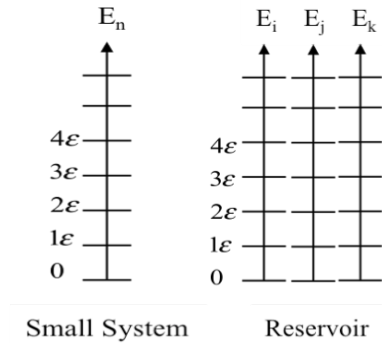


1. Consider a small system containing one oscillator that is brought into thermal contact with a larger system (“Reservoir”) consisting of three oscillators:

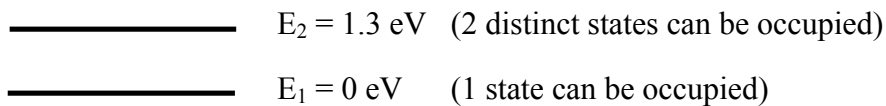


The total energy of the system  $U \equiv E_n + E_i + E_j + E_k = 5\epsilon$ .

a) [5 points] What is the probability to find the *small system* with **1ε** of energy?

b) [5 points] What is the total entropy  $S$  given this energy for the small system?

2) Consider a molecule that has 2 energy levels as shown below:



In this particular molecule, the *excited state* is “doubly-degenerate” (i.e. there are two distinguishable states with energy  $E_2$ , each of which can be occupied)

a) [5 points] What fraction of the molecules will have energy  $E_2$  when  $T = 4800 \text{ K}$ ?

b) [5 points] What is the entropy  $S$  of an ensemble of *1 billion* of such molecules at very high temperatures (i.e. as  $T \rightarrow \text{infinity}$ ) assuming each molecule is distinguishable?