PHY131H1S - Class 22

Today:

- Fluids
- Pressure
- Pascal's Law
- Gauge Pressure
- Suction

A little pre-class reading quiz…

Which of the following is closest to the density of water in S.I. Units, kg/m^3?

A. 10^{-5}
B. 0.01
C. 0.1
D. 1
E. 1000

A little pre-class reading quiz…

Which of the following is closest to the density of the air in this room, in S.I. Units, kg/m^3?

A. 10^{-5}
B. 0.01
C. 0.1
D. 1
E. 1000

Announcements

- Test 2 has been marked and will be returned to you this week in Practicals. After adjustment, the average was the same as for Test 1: 65%.
- Look over the marking. If there are any issues that need to be addresses, such as a marking error, the deadline for reporting this to April Seeley in MP129 is Dec. 8 by 5:00pm
- Course evaluations are happening this week in Practicals. This is your chance to officially and anonymously let the world (and my boss!) know how we are doing.
- NOTE: There ***is*** class on Wednesday December 7 – it is our last class; I will be finishing up Ch. 15, doing a little review, and Professor Jones has a few words of wisdom for you about PHY132

Resonance: When a periodic driving force matches the natural oscillation frequency of a system

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Resonance: When a periodic driving force matches the natural oscillation frequency of a system

On Nov. 7, 1940 the Tacoma Narrows Bridge in Washington State collapsed. It had been known to oscillate in the wind at about 0.2 Hz, and was nicknamed "Galloping Gertie". Aeroelastic fluttering caused the wind to become a periodic driving force.

Last day I asked at the end of class:

- If you stand on a waterproof bathroom scale in a wading pool, so that part of your legs are immersed in the water, will your measured weight be different than normal?
- ANSWER:
- Yes! Your weight will be **less**.
- That is because the water exerts an upward buoyancy force on the part of your legs that is immersed.
- Archimedes' Principle states that your weight will be less by the weight of the amount of water that your legs displace.

Definition: **Density**

The ratio of a fluid's or object's mass to its volume is called the **mass density**, or sometimes simply "the density."

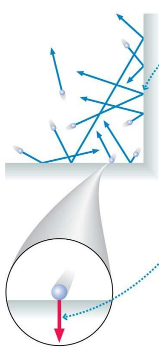
$$\rho = \frac{m}{V} \qquad \text{(mass density)}$$

The SI units of mass density are kg/m^3.

The density of water is 1.00×10^3 kg/m^3.

Your body is composed of about 60% water.

Pressure is due to the net force of the molecules in a fluid colliding with the walls.



Definition: **Pressure**

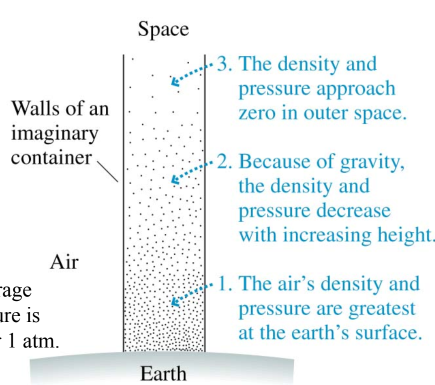
A fluid in a container presses with an outward force against the walls of that container. The **pressure** is defined as the ratio of the force to the area on which the force is exerted.

$$p = \frac{F}{A}$$

The SI units of pressure are N/m^2, also defined as the pascal, where 1 pascal = 1 Pa = 1 N/m^2.
Other units:

1 atm = 1.01×10^5 Pa
1 mmHg = 133 Pa
1 kPa = 10^3 Pa
1 psi = 6890 Pa

Atmospheric Pressure



The global average sea-level pressure is 1.01×10^5 Pa, or 1 atm.

Gauge Pressure

Pressure gauges, such as tire gauges and blood pressure monitors, measure not the actual or absolute pressure p but what is called **gauge pressure** p_g.

$$p_g = p - 1 \text{ atm}$$

where 1 atm = 1.01×10^5 Pa.

- ie "120 over 80" means the maximum gauge pressure in your arteries is 120 mmHg or 1.6×10^4 Pa.
- The actual, or "absolute" pressure in your arteries has a maximum of $p = p_g + 1$atm
$= 1.6\times10^4 + 1.01\times10^5$ Pa $= 1.17\times10^5$ Pa

Is *gauge pressure* larger, smaller, or equal to true pressure?

A. Larger
B. Smaller
C. equal to

Pressure and "Suction"

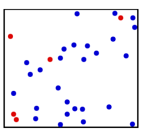
What is the force of air pressure on the top of your outstretched hand?

Atmospheric Pressure:

$$\left(1.013\times10^{5}\ \frac{\text{N}}{\text{m}^2}\right)\left[\frac{0.0254\text{m}}{1\ \text{inch}}\right]^2\left[\frac{2.2\ \text{pounds}}{9.8\ \text{N}}\right]=15\text{psi}$$

- 20 square inches = 300 pounds!
- Why don't you feel that force pushing your hand down?
- What if all the air below your hand was removed (a vacuum)?

Pressure and "Suction"



A fluid can only **push** walls or objects; a fluid **cannot pull** on a wall.

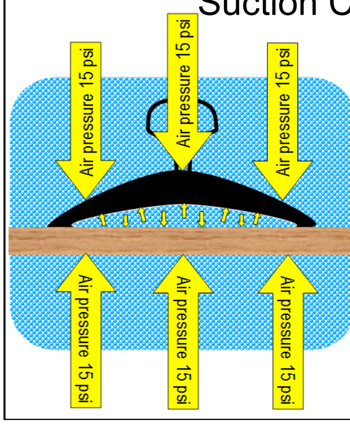
What we call "suction" is when the fluid on one side has a higher pressure than the fluid on the other side.

It is the pressure **difference** which creates a pushing force into the lower pressure area (into the vacuum).

This is how we breath:

1. We expand our lung cavity, lowering the pressure inside.
2. The higher air pressure outside ***pushes*** air into our lungs.

Suction Cups



When we lower the pressure inside a suction cup, it is the pushing forces of the pressurized air all around which creates the net forces.

Suction cups would not work on the moon!

Harlow uses a toilet plunger to pull a large wooden podium.
The maximum pulling force that Harlow can exert on the podium in this way

A. is determined by Harlow's strength.
B. is determined by the strength of the door.
C. equals $P_{atm} A$, where A = area of the suction cup
D. equals $m\,g$, where m = mass of the podium
E. equals $\mu_s\,(m\,g)$, where μ_s is the coefficient of static friction between the cup and the podium

Before Class 22 on Wednesday

- On Friday there is a MasteringPhysics Problem Set due by 11:59pm.
- Before Practicals this week, please read the first 4 sections of Chapter 15 of Knight.
- Something to think about: The two identical beakers shown are filled to the same height with water. Beaker B has a plastic sphere floating in it. Which beaker, with all of its contents, weighs more? Or are they the same weight?