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A joined up approach to  
• teaching and learning  
mathematics

# Entropy changes in statistical mechanics

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- 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:  $\frac{\partial \Phi}{\partial \alpha^{(j)}} d\alpha^{(j)} = d\Phi$



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- Give an expression that allows one to calculate  $\Psi$ .

- 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:  $\frac{\partial \Psi}{\partial \alpha^{(j)}} = -\sum_k \frac{\partial \lambda_k}{\partial \alpha^{(j)}} \langle B^{(k)} \rangle - \sum_k \lambda_k \left\langle \frac{\partial B^{(k)}}{\partial \alpha^{(j)}} \right\rangle$



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