1. The conversion of pyruvate to acetaldehyde follows the reaction

\[
\text{pyruvate} \xleftrightarrow{k_1, k_{-1}} \text{acetaldehyde + CO}_2
\]

A plot of the energy of the system as a function of progress of the reaction looks like

a) If the activation energy barrier for the forward rate constant is 80 kJ/mol at T = 300 K, will the forward rate constant increase or decrease, and by what percent, if T = 310 K?

b) The equilibrium constant for this reaction at T = 300 K is 2,800. What is the activation energy barrier for the reverse rate constant at this temperature? (Hint: What is ΔG for the net reaction?)
2. Suppose you are studying a system that has five energy levels available to particles as shown at left. Each energy level is higher in energy than the previous by an amount \( e \), and the first energy level has energy \( e \).

a) If the average energy of two particles is \( 3e \), what is the most probable distribution of single particle energies?

b) How many ways can the two-particle system from part a) exist at an average energy of \( 3e \)?

c) What is the entropy of the 2-particle system when its average energy is \( 3e \)?

d) What is the entropy of a 3-particle system when its average energy is \( 3e \)?