

Science 8  
June 4<sup>th</sup>

We can use machines to produce an output force that is much greater than the input force.

For example, a ramp can enable someone to push a heavy load upward with only a small effort force.

The same is true for hydraulic systems.

The pressurized liquid can enable an ordinary person to lift a car using only the amount of force that can be

exerted by human muscles.

## Hydraulic and Pneumatic Systems

Hydraulics → The study of pressure in liquids.

pneumatics → The study of pressure in gases.

Pressure → The <sup>force.</sup> ~~force~~ acting perpendicular to a certain surface area.

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

$P = \text{Pressure} \rightarrow \text{N/m}^2$

$F = \text{force} \quad \text{N}$

$A = \text{area.} \quad \text{cm}^2, \text{m}^2$

$$1 \text{ N/m}^2 = 1 \text{ Pa}$$

$$\text{Pa} \rightarrow \text{Pascal}$$

Example:

500 N applied to 5 cm<sup>2</sup>

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

$$= \frac{500 \text{ N}}{5 \text{ cm}^2}$$

$$= 100 \text{ N/cm}^2$$

## Pascal's Law

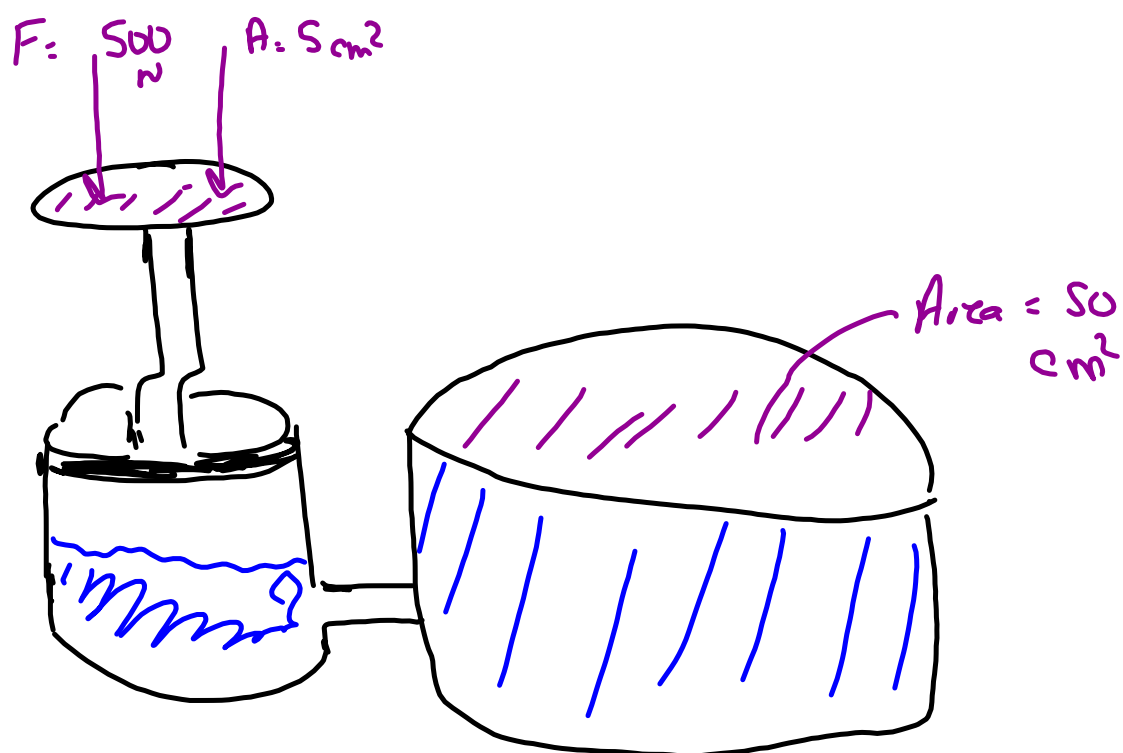
A law stating that when pressure is exerted on one part of a fluid, the same pressure is transmitted unchanged to all parts of the fluid, no matter what the shape of the container holding the fluid.

many hydraulic and pneumatic systems make use of Pascal's Law.

example: A hydraulic lift is a mechanical system that raises heavy objects, such as a vehicle on a service station lift,

→ uses fluid under pressure in a closed system.





$$P = \frac{F}{A} = \frac{500 \text{ N}}{5 \text{ cm}^2} = 100 \text{ N/cm}^2$$

Pascal's law states that this pressure is transmitted unchanged throughout the liquid. Therefore, the larger piston will also have a pressure of  $100 \text{ N/cm}^2$  applied to it.

If the large piston's area is  $50 \text{ cm}^2$ , then the total force would be

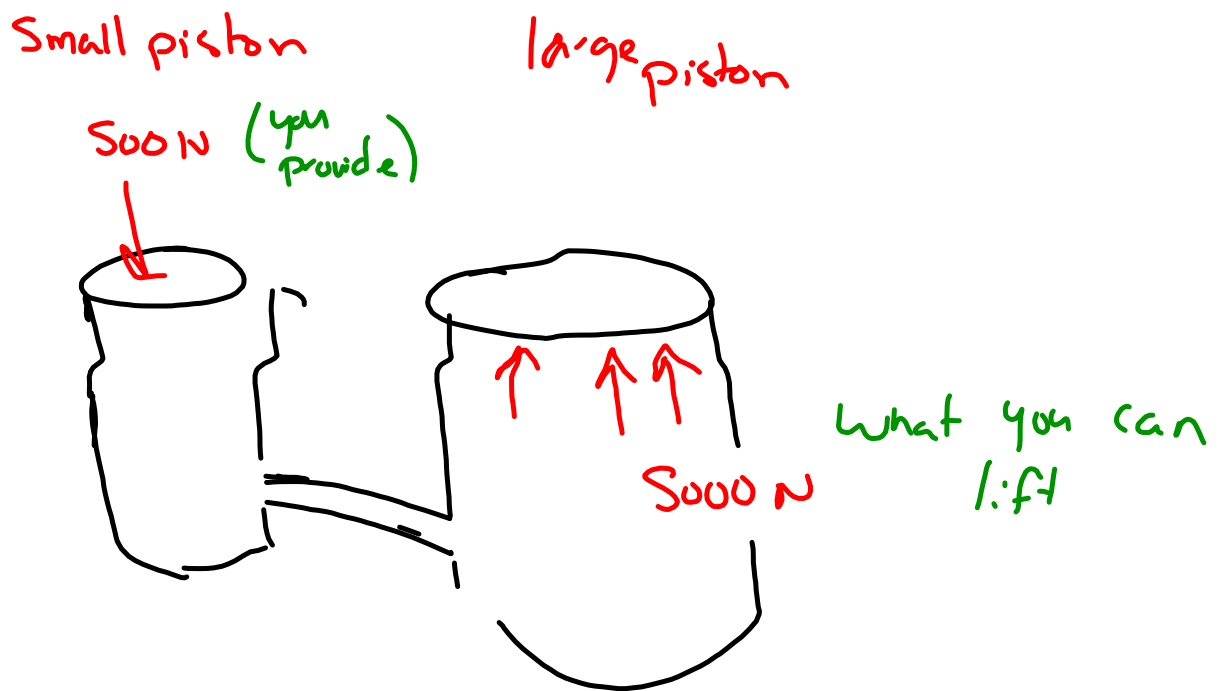
$$P = \frac{F}{A}$$

$$F = PA$$

$$= 100 \text{ N/cm}^2 \times 50 \text{ cm}^2$$

$$= 5000 \text{ N}$$

↑  
10x bigger



This is 10 times bigger than the force applied to the small piston.  
Using this machine, you could use your own weight to lift something ten times as heavy as you are.

$$1 \text{ Pa} = 1 \text{ N/m}^2$$

Mechanical Advantage  $\rightarrow$  The ratio of the force produced by the machine or system (the load), to the force applied to the machine or system.

$$\begin{aligned} \text{Last example } MA &= \frac{5000 \text{ N}}{500 \text{ N}} \\ &= 10 \end{aligned}$$

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