

## Answer on Question #76969, Physics / Other

a) A hydraulic braking system has been found to have a mechanical advantage of 25. In this system, what force must be exerted on the master cylinder to produce a force of 400 N on the brake cylinder?

b) Describe one way to improve the mechanical advantage.

### Solution:

Mechanical advantage is the factor by which a mechanism multiplies the force applied to it. It may be used to look at a ratio of distances or forces. Essentially, with the braking we can understand mechanical advantage as the ratio between the amount of force needed to pull the brake lever and the amount force created by this action as the brakes press against the braking surface.

a) The equation used to calculate mechanical advantage is literally output force divided by input force.

$$MA = \frac{F_o}{F_i}$$

In our case,

$$F_i = \frac{F_o}{MA} = \frac{400 \text{ N}}{25} = 16 \text{ N}$$

**Answer:** 16 N

b)

Pascal's law states that when there is an increase in pressure at any point in a confined fluid, there is an equal increase at every other point in the container.

We can derive a relationship between the forces in this simple hydraulic system by applying Pascal's principle. The pressure due to  $F_1$  acting on area  $A_1$  is simply

$$p_1 = \frac{F_1}{A_1}$$

According to Pascal's principle, this pressure is transmitted undiminished throughout the fluid and to all walls of the container. Thus, a pressure  $p_2$  is felt at the other piston that is equal to  $p_1$ . That is,  $p_1 = p_2$ .

However, since  $p_2 = \frac{F_2}{A_2}$ , we see that

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

The mechanical advantage is

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

So, one way to improve the mechanical advantage is **to decrease the master cylinder bore size**  $A_1$ .

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