Pascal's Principle

Hydraulics

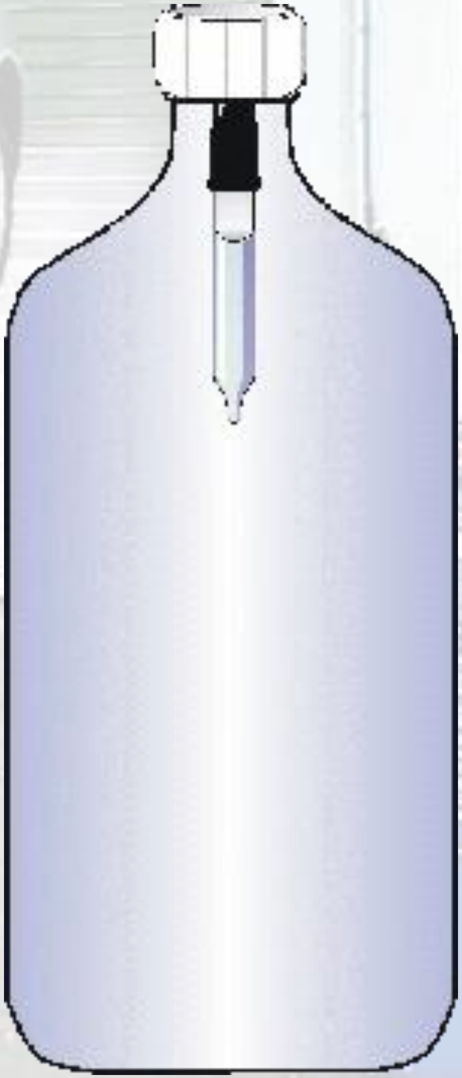
Force and Phase

- When you press on a solid, the particles do NOT move.

- When you press on a liquid the particles DO move.

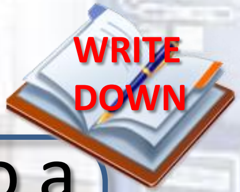
Force and Liquid

- When you press on a liquid, it moves, . . . but what if the liquid is in a closed bottle with nowhere to go?
- This can be examined by making a Cartesian diver from a soda bottle with water and a medicine dropper.
- When you squeeze on the soda bottle, the dropper dives.
- This is because as the liquid presses on the bubble in the medicine dropper compressing it, and making room for the water.



The Principle

- A liquid cannot be compressed.
- The particles of a liquid can move from place to place.
- When pressure is exerted on a liquid, particles of the liquid exert pressure on neighboring particles.
- Pascal's principle follows from these facts.



Pascal's principle = when pressure is applied to a liquid in a closed container, the pressure is transmitted equally throughout the liquid.

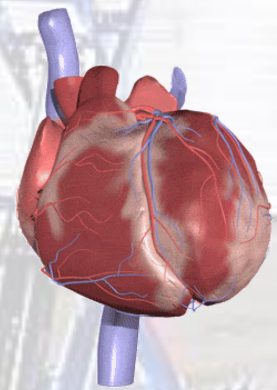
Applications

Force Pump

Hydraulic Lift

Force Pump

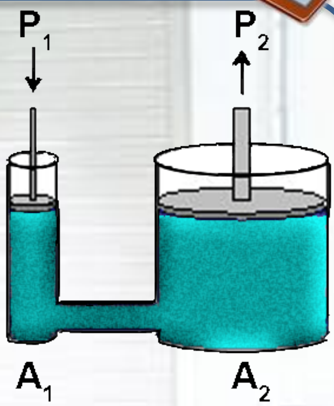
- Force pump = when pressure is applied to a liquid in a container with one opening, the liquid will come out of the opening.
- Examples:
  - Heart



  - Toothpaste tube

Hydraulic Lift

WRITE DOWN

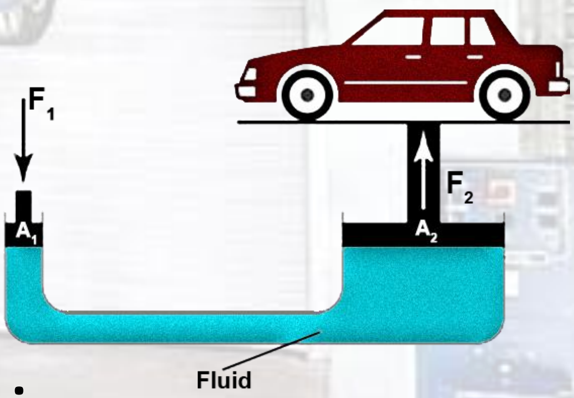


- In a hydraulic lift:
  - Pressure is applied to a piston (P_1)
  - Pressure is transmitted to another piston (P_2) through a fluid
- $P_1 = P_2$ according to Pascal's Principle
- Since pressure is force per unit area ($P = \frac{F}{A}$), and $P_1 = P_2$, $\frac{F_1}{A_1} = \frac{F_2}{A_2}$.
- If the surface area of the second piston is greater, the force is magnified.

Sample Problem

WRITE DOWN

A 3,000 N forcer is exerted on 2.0 m^2 piston in order to raise a car on a 60.0 m^2 piston of a hydraulic lift. How heavy is the car?



- **<u>Step 1</u>**: Identify your variables

  $F_1 = 3{,}000\text{ N}$ $F_2 = ?$

  $A_1 = 2.0\text{ m}^2$ $A_2 = 60.0\text{ m}^2$

- **<u>Step 2</u>**: Substitute into the equation

  $$\frac{F_1}{A_1} = \frac{F_2}{A_2} \text{ so } \frac{3{,}000\text{ N}}{2.0\text{ m}^2} = \frac{F_2}{60.0\text{ m}^2}$$

- **<u>Step 3</u>**: Solve

  $$F_2 = \frac{(3{,}000\text{ N})(60.0\text{ m}^2)}{2.0\text{ m}^2} = 90{,}000\text{ N}$$