1 Adiabatic Compression

A diesel engine requires no spark plug. Rather, the air in the cylinder is compressed so highly that the fuel ignites spontaneously when sprayed into the cylinder.

In this problem, you may treat air as an ideal gas, which satisfies the equation $pV = Nk_BT$. You may also use the property of an ideal gas that the internal energy depends only on the temperature T, i.e. the internal energy does not change for an isothermal process. For air at the relevant range of temperatures the heat capacity at fixed volume is given by $C_V = \frac{5}{2}Nk_B$, which means the internal energy is given by $U = \frac{5}{2}Nk_BT$.

Note: Looking up the formula in a textbook is *not* considered a solution at this level. Use only the equations given, fundamental laws of physics, and results you might have already derived from the same set of equations in other homework questions.

(a) If the air is initially at room temperature (taken as 20^oC) and is then compressed adiabatically to $\frac{1}{15}$ of the original volume, what final temperature is attained (before fuel injection)?

(b) By what factor does the pressure increase (before fuel injection)?