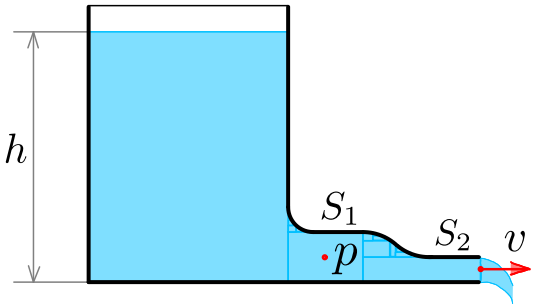
Review of Physics 2 - Exam

Semestr: *sommer, 2019/20,* ***Tutor:*** *Martin Žáček,* ***Date:*** *2020-07-03*

For every task is for correct general result 1 point, for correct numerical result 1 point and correct way of solution for 3 points, i.e. maximum of possible points is 5 per task and maximum 20 points for the test. Numerical results estimate with the 1-digit of precision.

Task 1 - Water flowing out of a vessel

A vessel is filled with water to the height $h = 0.5\ \mathrm{m}$. At the bottom is connected a horizontal tube consisting of two parts. The first one has cross-section $S_1 = 1\ \mathrm{cm}^2$, the second one $S_2 = 0.5\ \mathrm{cm}^2$ and its end is open so water can flow freely out of the vessel (see picture).



1. Calculate the speed v of the outflowing water at the end of the tube.
2. Calculate the pressure p in the first part of the tube.

Calculate with the density of water $\rho = 1\,000\ \mathrm{kg\,m^{-3}}$ and the gravity acceleration $g = 10\ \mathrm{m\,s^{-2}}$.

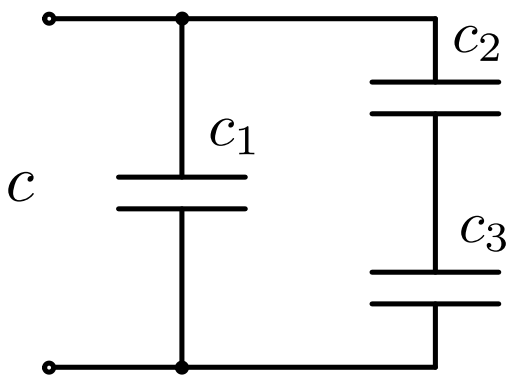
Task 2 - The seconds pendulum

The seconds pendulum is a pendulum whose length is set so that the period is equal to 2 seconds.

1. Calculate the length of the seconds pendulum, assume gravitational acceleration as $g = 10\ \mathrm{m\,s^{-2}}$.
2. Calculate the total energy of the second pendulum, if the mass is equal $m = 2$ kg and the initial deflection is $\varphi_0 = 2^\circ$
3. What is the ratio of the lengths $l_\mathrm{E}/l_\mathrm{M}$ and total energies $E_\mathrm{E}/E_\mathrm{M}$ for pendulums located on Earth and the Moon with equal initial deflections $\varphi_0 = 2^\circ$? Assume the ratio of accelerations as $g_\mathrm{E}/g_\mathrm{M} = 9.81/1.62 = 6.056 \approx 6$.

Task 3 - Capacitors

Three capacitors with capacities $C_1 = 5\ \mu\mathrm{F}$, $C_2 = 3\ \mu\mathrm{F}$ and $C_3 = 2\ \mu\mathrm{F}$ are connected serio-paralell where the first one is connected paralel with the remaining two, which are connected in series (see picture). Initially, the capacitors were not charged. Then was connected to a source with voltage $U = 10\ \mathrm{V}$.



1. Calculate the total capacity.
2. Calculate the voltage at the capacitor C_3.
3. Calculate the total bound charge of all capacitors.

Task 4 - Weight of the atmosphere

From the pressure acting to the Earth's surface calculate

1. The total weight m of the atmosphere.
2. The total amount of matter s of the atmosphere.
3. The total amount of particles N in the the atmosphere.
4. The teoretical height h of the the atmosphere with assumption that their concentration $n = N/V = \mathrm{const}$.

Assume the behavior of the atmosphere as an ideal gas with the constant pressure $p = 10^5\ \mathrm{Pa}$ and the constant temperature $\vartheta = 20\ ^\circ\mathrm{C}$. Calculate with the Earth's radius $R = 64 \cdot 10^5\ \mathrm{m}$. Relative atomic mass use as 14 and 16 for nitrogen and oxygen respectively; atmosphere take as compoud of two-atomic molecules with the N:O ratio as 4:1; the molar gas constant is $R_\mathrm{m} = 8.3\ \mathrm{J\,K^{-1}\,mol^{-1}}$ and Avogadro constant is $N_\mathrm{A} = 6.6 \cdot 10^{23}\ \mathrm{mol^{-1}}$.