Social Studies Connection

In 1850, and over the next fifteen years, a German physicist Rudolf Clausius began to use the mechanical equivalent of heat as a base of his *Mechanical Theory of Heat*, which is considered a respected theory of modern thermodynamics. In his first article "On the Motive Power of Heat and on the Laws which can be Deduced from it for the Theory of Heat", Clausius had started by citing the mechanical equivalent of heat resulting of Holtzmann, Mayer, and Joule, but then applied its logic to the heat-generating working action of the "working body" and the most likely changes that resulted in the condition of the working body in a Carnot cycle. In this direction, by 1854 Clausius had created what he called the *Theorem of the Equivalence of Heat and Work* as such: “Mechanical work may be transformed into heat, and conversely heat into work, the magnitude of the one being always proportional to that of the other.” This logic was then molded, through a number of arguments, into both the *Conservation of Energy* and the *Equivalence-Value of all Uncompensated Transformations*, or what are most commonly known as the first and second laws of thermodynamics, respectively. In 1856, a French physicist by the name of Gustave-Adolphe Hirn conducted experiments trying to determine the mechanical equivalent of heat of a human being in working action. In particular, Hirn calculated a value for the mechanical equivalent of heat for a man doing work, for example, running on a paddle-wheel like stair-climber treadmill, in a sealed chamber. To achieve this end, a man was placed in a completely closed chamber, and made to turn a wheel which could, at his choice, revolve with or without doing work. The heat given out in the chamber was then determined by the ordinary calorimetric process. From these experiments, Hirn deduced an evaluation of the mechanical equivalent of heat for animated motors; but the number which he obtained differed considerably from the standard obtained by Joule via physico-mechanical methods. In 1912, German physical chemist Otto Sackur, in his *Thermochemistry and Thermodynamics* (chapter three), gives a fairly good history and derivation of the mechanical equivalent of heat and its various calculations.