

SMS-204: Integrative marine sciences.

HMWK 3 (please pay attention to provide uncertainties and round off numbers to the appropriate significant digits):

1. (25pts) Using results from lab station 1 in lab (Archimedes' ball):

Work out mathematically how much air needs to be pulled out of the ball by the syringe in order for the ball to barely start sinking in the surrounding water. How does it compare to your observations (are they within the observation uncertainties)?

2. (30pts) Using results from station 4 in lab:

- a. Report the cross section area, volume and weight of the empty box.
- b. For the four box weights in which the box did not sink quickly create a table showing the weights added, the box weight in air, the box weight in water, and the depth to which the box was immersed in water.

Weight added to box	Box weight in air	Box weight in water	Immersion depth

- c. Plot the depth to which the box is immersed in water as function of the weight of the box in air (5pts).
- d. Obtain the slope of the best-fit line. (5pts)
- e. What should the slope be based on Archimedes's principle (5pts)?
- f. How does it compare to the slope of your plot? (5pts)
- g. Consider the final trial when you added enough weight so that the box quickly *sinks* in water.

In that case, what is the weight of the box when immersed in water and when outside water? What is the difference between them? (5pts)

- h. Is this difference reasonable given what you know about buoyancy? Explain. (5pts)

3. (25pts) In the 2nd lab you were studying water squirting out from a hole in a cylinder filled with water. Just as a falling ball falling converts potential energy to kinetic energy, water pressure pushed water out of the hole by converting potential energy per unit volume to kinetic energy per unit volume. The horizontal speed of the water squirting out of the hole should equal the speed of a ball dropped from a height equal to the water depth. After the water leaves the hole, it will fall towards the ground in the same manner as a falling ball. Look up “equations for a falling body” in Wikipedia.

Assume you have a water depth of 40cm above the hole and that the hole is 20cm above ground.

1. What is the horizontal speed at which the water leaves the hole?
2. How long will it take it to reach the ground?
3. How far will the water travel horizontally before reaching the ground?
4. How does the horizontal distance the water travels change with the height of the water above the hole (provide an equation or a relationship)?
5. How does the horizontal distance the water travels change with the height of the hole above ground (again, provide an equation or a relationship)?

4. (20pts) based on the video Fluid dynamics of drag, part III:

- a. What is the Reynolds number?
- b. For low Reynolds number flows, what are the physical characteristics of the fluid, the object and the flow around an object that the drag is proportional to?
- c. For high Reynolds number flows, what are the physical characteristics of the fluid, the object and the flow around an object that the drag is proportional to?
- d. How do laminar and turbulent flows differ? How are they related to Reynolds number?
- e. What is a boundary layer (BL)? How is the BL thickness affected by viscosity for a given bottom type and a given fluid velocity in the interior of the fluid?