Pressure in a cylinder following combustion

A. If the initial volume is 0.02 L and the pressure is 5.4 atm as in the previous problem what is the final volume if the pressure drops to 1 atm at constant temperature?

B. In order to drive the combustion process fuel and air are forced into the cylinder. How many moles of gas are needed at the initial conditions (V_1 = 0.02 L, T = 1200 K) in order for the expansion to go to completion (i.e. for the cylinder to expand to 0.5 L at 1200 K)?

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A. If the initial volume is 0.02 L and the pressure is 5.4 atm as in the previous problem what is the final volume if the pressure drops to 1 atm at constant temperature?

Solution: This problem is an isothermal expansion

$$P_1V_1 = P_2V_2$$

Solving for the final volume V_2, we find

$$V_2 = \frac{P_1V_1}{P_2} = \frac{(5.4\ atm)(0.02\ L)}{(1\ atm)} = 0.108\ L$$

Clearly, this expansion is not complete, since the volume of the cylinder is 0.5 L.

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B. How many moles of gas are needed at the initial conditions (V_1 = 0.02 L, T = 1200 K) in order for the expansion to go to completion?

Solution: First we determine the needed pressure. Then we solve the number of moles.

$$P_1 = \frac{P_2 V_2}{V_1} = \frac{(1\ atm)(0.5\ L)}{(0.02\ L)} = 25\ atm$$

Now we use the ideal gas law:

$$n = \frac{PV}{RT} = \frac{(25\ atm)(0.02\ L)}{\left(0.08206\ \frac{Latm}{molK}\right)(1200\ K)} = 0.0051\ mol$$