UNIVERSITÄT LEIPZIG

FAKULTÄT FÜR PHYSIK UND GEOWISSENSCHAFTEN

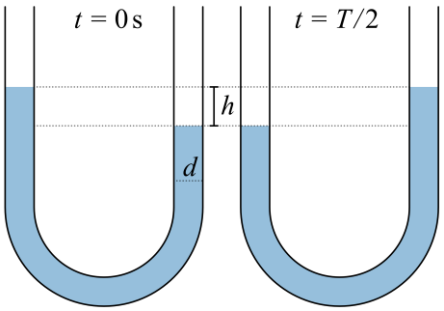
EXPERIMENTAL PHYSICS 1

EXERCISE 12
Date of Issue 17th of January 2023

Lecturer: Prof. Käs
Tutor: Salvador Rivera Moreno
E-Mail: Chava_rm@outlook.com

Problem 1: Oscillating Fluids — $2 + 2 + 2$ Points

A **U**-shaped hollow glass tube with circular cross-section and diameter of $d = 1\,\mathrm{cm}$ is filled with 30 grams of water, $m_{\mathrm{water}} = 0.03\,\mathrm{kg}$. You gently shake it and the water level starts to oscillate quickly up and down, see figure aside. The amplitude between highest and lowest water level is $h = 4\,\mathrm{cm}$. Friction can be neglected.



a. Find the equation of motion of the water level.
b. Calculate the oscillation frequency f of the water level.
c. Calculate the maximum speed of the water level.

Problem 2: Trigonometric properties — $2 + 2$ Points

a. Show that $A_0 \cos(\omega t + \delta)$ can be written as $A_S \sin(\omega t) + A_C \cos(\omega t)$ and determine A_S and A_C in terms of A_0 and δ.

b. Relate A_C and A_S to the initial position and velocity of a particle undergoing simple harmonic motion.

Problem 3: Pendulum **$4 + 3$ Points**

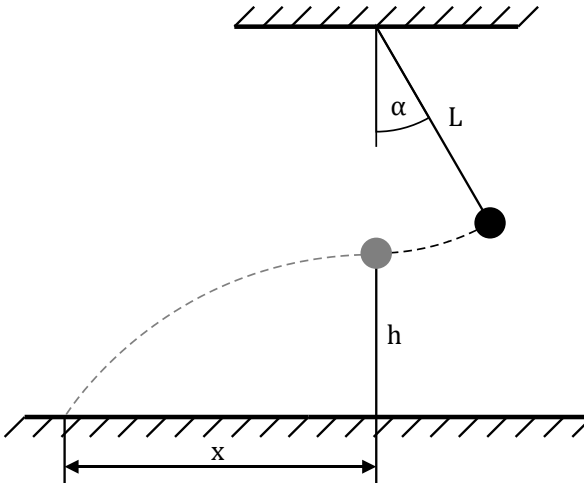
A pendulum that is used in your physics laboratory experiment has a length of $75\ \mathrm{cm}$ and a compact bob with a mass equal to $15\ \mathrm{g}$. To start the bob oscillating, you place a fan next to it that blows a horizontal stream of air on the bob. With the fan on, the bob is in equilibrium when the pendulum is displaced by an angle of $5.0°$ from the vertical. The speed of the air from the fan is $7.0\,\frac{\mathrm{m}}{\mathrm{s}}$. You turn the fan off and allow the pendulum to oscillate.

a. Assuming that the drag force due to the air is of the form $b \cdot v$, predict the decay time constant τ for this pendulum.

b. How long will it take for the pendulum's amplitude to reach $1.0°$?

Problem 4: Colliding pendulum **$1 + 3 + 1$ Points**

A pendulum with a length L and mass m starts at a time $t = 0$ with a velocity $v = 0$, displaced by an angle α. At the lowest point it hits another mass which sits on a pole, and an elastic collision happens.



a. How much time passes from the beginning of the movement unto the collision?
b. What are the speeds of the pendulum and the mass on the pole before and after the collision?
c. How far does the mass on the pole fly until it hits the ground?

Task to think about:

What is the difference between fluctuations around a stable position and oscillations around this position?