UNIVERSITÄT LEIPZIG

FAKULTÄT FÜR PHYSIK UND GEOWISSENSCHAFTEN

EXPERIMENTAL PHYSICS 1

EXERCISE 9
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Lecturer: Prof. Josef Käs
Tutor: M.Sc.Salvador Rivera
E-Mail: chava_rm@outlook.com

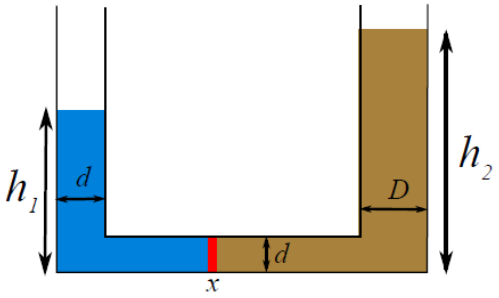
Problem 1: Surface tension **$2 + 2 + 3$ Points**

The surface tension of mercury at a temperature $T = 20°C$ is about $\sigma = 0.465 \frac{\mathrm{N}}{\mathrm{m}}$, its density at same temperature is $\rho = 1.55 \cdot 10^3 \frac{\mathrm{kg}}{\mathrm{m}^3}$.

a) 8000 Hg-beads of radius $r_1 = 0.1\mathrm{mm}$ fuse together resulting in a big sphere of radius $r_2 = 0.1\mathrm{mm}$. What is the released energy ΔW?
b) How large is the excess pressure p (resulting from surface tension) that is present in the small and in the large bead?
c) The mercury is now filled in an open u-pipe that has inner diameters of $2\,\mathrm{mm}$ and $0.5\,\mathrm{mm}$. How large is the height difference Δh between the 2 pipe segments with the different diameters? Assume that the mercury forms a convex meniscus on the tube walls.

Problem 2: Fluids under Gravity **$1 + 2 + 2$ Points**

In a u-shaped tube, water and ethanol (0.789 g/cm³) are separated by a movable membrane.



a. What is the ratio of the heights h_1, h_2 when the system is still?
b. Now the membrane is fixed and the water (left side) is filled up until $h_1 = h_2$. What is the displacement of the membrane, when it is made movable again (after long time when the system is still again)?
c. Consider that the mass of the membrane M_m is much higher than the total mass of both liquids. Also, the energy dissipation during the process described in b) is very small, so it takes a long time (and a high number of oscillations) for the system to become still. What will approximately be the maximum speed of the membrane?

Hints: Consider all the parameters in the sketch as well as fundamental constants given; consider bottom part of the tube long enough for any membrane displacements, consider d significantly smaller than h_1 or h_2.

Problem 3: Balloon with hydrogen gas **$2 + 2 + 2$ Points**

A sphere-like balloon with a case of fixed diameter 3m and mass $m_B = 2\ \text{kg}$ is filled with hydrogen gas.

(a) How large is the force acting on the balloon if an air pressure of p_0= 1 bar at temperature $T = 20°\text{C}$ is assumed? As densities, take $\rho_{0,O}$= 1.29 $\frac{\text{kg}}{\text{m}^3}$ for air and $\rho_{0,H}$= 0.09 $\frac{\text{kg}}{\text{m}^3}$ for hydrogen.

(b) To which height will the balloon rise if we assume a constant temperature of $T = 0°\text{C}$ at all heights? Take into account that realistically, the balloon is opened at its bottom i.e. the pressure of the hydrogen is equal to the pressure of the surrounding air at any given height. Assume ideal gasses for this task.

(c) How does the maximum height changes if helium is filled into the balloon instead of hydrogen? ($\rho_{0,He}$=0.18 $\frac{\text{kg}}{\text{m}^3}$)

Problem 4: Friction on ice **$2 + 2$Points**

An ice speed skater is accelerating to a velocity of $v = 50.76\frac{\text{km}}{\text{h}}$. The sliding friction between the ice skates and ice is given as 0.012.

a) What distance can the ice skater reach if they just let it slide?
b) How long does it take for the ice skater to come to a halt?

Task to think about:

Are gases and Fluids the same?