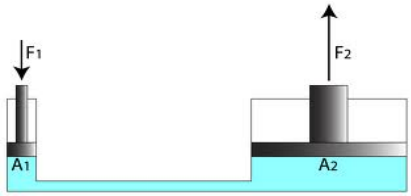
1.2 Pascal's Principle



Pascal's Principle

"Pressure applied to an enclosed fluid is transmitted undiminished to every point in the fluid and to the walls of the container."

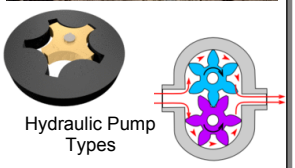
In incompressible liquids (water, hydraulic fluid), this happens instantaneously. In gases, the temperature and pressure change before reaching equilibrium (the principle still applies).

This is used extensively in machinery operation.

Hydraulics

Heavy equipment uses a hydraulic pump to move pressurized liquid to and from different parts of the machine through hoses.
At the end of the hoses are pistons which move in or out, depending on the position of hydraulic valves which the operator controls.
Syringe Demo.

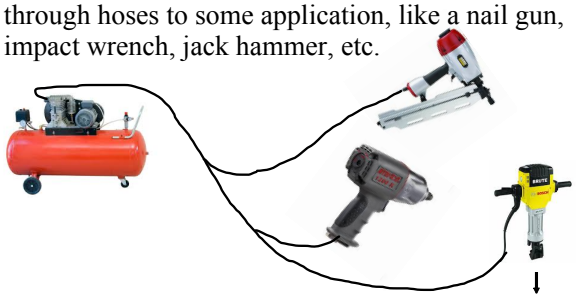
Piston goes in or out.



Hydraulic Pump Types

Pneumatics

Work similarly to hydraulics, but the working fluid is air, so there does not need to be a return line to the compressor: one way street (sound = psshhhhht!!).
A compressor pressurizes gas, which travels through hoses to some application, like a nail gun, impact wrench, jack hammer, etc.



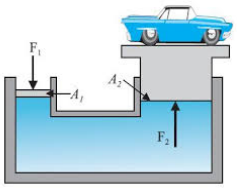
Hydraulic Lift Equation

By having different input and output areas of a hydraulic system, the magnitude of pressure can be multiplied:

$$\frac{F_i}{A_i} = \frac{F_o}{A_o}$$

F = Force (N)
A = Area (m^2)
i = input
o = output

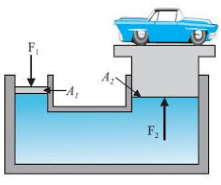
So: $$F_o = \left(\frac{A_o}{A_i}\right) F_i$$



Hydraulic Lift Example

A garage lift has input and lifting (output) pistons with diameters of 10.0 cm and 30.0 cm, respectively. The lift holds up a car with a weight of 1.40 E 4 N.

1. What is the force on the input piston?
2. What pressure is applied to the input piston?



Hydraulic Lift Answer (Slide 1)

Given information:

d_i = 10.0 cm, so r_i = 0.0500 m
d_o = 30.0 cm, so r_o = 0.150 m
F_o = 1.4 E 4 N

Areas: $A_{circle} = \pi r^2$

$$A_i = \pi \bullet (0.0500\,m)^2 = 0.00785\,m^2$$

$$A_o = \pi \bullet (0.150\,m)^2 = 0.0707\,m^2$$

$$\frac{F_i}{A_i} = \frac{F_o}{A_o}$$

$$F_i = \frac{A_i \bullet F_o}{A_o} = \frac{0.00785\,m^2 \bullet 1.40\,E\,4\,N}{0.0707\,m^2} = 1560\,N$$

Hydraulic Lift Answer (Slide 2)

From the previous problem:
F_i = 1560 N

and calculated A_i of 0.00785 m^2,

$$P = \frac{F_i}{A_i} = \frac{1560\,N}{0.00785\,m^2} = 1.99\,E\,5\,Pa$$

Homework 1.2

Read 9.3 in your books (if you've got one)

1.2 Problems