Statistical Physics B

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1. **Exercise 1:** (Exercise 4.1 Pathria) Show that in every ensemble we can express entropy as:

$$S = -k \sum_{r,s} P_{r,s} \log P_{r,s} \quad ,$$

   where $P_{r,s}$ is a probability of being in a microstate denoted by variables r and s.

2. **Exercise 2:** (Exercise 4.2 Pathria) Explain why in thermodynimc limit the q-potential can be evaluated by:

$$q \approx \log\left(e^{\mu\beta N^*} \sum_s e^{-\beta E_s} \right)$$

   Hint: *In thermodynamic limit $q = \frac{pV}{kt}$ shoud be a quantity which is the same as in a canonical ensemble.*

3. **Exercise 3:** (Exercise 4.5 Pathria and expression 4.3.20) Using the fact that

$$S = \frac{U - N\mu + pV}{T} = \frac{U - A}{T}$$

   show that:

$$S = kT \left(\frac{\partial q}{\partial T}\right)_{z,V} - Nk \log z + kq = k\Big(\frac{\partial}{\partial T} Tq\Big)_{V,\mu}$$

4. **Exercise 4:** (Exercise 4.3 Pathria)

5. **Exercise 5:** (Exercise 4.4 Pathria)