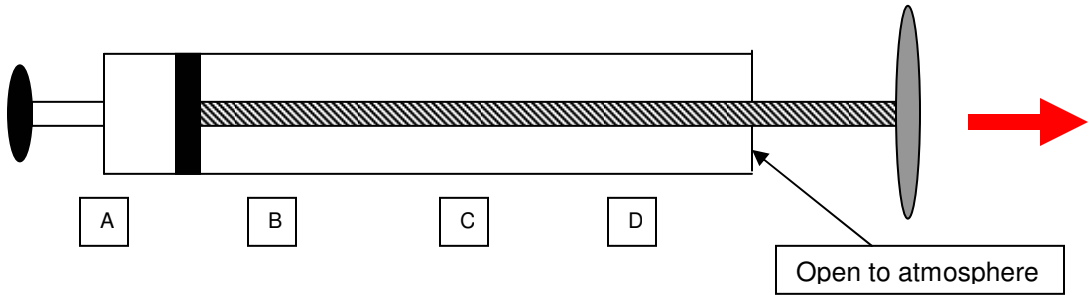
I have a standard syringe 1” diameter, with a freely moving plunger requiring uniform force to move the length of the cylinder providing smooth uniform travel.

Cross sectional area = πr^2 = 3.1415 * 0.5” * 0.5” = 0.785 in^2
Negative pressure acting on the piston = 0.758 in^2 * 14.7 psi = 11.545 lbs

I start from the plunger fully inserted into the cylinder; therefore, the vacuum chamber is completely empty, except for the nozzle portion. A sealed applied to the nozzle makes it airtight so no air can enter the vacuum chamber.

The force required to pull the plunger out (thus increasing the volume of the vacuum chamber) is initially minimal (@11.545 lbs) but quickly increases as the plunger moves out further and further from point A to B to C and to point D, until the plunger cannot be pull any further, by hand.



The questions:

1. Why those it get significantly harder to pull the plunger out?
2. How can this be calculated?