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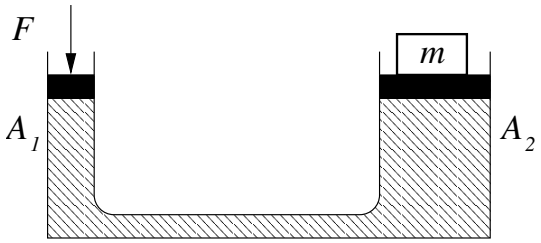
Exercises and Complements for the Introduction to Physics I for Students of Biology, Pharmacy and Geoscience

Sheet 7 / 29.10.2020 Zoom - Q&A on the Exercises: **03.11.2020/04.11.202020**

Exercise 31.

A mass of $m = 1.5$ t should be slightly lifted by a hydraulic system (cross section of the pistons $A_1 = 20$ cm^2, $A_2 = 0.36$ m^2), see figure. The mass of the big piston is $m_K = 100$ kg. Compared to that, the mass of the small piston is much smaller and therefore can be neglected. The pistons are at the same height. How big should the force F applied to the small piston be in order to lift m?

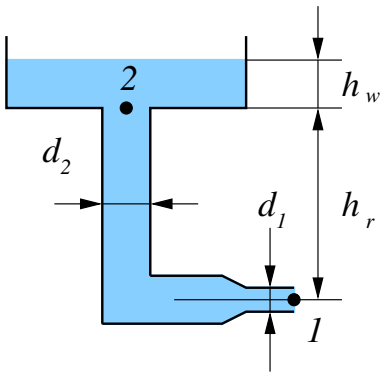


Exercise 32.

The transport of water from the roots to the leaves of a tree is realized through capillaries by the use of surface tension. Assume the density of nutrients containing water to be $\rho = 1.01$ kg/dm^3, the surface tension towards air is $\sigma = 0.073$ N/m and the angle at the edge is $\theta = 23$ degrees. How big is the maximum diameter of the capillary for a 12 m tall tree?

Exercise 33.

The water level in an open container is kept constant at a height of $h_w = 4$ m by continuously adding water. A tube (diameter $d_2 = 60$ mm and height $h_r = 10$ m) gets narrower at the horizontal opening. There, the diameter is reduced to $d_1 = 40$ mm. The air pressure is 990 mbar. Calculate:
(a) the flow rate at the exit v_1 (position 1).
(b) the flow rate v_2 at position 2.
(c) the pressure p_2 at the entrance (position 2).



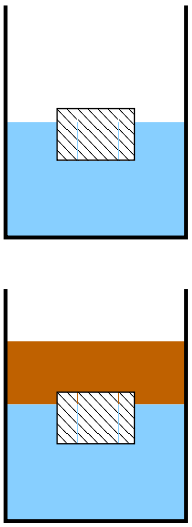
Exercise 34.

A reservoir is emptied via four tubes which are positioned next to each other. Each tube is l long and has a radius of $r_0 = 0.1$ m. The four tubes should be replaced by a single tube with a radius of r_1. The flowing resistance and the length l should be the same for both cases.

(a) Calculate r_1.
(b) The flow of the volume I_v should be equal in both cases. How big is the Reynolds number for the second case (Re_1) compared to the first (Re_0)?
(c) For which case is a turbulent flow more probable if you assume that the critical Reynolds number is the same for both cases? Explain your answer.

Exercise 35.

A wooden cuboid floats in a glass of water, see figure. 90% of its volume enters the water



(a) Calculate the density of the wood.
(b) We add oil ($\rho = 0.85 \cdot 10^3$ kg/m^3) to the water till the cuboid is completely covered, see figure. Is the volume entering the water bigger, smaller or equal than before? Argue qualitatively.

Solutions:

Exercise 31. 87.2 N

Exercise 32. 2.26 μm

Exercise 33. (a) 16.57 m/s (b) 7.36 m/s (c) 1.11 bar

Exercise 34. (a) 0.141 m (b) $Re_0/Re_1 \frac{1}{2\sqrt{2}}$

Exercise 35. (a) $0.9 \cdot \rho_w$