Lecture 34

Wednesday, November 29, 2017 12:45

To do ...

- Quiz 7 next week
- WA 4 due **Fri**
- HW 25 ME due **Sat**
- HW 24 PL due **Tues**

Monday, November 7, 2016 11:21

Mechanics is a branch of the physical sciences that is concerned with the **state of rest or motion of bodies that are subjected to the action of forces**

SOLIDS

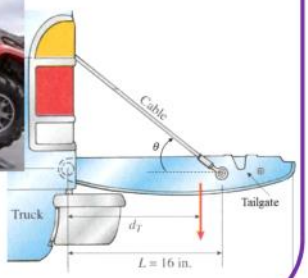
Rigid Bodies

TAM 210/211: Statics

TAM212: Dynamics

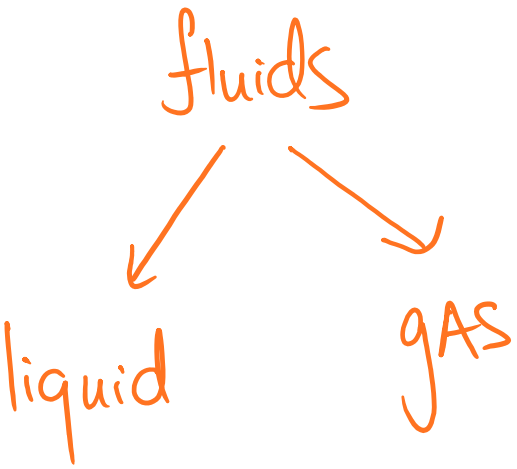
Deformable Bodies

TAM 251: Solid Mechanics



FLUIDS

Stuff that flows!



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What Makes a Fluid or Solid?

Honey

Rock

fluids take the shape of its container

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What is Sand?

A - fluid

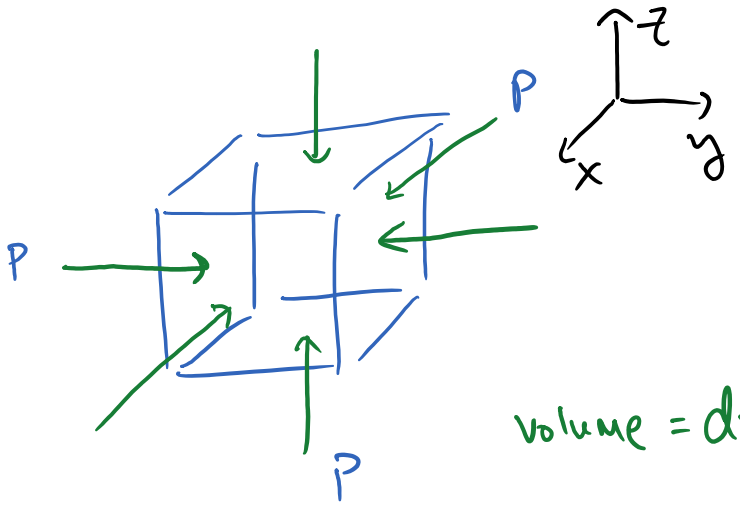
B - Solid

C - neither

D - both

Fluids

Pascal's law: A fluid at rest creates a pressure p at a point that is the *same* in *all* directions



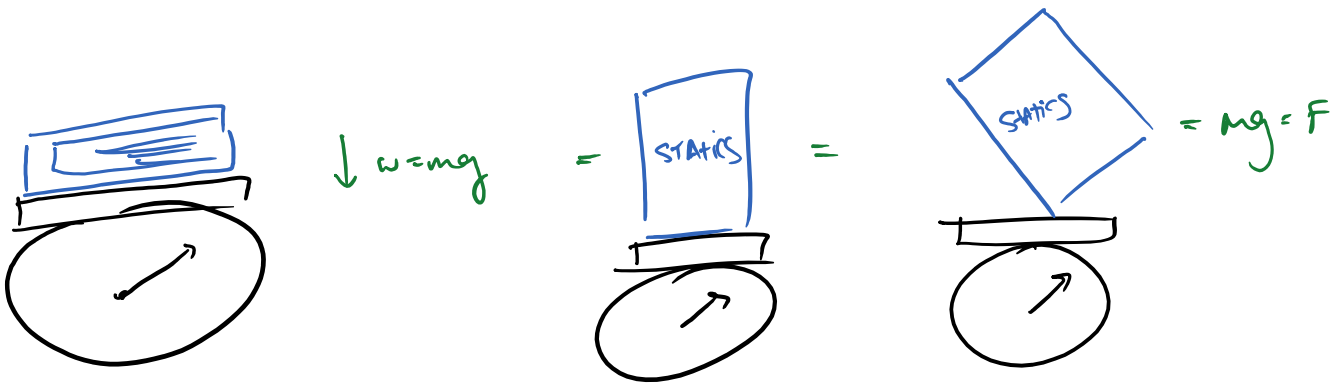
ΣF_x: ? – Body forces

ΣF_y: ? And

ΣF_z: ? – Surface forces

volume = $dx\,dy\,dz$

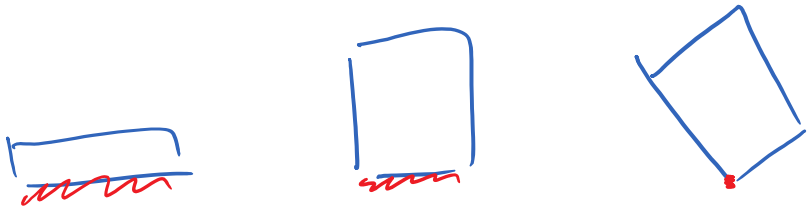
Incompressible: An incompressible fluid is one for which the mass density ρ is independent of the pressure p.



Replace weight scale with hand.

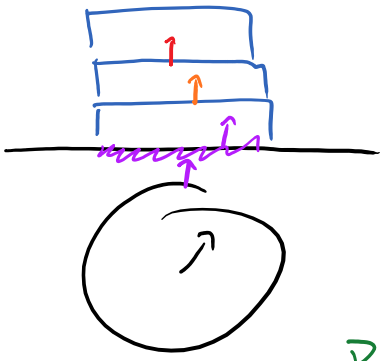
What is Different?

Contact Area this force is acting on.



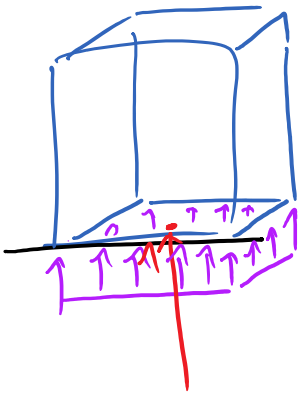
$P_1 = \frac{F}{A_1} < P_2 = \frac{F}{A_2} < P_3 = \frac{F}{A_3}$

$\text{Pressure} = \frac{\text{FORCE}}{\text{AREA}} = \frac{N}{M^2}$ → Similar to Stress...



$F = mg + mg + mg$

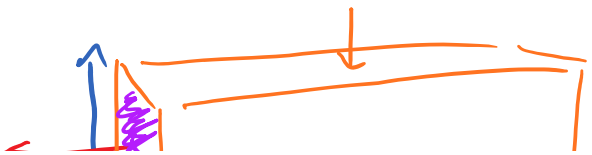
$P = \frac{F}{A_1} = \frac{nmg}{A_1}$

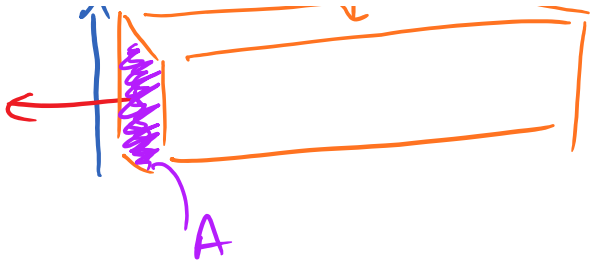


this is true for a solid

Stress $\sigma = \frac{F}{A} = \frac{N}{m^2}$

think about beams compressed / stretched / sheared

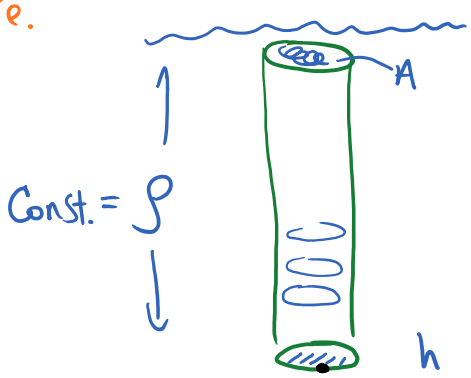



A

Fluid Pressure

For an incompressible fluid at rest with mass density , the pressure varies linearly with depth z

Hydrostatic pressure.



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

ΣF_y: $F_n - Mg = 0$

$m = \rho V = \rho A h$

$pA - \rho A h g = 0$

$p = \rho g z = \gamma z$

magnitude!

direction?

γ = Specific weight

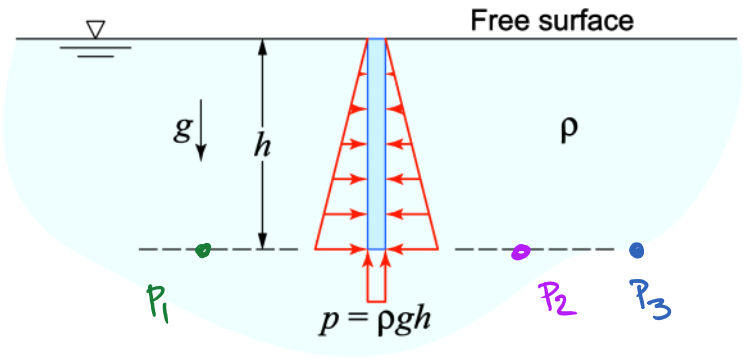
$\gamma = \frac{N}{m^3}$

- At point p, same in all directions
- At a surface, perpendicular
- pressure

$p = \rho g z = \left[\frac{kg}{m^3}\right]\left[\frac{m}{s^2}\right][m]$

$$P = \frac{N}{M^2} = \text{Pascal}$$

Observe that the pressure varies *linearly* from the free surface, and is *constant* along any horizontal plane (since h is constant):



$P_1 = P_2 = P_3$

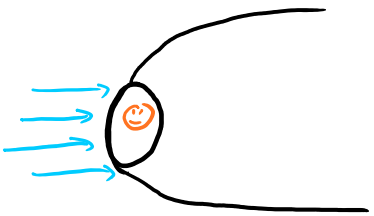
Average depth of submarine.

$z = 100 - 500$ m

$P = \rho g z = (1020)(9.81)(250) = 2.5$ MPa

$F = pA = 4.91 \times 10^5$ N

$F = pA = 50$ tons



$A = \pi r^2 = \pi\left(\frac{1}{4}\right)^2 = \frac{\pi}{16}$

DEEP SEA Challenger!

$z \sim 11$ km ~ 6.8 miles

$p = \rho g h = (1020)(9.81)(11{,}000) = 110$ MPa

$f = pA = 2.16 \times 10^7$ N $= 2202$ tons