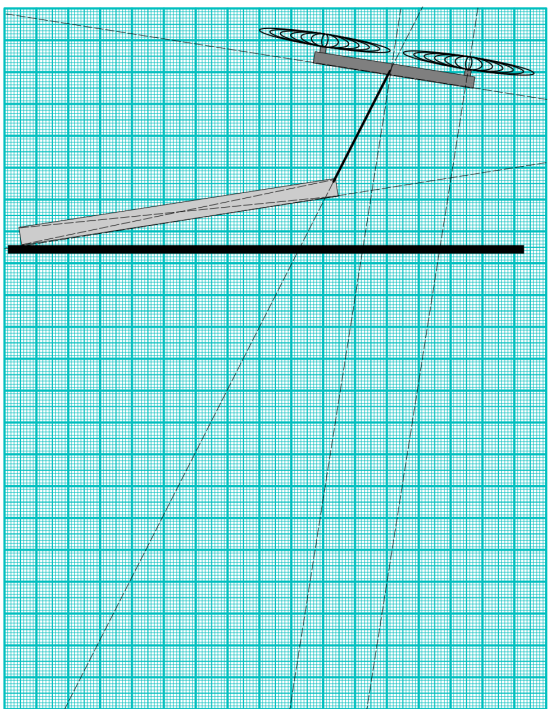
4. Drone (9 points) — *Lasse Franti and Jaan Kalda.*

A drone is pulling a cuboid with a rope as shown in the sketch; the cuboid is sliding slowly, with a constant speed, on the horizontal floor. The cuboid is made from an homogeneous material. You may take measurements from the sketch (on a separate page) assuming that the dimensions and distances on it are correct within an unknown scale factor. In order to help you in case you don't have access to a printer, and need to read the problem texts directly from the computer screen, some auxiliary dashed lines are shown in the diagram (which might or might not be useful).



i) *(2 points)* Find the coefficient of friction between the cuboid and the floor.

ii) *(2 points)* Find the mass of the cuboid if the mass of the drone is $m = 1\,\mathrm{kg}$.

iii) *(2 points)* Next we will be studying the flight of a drone in adiabatic atmosphere. In adiabatic atmosphere, air parcels are moving continuously up or down, and while doing so, expand or contract adiabatically. It can be shown that in adiabatic atmosphere, the temperature is a linear function of the height z: $T = T_0 - zg/c_p$, where $T_0 = 293\,\mathrm{K}$ is the temperature on the ground, $c_p = 1.00\,\mathrm{J\,g^{-1}\,K^{-1}}$ is the specific heat of air at constant pressure, and $g = 9.81\,\mathrm{m/s^2}$. Find the dependence of air density ρ as a function of height, in terms of the density ρ_0 at the ground level ($z = 0$), specific heat of air at constant volume $c_v = 0.718\,\mathrm{J\,g^{-1}\,K^{-1}}$, and other previously defined quantities.

iv) *(3 points)* Assuming that the maximal flight height $\mathbf{z}_{\max}$ of a drone with no load is limited by the power of its motor, find $\mathbf{z}_{\max}$ if it is known that the power is just enough for the drone to lift a load equal to **50%** of its mass off the ground. You may neglect the effect of turbulence on drone's thrust.