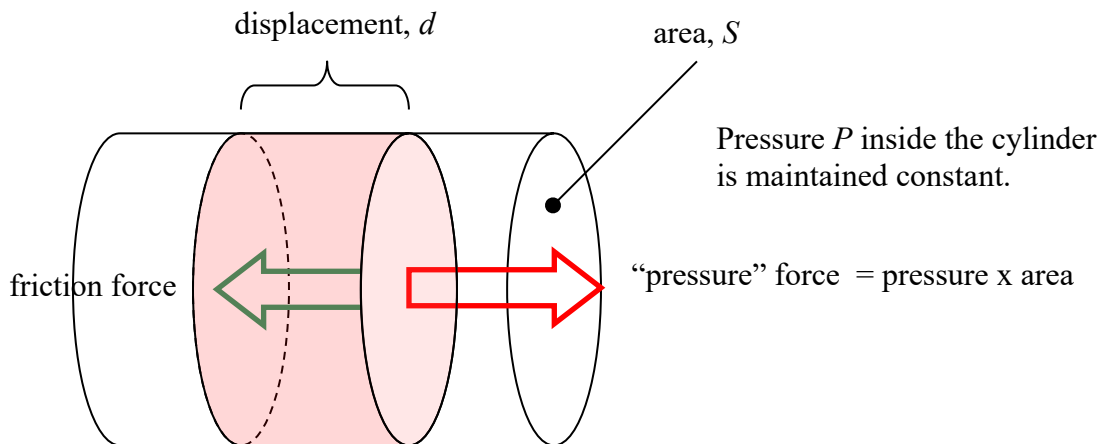


Homework

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:

$$W = P S d.$$

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 gas container 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.

The work done by the gas can be positive and negative. If the gas expands, its final volume is larger than the initial and change in the gas volume is positive, since it is “final volume minus initial one”. In the case of gas compression, the final volume is less than the initial and the change in the gas volume is negative, so is the gas work. In this case we can say that the work is done *on the gas* by some external force.

Problems:

1. Find molar mass of molecular oxygen O_2 using periodic table. Using it, find the mass of oxygen in a 10 liter cylinder if it has temperature $T=13^\circ\text{C}$ and pressure $P = 9 \cdot 10^6 \text{ Pa}$ (note that it is 90x the normal atmospheric pressure!). For how long can the oxygen in this cylinder sustain a scuba diver, if an average person needs to inhale about 2 grams of oxygen per minute?
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?

