FLUIDS and MATERIALS

What do you think?

- Order the drink with the greatest density.
- What do you drink?
  - Orange Drink
  - Milkshake

Density

- Mass / Volume
  - g/cm^3
    - water = 1g/cm^3
  - kg/m^3
    - water = 1000 kg/m^3
  - NOT the same as how "thick" something is

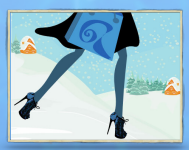
$$\rho = \frac{m}{V}$$

Sample Problem

- Calculate the density
  - Diameter = 4 cm
  - Height = 15 cm
  - Mass = 625 g
  - V = π r^2 h
  - V= 188.4 cm^3
  - ρ = 3.31 g/cm^3

What do you think?

Which shoes apply the greatest force to the ground below?



Pressure

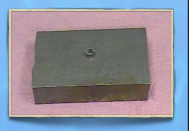
- Force / Area
  - PSI
  - N/m² = Pascal (Pa)
  - ATM
  - mmHg = Torr

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

1 ATM =	14.7 PSI
	101.3 kPa
	760 Torr

Sample Problem

- Calculate the pressure under a steel block 15 x 20 x 3 cm.
  - (when resting on its largest face)
  - Density = 7.86 g/cm³



Sample

- Density = 7.86 g/cm³
- Volume= 15 x 20 x 3 = 900 cm³ *(match units)*
- Mass = ρ x V = 7.86 g/cm³ x 900 cm³ = 7,074 g
- Weight = 7.074kg x 9.8 = 69.33 N
- Area = 0.15m x 0.2m = 0.03 m² *(match units)*
- Pressure = 2,310 Pa = 2.31 kPa

What do you think?

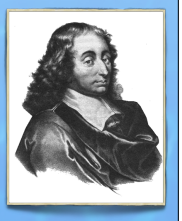
Which Fluid?

The word "**hydraulics**" originates from the Greek word **ὑδραυλικός** (hydraulikos) which in turn originates from **ὕδωρ** (hydor, Greek for water) and **αὐλός** (aulos, meaning pipe).

Pneumatics, from Greek **πνεύμα**, uses an easily compressible gas such as air or a suitable pure gas

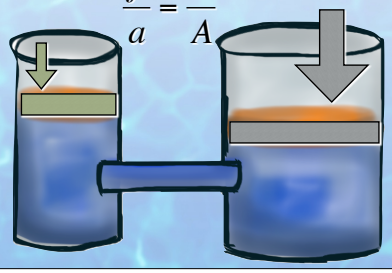
Pascal's Principle

- **Pressure applied to an enclosed fluid is transmitted undiminished to every part of the fluid, as well as to the walls of the container.**

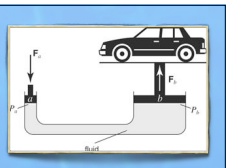


Another Machine

$$\frac{f}{a} = \frac{F}{A}$$



Sample - Fluid System



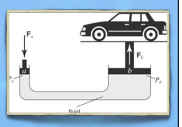
- **A car weighs 540 N, and sits on the larger piston of a hydraulic lift. The diameter of the larger side is 1.5 m, the smaller is 0.5 m.**
- **How much force is required to lift the car?**

Sample - Fluid System

$$\frac{F}{A} = \frac{f}{a}$$

$$\frac{540}{\pi(.75)^2} = \frac{f}{\pi(.25)^2}$$

- **f = 60 N**
  - **1/3 of the radius**
  - **1/9 of the Force**



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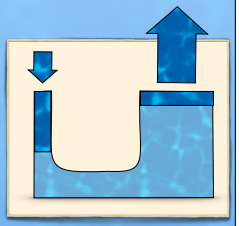
Distance Moved

- Remember Machines
- Can't be more than 100% efficient
- Greater force ⇒ smaller distance
- ratio of areas
- constant volume



What do you think?

Torque

What is the BEST way to open a door?

- The most force
- Far from the hinges
- The right direction

$$T = F\ d\ \sin\theta$$

Torque (Nm)

Force (N)

distance (m)

or r for radius or l for lever arm

θ the angle between F and d

so, push on a door at a right angle with a force of 25N, 80cm from the hinges...

Torque (Nm)= **25**N **0.8**m sin90°

- A 3,300 pound car..
- wait.. science…
- A 1500 kg car
- Mass x Gravity = Weight
- Weight = 14,700 Newtons
- Strong man just lifts it all

So.. what if you aren't so strong?

- Weight = 14,700 Newtons
- Lever arm is 5 times greater
- 2,940 N (660 lbs)