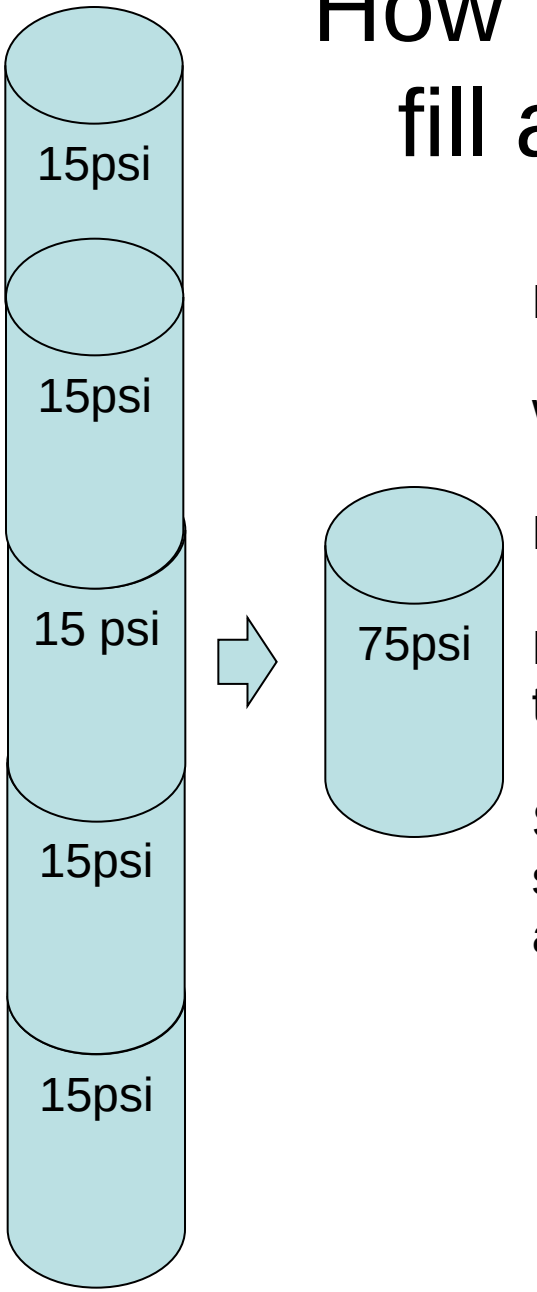
How much work does it take to fill a 2 liter bottle to 60 psi?



First, how much air do we need?

We assume constant temperature, so PV=const.

Note: Atmospheric pressure is about 15psi (14.7psi)

NOTE: We are talking about 60psi on the gauge, that's about 75 psi absolute.

So $P_1V_1=P_2V_2$ and since the ratio of pressures is 5:1, so is the ratio of volumes. It takes ~10 liters of air from atmospheric conditions.

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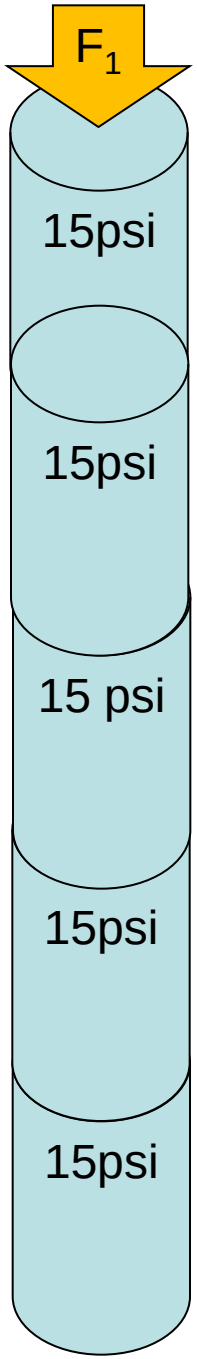

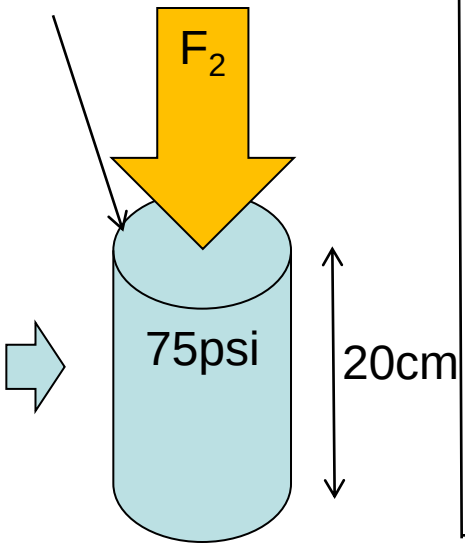

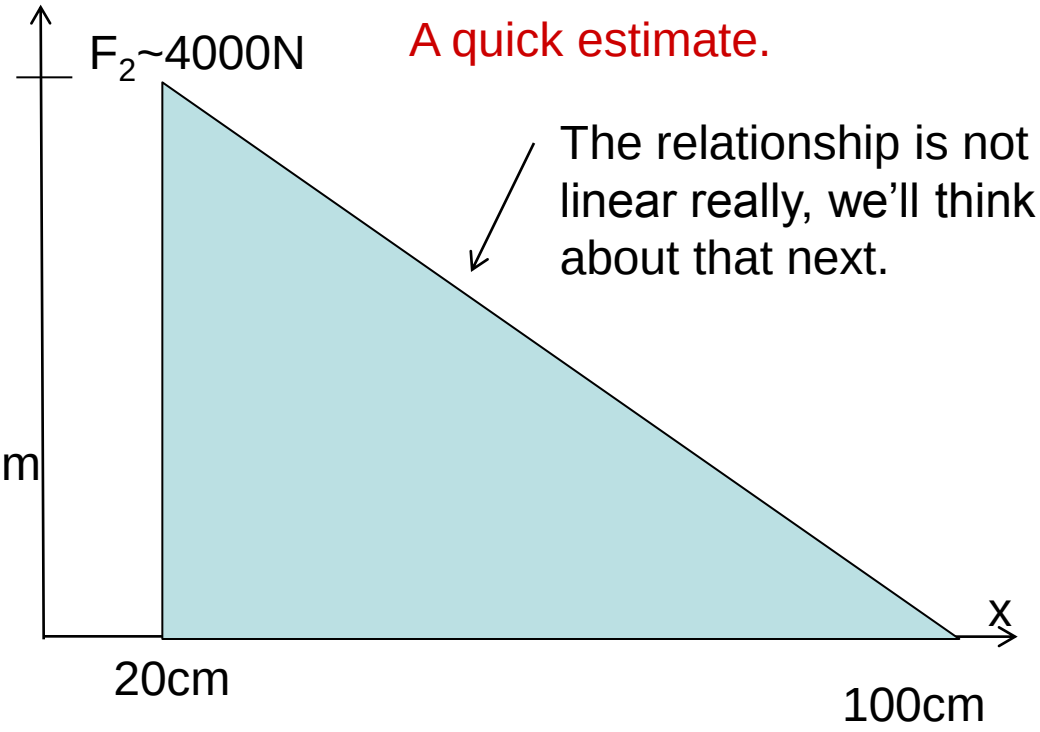

Assuming a linear change in force

W=area under the curve
= ½ * 4100N*80cm~1600J

This is an OVER estimate

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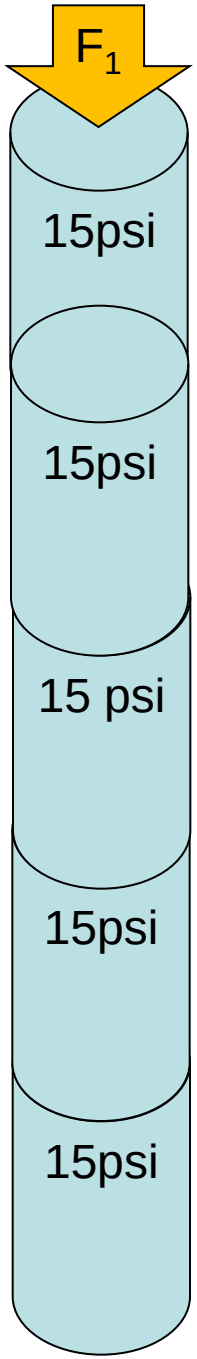

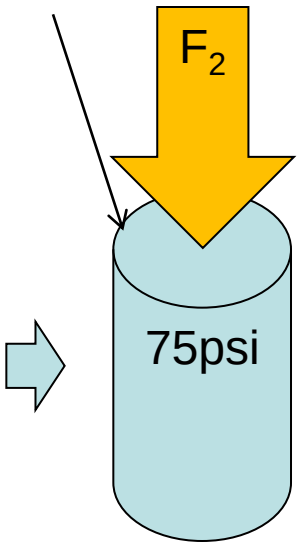

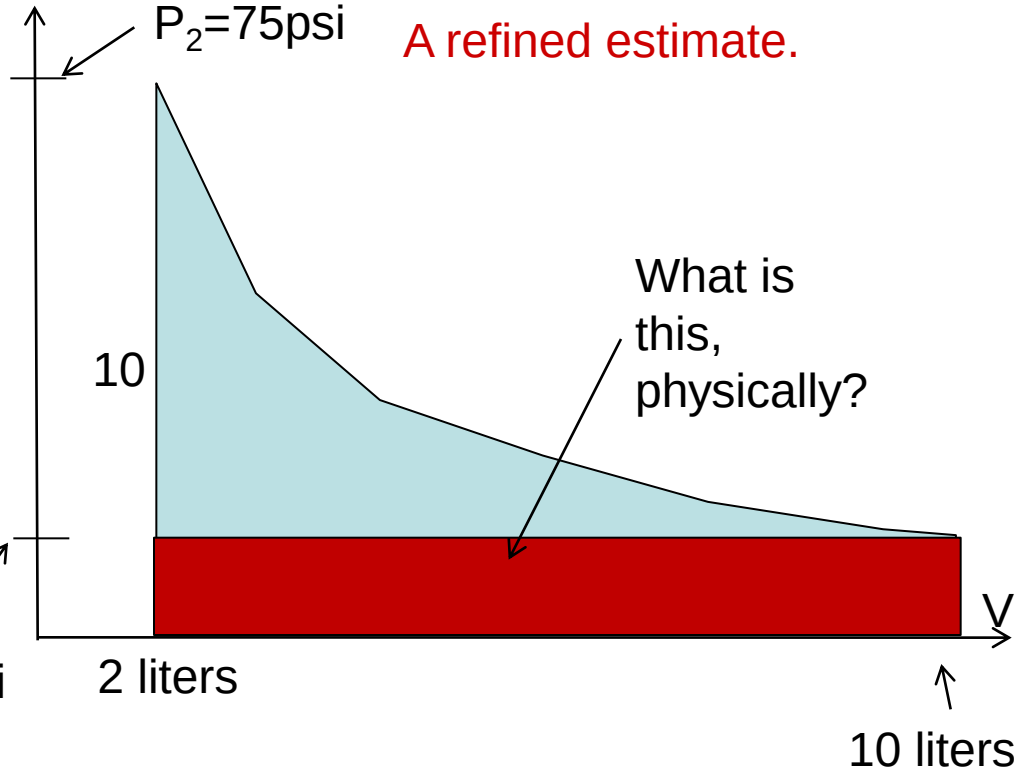

$$W = \int_{10liters}^{2liters} PdV = \int_{10liters}^{2liters} \frac{P_1 V_1}{V} dV = -1678J$$

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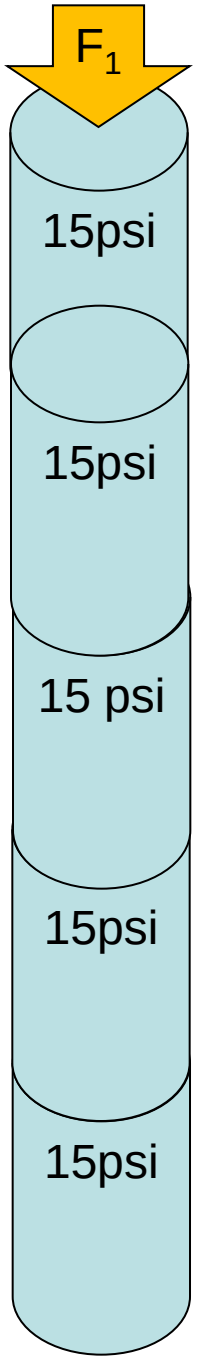

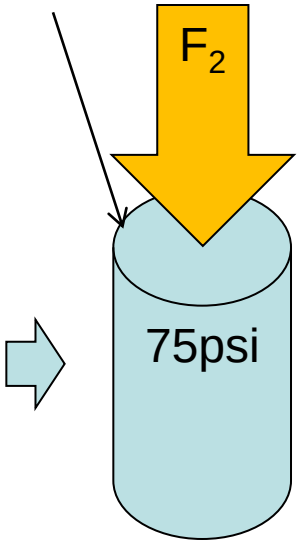

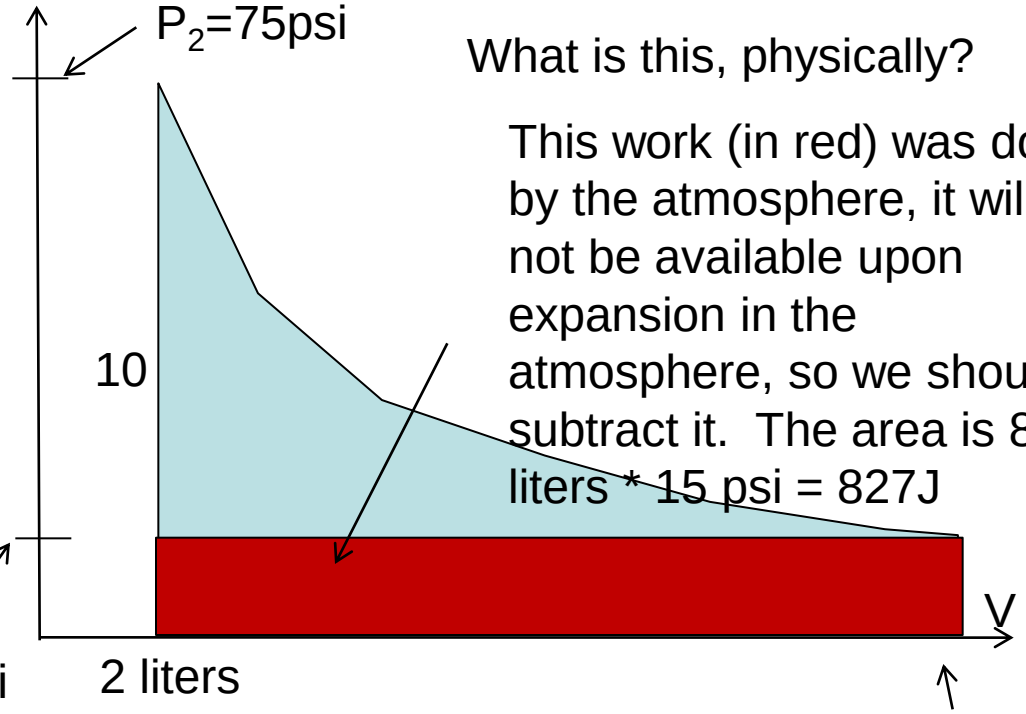

What is this, physically?

This work (in red) was done by the atmosphere, it will not be available upon expansion in the atmosphere, so we should subtract it. The area is 8 liters * 15 psi = 827J

$$W = \int_{10liters}^{2liters} PdV = \int_{10liters}^{2liters} \frac{P_1 V_1}{V} dV = -1678J$$

Correcting this solution we find, 1687J adjusted by the red area 827J making the final estimate **860J**