Let the magnetic field be directed along the z-axis. Then, when the magnetic field is being changed $v_z = Const.$ (because $t \gg \tau$). The change of the magnetic field changes the $x-y$-directional component. In the $x-y$ plane, an electron with speed v_{xy} has a radius of $R = \frac{mv_{xy}}{eB}$. The force acting on the electron due to changing magnetic field can be expressed using the change of flux through the circular orbit of the electron. Then

$$F = -eE = -e\frac{\varepsilon}{2\pi R} = \frac{e}{2\pi R}\frac{\mathrm{d}\Phi}{\mathrm{d}t} = \frac{e}{2\pi R}\frac{\pi R^2 \mathrm{d}B}{\mathrm{d}t} = \frac{eR}{2}\frac{\mathrm{d}B}{\mathrm{d}t} = \frac{mv_{xy}}{2B}\frac{\mathrm{d}B}{\mathrm{d}t}$$

$$m\frac{\mathrm{d}v_{xy}}{\mathrm{d}t} = \frac{mv_{xy}}{2B}\frac{\mathrm{d}B}{\mathrm{d}t}$$

$$\frac{\mathrm{d}v_{xy}}{v_{xy}} = \frac{1}{2}\frac{\mathrm{d}B}{B}$$

$$\mathrm{d}(\ln v_{xy}) = \frac{1}{2}\mathrm{d}(\ln B)$$

Thus

$$\frac{v_{xy}^2}{B} = Const.$$

The change of velocity after changing the magnetic field from $B = B_0$ to $B = 2B_0$ is

$$\frac{v_{xy}'^2}{2B_0} = \frac{v_{xy}^2}{B_0}$$

$$v_{xy}' = \sqrt{2}v_{xy}$$

Similarly, the change of velocity by changing the magnetic field from $B = 2B_0$ to $B = B_0$ is $v_{xy}' = \frac{1}{\sqrt{2}}v_{xy}$. Initially, let the average speed of electrons be $v_{\text{tot0}} = v_0$. Then $v_{\text{tot0}} = (v_z, v_{xy}) = \left(\frac{1}{\sqrt{3}}v_0, \sqrt{\frac{2}{3}}v_0\right)$. After changing the magnetic field from $B = B_0$ to $B = 2B_0$, the new velocity is $v_{\text{tot1}} = (v_z, v_{xy}) = \left(\frac{1}{\sqrt{3}}v_0, \frac{2}{\sqrt{3}}v_0\right) = \sqrt{\frac{5}{3}}v_0$. After time $\mathcal{T}$, the z- and $x-y$-directional velocities have stabilized and the velocity is $v_{\text{tot2}} = (v_z, v_{xy}) = \left(\sqrt{\frac{5}{9}}v_0, \sqrt{\frac{10}{9}v_0}\right) = \sqrt{\frac{5}{3}}v_0$. Finally, after decreasing the magnetic field from $B = 2B_0$ to $B = B_0$, the total velocity becomes $v_{\text{tot3}} = (v_z, v_{xy}) = \left(\sqrt{\frac{5}{9}}v_0, \sqrt{\frac{5}{9}v_0}\right) = \sqrt{\frac{10}{9}}v_0$. Since $T \propto v_{\text{tot}}^2$, the final temperature is $T' = \frac{10}{9}T$