

Announcements – Oct 29, 2009

- Exam 3 ends Monday, late fee after 1 pm
- Please don't put your name on extra credit papers you turn in. Just your CID.

Pressure

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

Demos: pressure vs. force; bed of nails (with sledgehammer!)

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

Atmospheric pressure: 1 atm = 14.70 lbs/in² (psi)
= 1.013 × 10⁵ N/m²

Comes from.....



Demos: collapsing can; “Magdeburg hemispheres”

Density

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

$$\rho_{\text{water}} = 1000 \text{ kg/m}^3 = 1.000 \text{ g/cm}^3 \text{ original definition of a gram}$$

“Specific Gravity” = $\rho_{\text{material}} / \rho_{\text{water}}$
(which = the density in g/cm³ units)

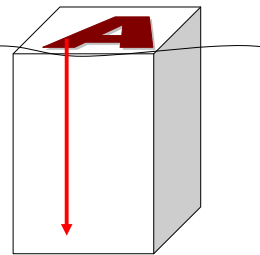
SG of some common substances:

Air, standard conditions	0.0013
Wood(Oak)	0.6 - 0.9
Liquid nitrogen	0.81
Ice	0.92
Water	1.00
Bricks	1.84
Aluminum	2.70
Steel	7.80
Silver	10.50
Lead	11.30
Gold	19.30
Platinum	21.40

Pressure vs depth in a fluid

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

w =



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

P =

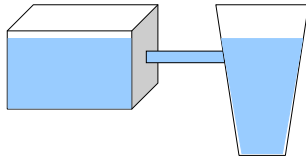
Videos: pressure vs depth, pressure pushes on _____

From warmup: Where is the pressure greater, one meter beneath the surface of Lake Michigan or one meter beneath the surface of a swimming pool?

- Lake Michigan
- swimming pool
- the same

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

All parts of fluid at same _____ have same _____



Demos: fluid levels; mechanical advantage; hydraulic “force amplification”

“Absolute” vs “gauge” pressure

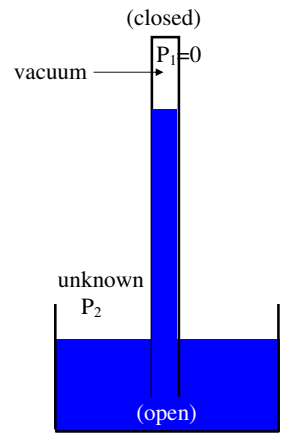
Gauge pressure is: _____

From warmup: Ralph measures the pressure in his flat tire with a standard automotive pressure gauge. The gauge reads zero. Is the pressure inside the tire really zero?

Answer from class:

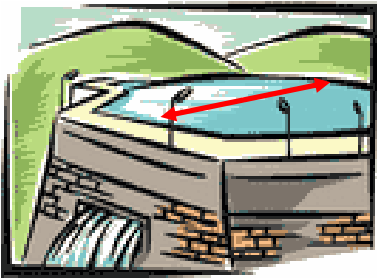
Barometers

How to read?



Straws:

How high can we lift water with a vacuum?

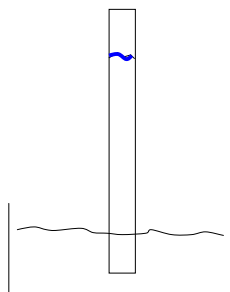


Clicker quiz: For a longer canyon behind the dam (red arrow length), the dam...

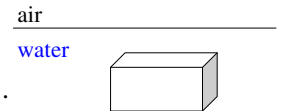
- a. can be weaker
- b. must be stronger
- c. can be the same.

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

- a. higher
- b. lower
- c. the same
- d. not at all



Buoyancy



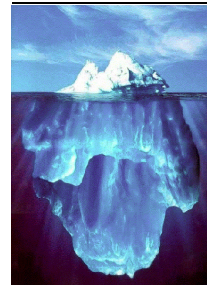
Water in a rectangular plastic bag...

Does the water inside the bag have mass?

Does the water inside the bag have weight?

Why doesn't it accelerate down?

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



$$F_{Buoyant} = B = m_{displaced\ fluid} \times g = \rho_{fluid} V_{object} g$$

Demos: Coke and other objects in tank
Does aluminum foil sink or float?

From warmup: The buoyant force of a submerged object always equals:

- the weight of the object
- the net force on the object
- the weight of the water that would otherwise occupy the object's space

Objects will **sink** if

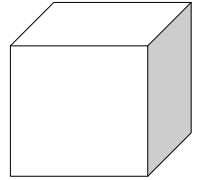
Objects will **float** if

Floating objects will rise out of the water until...

Colton - Lecture 18 - pg 9

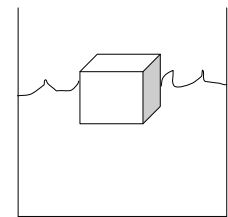
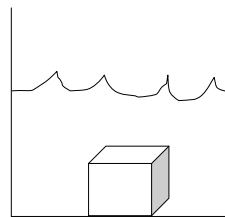
Clicker quiz: Three cubes of the same size and shape are put in water. They sink. One is lead, one is steel and one is a dense wood (ironwood). $\rho_{\text{lead}} > \rho_{\text{steel}} > \rho_{\text{ironwood}}$. The buoyant force is greatest on the _____ cube

- lead
- steel
- wood
- same buoyant force



Clicker quiz: Two cubes of the same size and shape are made out of wood. The ironwood cube **sinks**, but the walnut cube **floats**. The buoyant force is greatest on the _____ cube

- ironwood
- walnut
- same buoyant force



Colton - Lecture 18 - pg 10

Worked Problem: A raft of wood of size $0.5\text{m} \times 6\text{m} \times 5\text{m}$ weighs 30,000 N. It is loaded with cannon balls until it is (barely) completely submerged. How much weight was loaded?



Additional part: the balls are unloaded, and the raft now sits at equilibrium. How far is the raft submerged?

Answers: 117,000 N; 10.2 cm

Colton - Lecture 18 - pg 11

Archimedes: "Eureka"



Archimedes was charged with determining if a crown was pure gold. One method he may have used: he balanced the crown with pure gold outside water. After immersing, the balance tipped as shown.

Clicker quiz: The crown has density

- more than gold
- less than gold
- same as than gold

Colton - Lecture 18 - pg 12

Clicker quiz 1: A cannonball is put in a boat. The boat sinks down to displace more water. The amount of new water displaced is

- a. a volume of water that weighs **more than** the cannonball
- b. a volume of water that weighs **as much as** the cannonball
- c. a volume of water that weighs **less than** the cannonball

Clicker quiz 2: If the cannonball 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 cannonball
- b. a volume of water that weighs **as much as** the cannonball
- c. a volume of water that weighs **less than** the cannonball

From warmup (do as clicker quiz): Therefore...if the cannonball falls from the boat into the water and sits on the bottom of the lake, will the overall water level of the lake rise, fall or stay the same? (compared to when the cannonball was in the boat)

- a. rise
- b. fall
- c. stay the same

(Another way of looking at it: same questions, but instead of a cannonball use a pinhead of very VERY dense matter.)