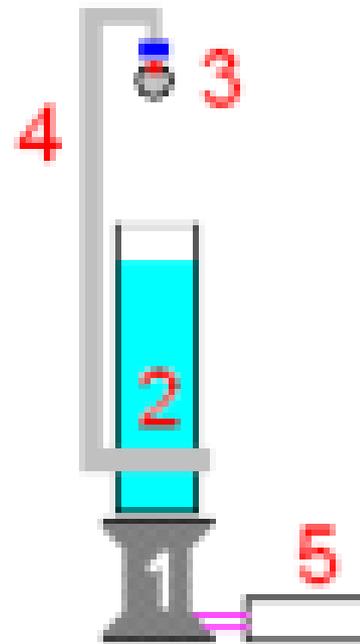


Falling Ball

Belarus

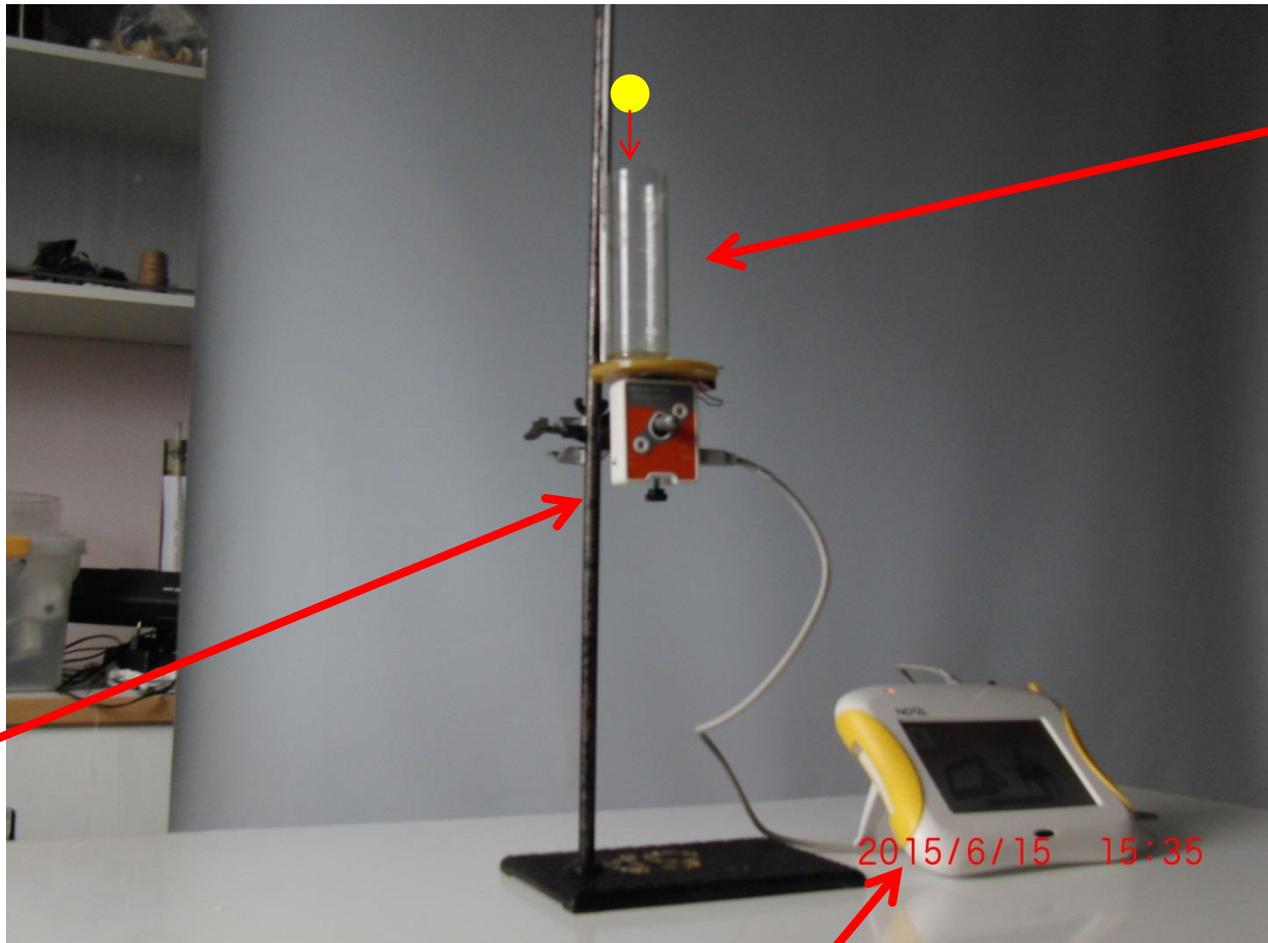
The problem

An electronic balance is connected to a PC in order to record the time dependence of the measured weight. A light frame is mounted on a tall beaker filled with water. The frame has a holder allowing controlled release of a small ball such that it falls into the water. The beaker is placed on the balance as depicted in the Figure. Investigate how the readings of the balance reflect the different phases of the motion of the ball.



Experiment

Experimental setup



Tall beaker

Force
sensor

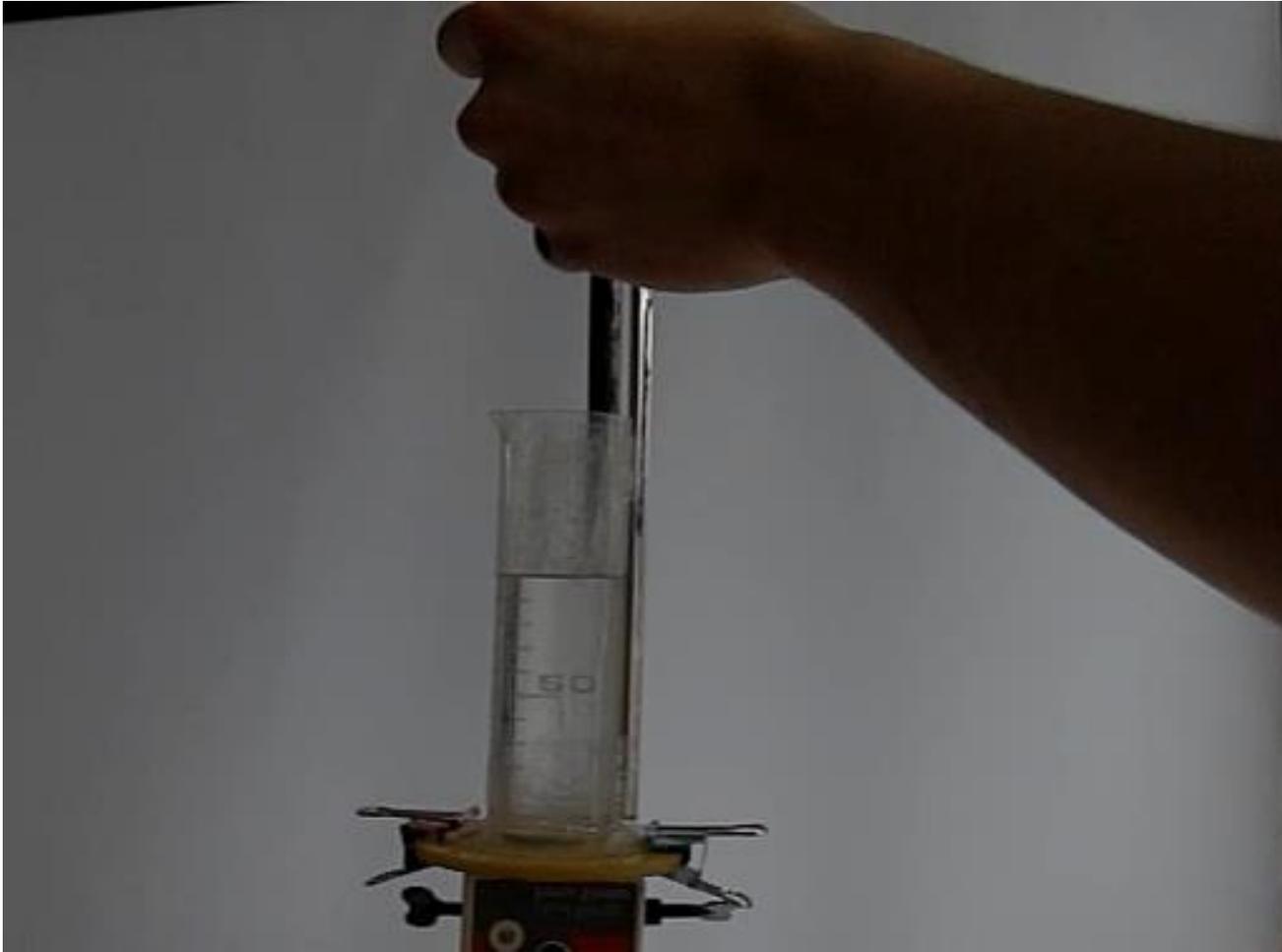
2015/6/15 15:35

Electronic laboratory "Archimed"

What is observed

PMS-300

12 times slow-down

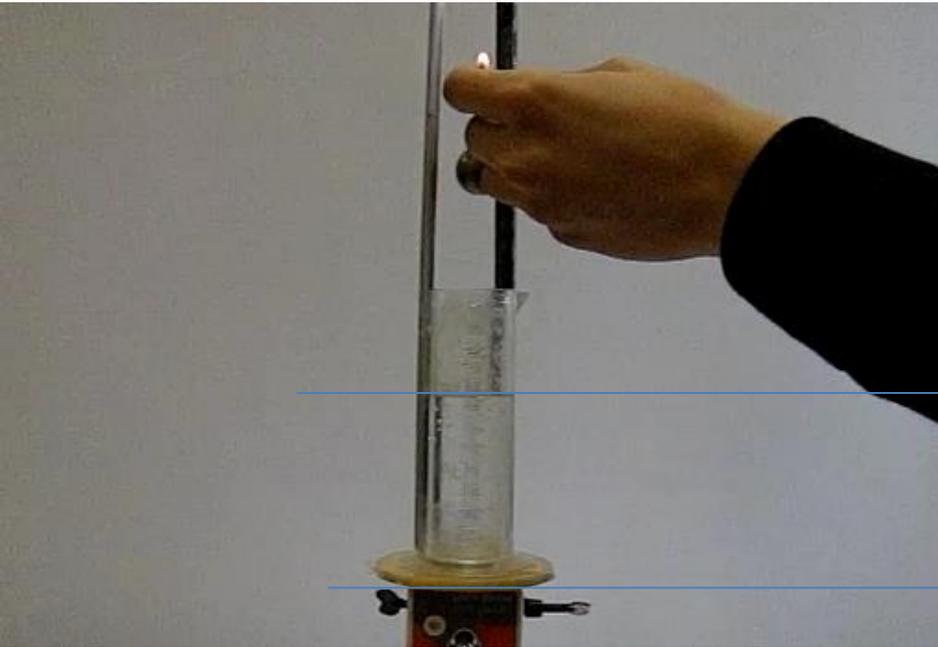


Phases of the ball movement

1. Free fall of the ball
2. Impact with liquid surface
3. Ball moves in the liquid
4. Impact with the bottom
5. Ball bounces

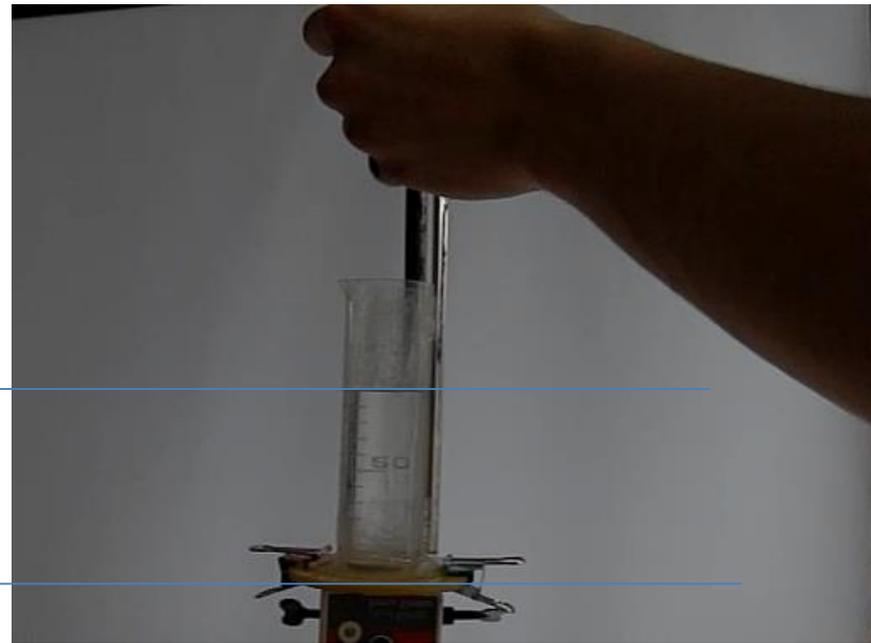
Comparing two media

Water



Water
 $\eta=0.001 \text{ Pl}$

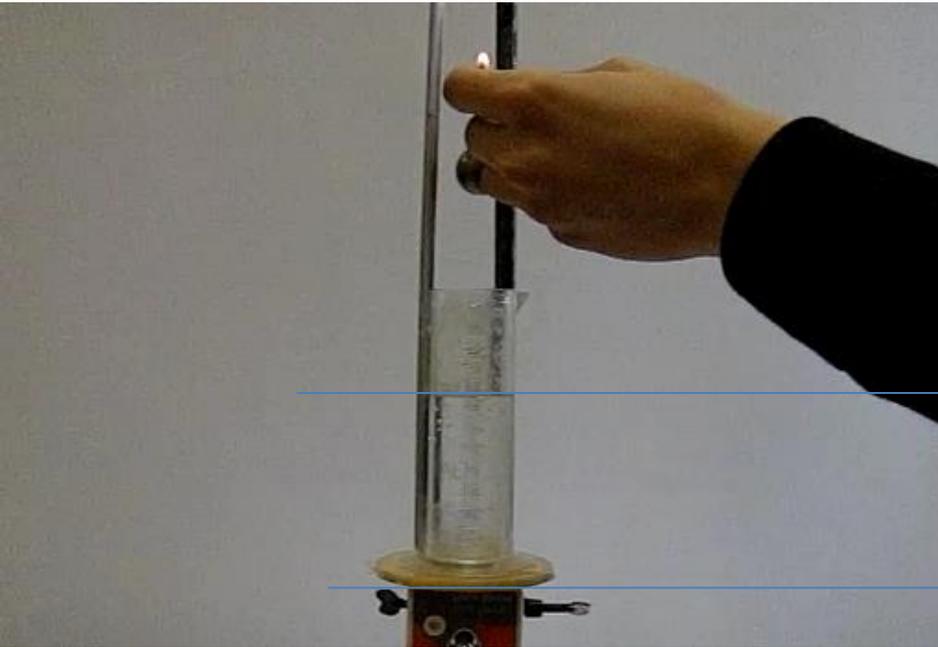
PMS-300



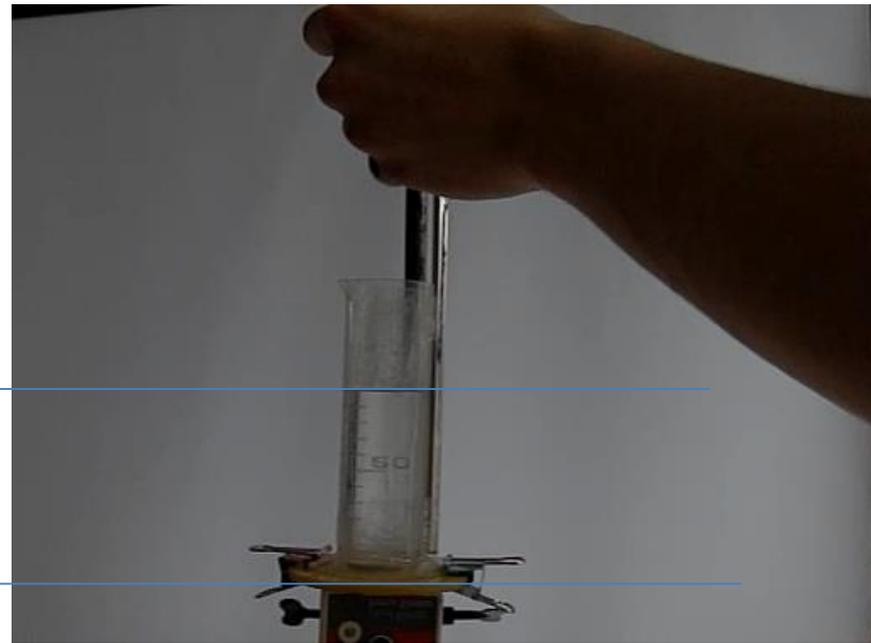
PMS - 300
 $\eta=0.3 \text{ Pl}$

Comparing two media

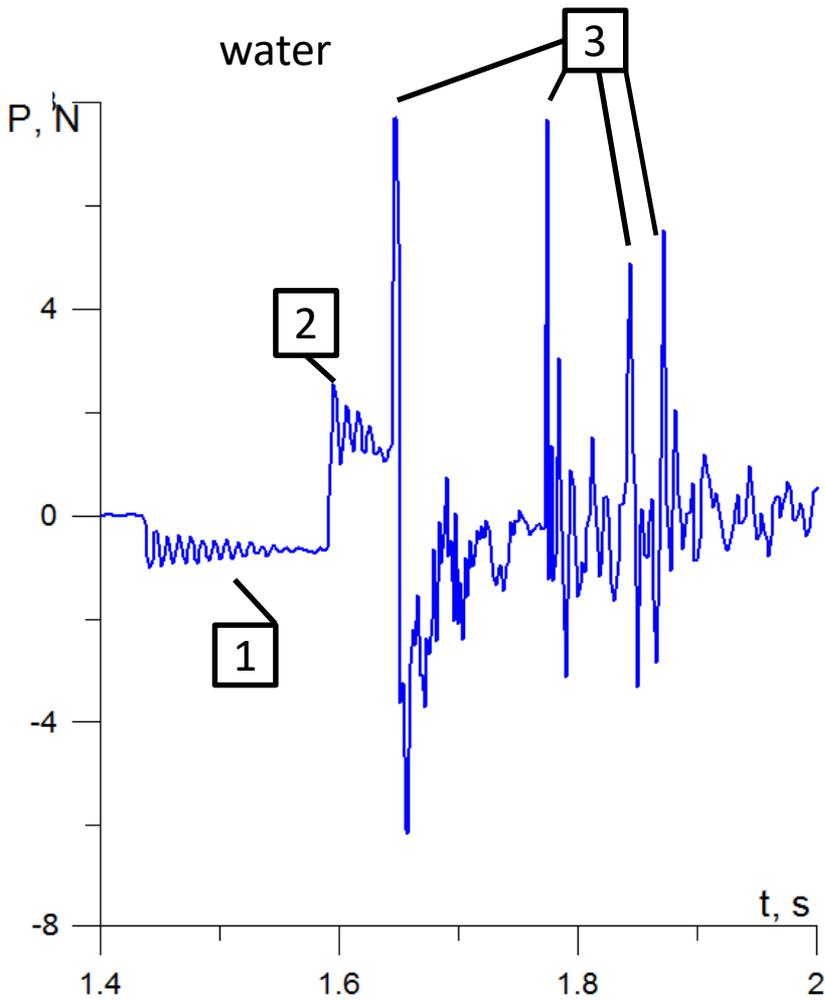
Water



PMS-300

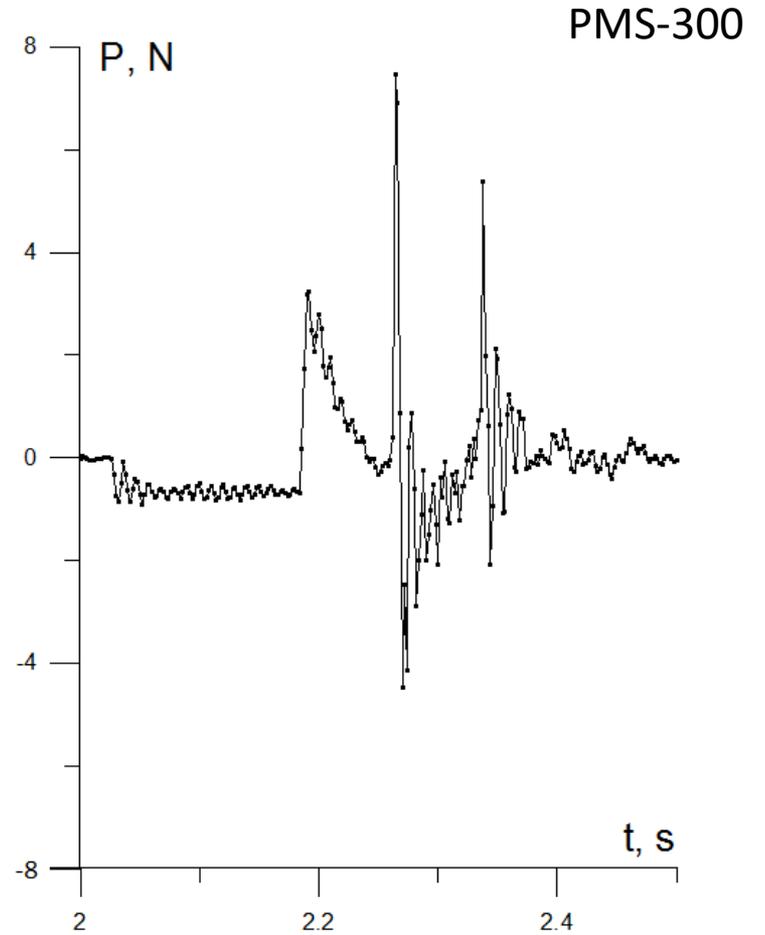


Results



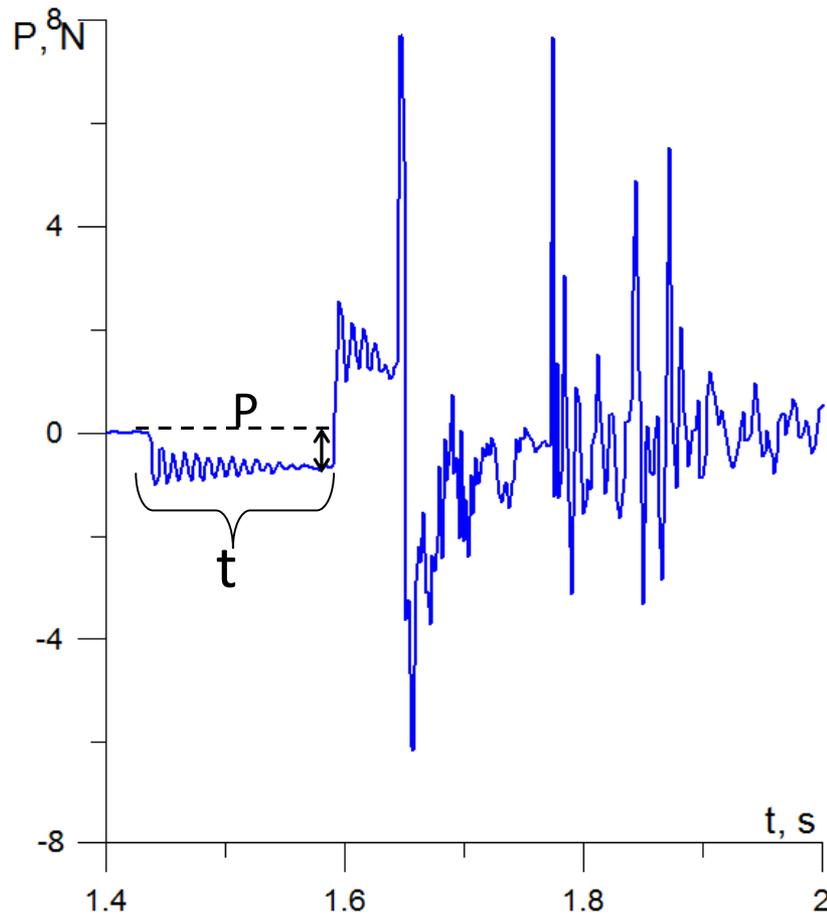
1. Ball in the air

2. Ball blows to water



3. Ball blows to the bottom

What can be deduced from the weight records



1. Mass of the ball (if we know the radius of the ball we can calculate the density)
2. Distance between the ball and liquid surface
3. Viscosity of PMS-300 is much higher than water viscosity (time of falling in liquid and number of bouncing)

IT IS NOT SIMPLE!

Does classical hydrodynamics applicable to this phenomenon?

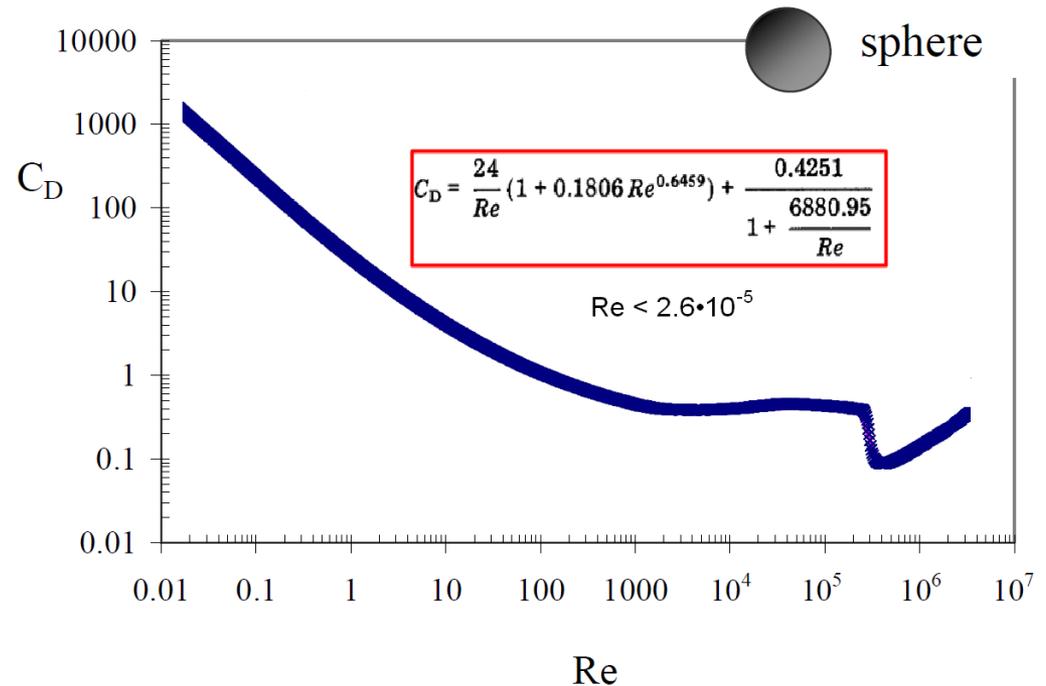
Everything Should Be Made as Simple as Possible, But Not Simpler

A. Einstein

$$Re = \frac{\rho v L}{\eta}$$

$$F_D = C_D \cdot S \cdot \frac{\rho v^2}{2}$$

C_D – drag coefficient



ESTIMATIONS OF FORCES AFFECTING BALL MOTION IN INFINITE LIQUID

For the impact velocity $v=1.4$ m/s

Re=28000

(turbulent flow)

$C_D=0.457$

Re=93.3

(laminar flow)

$C_D=1.13$

$$F_D + F_A < mg \quad !!!$$

Conclusions

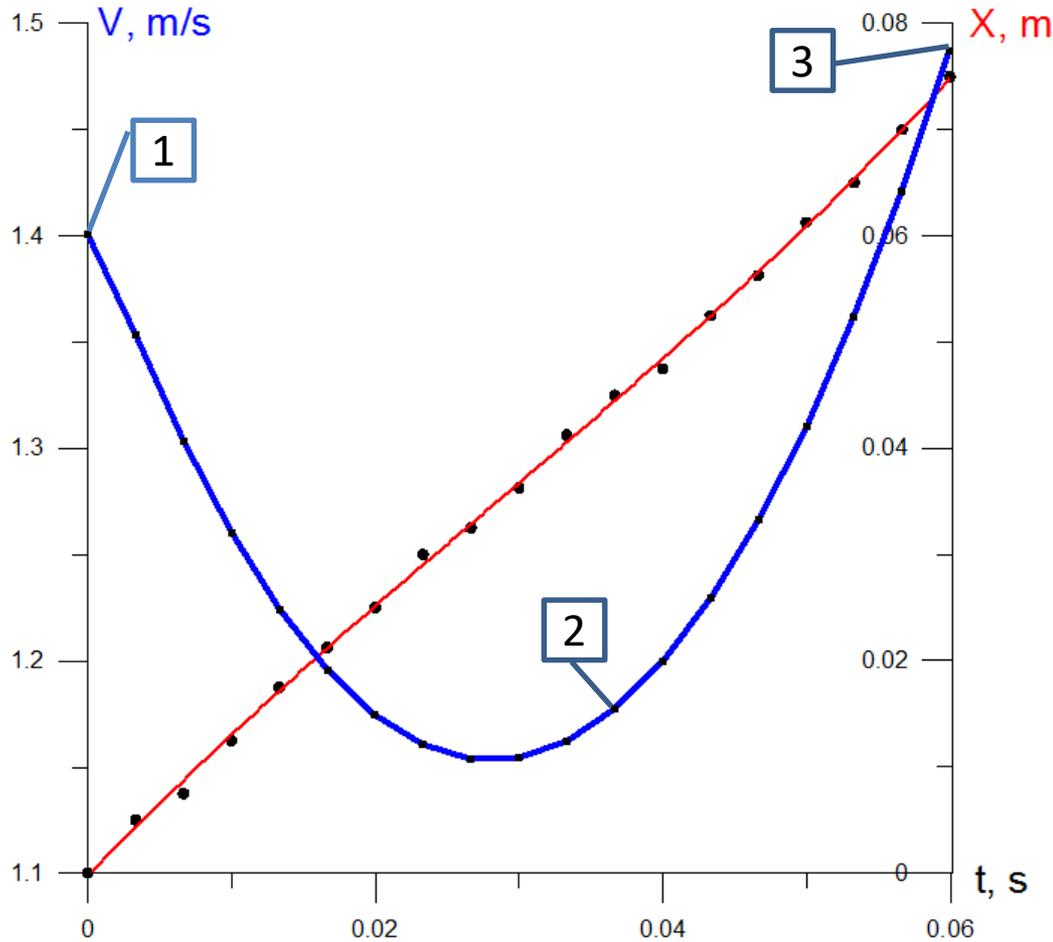
The phenomenon of a falling ball with entering another medium was studied. The readings of the balance were interpreted. It was found that the plot of the balance reading is complex and different stages of the experiment brought out were classified:

1. Free fall of the ball
2. Impact with liquid surface
3. Ball moves in the liquid
4. Impact with the bottom
5. Ball bounces

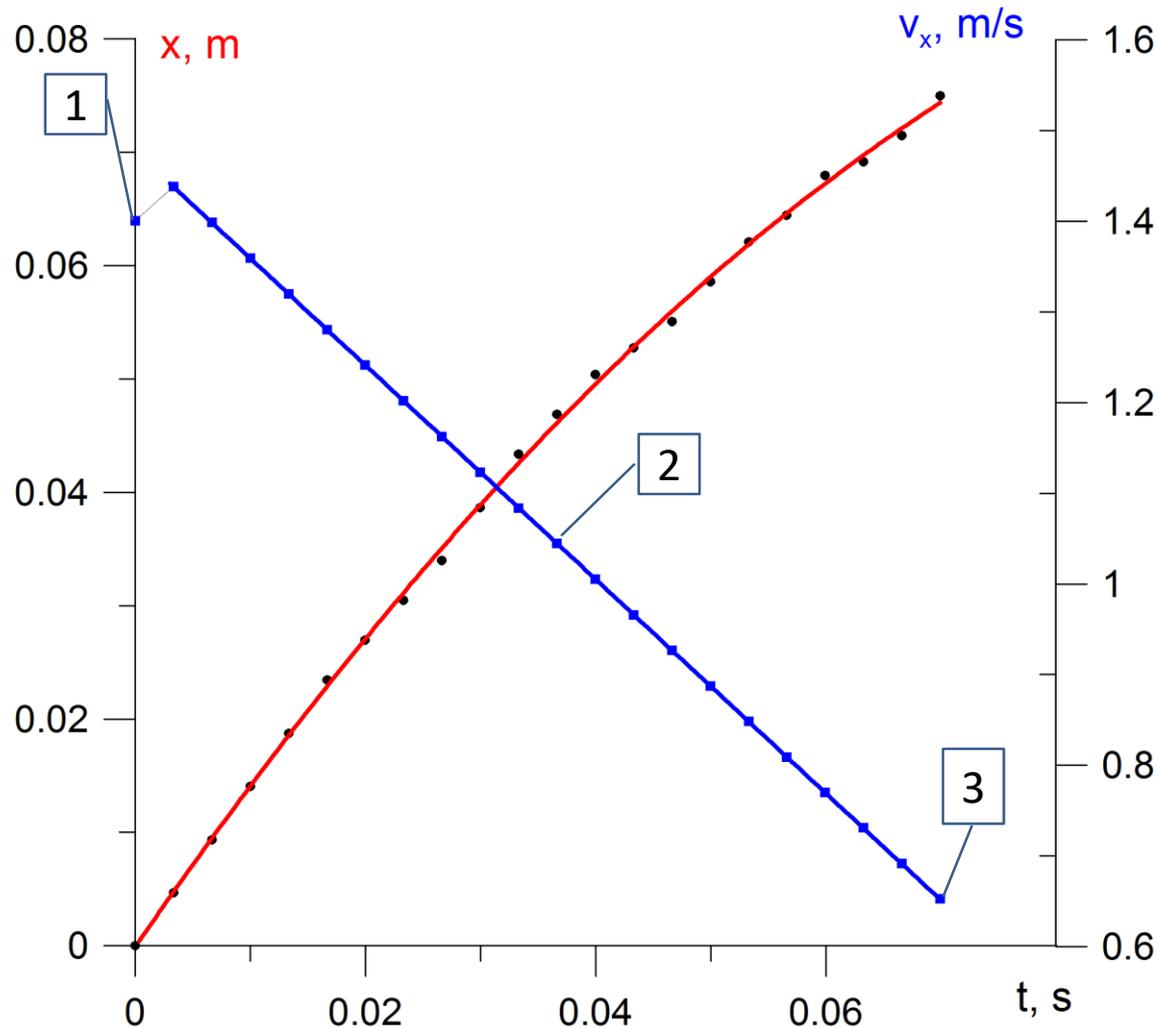
Certain characteristics were found to correlate with ball and liquid parameters.

Thank you for your attention!

Vertical coordinate and velocity of falling ball in water



Vertical coordinate and velocity of falling ball in PMS



Указать а

Re

Reynolds number is the ratio of hydrodynamic thrust to the viscous shear stress

Main features and discussion

1. Difference between weight records for water and PMS-300. Negative and positive acceleration.
2. Deep weight reduction at after ball impact with the bottom.