## Chapter 17 Problem 37 $^{\dagger}$

Given  $h = 100 \ cm = 1.00 \ m$   $D = 20.0 \ cm$   $r = 10.0 \ cm = 0.10 \ m$   $T_0 = 20^{\circ}C = 293 \ K$  $P_0 = 180 \ atm$ 

## Solution

a) Find the number of moles of air in the cylinder.

Convert the pressure into pascals.

$$P_0 = (180 \ atm) \left(\frac{1.013 \times 10^5 \ Pa}{1 \ atm}\right) = 1.82 \times 10^7 \ Pa$$

Next calculate the volume of the cylinder. Since the diameter is given, the cross-sectional area of the cylinder is that of a circle.

$$A = \pi r^2 = \pi (0.10 \ m)^2 = 0.0314 \ m^2$$

The volume is the cross-sectional area multiplied by the height

 $V = A \cdot h = (0.0314 \ m^2)(1.0 \ m) = 0.0314 \ m^3$ 

Now use the ideal gas law to find the number of moles

$$\begin{split} PV &= nRT \\ n &= \frac{PV}{RT} = \frac{(1.82 \times 10^7 \ Pa)(0.0314 \ m^3)}{(8.31 \ J/mol \cdot K)(293 \ K)} = 235 \ mol \end{split}$$

b) What volume would this air occupy if at 1 atm?

If the temperature and number of moles remains constant, then

$$P_0V_0 = const = P_fV_f$$

The final volume is then

$$V_f = \left(\frac{P_0}{P_f}\right) V_0 = \left(\frac{180 \ atm}{1 \ atm}\right) (0.0314 \ m^3) = 5.65 \ m^3$$

## <sup>†</sup>Problem from Essential University Physics, Wolfson