Problem 3

"Find the mean energy, the mean square energy and the mean square fluctuation of the kinetic energy of an atom."

So, we are looking for the mean energy $\bar{\varepsilon}$, the mean square energy $\overline{\varepsilon^2}$ and then $\overline{(\Delta\varepsilon)^2}$ for fluctuations.
All of these can be obtained from problem 4.

For the mean energy $\bar{\varepsilon} = \frac{1}{2} m \overline{v^2}$ we computed $\overline{v^2}$ in problem 2 with $n=2, r=1 \Rightarrow \bar{\varepsilon} = \frac{1}{2} m \frac{3T}{m} = \boxed{\frac{3T}{2}}$. The mean square energy $\overline{\varepsilon^2}$, we need $\overline{v^4}$ since $\overline{\varepsilon^2} = \frac{1}{4} m^2 \overline{v^4}$, and this is $\overline{v^4} = \left(\frac{T}{m}\right)^2 (2\cdot 2+1)!! = \frac{T^2}{m^2} 5!! = \frac{15T^2}{m^2}$ which yields:

$$\overline{\varepsilon^2} = \frac{1}{4} m^2 \overline{v^4} = \frac{1}{4} m^2 \cdot \frac{15T^2}{m^2} = \boxed{\frac{15T^2}{4}}$$

For the fluctuations $\overline{(\Delta\varepsilon)^2}$:

$$\overline{(\Delta\varepsilon)^2} = \overline{\varepsilon^2} - \bar{\varepsilon}^2 = \frac{15T^2}{4} - \left(\frac{3T}{2}\right)^2 = \boxed{\frac{3T^2}{2}}$$

(These results follow from problem 1 just by plugging in the correct "n".)