A hydraulic lift, such as the one shown in **Figure 6,** makes use of Pascal's principle. A small force F_1 applied to a small piston of area A_1 causes a pressure increase in a fluid, such as oil. According to Pascal's principle, this increase in pressure, P_{inc}, is transmitted to a larger piston of area A_2 and the fluid exerts a force F_2 on this piston. Applying Pascal's principle and the definition of pressure gives the following equation:

$$P_{inc} = \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

Rearranging this equation to solve for F_2 produces the following:

$$F_2 = \frac{A_2}{A_1} F_1$$

This second equation shows that the output force, F_2, is larger than the input force, F_1, by a factor equal to the ratio of the areas of the two pistons. However, the input force must be applied over a longer distance; the work required to lift the truck is not reduced by the use of a hydraulic lift.

extension

Integrating Technology
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Keyword HF6FLUX

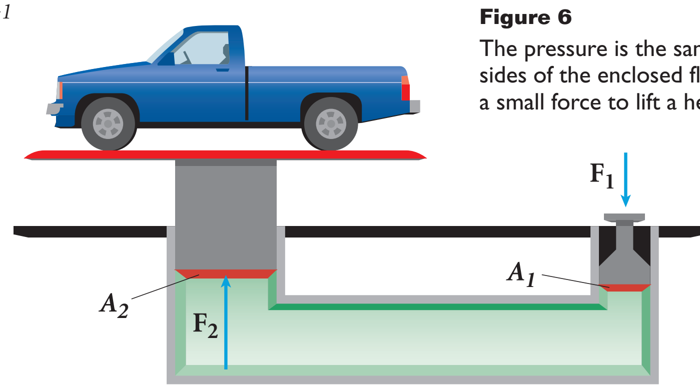

Figure 6
The pressure is the same on both sides of the enclosed fluid, allowing a small force to lift a heavy object.

SAMPLE PROBLEM B

Pressure

PROBLEM

The small piston of a hydraulic lift has an area of 0.20 m². A car weighing 1.20×10^4 N sits on a rack mounted on the large piston. The large piston has an area of 0.90 m². How large a force must be applied to the small piston to support the car?

SOLUTION

Given: $A_1 = 0.20 \text{ m}^2$ $\quad A_2 = 0.90 \text{ m}^2$

$F_2 = 1.20 \times 10^4 \text{ N}$

Unknown: $F_1 = ?$

Use the equation for pressure and apply Pascal's principle.

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = \left(\frac{A_1}{A_2}\right) F_2 = \left(\frac{0.20 \text{ m}^2}{0.90 \text{ m}^2}\right)(1.20 \times 10^4 \text{ N})$$

$$\boxed{F_1 = 2.7 \times 10^3 \text{ N}}$$