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11. Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is: $\left(\gamma = \frac{C_P}{C_V}\right)$

(1) $\frac{3\gamma + 5}{6}$ (2) $\frac{3\gamma - 5}{6}$ (3) $\frac{\gamma + 1}{2}$ (4) $\frac{\gamma - 1}{2}$

Answer:

We know that average time between collision $t = \frac{Mean\ free\ path(\lambda)}{Average\ speed\ (V_{rms})}$ $or\ t = \frac{\frac{1}{\frac{\pi d^2 N}{V}}}{\sqrt{\frac{3RT}{M}}}$ $or\ t = \frac{\sqrt{M}V}{\sqrt{3R}\pi d^2 N\sqrt{T}}$ $or\ t = \frac{CV}{\sqrt{T}}\ where\ C = \frac{\sqrt{M}}{\sqrt{3R}\pi d^2 N}$ $or\ \sqrt{T} = \frac{CV}{t}$ $or\ T \propto \frac{V^2}{t^2} \rightarrow (1)$	$we\ know\ that\ in\ adiabatic\ condition$ $TV^{\gamma-1} = constant \rightarrow (2)$ From equation (1) and (2) we get $or\ \frac{V^2}{t^2}V^{\gamma-1} = constant = C_1$ $or\ V^{\gamma-1+2} = C_1 t^2$ $or\ t \propto V^{\frac{\gamma+1}{2}}, given\ t \propto V^q\ therefore\ q = \frac{\gamma+1}{2}$ **Therefore correct option is (3)** $\frac{\gamma+1}{2}$