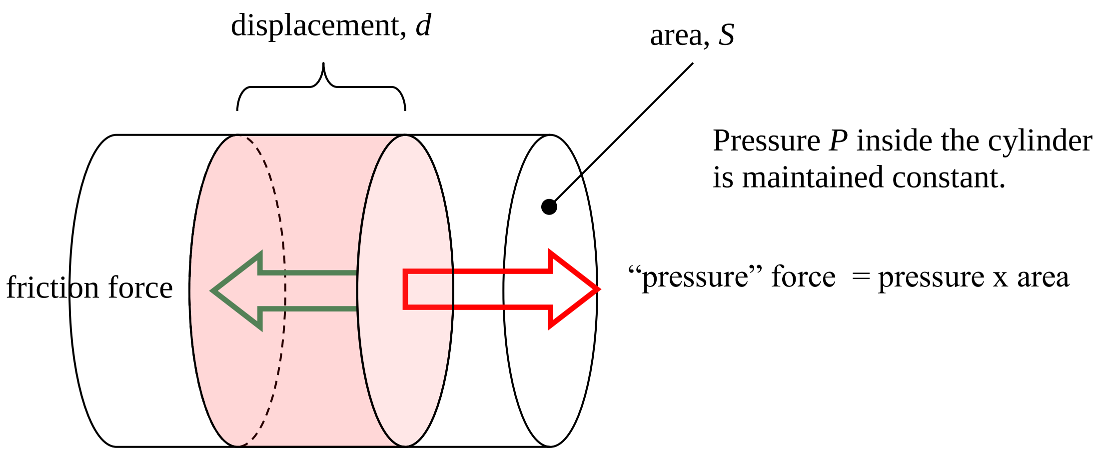
Homework 23.

Work, done by the gas.

We have learned is that gas can do work. Consider gas in a cylinder with a piston. We increased pressure inside the cylinder (say, connected the cylinder to a high pressure gas bottle). The piston moves at a constant velocity since the "pressure force" is compensated by the friction force. The expanding gas performs the work and heats the cylinder through friction. Let us calculate this work:



Work = force x displacement= pressure x area x displacement.

Or in a short form:

$$W=PSd.$$

But, as we can see, area multiplied by the displacement gives us change in volume, which we denote as ΔV. This change in volume is represented as the pink cylinder in the figure. So,

$$W = P \cdot \Delta V$$

It is interesting that this formula is valid for a cylinder of any shape as long as the pressure is *maintained constant*. If the gas is just expanding in a cylinder, the pressure changes as the gas pushes the piston outside and the work cannot be calculated that simply.

Problems:

1. There is a cylinder with a piston. The mass of the piston is 100kg, its area is 100cm^2. The cylinder contains 28g of nitrogen at T_1=273K. The cylinder is heated up to T_2=373K. How does the piston position change? The atmospheric pressure is ~101,000 Pa.

2. How much hydrogen (in grams) is in a cylinder with a piston if it performs work of 400J being heated from 250K to 680K? The gas pressure was maintained constant. Neglect the weight of the piston.

3. There is a closed from both sides cylinder with a piston inside. The piston divides the inner volume of the cylinder to two parts. One part contains 3g of hydrogen, the other contains 17g of nitrogen. What is the ratio of the volume of "hydrogen part" to the total volume of the cylinder?