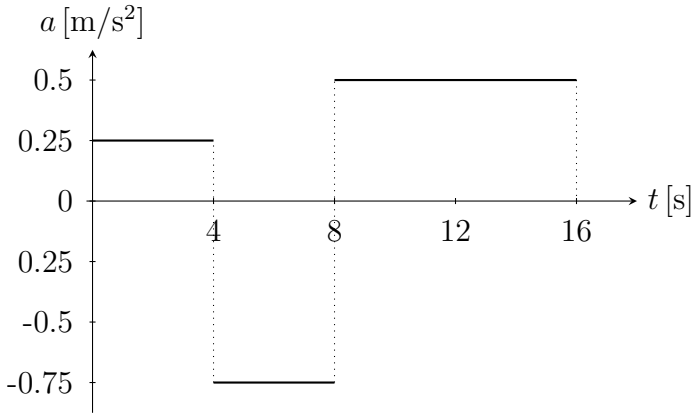
1st midterm exam. Fizika na FRI
10. December 2025 19:00 - 20:30

1. The acceleration of a body changes in time as shown in the graph below. The body is at rest at the time $t = 0$.

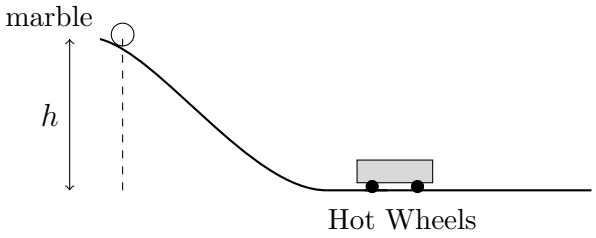


   (a) Calculate the velocity at times $t_1 = 2.7\,\mathrm{s}$ and $t_2 = 7.3\,\mathrm{s}$.

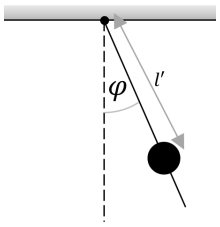
   (b) What is the position at time $t_3 = 14.5\,\mathrm{s}$? What is the path traveled up to that point?

   (c) Draw the graphs of velocity and position as functions of time!

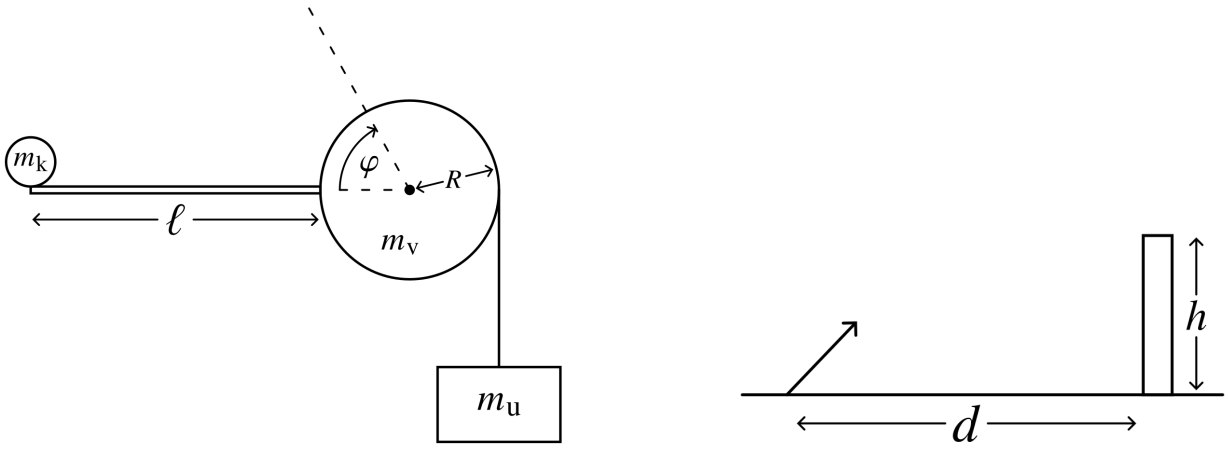
2. A marble with radius 1 cm rolls down an incline without slipping. A Hot Wheels car is parked at the bottom of the incline. After the collision, the car and the marble stick together. How high above the ground (h) did the marble start to roll, if the car's velocity after the collision is equal to $1.6\,\mathrm{m/s}$? The mass of the marble equals 20 g and the mass of the car 30 g. Neglect friction.



3. A pendulum of a mechanical clock can be described as the oscillation of a thin rod of mass $m = 0.1\,\mathrm{kg}$ and length $l = 1.05\,\mathrm{m}$ with a solid sphere of radius $r = 5\,\mathrm{cm}$ attached at distance $l' = 60\,\mathrm{cm}$ from the rotation axis, as shown in the following diagram. Calculate the mass of the sphere so that the oscillation period is equal to $t_0 = 1.6\,\mathrm{s}$.



4. A Gaul tribe wants to attack an enemy fortress using a new catapult shown in the left picture below. The catapult consists of a central cylinder of mass $m_\mathrm{v} = 100\,\mathrm{kg}$ and radius $R = 1\,\mathrm{m}$. The cylinder is mounted so that it is free to rotate around its central axis. A light rod of length $\ell = 2\,\mathrm{m}$ is attached to the cylinder. The Gauls place a stone of mass $m_\mathrm{k} = 15\,\mathrm{kg}$ and want to launch it over the defensive wall of the fortress. The catapult is driven by the gravitational force on a large weight of mass $m_\mathrm{u} = 500\,\mathrm{kg}$ that is wound around the cylinder and rotates the catapult from the horizontal position by an angle of $\varphi = 60°$. The catapult then stops, launching the stone. Can the Gauls launch the rock over a $h = 10\,\mathrm{m}$ high wall that is $d = 30\,\mathrm{m}$ away using their new catapult? Assume that the stone is fixed in place as the catapult moves between its initial and final positions.



5. The Kobayashi Maru tanker is approaching the port in Koper with an initial velocity $v_0 = 11\,\mathrm{m/s}$. When its engines are turned off, its deceleration changes to $a = -k\,v$, where $k = 2.5\,\mathrm{s}^{-1}$.

   (a) Calculate the time it takes for the tanker's velocity to reduce to $v = 1.1\,\mathrm{m/s}$.

   (b) Calculate the distance from the pier x_0, where the tanker must shut off its engines to reach the pier with a velocity smaller than $1.1\,\mathrm{m/s}$?