Question: A sample of gas initially at 4.00 atm was compressed from 8.00 L to 2.00 L at constant temperature. What is the pressure of the gas after the compression?

A. 4.00 atm
B. 2.00 atm
C. 1.00 atm
D. 8.00 atm
E. 16.0 atm

HINT: What variables are constant during this process?

Concepts: To answer this question we need to know the relationship between the volume of a sample of gas and the pressure of the same sample.

Connections:

What is given? We are given an initial volume and pressure of a gas sample along with a final volume and told the sample is at constant temperature.

What do I want to know? We want to know the final pressure of the gas after the volume has been reduced (i.e. the gas has been compressed). To do this we need to know what the relationship between volume and pressure is.

What else do we know? It is implicitly stated that the quantity of gas will not change during this process. This means n (# of moles of gas) is constant. So both T and n are constant, while P and V change.

To determine which gas law applies, we must look at the information given, determine what is constant and what is changing and then utilize the law that governs those conditions that are changing.

All of the variables are related via the ideal equation of state: PV = nRT.

In this problem, n and T (and of course R are constant). Therefore we can write:

$P_1V_1 = nRT$

and

$P_2V_2 = nRT$

Since the product nRT is the same for both situations we can set these two equal and we arrive at Boyle's Law:

$P_1V_1 = P_2V_2$

When utilizing Boyle's Law the units on pressure and volume do not matter so long as they are consistent. This is because all pressure or volume unit conversions are multiplication based and the process would cancel on both sides of the equation.

Be sure you understand everything above before moving on to the solution below.

Solution:

Start by summarizing the information given: n and T are constant.

P_1= 4.00 atm P_2=?

V_1= 8.00 L V_2= 2.00 L

In this question we are dealing with a pressure vs. volume relationship so the gas law that applies is Boyle's Law: $P_1V_1=P_2V_2$

After evaluating the problem do we begin doing math:

$P_1V_1=P_2V_2$

$P_1V_1/ V_2 = P_2$

(4.00 atm)(8.00 L)/(2.00 L)=16.0 L or answer choice E