Some tasks to solve

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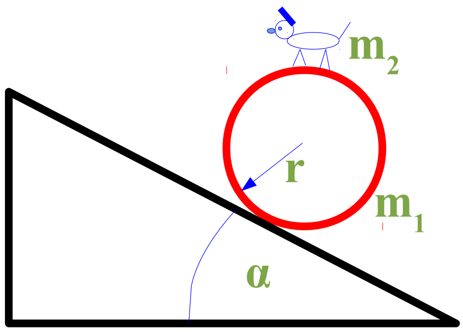
1 Kinematics

Task 1: On a horizontal trajectory, a train moves with a constant acceleration a_0. (At the begenning of the motion, its speed was equal to 0.) At a given time, direction of acceleration turnes into its negative. At a time t_0 (from the beginning of the motion), the train gets back to its initial position. Let us calculate the maximal distance between the train and the station.

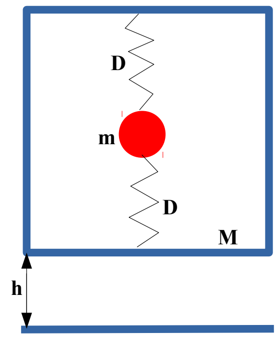
2 Dynamics

Task 1: On a slope with an angle α, a cylinder (with a radius r and mass m_1) is rolling downwards with a non-skidding roll. On the surface of this cylinder, a dog (with a mass m_2) is running to stay on the upper point of the cylinder. Let us find out the acceleration of the cylinder.

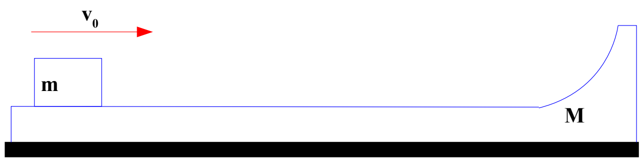


3 Work, energy, laws of conservation

Task 1: As it can be seen below, we have a box (with a mass $M = 4\text{kg}$) connected to a body (with a mass $M = 0.25\text{kg}$ by using two springs whose spring constants equal each other ($D = 200\frac{\text{N}}{\text{m}}$). This system is flopped from a height h. At the beginning of the fall, springs are unextended. At the end of the fall, impact is inelastic, and during the fall drag can be neglected. From how high shall we flop the box, if we want it to lift off from the ground, after its impact?



Task 2: As we can see below, we have a point-like body (with a mass m) on a biger one (with a mass M) standing on the ground. We push the little body with an initial velocity v_0. Let us calculate how high will the little body lift, if friction between little body and the big one (just like between the big body and the ground) can be neglected.



4 Hydrodynamics

Task 1: A barrel which is standing on a horizontal floor is filled with water till a height h.
a) How high (from the floor) shall we hole the barrel, if we want water to reach the floor at a maximal distance from the barrel?
b) How big is this maximal distance?

Task 2: We have a chimney with a diameter $d = 30cm$. Inside of this chimney (at its rump) the smoke flows with a speed $v = 15\frac{m}{s}$ and in this place the density of smoke equals $0.06\frac{kg}{m^3}$. How big is the speed of the smoke at the top of the chimney?

5 Thermodynamics

Task 1: We are astronauts travelling in a space modul with a volume $V = 20m^3$. We observe that though temperature is constant ($T = 300K$), air pressure is decreasing from its initial *normal* value with a rate $q = 1\frac{\%}{hour}$.
a) Let us try to estimate the size of the hole on the space capsule.
b) How much time remained for astronauts to repair the injury of the modul, if maximal allowed measure of fall in pressure equals 25%?

Task 2: In the space from a space shuttle (which is in the state of weightlessness) we take out a rotating iron disc with a radius $r = 1m$, mass $m = 100kg$, and speed $n_1 = 3000\frac{1}{min}$. Inside of the shuttle, temperature is $T_1 = 300Kelvin$. Temperature of space is $T_2 = -270Celsius$.
a) How much will be the value of n_2, after reaching thermal equilibrium?
b) How much is the value of the energy which was passed down by the disc to its environment, during the interaction? (Radiation of the Sun can be neglected.)
Data: $c_{iron} = 464\frac{J}{kg*Kelvin}$, $\alpha_{iron} = 1.1 * 10^{-5}\frac{1}{Kelvin}$.

Task 3: We have two equable metal spheres which are given egal energy of heat. One of these spheres is on a floor covered by lagging, and the other one is hanging on a wire covered by lagging (just like the floor). Which one will have the higher temperature?

Task 4: Let us find out the measure of energy which is absorbed by a surface with a reflection coefficient 0.6, in case of a heat flux density which equals $26\frac{W}{cm^2}$.