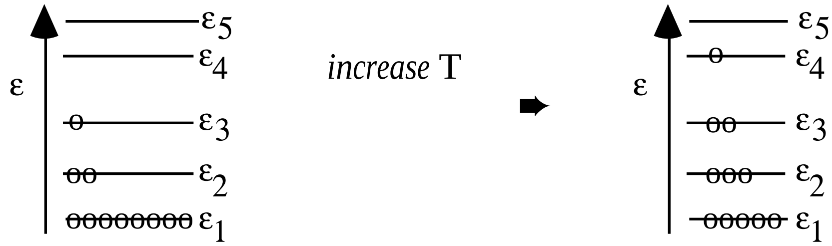
Internal Energy and q



$$U\text{-}U(0) = \frac{\sum n_i E_i}{\sum n_i}$$

$$U - U(0) = -\frac{1}{Q}\left(\frac{\partial Q}{\partial ß}\right)_V \qquad Q = \frac{q^N}{N!}$$

$$\left(\frac{\partial Q}{\partial ß}\right)_V = \frac{1}{N!}\left(\frac{\partial q^N}{\partial ß}\right) = \frac{N\, q^{N-1}}{N!}\left(\frac{\partial q}{\partial ß}\right)$$

$$U - U(0) = \frac{-N}{q}\left(\frac{\partial q}{\partial ß}\right)_V$$

$$\text{since } \left(\frac{\partial \ln q}{\partial ß}\right)_V = \frac{1}{q}\left(\frac{\partial q}{\partial ß}\right)_V$$

$$U - U(0) = -N\left(\frac{\partial \ln q}{\partial ß}\right)_V \qquad U - U(0) = -\left(\frac{\partial \ln Q}{\partial ß}\right)_V$$

$$U - U(0) = \frac{-N}{q}\left(\frac{\partial q}{\partial T}\right)_V \frac{\partial T}{\partial ß}$$

$$\frac{\partial ß}{\partial T} = \frac{\partial\left(\frac{1}{kT}\right)}{\partial T} = -\frac{1}{kT^2} \qquad \frac{\partial T}{\partial ß} = -kT^2$$

$$U - U(0) = \frac{NkT^2}{q}\left(\frac{\partial q}{\partial T}\right)_V \qquad U - U(0) = \frac{kT^2}{Q}\left(\frac{\partial Q}{\partial T}\right)_V$$

$$U - U(0) = \frac{nRT^2}{q}\left(\frac{\partial q}{\partial T}\right)_V \qquad Nk = nR$$

$$U - U(0) = NkT^2\left(\frac{\partial \ln q}{\partial T}\right)_V \qquad U - U(0) = kT^2\left(\frac{\partial \ln Q}{\partial T}\right)_V$$