

## 23.5: Specific Heat

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How can we compute the specific heat of a collection of harmonic oscillators? Starting from the temperature of a brick, as given by equation (23.21), we solve for the brick's internal energy:

$$E = Nk_B T \quad (\text{internal energy of } N \text{ oscillators}). \quad (23.5.1)$$

Recall that the specific heat is the heat required per unit mass to increase the temperature of the brick by one degree. For a solid body, essentially all the heat added to the body goes into increasing its internal energy. Thus, if the mass of the brick is  $M = Nm$  where  $m$  is the mass per oscillator, then the predicted specific heat of the brick is

$$C \equiv \frac{1}{M} \frac{dQ}{dT} \approx \frac{1}{M} \frac{dE}{dT} = \frac{k_B}{m} \quad (\text{specific heat of harmonic oscillators}). \quad (23.5.2)$$

This formula is in reasonable agreement with measurements when the temperature is high enough so that all the harmonic oscillators are in excited states, i. e., with  $r > 1$ . (We equate  $dQ = dE$  using the first law of thermodynamics, since no work is being done by the brick.)

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