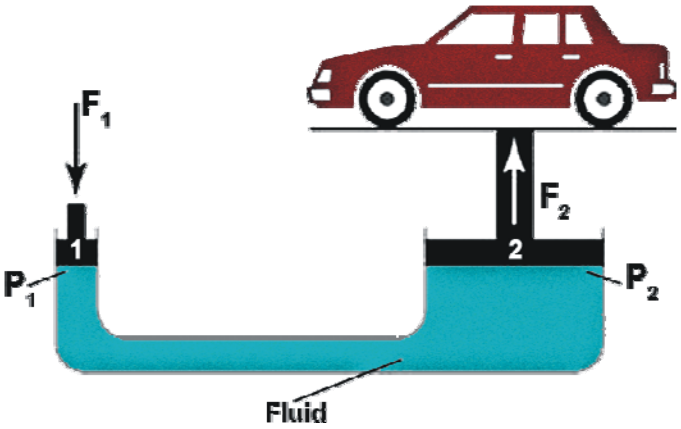
Pascal's Principle

According to Pascal's principle, when pressure is applied to a liquid in a closed container, the pressure is transmitted equally throughout the liquid. This is because, the liquid cannot be compressed, but the particles of a liquid can move from place to place, so when pressure is exerted on a liquid, particles of the liquid exert pressure on neighboring particles. Force pumps and hydraulic systems can be explained by Pascal's principle. A force pump exists when pressure is applied to a liquid in a container with one opening. As you might expect, the liquid will come out the opening. Examples of force pumps include the heart and a tube of toothpaste. Hydraulic systems use fluids to magnify force. Pressure is applied to a piston (P_1). The pressure is transmitted to another piston through a fluid (P_2). The pressures are equal, but since pressure is force per unit area, the force is not. If the surface area of the second piston is greater, the force is magnified. This is how a hydraulic lift in a garage picks up a car.



Sample Problem

What force must be exerted on 2.0 m^2 piston in order to raise a 90,000 N car on a 60.0 m^2 piston of a hydraulic lift?

Step 1: Identify variables

F_1 = ? F_2 = 90,000 N

A_1 = 2.0 m^2 A_2 = 60.0 m^2

Step 2: Substitute into the equation

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \text{so} \quad \frac{F_1}{2.0\ m^2} = \frac{90{,}000\ N}{60.0\ m^2}$$

Step 3: Solve the equation

$$F_1 = \frac{(90{,}000\ N)(2.0\ m^2)}{(60.0\ m^2)} = 3{,}000\ N$$

Solve the problems below using the procedure described above.

1. A 5,000 N force is exerted on 12.0 m^2 piston in order to raise a motorcycle on a 48.0 m^2 piston of a hydraulic lift. How heavy is the motorcycle?

2. What force must be exerted on 7.0 m^2 piston in order to raise a 120,000 N car on a 56.0 m^2 piston of a hydraulic lift?

3. A 3000 N force is exerted on 2.0 m^2 piston in order to raise a truck on a 100.0 m^2 piston of a hydraulic lift. How heavy is the truck?

4. What force must be exerted on 3.0 m^2 piston in order to raise a 72,000 N car on a 270.0 m^2 piston of a hydraulic lift?