5.1 Consider a particle that can be in only three states, with energies –0.05, 0, and 0.05 eV. This particle is in equilibrium with a reservoir at 300 K.

(a) Calculate the partition function for this particle.

(b) Calculate the probability for this particle to be in each state.

(c) Since the zero point for measuring energies is arbitrary, one can assign the three states as 0, +0.05, and +0.10 eV instead. Repeat (a) and (b).

5.2 Consider a property *E*, which may be energy, entropy…etc. The deviation of the property of a microstate *i* from its average is defined as $\Delta E_i = E_i - < E >$. The root-mean-square (rms) deviation, or standard deviation, σ_E, is defined as

$\sigma_E{}^2 =< \Delta E_i^2 >$.

(a) Show that $\sigma_E{}^2 =< E^2 > - < E >^2$.

(b) If the property is *U*, prove that $< U^2 >= \frac{1}{Q}\frac{\partial^2 Q}{\partial \beta^2}$.

(c) The heat capacity is defined as $C \equiv \partial < U > / \partial T$. Show that $\sigma_U = kT\sqrt{C/k}$.