

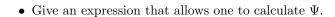
• Explain in your own words what the difference is between the extensive variables that I have labelled  $\alpha^{(j)}$  and the variables I have labelled  $B^{(k)}$  in the video.

• What derivative we trying to work out in this video? Use the space below to explain why and any details you think are relevant.

• Given that  $\frac{S}{k_B} = \Psi + \sum_k \lambda_k \langle B^{(k)} \rangle$  write an expression for the derivative that we would like to calculate.

• Explain in your own words why:  $\frac{\partial\Phi}{\partial\alpha^{(j)}}\mathrm{d}\alpha^{(j)}=\mathrm{d}\Phi$ 





 $\bullet$  Hence, give an expression for the derivative  $\frac{\partial \Psi}{\partial \alpha^{(j)}}$ 

• What is  $\frac{e^{-\sum_k \lambda_k B_i^{(k)}}}{e^{\Psi}}$  equal to?

• Use this result to explain in your own words why:  $\frac{\partial \Psi}{\partial \alpha^{(j)}} = -\sum_k \frac{\partial \lambda_k}{\partial \alpha^{(j)}} \langle B^{(k)} \rangle - \sum_k \lambda_k \left\langle \frac{\partial B^{(k)}}{\partial \alpha^{(j)}} \right\rangle$ 

## Entropy changes in statistical mechanics mathematics

• Give the final result for the change in infinitesimal change in entropy that accompanies an infinitesimal change in the fixed extensive thermodynamic variable  $\alpha^{(j)}$