Fluid Mechanics: Archimedes Principle
From Warmup

- This material is completely new to me, and as I am still getting in the hang of this semester and struggling a little bit, going over anything in class would be a great help.
- Just a good, healthy explanation of this with examples would be great!!
- So with a big metal ship, like an aircraft carrier, for example, does it stay afloat because it displaces only a little bit of water?
  - It displaces an amount of water equal to its weight. Why?
- Are buoyant forces in air affected much more by depth than in water because the density of air changes more easily?
  - Yes! Air is a compressible fluid.
Help on HW #2
Problem Solving Strategies:
State conceptually (not in math) why the system behaves like it does.
• Why is water on top and Mercury below?
• Why is the left side higher than the right?
Can you identify any points in the fluid where you know the pressure is the same? How do you know it is the same?
Our equation \( P = P_0 + \rho g h \) can’t apply here because \( \rho \) changes. Can you apply this equation to smaller components of the system individually?
From Warmup

- Lots of questions about HW #3
- TA Office hours (after class)
- Problem solving strategy: Make a sequence of related problem to connect what you know and what you want to know.
  1. What if the acceleration were zero?
  2. What if it were accelerating upward or downward? (e.g. in an elevator)
  3. What changes when acceleration is horizontal?
Problem Solving in class

- Giving too much away defeats the purpose.
- We usually don’t actually care about the answer, but about the process of finding the answer.
- Working out problems on the board creates the illusion of learning, but you aren’t actually learning anything valuable.
- Instead, we will discuss principles and problem solving strategies.
- My role is to ask questions and guide discussion.
- Coming up next Wednesday: Problem solving exercise related to fluids in preparation for the first “synthesis assignment.”
An apple is held completely submerged just below the surface of water in a container. The apple is then moved to a deeper point in the water. Compared with the force needed to hold the apple just below the surface, is the force required now bigger or smaller than at first? Explain your answer. (Assume that the density of water is the same at all depths.)

a) It is now less. The weight of the water above the submerged apple makes it easier to push the apple down.

b) The force required to hold the apple below the water is the same at any depth, as long as the apple is completely submerged. The difference in pressure at the top and bottom of the apple is constant. Thus, the buoyant force is also constant.

c) It is bigger because the pressure increases with greater depth.
It would be more fun if the apple got so deep that the pressure crushed it, decreasing the weight of displaced water and sending the apple down into the depths of the sea.

FYI, all warmup questions responses that I share are anonymous. Don’t worry about embarrassing yourself. This is a great way to generate discussion.
A wooden block floats in water, and a steel object is attached to the bottom of the block by a string. If the block remains floating, which of the following statements is true.

A. The buoyant force on the steel object is equal to its weight
B. The buoyant force on the block is equal to its weight
C. The tension in the string is equal to the weight of the steel object
D. The tension in the string is less than the weight of the steel object
Archimedes’ Principle

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Replace the parcel of water with a beach ball:

How will the force of gravity change?

A) Remains the Same
B) Larger in Magnitude
C) Smaller in Magnitude
Archimedes Principle

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Quick Quiz 14.4

You are shipwrecked and floating in the middle of the ocean on a raft. Your cargo on the raft includes a treasure chest full of gold that you found before you ship sank, and the raft is just barely afloat. To keep you floating as high as possible in the water you should:

A) Put the chest in the boat
B) Tie it to the bottom of the boat
C) Hang it from the bottom of the boat (as in the picture)