Course and Section _____ Names _____

Date_____ _____

FLUID STATICS SIMULATION

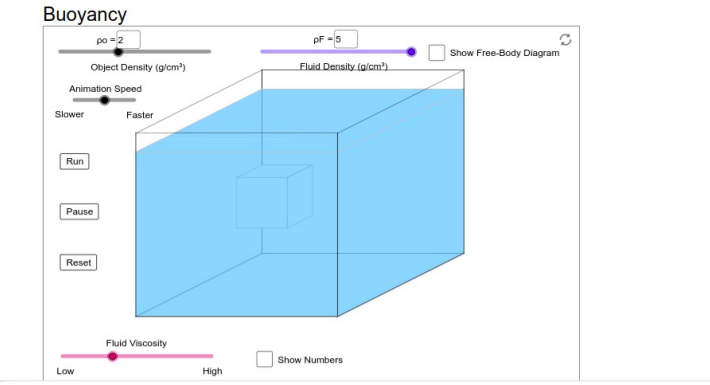
Introduction

Fluid Statics deals with fluids at rest. In this simulation you will study the proprieties of force and pressure within a fluid and how they are related to objects submerged in the fluid.

Submit your answers using Blackboard.

1 – Buoyancy

Open the simulation (https://ophysics.com/fl1.html)



Archimedes' principle states that an object submerged in a fluid is buoyed by a force that is equal to the weight of the displaced fluid.
1. If you decreased the mass of the object while the keeping volume constant, what happens to the density?

Run the simulation . You can change the densities of the object and the fluid in the simulation.
2. What happens when the density of the object is less than that of liquid?
3. What happens when the density of the object is more than that of liquid?

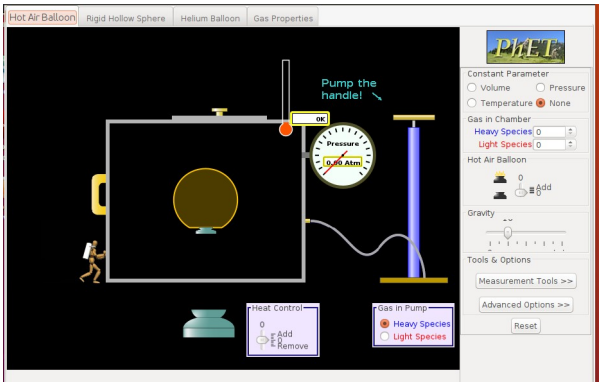
Set ρ_0 = 5 g/cm^3 and ρ_F = 0.1 g/cm^3. Run the simulation. Wait for the object to totally sink in the liquid. Check *Show Numbers* and *Free-Body Diagram*.
4. How does the volume of the liquid displaced compare to the volume of the object?
5. What is the volume of the liquid displaced in this case?
6. How does the mass of the liquid displaced compare to the mass of the object?
7. Which quantity is effected by a change of the fluid viscosity?

As you increase the density of the fluid:
8. What happens to buoyant force of the object?
9. What happens to weight of the object?
10. What happens to the normal force?
11. When $\rho_F = \rho_O$ what is the value of the normal force?
12. For what value of ρ_F are the Buoyant force and normal force equal?

Set ρ_0 = 2 g/cm^3 and ρ_F 5 g/cm$^{3.}$ Run the simulation and wait for the object to partially float on the liquid's surface.
13 What is the volume of the object outside of the water?
14. What is the ratio of the volume above and volume below?
15. What is the ratio ρ_0 / ρ_F equal to?
16. What is the relation between buoyant force and weight of the object?
17. What is the relation between the weight of the liquid displaced and the weight of the object?

2 – Hot Air Balloon

Open the simulation (https://phet.colorado.edu/en/simulation/legacy/balloons-and-buoyancy)



The sphere is like a hot air balloon. Its mass is not specified but assume it to be non-zero. Different molecules of air can enter and leave its volume and its temperature inside can be changed. Set *Gravity* to the second mark from the left (it might be already set this way).
Click to hold temperature in the container constant. Use the pump to add about 400 of the heavy blue particles.
18. What happens to the balloon as the particles enter into the container?
19. Keep observing the balloon for a few minutes, does it stay afloat?
20. How does the final density inside the balloon compare to the density above it?

Start over by clicking on *Reset.* Use the pump to add about 400 of the light red particles.
21. Observer the balloon for a few minutes, does it stay afloat?

Add slowly about 400 more of the heavy blue particles.
22. What happens to the balloon as the blue particles enter into the container?
23. Keep observing the balloon for a few minutes, does it stay afloat?

Keep the simulation running and increase gravity to mark midway in the bar.
24. Which statement better describes how the particles behave?

25. How does the final density inside the balloon compare to the density above it?

Start over by clicking on *Reset.* Set gravity to the first mark and constant temperature selected. Play the simulation and add about 500 of the light red particles. Wait for the balloon to sit at the bottom.

Now increase the temperature of the Hot Air Balloon.

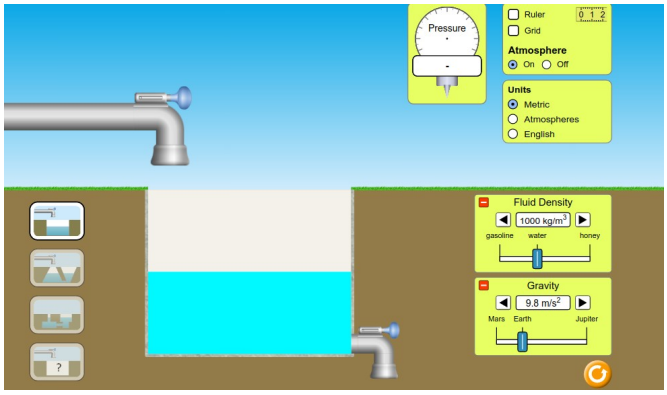
26. What happens to the balloon?
27. Does it stay afloat?

Now, visually compare the number density of particles inside the balloon vs the number density outside

28. How does the density inside compare to the density of the surrounding medium?
29. Did increasing the temperature inside the balloon decrease its density?

3 – Pressure in a Fluid

Open the simulation (https://phet.colorado.edu/sims/html/under-pressure/latest/under-pressure_en.html



Select to display G*rid* and set *Atmosphere off* . You can drag around the pressure 'clock' to read the pressure at different locations and use the ruler to measure the depth. Fill up the tank with water using the tap.

<u>Pressure and depth</u>

30. What is the pressure on the surface of the water.
31. What happens to the pressure as you move the clock deeper?
32. Where is the maximum pressure?
33. What does the pressure clock read at depth of 2 m?
34. Calculate the pressure at depth 2 m using $P = \rho gh$
35. What is the experimental error of the two values of the pressure?

Set the pressure clock at about 2 meters. Open the valve at the bottom to decrease the amount of water.

36. What happen to the pressure as the water level decreases?

Now select the third stage. You see a container on the left and a container on the right. The two containers have different shapes and are connected by a channel under the ground.
Select to display G*rid* and set *Atmosphere off* .

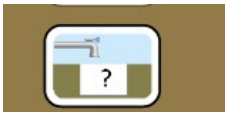
Keep the pressure clock at fixed depth = 2 m.
37. How does the pressure on the right compare to the pressure on the left?
Drop a weight
38. What happens to the pressure on the left?
39. How does the pressure on the right compare now to the pressure on the left?

Pressure and density and gravity

Reset all. Select to display G*rid* and set *Atmosphere off* and fill the tank. Now change the density to different values and observe the pressure at a fixed depth.
40. What happens to the pressure as you decrease the density?
Set the density to 700 kg/m^3 (gasoline) and pressure clock at depth = 2 m. Make a note of the value of the pressure.
41. Increase density to 1400 kg/m^3. How does the pressure change?
42. What happens to the pressure as you decrease gravity?

Mystery Fluid

Now select the fourth stage. You can select three different types of fluids.



43. What is the ratio of the densities of fluid A and B? i.e. ρ_A/ρ_B
44. What is the density of mystery fluid C?