Collection By

Veerapandian.K

Mechanical Engineering

www.pandianprabu.co.cc

Source website:
http://boomeria.org/physicstextbook/physglossary.html

Pascal's Law and Bernoulli's Principle

Blaise Pascal ..... Daniel Bernoulli

Pascal & Pressure:

High Heels
Bed of Nails
Gramophone needle
Big Tyres on Small People
Water Tanks
Manometers, Water & Mercury
Bourdon Gauges
Tower 2 & 88mm Aqua Cannon
Submarines
Bathyscaph at 10,000 meters
Coiled Hose Trick
An Uplifting Experience!
Pascal's Vases
Divers exhaust during ascent
Balloon in Bell Jar demo.
The Bends
Dams
Cut Steel with water jet
Press at center of Earth = 1 $X10^6$ atm Temp = 4000°C
Pascal's Vases
Burst the Barrel
Disintegrate the Jug
Hydraulics Demos:
Brakes
Lifts
Presses (make diamonds)
Syringe pistons
King Hiero's Fountain
An uplifting experience (vacuum cleaner & garbage bag).
Pushy Balloons

Pressure & Pascal's Law

Pressure is force per area. $p = f/a$

Liquid Pressure = (depth)(density) $p = h\rho$

Units of pressure:

- pascal = n/m^2
- Atmosphere,
- mm of Hg (in manometer)
- kg/cm^2 (mass units).

Blaise Pascal

Common pressures:

1 atm =
- 100 kPa
- 760 mm of Hg
- 10 m of H_2O
- 1 kg/cm^2

Tap water pressure =
- 4 atm
- 400 kPa
- 4 kg/cm^2

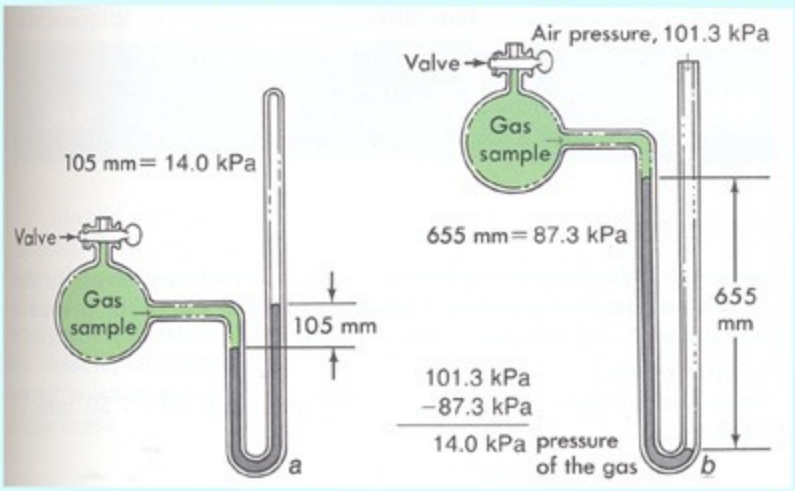
Car tire 2 atm

Total Force = (pressure)(area)

$$TF = pA$$

Manometers

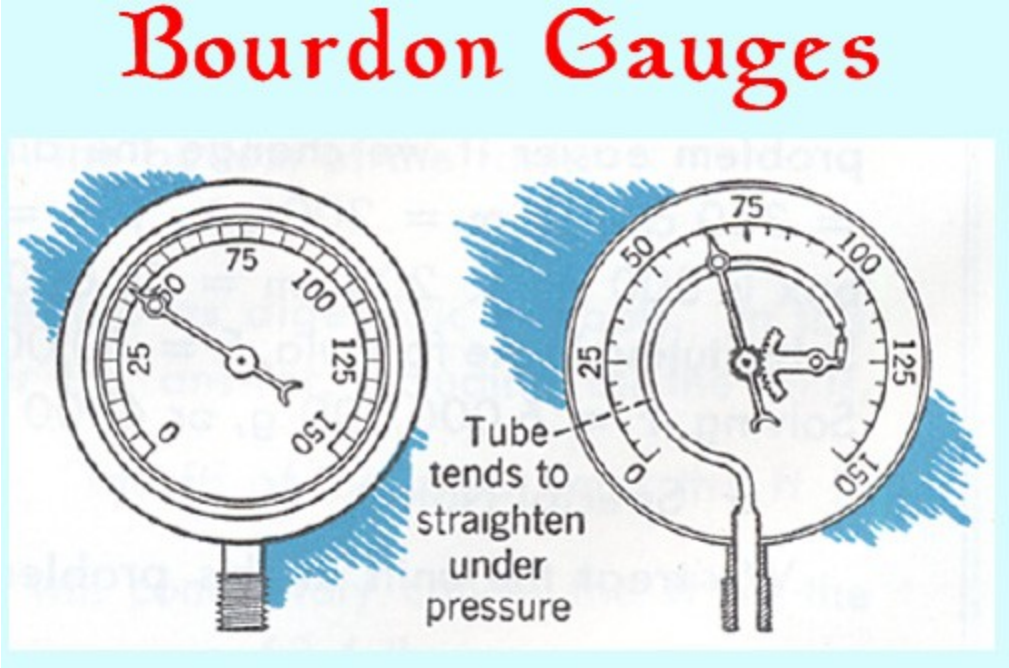
Open & Closed tube manometers measure pressure.



One atmosphere = 760mm of Hg = 101 kPa.
So 1mm of Hg = 0.13 kPa.

The Spygmomanometer measures blood pressure
in millimeters of mercury.


TRIMLINE
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
290
270
250
230
210
190
170
150
130
110
90
70
50
30



A larger surface area on the outer edge of the tube gives a greater total force.
Hence the tendency to straighten out under pressure.

Bourdon Gauges at Boomeria

Main machinery space

Main Machinery Spaces, Boomeria

Two Sample Problems

Solutions are on the next page

Find the pressure needed to push water to the top of Tower 2, a height of 8.0 meters. (Use mass units).
The density of water is 1.0 g/cm³.

Mainmachinery

Castle attack

Find the Total Force on the filled school dam whose dimensions are 5.0m by 2.0m. The average depth is 1.0m.

Hint: Pressure = (depth)(density)

Total force = (average pressure)(area)

Solution to the above problems:

Solutions

Find the pressure needed to push water to the top of Tower 2, a height of 8.0 meters. (Use mass units). *The density of water is 1.0 g/cm³.*

$$p = h\rho$$
$$= (8.0\cancel{m})(100\cancel{cm}/\cancel{m})(1.0 g/cm^{\cancel{3}\,2})$$
$$= 800\ g/cm^2$$

Find the Total Force on the filled school dam whose dimensions are 5.0m by 2.0 m. The average depth is 1.0 m.

$$f = pA$$
$$= (100 g/\cancel{cm^2})(10.0\cancel{m^2})(10^4 \cancel{cm^2}/\cancel{m^2})\ *$$
$$= 1 \times 10^7\ g = 1 \times 10^4\ kg \text{ or } 10 \text{ tons!}$$

Note: 1kg = 1000g
1 metric ton = 1000kg

$$A = LW$$
$$= (5.0m)(2.0m)$$
$$= 10.0\ m^2$$

* There are 10^4 cm² in a m².

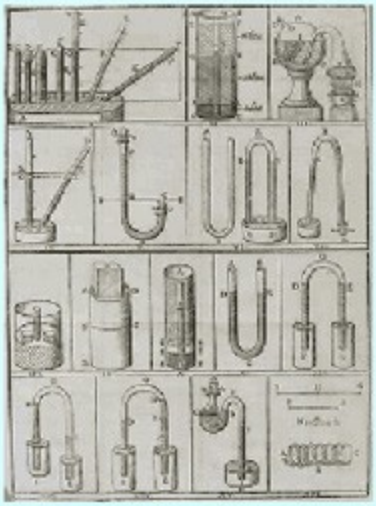
$$p = h\rho$$
$$= (1.0\cancel{m})(100\cancel{cm}/\cancel{m})(1.0 g/cm^{\cancel{3}\,2})$$
$$= 100\ g/cm^2$$

Pascal's Law

Pascal's Law-- The pressure on a confined fluid is transmitted in all directions.

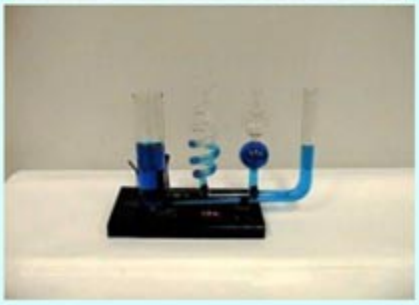
Examples Demos:

- Pascal's Vases
- Burst the Barrel
- Disintegrate the Jug
- Hydraulics *Demos:*
  - *Brakes*
  - *Lifts*
  - *Presses (make diamonds)*
  - *Syringe pistons*
  - *King Hiero's Fountain*
  - *An uplifting experience*
  - *Pushy Balloons*



Pascal's Vases show pressure depends only on depth & density.

Pascal's Vases



Pascal's Law applied to the water rocket Video:

The Coiled Hose Mystery

Boom tried pouring water in one end of an *empty* hose with a funnel.

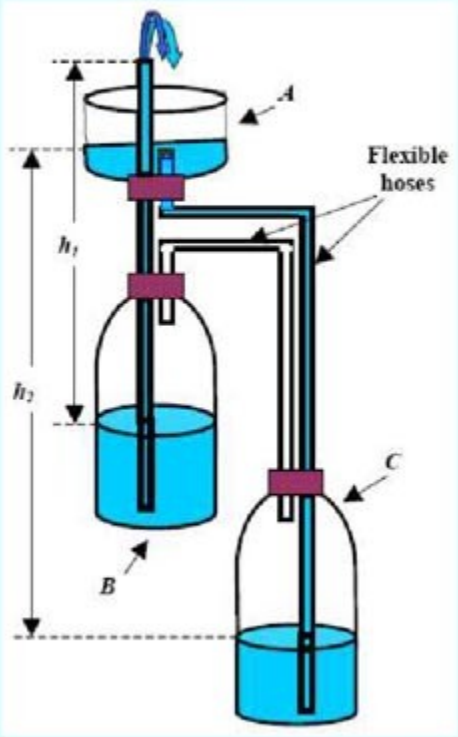
Much to his surprise, the hose acted as if it were clogged!

Ah, the pressure of each loop is added to give the total pressure!

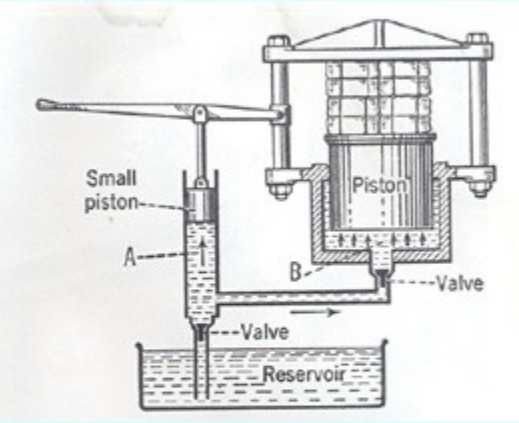
If the hose is lying flat so that there are no hills to climb, the water flows smoothly.

Hiero's Fountain

h_2 is higher than h_1, so the pressure is greater in the right system which pushes the water up into the fountain.



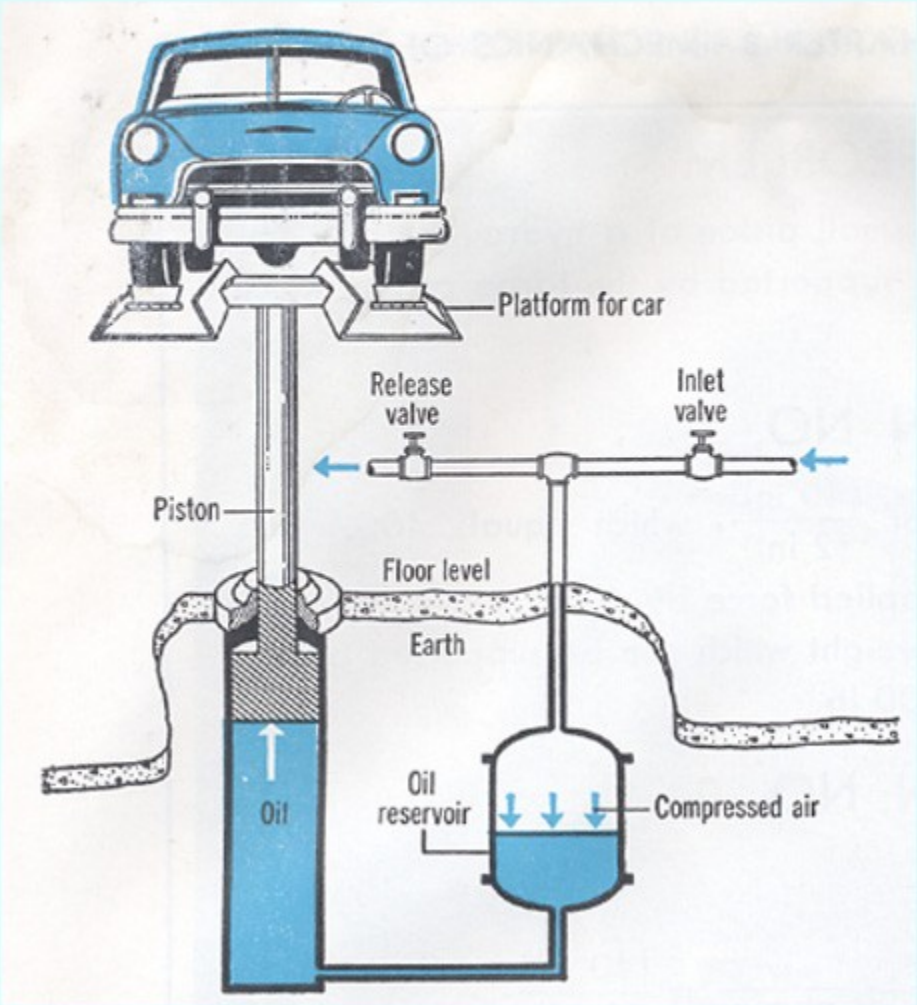
Hydraulic Press Means Business



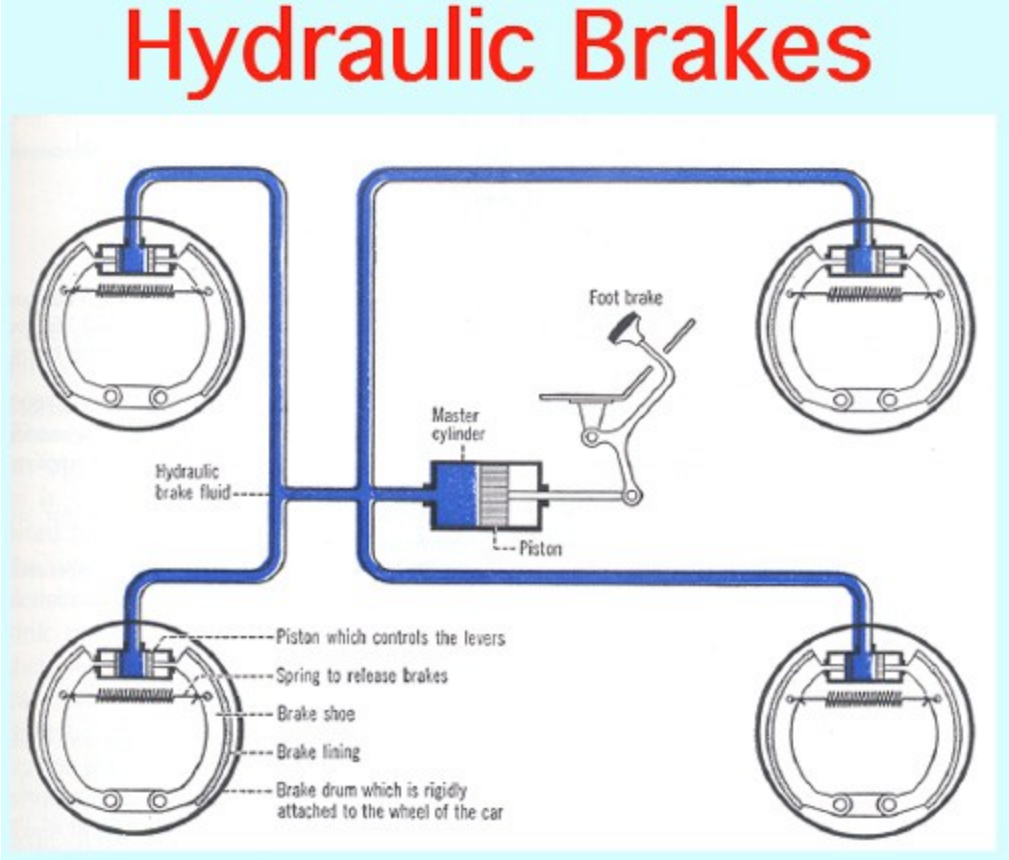
The Surface Area ratio is 1000/1

One newton of force on the small piston will produce 1000 newtons on the large piston!

Hydraulic Lift

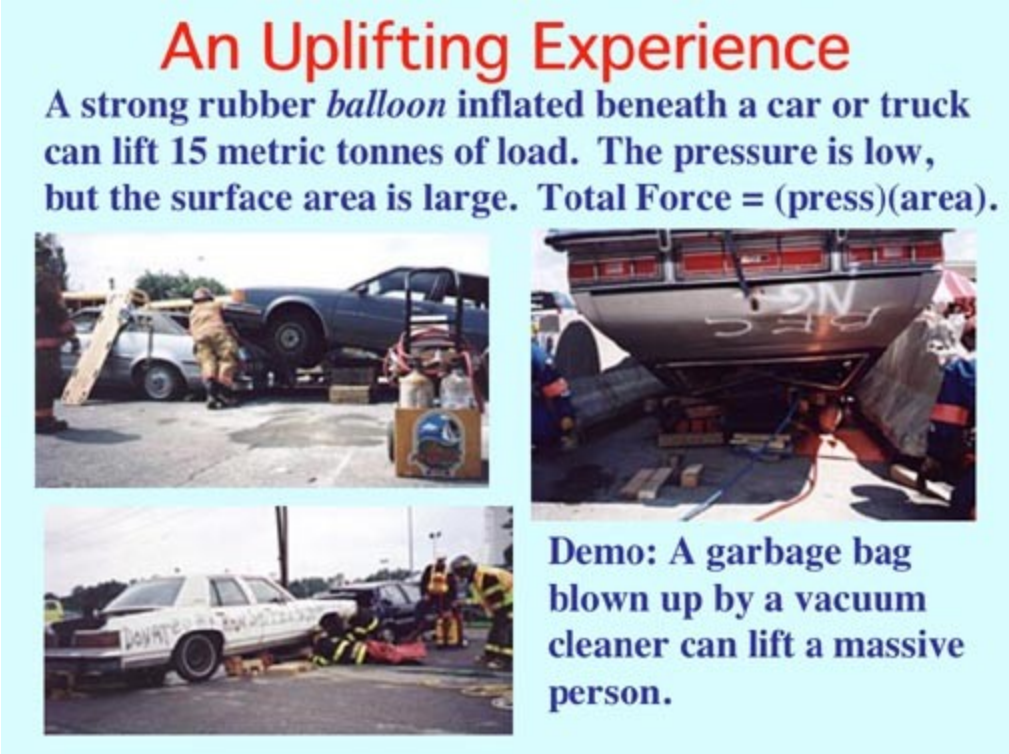


The pressure is transmitted undiminished in all directions!



The fluid pressure from the master cylinder is transferred equally to all the brake shoes.

Pascal's Hydraulic pistons can crush a car with a body in the trunk. Video:



An Uplifting Experience. Total force = pressure X area. Video:

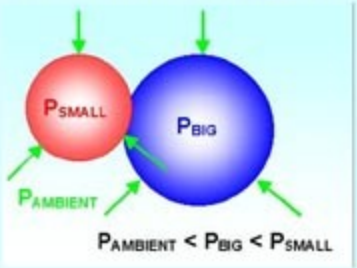
Hydraulics easily lifts a house, Video:

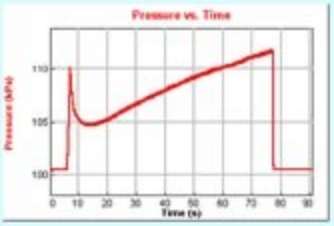
Total Force = Pressure X Area. Movie

Pushy Balloons (Demo)

A vector problem showing that the greater curvature in a small balloon causes higher pressure than the lesser curvature of a largely inflated balloon. (Same balloon).

Remember that it is harder at the start to blow it up.



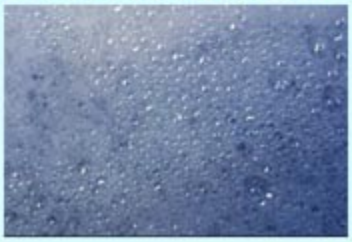


Courtesy of:
www.vernier.com

The Bends (demo)

Pressure dissolves more nitrogen into the blood. Each ten meters of depth increases the pressure by one atmosphere (1 kg/cm^2) Relieving the pressure too fast, causes the N_2 to bubble out in the blood.

Baaaad news diver!



Courtesy of phil@mit.edu

Bed of Nails & Broken Glass

Pressure = force/area
so a large area of contact reduces the pressure.

Busting the Blocks

The blocks are separated by a few millimeters. If you can break one, the others will follow. Same force all the way down.

Use your head!

Notice the spaces between the blocks.

Examples & Demos of Pressure

High Heels
Bed of Nails
Gramophone needle
Big Tyres on Small People
Water Tanks
Tower 2 & 88mm Aqua Cannon
Submarines
Bathyscaph at 10,000 meters
Coiled Hose Trick

An Uplifting Experience!
Pascal's Vases
Divers exhaust during ascent
Balloon in Bell Jar demo.
The Bends
Dams
Cut Steel with water jet
Quicksand!
Press at center of Earth =
1×10^6 atm Temp = 4000°C

Bernoulli and his Equation

Daniel Bernoulli (1700-1782)
Courtesy of The Royal Society, London, England

BERNOULLI'S EQUATION

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

pressure + kinetic energy per unit volume + gravitational potential energy per unit volume = constant along a given streamline

Bernoulli's Principle

Bernoulli's Principle-- The faster a fluid flows, the less pressure it exerts sideways.

Examples *Demos:*

Spool & Paper Blow
Papers blown together
"Pahdon me Suh...?"
Airplane Lift
Curve Baseball
The Brass Aspirator
Carburetor
Convertible Top Bulge
Ears pop when roll up car window
NASA Wind Tunnel
Chimney Drought
Shower Curtain Hugger
Pop can attraction
Ping Pong ball blaster

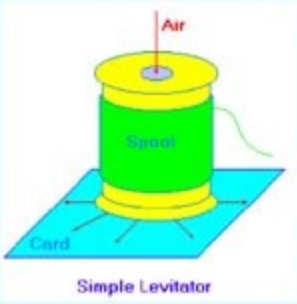
The Coanda Effect

The Coanda Effect is the tendency of a fluid jet to stay attached to an adjacent curved surface that is very
well shaped by a combination of the greater pressure above the fluid flow and the lower pressure
below the flow caused by an evacuating effect of the flow itself.

Demos: Spoon with water flowing over the convex surface, blow out a candle that is behind a beaker or finger.

Spool and Paper Blow Off

And the Pepsi Can Crash. ***Pahdon me, Suh!***



The greater the forward flow of a fluid, the less pressure is exerted sideways.

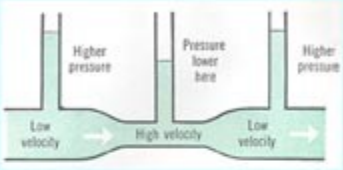
Ping-Pong ball in funnel with air blast.

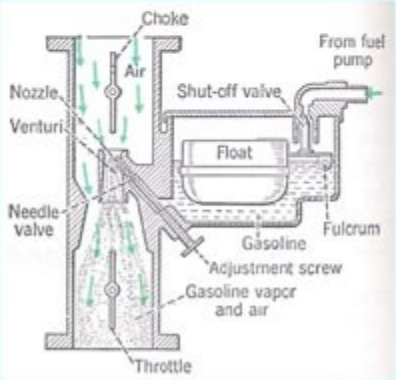
Venturi Tube, Carburetor & Aspirator

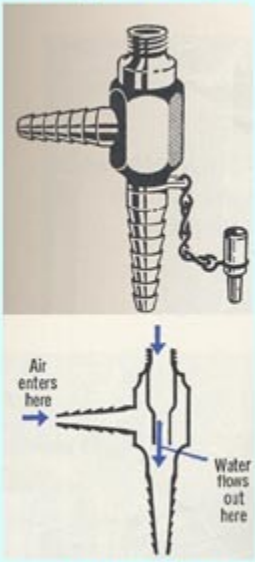
Demos:

A Venturi Tube has a constriction that causes the fluid flow to speed up.

The higher the forward velocity the lower the pressure sideways.

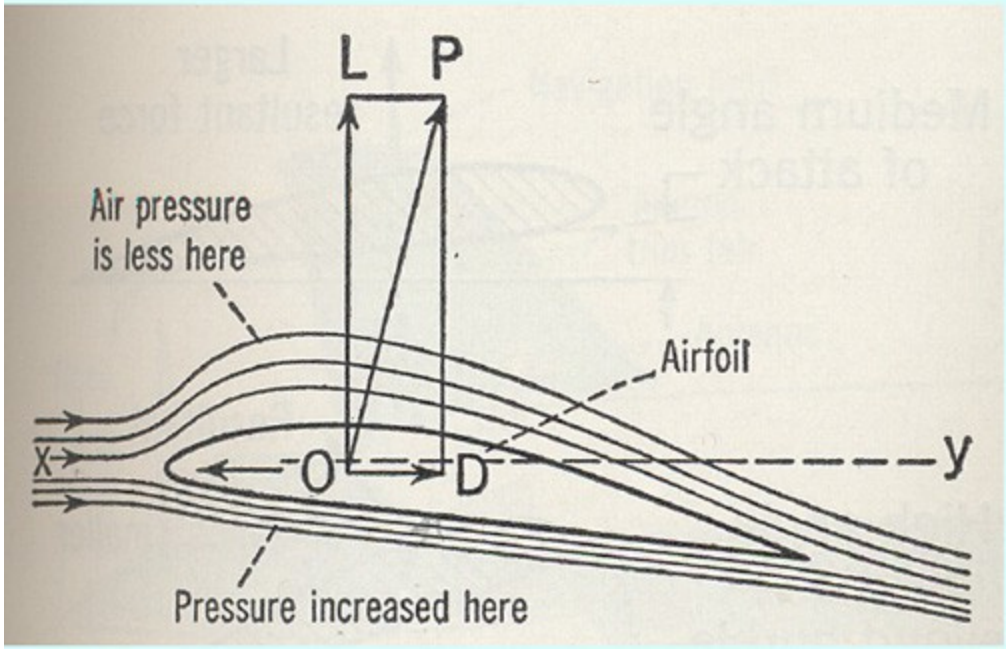






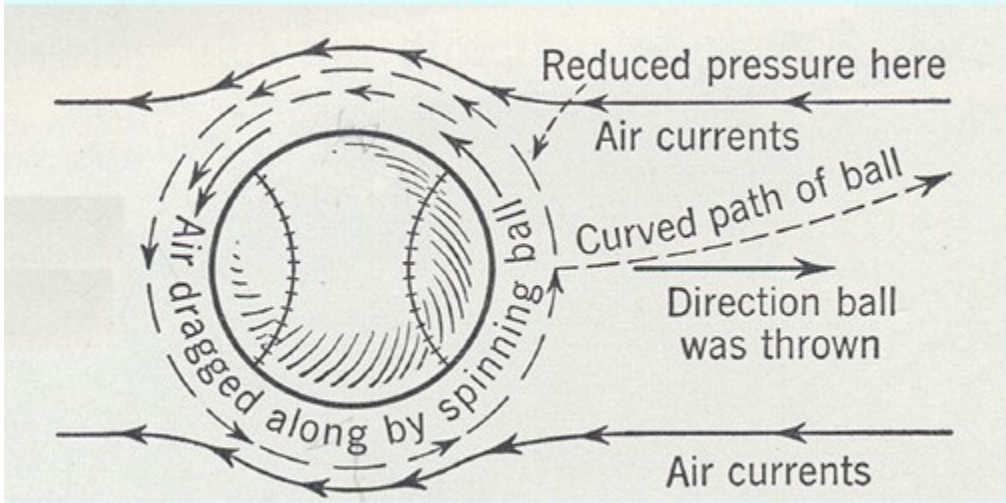
The Brass Aspirator

Airplane Lift

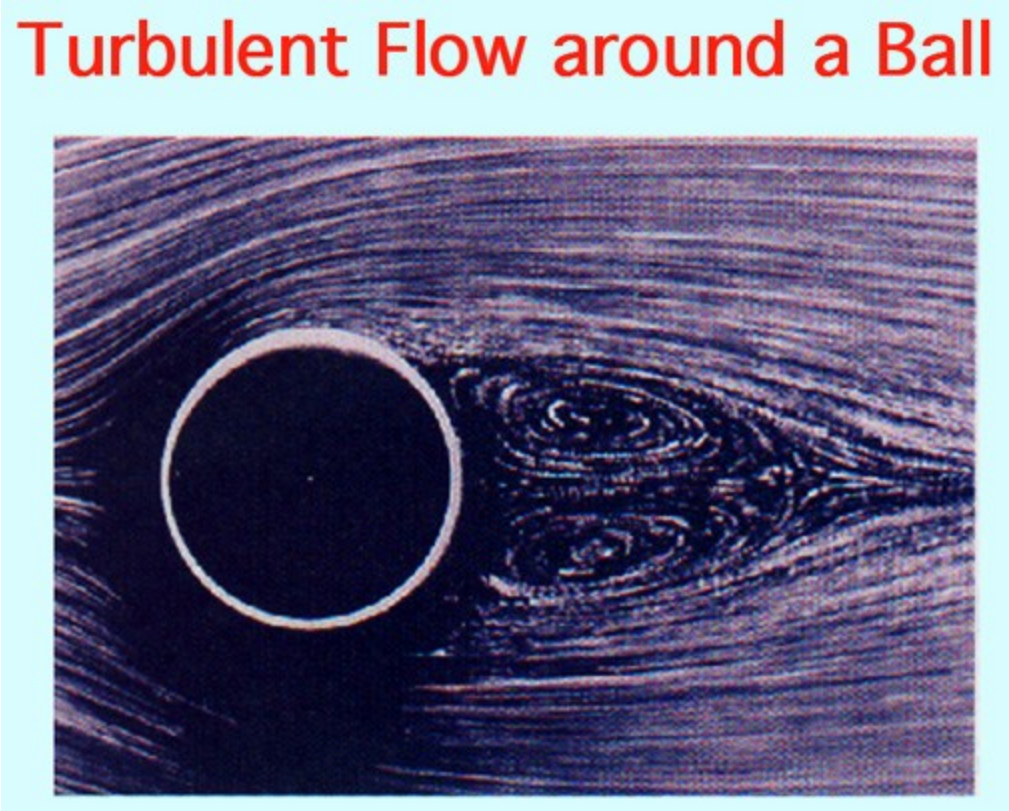


The faster the forward velocity of the air, the lower the pressure exerted upward.

Curving Baseball



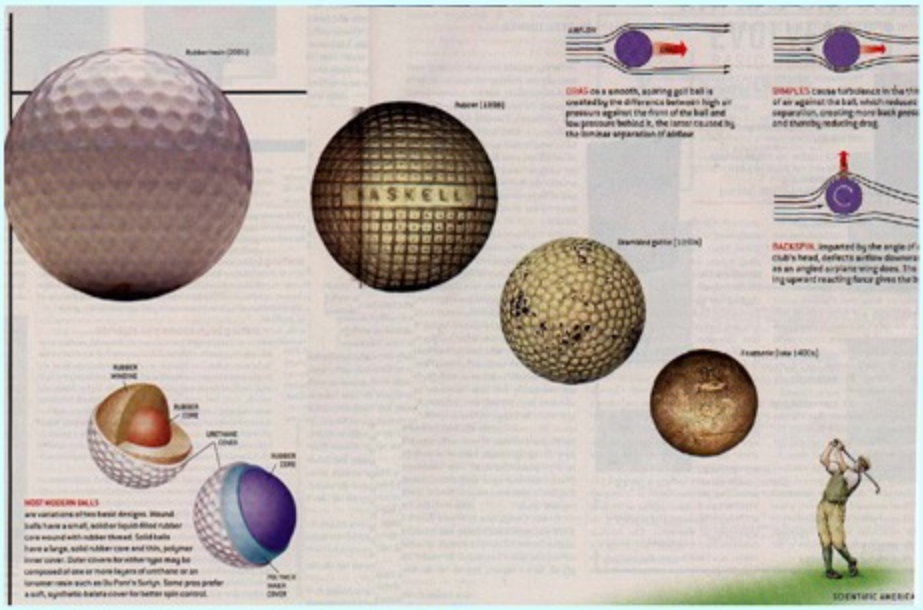
The faster the forward velocity of the air, the lower the pressure exerted sideways.



A Bernoulli Ball and a TP attack! Video:

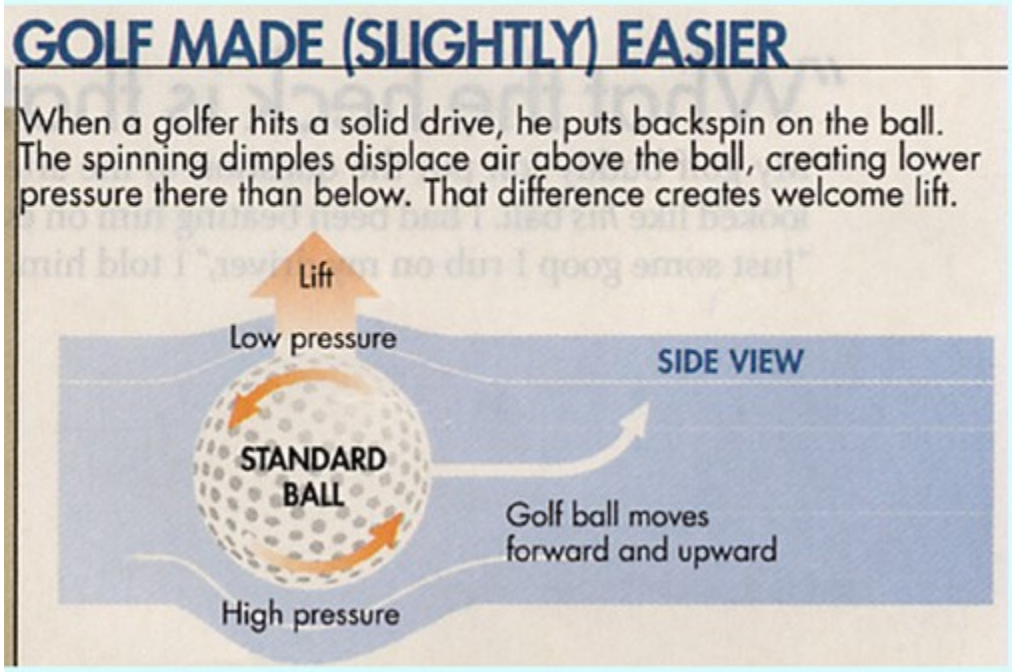
Golf Dimples & Turbulent Flow

If ball sans dimples goes 100m the dimpled one goes 250m!

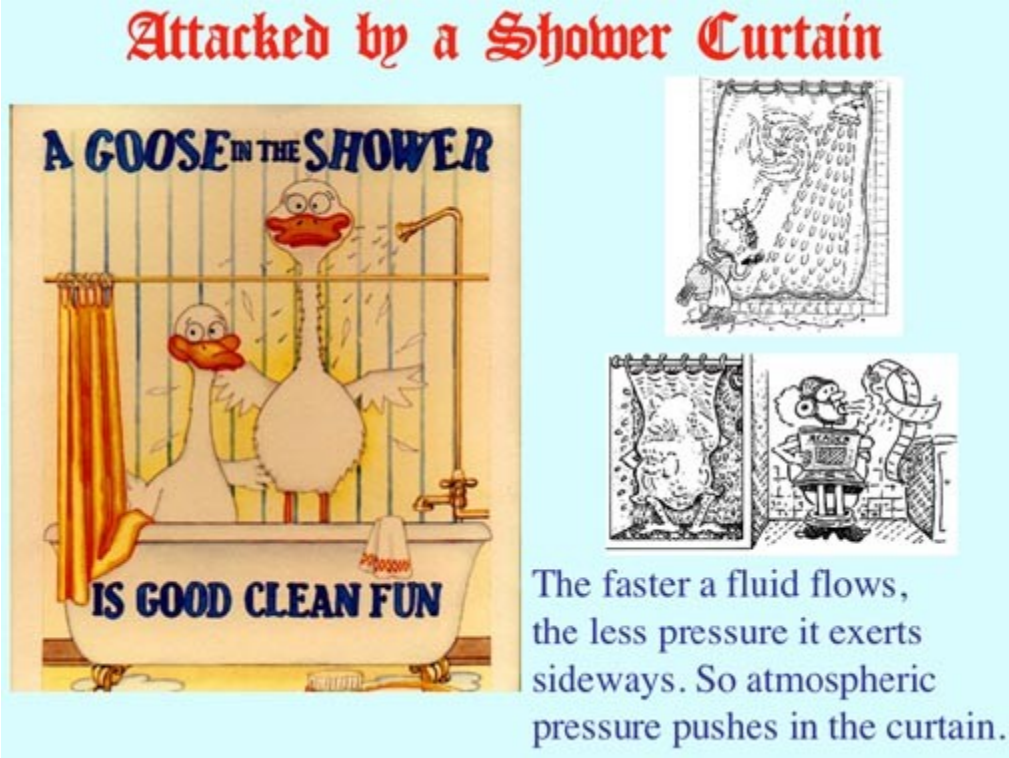


Dimples streamline the flow & Bernoulli's Principle gives lift.

Golf and Bernouilli



Bernoulli in the shower!



Attacked by a fierce, wild shower curtain.

Collection By

Veerapandian.K

Mechanical Engineering

www.pandianprabu.co.cc

Source website:
http://boomeria.org/physicstextbook/physglossary.html