Announcements

1. Exam 3 next week!!
   a. Starts on Friday, goes to Monday, as usual
   b. Covers momentum, circular motion, torques, etc.
   c. Last lecture was the end of that material
2. Today's lecture: stuff for Exam 4 (fluids, pressure, etc.)

Pressure

$$P = \frac{Force}{Area}$$

Demo: nails and block, bed of nails

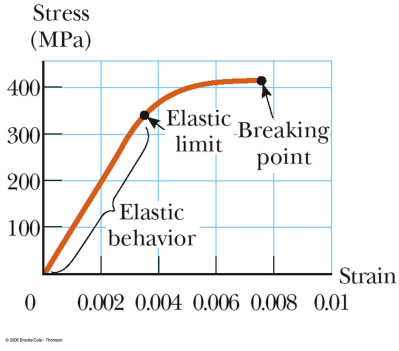
Why do they never show anyone *standing* on a bed of nails?

Atmospheric pressure: 1 atm = 14.70 lbs/in^2 = 1.013×10^5N/m^2
Comes from…..

Demo: lungs, can

Solids

- Act like springs, to a point
  i. Amount of stretch proportional to force
  ii. Where it fails: "elastic limit"



- See textbook for more details

Solids & Liquids:

- Basically incompressible—volume doesn't change *much* when you press on it (does change a *little)*

Density

$$\rho = \frac{mass}{volume}$$

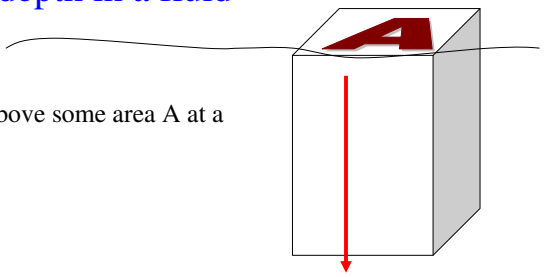
ρ_{water} = 1000 kg/m^3
(= 1.000 g/cm^3) (original definition of a gram)
ρ_{air} = 1.29 kg/m^3

"Specific Gravity" = density of material/density of water

SG of some common substances:

Air	0.0013
Wood(Oak)	0.6 - 0.9
Ice	0.92
Water	1.00
Bricks	1.84
Aluminum	2.70
Steel	7.80
Silver	10.50
Gold	19.30

Pressure vs depth in a fluid

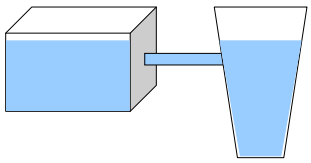


Weight of water above some area A at a depth of *h*.

Pressure at h: (Include the pressure on the top of the fluid).

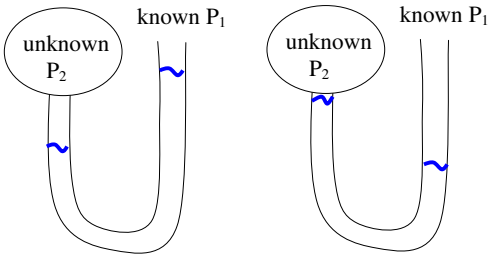
Pushes on all sides of an object!

Pascal's principle: For a fluid at rest, the pressure in the fluid depends only on the depth, not the shape of the container.



Demo: force amplification (Pressure "lever")

Manometers



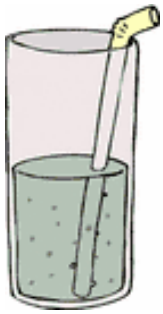
Barometers

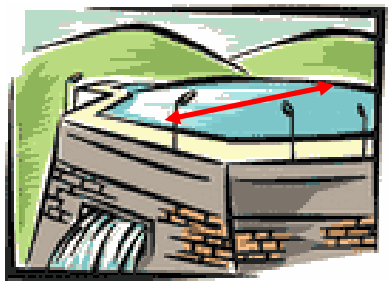
How to read

Absolute vs gauge pressure

Barometer and straws:

How high can we lift water with a vacuum?



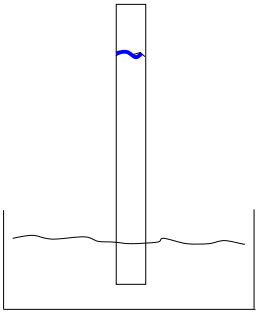


Q4. For a longer canyon behind the dam (red arrow length), the dam…

a. can be weaker
b. must be stronger
c. can be the same.

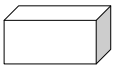
Q5. On the moon, where gravity is less, but there is no atmosphere, if you pumped out the air at the top of a barometer, the mercury would rise _____ compared to on earth.

a. higher
b. less high
c. the same
d. not at all

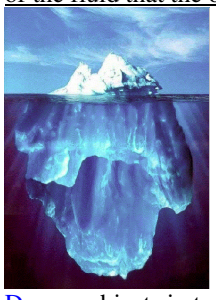


Buoyancy:

Where does it come from?



Archimedes' Principle: The buoyant force is the weight of the fluid that the object is displacing at the moment.



$$F_B = m_{displaced\ fluid} \times g$$
$$= \rho_{fluid} V_{object} g$$

Demo: objects in tank

Objects will want to **sink** if

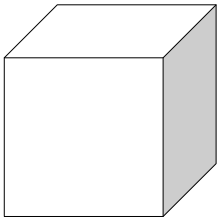
Objects will want to **float** if

They will rise out of the water until…

Demo: Cartesian diver

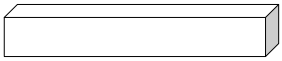
Three cubes of the same size are **completely submerged** under water: lead, steel and wood.

Q6. The bouyant force is greatest on the _____ cube
a. lead
b. steel
c. wood
d. none…same



Worked Problem: A raft of wood of size 0.5m x 8m x 2m weighs 30,000 N. It is held all the way under the water with a chain.

Draw a FBD of the raft



What is the buoyant force on the wood?

What tension is in the chain?

How much of the block will be submerged if the chain is removed?

How many men, of weight 1200 N each, could it hold before sinking?

Archimedes was charged with determining if a crown was pure gold. He balanced the crown with pure gold outside water. After immersing, the balance tipped.

Q7. The crown has density
a. more than gold
b. less than gold
c. same as than gold
d. depends on shape of crown

Q8. A cannon is placed in a boat. The boat sinks more to displace more water. The amount of new water displaced is
a. a volume of water that weighs **more than** the cannon
b. a volume of water that weighs **as much as** the cannon
c. a volume of water that weighs **less than** the cannon

Q9. If the cannon now falls from the boat into the water and sits on the bottom of the lake, the amount of water displaced by the cannon is
a. a volume of water that weighs **more than** the cannon
b. a volume of water that weighs **as much as** the cannon
c. a volume of water that weighs **less than** the cannon

Q10. So if the cannon falls from the boat into the water and sits on the bottom of the lake, will the water level of the lake rise, fall or stay the same? (Compared to when the cannon was in the boat.)
a. rise
b. fall
c. stay the same