Answer on Question #40966, Physics, Mechanics

A force of 250 N is applied to a hydraulic jack piston that is 5.0E-3 m in radius. If the piston which supports the load has a radius of 0.05 m, approximately how much mass can be lifted by the hydraulic jack? Ignore any difference in height between the pistons.

(a) 255 kg

(c) 800 kg

(e) 6300 kg

(b) 500 kg

(d) 2550 kg

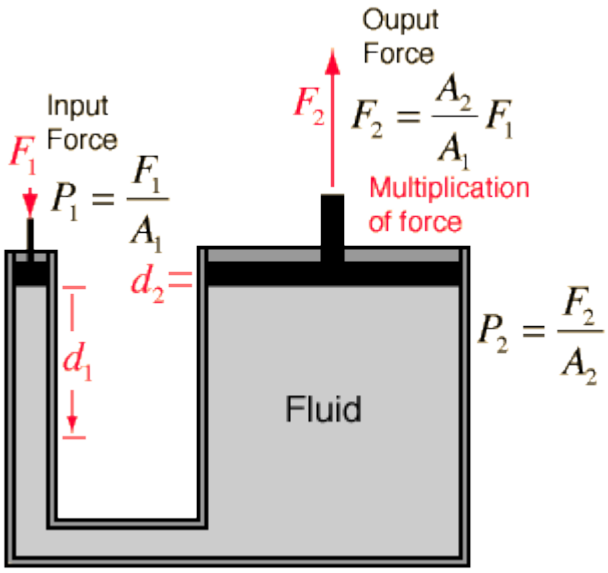
Solution:

Any externally applied pressure is transmitted to all parts of the enclosed fluid, making possible a large multiplication of force (hydraulic press principle).

A multiplication of force can be achieved by the application of fluid pressure according to Pascal's principle, which for the two pistons implies

$$P_1 = P_2$$

This allows the lifting of a heavy load with a small force.



F_1 / Area small piston = F_2 / Area of large piston

Area of circle is $A = \pi R^2$

Area of small piston $A_1 = \pi \cdot (5 \cdot 10^{-3})^2 = \pi \cdot 25 \cdot 10^{-6}$

Area of the large piston $A_1 = \pi \cdot (0.05)^2 = \pi \cdot 25 \cdot 10^{-4}$

We need not figure these areas out any further. The π's will cancel.

$F_1 = m_1 g = 250$ N, $F_2 = m_2 g$

Thus,

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

$$\frac{F_1}{A_1} = \frac{m_2 g}{A_2}$$

So,

$$m_2 = \frac{F_1 A_2}{A_1 g} = \frac{250 \cdot \pi \cdot 25 \cdot 10^{-4}}{\pi \cdot 25 \cdot 10^{-6} \cdot 9.81} \approx 2550 \text{ kg}$$

Answer. (d) 2550 kg.