Gas Laws—conceptual pressure

Rank the following in terms of pressure. Size of the box indicates volume.

Greatest 1___C___ 2__A___ 3___D__  4___F__  5___B = E__  6____ Least

Explain your reasoning below. Be sure to reference the kinetic-molecular theory in your explanation. No calculations are needed nor appropriate.

All boxes have the same volume, so that is not a factor in the pressure. If it was, smaller boxes would have a larger pressure.

Boxes also vary in number of molecules. More molecules means more hits per area so higher pressure. The size of the particle does NOT matter. While they are bigger, they also move slower. They will have the same kinetic energy as the small molecules and the kinetic energy determines pressure not mass of molecules alone. Based on this A, B and E should be the same and C, D and F are the same.

Boxes vary in temperature. At higher temperatures, the molecules will have more kinetic energy, therefore hit the box with more force, increasing the pressure. Consequently we would expect “C” to be highest and B& E lowest.

So within the groups from number of molecules
\[ A > B = E \]
\[ C > D > F \]

These answers will get you full credit for the problem.

To compare the two groups, you will need calculations (ideal gas law is good). Since you don’t have numbers for every value, you will have to make some assumptions. As long as you are consistent, it will work. One (easy) way is to assume each molecule actually represents a mole of molecules; you will need some number for volume, so let’s make it easy and assume one liter (as long as it is the same, any value will work)

\[ PV = nRT \]

A: \[ P(1L) = 4(0.0821 \text{ L·atm/mol·K})(300K) \] \[ P = 98.5 \text{ atm} \]
B: \[ P(1L) = 4(0.0821 \text{ L·atm/mol·K})(100K) \] \[ P = 32.8 \text{ atm} \]
C: \[ P(1L) = 2(0.0821 \text{ L·atm/mol·K})(700K) \] \[ P = 114.9 \text{ atm} \]
D: \[ P(1L) = 2(0.0821 \text{ L·atm/mol·K})(500K) \] \[ P = 82.1 \text{ atm} \]
E: \[ P(1L) = 4(0.0821 \text{ L·atm/mol·K})(100K) \] \[ P = 32.8 \text{ atm} \]
F: \[ P(1L) = 2(0.0821 \text{ L·atm/mol·K})(300K) \] \[ P = 49.3 \text{ atm} \]