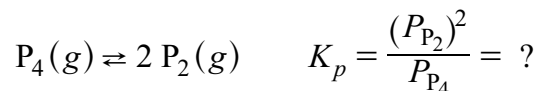
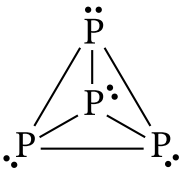


Question 4

4. White phosphorus, $\text{P}_4(g)$, can decompose into $\text{P}_2(g)$ at elevated temperatures. A balanced chemical equation, K_p expression, and Lewis diagrams for the chemical species involved in the reaction are given.



Compound	P_4	P_2
Lewis diagram		$:\text{P} \equiv \text{P}:$

Part A

The average bond length in P_4 molecules is 221 pm, whereas the average bond length in P_2 molecules is 189 pm. **Explain** why the average bond length in P_4 is greater than the average bond length in P_2 .

Part B

A sample of $\text{P}_4(s)$ is placed in a sealed rigid container and heated to 1600. K, at which point the initial partial pressure of $\text{P}_4(g)$ is 0.470 atm. Some of the $\text{P}_4(g)$ decomposes into $\text{P}_2(g)$ as the system reaches equilibrium. At equilibrium, the partial pressure of $\text{P}_2(g)$ is determined to be 0.630 atm.

Calculate the value of the equilibrium constant, K_p , for the reaction at 1600. K. Show the work that leads to your answer.

Part C

The reaction is thermodynamically favorable under standard conditions only at temperatures above 1500 K. A student claims that the reaction must be endothermic because it is favorable only at high temperatures. Do you agree or disagree? **Justify** your answer using $\Delta S_{\text{rxn}}^\circ$ and $\Delta G_{\text{rxn}}^\circ$.