Announcements – Oct 28, 2014

1. Prayer

2. **Exam 2** starts Thursday, Oct 30
   a. Late fee on Monday Nov 3, after 2 pm
   b. Closes on Tuesday Nov 4, 2 pm
   c. Jerika exam reviews, both in room C295 ESC:
      i. Wed Oct 29 7 - 8:30 pm
      ii. Thurs Oct 30 5:30 - 7 pm
   d. Exam covers through today's lecture
      i. Ch. 5, 6, 7.1-7.3, 8
      ii. HW 10-17

e. Info about the exam in yesterday's email

“Which of the problems from last night's HW assignment would you most like me to discuss in class today?”

Angular momentum review

With no external torque, angular momentum is conserved

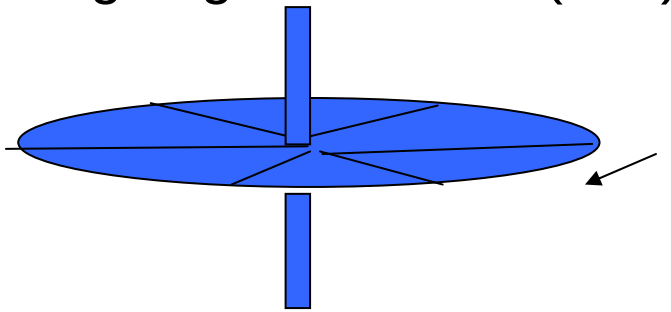
With external torque?

Demo: wacky briefcase

To fully describe what happens to angular momentum with external torques present takes more math than we have… just understand that strange things can happen. ☺

Clicker quiz

José sits still on frictionless ice, holding a bicycle wheel that's already spinning. Viewed from above it is going **clockwise** (CW).



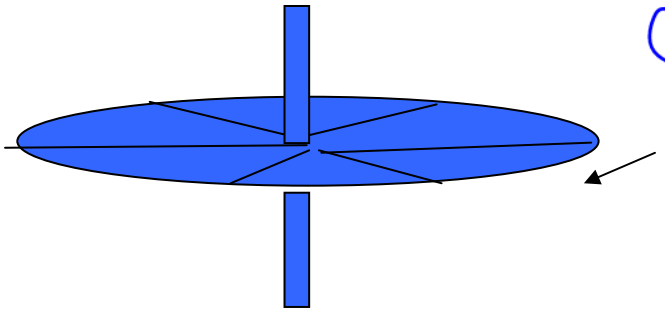
If he grabs on to the wheel edge firmly and stops it from spinning he will:

a. Start to turn CW (viewed from the top)
b. Start to turn CCW
c. Remain sitting without turning

$L_{bef} = L_{aft}$

$CW = L_{wheel} + L_{Bicycle}$

Clicker quiz



José still on frictionless ice holding this spinning wheel. Viewed from above it is going **clockwise** (CW).

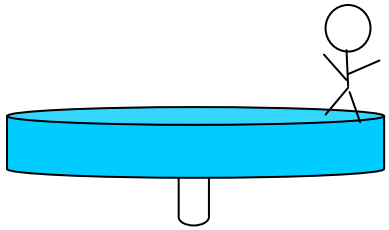
If, instead of stopping the wheel, he carefully turns it over so it is going CCW (viewed from the top), he will start to:

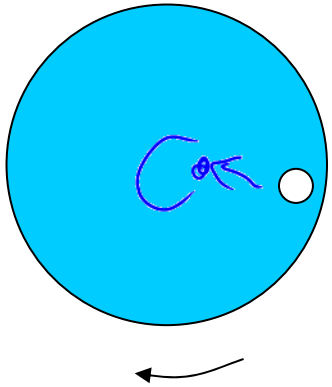
a. Turn CW, but slower than in the previous problem
b. Turn CCW, but slower than in the previous problem
c. Turn CW, but faster than in the previous problem
d. Turn CCW, but faster than in the previous problem
e. Remain sitting without turning

Demos: rotating platform & bicycle wheel
Demo: double bicycle wheels

Clicker quiz

What will happen to the rotational speed ω of the merry-go-round if the girl…





…walks towards the center?

a. it slows down
b. it stays same speed
c. it speeds up

$L_{bef} = L_{aft}$

$I_o \omega_o = I_f \omega_f$

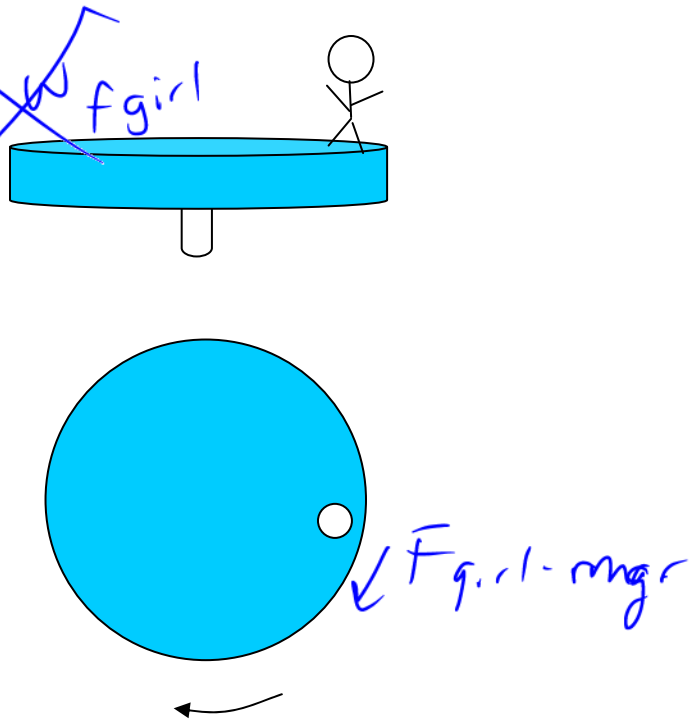
I_f: smaller

ω_f: larger

Clicker quiz

$I_{0girl}\omega_{0girl} + I_0\omega_0 = I_f\omega_f + I_{fgirl}\omega_{fgirl}$

increase

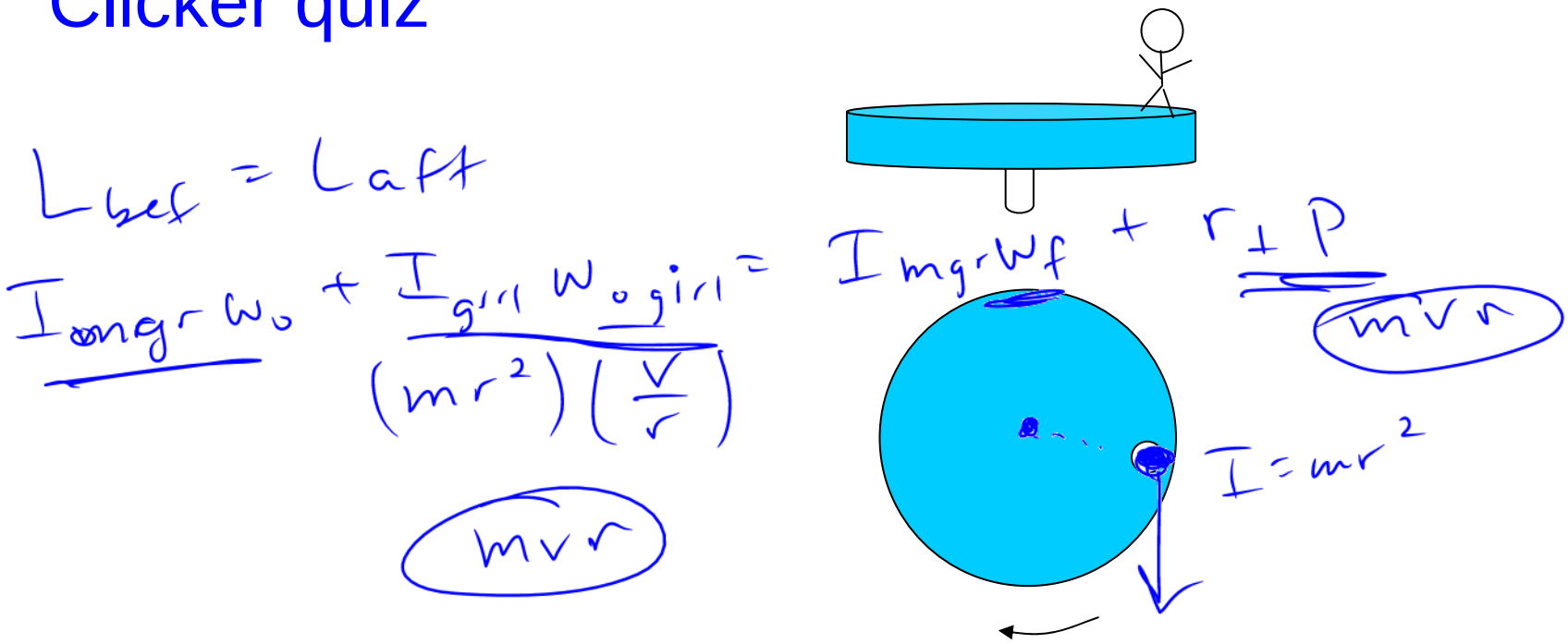


…starts running opposite to the spinning so she is at rest vs the ground?

a. it slows down
b. it stays same speed
c. it speeds up

HINT: Sometimes it's easier to think of the **forces (torques)** she puts on the merry-go-round to change, rather than conservation of L.

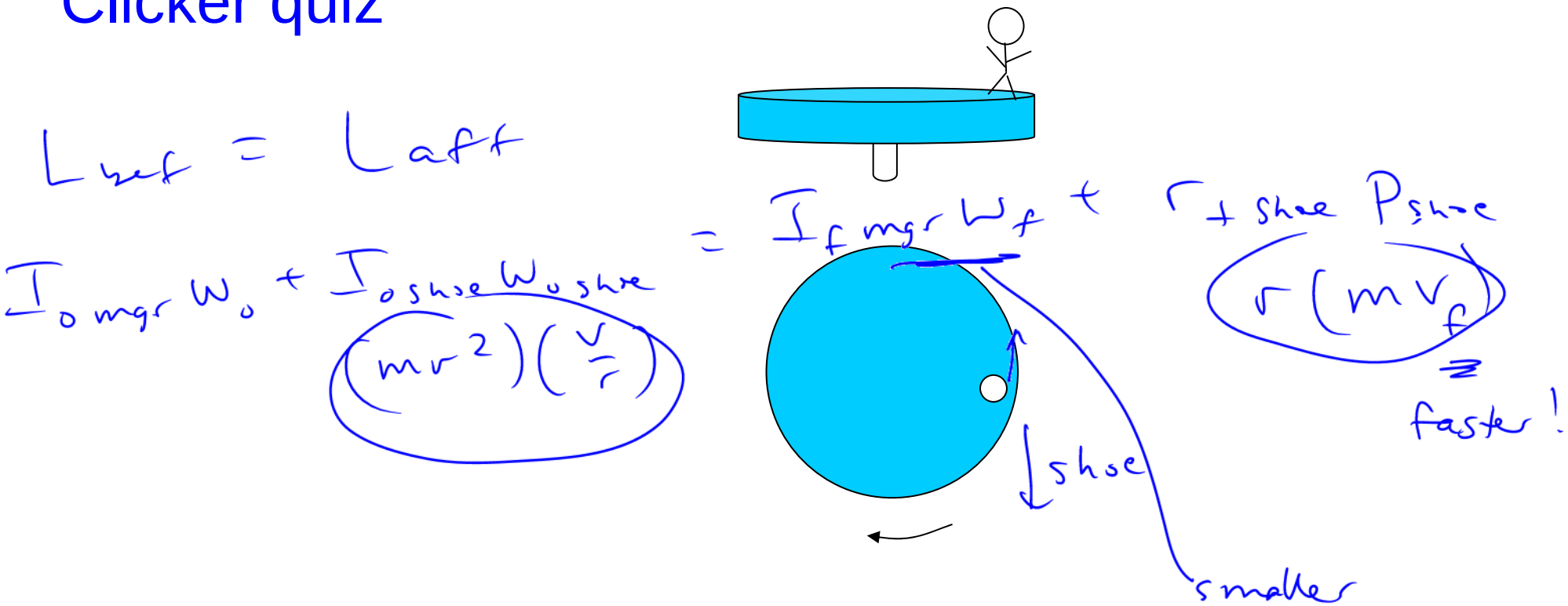
Clicker quiz



…slips off when she steps on a frictionless icy part?

a. it slows down
b. it stays same speed
c. it speeds up

Clicker quiz



…throws her shoe off tangentially in the direction she's moving?

a. it slows down
b. it stays same speed
c. it speeds up

The End of Exam 2 Material

Pressure

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

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/in^2 (psi)

= 1.013×10^5 N/m^2

Pascal "Pa"

Comes from…..

Demo: Collapsing can

Demo: “Magdeburg hemispheres”

Otto Von Geuricke,
1602-1686

Deutsches Museum, Munich

Wikipedia: “Guericke's demonstration was performed on 8 May 1654 in front of the Imperial Diet, and the Emperor Ferdinand III in Regensburg. Thirty horses, in two teams of fifteen, could not separate the hemispheres until the valve was opened to equalize the air pressure. In 1656 he repeated the demonstration with sixteen horses (two teams of eight) in his hometown of Magdeburg, where he was mayor. He also took the two spheres, hung the two hemispheres with a support, and removed the air from within. He then strapped weights to the spheres, but the spheres would not budge. Gaspar Schott was the first to describe the experiment in print in his Mechanica Hydraulico-Pneumatica (1657). In 1663 (or, according to some sources, in 1661) the same demonstration was given in Berlin before Frederick William, Elector of Brandenburg with twenty-four horses.”

Density

"rho"

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

$m = \rho V$

ρ_{water} = 1000 kg/m^3

= 1.000 g/cm^3 original definition of a gram

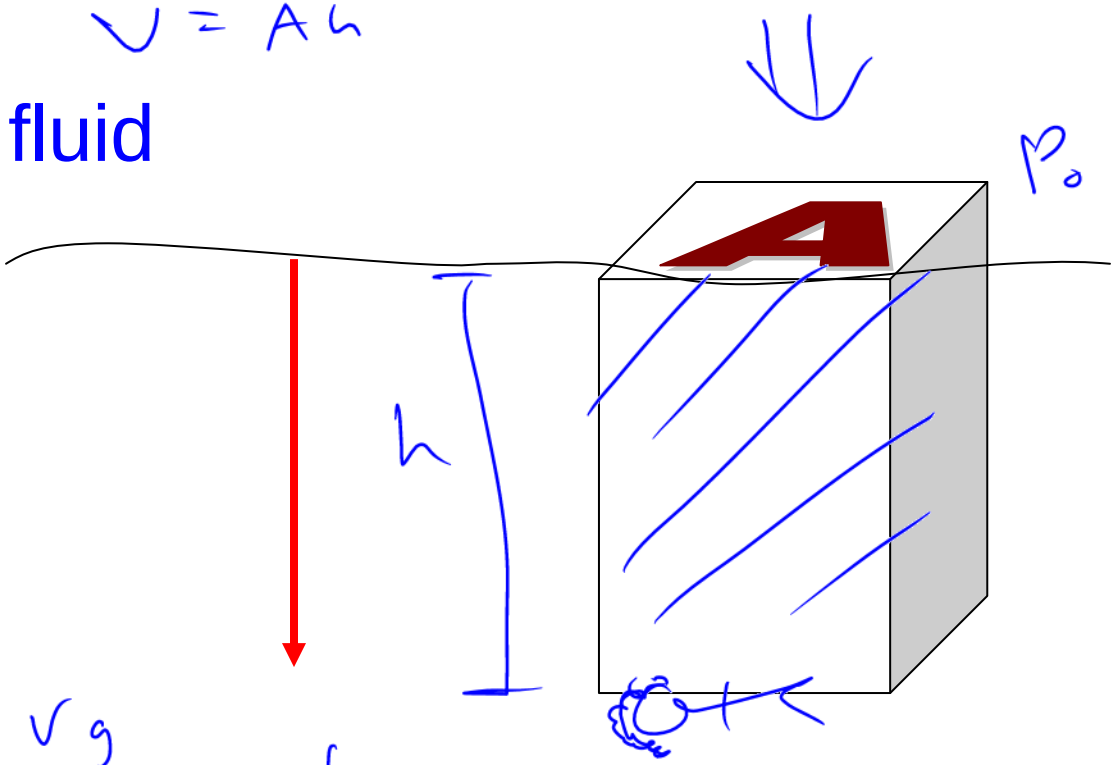
"Specific Gravity" = $\rho_{material}/\rho_{water}$

(i.e., the density in g/cm^3 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.*

$w = mg = (\rho \cdot V)(g)$

$P = F/A = w/A = \frac{\rho V g}{A} = \rho g h$

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

$$P = P_0 + \rho g h$$

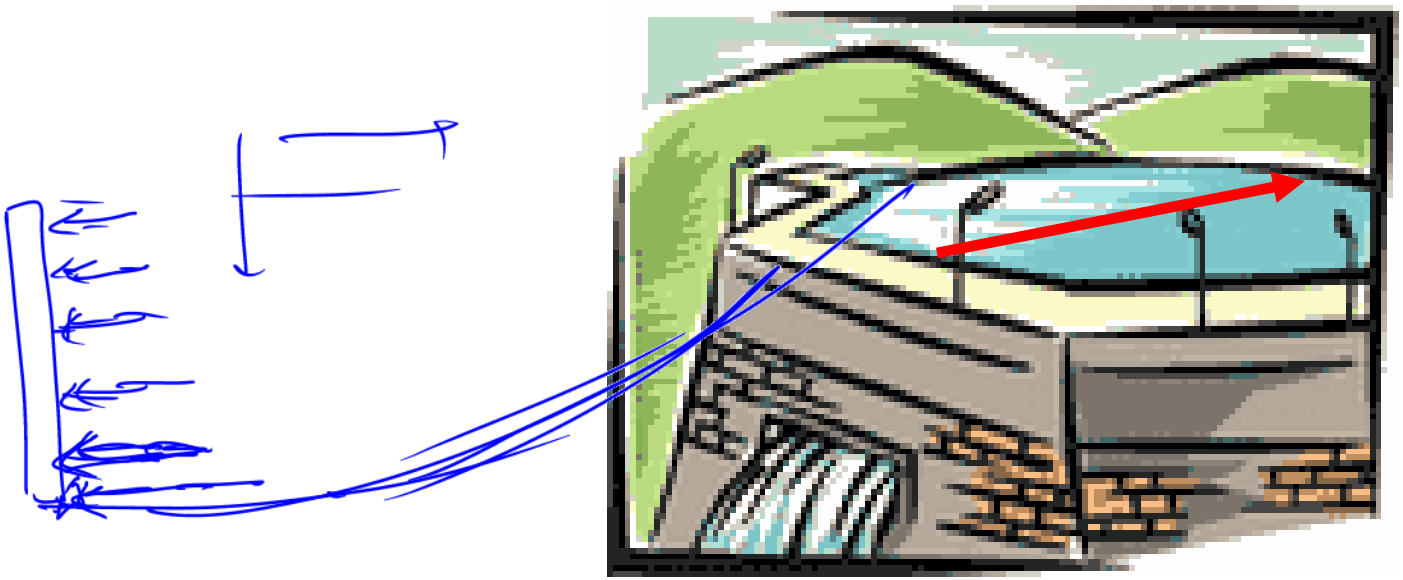
Videos

pressure vs depth

pressure pushes on all sides

Clicker quiz

$P = F/A$ $\quad F = P \cdot A$



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 strength

From warmup

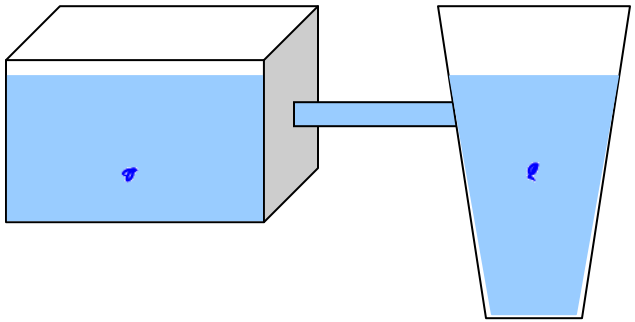
Where is the pressure greater, one meter beneath the surface of Lake Michigan or one meter beneath the surface of a swimming pool?

a. Lake Michigan
b. swimming pool
c. 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 depth have same pressure



Any change in pressure is felt by entire fluid

Demos

fluid levels

mechanical advantage

hydraulic “force amplification”

$$P = F/A$$

$$F = P \cdot A$$

From warmup

Ralph measures the pressure in his flat tire with a standard automotive pressure gauge. The gauge reads zero. This confuses Ralph, because he thinks there is probably still air in the tire. Help Ralph understand what is going on.

$P = P_{gauge} + P_{atm}$

"Think-pair-share"

- Think about it for a bit
- Talk to your neighbor, find out if he/she thinks the same as you
- Be prepared to share your answer with the class if called on

Clicker: I am now ready to share my answer if randomly selected.

a. Yes

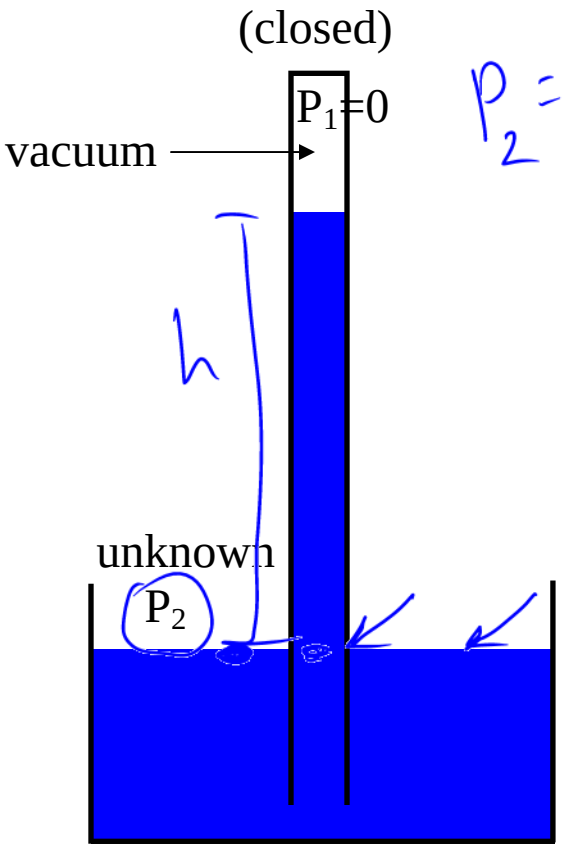
Note: you are allowed to "pass" if you would really not answer.

“Absolute” vs “gauge” pressure

Gauge pressure is: _____

Barometers

How to read?

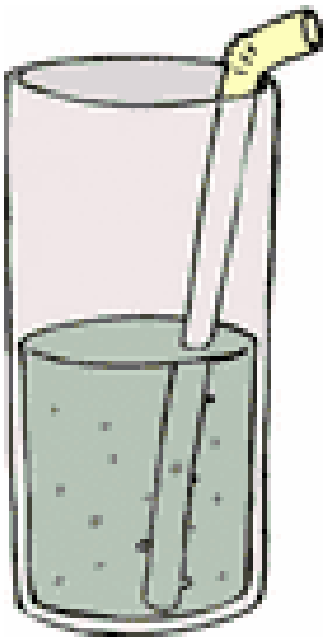


$P_2 = \cancel{P_1} + \rho g h$

$\uparrow$

$\rho_{Hg}(9.0\ m/s^2)(.760\ m)$

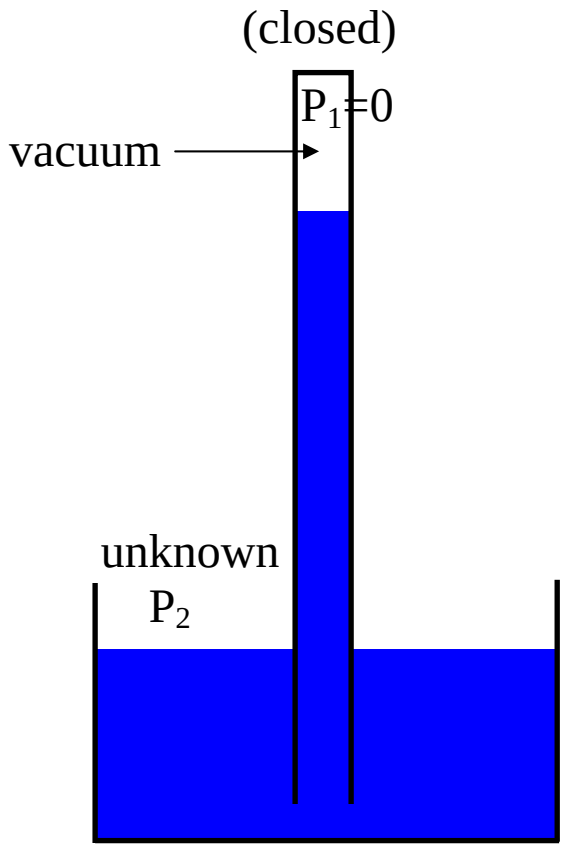
$= 101000\ Pa$



Straws:

How high can we lift water with a vacuum?

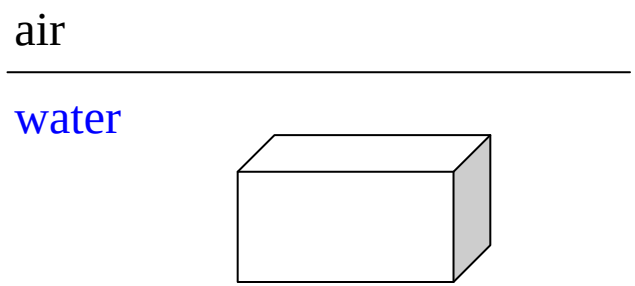
Clicker quiz



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 thin rectangular plastic bag…

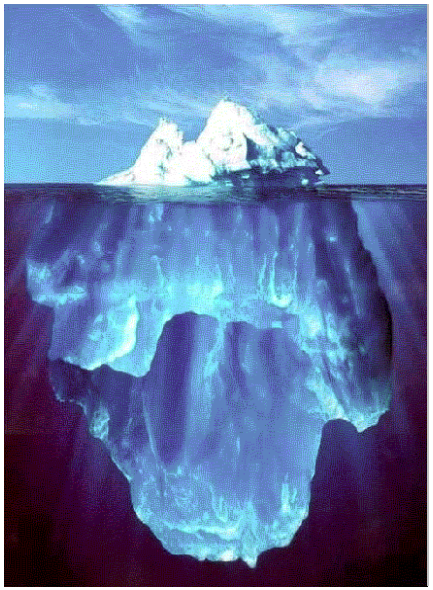
Does the water inside the bag have mass?

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.



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

just the submerged volume

Demos

- Does a can of soda sink or float?
- Does aluminum foil sink or float?

From warmup

The buoyant force of a submerged object always equals:

a. the weight of the object
b. the net force on the object
c. the weight of the water that would otherwise occupy the object's space

Sink vs. Float

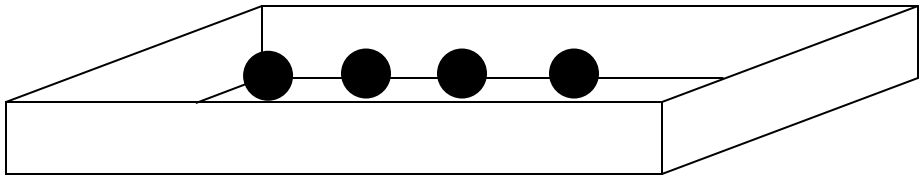
Objects will **sink** if

Objects will **float** if

Floating objects will rise out of the water until…

Worked Problem

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



Answer: 117,000 N

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

Answer: 10.2 cm

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

a. more than gold
b. less than gold
c. same as than gold