

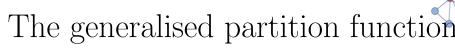


• How is the average energy,  $\langle E \rangle$ , calculated from the probabilities of being in the various microstates  $P_i$  and the energies of the various microstates  $P_i$ 

• Explain what two types of constraints are introduced on extensive thermodynamic variables when constructing thermodynamic states from the various microstates in phase space.

• Complete the following sentence: We can determine the probability of being in any given microstate by...

• Write down the function for which we are finding the constrained minimum and the two constraints on this function





• Write down the extended function whose unconstrained optimum is found in order to find the required constrained optimum.

• Write down the partial derivative of the function you have just written down with respect to  $P_j$ .

• Explain why the derivative of  $f = \sum_i P_i$  with respect to  $P_j$  is equal to one.

• Give an expression for the derivative of  $g = \sum_i \lambda B_i P_i$  with respect to  $P_j$ .

The generalised partition function



• Give an expression for the derivative of  $h = \sum_i P_i \ln P_i$  with respect to  $P_j$ .

• Explain (by making reference to the results that you have written down to the previous questions) why the probability of being in a microstate is given by:  $P_j = \frac{e^{-\sum_k \lambda_k B_j^{(k)}}}{e^{\Psi}}$ 

• Give an expression for the generalised partition function and explain how this is derived.